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Contents

About the Book

Dear Students

Our purpose in developing and distributing this Book is twofold: It is essentially to assist you all – post-SEE students – preparing for +2 Entrance Exams to gain entry to colleges of your choice. Further, and importantly, the Book may also help you in getting scholarships whether in different college Entrance Exams or NEB Scholarships Tests.

The Book is a mine of knowledge! It refreshes students about preliminary concepts relating to the higher secondary level of education in Nepal. The essentials of English, Mathematics, and Science as subjects have been covered simply and clearly. There are ample, wide-ranging questions and fine explanations. Many of the questions given relate to current or latest trends alongside the set, continuing patterns in competitive colleges or SS in the country.

The Book also has guidelines about fostering scholastic abilities especially managing time. Study skills too have been dealt with suitably. Advice and suggestions about preparing for Entrance Exams are included. There are excellent Entrance Exam Tips especially for tackling MCQs. Significantly, there are 5 full Practice Tests with answers that will prove very useful for competing students.

We'd like to thank the contributors!

Wishing you all **GREAT SUCCESS** in the forthcoming +2 Entrance Exams!

KIST College & SS

April 2018

Disclaimer

The Book provides guidelines, common steps or tips, and study & practice materials. It is not a complete solution package for all +2 entrance exams. We suggest students to study relevant textbooks and consult reference materials for entrance preparation.

Guidelines

Getting Ready

As a student, you ought to be rather serious about studying all the needed course material. Try to understand, not merely to memorize, the likely subject content. Pick up good test-taking tips about solving MCQs – Multiple Choice Questions. Remember, subject knowledge and tips, not tricks, are what give you an extra edge in the entrance examinations.

Starting Off

When doing any Entrance Test, keep these tips in mind:

- Answer each question after reading it most carefully.
- Pay attention to detail.
- Think critically to understand what's being tested.
- Do the easy questions first.
- Answer questions you find hard at the end.
- Do not spend too much time on any one question.
- Do not keep changing your answer.
- Use the process of elimination to reach the correct choice.
- Feel free to make intelligent guesses if you are still unsure.
- Answer all questions where marks are not deducted for wrong answers.
- Use the remaining time at your disposal for revision.

Fostering Scholastic Abilities

Students need to acquire the right academic abilities to take on the challenges of higher modern education and to do well in their studies. Such abilities are an admixture of skills, habits, qualities, and attitudes that are inculcated or their aptitude that is inborn. Personality traits like calmness play a huge role in any student's success, especially in entrance exams. The right psychological temperament along with the needed abilities can largely be fostered through proven strategies:

Managing Time

Time saved is time gained provided it is managed well. This limited pre-Entrance Exam period is critical and your management of time will be the key to your success in getting into the college of your choice.

Routine

A daily routine assists you to study and to lead your life most gainfully.

- Write out how exactly you'd spend the day after you get up.
- Set your priorities.
    - Give yourself ample time to study.
    - Allot adequate time for exercise.
    - Sleep fully.
- Reduce socializing, watching TV, or entertainment.
- Once you've planned how to use your hours, you'll be better organized.
- Display your routine so that you can glimpse at it during the day.
- Regularly check if you're following the routine you've set for yourself.
- Self-disciplined, you'll gain control over your time, output, and life.

To Do Lists

To do lists are reminders made daily mentioning what needs to be done. They are necessary tools for self-management. Pay attention to the following guidelines while preparing them

- Plan 2, or at the most 3, things to do on a particular day.
- Prioritize things planned to be done.
- If practicable, do 1 thing at a time.
- Find time for doing these important things.
- See your To Do list time and again.
- Don't waste time on unimportant things.
- Don't postpone action planned.
- Try your best to complete targets set.

Reminders

It is a good idea to make reminders about important things to be done during the day, the week, or the month and display them prominently in your room.

- Put up reminders about assignments that need to be completed.
- Put up reminders about your academic targets.
- Put up reminders about approaching tests or exams.

Study-Time Tips

Being organized saves time. Planned action help you become productive academically and achieve goals set:

- Make study lists containing only 2 or 3 tasks per day.
- Fix realistic study-related deadlines
- Allot blocks of study-time with short breaks.
- Review your study output daily/weekly.

Nurturing Study Habits

Fine study habits bring good results. The key to academic success is hard work combined with studying well. To study well you need to be physically fit and mentally calm, concentrated, and committed in a congenial environment. If you do so, you'd soon acquire the right study habits.

Health

- Health – Keep healthy! Exercise regularly; eat properly and sleep fully.
- Keep snacks and fresh water to refresh yourself.

Mindset

- Approach – a positive mindset greatly matters.
- Responsibility – Be decisive and act responsibly as you face challenges. Exercise self-control.
- Creativity – Look for better solutions to problems. Think outside the box too!
- Hope – Be optimistic yet have expectations that are reasonable.
- Be realistic – Set achievable goals!
- Life Balance – Poise, self-control, and harmony make your life easier.

Workplace

- An ideal study place without distractions is excellent for your mood.
- Workplace – A computer, textbooks, study materials, and stationery should be available in your well-equipped and organized workstation.

Course of Action

- Schedule – Studying on a regular basis prepares you better.
- Note-taking – Outline/rewrite notes to organize them for quick retrieval.
- Digitalization of your study materials is recommended if feasible.
- Learning – Do whatever helps you to learn subject-matter thoroughly.
- Mnemonics – Use memory techniques to remember subject matter.
- Practice – There is no substitute to plenty of regular practice.
- Difficulty – Tackling hard topics first makes your preparation easy.

Acquiring Academic Skills

Academic Skills are all about helping you to learn how to be a more effective learner and develop the power to do well in all kinds of exams.

Skills

Academic skills comprise identifiable abilities like:

- Reading effectively
  - Surveying, skimming, and scanning text
  - Surfing the Internet
- Understanding text
  - Identifying ideas or facts
  - Finding word meanings
- Organizing the material learned
  - Note-taking and memorizing
  - Filing data digitally
- Assimilating knowledge
  - Recalling what has been learned
  - Revising exam-related topics
- Practising questions or tests
  - Going through varied questions
  - Doing practice tests
- Reinforcing scholastic mastery
  - Checking answers
  - Reading explanations
- Evaluating learning
  - Requesting feedback
  - Assessing strengths & weaknesses

Plan of Action

The academic Plan of Action while doing your exams suggests that you should:

- Avoid anxiety or panic so as to be able to think clearly.
- Concentrate on the work at hand whatever the situation.
- Go through what's in front of you.
- Quickly survey every page of the exam paper.
- Read the instructions carefully.
- See what's exactly expected of you.
- Re-read the instructions.
- Prioritise what needs to be done.
- Use your time according to the importance/difficulty of the questions.
- Focus on writing something rather than leaving the answer sheet blank.
- Answer the easiest questions first to guarantee satisfactory marks.
- Answer questions without wasting time.

- Pace yourself yet do not rush through the exam.
- Keep an eye on your watch.
- Regularly check time left for the questions not done.
- Do not leave early.
- Use all the time allowed.
- Revise all your answers time permitting.
- Ask the invigilator for permissible assistance.

Avoiding Stress

Stress has become an integral aspect of modern lifestyles. Eliminating or reducing stress among youngsters is largely possible and desirable.

Types of Stress

Generally, there are three types of stress found among all students:

- General anxiety that affects all humans, young or old.
- Study-stress is normal among almost all students nearly everywhere.
- Exam fear or test anxiety that often ruins performance.

Handling Stress

On the whole, the right personality traits and attitude, study habits, academic skills, and time management greatly reduce stress. These tips are useful:

- Sleep fully – Youngsters usually need 7-8 hours of sleep every night.
- Eat well – Nourishing and fresh food makes you active and happy.
- Exercise regularly – Bodily exertion releases stress wonderfully.
- Stay clean – A daily bath and clean clothes keep you fresh and liked.
- Be conscientious – Carry out your duties and responsibilities.
- Work hard – Attend to your assignments and you'll have no worries.
- Prioritize tasks – Work first on urgent or important things.
- Simplify work – Break down tasks into manageable chunks.
- Prepare well – Thorough preparation makes you confident and upbeat.
- Relax often – Deep breathing, light exercise, or a change of activity.
- Be firm – Say *NO* to anything that holds back your exam preparation.
- Get support – Develop a strong team rather than feel isolated.
- Be positive – Focus constructively on the present.
- Be vigilant – Keep your future goals in mind as you work.
- Remain calm – Face failure, pressure, or competition with composure.
- Be realistic – Do your best without seeking perfection or overworking.
- Control stress – Take professional help to manage *excessive* stress.

Preparing for Entrance Exams

Getting Acquainted

Get to know all about these Entrance Exams.

Follow these steps:

- The +2 Entrance Exams for courses in Science, Management, and Humanities of most of the good colleges in Kathmandu valley vary in their structure, duration, and content. Their length is normally limited to 100 Multiple Choice Questions – MCQs – though the time allotted could be from 75 to 120 minutes. The coverage of topic areas in different subjects may vary from college to college. *Significantly, a mastery of MCQs is the key to success!*
- As a rule, such exams, including the NEB scholarship tests for students from either private or community schools, are held ONLY after the publication of the SEE results. The venues of the tests are selected by the respective institutions.
- Students are advised to be absolutely clear about which +2 course they would like to do depending on their area of interest or need.
- Students should carefully consider the options available to them in terms of the colleges they would like to or could join.

Preparing Yourself

Entrance tests need solid and timely preparation. So, remember these steps:

- Start preparing early instead of waiting till the last few days.
- Give time to master the subject matter and question types.
- Work regularly, systematically, and hard.
- Collect sample entrance test papers provided by different colleges.
- See past question papers of the colleges you are interested to join.
- Be clear about the format and content of the exams.
- Consult relevant textbooks and reference material.
- Concentrate upon learning how to answer **MCQs** effectively.

Doing Your Best

To prepare for a multiple choice exam, consider the following steps:

- Begin studying as early as feasible alone or in a group.
- Multiple choice exams with MCQs tend to focus on memorizing details.
- Learn a little bit each day and allow plenty of time for repeated reviews.
- Pay particular attention to fundamental terms and concepts.
- Study your class notes and assigned readings
- Make further notes and lists or tables.
- Brainstorm possible questions with other students doing these exams.
- Practice on sample or likely questions.
- Study carefully & systematically before the actual exams.

During the Exams

Keep in mind these steps for *all* exams:

- Pacing is what matters.
- Survey the entire test or exam quickly.
- Answer the questions you find easy.
- Do the questions you have left out.
- Finish in time.

Acing the Practice Tests

The following steps will help in doing the Practice Tests in this Book properly:

- Enter all the required information – name/ID number – on the answer sheet.
- Read the directions carefully.
- Jot down important formulas and mnemonics you might forget.
- Survey the test.
- Note whether some sections are worth more points than others.
- Plan using your time accordingly.
- Skip questions that take long to answer and come back to them later.
- Use process of elimination to eliminate wrong choices.
- Guessing is useful when you exhaust all other strategies.
- Utilize hints from questions you know to answer dissimilar MCQs.
- Remember that you are looking for the best answer.
- Note that *the* answer is always there in the choices.
- Change your answer only when you have a concrete reason.
- Keep in mind that often first choices turn out to be right.
- Remember positive choices are more likely to be true than negative ones.
- Remember correct answers are often choices with the most information.
- Fill the right bubbles or boxes for choices carefully on the answer sheet.
- Use the remaining time to check careless errors or double-check answers.
- Ensure you answer every MCQ to the best of your knowledge.
- Ascertain the reasons for errors you make in our **5 Practice Tests**.

Tackling MCQs

Overview

MCQs can prove difficult. So, students need to be

- Familiar with a broad range & depth of subject material
- Familiar with details like dates, names, or vocabulary items
- Prepared systematically & fully through focused practice

Tips

MCQs are best handled through the following strategies & tactics or **tips**:

The MCQ as a Whole

MCQs have a **stem** asking a student to recognize the right or correct answer, the **key**, among a set of typically 4 options, called the responses or **choices** that include 3 wrong or incorrect answers called **distractors**. *Because of distractors, MCQs aren't easy*. Consequently, students often end up choosing the wrong answers especially in exams. To be able to answer this type of question asked in + 2 Entrance Exams, it is necessary to:

- Know the **components** of MCQs.
- Think of MCQs as a series of true or false statements.
- Read each MCQ component most carefully.

MCQ Components

The MCQ comprises the

- **Stem**, i.e. essentially the question part that needs to be answered.
- **Choices** (4), i.e. responses or options, which contain
  - **Distractors**, the wrong answers (3)
  - **Key**, the right answer (1)

*In short, the MCQ contains the right answer, i.e. the **key**, within its textual framework. You don't need to look beyond the choices given!*

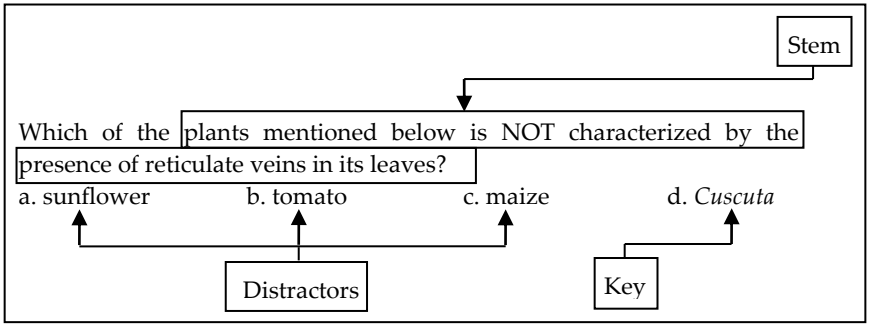


Figure: Sample MCQ – Components

Procedure

MCQs are done best keeping in mind the following tips:

- Turn the MCQ stem into a question form if it is a statement.
- Combine the MCQ stem with each choice for clear understanding.
- Read the MCQ stem and choices independently if both aren't clear.
- Always *cover* the choices while you read the MCQ stem.
- Anticipate the correct choice before you actually read all the choices.
- Eliminate choices that seem wrong to avoid choosing any distractor.
- Mark the correct choice and ascertain that no other is better.
- Consider other strategies if you see unexpected MCQ stems or choices.

Understanding the Stem

The MCQ stem has vital content. It often focuses on details hence your knowledge of a particular subject area. These tips are useful:

- Look for basic concepts and terminology in the stem.
- See if the stem describes subject-related events and features.
- Check if the stem joins related ideas or facts in the choices.
- Pay attention to any multi-step processes.
- Spot ideas, events, or objects that form sequences or groupings.
- Look for similarities and differences to eliminate distractors.
- Try to anticipate what the key might be for a particular MCQ stem.
- Paraphrase the MCQ stem.
- Notice words in the stem relating to those in the choices.
- Think carefully about stem content in all MCQ s – easy, medium, or hard.
- Choose finally only after using these test tips.

Understanding the Choices

The following tips will help you with the choices:

- Be careful about challenging, analytical MCQ choices.
- Remember the wording of MCQ choices may differ from known patterns.
- Look for semantic clues pointing to the right answer, the key.
- Look for context clues – *All of the Above* is a positive indicator of the key.
- Avoid double negatives as they relate to distractors.
- Look for grammatical clues in the MCQ stem linking it to the key.
- Look for verbal associations like key words both in the stem & key.
- Pay attention to textual length – the longest choice may be the key.

Getting Rid of Distractors

Follow these tips about distractors that are wrong answers and can be classified by their levels of difficulty – easy, medium, or hard.

All distractors – easy, medium, or hard – must be detected and eliminated:

- Read all the choices & consider them carefully.
- Keep an open mind and don't dismiss any choice as such.
- Be cautious when MCQ stems contain *not*, *except*, or *false*.
- Look for a true, not false, statement.
- Similar choices are probably correct for *All of the Above/Both _ and _*.
- Notice paired choices – the key may be one of these options.
- Look for grammatical inconsistency between the MCQ stem and choices.
- Read the MCQ stem along with each choice to see if the two *fit*.
- Make the best selection by the process of elimination.
- Eliminate completely or partly false, impossible, or generalized choices.

Hard distractors, in particular, require careful consideration. Keep in mind:

- When 2 or even 3 choices seem correct, *All of the above* is a strong possibility.
- Choices that mean the same thing, mostly cancel each other out.
- When two alternatives seem correct, compare the choices for differences.
- Refer to the MCQ stem to decide upon the key.
- When 2 choices are opposites – *echo options* – one of them is often the key.
- Consider choices that contain qualifiers, or are long, or are more inclusive.
- Low-frequency or technical words are mostly incorrect answers.
- Extreme statements are normally false.

Finding the Key

Keys or the right answers *mostly* have common traits as shown by these tips:

- They are often long.
- They could contain qualifiers.
- They may have numbers – dates, years, and statistics.

Reviewing Our Steps & Tips

- Always remember to use these steps or tips where & when applicable.
- None of the given strategies and tactics, however, is *infallible*.
- Do not bank on techniques or to hunt for short-cuts or tricks.
- The best thing is improving your subject knowledge and practising hard.
- Do make use of our Book sensibly to your fullest advantage!

English

Reading Comprehension

Reading comprehension means understanding of a text in depth. A proper understanding of the text given requires a keen power of observation, a quick understanding of the central idea, an ability to detect error in logic, a quick reading habit, a sufficient stock of words and a little bit of imagination. Reading consists of three important stages: scanning (move quickly over the paragraphs), skimming (speed reading) and detailed reading.

You cannot enter into the spirit of the passage unless you read with concentrated attention following reading processes. Lackluster approach or casual reading won't be of much helping giving brief and pointed answers to the questions asked. The questions asked in any reading comprehension aim at testing your power of observation, ability to think about the passage and make logical response to it.

Method of comprehension:

- Notice the key words and see how the text is developed.
- Read with an open mind, with purposeful concentrated attention even if the topic is new, unfamiliar or not to your liking.
- Read all questions carefully and reread the passage bearing the questions in mind.
- Answer the questions methodically, one by one. If you are bogged by a particular question, don't waste your time over it. Switch over to the next question.
- Avoid verbosity and repetition but be precise and to the point.

Example I

On the 16 August, 1987 when I was told I had cancer of the lungs, my relatives and friends were alarmed at the apparent with which I received the news. I suppose they overlooked the fact that at my age (I turned 72 on January 26) you develop a practical acceptance which helps face the impact of even such shockers. Besides, the tendency to set a good example as head of a large family somehow grows on you. However, despite the outward bravado, deep inside I was jolted by the news. This was because, as far back as I can remember, my health had never given me cause for concern.

MCQs

1. The 'I' in this passage stands for:
   a. the nurse b. the patient c. the doctor d. an accident victim
2. The narrator in this passage suffers from:
   a. tuberculosis b. typhoid c. cancer of the lungs d. bone cancer
3. In terms of age, the patient is:

a. a young man b. a school-going kid
c. a middle-aged person d. an old man

4. On hearing of the disease that has struck him, the narrator feels:
   a. relieved b. anxious c. indifferent d. shocked
5. Before the disease struck him, the narrator's health had always been:
   a. good b. poor c. indifferent d. full of problems

Example II:

Diamond value is based on four characteristics: carat, color, clarity, and cut. A diamond's size is measured by carat weight. There are 100 points in a carat and 142 carats in an ounce. Each point above 1 carat is more valuable than each point below 1 carat. Thus, a stone that weighs more than 1 carat is more valuable per point than a stone that is smaller than 1 carat.

The scale used for rating a diamond's color begins with "D," which means the stone is *absolutely* colorless and therefore most valuable. "E" and "F" are almost colorless. All three are good for investments. A stone rated between "G" and "J" is good for jewelry. After that the stones take on a slightly yellowish color, which gets deeper as the grade declines.

The clarity of stone is determined by its lack of carbon spots, inner flaws, and surface blemishes. While most of these are invisible to the unaided eye, they do affect the diamond's brilliance. For jewelry, a diamond related VVSI (very very slight imperfections) is as close to *flawless* as one will find. After that the scale goes to VVS2, VS1, VS2 SI, SI2, I1, I2, and so on.

Final characteristic is cut. When shaped (round, oval, emerald, marquise, pear, or heart), the diamond should be faceted so that light is directed into the depth of the prism and then reflected outward again. A well-cut diamond will separate the light into different colors when the light is reflected. Only stones of similar shape should have their reflective qualities compared, as some shapes are more reflective than others. For example, the round shape is the most reflective.

MCQs

1. The passage is mainly about
   a) the cost of diamonds.
   b) qualities affecting diamond values.
   c) how to judge an expensive diamond.
   d) buying diamonds for jewelry.

2. What can be said about a 1-carat diamond?
   a) It has 100 points.

b) It weighs announce.
c) It costs twice as much as a smaller once.
d) It has the same quality as a half-carat diamond.

3. The word *absolutely* is closest in meaning to
   a. actually b. positively c. greatly d. completely
4. A stone that has no color at all is rated
   a. A b. Z c. D d. J
5. The word "*flawless*" is closest in meaning to
   a. unblemished b. unsaturated c. unrefined d. unburied
6. It can be inferred from the passage that a diamond which is perfect is:
   a. not used for jewelry. b. rated VVS1.
   c. very large. d. invisible to the unaided eye.

Example III:

Gavin is a successful freelance IT consultant- but he hasn't always been one. His original training was as an architect and he went on to practice that profession for several years, before losing his job in recession. Rather than look for another job within architecture, he decided to see if he could make a living from his favorite leisure occupation-computers. 'I never imagined I'd make such good earning,' he says.

And he's doing well- the quality of his work means that his phone is always ringing. 'Because I know both the software and the hardware side of computers, I can find out where problems are quickly.' It's often the case in consultancy that different specialists are only able to work on certain aspects.

Of course, there are disadvantages to the job. Scheduling can sometimes be a problem. If he's already busy, and then someone calls with an urgent problem, it can either mean letting them down, and so missing out on the payment, or having to work very late to get all the jobs done. People are often very irritated with their computers and the delays breakdowns cause them, but Gavin knows this anger isn't aimed at him.

Most of his clients are private individuals working from home. However, he also deals, for example, with families where the parents want to learn about the Internet in order to keep up with their children, and occasionally with small companies, although crowded offices are not necessarily enjoyable places to do his work in. He's lucky that the kind of client that accounts for most of his business is also the one he prefers to work with.

It's a strange truth that because he's effective in his work, he doesn't often need to be asked back to do more. But personal contact does help, in that clients are always recommending him to their friends and colleagues, and this of course saves the time and effort of advertising in newspapers or building a website.

Despite the stress he feels sometimes as he hurries from one side of the city to the other to keep appointments, he enjoys his work. 'When people suddenly realize what their

machine can do for them and how many boring task it can take away from them, that's brilliant. What that happens, it's all worth it.'

MCQs

1. Gavin chose IT as a profession because he:
   a. Hoped to earn a high income
   b. became bored with his previous job
   c. enjoyed using computers as a hobby
2. According to the second paragraph, he's effective in his job because he:
   a. Can always be contacted by phone
   b. has experience in different business
   c. has a wide range of computer skills
3. What problem does he often experience?
   a. Late payment
   b. calls at short notice
   c. angry clients
4. What's his favorite type of customer?
   a. Individuals
   b. families
   c. companies
5. Most of his business comes from:
   a. His website
   b. repeat orders
   c. word of mouth
6. What does he find most rewarding about his work?
   a. Seeing clients understand how computers can help them
   b. being able to manage his own time effectively
   c. learning to use new computer applications

Grammar

Causative Verbs

The causative verbs are used to indicate that one person causes a second person to do something for the first person. Have, get, make are the causative verbs. Though 'let' and 'help' are not actually causatives, they function as causatives.

General structures:

a. Get and have can be used without agent. In such case, the structures to be used are: i) Subject +has/ have/had + agent + infinitive and ii) subject + get/gets/got + agent + to- infinitive
   For e.g.: My sister had a maid work in the kitchen.

I got my friend to write an essay.

b. Get and have can be used with object. In such case, the structures to be used are: i) Subject + has/have had + object+ V3 and ii) Subject + get/gets/got + object + V3
For e.g.: I had my job done yesterday.
My dad got his letters typed.

c. Make is used to make someone do something. In such case , the structure to be used is: subject + make/makes/made + agent + infinitive.
For e.g.: John makes Julia wash his clothes.

MCQs

1. I got my uncle (mend) the pressure cooker.
   a. to mend b. mending c. mended d. mend
2. I had my mother (wash) the clothes.
   a. washing b. to wash c. wash d. to have washed
3. His remarks made Rosy (burst) into tears.
   a. bursting b. to burst c. burst d. bursted
4. I shall have my hair (wash).
   a. wash b. washed c. to wash d. washing
5. I pushed the car and it moved. I got the car (move).
   a. move b. moving c. moved d. to have moved

Voice

Voice is that form of verb which shows the relation of the subject of the verb to the action expressed by it. It shows whether the subject of the verb acts or is acted upon. The transitive verb has two voices: active and passive. In active voice, the doer of the action (agent) is the subject whereas in passive voice, the recipient of action (patient) is the subject. The active voice is used when the agent is to be made prominent; the passive voice is generally used when the agent is not known, is not important, or is not to be mentioned. The following points are to be taken note of while changing sentences from active to passive voice:

A. The object of the active sentence becomes the subject of the passive sentence.
B. The subject of the active sentence becomes the object of the passive sentence.
C. The past participle form of the main verb is used.
D. The past participle of the main verb is preceded by the appropriate form of the verb 'to be' (am, is, are, was, were, be, been, being), keeping in mind the number of the subject and the tense of the verb.

E. By precedes the agent of the passive voice, if it is necessary. We use another word instead of 'by' when the verbs express 'states' rather than action done by the agent.

Some of the formulas for conversion of the verbs of active sentences into passive form are given below:

1. Passive of imperatives:

A. If the imperative sentence denotes command, the passive form will be: Let +subject + be +V3

E.g.: i. Open the door. → Let the door be opened.
ii. Call the waiter on duty. → Let the waiter on duty be called.

B. If the imperative sentence denotes advice its passive form will be: Subject +should be + V3

E.g.: Speak the truth. → Truth should be spoken.
Love the children. → The children should be loved.

C. If the active sentence contains Please/Kindly, its passive form will start with 'You are requested to…. Please and kindly should be dropped.

E.g.: Kindly lend me some money. → You are requested to lend me some money.
Please read this book. → You are requested to read this book.

2. Passive of yes-no questions:

A. If the active sentence begins with Do/Does/Did, the form of passive sentence will be: Is/Am/Are/Was/Were+V3

E.g.: Did she complete the task? → Was the task completed by her?
Does he help us? → Are we helped by him?

B. If the question in the active sentence begins with Has/Have/Had, its passive form will be: Has/Have/Had+been+V3

E.g.: Has she cheated you? → Have you been cheated by her?
Had Gerard scored the winning goal? → Had the winning goal been scored by Gerard?

3. Passive of questions with Modal Verbs:

If the question in the active sentence starts with modal verbs such as, Can/Could/Shall/Should/May/Might/Will/Would/Must/Ought to etc, its passive will be like: Modal Auxiliaries+be+V3

E.g.: Can she do it? → Can it be done by her?
Will they help you? → Will you be helped by them?

4. Passive of infinitives:

If the active sentence contains infinitive (to + verb), its passive form will be: Subject+ to be + V3

E.g.: There is nothing to do. → There is nothing to be done.
He is a man to rely on. → He is a man to be relied on.

5. The passive of the sentences having Verb+ preposition+ object is: Sub+ Aux Verb+ V3+ Preposition+ by + object

   E.g.: I will look after you well. → You will be well-looked after.
   The police enquired into this case. → This case was enquired into.

6. The passive of verb 'to have': Sub+ has/have/had+ to be + V3+ by+ object

   E.g.: I have to teach you. → You are to be taught by me.
   They had to help us. → We had to be taught by them.

7. The passive of verb 'to be': Sub+ Aux Verb (is/am/are/was/were etc.)+ to be + V3 + by + object

   E.g.: They are to do this. → This is to be done by them.
   He is to invite us. → We are to be invited by them.

MCQs

1. The passive form of 'She doesn't like anyone looking at her':
   a. She doesn't like people looking at her.
   b. She doesn't like looking at people.
   c. She doesn't like being looked at.
   d. She doesn't like people look at her.
2. I saw him leaving the house. The passive form of this sentence is:
   a. He was seen to be leaving the house by me.
   b. Leaving the hose he was seen by me.
   c. He was seen leaving the house by me.
   d. He had been seen leaving the house by me.
3. The passive form of 'Why do you laugh at me?' is:
   a. Why am I laughed by you?
   b. Why am I laughed at by you?
   c. Why am I being laughed at?
   d. Why am I to laugh at me?
4. His pocket has been picked. It means:
   a. Picked has been his pocket.
   b. They have his pocket picked.
   c. Someone has picked his pocket.
   d. Picking has been done to his pocket.
5. The passive of "When do they convene a meeting?" is:
   a. When is a meeting being convene by them?
   b. When do a meeting convened by them?
   c. When is a meeting convened by them?
   d. Has meeting been convened by them?
6. The passive of 'The news shocked me' is:
   a. I was shocked by the news.

b. I was shocked with the news.
c. I was shocked at the news.
d. The news have shocked me.

7. The passive of "Who taught her such thing?" is:
   a. Who was she taught such things by?
   b. By whom she was taught such things?
   c. Whom was she taught such things?
   d. By who was she taught such things.

Tag Questions

A tag is used at the end of a statement to confirm it.
General rules:

1. Use of auxiliary verbs: Auxiliary verbs are to be repeated in the question tag
   Example:
   She is fit and fine, isn't she?
   They were firing the guns, weren't they?
2. Use of main verbs: Main verbs are to be changed into auxiliary verbs according to their tense forms.
   Example:
   They work hard, don't they?
   She danced beautifully, didn't she?
3. Use 'will you' in imperative sentences (whether it is negative or affirmative)
   Example:
   Go there, will you?
   Don't waste your time, will you?
4. Use 'shall you' in *Let's…* and 'will you' in *Let us…*
   Let us go for a long walk, will you?
   Let's go to the party, shall we?
5. With everybody, everyone, someone, somebody, use plural auxiliary verb and they in the tag. But with something, nothing, use singular verb forms and it in the tag.
   Example:
   Everyone was present, weren't they?
   No one called me, did they?
   Something is wrong, isn't it?
6. If two subjects and two verbs are used in the statement, use tag with respect to the second pair.
   Example:
   I trust you are fit and fine, aren't you?
   People suppose that the rebel troops are winning, aren't they?
7. The subject *This*/*These* take 'it' and *Those*/*These* take 'they' and *There* is repeated in the tag.

Example:

There are some people swimming in the river, aren't there?

This is my sister's car, isn't it?

Those books are mine, aren't they?

8. Contraction forms

   I'd rather stay here, wouldn't I?

   You'd better go by taxi, hadn't you?

9. If 'need' and 'dare' are used in the affirmative, auxiliary verbs are used in the tag but if they are used in the negative, the same main verbs are used in the tag.

   For example:

   I needn't pay for it, need I?

   She dared opposing her dad's opinion, didn't she?

MCQs

1. Let's have some breakfast,……..?
   a. shall you b. shall we c. won't you d. will you
2. Let him watch TV,……..?
   a. will you b. won't you c. shall he d. will he
3. We have our room cleaned, …….?
   a. don't we b. don't they c. do we d. haven't we
4. I shall never forget you,……..?
   a. shalln't I b. should I c. shan't I d. shall I
5. Do it now or never, …….?
   a. don't you b. do you c. will you d. shall you

Conditionals

Conditional sentence consists of two clauses: conditional clause and main clause. There are basically four types of conditional sentences, though combinations of the four are also possible depending on the context.

Zero Conditional

The zero conditional is basically used to indicate certainty. This conditional uses the present simple in the if clause and the present simple in the main clause.

We use the zero conditional to express general truths and scientific facts.

If you **boil** water, it **changes** into water vapor.

Ice **melts** if you **heat** it.

1st Conditional

The 1st conditional is generally used to refer to possibility. This conditional uses the present simple in the if –clause and will + infinitive in the main clause.

We use the 1st conditional to talk about possible future situations that we think may happen.

If it **rains** hard, I''**ll stay** here.

We can replace *will* with a model verb such as *can*, *may*, *must*, *should*, etc.

2nd Conditional

The second conditional is used to refer to hypothetical situation. This conditional uses the past simple in the if clause and would+ infinitive in the main clause.

We use the second conditional to talk about situations that we think are less likely, imaginary, or impossible.

If I **lost** my job, I'**d start** my own business. (I'm unlikely to lose my job.)

In the *if* clause, we can use *were* instead of *was*.

3rd Conditional

The third conditional uses the past perfect simple in the 'if clause' and would have+ past participle in the main clause. We use the third conditional to talk about past situations that did not happen in reality.

If it **hadn't rained**, more people **would have attended** the party. (in reality it did rain)

If I **had studied** well, I **would have scored** impressive marks. (in reality I didn't)

MCQs

1. If I had a bicycle, I……..ride it every day.
   a. will b. would c. shall d. may
2. If a thief……in my room at night, I'd throw something at him.
   a. will come b. comes c. came d. is coming
3. If I had enough money, I ……. a car.
   a. would have bought b. will buy c. would buy d. would be buying
4. If you heat ice, it…….
   a. will melt b. would melt c. melts d. would have melted
5. If I……him, I would accept the proposal.
   a. am b. was c. were d. had been me

Speech: Direct and Indirect

Direct speech is a form of speech in which actual words of the speaker are put within the inverted commas. But, if we report the substance of what the speaker said, we call it indirect speech.

Rules:

I. Reported speech: the tense change

A. When do we change the tenses?

After a past-tense verb (e.g. **said**), there is often tense change.

E.g.: 'I am doing my official work' _ He said that he was doing his official work.

If the statement is still up to date when we report it, then we have a choice. We can either leave the tense as it is, or we can change it. But if the statement is no longer up to date, then we change the tense.

For e.g.: You said you **like/liked** chocolate. Julia told me her father **owns/owned** a racehorse.

B. Is – was, like – liked, etc.

Direct speech	**Indirect speech**
'Andrew is working.'	Jessica said Andrew was working.
'We like the flat.'	The couple said they liked the flat.

C. Modal verbs: can- could, may-might, will-would etc.

Could, might, ought, should and **would** stay the same. But **must** can change to **have to**.

'I may go to London again.' – Tom said he might go to London again.

'Sarah would love holiday.' – Mark thought Sarah would love holiday.

II. Reported questions:

In reported questions, the subject comes before the verb as in a statement.

A. Yes/No questions

Reported yes/No questions have if or whether

III. Changing time and persons:

Direct	**Indirect**
Now	then
My	his/her
This, these	that, those
he/she	
Here	there
We	they
Today	that day
Us	them
Come	go
Our	their
Tomorrow	the next day/the following day
Yesterday	the previous day
Last night	the previous night

Study the following examples:

Direct: John said, "He won lottery yesterday."
Indirect: John said that he had won lottery the day before.

Direct: He said, "He is watching television now."
Indirect: He said that he was watching television then.

Direct: Julia said, "I have completed the task."
Indirect: Julia said that she had completed the task.

Direct: Rayan said, "I will play cricket."
Indirect: Ryan said that he would play cricket.

Direct: The teacher said, "The earth goes round the sun."
Indirect: The teacher said that the earth goes round the sun.

Direct: He said to me, "Give me your book."
Indirect: He told me to give him my book.

MCQs

1. He asked me…….
   a. what is your name b. what your name is
   c. what my name is d. what my name was
2. The teacher asked us……..
   a. what do we want b. what we wanted
   c. what did we want d. what we are wanting
3. I replied that I came from London when she said to me, "…….?"
   a. where do I come from b. where you come from
   c. where do you come from d. where I came from
4. The policeman asked me where…….
   a. I'm going b. are you going
   c. I was going d. I have been going
5. He said, "What a beautiful girl she is!" He exclaimed that……
   a. what was she beautiful girl b. she is a beautiful girl
   c. she was a beautiful girl d. How beautiful girl she is

Subject-Verb Agreement

The subject and verb must always agree. If the subject is singular, the verb is singular; If the subject is plural then the verb must also be plural.

1. The use of two negatives to express a single negative idea is wrong. Two negatives lead to a positive meaning. One negative word should, therefore, be used for the expression of a negative idea. For example:
   They don't know nothing about it. (Incorrect)
   They don't know anything about it. (Correct)
   I didn't see nobody there. (Incorrect)
   I didn't see anybody there. (Correct)
2. When a pronoun is the object of a verb or a preposition, it should be in objective case. For example:
   These books are for you and I. (Incorrect)
   These books are for you and me. (Correct)
   There is a dispute between he and I. (Incorrect)
   There is a dispute between him and me. (Correct)
3. 'Either' or 'neither' is used in reference to two only. 'Anyone' or 'None' is used for more than two. For example:
   Neither of the three girls came. (Incorrect)
   None of the three girls came. (Correct)
   None of the two girls came. (Incorrect)
   Neither of the two girls came. (Correct)
4. When expressions of measurement, amount and quantity are used as adjectives, they are usually singular. The noun occurring after the hyphen is always singular notwithstanding the fact that the preceding word indicates plurality. For example:
   It is a ten-miles walk. (Incorrect)
   It is a ten-mile walk. (Correct)
   It is a four-men committee. (Incorrect)
   It is four-man committee. (Correct)
5. The following nouns are always used only in singular form and the verb that follows must also be singular.

sand	meat	advice	jewelry
homework	equipment	hardware	physics
food	poetry	literature	soap
mathematics	economics	bread	work
news	advertising	furniture	mumps
money	luggage	air	traffic
politics	hair	machinery	measles

scenery clothing information make-up

For example: The advice was good.

The information was conveyed.

6. Some nouns relating to nationality ending in (-ch, -sh, ese) used with the definite article 'the' take plural verbs. For example:

   The Nepalese are hospitable.

   The English have led in the field of medicine.

7. Certain adjectives used with the definite article 'the' to indicate a group of people in a particular situation take plural verbs.

the deaf	the meek	the dead	the rich
the sick	the handicapped	the young	the brave
the dumb	the old the blind	the unemployed	the poor
the mumble			

   For example: The poor are mistreated.

   The unemployed have protested.

8. Following nouns always take singular verbs.

Each	neither	somebody	every
either	nobody	something	someone
no one	nothing	everyone	everybody

   For example: Everybody was on time.

   Something is better than nothing.

9. In affirmative sentence, the singular form of dare/need (that is, dares/needs) is used with singular subject. But need not and dare not admit of no change even if the subject is third person singular. For example:

   She need not seek my help.

   She dare not walk in the dark.

10. In expressions using structures like 'neither … nor', 'either … or', the verb agrees with the neararest subject.

    For example: Neither Rayan nor his friends have done this.

    Neither his friends nor Ryan has done this.

    Either Sita or her sisters have arrived.

11. 'There is/was/has been' take a non-count or singular count noun. 'There are/were/have been' take a plural countable noun.

    For example: There has been an increase in the price of oil.

    There have been many interruptions in class daily.

12. A number of + plural noun + plural verb …

    The number of + plural noun + singular verb …

    For example: A number of students are going to the class picnic.

    The number of days in a week is seven.

    A number of applicants have already been interviewed.

    The number of residents who have been questioned on this matter is quite small.

13. The following nouns are always considered plural.

scissors	jeans	eyeglasses	shorts	tongs
pliers	pants	trousers	tweezers	

They cannot be singular. In order to speak of them as singular, one must say 'a pair of -----.'

For example: The pants are short enough to fit me.
A pair of pants is in the drawer.
These scissors are dull.
This pair of scissors is dull.

14. Collective nouns used as units take singular verbs.

Committee	crowd	jury	audience	class
minority	team	group	family	council
club	organization	parliament	army	band

For example: The team has won the match.
The family has planned to sell the old house.

However, if we talk about individual members of the collective, then the verb is plural.

For example: The members of the team have won the match.
The members of the family have planned to sell the old house.
The jury has made a decision.
The jury were divided in their opinions.

15. When 'and' connects two or more titles or designations of the same person, the verb is always singular. But, when 'and' connects two or more titles or designations with the article 'the' before each of them, the expression refers to two different persons. The verb in such a case is always plural.

For example: The principal and secretary is on leave.
The prime minister and chancellor of this university has given this directive.
The principal and the secretary are present.

16. The following expressions take singular verbs:

a lot of	a batch of	a bouquet of	a class of
a here of	a band of	a flock of	a chain of
a pile of	a series of	a galaxy of	a great deal of
a tone of	a bunch of	a pack of	

For example: A bouquet of flowers for sale.
A galaxy of stars is seen in the sky.
A series of mistakes was made.
A team of doctors has been called in.

17. The following expressions are determined by the preposition 'of'.

lots of	all of	most of	miles of
series of	groups of	piles of	none of

For example: Series of books are to be studied.
None of your work is satisfactory.
None of them are here.

18. Names of books, authors, newspapers, magazines, expressions, idioms, quotations, proverbs, phrases take singular verbs.
    For example: Everything that glitters is not gold.
    'Reader's Digest' is popular among the youth.
19. Particular distance, quantity, time or amount, though plural in form, but indicate a unit and functioning as subject of the sentence, the agreeing verb is singular.
    For example: A thousand rupees is enough for me.
    Ten liters of milk is sufficient.
    Two hours is enough time for the task.
20. Singular and plural forms:

Singular	**Plural**	**Singular**	**Plural**
datum	data	formula	formulae
radius	radii	nucleus	nuclei
index	indices	ovum	ova
phenomenon	phenomena	synthesis	syntheses
syllabus	syllabi	analysis	analyses
basis	bases	fungus	fungi
criterion	criteria	bacterium	bacteria
oasis	oases	crisis	crises

21. When several singular subjects represent the same person or thing, or when they form one collective idea, a singular verb is used.
    For example: Bread and butter is a wholesome meal.
    Slow and steady wins the race.
    Truth and honesty is the best policy.
22. The given expressions below have no effect on the subject-verb agreement. That is, whatever comes after these expressions don't determine the agreement, what comes before does.

as well as	besides	no less than	together with
accompanied by	except	along with	in addition to

    For example: Hari, as well as Gopi, was playing.
    He, along with his family, has arrived.
    The president, in addition with his advisors, is appealing for help.
    The letter, together with other documents, was lost.
23. When the two changes happen together, it is expressed by: the + comparative degree + the + comparative degree.
    For example: The higher you go, the cooler you feel.
    The older you get, the wiser you grow.
24. When a noun or pronoun is placed before a gerund, it should be put in possessive case. For example: Please excuse *my* being late.
    She disliked my coming late.
25. If the subject of the sentence is a fraction, the verbs agrees with the noun/pronoun that after the preposition 'of'.

For example: Two-fifths of the information was conveyed.
One-tenth of them have arrived.
Half of it is useful.
Half of them are rotten.

MCQs

From the underlined portions, select the part which is incorrect:

1. Either of the two plans are acceptable as both will work equally well. No error
   A B C D E
2. The assassins hastily to hide the evidence against them. No error
   A B C D E
3. During the bleak winter, food became too scarce that starvation and famine were
   A B C
   widespread. No error
   D E
4. Despite the decline in media attention, there still are, above the western Pacific
   A B
   Ocean, a growing ozone hole. No error
   C D E

5. *Fortuitous means* "happening by chance," but since so many have used it to mean
   A B
   "lucky," this malapropism has been added to dictionaries as a secondary
   C D
   definition. No error
   E
6. During late summer evenings, we would sit on the porch swing and rock very
   A B
   slow in time to the sound of the cicadas. No error
   C D E
7. Excessive sugar intake can lead to addiction, obesity, and to diabetes. No error
   A B C D E
8. After the parents took they're child to see a horror film, he cried all night.
   A B C D
   No error
   E

Articles

'A' and 'an' come before only singular countable nouns; they mean one. They can be used in a general statement or to introduce a subject which has not been previously mentioned. For example:

I bought an umbrella.

I saw a man walking in the street.

'An' is used before words that begin with a vowel sound. 'A' is used before words that begin with a consonant sound.

The following words begin with a consonant sound and thus must always be preceded by 'a'.

European	Eulogy	Euphemism	Eucalyptus
House	Home	Heavy	Half
Uniform	University	Universal	Union

The following words begin with a vowel sound and thus must always be preceded by an.

Hour	Heir	Herbal	Honor
Uncle	Umbrella	Unnatural	Understanding

'The' is used to indicate something that we already know about or something that is common knowledge.

Use THE with:

- Oceans, rivers, seas, gulfs, plural lakes: the Red Sea, the Atlantic Ocean, the Great Lakes
- Mountains: the Rocky Mountains, the Andes
- Ordinal numbers before nouns: the First World War, the third chapter
- Schools, Colleges, Universities when the phrase begins with school, college etc: the University of Florida, the College of Arts and Sciences
- Historical documents: the Constitution, the Magna Carta
- Ethnic groups: the Indians, the Mongolians

Don't use THE with:

- Singular lakes: Lake Rara, Lake Phewa
- Mounts: Mount Everest
- Ordinal numbers after nouns: World War One, chapter three
- Schools, Colleges, Universities, when the phrase begins with a proper noun: Tribhuvan University, St. Xavier's College
- Sports: basketball, football
- Abstract nouns: happiness, freedom
- General areas of subject matter: mathematics, sociology
- Holidays: Christmas, thanks giving

MCQs

1. He got into……car with me.
   a. a b. an c. the d. no article
2. Have you any idea who invented……..fridge?
   a. the b. an c. a d. no article
3. My new class will start in……..august.
   a. an b. a c. the d. no article
4. Help……..poor.
   a. a b. the c. an d. a
5. He doesn't believe in god. He's…….atheist.
   a. an b. a c. the d. no article

Choice of Words

A. Use of like, alike, unlike

When 'like' is a preposition followed by an object, it means 'similar'.
For e.g.: Like her dad, Ms Thapa is a poet.
'Unlike' is a preposition followed by an object and means 'not similar'.
For e.g.: Unlike my brother, I am interested in engineering.
'Alike' can be an adverb meaning 'equally' or an adjective meaning 'similar'.
For e.g.: New educational plan was opposed by students and teachers alike.
Jacob and Johnson are alike in many ways.

B. Use of many, much, few, little

'Many' and 'few' are used with countable nouns; 'much' and 'little' are used with uncountable nouns. For e.g.:
Few students are present today.
Many cities are affected by earthquake.
He has made little progress on the contract.

C. Use of so, enough, too

'So' can be used in adverb clauses of cause/result before adverbs and adjectives.
For e.g.: The rain fell so hard that the river overflowed.
She ate so much that she got stomachache.
'Enough' follows adjective or adverb.
For e.g.: He is not tall enough to touch the ceiling.
He ran fast enough to win the race.
'Too' precedes an adjective or adverb.
For e.g.: John is too short to touch the ceiling.
Julia wrote too slowly to finish all answers within one hour.

D. So, as, such as

'So' connects two independent clauses. It means therefore/as a result.

'As' is used to introduce an adverb clause. It means while, like, because, the way, or since.

'Such as' is used to introduce examples.

For e.g.: So was scared so she left already.

It began to rain as I was walking.

I would like to visit the US cities such as: Boston, Los Angeles, New York etc.

MCQs

1. He likes to play games……: cricket, basketball and baseball.
   a. So b. as c. such as d. so as
2. Breathing into a paper bag is yet……..cure for the hiccups.
   a. the other b. another c. others d. other
3. I don't want this book, I want…….one on the shelf.
   a. the another b. others c. the others d. the other
4. ……a bike, a car has four wheels.
   a. like b. Alike c. Likes d. Unlike
5. Some artists use traditional designs while……use more modern themes.
   a. the other b. another c. others d. the others.
6. The twins are……
   a. like b. unlike c. alike d. likely

Conjunctions

Conjunctions are words that join sentences. Conjunctions are of two types: coordinating conjunctions and subordinating conjunctions.

A. Coordinative conjunctions are: and, but, however, nevertheless, for, or, either…or, neither…nor etc.
   I. Cumulative conjunction (expressions: and)- adds one affirmative sentence to another affirmative sentence. For e.g.: She can sing and dance.
   II. Adversative conjunction (expressions: but, however, nevertheless): joins one negative sentence to an affirmative sentence. For e.g.:
   She can speak English but she can't speak Spanish.
   He was poor however he offered help to the earthquake victims.
   III. Alternative conjunction (expression: or, either…or, neither…nor): expresses choice between two alternatives. For e.g.:
   She can neither sing nor dance.
   He must be dutiful or he will be fired.
   Either he is weak or he is unmindful.
   IV. Illative conjunction (expressions: for): expresses inference. For e.g.:
   There is certainly someone inside for I heard a yell.

B. Subordinating conjunctions are before, after, when, while, whenever, by the time, as soon as, because, because of, as, since, so that, so…that, such…that etc.

I. Expressing time (expressions: before, after, when, while, whenever, by the time, as soon as etc)
For e.g.: I go to the cinema whenever I have free time.
She made a call to me before she left home.

II. Expressing cause and effect (expressions: because, because of, since, as etc)
For e.g.: I stayed at home because I was not feeling well.
Paddy crop was destroyed because of the heavy rainfall.
As she left him, he searched for a new girl and married her.

III. Expressing purpose (expressions: so that)
For e.g.: She is taking language class so that he could be a language instructor.
Jim quit his job so that he could give enough time to his family.

IV. Expressing result and consequence (expression: so…adj./adv…that, such…that…)
For e.g.: He is so busy that he can manage time for nothing.
She spoke so well that everyone present there got impressed.

V. Expressing condition (expressions: if, unless)
For e.g.: If she comes in, I will go out.
Unless you respect them, they won't love you.

VI. Expressing concession (expressions: though, although, even though, despite, in spite of)
For e.g.: Though he is wounded, he offered his help the other victims.
Despite his intelligence, he scored low grades in the test.

MCQs

1. He is…….a lawyer and a professor.
   a. not only b. both c. as well as d. and
2. She arrived late in the class……a traffic jam.
   a. because b. as c. because of d. since
3. ……Julia was absent for three weeks, she still completed her work on time.
   a. despite b. In spite of c. Though d. Nevertheless
4. It was……expensive car, therefore I didn't buy it.
   a. so b. such c. too d. such an
5. He is…….intelligent…….capable of doing that work.
   a. either, or b. as though, were c. as well as d. neither, nor
6. You can stay in this room……..you you don't make noise.
   a. provided that b. as c. because d. so that
7. She looks…….she…….sick.
   a. whether, not b. as if, is c. as though, were d.as though, was

Use of Punctuation

Punctuation refers to right use of putting points or stops in the sentences. The following are the principal stops:

1. **The full stop (.)**: It is used to mark the end of a declarative/ imperative sentence and to mark the abbreviations. For example:
   The boys are playing cricket.
   Go there.
   He is a Ph.D. scholar.
2. **The comma (,)**
   The comma is used:
   - To separate a series of words in the same construction.
     For example: John, Julia and Jenny are travelling round the world.
   - To indicate the omission of a word, especially a verb.
     For example: Harry received a bouquet of roses; Howard, a watch.
   - Before certain coordinating conjunctions.
     For example: To repeat the same mistake is not wisdom, but foolishness.
   - To mark the direct quotation from the rest of the sentence.
     For example: Jack said, "I love dancing."
3. **The semi-colon (;)**
   The semi-colon is used:
   - To separate sentences when they are not linked with conjunctions.
     For example: Reach there on time; Annie will be waiting for you.
4. **The colon (:)**
5. **The question mark (?)**
   The question mark is used after a direct question.
   For example: Did you sip tea?
6. **The exclamatory mark (!)**
   The exclamatory mark is used after words/sentences which are used to express sudden emotions (joy, sorrow, surprise, annoyance etc.). For example: Ouch! You stepped on my feet.
7. **Capital letter**
   Capital letter is used:
   - At the beginning of a sentence
     For example: **T**hey are fond of eating
   - With proper nouns
     For example: Elizabeth, Paris, Thames etc.
   - For names of days, months, festivals and historical events
     For example: New Year's Day, Sunday, January, Christmas etc.
   - For the first letter of a title.
     For example: The Principal, The Prime Minister etc.

8. **The inverted comma:**
   The inverted comma is used in indirect speech for the exact words spoken by a person. For example: Aaron said, "Am I not nominated for the award?"

Questions

Correct the following sentences for correct use of punctuations:

1. I came I saw I conquered
2. His story was in several ways improbable
3. He said to me do you love me
4. Bacon says reading makes a full man writing an exact man and speaking a ready man
5. What a fine painting
6. Reach there on time Annie will be waiting for you

Prepositions

A preposition is a word used to show the way in which other words are connected. It is used to express basic relationships between words. There are six different types of prepositions. They are as follows:

1. Simple prepositions- at, by, in, through, over, under etc. For example: John is at school. The trees are cut down by my brother. The sun shines over the earth. This building is under construction.
2. Double preposition- out of, from within, from among, from under etc.
   Why were they driven out of duty station? A rebellious voice came from within my heart. She was selected from among twenty conestants.
3. Compound prepositions- across, along, above, about, before, behind, beyond, beside, without etc.
   My house is across the river. The baby is walking along the river bank. He is about to go crazy. The new class starts before six in the morning.
4. Phrase prepositions- on account of, in course of, on the brink of, with reference to etc.
   In course of her conversation, she revealed all her privacies. She criticized me with reference to my opinion.
5. Participal preposition- concerning, considering, regarding, during, pending etc.
   Considering her age, she should be given light punishment. Let us talk with the principal regarding this matter. We will visit Pokhara during summer vacation.
6. Disguised prepositions- weakened forms of the prepositions on or of..
   They went out a-hunting. (=on hunting). It is 10 o'clock. (=of the clock)
   Supply the missing prepositions of time (at, on, in, till/until, to, for, since, from, by, before, after, during etc.):

MCQs

1. He was told not to worry……the matter.
   a. for b. at c. about d. on
2. John's father disapproved……his intention to become an actor.
   a. on b. of c. at d. for
3. The cat was killed by a truck which went…….it.
   a. under b. on c. through d. over
4. Some dreams last…….hours.
   a. till b. from c. for d. until
5. A hawker goes……house…….house.
   a. to, to b. from, at c. by, to d. from, to
6. He is born…….rich parents.
   a. from b. by c. for d. of
7. You must dispense…….his services.
   a. of b. with c. on d. at

Vocabulary

I. Single word substitution

1. A tendency to put off events/postpone events – Procrastinate
2. One who gets pleasure on others trouble and pain – Sadistic
3. One who looks at everything from a personal point of view – Egocentric
4. One who is shy, timid and unwilling to face a situation – Different
5. The most capable part of the group, town or place – Elite
6. One who is simply and easily deceived – Gullible
7. A list of things to be discussed at a meeting – Agenda
8. Too much official government formality – Red tapism
9. A person/nation engaged in war – Belligerent
10. A person who always wants to fight – Bellicose
11. An exaggerated statement - Hyperbole
12. A person who looks at the dark side of life – Pessimist
13. A person who looks at the bright side of life – Optimist
14. Promise given by a prisoner not to escape – Parole
15. Aggressor in army – Vanguard
16. Ephemeral ecstasy – Euphoria
17. Property left to someone by will – Legacy
18. An instrument for detecting earthquakes – Seismograph
19. A word on longer in use – Obsolete
20. A government which honors all religions – Secular
21. A person who is very fond of his wife – Uxorious
22. Total loss of voice – Aphonia
23. Yearly return of a date – Anniversary
24. People at a sport – Spectators

25. People at a concert – audience
26. A letter or document which does not bear the name of the author – Anonymous
27. A person who commits the first act of attack – Aggressor
28. A government where the powers are concentrated in the hands of one person – Autocracy
29. A short story designed to teach a moral or religious lesson – Allegory
30. A minister representing a sovereign/state in a foreign country – Ambassador
31. That which occurs after every two years – Biennial
32. A group, especially in the arts, regarded as being the most experimental – Avant Garde
33. Land that does not grow anything – Barren
34. A bunch of flowers – Bouquet
35. A rowdy crowd – Rabble/mob
36. The act of spying – Espionage
37. A morbid fear of enclosed spaces – Claustrophobia
38. People outside a church, temple or mosque – Congregation
39. A building for loading soldiers – Barracks
40. Line of beds in a school/college especially for students to sleep – Dormitory
41. An official bulletin – Communiqué
42. Something very brightly colorful – Flamboyant
43. One who is new to a profession – Novice
44. One who studies things of the past – Antiquarian
45. One who walks on foot – Pedestrain
46. One who supports woman's problems – Feminist
47. A man who has womanish ways – effeminate
48. One who is indifferent to pain and pleasure – Stoic
49. A well-experienced person – Sophisticated
50. One for whom the world is his/her home – Cosmopolitan

MCQs

1. The art of correct spelling:
   a. calligraphy b. phonetics c. orthography d. orthodontist
2. Gift left by will:
   a. alimony b. parsimony c. legacy d. property
3. A list of things to be discussed at a meeting:
   a. list b. agenda c. manifesto d. minutes
4. Money paid to a person after the completion of a work:
   a. sinecure b. salary c. cheque d. remuneration
5. Changing one's mind too quickly:
   a. adaptability b. instability c. versatility d. vacillations
6. A word no longer in use:

a. exotic b. primitive c. obsolete d. ancient

7. One who readily believes:
   a. skeptical b. hopeful c. atheist d. credulous
8. A person who walks in his sleep:
   a. somnambulist b. soliloquist c. night walker d. thief
9. A person who is very fond of his wife:
   a. lover b. crazy c. uxorious d. fanatic
10. A short walk for pleasure or exercise:
    a. jog b. gallop c. stroll d. promenade

II. Analogy

An analogy is a similarity or resemblance between two things. In other words, we have to find relationship between the two words.

Example: LAWYER : COURT

a) **Professor : University**
b) Author : Book
c) Wine : Grapes
d) Volume: Liter

Explanation: The work place of a lawyer is a court, in the same way the workplace of a professor is a university.

1. ABATE: LESSEN
   a. sweet: bitter b. secret : clandestine c. ice : solid d. dog : bitch
2. LION : LIONESS
   a. convict: prison b. duck: drake c. miner : ore d. captain : boat
3. EDUCATION: DEVELOPMENT
   a. man: speech b. motor : truck c. child: grow d. nutrition: health
4. FROGS: CROAK
   a. hare: leveret b. filly : colt
   c. liquor: intoxication d. serpents : hiss
5. HORSE: COLT
   a. dog: puppy b. goat: bleat c. actor: stage d. listen : record
6. CONFIDENCE: DIFFIDENCE
   a. dastard: coward b. elephant : ant c. baffle: clarify d. field: farm
7. EGG: OMELET
   a. man: child b. muscle : tendon c. judge: justice d. jute: sack
8. SPICY: INSIPID
   a. peppery: salty b. hot : creamy c. keen : dull d. pickled : sweet

9. SCYTHE: DEATH

a. fall : winter
b. knife : murder
c. sickle : grain
d. arrow: love

10. HYGROMETER : HUMIDITY

a. clock : second
b. thermometer : temperature
c. odometer : speed
d. barometer: weather

III. Synonyms

Word	**Synonym**
Adroit	proficient
Adulation	adoration
Aggrandize	amplify
Animate	Energize
Apathy	indifference
Apocryphal	unauthenticated
Beleaguer	surround
Bemused	bewildered
Blandishment	enticement
Candid	Frank
Censorious	denouncing
Cherubic	sweet
Dishearten	dismay
Disinterment	exhumation
Dispassionate	calm
Dissonant	*c*acophonous
Divination	forecast
Emanate	emit
Embroil	involve
Emulate	model
Enervate	Exhaust
Felicity	bliss
Fickle	spasmodic
Garish	excessive
Hamper	impede
Hedge	fence
Herald	broadcast
Impetuous	hasty
Word	**Synonym**
Improvident	reckless
Inauspicious	unfavorable
Jollity	merriment
Judicious	logical
Knotty	tangled
Laconic	concise
Lamentation	moan
Lassitude	fatigue
Levity	lightness
Lethargy	idleness
Lurid	horrifying
Mendicant	parasite
Moribund	failing
Mundane	tedious
Nascent	beginning
Nebulous	vague
Nemesis	retribution
Odious	loathsome
Opulent	affluent
Ostentatious	conspicuous
Paucity	scarcity
Pedantic	stuffy
Pejorative	derogatory
Philistine	barbarian
Pithy	concise.
Quandary	étranglement
Querulous	disagreeable
Rancorous	hostile
Word	**Synonym**
Raucous	piercing
Redundant	repetitious
Squalor	filthiness
Strife	turmoil
Tantamount	indistinguishable
Taper	loud
Word	**Synonym**
Trepidation	apprehension
Unfathomable	incomprehensible
Vacillate	fluctuate
Variegated	varied
Venerate	admire
Wistful	pensive
Writhe	twist

MCQs

A. Select the word which is similar in meaning to the given word:

1. ENTICE

   a. tempt b. attract c. tease d. rebuke

2. PEJORATIVE

   a. Fluctuate b. admire c. degrading d. dilemma

3. TANTAMOUNT

   a. Showy b. puzzling c. pious d. indistinguishable

4. APOCRYPHAL

   a. Disputed b. difficult c. honest d. fertile

5. WOE

   a. Awesome b. awe-inspiring c. beautiful d. anguish

B. Pick the word similar in meaning to the word italicized in each of the sentences given:

1. He has lost the *equilibrium* of his mind.

   a. Strength b. balance c. energy d. talent

2. She is young and *impetuous*.

   a. Sociable b. violent c. cultured d. civilized

3. With a *flamboyant* gesture he threw off the covering.

   a. Showy and confident b. meek and submissive
   c. gracious d. modest

4. His *arrogance* is responsible for the change in his fortune.

   a. Weakness b. pride c. humility d. timidity

5. His *pragmatic* approach to the problem was appreciated.

   a. Idealistic b. practical c. unbiased d. cautious

IV. Antonyms

Word	**Antonym**	**Word**	**Antonym**
Addicted	averse	meek	arrogant
Adopt	reject	modest	conceited
Ascend	descend	nimble	lazy
Anger	forbearance	novice	veteran
Bleak	bright	pacify	irritate
Blame	praise	persuade	dissuade
Benevolent	malevolent	perturbed	calm
Bawdy	decent	pompous	humble
Boisterous	placid	prologue	epilogue
Bold	timid	prolong	shorten
Calm	stormy	propagate	suppress

Clandestine	open	progress	retrogress
Coarse	fine	prompt	slow
Censure	praise	prudence	indiscretion
Concord	discord	pursue	avoid
Docile	headstrong	rash	steady
Dwarf	giant	rear	front
Ease	disquiet	rebuke	praise
Eclipse	shine	rebellious	submissive
Egocentric	altruist	rectify	falsify
Effeminate	manly	reputation	notoriety
Emigrant	native	sacred	profane
Excess	dearth	savage	civilized
Extravagant	frugal	superficial	profound
Ferocious	gentle	sympathy	antipathy
Fickle	constant	tranquil	agitated
Genuine	spurious	thrifty	extravagant
Grotesque	congruous	vice	virtue
Gorgeous	simple	vivid	dim
Hollow	solid	wax	wane
Hurt	heal	wed	divorce
Hypocrisy	sincerity	wicked	virtuous
Insult	esteem	wit	stupidity
Insipid	tasty	yield	resist
Jest	earnest	youthful	mature
Jolly	gloomy	zenith	nadir

MCQs

Select the correct antonym:

1. Genuine
   a. true b. original c. pure d. facsimile
2. Antipathy
   a. indifference b. unwillingness c. sympathy d. hatred
3. Malevolent
   a. benevolent b. hateful c. abhor d. spiteful
4. Fiasco
   a. failure b. success c. uncertain d. mismanagement
5. Hypothesis
   a. fact b. supposition c. fiction d. untrue

6. Orthodox
   a. conservative b. covert c. narrow-minded d. candid
7. Comply
   a. follow b. abide c. listen d. violate
8. Holy
   a. righteous b. spiritual c. profane d. sacred
9. Bawdy
   a. decent b. dirty c. stinking d. pungent
10. Parsimony
   a. generous b. selfish c. economical d. meanness

Answers & explanations:
Reading comprehension

Example I

1. **b** the patient
2. **c** cancer of the lungs
3. **d** an old man
4. **d** shocked
5. **a** good

Example II

1. **b** qualities affecting diamond values.
2. **a** it has 100 points.
3. **d** completely
4. **c** D
5. **a** unblemished
6. **b** rated VVS1.

Example III

1. **c** enjoyed using computers as a hobby
2. **c** has a wide range of computer skills
3. **b** calls at short notice
4. **a** individuals
5. **c** word of mouth
6. **a** seeing clients understand how computers can help them

Grammar

Causative Verbs

1. **a** to mend
2. **c** wash
3. **c** burst
4. **b** washed
5. **c** moved

Voice

1. **c** She doesn't like being looked at.
2. **c** He was seen leaving the house by me.
3. **b** Why am I laughed at by you?
4. **c** Someone has picked his pocket.
5. **c** When is a meeting convened by them?
6. **c** I was shocked at the news.
7. **a** Who was she taught such things by?

Tag Questions

1. **b** shall we
2. **a** will you
3. **d** haven't we
4. **c** shan't I
5. **c** will you

Conditionals

1. **b** would
2. **c** came
3. **c** would buy
4. **c** melts
5. **c** were

Speech

1. **d** what my name was
2. **b** what we wanted
3. **c** where do you come from
4. **c** I was going
5. **c** she was a beautiful girl

Subject-Verb Agreement

Explanatory notes:

1. **A** Either of the two plans is…
2. **B** Change hastily into hastened
3. **B** Change 'too' into 'so'
4. **B** Use 'is' instead of 'are'
5. **E** No error
6. **C** Use 'Slowly' instead of 'slow'
7. **D** Use 'diabetes', not 'to diabetes'
8. **B** Change 'they're' into 'their'

Articles

1. **c** the
2. **a** the
3. **d** no article
4. **b** the
5. **a** an

Choice of words

1. **c** such as
2. **b** another
3. **d** the other
4. **d** unlike
5. **c** others
6. **c** alike

Conjunctions

1. **b** both
2. **c** because of
3. **c** though
4. **d** such an
5. **d** neither, nor
6. **a** provided that
7. **c** as though, were

Use of Punctuations

1. I came, I saw, I conquered.
2. His story was, in several ways, improbable
3. He said to me, "Do you love me?"
4. Bacon says: Reading makes a full man, writing an exact man, and speaking a ready man
5. What a fine painting!
6. Reach there on time; Annie will be waiting for you.

Prepositions

1. **c** about
2. **b** of
3. **d** over
4. **c** for
5. **d** from, to
6. **d** of
7. **b** with

Vocabulary

I. Single word substitution

1. **c** orthography
2. **c** legacy
3. **b** agenda
4. **d** remuneration
5. **d** vacillations
6. **c** obsolete
7. **d** credulous
8. **a** somnambulist
9. **c** uxorious
10. **c** stroll

II. Analogy

1. **b** secret : clandestine
2. **b** duck: drake
3. **d** nutrition: health

4. **d** serpents : hiss
5. **a** dog: puppy
6. **c** baffle: clarify
7. **d** jute: sack
8. **c** keen : dull
9. **d** arrow: love
10. **b** thermometer : temperature

Answers explanations:

1. Lessen is synonym of abate; similarly clandestine is the synonym of secret.
2. Lioness is feminine gender of lion; likewise drake is feminine form of duck.
3. Education is the cause of development; likewise, nutrition is the cause of health.
4. Croak is the sound of frogs; in the same way, hiss is the sound of serpents.
5. Young baby of a horse is called colt; similarly, young baby of dog is called puppy.
6. Opposite of confidence is diffidence; likewise opposite of baffle is clarify.
7. Omelet is prepared out of egg; in the same way sack is prepared out of jute.
8. Insipid is antonym of spicy; similarly dull is antonym of keen.
9. Scythe symbolizes death; similarly arrow symbolizes love.
10. Hydrometer measures humidity; likewise thermometer measures temperature.

III. Synonyms

A.

1. **a** tempt
2. **c** degrading
3. **d** indistinguishable
4. **a** disputed
5. **d** anguish

B.

1. **b** balance
2. **b** violent
3. **a** showy and confident
4. **b** pride
5. **b** practical

IV. Antonyms

1. **d** facsimile
2. **c** sympathy
3. **a** benevolent
4. **b** success
5. **a** fact
6. **d** candid
7. **d** violate
8. **c** profane
9. **a** decent
10. **a** generous

Mathematics

Sets

A set is defined as the collection of well defined objects. The term well defined means the object which has specific identity in the universe.

Sets are usually denoted by the capital letters A, B, C, ... X, Y, Z, and small letters a, b, c, ... x, y, z are used to represent the members of the set.

1. Ways or Methods of sets representation

Description Method	The common properties of the elements of a set are described by words.	A set of even numbers less than 10.
Listing or Roster Method	The elements of a set are listed inside by curly brackets	E={2,4,6,8}
Set builder method or Rule method	The elements are represented by a variable stating their common properties	{x : x is an even number less than 10}

2. Types of sets:

i. **Null set**: The set consisting no element is a null set and it is often denoted by the symbols: ϕ, {}.
Example: X= {x: x ≠ x}

ii. **Singleton set** : The set consisting only one element is a singleton set.
Example: A= {x: 2x+1=0}

iii. **Finite set**: A set consisting finite numbers of elements is called finite set.
Example: V={a, e, i, o, u}

iv. **Infinite set** : A set consisting infinite number of elements is infinite set.
Example: N = {x: x is a natural numbers)

v. **Universal set**: A set consisting the members which are totality of our consideration or matter of discussion is universal set. It is often denoted by U.

3. Relation between sets:

i. **Equal sets:** The sets A and B are said to be equal if every elements of set A is an elements of set B.
consider any two sets ,X = {f, l, o, w}and Y = {f, o, l,l,o, w} then X = Y.

ii. **Equivalent sets:** The sets A and B are said to be equivalent if A and B consist the elements which are equal in number. It is written as A ~ B.
Two sets X = {a, b, c, d, e}and Y = {1, 2,3,4, 5}are equivalent sets. Then we write X ~ Y.

iii. **Joint sets:** The sets A and B are said to be joint, if both set has at least one element common. The sets A = {1,2,3,4}, B = {x: 3 < x < 6} are joint sets.

iv. **Disjoint sets:** The sets A and B are said to disjoint, if they have no common element.
The sets A = {vowel sound of English alphabet} B = {x, y, z} are disjoint sets.

v. **Subsets:** Set A is said to be said to be subset of set B if every element of set A is also the elements of set B. Symbolically, if $x \in A$ implies $x \in B$ then $A \subseteq B$.

- **Proper Subset**: Let A and B be two sets. The set A is said to proper subset of set B if every elements of A is also an elements of set B and the set B contains at least one element that is not contained in set A. It is denoted by $A \subset B$.
- **Improper Subset**: The set itself is called the improper subsets of the set. Which is written as $A \subseteq A$.
  - There are 2^n no. of possible subsets for any set. Where n is the counting element in the set.
  - There is only one improper subset for any set.
  - There are $2^n - 1$ no. of proper subsets for any set.
  - There are $2^n - 2$ no. of non-empty proper subsets for any set.

vi. Power set: Set P is said to be power set of set A if P consists the element that are all possible subsets of set A.
Example : Let A = {a, b}
The possible no of subsets of set A is $2^n = 2^2 = 4$.
They are: $A_1 = \phi$, $A_2 = \{a\}$, $A_3 = \{b\}$, $A_4 = \{a, b\}$
Then, P = {ϕ, {a}, {b}, {a, b}}.

4. Operation on sets:

i. **Union of sets :** The union of two sets A and B is denoted by $A \cup B$ and defined by $A \cup B = \{x: x \in A \text{ or } x \in B\}$

ii. **Intersection of sets:** The intersection of two sets A and B is denoted by $A \cap B$ and defined by $A \cap B = \{x: x \in A \text{ and } x \in B\}$

iii. **Complement of sets:** The complement of set A is denoted by A' or A and defined by $\bar{A} = \{x: x \in U \text{ and } x \notin A\}$

iv. **The difference of sets** : The difference of sets A and B is denoted by A - B and defined by $A - B = \{x : x \in A \text{ and } x \notin B\}$

v. **Symmetric difference of sets:** The symmetric difference of sets A and B is denoted by $A \Delta B$ and defined by $A \Delta B = \{x: x \in (A - B) \text{ or } x \in (B - A)\}$
i.e. $A \Delta B = (A - B) \cup (B - A) = (A \cup B) - (A \cap B)$.

Laws of Set Algebra

1. $A \subseteq A$; $A \subseteq B, B \subseteq A \Rightarrow A = B$ $\phi \subseteq A$	Inclusion law
2. $A \cup A = A, A \cap A = A$	Idempotent law
3. $A \cup \phi = A, A \cap \phi = \phi$	Identity law

	$A \cup U = U,\ A \cap U = A$	
4.	$A \cup \bar{A} = U,\ \bar{\bar{A}} = A$ $A \cap \bar{A} = \phi,\ \bar{U} = \phi$ and $\bar{\phi} = U$	Complement law
5.	$A \cup B = B \cup A,\ A \cap B = B \cap A$	Commutative law
6.	$A \cup (B \cup C) = (A \cup B) \cup C$ $A \cap (B \cap C) = (A \cap B) \cap C$	Associative law
7.	$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$	Distribution law
8.	$(\overline{A \cup B}) = (\bar{A} \cap \bar{B})$ $(\overline{A \cap B}) = \bar{A} \cup \bar{B}$	De'morgans law
9.	$A-(B \cup C) = (A-B) \cap (A-C)$ $A-(B \cap C) = (A-B) \cup (A-C)$	Difference law

Some Important Result Results

* $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
* $n(A \cup B) = n(A) + n(B)$ if $n(A \cap B) = 0$
* $n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(C \cap A) + n(A \cap B \cap C)$
* $n(A - B) = n(A) - n(A \cap B) = n_0(A)$ for two sets A and B.
* $n(A \cup B)$ will be maximum if $n(A \cap B)$ is minimum
* $n(A \cup B)$ will be minimum if $n(A \cap B)$ is maximum.

Number System

* **Natural numbers** is the set of counting numbers begins from 1. It is written as, N = {1, 2, 3, 4, ...}
* **Whole numbers** is the set of Natural numbers including zero. It is written as, W = {0, 1, 2, 3, ...}
* **Integers** is the set of union of whole numbers and negative natural numbers, It is written is Z = {.....3, –2, –1, 0, 1, 2, 3 .....}
* **Rational numbers** is the numbers which is expressed in the form of $\frac{p}{q}$;where p, q ∈ Z and q ≠ 0. The set of rational numbers is denoted by Q.A set of rational numbers can also be expressed as a terminating or a repeating decimal.
* The set of numbers, which is neither terminating nor repeating decimals, is **irrational numbers.** It is given by I= { π, e, $\sqrt{2}$, $\sqrt{3}$…….}
* **Real numbers** is the set of rational and irrational numbers together. It is written as R = {x: $-\infty < x < \infty$}.
  Infact, N⊂W⊂ Z ⊂ Q ⊂ R.

Interval: The set of points on the real line between two numbers a and b is known as an interval. Graphically, we have following types of intervals:

i. Open interval: An open interval between two real numbers a and b is denoted by (a, b) and defined by (a ,b) = {x: a< x< b}

ii. Closed interval : A closed interval between two real numbers a and b is denoted by [a,b] and defined by [a,b] = {x: a≤ x ≤b}

iii. Left open interval : A left open interval between two real numbers a and b is written as (a,b] and defined as (a,b] = { x: a < x < b}

iv. Right open interval : A right open interval between two real numbers a and b is written as [a, b) and defined as [a, b) = {x: a ≤ x < b}

Absolute Value

Let x be any real number. The absolute value (or modulus) of x, is a non negative number defined by $|x| = \begin{matrix} x \text{ if } x \geq 0 \\ -x \text{ if } x < 0 \end{matrix}$

For any real numbers x and y the simple properties of absolute values are;

i. $|x| \geq 0$

ii. $|x| \geq x$ and $|x| \geq -x$

iii. $-|x| \leq x \leq |x|$

iv. $|x + y| \leq |x| + |y|$

v. $|x - y| \geq |x| - |y|$

vi. For any real number x and positive number a, $|x| \leq a \Leftrightarrow -a \leq x \leq a$.

MCQs

1. Let A = {1, 2, 3}, the possible numbers of non-empty proper subset for the set A is .....
   a. 8 b. 7 c. 6 d. 9
2. If P is power set of set A = {x: $x^2 - x - 2 = 0$}, then n(P) = ...
   a. ϕ b. 2 c. 3 d. 4
3. If A = {x: x = (2n + 1), n ≤ 5, n∈ N} and B = {x: x = 3n - 2, n ≤ 4, n∈ N} then (B – A) = ...
   a. {3, 5, 7} b. {1, 4, 10} c. {1, 7, 10} d. {3, 9, 10}
4. If n(U) = 100, n(A) = 50, n(B) = 65, then min. possible of n(A∩B) = ...
   a. 0 b. 15 c. 50 d. 65
5. If A = {1, 2, 3, 4}, B = {2, 4, 6, 8, 10}, then (AΔB) = ...
   a. {1, 2, 3, 4} b. {2, 4, 6, 8, 10}
   c. {2, 4} d. {1, 3, 6, 8, 10}
6. 20 teachers of a school either teach mathematics or physics. 12 of them teach mathematics while 4 teach both the subjects. Then the number of teachers teaching physics only is:
   a. 12 b. 8 c. 16 d. None
7. Let A and B are any two non-empty sets then $A \cap \overline{B}$ = ...
   a. A ∩ B b. A c. A – B d. B – A
8. There are 150 students in a school. 66 plays baseball, 45 play cricket and 42 play soccer. 27 students play exactly two sports and 3 students play all 3 of sports. How many of 150 students play none of these?
   a. 10 b. 40 c. 30 d. 25

9. Which one of the following is the multiplicative inverse of -a?
   a. -1/a b. a c. 1 d. 1/a
10. In a class of 175 students, 100 students are studying mathematics, 70 are studying physics, 46 studying chemistry, 10 studying mathematics and physics, 28 mathematics and chemistry, 23 physics and chemistry and 18 studying all three subjects. Find how many studying non of these three subjects?
   a. 5 b. 2 c. 1 d. 0
11. Which one of the following is an irrational number?
   a. 22/7 b. π c. 0.333.... d. 4.5679
12. The solution of x for the inequality $-2 \leq 3x + 1 \leq 7$ is:
   a. (-2, 7) b. [-1, 7) c. (-1, 2) d. [-1, 2]
13. If A = (-2, 3] and B = (0, 5) then B – A = ...
   a. (0, 5) b. (3, 5) c. [3, 5) d. None

Relation & functions

Ordered Pairs: Two elements a and b, listed in specific order, form an ordered pair and denoted as (a, b). Two ordered pairs (a, b) and (c, d) are equal if a = c, b = d.

Cartesian Products: The Cartesian product A × B and defined as the set of all possible ordered pairs such that.

$A \times B = \{(x, y) : x \in A \text{ and } y \in B\}$

eg. Let A = {1, 2, 3}, and B = {5, 6}

$A \times B = \{(1, 5), (1, 6), (2, 5), (2, 6), (3, 5), (3, 6)\}$

Note: Let A and B are any two non empty sets then $n(A \times B) = n(A) \times n(B)$.

Relations: Relation is the subset of cartesian product A × B. a relation from A to B is denoted by x Ry or simply R, and defined by $R = \{(x, y): x \in A, y \in B\} \subseteq A \times B$.

Example:

Let A = {–1, 0, 1}. Find the relation on A such that $\{(x, y): x < y\}$

Solution:

Given A = { –1, 0, 1}

Now, A × A = {–1, 0, 1} × { –1, 0, 1}

$A \times A = \{(-1, -1), (-1, 0), (-1, 0), (0, -1), (0, 0), (0, 1)(1, -1), (1, 0) (1, 1)\}$

$R = \{(x, y): x < y\} = \{(-1, 0), (0, 1), (-1, 1)\}$

which is required.

Note: The possible number of relations from set A to set B is n(B) n(A).

Domain and Range of a Relation: If R is a relation from A to B, then the set of all first co-ordinates of elements of order pair of R is called the domain of R, while the second elements of oder pair of R is called the range.

Inverse relations: A relation obtained by interchanging the first and second element in the ordered pairs of a relation is known as the inverse to given relation. If R denotes a relation, its inverse is denoted by R^{-1}.

Various Types of Relations

i. **Reflexive:** If aRa, for all $a \in A$.
ii. **Symmetric:** If $aRb \Leftrightarrow bRa$.
iii. **Transitive:** If aRb and $bRc \Leftrightarrow aRc$.
iv. **Antisymmetric:** If aRb and $bRa \Leftrightarrow a = b$

Equivalence Relation: A relation which is reflexive, symmetric and transitive is called an equivalence relation.

Functions: A relation f from a set A to B is a function if for all $x \in A$ there exists unique $y \in B$ such that $y = f(x)$. And we write $f: A \to B$.

One to one function (Injective): Let $f : A \to B$ be a function then f is called one to one, if no two different elements in A have the same image. i.e. for all $x_1, x_2 \in A$; $x_1 \neq x_2 \Rightarrow f(x_1) \neq f(x_2)$.

Many to one functions: A function $f: A \to B$ is said to be many to one function if more then one elements of set A has same image in set B. i.e. for all $x_1, x_2 \in A$; $x_1 \neq x_2 \Rightarrow f(x_1) = f(x_2)$.

Onto function (Surjective): A function $f: A \to B$ is said to be an onto function, if each and every element of set B has at least one pre–image in set A.

Into function: A function $f: A \to B$ is said to be an into function, if at least one element of set B has no pre-image in set A.

One to one and onto function (Bijective): A function $f: A \to B$ is said to be one to one and onto if each and every element of set B has only one pre-image in set A.

Inverse function: Let $f: A \to B$ be one to one and onto function, then the inverse of f is written as f^{-1} and defined as $f^{-1}: B \to A$ and $f^{-1}(y) = x$ for $x \in A$ and $y \in B$.

Composite function: Let $f: A \to B$ and $g: B \to C$ be any two function. Then the composite of f and g is given by $gof: A \to C$ such that $gof(x) = g(f(x))$, for all $x \in A$ and $f(x) \in B$.

Domain and Range of a functions: Domain of a function $f: A \to B$ is written as Dom(f) and defined as $Dom(f) = \{x: x \in A\}$. **Range** of a function $f: A \to B$ is written as Ran(f) and defined as $Ran(f) = \{x: x \in B, y = f(x)\}$

Properties of real valued functions: Let f and g are any two real valued functions:

a. $(f \pm g)(x) = f(x) \pm g(x)$
b. $(f.g)(x) = f(x).\ g(x)$
c. $\frac{f}{g}(x) = \frac{f(x)}{g(x)} \text{ for } g(x) \neq 0$
d. $(kf)(x) = kf(x)$
e. $|f|(x) = |f(x)|$
f. $f^n(x) = [f(x)]^n$

MCQs

1. If $f(x-1) = 2x-5$, then $f(x+2)$ = ...
   a. x b. $2x-1$ c. $2x-5$ d. $2x+1$
2. A function f: R→R be defined by $f(x): x^2-4$, then f is .....
   a. one to one b. onto c. one to one onto d. neither one to one nor onto
3. Consider a set A = {–1, 0, 1}, then relation R satisfying the condition $x < y$, for all $x, y \in A$ is ....
   a. {(-1, 1), (0, -1), (0, 1)} b. {(-1, 0), (-1, 1), (0, 1)}
   c. {(1, 1), (0, 0), (0, 1)} d. {(-1, 1), (0, -1), (0, 1), (1, 0)}
4. Let A and B are any two sets such that n(A) = 3, n(B) = 4, then the number of all possible relations from set A to B is .....
   a. 12 b. 64 c. 81 d. 63
5. Let R = {(x, y): $x, y \in N, 2x + y = 7$}, then which one of the following is Range?
   a. {3} b. ϕ c. {1, 2, 3} d. {1, 3, 5}
6. If R = {(3, 2), (4, 2), (3, 1), (7, 1), (2, 3)} is to be a function. Then which one of the following must be removed from the set?
   a. (3, 2) b. (4, 2) c. (2, 3) d. (7, 1)
7. Which one of the following cannot be a domain of f(x): $\frac{x+2}{x-2}$?
   a. 2 b. –2 c. 0 d. 2 and –2
8. If $p(x) = 4x - 6$ and $p(a) = 0$, then a = ...
   a. 3/2 b. –6 c. 2/3 d. -3/2
9. Which one of the following relation is both even and odd?
   a. $x^2 + y^2 = 1$ b. $x - y = 0$ c. $x + y = 0$ d, $x^2 + y = 1$
10. If $f(x, y) = 3x + 2y$ and $g(x, y) = x^2 - y^2$ for all real number x and y then f(g(1, 2), 3) = ...
    a. 40 b. –3 c. 9 d. 6
11. If $g(x) = 3x + 2$ and g(f(x)) = x, then f(2) = ...
    a. 6 b. 3 c. –1 d. 0
12. Which one of the following values must be excluded from the domain of $\frac{f}{g}(x)$ if $f(x) = 3x^2 - 4x + 1$ and $g(x) = 3x^2 - 3$?
    a. 3 b. 1/2 c. –1 d. none
13. Let f: R→R be defined by $f(x) = 2x - 1$, then $(f - 3)x$ = ...
    a. $2x - 4$ b. $-x - 4$ c. $5x - 1$ d. $5x - 3$
14. Let f: R – {2} → R – {1} be defined by $f(x) = \frac{x}{x-2}$ then which one of the following is the formula that defined f^{-1}?
    a. does not exists b. $\frac{2x}{x-1}$ c. $\frac{x}{x-1}$ d. $\frac{x}{2}$
15. If $f(x) = (10 - x)^2$ and m = f(6), then which one of the following equal to 4m?
    a. f(12) b. f(18) c. f(24) d. f(8)
16. If $f(x) + 2f(x) = x$ and $f(1/x) - 3f(1/x) = 1/2x$, then f(x) is .....
    a. x b. $\frac{x}{10}$ c. $\frac{x}{1}$ d. $\frac{1}{10x}$

Polynomial

Polynomial function: An expression f(x) = $a_0x^n + a_1x^{n-1} + a_2x^{n-2}.....+a_n$, where the constant $a_0 \neq 0$; n, n - 1, n - 2 ..... are in descending is called polynomial function of degree n in x.

When f(x) = 0, the expression $a_0x^n + a_1x^{n-1} + a_2x^{n-2} + ...+a_n = 0$ is known as polynomial equation of degree n in x.

Value x = a is said to be zero's of polynomial f(x) whenever f(a) = 0.

let $f(x) = x^2 - 7x + 12$,

Here, $f(3) = 3^2 - 7.3 + 12 = 0$

$f(4) = 4^2 - 7.4 + 12 = 0$

$\therefore$ 3 and 4 are the zero's of f(x).

The values of the variable which satisfies the polynomial equation f(x) = 0 are called the roots (solutions) of the equation.

Note: 1. Every polynomial equation has at least one root (fundamental theorem of Algebra).

2. The number of the roots of any polynomial equation is not exceeds the degree of the equation.

Factor theorem (Division Algorithm): When any polynomial function f(x) is divided by x - a, there exists Q(x) the quotient and R(x) the remainder then F(x) = (x - a) Q(x) + R(x)

If R(x) = 0, then f(x) = (x - a) Q(x) $\Rightarrow$ (x - a) is a factor of f(x).

Remainder theorem: A polynomial f(x) is divided by x - a then the remainder R = f(a).

Quadratic equation:- The equation of the ferm $ax^2 + bx + c = 0$, where a, b, c are constant and $a \neq 0$ is known as quadratic equation in x. i.e. second degree polynomial equation in a certain variable is called a quadratic equation.

The quadratic equation of the form $ax^2 + c = 0$ is known as pure quadratic equation.

The roots of pure quadratic equation are $x = \pm \sqrt{\frac{-c}{a}}$.

Let α and β are roots of $ax^2 + bx + c = 0$, such that $\alpha = \frac{-b+\sqrt{b^2-4ac}}{2a}$, $\beta = \frac{-b-\sqrt{b^2-4ac}}{2a}$.

Then sum of roots, $\alpha + \beta = \frac{-b+\sqrt{b^2-4ac}}{2a} + \frac{-b-\sqrt{b^2-4ac}}{2a}$

$= \frac{-b+\sqrt{b^2-4ac}-b-\sqrt{b^2-4ac}}{2a}$

$= -\frac{2b}{2a}$

$= -\frac{b}{a}$

Product of roots , $\alpha.\beta = \frac{(-b+\sqrt{b^2-4ac})}{2a}\frac{(-b-\sqrt{b^2-4ac})}{2a}$

$$= \frac{(-b)^2-(\sqrt{b^2-4ac})^2}{4a^2}$$

$$= \frac{b^2-b^2+4ac}{4a^2}$$

$$= \frac{c}{a}$$

The quadratic equation $ax^2 + bx + c = 0$ for $a \neq 0$

$\Rightarrow x^2 + \frac{b}{a}x + \frac{c}{a} = 0$

$\Rightarrow x^2 - \left(-\frac{b}{a}\right)x + \frac{c}{a} = 0$

$\Rightarrow x^2 -$ (sum of roots)x + product of roots = 0

For any quadratic equation $ax^2 + bx + c = 0$, $b^2 - 4ac$ is discriminant of the roots.

1. When $b^2 - 4ac > 0$, the roots of the equation are real and unequal. In particular, $b^2 - 4ac > 0$ and perfect square, the roots of the equation are rational and unequal provided a, b, c are rational.
2. When $b^2 - 4ac = 0$, the roots of the equation are real (rational) and equal.
3. When $b^2 - 4ac < 0$, the roots of the equation are imaginary and unequal.

- If one root of equations $a_1x^2 + b_1x + c_1 = 0$ and $a_2x^2 + b_2x + c_2 = 0$ is common then $(a_1b_2 - a_2b_1)(b_1c_2 - b_2c_1) = (c_1a_2 - c_2a_1)^2$.
- If both roots of the equations $a_1x^2 + b_1x + c_1 = 0$ and $a_2x^2 + b_2x + c_2 = 0$ are common then $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$.
- If root of $ax^2 + bx + c = 0$ is reciprocal of other then a = c.
- If one root of $ax^2 + bx + c = 0$ is equal to the other roots in magnitude but opposite in sign then b = 0.
- The roots of a quadratic equation having rational co-efficient are not rational.
  - Then they are both irrational or both imaginary
  - The roots appears as conjugate to each other.
- The roots of quadratic equation $ax^2 + bx + c = 0$ are real and same sign if a and c has same sign but b has opposite sign and are in opposite sign if a and c has opposite sign.

MCQs

1. The Remainder when $4x^3 - 3x^2 + 2$ is divided by x - 2 is:
   a. 20 b. 22 c. 16 d. 24
2. 2 and 3 are the zeros of $f(x) = 2x^3 + mx^2 - 13x + n$ then the values of m and n respectively are:
   a. -5, -30 b. -5, 30 c. 5, 30 d. 5, -30
3. The remainder when $x^3 - 3x^2 - 2x + a$ is divided by x + 2 is twice the remainder when it is divided by x – 3. Then the value of a is:
   a. 6 b. 0 c. 2 d. -4
4. The sum of the roots of $3x^2 - 4x + 4 = 0$ is:
   a. $\frac{4}{3}$ b. 3 c. $-\frac{4}{3}$ d. 4
5. If sum and product of roots of any quadratic equations are 2 and 3 then the equation is:
   a. $x^2 - 2x + 3 = 0$ b. $x^2 + 3x - 2 = 0$ c. $x^2 + 5x + 6 = 0$ d. $x^2 - 5x + 6 = 0$
6. For what value of k one root of $2x^2 - (6 + k)x + (2 + k) = 0$ is zero?
   a. 0 b. 6 c. 2 d. -2
7. For what value of m will the quadratic equation $x^2 - 2(5 + 2m)x + 3(7 + 10m) = 0$ have reciprocal roots?
   a. $\frac{1}{2}$ b. 2 c. $-\frac{2}{3}$ d. $\frac{2}{3}$
8. Which one of the following is the quadratic equation whose roots are twice the roots of $7x^2 + 4x + 3 = 0$?
   a. $2x^2 - 5x + 4 = 0$ b. $3x^2 + 4x - 7 = 0$
   c. $7x^2 - 8x + 12 = 0$ d. $12x^2 - 7x + 5 = 0$
9. If roots of the equation $x^2 - px + q = 0$ be in the ratio 2:3 then .....
   a. $2p^2 = 9q$ b. $6p^2 = 25q$ c. $4q^2 = 9p^2$ d. $3q^2 = 25p$
10. For what value of k which the equation $3x^2 - (7 - k)x + 9 = 0$ has roots numerically equal but opposite in sign.
    a. 3 b. - 9 c. -7 d. 7
11. If α and β are the roots of the equation $x^2 - x - 2 = 0$ then $\alpha^2 + \beta^2$ = ...
    a. 5 b. 2 c. -2 d. 9
12. The roots of the equation $7x^2 - 3x - 4 = 0$ are .....
    a. real and unequal b. real and equal
    c. rational and unequal d. imaginary and unequal
13. The value of the expression $\sqrt{6+\sqrt{6+\sqrt{6+.....}}} + \infty =$
    a. 1, 0 b. 2, -1 c. 3, 1 d. -3, 2

Trigonometry

System of measurement of angles

a. Sexagesimal system:

In this system, the unit of measurement of angles is degree.

60 seconds = 1 minute (symbolically 60'' = 1')

60 minutes = 1 degree (symbolically 60' = 1^0)

Types on angles:

i. an acute angle: $0^0 \le \theta < 90^0$

ii. an obtuse angle: $90^0 < \theta < 180^0$

iii. a reflex angle: $180^0 < \theta < 360^0$

iv. a right angle: $\theta = 90^0$

v. a straight angle: $\theta = 180^0$

Note:

i. The hour hand of a clock rotate through an angle of 30^0 in one hour.

i.e. in 12 hrs = 360^0

$$1 \text{ hr} = \frac{360^0}{12} = 30^0$$

ii. The minute hand of a clock rotate through an angle of 60^0 in one minute.

i.e. in 60 minutes = 360^0

$$1 \text{ minute} = \frac{360^0}{60} = 6^0$$

iii. $\pi = \dfrac{\text{Circumference of a circle}}{\text{Diameter of a circle}}$

$\left(\dfrac{2\pi r}{2r} = \pi\right)$

iv. $\theta = \dfrac{s}{r}$ (radian measure)

where

$s \rightarrow$ length of an arc

$\theta \rightarrow$ angle subtended by the arc at the centre of the circle

$r \rightarrow$ radius of the circle

are of sector (A) = $\dfrac{1}{2} r^2\theta$

Trigonometric ratios:

a. $\tan\theta = \dfrac{\sin\theta}{\cos\theta}, \cot\theta = \dfrac{\cos\theta}{\sin\theta}$

$\sin\theta . \operatorname{cosec}\theta = 1$

$\cos\theta . \sec\theta = 1$

$\tan\theta . \cot\theta = 1$

b. (i) $\sin^2\theta + \cos^2\theta = 1$

(ii) $\sec^2\theta - \tan^2\theta = 1$

(iii) $\operatorname{cosec}^2\theta - \cot^2\theta = 1$

c. $|\sin\theta| \le 1$, $|\cos\theta| \le 1$

$|\operatorname{cosec}\theta| \ge 1$, $|\sec\theta| \ge 1$, for all real θ

$\tan\theta, \cot\theta \in \Re$

Table of values of Trigonometric function and different angles.

θ	**0^0**	**30^0**	**45^0**	**60^0**	**90^0**	**120^0**	**135^0**	**150^0**	**180^0**
sinθ	0	1/2	1/√2	√3/2	1	√3/2	1/√2	1/2	0
cosθ	1	√3/2	1/√2	½	0	-1/2	-1/√2	-√3/2	-1
tanθ	0	1/√3	1	√3	∞	-√3	-1	-1/√3	0
cosecθ	∞	2	√2	2/√3	1	2/√3	√2	-√3	∞
secθ	1	2/√3	√2	2	∞	-2	-√2	-2/√3	-1
cotθ	∞	√3	1	1/√3	0	-1/√3	-1	-√3	∞

Formulas for t-ratios

I.

i. sin (-A) = sinA
ii. cos (-A) = cosA
iii. tan (-A) = -tanA
iv. cot (-A) = cotA
v sec (-A) = secA
vi. cosec (-A) = cosecA

II.

i. sin (90 + A) = cosA
ii. cos (90 + A) = -sinA
iii. tan (90 + A) = -cotA
iv. cot (90 + A) = -tanA
v. sec (90 + A) = cosecA
vi. cosec (90 + A) = secA

III.

i. sin(90 - A) = cosA
ii. cos(90 - A) = sinA
iii. tan(90 - A) = cotA
iv. cot(90 - A) = tanA
v cosec(90 - A) = secA
vi. sec(90 - A) = cosecA

IV.

i. sin(180 - A) = sinA
ii. cos(180 - A) = -cosA
iii. tan(180 - A) = -tanA
iv. cot(180 - A) = -cotA
V cosec(180 - A) = cosecA
vi. sec(180 - A) = -secA

V.

i. sin(180 + A) = -sinA
ii. cos(180 + A) = -cosA
iii. tan(180 + A) = tanA
iv. cot(180 + A) = cotA
v sec(180 + A) = -secA
vi. cosec(180 + A) = -cosecA

VI.

i. sin(270 - A) = -cosA
ii. cos(270 - A) = -sinA
iii. tan(270 - A) = cotA
iv. cot(270 - A) = tanA
V sec(270 - A) = -cosecA
vi. cosec(270 - A) = -secA

VII.

i. sin(270 + A) = -cosA
ii. cos(270 + A) = sinA
iii. tan(270 + A) = -cotA
iv. cot(270 + A) = -tanA
v sec(270 + A) = cosecA
vi. cosec(270 + A) = -secA

VIII. For n ∈ I

i. sin(n.360 + θ) = sinθ
ii. cos(n.360 + θ) = cosθ
iii. tan(n.360 + θ) = tanθ
iv. sec(n.360 + θ) = secθ
V cosec(n.360 + θ) = cosecθ
vi. cot(n.360 + θ) = cotθ

Results on compound angles

a. sin(A + B) = sinA. cosB + cosA. sinB
b. sin(A – B) = sinA. cosB – cosA. sinB
c. cos(A + B) = cosA cosB – sinA. sinB
d. cos(A – B) = cosA. cosB + sinA.sinB

e. $\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A.\tan B}$

f. $\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A.\tan B}$

g. $\cot(A + B) = \frac{\cot A.\cot B - 1}{\cot B + \cot A}$

h. $\cot(A - B) = \frac{\cot A.\cot B + 1}{\cot B - \cot A}$

i. sin(A + B). sin(A - B) = $\sin^2 A - \sin^2 B = \cos^2 B - \cos^2 A$

Multiple angles

i. $\sin 2\theta = 2\sin\theta.\cos\theta = \frac{2\tan\theta}{1 + \tan^2\theta}$

ii. $\cos 2\theta = \begin{cases} \cos^2\theta - \sin^2\theta \\ 1 - 2\sin^2\theta \\ 2\cos^2\theta - 1 \end{cases}$

$= \frac{1-\tan^2\theta}{1+\tan^2\theta}$

iii. $\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta}$

iv. $2\cos^2 A = 1 + \cos 2A$

$\Rightarrow \cos^2 A = \frac{1+\cos 2A}{2}$

$2\sin^2 A = 1 - \cos 2A$

$\Rightarrow \sin^2 A = \frac{1-\cos 2A}{2}$

v. $\sin 3A = 3\sin A - 4\sin^3 A$

vi. $\cos 3A = 4\cos^3 A - 3\cos A$

vii. $\tan 3A = \frac{3\tan A - \tan^3 A}{1-3\tan^2 A}$

viii. $\cot 3A = \frac{\cot^3 A - 3\cot A}{3\cot^2 A - 1}$

Half Angles

a. $\sin A = 2\sin\frac{A}{2}.\cos\frac{A}{2} = \frac{2\tan\frac{A}{2}}{1+\tan^2\frac{A}{2}}$

b. $\cos A = \cos^2\frac{A}{2} - \sin^2\frac{A}{2}$

$= 1 - 2\sin^2\frac{A}{2} = 2\cos^2\frac{A}{2} - 1$

$= \frac{1-\tan^2\frac{A}{2}}{1+\tan^2\frac{A}{2}}$

c. $\tan A = \frac{2\tan\frac{A}{2}}{1-\tan^2\frac{A}{2}}$

d. $2\cos^2\frac{A}{2} = 1 + \cos A$

e. $2\sin^2\frac{A}{2} = 1 - \cos A$

f. $\sin A = 3\sin\frac{A}{3} - 4\sin^3\frac{A}{3}$

g. $\cos A = 4\cos^3\frac{A}{3} - 3\cos\frac{A}{3}$

h. $\tan A = \frac{3\tan\frac{A}{3} - \tan^3\frac{A}{3}}{1-\tan^2\frac{A}{3}}$

Transformation formulae

a. $2\sin A.\cos B = \sin(A+B) + \sin(A-B)$

b. $2\cos A.\sin B = \sin(A+B) - \sin(A-B)$

c. $2\cos A.\cos B = \cos(A+B) + \cos(A-B)$

d. $2\sin A.\sin B = \cos(A-B) - \cos(A+B)$

e. $\sin C + \sin D = 2\sin\left(\frac{C+D}{2}\right).\cos\left(\frac{C-D}{2}\right)$

f. $\sin C - \sin D = 2\cos\left(\frac{C+D}{2}\right).\sin\left(\frac{C-D}{2}\right)$

g. $\sin(A+B).\sin(A-B) = \sin^2 A - \sin^2 B = \cos^2 B - \cos^2 A$

h. $\cos(A+B).\cos(A-B) = \cos^2 A - \sin^2 B = \cos^2 B - \sin^2 A$

Inverse Trigonometric Function:

If x = sinθ, cosθ, tanθ ..... then the functions $\sin^{-1}x$, $\cos^{-1}x$, $\tan^{-1}x$ ..... represents inverse trigonometric function.

Properties of Triangle

- **Cosine law: For any triangle ABC,**
  1. $\cos A = \frac{b^2+c^2-a^2}{2bc}$
  2. $\cos B = \frac{c^2+a^2-b^2}{2ac}$
  3. $\cos C = \frac{a^2+b^2-c^2}{2ab}$
- **Sine Law:**
  1. For any triangle ABC,
     $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
  2. For any triangle ABC,
     $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$
     Where R is circum radius.
- **Projection Law:**
  For any triangle AB C,
  1. a=b cosC + c cos B
  2. b=c cosA + a cos C
  3. c= a cosB + b cos A

- **Area of triangle:**
  1. $\Delta = \frac{1}{2} \times \text{base} \times \text{height}$
  2. For any triangle ABC.
     $\Delta = \frac{1}{2}bc\sin A = \frac{1}{2}ac\sin B = \frac{1}{2}ab\sin C$
  3. $\Delta = \frac{1}{2}bc\sin A$
     $\Rightarrow \Delta = \frac{1}{2}bc.\frac{a}{2R}$ [sine law]
     $\Rightarrow \Delta = \frac{abc}{4R}$
  4. $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$
     where $s = \frac{a+b+c}{2}$
  4. $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$,
     $\Rightarrow \Delta = \frac{1}{4}\sqrt{2a^2b+2b^2c^2+2c^2a^2-a^4-b^4-c^4}$

MCQs

1. The radius of a circle if an angle of 20^0 is subtended at its centre by an area of length 44 cm is:
   a. 220 cm b. 396 cm c. 144cm d. 126 cm
2. Value of $\sin^2 25^0 + \sin^2 65^0$ = ...
   a. 0 b. 1 c. -1 d. none
3. The minimum value of $\sin^4\theta+\cos^4\theta$ = ……..
   a. 0 b. $\frac{1}{2}$ c. 2 d. $\frac{1}{\sqrt{2}}$
4. The maximum value of $3\cos\theta+4\sin\theta$ is :
   a. 3 b. 4 c. 5 d. 1
5. Value of $\cos 22\frac{1}{2}^0$ = …….
   a. $\frac{-1+\sqrt{5}}{4}$ b. $\frac{-1-\sqrt{5}}{4}$ c. $\sqrt{\frac{\sqrt{2}-1}{2\sqrt{2}}}$ d. $\frac{1}{2}\left(\sqrt{2+\sqrt{2}}\right)$
6. Value of $\cot 7\frac{1}{2}^0$
   a. $\frac{\sqrt{\sqrt{3}+2}-1}{2\sqrt{2}}$ b. $\frac{\sqrt{3}+1}{2\sqrt{2}}$ c. $\sqrt{6}+\sqrt{3}+\sqrt{2}+2$ d. $\sqrt{3}+\sqrt{2}+1$
7. Value of $\sin\frac{\pi}{10}+\sin\frac{9\pi}{10}$ =
   a. $\frac{\sqrt{3}}{2}$ b. $\frac{1}{\sqrt{2}}$ c. $-\frac{1}{2}$ d. $\frac{\sqrt{5}-1}{2}$
8. Value of $\cos 12^0 + \cos 84^0 + \cos 156^0 + \cos 132^0$ = ……..
   a. $\frac{1}{2}$ b. 1 c. $-\frac{1}{2}$ d. $-\frac{1}{8}$
9. If $\tan\theta+\sin\theta = m$ and $\tan\theta - \sin\theta = n$, then m^2-n^2= ……..
   a. 4mn b. $4\sqrt{mn}$ c. $2\sqrt{mn}$ d. m^2+n^2
10. If $\sin\alpha+\sin\beta = a$, $\cos\alpha + \cos\beta = b$. Then $\sin(\alpha+\beta)$= ……..
    a. $\frac{2ab}{a^2+b^2}$ b. $\frac{ab}{a^2-b^2}$ c. $\frac{ab}{a^2+b^2}$ d. $\frac{ab}{a+b}$
11. If $\sin A+\operatorname{cosec} A = 2$. Then $\sin^8 A+\operatorname{cosec}^{16} A$ = ……..
    a. 2 b. 1 c. 0 d. -2
12. If $\sin Q_1+\sin Q_2+\sin Q_3 = 3$, then $\cos Q_1+\cos Q_2+\cos Q_3$ = …….
    a. 3 b. 2 c. 1 d. 0
13. If $\cos\theta-\sin\theta = \sqrt{2}\sin\theta$, then $\cos\theta+\sin\theta$ = …….
    a. $\sqrt{2}\cos\theta$ b. $\sqrt{2}\sin\theta$ c. $2\cos\theta$ d. $-\sqrt{2}\cos\theta$

14. $Tan1^0.Tan2^0$ ……..$Tan89^0$=……
    a. ∞ b. $\frac{1}{2}$ c. 1 d. $\frac{1}{\sqrt{2}}$
15. If three sides of a triangle are 1, $\sqrt{3}$, 2 then the smallest angle of the triangle is …….
    a. 30^0 b. 90^0 c. 120^0 d. 150^0
16. In a triangle ABC, x^2+x+1, 2x+1 and x^2-1 , represent the sides, then the greatest angle of a triangle is:
    a. 60^0 b. 90^0 c. 120^0 d. 135^0
17. If the ratio of angles of a triangle is 1:2:3 then which one of the following is ratio of its sides?
    a. 1:2:3 b. 1: $\sqrt{2}$:3 c. 1: $\sqrt{3}$: 2 d. 2:3: $\sqrt{6}$

Arithmetics

Percentage

Percent refers a specified amount in every hundred. The fraction of x parts out of hundred equal parts is known as x percentage and written as x%.

Fraction Decimal Percentage

$\frac{4}{5} \longrightarrow 0.8 \longrightarrow \frac{80}{100} = 80\%$

- To find the value of given percentage of a given quantity, multiply the quantity by the given percentage. i.e. 40% of 60 = $\frac{40}{100} \times 60 = 24$
- To express the part of whole quantity as the percent of a whole quantity, make the ratio of part to the whole quantity and multiply it by 100%. i.e. the percentage of 40 out of 200 = $\frac{40}{200} \times 100\% = 20\%$.
- To find the whole quantity when its value of certain percentage is given, divide the given value by given percentage.

  i.e. the number whose 25% is 40 = $\frac{40}{25\%} = \frac{\frac{40}{25}}{100} = 160.$
- The percentage increase of a quantity = $\frac{\text{actual increase}}{\text{original quantity}} \times 100\%$
- The percentage decrease of a quantity = $\frac{\text{actual decrease}}{\text{original quantity}} \times 100\%$
- To increase a number by x% multiply it by (1 + x%)

- To calculate the net% increase or decrease for two successive increase or decrease. Use the formula tabulated below.

	change in x	change in y	net change %
1.	Increase by x%	Increase by y%	$x + y + \frac{xy}{100}$
2.	Increase by x%	Decrease by y%	$x - y - \frac{xy}{100}$
3.	Decrease by x%	Increase by y%	$-x + y - \frac{xy}{100}$
4.	Decrease by x%	Decrease by y%	$-x - y + \frac{xy}{100}$

  The net change will be increase or decrease according as the results occurs positive (+ve) or negative (-ve).
- If a number is result of increment of another number by x%, then the original number = $\frac{\text{Increase amount}}{1+x\%}$
- If a number is result of decrement of another number by x%, then the original number = $\frac{\text{Decrease amount}}{1-x\%}$

Profit and Loss

When an article is sold higher price than its cost price then one can make a profit. Instead, if an article is sold for lower price than its cost price then one can make a loss.

- A sum of money paid to agent or sellers by the company or a manufactures at a fixed rate based on the type of goods sold is called **commission**. In general, the commission is expressed as percentage (%).
- The deduction of the sum of money from the marked price of the goods is called the **discount**. The discount is usually expressed as the percentage.
- **Bonus** is the lump sum of money paid annually besides the salaries of the employees of the company as an incentive on the basis of the profit gained by the company. It is usually expressed in percentage and is decided by the management.

Some formulae

1. Discount = $\frac{\text{Actual Discount}}{\text{Marked Price}} \times 100$
2. Reduction in consumption after the price increment = $\left(\frac{r \times 100}{100+r}\right)\%$
3. Increasing rate in consumption after the reduction in price = $\left(\frac{r \times 100}{100-r}\right)\%$
4. Profit = S.P. – C.P.
5. Loss = C.P. – S.P.

6. Profit % = $\frac{\text{Profit}}{\text{C.P.}} \times 100$
7. Loss% = $\frac{\text{Loss}}{\text{C.P.}} \times 100$
8. S.P. = $\frac{(100+\text{P\%})\text{C.P.}}{100}$ Or, $\frac{(100-\text{L\%})\text{C.P.}}{100}$
9. C.P. = $\frac{100\times\text{S.P.}}{100+\text{P\%}}$ Or, $\frac{100\times\text{S.P.}}{100-\text{L\%}}$
10. Marked Price (M.P) = S.P. + Discount
11. MP – Discount = CP + Profit
12. If the price of an article is Rs. x and a discount of d% and VAT of V% is applied on it, then the price after VAT = $\frac{x\times(100-d\%)(100+V\%)}{100\times100}$
13. If two articles are bought for Rs. p and one is sold for x% profit and other for x% loss so that the selling price of both are equal then there will be always loss and percentage of loss = $\left(\frac{x}{10}\right)^2\%$.
14. Meaning of x% profit; S.P. = x% of (100 + x)%
15. Meaning of x% loss; S.P. = (100 – x)% of C.P.

Simple interest and Compound interest

If principal = P, Time = T, Annual rate of interest = R, Compound interest = C.I. and compound amount = C.A., then

1. Simple interest (I) = $\frac{P\times T\times R}{100}$
2. Time taken by certain sum of money to be n times itself is given by, T = $\frac{100(n-1)}{R}$
3. According to annual compound interest
   C.I. = $P\left[\left(1+\frac{R}{100}\right)^T-1\right]$ and C.A. = $P\left(1+\frac{R}{100}\right)^T$
4. According to semiannual compound interest
   C.I. = $P\left[\left(1+\frac{R}{200}\right)^{2T}-1\right]$ and C.A. = $P\left(1+\frac{R}{200}\right)^{2T}$

Compound depreciation and population growth

1. Compound Depreciation; $P_T = P\left(1-\frac{R}{100}\right)^T$

   Here, P_T = Price after T years

P = Initial Price
R = Depreciation Rate
T = Time

2. Population Growth; $P_T = P\left(1+\frac{R}{100}\right)^T$

Here, Population after T years
P = Initial population
R = Growth Rate
T = Time

Mensuration

Mensuration is the branch of mathematics which deals with the study of different geometrical shapes, their areas and Volume. In the broadest sense, it is all about the process of measurement.

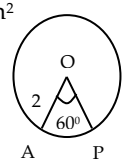
SN	Name	Area	Perimeter	Nomenclature
1.	Rectangle	A = $l \times b$	2(l + b)	l = length;b = breadth
2.	Square	a^2	4a	a = side
3.	Triangle	$\frac{1}{2}$bh or $\sqrt{s(s-a)(s-b)(s-c)}$	2s = a+b+c	b = base; h = height. a, b, c are sides; s = semi-perimeter
4.	Right triangle	$\frac{1}{2}$bh	2s = h+d+b	hypotenuse = $\sqrt{b^2+d^2}$
5.	Equilateral triangle	$\frac{1}{2}$ah or $\frac{\sqrt{3}}{4}a^2$	3a	a = side h = altitude
6.	Isosceles right triangle	$\frac{1}{2}a^2$	d + 2a	d = hypotenuse = $a\sqrt{2}$; a = each of equal side
7.	Parallelogram	b × h	2(a + b)	h = height; b = base; a = side
8.	Rhombus	$\frac{1}{2}d_1 . d_2$	4a	a = side; d_1 & d_2 are diagonals
9.	Quadrilateral	$\frac{1}{2}d(h_1 + h_2)$	sum of 4 sides	d = diagonal where heights h_1 & h_2 rests.
10.	Trapezium	$\frac{1}{2}h(a+b)$	sum of 4 sides	a & b are parallel sides and h is height
11.	Path outside	2d(l+b+2d)	-	d = width of paths
12.	Path inside	2d((l+b-2d)	-	b = breadth
13.	Path crossing	d(l+b-d)	-	l = length

14.	Circle	πr^2	$2\pi r$	r = radius
15.	Semicircle	$\frac{1}{2}\pi r^2$	$\pi r + 2r$	-
16.	Circular ring	$\pi(R^2-r^2)$	-	R = outer radius; r = inner radius
17.	Sector of circle	$\frac{\theta}{360} \times \pi r^2$	$l+2r$ where, $l = \frac{\theta}{360} \times \pi r^2$	θ = central angle; r = radius; l = length of arc.
18.	Segment of circle	$r^2\left(\frac{\pi\theta}{360} - \frac{\sin\theta}{2}\right)$	$\frac{\theta}{360} \times 2\pi r + 2r \sin\frac{\theta}{2}$	r = radius; θ = angle of the related sector

SN	Name	Lateral Surface Area	Total Surface Area	Volume	Nomenclature
1.	Cuboid	$2h(l+b)$	$2(lb+bh+lh)$	lbh	l = length; b = breadth; h = height
2.	Cube	$4a^2$	$6a^2$	a^3	a = side
3.	Right Circular cylinder	$2\pi rh$	$2\pi r(r+h)$	$\pi r^2 h$	r = radius of base; h = height
4.	Sphere	-	$4\pi R^2$	$\frac{4}{3}\pi R^3$	R = Radius
5.	Hemisphere	$2\pi R^2$	$3\pi R^2$	$\frac{2}{3}\pi R^3$	R = Radius
6.	Spherical Shell (Hollow)	-	$4\pi(R^2+4\pi r^2)$	$\frac{4}{3}\pi(R^3-r^3)$	R = outer radius; r = inner radius
7.	Cone	πrl	$\pi r(l+r)$	$\frac{1}{3}\pi r^2 h$	r = radius; h = height; l = slant height
8.	Tetrahedron	$\frac{3\sqrt{3}a^2}{4}$	$\sqrt{3}\,a^2$	$\frac{\sqrt{2a^3}}{12}$	a = side
9.	Right pyramid	$\frac{1}{2}$ (perimeter of base) × (slant height)	Area of base + lateral surface area	$\frac{1}{3}$ (area of base) × height	-
10.	Square based Pyramid	$a\sqrt{4h^2+a^2}$	$a^2 + \sqrt{4h^2+a^2}$	$\frac{1}{3}a^2h$	a = side; h = height

MCQs

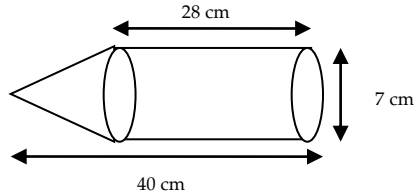
1. The area of square field is 144 m^2, then its perimeter is ...
   a. 12m b. 48m c. 144m d. 150m
2. If length of diagonal of square field is $7\sqrt{2}$ m, then which one of the following is its area?
   a. $28\sqrt{2}m^2$ b. $98m^2$ c. $49m^2$ d. $14m^2$
3. The breadth of a rectangular garden having 120m length is one third less than length. What will be the cost of pairing the garden with square stones of length 40m at Rs.20 for each stone?
   a. Rs. 270 b. Rs. 400 c. Rs. 600 d. Rs. 900
4. 2m wide paths are crossed each other at the middle of rectangular field. If the area of cross path is $196m^2$ and it's length 60m, then what will be its breadth?
   a. 48 b. 40 c. 38 d. 28
5. If the circumference of a circle is 4π. Then its area is ...
   a. π b. 2π c. 3π d. 4π
6. If a motor car is driven at the rate of 66km/hr. Each of its wheel makes 500 revolution per minute. What is the radius of wheel?
   a. 0.35m b. 0.67m c. 0.7m d. 0.87m
7. Which one of the following is the area of triangle ABC?
   a. $\frac{455}{4}cm^2$ b. $\frac{1}{4}\sqrt{455}\ cm^2$ c. $4\sqrt{455}\ cm^2$ d. 12 cm^2
8. The area of sector AOP in the adjoining figure is ....
   a. 4π b. 6π c. $\frac{2\pi}{3}$ d. $\frac{4\pi}{3}$



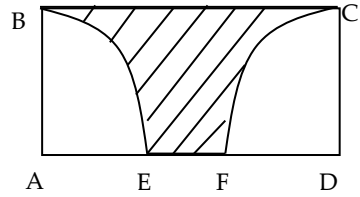
9. How many cubes with 4 cm can be made from a cube with 16 cm in length?
   a. 4 b. 16 c. 64 d. 404
10. Which one of the following is circumference of a cylinder of which the total surface area is 1628 cm^2 and sum of height and radius is 148 cm?
    a. 11.3 cm b. 12 cm c. 10.5 cm d. 11 cm
11. A solid sphere of radius 2 cm has been cut into two equal halves. Then the total surface area of single half is .....
    a. $16\pi\ cm^2$ b. $8\pi cm^2$ c. $12\pi cm^2$ d. $4\pi cm^2$
12. How much litre of water be occupied by a tank of length 3m, breadth 2m and weight 1m?
    a. 6 ltr b. 600 ltr c. 6000 ltr d. 60,000 ltr
13. A square pyramid is inscribed in a cylinder whose base radius is 4 and height is 9. What is the volume of the pyramid?
    a. 108 b. 96 c. 144 d. none

14. A right circular cone whose base radius is 12 is inscribed in a sphere of radius 13. What is the volume of the cone?
    a. 720π b. 1440π c. $2592\ \pi$ d. $864\ \pi$

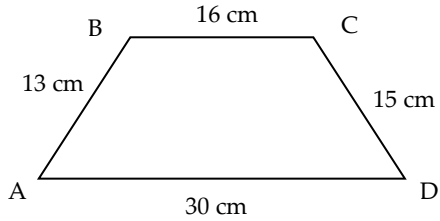
15. Three tennis balls that fit in cylindrical tennis ball cane. If each ball is 2.5 inches in diameter, what is the volume of air left between the balls and the cane?
    a. 8.2 b. 65.4 c. 8.2 d. 12.3
16. Which one of the following is the curved surface area of the given solids?
    a. 616 cm^2 b. 700 cm^2 c. 132 cm^2 d. 748 cm^2



17. In the figure ABCD is a rectangle, BC = 5, AB = 2, BE and CF are the areas of the circle centered at A and D. What is the area of shaded region?
    a. 2π b. π c. $10 - 2\pi$ d. $5 - \pi$



18. What will be the area of adjoining Trapezium?
    a. 276 cm^2 b. 240 cm^2 c. 195 cm^2 d. 225 cm^2



19. If the diameter of a sphere is doubled then the volume is increased by .....
    a. 2 times b. 4 times c. 6 times d. 8 times

Arithmetic

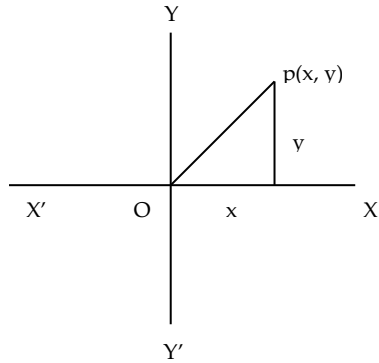
MCQs

1. If x is increased by 20%. Then by how much x^2 is increased?
   a. 20% b. 400% c. 44% d. 444%
2. If A man losses Rs. 60 if 15% discount is offered for a marked price and makes the profit of Rs. 60 if 10% discount is offered. Then the marked price of the goods is....
   a. Rs. 2400 b. Rs. 2100 c. Rs. 2000 d. Rs. 1800
3. The salary of A is 25% more than the salary of B. The by how much salary of B is less than salary of A?
   a. 25% b. $16\frac{2}{3}\%$ c. $22\frac{1}{2}\%$ d. 20%
4. By selling watch for Rs. 4500 a dealer losses 10%. At what price should he sell so as to gain 10%.
   a. 4500 b. 5000 c. 5050 d. 5500
5. If the radius of a circle is decreased by 30%, by what percent will the area of circular region be decreased?
   a. 15% b. 49% c. 51% d. 60%
6. If there are two containers of sugar solution, the first is 4% concentration and second is 8% concentration. How much of each should we combine to get 40 gallons of 5% concentrate solution?
   a. 20, 20 b. 10, 30 c. 30, 10 d. 15, 25
7. If a tourist paid Rs. 5610 for a carvel window mode of wood with a discount of 15% including 10% VAT, what is the marked price of window?
   a. 5000 b. 6000 c. 6500 d. 6700
8. The price of commodities is increased by 20% then by how much the consumption should to reduce so as to maintain the previous status?
   a. 20% b. 18% c. $16\frac{2}{3}\%$ d. 25%
9. A milkman mixes 120 *l* of milk containing 5% of water with 80 ltr. of milk containing 10% of water. Then the percentage of water in mixture is,
   a. 7.5% b. 7% c. 10% d. 15%
10. The population of a village is 18000. When the male popu7lation is increased by 5% and female population is decreased by 5%, the total population remains the same. Then which one of the following is the female population of the village?
    a. 10,000 b. 8,000 c. 9,000 d. 7200
11. The sum of money that yields daily interest of Rs 5 at 10% per annum is
    a. Rs. 50 b. Rs. 1800 c. Rs. 18,250 d. Rs. 6400
12. A bank reduces the interest rate from 12% p.a. to 10.5% p.a. to expand its business. By how much is the yearly interest on Rs. 8,400 decreased?
    a. Rs. 126 b. Rs. 1008 c. Rs. 882 d. None

13. At what time a sum of money double itself at the rate of 8% p.a.?
    a. 8 year b. 10 year c. 12.5 year d. 16 year
14. A man deposited a part of Rs.1200 for 4 years at 12% p.a. in a finance company and he deposited remaining part for $3\frac{3}{5}$ years at 8% p.a. in a bank. If he received the same amount interest from the company and the bank. Then the sum deposited in these two places is.
    a. Rs. 1200, 450 b. Rs. 1200, 750 c. Rs. 1200, 1000 d. Rs. 450, 750
15. The sum of money increases by $\frac{1}{20}$ of itself every year. If it amounts to Rs. 1440 in 4 year then which one of the following is the sum?
    a. Rs. 1400 b. Rs. 1350 c. Rs. 1200 d. Rs. 1000
16. Which one of the following is the compound amount when Rs. 4500 is invested for 3 years at 15% per annum?
    A. Rs. 2343.94 b. Rs. 6843.94 c. Rs. 6000.45 d. Rs. 6063.06
    Ans (b)
17. Ramesh deposits Rs. 1000 in a finance company at the rate of 12% per annum. If the finance pays the interest compounded half yearly then which one of the following is the interest paid by the company at the end of 2 year?
    a. Rs. 1240 b. Rs. 120 c. Rs. 262.48 d. Rs. 254.40
18. If Rs. 1326 = $17 and Rs.1650 = £15, how many dollars can be exchanged for £195?
    a. $ 275 b. $ 225 c. $ 195 d. $ 625
19. The monthly minimum charge for 100 local calls each of 3 minutes duration is Rs. 180. The charge for per extra call of 3 minutes duration is Rs. 3. If a household paid a telephone bill of Rs.726 for a month including 10% TSC and 10% VAT, the number of extra calls in the month is,
    a. 420 b. 180 c. 140 d. 120
20. A can do a piece of work in 20 days, 'B' in 30 days 'C' in 40 days. All of them started the work together but A leaves its after 5 days and 'C' before 10 days of completion. Then B completes the work then the total time taken by work is .....
    a. $17\frac{1}{7}$ days b. $7\frac{1}{17}$ days c. $7\frac{1}{7}$ days d. $7\frac{1}{17}$ days
21. A tank is filled up by a pipe in 12 minutes and another pipe empties it in 15 minutes. If initially tank is empty and both pipes are left open then how long it takes to filled up?
    a. $6\frac{2}{3}$ min b. 60 min. c. 10 min. d. 9 min.
22. There was food for 1500 solders which would last them for 48 days. After 13 days some more soldiers joined them and the remaining food stuff lasted for 25 more days. Find how many solders joined them?
    a. 200 b. 400 c. 600 d. 800

Coordinate Geometry

A system of geometry where the position of points on the plane is described by using an order pair of numbers. The points are placed on the co-ordinate plane determined by two mutually perpendicular lines. The perpendicular distance of a point from y-axis is known as x-coordinate and is also known as 'abscissa' and the perpendicular distance of the point from x-axis is called y-coordinate and is also known as ordinate. The coordinate of any point is written in the form (x, y).



The Distance and Slop of a Line between two Points

If $P(x_1, y_1)$ and $Q(x_2, y_2)$ be any two points in the plane, then the distance between two points is:

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\text{Slope of } PQ = \frac{y_2 - y_1}{x_2 - x_1}$$

Area of the Triangle

The area of the triangle formed by the three points (x_1, y_1), (x_2, y_2) and (x_3, y_3) is:

$$\Delta = \frac{1}{2}\{x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3((y_1 - y_2)\}$$

Area of the triangle may be expressed in determinant form as: $\frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$

Section (Division) Formula

If a point (x, y) divides the line joining $A(x_1, y_1)$ and $B(x_2, y_2)$ in the ratio m:n **internally**, then the coordinates (x, y) can be obtained by

$$x = \frac{mx_2 + nx_1}{m + n}; \qquad y = \frac{my_2 + ny_1}{m + n}$$

and for **external** division, $x = \frac{mx_2 - nx_1}{m - n}$; $y = \frac{my_2 - ny_1}{m - n}$

Mid-point formula: If(x, y) is the mid-point of lane joing the points (x_1, y_1) and (x_2, y_2) Then

$$x = \frac{x_1 + x_2}{2}, \; y = \frac{y_1 + y_2}{2}$$

The Centroid of Triangle

The concurrent point of three medians of a triangle is called the centroid of the triangle, if A(x_1, y_1) , B (x_2 , y_2) and C (x_3, y_3) are three vertices of a triangle ABC then the centroid (x , y) of triangle is given by

$$x = \frac{x_1 + x_2 + x_3}{3} \text{ , } y = \frac{y_1 + y_2 + y_3}{3}$$

Locus and Equation

A path traced out by a point moving under some geometrical condition is called the locus of the point. The equation which satisfies every point on the locus but not the other points is called the equation of the locus.

Standard Equation of a Straight Lines

(i) Slope – intercept from: $y = mx + c$

(ii) Double – intercept from: $\frac{x}{a} + \frac{y}{b} = 1$

(iii) Point slope from: $y - y_1 = m(x - x_1)$

(iv) Two point from: $y - y_1 = \frac{y_2 - y_1}{x_2 - x_1} (x - x_1)$

(v) Normal from: $x \cos\alpha + y \sin\alpha = p$

Collinear Points

Any three points A, B and C are said to be collinear if they all lie on the same straight line. Three points A, B and C are collinear if any one of the following conditions is satisfied.

(i) AB + BC = AC or BC + CA = AB or CA + AB = BC

(ii) Slope of AB = Slope of BC

(iii) Co-ordinate of C satisfies the equation of the line passing through the points A and B.

(iv) Area of triangle ABC = 0.

Parallel Lines: Two lines are said to be parallel if their slopes are equal i.e. $m_1 = m_2$

Perpendicular Lines: Two lines are said to be perpendicular if the product of their slopes is -1. i.e. $m_1.m_2 = -1$.

Concurrent Lines: Any three lines are said to be concurrent if each of them passes through the point of intersection of the other two.

Angle between two Lines

The angles θ between two lines $y = m_1x + C_1$ and $y = m_2x + C_2$ is:

$$\tan\theta = \pm\left(\frac{m_1 - m_2}{1 + m_1m_2}\right) \qquad \Rightarrow \theta = \tan^{-1} \pm\left(\frac{m_1 - m_2}{1 + m_1m_2}\right)$$

The equations $A_1x + B_1y + C_1 = 0$ and $A_2x + B_2y + C_2 = 0$ in general form will be perpendicular if $A_1A_2 + B_1B_2 = 0$ and they will be parallel if $\frac{A_1}{A_2} = \frac{B_1}{B_2}$

Length of the Perpendicular from a Point on a Straight Line

(1) The perpendicular distance from a point (x^1, y^1) to the line $x\cos\alpha + y\sin\alpha = P$ is:
$\pm (x^1\cos\alpha + y^1\sin\alpha - P)$

(2) The perpendicular distance from a point (x^1, y^1) to the line $Ax + By + C = 0$ is:

$$\left|\frac{Ax^1 + By^1 + C}{\sqrt{A^2 + B^2}}\right|$$

- If $ax + by + c_1 = 0$ and $ax + by + c_2 = 0$ are two parallel lines then distance between them is $\left|\frac{C_1 - C_2}{\sqrt{a^2 + b^2}}\right|$
- Line parallel to x-axis is $y = b$.
- Line parallel to y-axis is $x = a$.
- Equation of x-axis is $y = 0$.
- Equation of y-axis is $x = 0$.
- The single equation $(a_1x + b_1y + c_1)(a_2x + b_2y + c_2) = 0$ represents two straight lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$.

Pair of straight lines

An equation in which the sum of the indices of unknown variables involving in the equation is the same to each term known as homogeneous equation.

An equation in which the sum of indices of unknown variable to each term is 2, known as homogeneous equation of degree-two.

$ax^2 + 2hxy + by^2 = 0$ always represents a line pair through origin.

Angle between the line pair represented by $ax^2 + 2hxy + by^2 = 0$

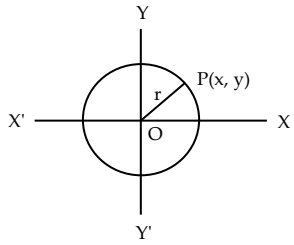
is given by $\text{Tan}\phi = \pm\frac{m_1 - m_2}{1 + m_1m_2} \Rightarrow \phi = \text{Tan}^{-1} \pm \frac{2\sqrt{h^2 - ab}}{a + b}$

The lines represented by $ax^2 + 2hxy + by^2 = 0$ will be parallel if $h^2 = ab$ and will perpendicular if $a + b = 0$

- The general equation of 2nd degree is $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$.
- The condition that the given equation of second degree represents a pair of straight line is
  $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$.
  i.e. $\begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0$
- The lines represented by $ax^2 + 2hxy + by^2 = 0$ will be real and distinct if $h^2 > ab$.
- If lines represented by $ax^2 + 2hxy + by^2 = 0$ are given by $y = m_1x$ and $y = m_2x$ then $m_1 + m_2 = -\frac{2h}{b}$ and $m_1m_2 = \frac{a}{b}$.

Circle

A circle is a locus points which moves in a plane such that its distance from a fixed point is always constant. The fixed point is called the centre and the constant distance is called the radius of the circle.



Equation of a Circle

(i) Centre at the origin (standard form)

$x^2 + y^2 = r^2$

(ii) Centre at any point (h, k)

$(x - h)^2 + (y - k)^2 = r^2$

(iii) The General equation $x^2 + y^2 + 2gx + 2fy + c = 0$ represents a circle whose centre is at $(-g, -f)$ and radius $\sqrt{g^2 + f^2 - c}$.

- The general equation of second degree $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ represents a circle if a = b and h = 0.
- The equation of circle on the join of (x_1, y_1) and (x_2, y_2) as diameter is $(x-x_1)(x-x_2) + (y-y_1)(y-y_2) = 0$.
- The circle $x^2 + y^2 + 2gx + 2fy + c = 0$ is real or imaginary accordingly as $g^2 + f^2 - c > 0$ or $g^2 + f^2 - c < 0$.
- If $g^2 + f^2 - c = 0$ then circle is point circle.
- The point $p(x_1, y_1)$ will be inside or on or outside the circle $x^2+y^2 = a^2$ accordingly as $x_1^2 + y_1^2$ is less, equal or greater than a^2 respectively.
- If C_1 and C_2 be the center of two circle with radii r_1 and r_2 then they will touch externally if $C_1C_2 = r_1+r_2$ and internally if $C_1C_2 = r_1-r_2$.

Some Important Points

(a) **Centroid:** The medians of a triangle meet at a point. This point is called centroid.

(b) **Orthocentre:** The perpendiculars drawn from the vertices on their opposite sides meet at a point. This point is known as 'orthocentre.'

(c) **Circumcentre:** The perpendicular bisectors of the sides of a triangle meet at a point. Then the point is known as circumcentre. The circumcentre is equidistance from vertices of the triangle. The equidistance is called circum radius, is denoted by R and the circle formed by the centre and the radius is called circumcircle.

(d) **In centre:** The bisectors of the internal angles of a triangle meet at a point known as incentre. The perpendicular distance from incentre to each sides of a triangle are equal, is called inradius, denoted by r. The circle formed by the centre and radius is called in circle.

(e) **Excentre:** The bisector of two external angles of a triangle meet at a point, called excentre. The distance between excentre to the substanded side, is called exradius and the circle formed by the centre and radius is called excircle. There are three excircle and the corresponding radius are denoted by r_1, r_2, r_3.

Centroid: $(x , y) = \left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3} \right)$

Incentre: $(x , y) = \left(\frac{ax_1 + bx_2 + cx_3}{a + b + c}, \frac{ay_1 + by_2 + cy_3}{a + b + c} \right)$.

MCQs

1. If (4, y) divides the join of (6, -1) and (3, 2) in the ratio of 2:1 then the value of y is:
   a) 2 b) 8 c) 1 d) 1/2
2. The acute angle between the line x – 3y -6 = 0 and y =2x +5 is:
   a) 30^0 b) 60^0 c) 45^0 d) 75^0
3. For what value of k, the three lines x -2y +1 = 0 and 2x – 5y + 3 = 0 and 5x + 9y + k = 0 are concurrent?
   a) -14 b) 4 c) 4 d) 14
4. The line x–y = 2 cuts the join of (3, -1) and (8, 9) in the ratio of …..
   a) 1:3 b) 2:3 c) 3:1 d) 3:2
5. The distance between 4x + 3y = 11 and 8x + 6y = 15 is:
   a) 7/2 b) 4 c) 7/10 d) None
6. Find the equation of line passing through (3, 2) and perpendicular to the line y = x is:
   a) x – y = 5 b) x + y = 5 c) x + y = 1 d) x – y = 1
7. The length of perpendicular from the point (a, 3) on line 3x + 4y + 5 = 0 is 4 then a =
   a) 1 b) -3 c) -3/4 d) 2
8. For what value of K will the points (1, 4), (-3, 16) and (K, -2) are collinear?
   a) 1 b) 3 c) 6 d) 10
9. The lines represented by the equation $x^2 + 2xy + y^2 – 2x -2y -15 = 0$ are
   a) x +y = 5 and x + y = 3 b) x + y = -5 and x – y =3
   c) x + y = -5 and x + y = 3 d) x + y =5 and x+ y = -3
10. The angle between the pair of lines given by $x^2 + 6xy + 9y^2 + 4x +12y -5 = 0$ is
    a) 0^0 b) 60^0 c) 30^0 d) 90^0
11. The equation $8x^2 +8xy+2y^2+ 26xy +13y+15 = 0$:
    a) Represents a pair of perpendicular lines
    b) Represents a pair of parallel lines
    c) Does not represents a pair of lines
    d) Represents a pair of lines inclined at certain angle
12. For what value of a will $(5a + 4)x^2 – (10a + 4)xy + (5a + 3)y^2 = 0$ represent two coincident lines?
    a. $\frac{8}{15}$ b. $\frac{-8}{25}$ c. 0 d. $\frac{16}{25}$

13 The angle between the pair of lines given by equation $x^2 + 2xy - y^2 = 0$ is:

a) $\frac{\pi}{3}$ b) $\frac{\pi}{6}$ c) $\frac{\pi}{2}$ d) 0

14. For what value of k, the equation
$4x^2 + 10xy + ky^2 + 5x + 10y = 0$ may represent two lines:

a) 2 b) -4 c) 2, $\frac{-3}{2}$ d) 4

15. What will be the angle between the pair of the straight lines represented by the equation
$x^2 - 2xy \operatorname{Cosec} 2\alpha + y^2 = 0$?

a) $(90^0 - 2\alpha)$ b) $(90^0 + 2\alpha)$ c) $(180^0 - 2\alpha)$ d) $(180^0 + 2\alpha)$

16. The angle between the lines $xy = 0$ is:

a) 60^o b) 90^o c) 0^o d) 120^o

17. For what value of λ will $(\lambda - 5)x^2 + 2\lambda y^2 - 5x + 6y - 3 = 0$ represents a circle.

a) 5 b) 10 c) 2 d) -5

18. What is the area of circle $x^2 + y^2 - 2x - 8y - 16 = 0$?

a) 36π b) 24π c) 33π d) 16π

19. The centre of the circle through origin, (p, 0) and (0, q) is ……

a) (p, q) b) $\left(\frac{p}{2}, \frac{q}{2}\right)$ c) (2p, 2q) d) (0, 0)

20. If the radius of the circle $x^2 + y^2 - 2x - 3y - k = 0$ is $\frac{5}{2}$ then the value of k is …..

a) 2 b) 3 c) 4 d) 5

21. ABC is an equilateral triangle of side 24cm. If the centroid O is the centre of the circle, then the radius of the circle is

a) $2\sqrt{3}$ cm b) $3\sqrt{3}$ cm c) $4\sqrt{3}$ cm d) None of these

Algebra I

An algebra is the branch of mathematics that deals with the general statements of relations, using the symbols or letters to represent specific sets of numbers, values, vectors, etc., in the description of such relations.

1. $a^2 - b^2 = (a + b)(a - b)$
2. $(a - b)^2 = a^2 - 2ab + b^2$
3. $(a + b)^2 = a^2 + 2ab + b^2$
4. $a^3 + b^3 = (a + b)(a^2 - ab + b)^2$
5. $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
6. $(a + b)^3 = a^3 + 3ab(a + b) + b^3$
7. $(a - b)^3 = a^3 - 3ab(a - b) + b^3$
8. $a^2 + b^2 = (a + b)^2 - 2ab$
9. $a^2 - b^2 = (a - b)^2 + 2ab$
10. $a^3 + b^3 = (a + b)^3 - 3ab(a + b)$
11. $a^3 - b^3 = (a - b)^3 + 3ab(a - b)$
12. $(a + b)^2 = (a - b)^2 + 4ab$
13. $(a - b)^2 = (a + b)^2 - 4ab$
14. $a^2 + b^2 = \frac{(a + b)^2 + (a - b)^2}{2}$
15. $ab = \frac{(a + b)^2 - (a - b)^2}{4}$
16. $(a + b + c)^3 = a^3 + b^3 + c^3 + 3(a + b)(b + c)(c + a)$
17. $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$
18. $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - 2ab - 2bc - 2ca)$

Indices

1. $a^m \times a^n = (a)^{m+n}$
2. $a^m \div a^n = (a)^{m-n}$
3. $(a^m)^n = (a)^{mn}$
4. $(a^m b^n)^p = a^{mp}\, b^{np}$
5. $\sqrt[n]{a^m} = a^{m/n}$
6. $(a)^0 = 1$

Ratio and proportion

1. The duplicate ratio of $\frac{x}{y}$ is $\frac{x^2}{y^2}$.
2. The sub duplicate ratio of $\frac{x}{y}$ is $\frac{\sqrt{x}}{\sqrt{y}}$.
3. The triplicate ratio of $\frac{x}{y}$ is $\frac{x3}{y3}$
4. The sub triplicate ratio of $\frac{x}{y}$ is $\frac{\sqrt[3]{x}}{\sqrt[3]{y}}$.
5. Two quantities are said to be ***commensurable***, if their can be exactly as the ratio of two integers, otherwise they will be ***incommensurable*** .
6. Quantities are said to be in continued proportion when the first is to the second as second is to the third, as third is to fourth ; and so on. i.e. a, b ,c, d are in continued proportion when a:b = b:c = c:d.
7. If three quantities a, b, c be in continued proportion, then b is called mean proportional between a and c.

8. If $\frac{a}{b} = \frac{c}{d}$, then $\frac{a+b}{a-b} = \frac{c+d}{c-d}$ is called ***componendo and dividendo*** .
9. A quantity is said to be vary directly as another, if change in one make the change in other in the same proportion.
10. A quantity is said to be vary inversely as another, when the first varies directly as the reciprocal of the second.

MCQs

1. If $x = 3 + \sqrt{8}$, then the value of $x^3 + \frac{1}{x^3}$ is:

   a. 6 b. 216 c. 198 d. 196

2. If $x = \frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ and $y = \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$, then the value of $x^2 + xy + y^2$ is:

   a. $5 - 2\sqrt{6}$ b. $5 + 2\sqrt{6}$ c. 10 d. 99

3. If $2^{x+3} = 32$, what is the value of 3^{x+2}?

   a. 5 b. 9 c. 27 d. 81

4. If $x = 3a + 7$ and $y = 9a^2$, what is 'y' in terms of x?

   a. $(x - 7)^2$ b. $3(x-7)^2$ c. $\frac{(x-7)^2}{3}$ d. $(x+7)^2$

5. If $y - \frac{1}{y} = 3$, find the value of $y^2 + \frac{1}{y^2}$.

   a. 12 b. 11 c. 9 d. 8

6. Simplify: $\sqrt[3]{a^{-5}.b^{-2}} \times \sqrt[3]{a^2b^5}$

   a. $\frac{a}{b}$ b. ab c. $\frac{b}{a}$ d. $a\sqrt{b}$

7. Simplify: $\frac{3^{x+2} - 3^x}{8.3^x}$

   a. 1 b. -1 c. 0 d. None of above

8. If $a^b = b^a$ and $a = 2b$, then value of a is...

   a. 1 b. 0 c. − 1 d. $\frac{1}{2}$

9. If $a = b^x$, $b = c^y$ and $c = a^z$, then x.y.z = ….

   a. 2 b. 1 c. 0 d. abc

10. If $x = 3^{1/3} - 3^{2/3}$, then $x^3 + 9x + 6$ = …..

    a. 0 b. 1 c. 2 d. 3

11. Which one of the following represents the degree of the $f(x, y) = x^3y^2 + 2x^2y + 4x^4$?

    a. 11 b. 4 c. 3 d. 5

12. If $50^{100} = k\,(100^{50})$ the value of k is

    a. 25^{50} b. 50^{50} c. $\left(\frac{1}{2}\right)^{50}$ d. None

13. If $x + \frac{1}{x} = 2$ then $\sqrt{x} + \frac{1}{\sqrt{x}}$ is

a. 2 b. -2 c. $\frac{2}{\sqrt{3}}$ d. $\sqrt{2}$

14. If $a^2 - 6a - 1 = 0$, then the value of $a^2 + \frac{1}{a^2}$ is

a. 30 b. 36 c. 38 d. 40

15. The factors of $a^2 + \frac{1}{a^2} - 11$ are

a. $\left(a + \frac{1}{a} + 3\right), \left(a - \frac{1}{a} + 3\right)$ b. $\left(a - \frac{1}{a} - 3\right), \left(a - \frac{1}{a} + 3\right)$

c. $\left(a - \frac{1}{a} - 3\right), \left(a + \frac{1}{a} + 3\right)$ d. $\left(a + \frac{1}{a} - 3\right), \left(a - \frac{1}{a} - 3\right)$

16. If $x^{1/m} = y^{1/m} = z^{1/p}$ and $xy = 1$ then $m + n + p$ is

a. 0 b. 1 c. 2 d. Cannot determined

17. If $\frac{2}{3}(x - 1) \le \frac{x + 4}{6}$ then

a. $x \le \frac{5}{3}$ b. $x \le \frac{8}{3}$ c. $x \le \frac{5}{4}$ d. $x \ge \frac{5}{3}$

18. If $a = 10^x$ $b = 10^y$ and $a^x b^y = 100$, then which of the following is true

a. $\frac{x}{y} = 10$ b. $xy = 100$ c. $xy = 1$ d. $\frac{y}{x} = 100$

19. A boy is 3 years older than his sister. Two years ago the sum of their ages was 19. How old is the boy now?

a. 13 years b. 12 years c. 11 years d. 10 years

20. The ratio of present age of Alex and his father is 1:4. After 6 years if the ratio of their ages will be 5:14, then which one of following represents their respective ages ?

a. 5 and 20 b. 7 and 21 c. 9 and 36 d. 3 and 12

21. For first 100 km of trip, Mr. A drove at 40 km per hour,then he drove at 40 km per hour for the next 120 km. What was his average speed in the entire trip ?

a. 45 km/hr b. 44 km/hr c. 60 km/hr d. 80 km/hr

22. In a race of 1 km, if A beats B by 50 m and B beats C by 50m. Then by how much A beats C ?

a. 250m b. 150m c. 147.5m d. 145m

23. If $2x = 3y = 4z$,then x:y:z =...

a. 2:3:4 b. 4:3:2 c. 6: 4:3 d. 2: 6:9

Sequence and Series

A sequence is an ordered set of numbers. The algebraic sum of the terms of the sequence is called series. A sequence is also called progression. In practice, we have following sequences:

Arithmetic Sequence: An ordered set of numbers in which the difference between any two successive terms always has the same value is called an arithmetic sequence. It is also called Arithmetic Progression (AP)

Geometric Sequence: An ordered set of numbers in which the ratio of each successive term to its preceding term is always has same value is called geometric sequence. It is also called Geometric Progression (GP)

Harmonic Sequence: An ordered set of numbers which is formed by taking the reciprocal of terms of an arithmetic sequence is known as harmonic sequence. It is also called Harmonic Progression (HP)

Means: The terms which are inserted between any two terms of a sequence is known as means.

For AP:

- If a, b, c are in AP, then b is called arithmetic mean between a and c such that b = $\frac{a+c}{2}$
- n^{th} term $t_n = S_n - S_{n-1}$ and common difference $d = S_n - 2S_{n-1} + S_{n-2}$
- n^{th} term $t_n = a + (n-1)d$
- Common difference (d) = $t_n - t_{n-1}$ for n>1
- Sum of first n terms $S_n = \frac{n}{2}(a+l)$ or $\frac{n}{2}$ [2a + (n-1)d]
- If a+d, a+2d, a+3d, ---, a+nd are the n arithmetic means between a and b then the common difference $d = \frac{b-a}{n+1}$
- Sum of first n natural numbers = $\frac{n(n+1)}{2}$
- Sum of first n even natural numbers = n(n+1)
- Sum of first n odd natural numbers = n^2
- Sum of the squares of first n natural numbers = $\frac{n(n+1)(2n+1)}{6}$
- Sum of cubes of first n natural numbers = $\left[\frac{n(n+1)}{2}\right]^2$

For GP:

- n^{th} term, $t_n = ar^{n-1}$
- Common ratio ,$r = \frac{t_n}{t_{n-1}}$ i.e $r = \frac{a_{k+1}}{a_k}$ for $k \geq 1$
- Sum of first n terms,

  $S_n = \frac{a(1-r^n)}{1-r}$ for $|r| < 1$

  And, $S_n = \frac{a(r^n-1)}{r-1}$ for $|r| > 1$
- Sum of infinity $S_\infty = \frac{a}{1-r}$ for $|r|<1$
- Geometric mean between a and b is $\sqrt{ab}$
- If ar, ar^2, ar^3, ---, ar^n are n GM inserted between two numbers a and b. then the common ratio, $r = \left(\frac{b}{a}\right)^{\frac{1}{(n+1)}}$

For HP:

- If a, b, c are in AP then, $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in H.P.
- If a, b, c are in HP then b is harmonic mean between a and c such that $b = \frac{2ab}{a+b}$
- n^{th} term of HP is given by $t_n = \frac{1}{a+(n-1)d}$

The AM, GM and HM between any two unequal positive numbers satisfy the following relations:

a) $(GM)^2 = AM \times HM$
b) $AM > GM > HM$

MCQs

1. The sum of 1^{st} 20 terms of an A.P. whose 1^{st} term is 2 and common difference 3 is..
   (a) 520 (b) 610 (c) 400 (d) 730
2. If 1 + 6 + 11 + ... + x = 148, then x
   (a) 36 (b) 8 (c) 30 (d) none
3. The value of $9^{1/3}. 9^{1/9}.9^{1/27}$ ..... ∞ is
   (a) 9 (b) 18 (c) 27 (d) 3
4. A.M. between two numbers is 15 and G.M. is 9, then H.M. is
   (a) $\frac{9}{13}$ (b) $\frac{7}{5}$ (c) $\frac{27}{5}$ (d) $\frac{3}{2}$
5. If a, b, c are in G.P. and $a^{1/x} = b^{1/y} = c^{1/z}$, x, y, z are in
   (a) A.P. (b) G.P. (c) H.P. (d) none

6. If S_{11} of A.P. is 77 then t_6 is..
   (a) 7 (b) 8 (c) 12 (d) 4
7. a, b, c are in A.P. and x, y, z are in G.P. then
   $x^{b-c}.y^{c-a}.z^{a-b}$ = ….
   a) 0 b) -1 c) 1/2 d) 1
8. If $S_n = n^2 + 5$ then t_{10} is equal to ……
   a) 20 b) 21 c) 19 d) 10
9. The minimum number of terms of the series
   1 + 3 + 9 + 27 + --- so that the sum may exceed 1000 is:
   a) 7 b) 5 c) 3 d) None
10 Which of the following is the number of terms in the G.P of $\frac{1}{18}+\frac{1}{6}+\frac{1}{2}+.....+\frac{81}{2}$?
   a) 6 b) 3 c) 7 d) 4
11. The second, fourth and eighth terms of an arithmetic progression are in geometric progression. What is the common ratio of GP?
   a) 3 b) 4 c) 5/2 d) 2

Geometry

Euclid's Postulates

1. A straight line segment can be drawn joining any two points.
2. Any straight line segment can be extended indefinitely in a straight line.
3. Given any straight lines segment, a circle can be drawn having the segment as radius and one endpoint as center.
4. All Right Angles are congruent.
5. If two lines are drawn which intersect a third in such a way that the sum of the inner angles on one side is less than two Right Angles, then the two lines inevitably must intersect each other on that side if extended far enough. This postulate is equivalent to what is known as the Parallel Postulate.

Properties of Triangle

- The sum of angles of any triangle is equal to two right angles.
- The exterior angle of a triangle is equal to the sum of two opposite interior angles.
- The sum of any two sides of a triangle is greater than the third side.
- In any triangle, the angle opposite to the longer side is greater than the angle opposite to shorter side.
- If any two sides of triangle are equal the angle opposite to them are equal and vice versa.
- The bisector of a vertical angle of a isosceles triangle is the perpendicular bisector of the base.

Condition of congruency of triangles

i. S.S.S. axiom: When three sides of a triangle are respectively equal to three corresponding side of another triangle, they are said to be congruent.
ii. S.A.S. axiom: When two sides of one triangle and angle made by them are respectively equal to the corresponding sides and angle of another triangle they are said to be congruent triangles.
iii. A.S.A. axiom: When two angles and their adjacent side of one triangle are respectively equal to the corresponding angles and sides of another triangle, they are said to be congruent triangles.
iv. R.H.S. axiom: In two right-angled triangles, when the hypotenuse and one of the two remaining sides are respectively equal, they are said to congruent triangles.
v. A.A.S. axiom: When two angles and a side of one triangle are respectively equal to the corresponding angles and sides of another triangle, they are said to be congruent triangles.

Condition of similarity of triangles

i. When all angles of one triangle are respectively equal to the corresponding angles of another triangle, the triangles are said to be similar.
ii. When the ratios of the corresponding sides of triangles are equal, i.e. the corresponding sides of triangles are proportional, the triangles are said to be similar.
iii. Two equiangular triangles are similar.
iv. If any two corresponding sides of triangles are proportional and the angles included by them are equal, the triangles are similar.
v. If two triangles have their corresponding sides proportional, then the triangles are similar.

Properties of polygon

i. The sum of n interior angles of a polygon with n number of sides is $(n-2)180$.
ii. Each angle of a regular polygon of n number of sides is $\frac{(n-2)180}{n}$
iii. The sum of exterior angle of a polygon is 360^0.
iv. The sum of each exterior angle of a regular polygon with n number of sides is $\frac{360}{n}$.
v. The number of diagonals in a polygon is $\frac{n(n-3)}{2}$, where n is number of sides in polygon.

Properties of Parallelogram

i. Properties of rectangle
   a. Its opposite sides are equal.
   b. Each of its angle is a right angle (90^0)

c. It's diagonals are equal.
d. Diagonals of a rectangle bisect each other.

ii. Properties of square
   a. Its all sides are equal.
   b. Each of its angle is a right angle.
   c. Its diagonals bisect each other at right angle.
   d. Its diagonals are equal and bisect the opposite angle.

iii. Properties of rhombus
   a. Its all sides are equal.
   b. Its opposite angles are equal.
   c. Its diagonals are not equal and bisect each other at right angle.
   d. Its diagonals bisect the opposite angles.

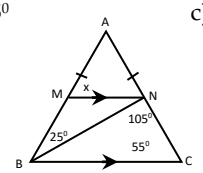
- The straight line segments that join the ends of two equal and parallel line segments towards the same sides are also equal and parallel.
- The straight line segments that join the ends of two equal and parallel line segments towards the opposite sides bisect each other.

Properties of circle

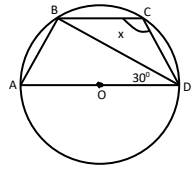
- The perpendicular drawn from the centre of a circle to a chord, bisects the chord.
- Equal chords of a circle are equidistant from the centre.

MCQs

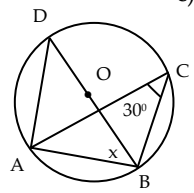
1. The supplement of an angle is five times the angle, then the angle is ....
   a. 150^0 b. 60^0 c. 120^0 d. 30^0
2. The complement of an angle is 20^0 less than 4 times the angle then the angle is .....
   a. 24^0 b. 22^0 c. 33^0 d. 44^0
3. An exterior angle of a regular polygon is equal to an interior angle of regular triangle. Then the number sides of the polygon is ....
   a. 4 b. 5 c. 6 d. 8
4. In the figure along side what will be the value of x?
   a) 45^0 b) 25^0 c) 60^0 d) 30^0



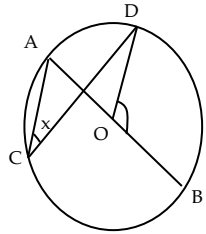
5. In the figure along side, what will be the value of x, if O is the centre of the circle?
   a) 90^0 b) 60^0 c) 70^0 d) 120^0



6. In the figure along side, what will be the value of x, if O is the centre of the circle?
   a) 30^0 b) 90^0 c) 60^0 d) 45^0

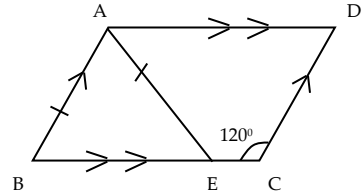


7. In the figure, O is the centre of circle and AB is the diameter. If $\angle BOD = 120^0$, then what will be the value of x.
   a. 60^0 b. 90^0 c. 120^0 d. 30^0



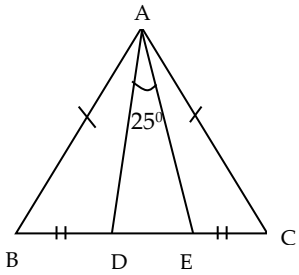
8. In the given figure, ABCD is a parallelogram. $\angle BCD = 120^0$ and AB = AE. Find the size of $\angle$ AEB.

a. 120^0 b. 60^0 c. 30^0 d. 45^0



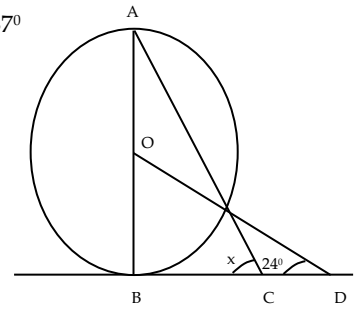
9. In the given figure AB = AC, BD = EC and $\Delta DAE = 25^0$. Then the value of $\angle ADE$ = ...

a. 60^0 b. 75^0 c. 77.5^0 d. 85^0



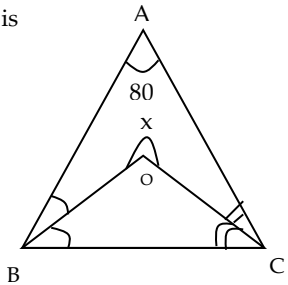
10. In the adjoining figure which one of the following is the value of x?

a. 57^0 b. 67^0 c. 47^0 d. 37^0



11. The value of x in the adjoining figure is

a. 130^0 b. 230^0 c. 115^0 d. 215^0



Statistics and Probability

Statistics is the branch of mathematics in which facts and information are collected, sorted, displayed and analyzed. Statistics are used to make decision and prediction about the future plans and policies.

The collected statistical data can present using the diagrams: histogram, line graphs and pie chart. Similarly, the collected data can be present graphically using the frequency curve which is known ogive or cumulative frequency curve.

Measures of central tendency: The degree of clustering of the values of a statistical distribution that is usually measured by mean, median and mode is known as central tendency.

i. **Mean:** Arithmetic mean is the most common type of average. It is the number obtained by dividing the sum of all the items by the number of items.

i.e. Mean= $\frac{\text{sum of all the items}}{\text{the number of items}} = \frac{\sum x}{N}$, where x is numerical value of all observation.

Types of data	**individual data**	**discrete data**	**Continuous data**
Mean	$\frac{\sum x}{N}$	$\frac{\sum fx}{N}$	$\frac{\sum fm}{N}$, m is mid value of class interval

If n_1 and n_2 be the sizes, $\bar{x}_1$ and $\bar{x}_2$ the arithmetic means then the combined mean of series x_1 and x_2 is given by $\bar{x}_{12} = \frac{n_1\bar{x}_1 + n_2\bar{x}_2}{n_1 + n_2}$

ii. **Median:** Median represents the value of middle most observation, when the data are arranged in the ascending or descending order of magnitude.

Types of data	**individual data**	**discrete data**	**Continuous data**
Position Median	$\left(\frac{N+1}{2}\right)^{th}$	$\left(\frac{N+1}{2}\right)^{th}$	$\left(\frac{N}{2}\right)^{th}$

for continuous data, the actual value of median is determined by,

$M_d = L + \frac{\frac{N}{2} - c.f}{f} \times h$, where L=lower limit of class interval, c.f. = Cumulative frequency, f=corresponding frequency, h=height of interval.

iii. Mode: Mode is the highest repeated observation of the data.

- For individual and discrete data mode is corresponding value for highest frequency.
- For continuous data model class is corresponding to highest frequency and the actual mode is given by, Mode = $L + \frac{f_1 - f_2}{2f_1 - f_0 - f_2} \times h$

where, f_1 = maximum frequency

f_0 = frequency preceding modal class

f_2 = frequency following modal class

h = size of the modal class.

Relation between various measures of central tendency

i. For symmetrical distribution, mean = median = mode.

ii. If the distribution is not symmetrical, then Mode = 3 Median – 2Mean

Partition of data: The well arranged data which are divided into n – equal parts is called partition of data which are given by:

a. Median: Data is divided into two equal parts.

b. Quartile: Data is divided into four equal parts.

c. Decile: Data is divided into ten equal parts.

d. Percentile: Data is divided into hundred equal parts.

Measure of dispersion: Dispersion is the measure of scatterness or variation of the items from the central value. We have following methods of measuring dispersions:

a. **Range:** Range is defined as the difference between the largest item and the smallest item in the set of observations. So in a set of observations if L is the largest item and S the smallest item, then the range is defined by Range = L – S.

b. **Semi interquartile range or Quartile Deviation:** The difference between the upper and lower quartiles is known as Interquartile range. Half the interquartile range is known as semi-interquartile range or quartile deviation.

Quartile deviation = $\frac{Q_3 - Q_1}{2}$

c. **Mean deviation:** Mean deviation (M.D.) is defined as the arithmetic mean of the deviations of the items from mean, median or mode, when all the deviations are considered positive. M.D. from mean = $\frac{\sum|x-\bar{x}|}{n}$

Also, M.D. from mean = $\frac{\sum f|x-\bar{x}|}{N}$

M.D. from median and mode can similarly be obtained by replacing $\bar{x}$ by M_d and M_o respectively.

d. **Standard Deviation:-** Standard deviation (S.D) is defined as the positive square root of the mean of the square of the deviations taken from the arithmetic mean. It is denoted by σ.

If x be the variate values and $\bar{x}$ their arithmetic mean then the S.D. denoted by σ_x or simply σ is given by

$$\sigma = \sqrt{\frac{\sum(x-\bar{x})^2}{n}} = \sqrt{\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2} \text{ Also } \sigma = \sqrt{\frac{\sum f(x-\bar{x})^2}{N}} = \sqrt{\frac{\sum fx^2}{N} - \left(\frac{\sum fx}{N}\right)^2}$$

Combined standard deviation:- If n_1 and n_2 be the sizes, $\overline{x_1}$ and $\overline{x_2}$ the arithmetic means and σ_1 and σ_2 the respective standard deviations of two component series, then their combined standard deviation denoted by σ_{12} is given by, $\sigma_{12} = \sqrt{\frac{n_1\sigma_1^2 + n_2\sigma_2^2 + n_1d_1^2 + n_2d_2^2}{n_1+n_2}}$, where $d_1 = x_1 - \bar{x}_1$ & $d_2 = x_2 - \bar{x}_2$

MCQs

1. Which one of the following is the graphical representation of cumulative frequency of a statistical distribution
   a. Bar diagram b. Histogram c. Pie-chart d. Ogive curve
2. The mean of 17 observation is 20. If the mean of first 9 observation is 23 and that of last 9 observation is 18, then 9^{th} observation is
   a. 29 b. 19 c. 14.5 d. 15
3. In a hospital account of 900 patient the different blood group patient in a year are observed as: A – 41%, B – 10%, AB – 4%, O – 45%. What will be the angular measurement for blood group O in a pie chart?
   a. 157 b. 147.6^0 c. 162^0 d. 175^0
4. In a survey at a village a surveyor found that the mean age of 20 girls was 15 years and that of 15 boys was 20 years. What is their mean age?
   a. 15.5 year b. 20 year c. 16 year d. 17.14 year
5. If the average of the wages: 30, 36, p, 40, 44; received by 5 worker is Rs.35; the value of p is ....
   a. 25 b. 27 c. 30 d. 35
6. For what value of m the mean of the given data is 17?

x	5	10	15	20	25	30
f	2	5	10	m	4	2

   a. 21 b. 15 c. 14 d. 7
7. The mean marks of 200 students was calculated to be 50. Later it is found that 80 was mistakenly written for 150 and 8 was written for 88. Then, what should be the mean value?
   a. 50 b. 50.75 c. 51.2 d. 52.8
8. For given individual data if observed values are doubled then arithmetic mean of new set data is .....
   a. doubled b. tripled c. halved d. four times
9. If $x + y - z = 3$, $x - y + z = 8$ and $-x + y + z = 4$, then the average value of x, y, z is:
   a. 3 b. 15 c. 45 d. 5
10. The s.d. of the data: 1, 2, 3, 4, 5 is .....
    a. $\sqrt{2}$ b. 2.5 c. $\sqrt{3}$ d. 5

Probability

The chance or likelihood of happening of some event is known as probability. The subject of probability tries to estimate the degree of happening in a trial and to decide our course of action.

Some basic terms which are frequently used in probability are discussed below:

- Any experiment whose outcome cannot be predicted is called a **random experiment.**
- Every possible outcome or group of outcomes of a random experiment is called an **event**.
- A **sample space** is the set of all possible outcomes of an experiment.
- The total number of all possible outcomes of a random experiment is known as **exhaustive cases.**
- Two events E_1 and E_2 are said to be **independent events** if occurrence of one event does not depend upon the occurrence of other.
- Two events associated with an experiment are **mutually exclusive** if the subjects of sample space representing the two events are disjoint.

Probability: If E is any event, the probability of occurrence of E is given by $P(E) = \frac{\text{number of favourable outcomes}}{\text{total number of possible outcomes}}$

Empirical probability: $P(E) = \frac{\text{number of times event occurs}}{\text{total numbers of experimental trials}}$

- If E is impossible, P(E) = 0.
- If E is sure event, P(E) = 1.
- For any event E, $0 \le P(E) \le 1$.
- The probability of non-happening of the event is given by P'(E) = 1 – P(E).
- If E and F are mutually exclusive events, then $P(E \cup F) = P(E) + P(F)$

Addition theorem of probability: Let A and B are any two equally likely events. Let an experiment then probability of occurrence of at least one events is given by $P(A \cup B) = P(A) + p(B)$, where $P(A \cap B)$ is simultaneous occurrence of at events A and B.

Multiplication theorem of probability: Let A and B are any two equally likely events of an experiment. Then the probability of simultaneous occurrence of events A and B is the product of their individual probability. i.e. $P(A \cap B) = P(A).\ P(B)$.

Conditional probability: If A and B are events in a sample space S with P(B) > 0, then conditional probability of event A, given event B, is denoted by P(A/B), is defined by $P(A/B) = \frac{P(A \cap B)}{P(B)}$. Here, P(A/B) denotes the probability of happening B before A.

MCQs

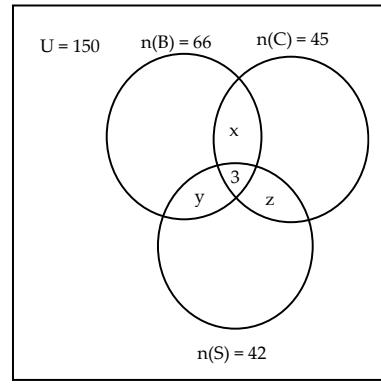
1. What is the probability of getting a 2 or a 6 in a roll of a dice?
   a. 1/2 b. 1/3 c. 1/4 d. 1/6
2. A card is drawn at random from a shuffled deck of 52 cards. What is the probability that it is a face card?
   a. 1/4 b. 3/13 c. 1/13 d. 4/13
3. For any events A, B and C, if P(A) = P(B) = 1/2 P(C), then P(C) = ...
   a. 1/2 b. 4/5 c. 2/5 d. 1/5
4. A coin is weighted so that the head is three times as likely to appear as tail then what will be the probability occurrence of head?
   a. 1/2 b. 1/4 c. 3/4 d. none
5. If A and B are two mutually exclusive events such that $P(\overline{A}) = 5/6$ and P(B) = 1/4. Then which one will be $P(A \cup B)$?
   a. 11/12 b. 5/24 c. 5/12 d. 1/12
6. The probability of A can solve a problem is 1/3 and probability that B can solve the problem is 2/3. What is the probability that the problem will be solved if both of them try?
   a. 7/9 b. 2/9 c. 1/3 d. 1/9
7. A couple plans to have three children, what is the probability that exactly two will boys?
   a. 1/3 b. 2/3 c. 2/8 d. 3/8
8. A and B are two events where P(A) = 0.25 and P(B) = 0.5, the probability of both happening together is 0.14. The probability of both A and B not happening is .....
   a. 0.39 b. 0.25 c. 0.11 d. 0.2
9. A and B appear for an interview for two posts. The probability of A's selection is 1/3 and that of B's selection is 2/5. Find the probability that only one of them will be selected.
   a. 4/15 b. 7/15 c. 2/3 d. 3/5
10. A box contains 5 yellow, 4 red and 3 blue balls if a ball is drawn at random what is the probability of its not being yellow?
    a. 7/12 b. 5/12 c. 5/7 d. 7/8
11. Three coins are tossed simultaneously what is the probability of getting not more than two heads?
    a. 1/2 b. 2/3 c. 5/8 d. 7/8
12. If the probability of germinating a seed of a pea plant is 0.85 how many seeds out of 1000 will germinate?
    a. 85 b. 150 c. 850 d. 1000
13. A number card numbered from 1 to 30. What is the probability of getting the card which is multiple of 5 or 6?
    a. 1/3 b. 1/6 c. 1/5 d. 11/30

14. A bag contains 4 white and 6 red balls. Two balls are drawn in succession. Find the probability that the first ball will be white and second will red if first ball is not replaced?
    a. 16/25 b. 11/15 c. 8/15 d. 4/15
15. A pair of dice is thrown. Find the probability that the sum is 10 or greater if a 5 appear on at least one of the dice.
    a. 1/3 b. 3/11 c. 11/36 d. 5/18
16. What is the probability that a leap year has 53 Sunday?
    a. 1/4 b. 1/3 c. 1/7 d. 2/7

Answers & explanations:

Sets

1. Ans (c): n(A) = 3, no. of possible subsets $2^n = 2^3 = 8$
   no. of non-empty proper subsets = $2^n - 2 = 2^3 - 2 = 6$
2. Ans (d): Solution of $x^2 - x - 2 = 0$ are x = 2, -1. $\therefore$ A = {2, -1}.
   no. of subset of A = $2^n = 2^2 = 4$.
   so P = {ϕ, {2}, {-1}, {2, -1}}
   $\therefore$ n(P) = 4.
3. Ans (b): A = {x: x = (2n+1), n < 5, n$\in$ N}
   putting n = 1, 2, 3, 4 we get,
   A = {3, 5, 7, 11}.
   Also, B = {x: x = 3n - 2, n $\leq$ 4, n$\in$ N},
   putting n = 1, 2, 3, 4 we get,
   B = {1, 4, 7, 10}
   so, B – A = {1, 4, 7, 10} – {3, 5, 7, 11}
   = {1, 4, 10}
4. Ans (b): Here, n(A) = 50, n(B) = 65
   Now, n(A) + n(B) = 50 + 65 = 115 > 100
   Min. possible of n(A$\cap$B) = 115 – 100 = 15
5. Ans (d): A – B = {1, 3}
   B – A = {6, 8, 10}
   Now, AΔB = (A – B) $\cup$ (B – A)
   = {1, 3, 6, 8, 10}
6. Ans (a): Let P, M are the sets who teaches maths and physics respectively.
   n(P$\cup$M) = n(P) + n(M) – n(P$\cap$M)
   $\Rightarrow$ 20 = n(P) + 12 – 4
   $\Rightarrow$ n(P) = 12
7. Ans (d): A $\cup$ $\bar{B}$ = {x: x $\in$ A and x $\in$ $\bar{B}$ }
   = {x: x $\in$ A and x $\notin$ B}
   = {x: x $\in$ (A – B)}
   = A – B
8. Ans (a): Let x be multiplicative inverse of -a then x. - a = 1
   $\therefore$ x = -1/a is multiplicative inverse of -a.
9. Ans (c): Let n(P) be no. of students who do not play any 3 of the sports.
   From diagram, 150 – n(p) = 66 – x – y – 3 + 45 – x – z – 3 – 42 – y – z – 3 + x + y + z – 3
   $\Rightarrow$ 150 – n(P) = 153 – (x + y + z) – 3
   $\Rightarrow$ n(P) = 30.



10. Ans (b): n($\cup$) = 175, n(m) = 100, n(p) = 70, n(c) = 46 n(m $\cap$ p) = 10, n(m $\cap$ c) = 28, n(p $\cap$ c) = 23, n(m $\cap$ p $\cap$ c) = 18
    Now, n(m$\cup$p$\cup$c) = n(m) + n(p) + n(c) – n(m$\cap$p) – n(p$\cap$c) – n(c $\cap$ m) + p(m $\cap$ p $\cap$ c)
    = 100 + 70 + 46 – 10 – 28 – 23 + 18
    = 234 – 61 = 173
    So, $\overline{n(m \cup p \cup c)}$ = n(U) – n(m$\cup$p$\cup$c) = 175 – 173 = 2
11. Ans (b): By definition, π is an irrational number
12. Ans (d): $-2 \leq 3x + 1 \leq 7$
    $\Rightarrow -3 \leq 3x \leq 6$ [subtracting all sides by 1]
    $\Rightarrow -1 \leq x \leq 2$ [dividing all sides by 3]
    $\Rightarrow$ [-1, 2]
13. Ans (b): B – A = (0, 5) – (2, 3]
    = (3, 5)

Relation & functions

1. Ans (d): $f(x-1) = 2x - 5$
   $\Rightarrow f[(x+3)-1] = 2(x+3) - 5$
   $\Rightarrow f(x+2) = 2x + 6 - 5 = 2x + 1$
2. Ans (d): $f: R \to R$, $f(x) = x^2 - 4$
   let, $-1, 1 \in R$, then,
   $f(1) = -3$, $f(-1) = -3$
   so, $-1 \neq 1 \Rightarrow f(1) = f(-1)$
   $\therefore$ f is not one to one.
   Again, $f(x) = x^2 - 4$
   $\Rightarrow y = x^2 - 4$
   $\Rightarrow x = \pm\sqrt{y+4} \notin R$ for all $y \in R$
   $\therefore$ f is not onto
3. Ans (b): $A \times A = \{-1, 0, 1\} \times \{-1, 0, 1\}$
   $= \{(-1,-1), (-1,0), (-1,1), (0,-1), (0,0), (0,1), (1,-1), (1,0), (1,1)\}$
   $R = \{(x, y): x < y\} = \{(-1, 0), (-1, 1), (0, 1)\}$
4. Ans (b): Number of relations from A to B is $n(B)^{n(A)} = 4^3 = 64$.
5. Ans (d): Here, $2x + y = 7$, $x, y \in N$
   So, we have following pairs (x, y) satisfies $2x + y = 41$
   i.e. $R = \{1, 5\}, (2, 3), (3, 1)$
   $\therefore$ Range = {5, 3, 1}
6. Ans (a): Either (3, 1) or (3, 2) must removed because only 3 is paired with two elements 1 and 2.
7. Ans (a): For $x = 2$, $f(2) = \infty$ (undefined)
   So, 2 do not have its image.
8. Ans (a): $p(x) = 4x - 6$
   $\Rightarrow p(a) = 4a - 6$
   $\Rightarrow 0 = 4a - 6$
   $\Rightarrow a = 3/2$
9. Ans (a): There is no change found $x^2 + y^2 = 1$ even x and y are replaced by -x and -y. So the relation $x^2 + y^2 = 1$ is an even.
10. Ans (b): $g(1, 2) = 1^2 - 2^2 = -3$
    so, $f(g,(1, 2),3) = f(-3, 3) = 3. -3 + 2.3 = -3$
11. Ans (d): for $x = 2$,
    $g(f(2)) = 2$
    $\Rightarrow 3(f(2)) + 2 = 2$
    $\Rightarrow 3f(2) = 0$
    $\Rightarrow f(2) = 0$
12. Ans (c): Since $\frac{f}{g}(x) = \frac{f(x)}{g(x)}$ for $g(x) \neq 0$
    $= \frac{3x^2 - 4x + 1}{3x^2 - 3}$ for $3x^2 - 3 \neq 0$
    If $3x^2 - 3 = 0$
    $\Rightarrow x^2 = 1$
    $\Rightarrow x = \pm 1$ must excluded.
13. Ans (a): Since, $(f - 3)x = f(x) - 3$
    $= 2x - 1 - 3$
    $= 2x - 4$.
14. Ans (b): Here f is one to one and onto both
    $\Rightarrow f^{-1}(x)$ exists
    let $y = \frac{x}{x-2}$
    Interchanging x & y
    $x = \frac{y}{y-2}$
    $\Rightarrow xy - 2x = y$
    $\Rightarrow xy - y = 2x$
    $\Rightarrow y(x - 1) = 2x$
    $\Rightarrow y = \frac{2x}{x-1} \Rightarrow f^{-1}(x) = \frac{2x}{x-1}$
15. Ans (b): $4m = 4.f(6) = 4(10 - 6)^2$
    $= 4.4^2 = 64$
    Also, $f(18) = (10 - 18)^2 = (-8)^2 = 64$
    $\therefore 4m = f(18)$
16. Ans (b): $f(x) + 2f(x) = x$ ..... (i)
    Also, $f(1/x) - 3f(1/x) = \frac{1}{2}.\frac{1}{x}$
    Replace, 1/x by x, we get,
    $f(x) - 3f(x) = \frac{1}{2}x$ .... (ii)
    Subtracting (ii) from (i)
    $5f(x) = x - \frac{x}{2}$
    $\Rightarrow f(x) = \frac{2x - x}{10} = \frac{x}{10}$

Polynomials

1. Ans (b): $f(x) = 4x^3 - 3x^2 + 2$
   $R = f(2) = 4(2)^3 - 3(2)^2 + 2 = 20$
2. Ans (c):
   $f(2) = 2(2)^3 - m(2)^2 - 13 \times 2 + n = -10 - 4m + n = 0$ ..... (i)
   $f(3) = 3(3)^3 - m(3)^2 - 13 \times 3 + n = 15 - 9m + n = 0$ ..... (ii)
   From (i) and (ii)
   $\therefore$ m = 5, n = 30
3. Ans (d): Here, $f(x) = x^3 - 3x^2 - 2x + a$
   By question, $f(-2) = 2f(3)$
   $\Rightarrow -8 - 12 + 4 + a = 2(27 - 27 - 6 + a)$
   $\Rightarrow -16 + a = -12 + 2a \quad \Rightarrow -a = -12 + 16$
   $\Rightarrow a = -4.$
4. Ans (a): on comparing equation to $ax^2 + bx + c = 0$ we get,
   a = 3, b = -4, c = 4.
   $\therefore$ sum of roots $= -\frac{b}{a} = -\frac{(-4)}{3} = \frac{4}{3}$
5. Ans (d): $x^2 -$ (sum of roots) x + product of roots = 0
   $\Rightarrow x^2 - 2x + 3 = 0$
6. Ans (d): Putting x = 0 in $2x^2 - (6 + k)x + (2 + k) = 0$
   we get, $2.0^2 - (6 + k).0 + (2 + k) = 0$
   $\Rightarrow 2 + k = 0 \quad \Rightarrow k = -2.$
   or, if one root zero,
   then product of root = 0
   $\Rightarrow \frac{c}{a} = 0 \quad \Rightarrow \frac{2+k}{2} = 0 \quad \Rightarrow k = -2.$
7. Ans (c) : Let α be one root then next root $= \frac{1}{\alpha}$
   So, product of roots, $\alpha.\frac{1}{\alpha} = \frac{3(7+10m)}{1}$
   [product of roots = c/a]
   $\Rightarrow 3(7 + 10m) = 1 \quad \Rightarrow m = -2/3$
8. Ans (c): let, α and β are roots of $7x^2 - 4x + 3 = 0$
   Then, $\alpha + \beta = -\frac{(-4)}{7} = \frac{4}{7}, \alpha.\beta = \frac{3}{7}$
   Now, the equation with roots 2α and 2β is
   $x^2 - (2\alpha + 2\beta)x + 2\alpha.2\beta = 0$
   $\Rightarrow x^2 - 2(\alpha + \beta)x + 4\alpha\beta = 0$
   $\Rightarrow x^2 - 2.\frac{4}{7}x + 4.\frac{3}{7} = 0$
   $\Rightarrow 7x^2 - 8x + 12 = 0.$
9. Ans (b): let one root = 2α
   Them next root = 3α
   Now, $2\alpha + 3\alpha = -\frac{(-p)}{1}$
   $\Rightarrow 5\alpha = p$
   $\Rightarrow \alpha = \frac{p}{5}.$
   Again $2\alpha.3\alpha = \frac{q}{1} \Rightarrow 6\alpha^2 = q$
   $\Rightarrow 6 \times \left(\frac{p}{5}\right)^2 = q \Rightarrow 6p^2 = 25q$
10. Ans (d) : let α be one root, then next root = $-\alpha$
    Now sum of roots, $\alpha + (-\alpha) = -\frac{(7-k)}{3}$
    $\Rightarrow 0 = \frac{7-k}{3} \quad \Rightarrow k = 7$
11. Ans (a): Sum of roots, $\alpha + \beta = -\frac{(-1)}{1} = 1$
    Product of roots $\alpha.\beta = \frac{-2}{1} = -2$
    Now, $\alpha^2+\beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$
    $= (1)^2 - 2.(-2) \quad = 1 + 4 = 5$
12. Ans (c): Here, $b^2 - 4ac = (-3)^2 - 4.7.(-4)$
    $= 9 + 112 = 121 > 0$ and perfect square.
    So, roots are rational and unequal.
13. Ans (d):
    Let $x = \sqrt{6 + \sqrt{6 + \sqrt{6 + ...}}}$
    $\Rightarrow x^2 = 6 + \sqrt{6 + \sqrt{6 + ...}}$
    $\Rightarrow x^2 = 6 + x \Rightarrow x^2 - x - 6 = 0 \Rightarrow x = 3, -2$

Trigonometry

1. Ans (d) : Here, $\theta = 20^0 = \left(20 \times \frac{\pi}{180}\right)^c = \frac{\pi^c}{9}$

   Now, $r = \frac{s}{\theta} = \frac{44}{\frac{\pi}{9}} = \frac{44 \times 9 \times 7}{22} = 126.$

2. Ans (b): $\sin^2 25^0 + \sin^2 65^0 = \sin^2 25^0 + [\sin(90^0 - 25^0)]^2$
   $= \sin^2 25^0 + \cos^2 25^0 = 1$

3. Ans (b) $\sin^4\theta + \cos^4\theta = (\sin^2\theta + \cos^2\theta)^2 - 2\sin^2\theta.\cos^2\theta$
   $= 1 - \frac{1}{2}(\sin 2\theta)^2$

   Which will be minimum if $(\sin 2\theta)^2$ is maximum
   but maximum of $(\sin 2\theta)^2 = 1^2 = 1$
   So minimum of $\sin^4\theta + \cos^4\theta = 1 - \frac{1}{2}.1 = \frac{1}{2}$

4. Ans (c): Since, maximum value of $a\cos\theta + b\sin\theta$ is $\sqrt{a^2 + b^2}$
   So, maximum value of $3\cos\theta + 4\sin\theta$ is $\sqrt{3^2 + 4^2} = 5$

5. Ans (d): Since, $\cos A/2 = \sqrt{\frac{1 + \cos A}{2}}$

   Let $A = 45^0$,

   So, $\cos\frac{45^0}{2} = \sqrt{\frac{1 + \cos 45^0}{2}}$

   $\Rightarrow \cos 22\frac{1}{2}^0 = \sqrt{\frac{1 + \frac{1}{\sqrt{2}}}{2}}$

   $= \sqrt{\frac{\sqrt{2} + 1}{2\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}}$

   $= \sqrt{\frac{2 + \sqrt{2}}{4}}$

   $= \frac{1}{2}\sqrt{2 + \sqrt{2}}$

6. Ans (c) : Since, $\cot A/2 = \frac{1 + \cos A}{\sin A}$

   let $A = 15^0$ then,

   $\cot 7\frac{1^0}{2} = \frac{1 + \cos 15^0}{\sin 15^0}$

   $= \frac{1 + \frac{\sqrt{3} + 1}{2\sqrt{2}}}{\frac{\sqrt{3} - 1}{2\sqrt{2}}}$

   $= \frac{2\sqrt{2} + \sqrt{3} + 1}{\sqrt{3} - 1} \times \frac{\sqrt{3} + 1}{\sqrt{3} + 1}$

   $= \frac{2\sqrt{6} + 2\sqrt{2} + 3 + \sqrt{3} + \sqrt{3} + 1}{3 - 1}$

   $= \frac{2\sqrt{6} + 2\sqrt{2} + 2\sqrt{3} + 4}{2}$

   $= \sqrt{6} + \sqrt{3} + \sqrt{2} + 2$

7. Ans (d): $\sin\frac{\pi}{10} + \sin\frac{9\pi}{10}$
   $= \sin 18^0 + \sin 162^0$
   $= \sin 18^0 + \sin(180^0 - 18^0)$
   $= \sin 18^0 + \sin 18^0$
   $= 2\sin 18^0$
   $= 2 \times \frac{\sqrt{5} - 1}{4}$
   $= \frac{\sqrt{5} - 1}{2}$

8. Ans (c): $\cos 12^0 + \cos 84^0 + \cos 156^0 + \cos 132^0$
   $= (\cos 12^0 + \cos 132^0) + (\cos 84^0 + \cos 156^0)$
   $= 2\cos\frac{12^0 + 132^0}{2}.\cos\frac{12^0 - 132^0}{2} + 2\cos\frac{84^0 + 156^0}{2}.\cos\frac{84^0 - 156^0}{2}$
   $= 2\cos 72^0.\cos 60^0 + 2\cos 120^0.\cos 36^0$
   $= 2\sin 18^0.\cos 60^0 + 2\cos 120^0.(1 - 2\sin^2 180^0)$
   $= 2.\frac{\sqrt{5} - 1}{4}.\frac{1}{2} + 2.-1/2\left[1 - 2\left(\frac{\sqrt{5} - 1}{4}\right)^2\right]$
   $= \frac{\sqrt{5} - 1}{4} - \frac{1 + \sqrt{5}}{4}$
   $= -1/2$

9. Ans (b): $\tan\theta + \sin\theta = m \quad \tan\theta - \sin\theta = n$
   $m^2 - n^2 = (\tan\theta + \sin\theta)^2 . (\tan\theta - \sin\theta)^2$

$= 4\tan\theta.\sin\theta$

$= 4\sqrt{(\tan\theta.\sin\theta)^2}$

$= 4\sqrt{(\sec^2\theta-1)\sin^2\theta}$

$= 4\sqrt{\tan^2\theta-\sin^2\theta}$

$= 4\sqrt{(\tan\theta-\sin\theta)(\tan\theta+\sin\theta)}$

$= 4\sqrt{mn}$

10. Ans (a): $\sin\alpha + \sin\beta = a$, $\cos\alpha + \cos\beta = b$

Now, $\frac{\sin\alpha+\sin\beta}{\cos\alpha+\cos\beta} = \frac{a}{b}$

$\Rightarrow \frac{2\sin\frac{\alpha+\beta}{2}.\cos\frac{\alpha-\beta}{2}}{2\cos\frac{\alpha+\beta}{2}.\sin\frac{\alpha-b}{2}} = \frac{a}{b}$

$\Rightarrow \tan\frac{\alpha+\beta}{2} = \frac{a}{b}$

Now, $\sin(\alpha+\beta) =$

$\frac{2\tan\frac{\alpha+\beta}{2}}{1+\tan^2\frac{\alpha+\beta}{2}} = \frac{2.a/b}{1+a^2/b^2} = \frac{2ab}{a^2+b^2}$

11. Ans (a): $\sin A + \operatorname{cosec} A = 2$

$\Rightarrow \sin A + \frac{1}{\sin A} = 2$

$\Rightarrow \sin^2 A + 1 = 2\sin A$

$\Rightarrow (\sin A - 1)^2 = 0$

$\Rightarrow \sin A = 1$

$\therefore \sin^8 A + \operatorname{cosec}^{16} A = \sin^8 A + \frac{1}{\sin^{16} A}$

$= 1^8 + 1^{\frac{1}{16}} = 1 + 1 = 2$

12. Ans (d): $\sin Q_1 + \sin Q_2 + \sin Q_3 = 3$

$\Rightarrow Q_1 = Q_2 = Q_3 = 90^0$

$\therefore \cos Q_1 + \cos Q_2 + \cos Q_3 = \cos 90^0 + \cos 90^0 + \cos 90^0$

$= 0 + 0 + 0 = 0$

13. Ans (a): $\cos\theta - \sin\theta = \sqrt{2}\sin\theta$

$\Rightarrow \cos\theta = (1+\sqrt{2})\sin\theta$

$\therefore \cos\theta + \sin\theta = (1+\sqrt{2})\sin\theta + \sin\theta$

$= (1+\sqrt{2}+1)\sin\theta$

$= (2+\sqrt{2})\sin\theta$

$= \sqrt{2}\ (\sqrt{2}+1)\sin\theta$

$= \sqrt{2}\cos\theta$

14. Ans (c): Given

$\tan1^0.\tan2^0.\tan3^0$ .....$\tan 89^0$

take a pair $\tan1^0.\tan89^0$

$= \tan(0^0 - 89^0).\tan89^0$

$= \cot89^0.\tan89^0 = 1$

Similarly, $\tan2^0 \tan88^0 = 1$

$\tan3^0.\tan89^0 = 1$

.....

$\tan44^0.\tan46^0 = 1$

$\tan45^0 = 1$

So, multiple of each pairs will be 1.

15. Ans (a): The angle opposite smallest side is the smallest angle of triangle

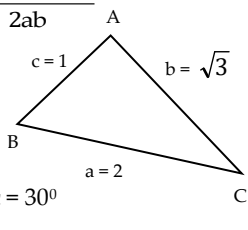
So, for any triangle ABC, consider $a = 2$, $b = \sqrt{3}$, $c = 1$ Then c is the smallest one

Now, $\cos c = \frac{a^2+b^2-c^2}{2ab}$

$\Rightarrow \cos c = \frac{4+3-1}{2.2\sqrt{3}}$

$\Rightarrow \cos c = \frac{6}{4\sqrt{3}}$

$\Rightarrow \cos c = \frac{\sqrt{3}}{2} \Rightarrow c = 30^0$



16. Ans (c): let $a = x^2 + x + 1$, $b = 2x + 1$, $c = x^2 - 1$
For $x = 2 \Rightarrow a = 7, b = 5, c = 3$
Here a is longest. So $\angle A$ is greatest.
Using cosine law, $\cos A = \frac{b^2 + c^2 - a^2}{2bc} \Rightarrow$
$\cos A = \frac{25 + 9 - 49}{2.5.3} = -\frac{1}{2} \Rightarrow A = 120^0$

17. Ans (c): Here A:B:C = 1:2:3
$\Rightarrow A = x, B = 2x, C = 3x$
Now, $A + B + C = 180^0$
$\Rightarrow 6x = 180^0 \quad \Rightarrow x = 30^0$
So, $A = 30^0, B = 60^0, C = 90^0$
Since, a:b:c = sinA:sinB:sinC
$= \sin 30^0 : \sin 60^0 : \sin 90^0$
$= \frac{1}{2} : \frac{\sqrt{3}}{2} : 1 = 1 : \sqrt{3} : 2$

Mensuration

1. Ans (b): Area (A) = $144m^2$
$\Rightarrow l^2 = 144m^2 \Rightarrow l = 12m$
So, perimeter = $4l = 4 \times 12m = 48m$.

2. Ans (c): Diagonal of square = $l\sqrt{2}$
$\Rightarrow 7\sqrt{2} \Rightarrow l = 7$
So, $A = l^2 = 7^2 = 49$.

3. Ans (a): Breadth (b) = 120
Here, breadth = one third less than length
$\Rightarrow b = l - l/3 \Rightarrow 120 = 2\frac{1}{3}$
$\Rightarrow l = 180$.
Area, $A = l \times b = 180 \times 120m^2$
Area of paving stone = $40^2 = 1600$ m^2
Now $160m^2$ cost Rs. 20
$1m^2$ cost Rs. $\frac{20}{1600}$
$\therefore 180 \times 120m^2$ cost Rs
$\frac{20}{1600} \times 180 \times 120 = 270$

4. Ans (b): $A = d(l + b - d)$
$196 = 2(60 + b - 2)$
$98 = 58 + b$
$b = 40$

5. Ans (d): Circumference = 4π
$\Rightarrow 2\pi r = 4\pi^2$
$\Rightarrow r = 2$
So, $A = \pi r^2 = 4\pi$.

6. Ans (a): In 1 min wheel makes 500 revolution.
Also, In 1 hr it travels 66 km
In 1 min it travels $\frac{66}{60}$ km
So, 500 revolution = $\frac{66}{60}$ km
1 revolution = $\frac{66}{60 \times 500}$ km
i.e. $2\pi r = \frac{66}{60 \times 500}$ km
$2 \times \frac{22}{7} \times r = \frac{66}{60 \times 500}$ km
$\therefore r = \frac{66}{60} \times 2 \times 22 \times \frac{7}{500}$ km $= 0.35m$

7. Ans (b): Let $a = 3, b = 4, c = 6$
$\therefore S = \frac{a + b + c}{2} = \frac{13}{2}$
Now, $A = \sqrt{s(s-a)(s-b)(s-c)}$
$= \sqrt{\frac{13}{2}\left(\frac{13}{2} - 3\right)\left(\frac{13}{2} - 4\right)\left(\frac{13}{2} - 6\right)}$
$= \sqrt{\frac{13}{2} \cdot \frac{7}{2} \cdot \frac{5}{2} \cdot \frac{1}{2}}$
$= \sqrt{\frac{455}{16}} = \frac{1}{4}\sqrt{455}$

8. Ans (c): Area of sector = $\frac{\theta}{360} \times \pi r^2$
$= \frac{60}{360} \times \pi \times 2^2$
$= \frac{2\pi}{3}$.

9. Ans (d): Volume of cubes of length 4 cm = $4^3 = 64 cm^3$
Volume of cubes of length 16 cm = $16^3 = 25856\ cm^3$
$\therefore$ no. of cubes = $\frac{25856}{64} = 404$

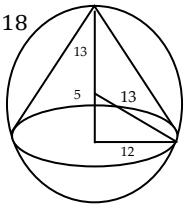
10. Ans (d) Total S.A. = $2\pi r\ (r + h)$
$\Rightarrow 1628 = 2\pi r \times 148$
$\Rightarrow 2\pi r = \frac{1628}{148} = 11\,cm$

11. Ans (c): T. S.A. of hemisphere = $3\pi r^2 = 3\pi.2^2 = 12\pi$
$= 3\pi r^2$
$= 3\pi.2^2 = 12\pi$

12. Ans (c): l = 3m, b = 2m, h = 1m
Now, volume, v = l × b × h
$= 3 \times 2 \times 1 = 6m^3$
Since, $1m^3$ occupy 1000 ltr
$\therefore$ $6m^3$ occupy 6000 ltr.

13. Ans (b): If the base of radius is 4, the side of square is $4\sqrt{2}$.
Volume of pyramid = $\frac{1}{3}\times$ area of base × h = $\frac{1}{3}.(4\sqrt{2})^2 \times 9 = 96$

14. Ans (d): height of cone = 18
$V = \frac{1}{3}\pi r^2 h = \frac{1}{3}.\pi.144.18$
$= 864\pi$



15. Ans (d): Volume of one tennis ball
$= \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{2.5}{2}\right)^3 = \pi\left(\frac{2.5}{6}\right)^3$
So, volume of all three balls = $3\times\pi\frac{(2.5)^3}{6} = \pi\frac{(2.5)^3}{2}$
Volume of cane = $\pi r^2 h = \pi\times \left(\frac{2.5}{2}\right)^3 \times 3 \times 2.5 = 3\pi\frac{(2.5)^3}{4}$
$\therefore$ Volume of air = 3π
$\frac{(2.5)^3}{4} - \pi\frac{(2.5)^3}{2} = \frac{\pi(2.5)^3}{4} = 12.3$

16. Ans (d): Length of cylindrical part (h) = 28 cm
radius of cylinder (r) = 7/2 cm = 3.5cm
So, C.S.A. of cylinder = $2\pi rh = 2\times \frac{22}{7}\times 3.5 \times 28 = 616 cm^2$
Length of central part (h) = 40 – 28 = 12
radius of cone (r) = 7/2 cm = 3.5 cm
C.S.A. of cone = πrh = $\frac{22}{7}\times 3.5 \times 12 = 132 cm^2$
$\therefore$ C.S.A of solid figure = (616 + 132) $cm^2 = 748\ cm^2$

17. Ans (c): In the figure, BC = 5, AB = 2
So, area of rectangle = 5 × 2 = 10
radius of sectors = AB = DC = 2.
Also, area of sector (BAE + CDF) = $2 \times \frac{1}{2}r^2\theta = r^2\theta = 4 \times \pi/2 = 2\pi$.
Required area of shaded part = $10 - 2\pi$.

18. Ans (a): Draw BM and CN 1^r to AD such that
DN = x $\Rightarrow$ AM = 14 – x.
$AB^2 = BM^2 + AM^2$
$\Rightarrow 13^2 = BM^2 + (14 - x)^2$
$BM^2 = 169 - (14 - x)^2$ ..... (i)
Similarly, $CD^2 = CN^2 + DN^2$
$\Rightarrow 15^2 = BM^2 + x^2$ [CN = BM]
$\Rightarrow BM^2 = 15^2 - x^2$ ..... (ii)
Combining (i) and (ii)
$169 - (14 - x)^2 = 15^2 - x^2$
$\Rightarrow 169 - 296 + 28x - x^2 = 225 - x^2$

$\Rightarrow x = 9$

So, from (ii) BM = 12

$\therefore$ Area of Trapezium = 1/2 [AD + BC]× BM

= 1/2[30+16]× 12 = 276 sq. unit

19. Ans (d): Let d be the diameter, then radius = d/2

$\therefore$ Volume of sphere = $4/3\pi\left(\frac{d}{2}\right)^3 = \frac{\pi d^3}{6}$

If diameter is doubled = 2d, then new radius = $\frac{2d}{2} = d.$

So, new volume of sphere = $\frac{4}{3}\pi d^3$

Times of increment = $\frac{\text{Increased Volume}}{\text{Original Volume}}$

$= \frac{\frac{4\pi d^3}{3}}{\frac{\pi d^3}{6}} = 8$ times

Arithmetic

1. Ans: (c) x is increased to x + 20% of x

$= x + \frac{20x}{100} = \frac{6x}{5}$

$\therefore x^2$ is increased to $\left(\frac{6x}{5}\right)^2 = \frac{36x^2}{25}$

So increased % in $x^2 = \frac{\frac{36x^2}{25} - x^2}{x^2} \times 100\%$

$= \frac{11x^2}{25x^2} \times 100\% = 44\%$

2. Ans (a): Let x be M.P. of the article

For 1st offer

S.P. = x – 15% of x

$= x - \frac{3x}{20} = \frac{17x}{20}$

$\Rightarrow 60 = C.P. - \frac{17x}{20}$

$C.P. = 60 + \frac{17x}{20}$ ..... (i)

For 2nd offer

S.P. = x – 10% of x

$= x - \frac{x}{10} = \frac{9x}{10}$

$\therefore 60 = \frac{9x}{10} - C.P$

$CP = \frac{9x}{10} - 60$ ..... (ii)

From (i) and (ii)

$60 + \frac{17x}{20} = \frac{9x}{10} - 60$

$\frac{1200 + 17x}{20} = \frac{9x - 600}{10}$

$1200 + 17x = 18x - 1200 \Rightarrow x = 2400$

3. Ans (d): Let salary of A = 100

salary of B = 100 + 25% of 100 = 125

less salary is 25 in 125.

$\therefore$ less salary % = $\frac{25}{125} \times 100\% = 20\%$

4. Ans (d):

$10 = \frac{C.P - 4500}{C.P.} \times 100$

$\Rightarrow C.P. = 10C.P. - 45000 \Rightarrow 9C.P = 45000$

$\Rightarrow C.P = 5000$

Again, $10 = \frac{S.P - 5000}{5000} \times 100$

$\Rightarrow 500 = SP - 5000 \Rightarrow SP = 5500.$

5. Ans (c): Let, r be radius circle, then area = πr^2

Decreased amount of radius = r = – 30% of r = $\frac{7r}{10}$

$\therefore$ decreased area = $\pi\left(\frac{7r}{10}\right)^2 = \pi\frac{49}{100}r^2$

Now % decreased region = $\frac{\pi r^2 - \pi\frac{49}{100}r^2}{\pi r^2}\times 100$

= $\frac{51\pi r^2}{100\pi r^2}\times 100$ = 51%

6. Ans (c): Let x and y are amount of 4% and 8% sugar concentration

Now, 5% concentration = $\frac{4\%\text{ of } x + 8\%\text{ of } y}{x+y}$

$\Rightarrow 5 = \frac{4x+8y}{x+y} \Rightarrow 5x + 5y = 4x + 8y$

$\Rightarrow x - 3y = 0$ …….. (i)

Also, x + y = 40 ….. (ii)

From (i) & (ii) we have x = 30, y = 10.

7. Ans (b) : Let M.P = x

SP = x – 15% of x = $\frac{17x}{20}$

VAT = 10% of $\frac{17x}{20}$ = $\frac{17x}{200}$

Amount paid = SP + VAT = $\frac{187}{200}$x

i.e. $\frac{187x}{200} = 5610$

$\therefore$ x = Rs.6000

8. Ans (c):

Suppose, the price of commodities = 100

After the increment of 20%, new price = 120

The amount of consumption to decrease = 20

$\therefore$ Required % = $\frac{20}{120}\times 100\% = \frac{100}{6} = 16\frac{2}{3}\%$

9. Ans: (b) The amount of water in 120 l of milk = 5% of 120l = 6l

The amount of water in 80l of milk = 10% of 80l = 8l

$\therefore$ Total amount of water in mixture = 6l + 8l = 14l

$\therefore$ % of mixture = $\frac{\text{amount of water}}{\text{Total amount}}\times 100\%$

= $\frac{14}{120+80}\times 100\% = 7\%$

10. Ans: (a): Let x be male population then, Female population = (18000 – x)

The increased male population = 5% of x = $\frac{x}{20}$

Decreased female population = 4% of (18,000 –x) = $\frac{18000 - x}{25}$

Since, $\frac{x}{20} = \frac{18000 - x}{25}$

$\Rightarrow$ x = 8000

$\therefore$ Female population = 10,000

11. Ans (c): Here, I = Rs. 5, R = 10% p.a., T = 1 day = $\frac{1}{365}$ years

Since, P= $\frac{I\times 100}{TR} = \frac{5\times 100\times 365}{1\times 10}$ = Rs.18,250

12. Ans (a): Here, P = Rs.8,400, T = 1 year, reduced rate = 1.5% p.a.

Reduced amount= $\frac{PTR}{100} = \frac{8400\times 1\times 1.5}{100}$ = Rs.126

13. Ans (c): Number of year = T, double amount (n) = 2, Rate (R) = 8% p.a.

$\therefore$ T =

14. Ans: (d): Let, P_1 = x then P_2 = (1200 – x)

T_1 = 4 yr $T_2 = 3\frac{3}{5}$ yr = $\frac{18}{5}$ year

R_1 = 12% p.a. R_2 = 8% p.a.

Here $I_1 = I_2$

$\Rightarrow \frac{x\times 4\times 12}{100} = \frac{(1200-x)\times 18\times 8}{100\times 5}$

$\Rightarrow$ x = Rs. 450 P_2 = 1200-x = 750

15. Ans (c): Here, A = 1440

Rate = $\frac{1}{20}\times 100\% = 5\%$

let p be sum of money

Then 1440 = P + I

$\Rightarrow 1440 = p + \frac{P \times T \times R}{100}$

$\Rightarrow 1440 = p + \frac{p \times 4 \times 5}{100}$

$\Rightarrow 1440 = p + \frac{p}{5}$

$\Rightarrow 1440 = \frac{6p}{5}$

$\Rightarrow p = 1200$

16. Here, P = Rs. 4500, R = 15%, T = 3 years

Since, $A = P\left(1+\frac{R}{100}\right)^T$

$= 4500\left(1+\frac{15}{100}\right)^3 = 4500\left(\frac{115}{100}\right)^3$

$= 4500 \times \frac{115}{100} \times \frac{115}{100} \times \frac{115}{100}$ = Rs. 6843.94

17. Ans (d): Here, P = Rs. 1000, R = 12%
T = 2 year = 2× 2 half year = 4 half year

Now, C.I. = $P\left[\left(1+\frac{R}{200}\right)^{2T}-1\right]$

C.I. = $1000\left[\left(1+\frac{12}{200}\right)^{2\times 2}-1\right]$

$= 1000\left[\left(\frac{212}{200}\right)^4-1\right]$

= 262.48

18. Ans (a): Let x be required dollars
We have, \$17 = Rs. 1326
Rs. 1650 = £ 15
£195 = \$x
Using chain rule, we get
x × 15 × 1326 = 195 × 1650 × 17
$\Rightarrow$ x = \$ 275

19. Ans (c): min. charge for 100 local calls = Rs. 180
Charge for telephone calls without VAT = Rs. 2
$\therefore$ x + 100 % of x = Rs.726
$\Rightarrow$ x = Rs 660.
Let y be telephone call without TSC
So, y +100% of y = Rs 660
$\Rightarrow$ y = Rs 600.
$\therefore$ Charge for extra call = Rs 600− Rs 180
Hence number of extra calls = 420/3 =140.

20. Ans (a): Let x be total days. In one day A, B, C works $\frac{1}{20}, \frac{1}{30}, \frac{1}{40}$ of whole works. By questions, A works 5 days B works x days and C works (x – 10) days.
But A + B +C = 1 work
i.e. $\frac{5}{20}+\frac{x}{30}+\frac{x-10}{40}=1$
$\Rightarrow \frac{30+4x+3x-30}{120}=1$
$\Rightarrow$ 7x = 120
$\Rightarrow x = 17\frac{1}{7}$ days.

21. Ans (b): First pipe can fill a tank in 12 min.
So, in 1 min. $\frac{1}{15}$ part of tank will emptied.
Now, in 1 min $\left(\frac{1}{12}-\frac{1}{15}\right)=\frac{1}{60}$ part of tank will filled.
$\therefore$ The tank will filled in 60 min.

22. Ans (c): 1500 soldiers have food for 48 days.
After 13 days, 1500 soldiers have food for 35 days.
If x additional solders be joined after 13 days.
Then, (1500 + x) soldiers have food for 25 days.
Using the relation of indirect proportion.
So, $\frac{1500}{1500+x}=\frac{25}{35}$ $\Rightarrow$ 1500 × 25 = 35 (1500 + x)
$\Rightarrow$ 1500 × 7 = 5(1500 + x)
$\Rightarrow$ 5x = 30,000
$\Rightarrow$ x = 600

Coordinate Geometry

1. Ans (c): Using section formula we get, $(4, y) = \left(\frac{2.3+1.6}{2+1}, \frac{2.2+1.-1}{2+1}\right)$
   $\Rightarrow (4, y) = (4, 1)$
   $\Rightarrow y = 1$
2. Ans (c): Slope of line $x - 3y - 6 = 0$ is, $m_1 = \frac{-1}{-3} = \frac{1}{3}$
   Slope of line $y = 2x + 5$ is, $m_2 = 2$
   So, angle between the lines, $\theta = \text{Tan}^{-1}\left(\pm\frac{m_1 - m_2}{1 + m_1.m_2}\right)$
   $= \text{Tan}^{-1}\left(\pm\frac{\frac{1-6}{3}}{\frac{5}{3}}\right)$
   $= \text{Tan}^{-1}\left(\pm -1\right)$
   $= \text{Tan}^{-1}(1) = 45^0$

3. Ans (a): Solving first two equations: $x - 2y + 1 = 0$ and $2x - 5y + 3 = 0$, we get, $(x, y) = (1, 2)$
   Substituting $(x, y) = (1, 1)$ in $5x + 9y + k = 0$ we get,
   $5.1 + 9.1 + k = 0$
   $\Rightarrow k = -14$
4. Ans (b): Let the line $x - y = 2$ divides (3, -1) and (8, 9) in the ratio k:1 at (x, y).
   So, $(x, y) = \left(\frac{k.8+1.3}{k+1}, \frac{k.9+1.-1}{k+1}\right)$
   $\Rightarrow (x, y) = \left(\frac{8k+3}{k+1}, \frac{9k-1}{k+1}\right)$
   Since, the point lie on $x - y = 2$
   $\Rightarrow \frac{8k+3}{k+1} - \frac{9k-1}{k+1} = 2$
   $\Rightarrow 8k + 3 - 9k + 1 = 2k + 2$
   $\Rightarrow -k + 4 = 2k + 2$
   $\Rightarrow -3k = -2$
   $\Rightarrow k = 2/3$

5. Ans (c): Given lines, $4x + 3y = 11$ .. (i)
   $8x + 6y = 15$
   $\Rightarrow 4x + 3y = \frac{15}{2}$ ..... (ii)
   $c_1 = 11,\ c_2 = \frac{15}{2}$, $a = 4$, $b = 3$.
   $\therefore d = \left|\frac{c_1 - c_2}{\sqrt{a^2 + b_2}}\right| = \left|\frac{11 - 15/2}{\sqrt{4^2 + 3^2}}\right| = \left|\frac{-7}{10}\right| = \frac{7}{10}$

6. Ans (d): Given line $y = x$
   $\Rightarrow x - y = 0$ ..... (i)
   line 1^r to $x - y = 0$ is $x - y + k = 0$
   But $x - y + k = 0$ pass through (3, 2)
   So, $3 - 2 + k = 0$
   $\Rightarrow k = -1$
   $\therefore x - y = 1$ is required line
7. Ans (a): Here, length of 1^r from (a, 3) on the line $3x + 4y + 5 = 0$ is 4
   $\therefore 4 = \pm\frac{3.a + 4.3 + 5}{\sqrt{3^2 + 4^2}}$
   $\Rightarrow 4 = \pm\frac{3.a + 17}{5}$
   $\Rightarrow 20 = \pm(3a + 17)$
   $\Rightarrow 20 = 3a + 17,\ 20 = -3a - 17$
   $\Rightarrow a = 1,\ a = 37/3$.
8. Ans (a): Consider the points A(1, 4), B(–3, 16), C(k, –2)
   Here, A, B, C are collinear
   So, slope of AB = Slop of BC
   $\Rightarrow \frac{16-4}{-3-1} = \frac{-2-16}{k+3}$
   $\Rightarrow \frac{12}{-4} = \frac{-18}{k+3}$
   $\Rightarrow k + 3 = 6$
   $\Rightarrow k = 3$
9. Ans (b): $\Delta = \frac{1}{2}\begin{vmatrix} 2 & 6 & 6 & 2 \\ -1 & 1 & 3 & -1 \end{vmatrix}$
   $= \frac{1}{2}|(2 + 6) + (18 - 6) + (-6 + 6)|$

$= \frac{1}{2}|8 + 12 + 0| = 10$ sq. unit

10. Ans (d): The combination of equations,
$x + y = 5$ and $x + y = -3$ is
$(x + y - 5)(x + y + 3) = 0$
$\Rightarrow x^2 + xy + 3x + xy + y^2 + 3y - 5x - 5y - 15 = 0$
$\Rightarrow x^2 + 2xy + y^2 - 2x - 2y - 15 = 0$

11. Ans (b): Taking homogeneous part of the equation as
$x^2 + 6x + 9y^2 = 0$
Here, $a = 1, h = 3, b = 9$
Now, $\theta = \text{Tan}^{-1}\left(\frac{2\sqrt{h^2 - ab}}{a + b}\right)$
$= \text{Tan}^{-1}\left(\frac{2.0}{10}\right)$
$= \text{Tan}^{-1} 0 = 0^0$

12. Ans (b): Lines $(5a + 4)x^2 - (10a + 4)xy + (5a + 3)y^2 = 0$ represent co-incident lines if $h^2 = ab$
$\Rightarrow \left(\frac{10a + 4}{2}\right)^2 = (5a + 4)(5a + 3)$
$\Rightarrow 100a^2 + 40a + 16 = 4(25a^2 + 35a + 12)$
$\Rightarrow 100a^2 + 40a + 16 = 100a^2 + 140a + 48$
$\Rightarrow 100a = -32$
$\Rightarrow a = -8/25$

13. Ans (c): Given equation $x^2 + 2xy - y^2 = 0$
$a - 1, h = 1, b = -1$
New, $a + b = 1 - 1 = 0$
So, lines are perpendicular to each other.

14. Ans (d): Given equation
$4x^2 + 10xy + ky^2 + 5x + 10y = 0$
on comparing $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$
we get, $a = 4, h = 5, b = k, g = 5/2, f = 5, c = 0$
equation represents a pair of lines
$\Rightarrow abc + 2fgh - af^2 - bg^2 - ch^2 = 0$
$\Rightarrow 0 + 125 - 100 - k.\frac{25}{4} - 0 = 0$
$\Rightarrow \frac{25}{4}k = 25 \Rightarrow k = 4$

15. Ans (a): Comparing the equation $x^2 - 2xy \text{ cosec} 2\alpha + y^2 = 0$ to $ax^2 + 2bxy + by^2 = 0$ we get,
$a = 1, h = \text{cosec} 2\alpha, b = 1$
Now, $\text{Tan}\theta = \pm\frac{2\sqrt{h^2 - ab}}{a + b}$
$\Rightarrow \text{Tan}\theta = \pm\frac{2\sqrt{\text{cosec}^2 2\alpha - 1}}{2}$
$\Rightarrow \text{Tan}^2\theta = \text{cosec}^2 2\alpha - 1$
$\Rightarrow \text{Tan}^2\theta = \cot^2 2\alpha$
$\Rightarrow \text{Tan}^2\theta = \text{Tan}^2(90 - 2\alpha)$
$\Rightarrow \theta = 90 - 2\alpha$

16. Ans (b): The lines $xy = 0$ gives two separate lines
$x = 0$ and $y = 0$
which are y and x axis.
$\therefore$ angle between lines is 90^0.

17. Ans (d): $(\lambda - 5)x^2 + 2\lambda y^2 - 5x + 6y - 3 = 0$ represent a circle if,
co-efficient of x^2 = co-efficient of y^2
$\Rightarrow \lambda - 5 = 2\lambda$
$\Rightarrow \lambda = -5$

18. Ans (c): Comparing $x^2 + y^2 - 2x - 8y - 16 = 0$ with
$x^2 + y^2 + 29x + 2fy + c = 0$, we get
$g = -1, f = 21, c = -16$
So, radius (r) $= \sqrt{g^2 + f^2 - c}$
$= \sqrt{1 + 16 + 16} = \sqrt{33}$
Area of circle $= \pi r^2 = 33\pi$

19. Ans (b): The centre of circle passing through (p, 0), (0, q) and (0, 0)
$\therefore$ centre of circle $= \left(\frac{p + 0}{2}, \frac{0 + q}{2}\right) = \left(\frac{p}{2}, \frac{q}{2}\right)$

20. Ans (b): Comparing $x^2 + y^2 - 2x - 3y - k = 0$
$x^2 + y^2 + 2gx + 2fy + c = 0$, we get

a = 1, b = 1, g = -1, f = 3/2, c = k

So, radius = $\sqrt{g^2+f^2-c}$

$\Rightarrow 5/2 = \sqrt{1+\frac{9}{4}+k}$

$\Rightarrow 5/2 = \sqrt{\frac{13+4k}{2}}$

$\Rightarrow 25 = 13 + 4k \quad \Rightarrow k = 3$

21. Ans (d): Area of triangle = $\frac{abc}{4R}$,

R = radius

$\frac{\sqrt{3}}{4}.a^2 = \frac{a^3}{4R}$ [a = b = c]

$\Rightarrow \sqrt{3} = \frac{a}{R}$

$\Rightarrow R = \frac{24}{\sqrt{3}}$

$\Rightarrow R = 8\sqrt{3}$ cm

Algebra I

1. Ans (c): Hints: $x + \frac{1}{x} = 3 + \sqrt{8} + \frac{1}{3+\sqrt{8}} = 6$

$x^3 + \frac{1}{x^3} = (x + \frac{1}{x})^3 - 3.x.\frac{1}{x}(x + \frac{1}{x})$

$= 6^3 - 3.6 = 198.$

2. Ans (d): xy = 1

$x^2 = \frac{3-2\sqrt{6}+2}{3+4\sqrt{3}+2} = \frac{5-2\sqrt{6}}{5+2\sqrt{6}}$

$y^2 = \frac{3+2\sqrt{6}+2}{3-4\sqrt{3}+2} = \frac{5+2\sqrt{6}}{5-2\sqrt{6}}$

$x^2 + xy + y^2 = \frac{5-2\sqrt{6}}{5+2\sqrt{6}} + 1 + \frac{5+2\sqrt{6}}{5-2\sqrt{6}}$

$= \frac{(5-2\sqrt{6})^2 + (5+2\sqrt{6})(5-2\sqrt{6}) + (5+2\sqrt{6})^2}{(5+2\sqrt{6})(5-2\sqrt{6})}$

$= \frac{(25-20\sqrt{6}+24) + (25-24) + (25+20\sqrt{6}+24)}{25-24}$

$= 99$

3. Ans (d): $2^{x+3} = 32$

$\Rightarrow 2^{x+3} = 2^5 \Rightarrow x + 3 = 5$

$\Rightarrow x = 2 \quad \therefore 3^{x+2} = 3^{2+2} = 81$

4. Ans (a): x = 3a + 7

$\Rightarrow 3a = x - 7$

Now, $y = 9a^2$

$\Rightarrow y = (3a)^2 \Rightarrow y = (x - 7)^2$

5. Ans (b): $y - \frac{1}{y} = 3$

So, $y^2 + \frac{1}{y^2} = \left(y - \frac{1}{y}\right)^2 + 2$

$= 3^2 + 2 = 11$

6. Ans (c): $\sqrt[3]{a^{-5}b^{-2}} \times \sqrt[3]{a^2b^5}$

$= (a^{-5}.b^{-2})^{1/3} \times (a^2.b^5)^{1/3}$

$= a^{-5/3}.b^{-2/3}.a^{2/3}.b^{5/3}$

$= a^{2/3-5/3}.b^{5/3-2/3}$

$= a^{-3/3}.b^{3/3} = a^{-1}b = b/a.$

7. Ans (a): $\frac{3^{x+2} - 3^x}{8.3^x} = \frac{3^x.3^2 - 3^x}{8.3^x}$

$= \frac{3^x(9-1)}{8.3^x} = \frac{3^x.8}{8.3^x} = 1$

8. Ans (d): We have, 2a = b

Choose the value of a = 2
from the given options
Then, $2a = b \Rightarrow b = 4$
and $a^b = b^a$
$\Rightarrow 2^4 = 4^2 \quad \Rightarrow 16 = 16$ true $\therefore$ a = 2.

9. Ans (b): Here, $a = b^x = b = c^y$, $c = a^3$
$a = b^x = (c^y)^x = c^{xy} = (a^3)^{xy} = a^{xyz}$
$\Rightarrow a^2 = a^{xyz} \Rightarrow xyz = 1$

10. Ans (a): Here, $x = 3^{1/3} - 3^{2/3}$
Then $x^3 + 9x + 6 = (3^{1/3} - 3^{2/3})^3 + 9(3^{1/3}-3^{2/3}) + 6$
$= (3^{1/3})^3 - (3^{2/3})^3 - 3.3^{1/3}.3^{2/3}.(3^{1/3}-3^{2/3}) + 9\,(3^{1/3}-3^{2/3}) + 6$
$= 3 - 3^2 - 3.3^{1/3+2/3}\,(3^{1/3} - 3^{2/3}) + 9\,(3^{1/3}-3^{2/3}) + 6$
$= 3 - 9 - 9(3^{1/3} - 3^{2/3}) + 9(3^{1/3}-3^{2/3}) + 6$
$= -6 + 6 = 0$

11. Ans (d): Oder of first term x^3y^2 is
3 + 2 = 5, is greater than other term in the function
so, 5 is degree of function

12. Ans (a): $50^{100} = k(100^{50})$
$\Rightarrow 50^{100} = k.(2.50)^{50}$
$\Rightarrow 50^{100} = k.(2^{50}.50^{50})$
$\Rightarrow k.2^{50} = 50^{50} \quad \Rightarrow k = \left(\frac{50}{2}\right)^{50} = 25^{50}$

13. Ans (a):
$$\left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2 = (\sqrt{x})^2 + 2.\sqrt{x}.\frac{1}{\sqrt{x}} + \left(\frac{1}{\sqrt{x}}\right)^2$$
$$\Rightarrow \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2 = \left(x + \frac{1}{x}\right) + 2$$
$$\Rightarrow \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2 = 4 \Rightarrow \sqrt{x} + \frac{1}{\sqrt{x}} = 2$$

14. Ans (c): $a^2 - 6a - 1 = 0$
$\Rightarrow a^2 - 1 = 6a$
$$\Rightarrow a - \frac{1}{a} = 6$$
$$\therefore\ a^2 + \frac{1}{a^2} = \left(a - \frac{1}{a}\right)^2 + 2a.\frac{1}{a}$$
$= 6^2 + 2 = 38$

15. Ans (b): $(a + 3)^2 - \left(\frac{1}{a}\right)^2$
From given options, the product of
$\left(a - \frac{1}{a} - 3\right)$ and $\left(a - 1/a + 3\right)$ is
$\left(a - \frac{1}{a} - 3\right)\left(a - 1/a + 3\right)$
$= \left(a - 1/a\right)^2 - 3^2$
$= a^2 - 2a.\frac{1}{a} + \left(1/a\right)^2 - 9$
$= a^2 - 2 + \frac{1}{a^2} - 9$
$= a^2 + \frac{1}{a^2} - 11$
$\therefore$ b is the correct choice

16. Ans (d): Let $x^{1/m} = y^{1/m} = 3^{1/p} = k$
$\Rightarrow x^{1/m} = k$, $y^{1/m} = k$, $3^{1/p} = k$
$\Rightarrow x = k^m$, $y = k^n$, $z = k^p$
Now, $xyz = k^m, k^n.k^p$
$\Rightarrow xyz = k^{m+n+p}$ [xy = 1]
$\Rightarrow k^{m+n+p} = z$
m+n+p, is not determined

17. Ans (b): $\frac{2}{3}(x-1) \le \frac{x+4}{6}$
$\Rightarrow 2(x-1) \le \frac{x+4}{3}$
$\Rightarrow 4(x-1) \le x + 4$
$\Rightarrow 4x - 4 \le x + 4$
$\Rightarrow 3x \le 8 \quad \Rightarrow x = 8/3$

18. Ans (c): $a = 10^x$, $b = 10^y$
Now, $a^xb^y = 100$
$\Rightarrow a^x.b^y = 10.10$
$\Rightarrow (10^x)^x.(10^y)^y = 10.10$
$\Rightarrow 10^{x^2}.10^{y^2} = 10.10$
on comparing
$x^2 = 1$, $y^2 = d$
$\Rightarrow x^2y^2 = 1 \quad \Rightarrow xy = \pm 1 \quad \therefore xy = 1$

19. Ans (a): Let x and y are current ages of boy and his sister such that x = y + 3.... (i)

Since, two years ago the sum of their ages was 19.

So, $x - 2 + y - 2 = 19$

$\Rightarrow x + y = 23$

$\Rightarrow y + 3 + y = 23$

$\Rightarrow 2y = 20 \quad \Rightarrow y = 10$

$\therefore x = 10 + 3 = 13$

20. Ans (c): Let x and y are the present ages of Alex and his father. Then $\frac{x}{y} = \frac{1}{4}$.....(i)

After 6 years their ages will be 5:14

So, $\frac{x+6}{y+6} = \frac{5}{14}$

$\Rightarrow 14x + 84 = 5y + 30$

$\Rightarrow 14x - 5y + 54 = 0$

$\Rightarrow 14x - 5.4x + 54 = 0$ [using i]

$\Rightarrow 6x = 54 \Rightarrow x = 9$

So, from (i), $\frac{9}{y} = \frac{1}{4}$ $= y = 36$.

21. Ans (b): For first trip, at the rate of 50 km/hr

100 km is travelled is 2 hr

For second trip, at the rate of 40 km/hr, 120 km is travelled in 3 hr.

So, average speed = $\frac{\text{Total distance}}{\text{Total time}} = \frac{100+120}{2+3} = 44\text{km/hr}$

22. Ans (d): Race course = 1 km = 1000m

A beats B by 100m and B beats C by 50m

So, $\frac{A}{B} = \frac{1000}{900}, \frac{B}{C} = \frac{1000}{950}$

Now, $\frac{A}{C} = \frac{1000}{900} \times \frac{1000}{950} = \frac{1000}{855}$

$\therefore$ A beats C by $1000 - 855 = 145$m

23. Ans (e): We have $2x = 3y = 4z$,

Now L.C.M of 2, 3 & 4 is 12,

So, $\frac{2x}{12} = \frac{3y}{12} = \frac{4z}{12}$

$\Rightarrow \frac{x}{6} = \frac{y}{4} = \frac{z}{3}$

$\therefore x : y : z = 6 : 4 : 3$

Sequence & Series

1. Ans (b): a = 2, d = 3

$S_n = \frac{n}{2}[2.a + (n-1)d]$

So, $S_{20} = \frac{20}{2}[2\times 2 + (20-1)3]$

$= 10[4 + 57]$

$= 610$

2. Ans (a): From given alternative. the term 36, lies on the series with first term 1 and common difference 5. So, Best choice is 36.

3. Ans (d): $9^{1/3}.9^{1/9}.9^{1/27}$ ..... ∞

$= 9^{1/3+1/9+1/27}$ .....∞

$= 9^{\left(\frac{1/3}{1-1/3}\right)}$ $\left[S_\infty = \frac{q}{1-r}\right]$

$= 9^{1/2} = 3.$

4. Ans (c): Let a and b are two numbers then

$\frac{a+b}{2} = 15,\ \sqrt{ab} = 9$

$\Rightarrow a + b = 30,\ ab = 81$

$\Rightarrow a = 3,\ b = 27$

So, H.M. $= \frac{2ab}{a+b} = \frac{162}{30} = \frac{27}{5}$

5. Ans (a): Let, $a^{1/x} = b^{1/y} = c^{1/z} = k,$

$\Rightarrow a = k^x,\ b = k^y,\ c = k^z$

Here, a,b,c are in G.P.

So, $b^2 = ac$

$\Rightarrow (k^y)^2\ b = k^x.k^z$

$\Rightarrow k^{2y} = k^{x+z}$

$\Rightarrow 2y = x + z$

$\Rightarrow y = \frac{x+z}{2}$

$\Rightarrow$ x, y, z are in A.P.

6. Ans (a): $s_n = \frac{n}{2}[2a + (n-1)d]$

$\Rightarrow s_{11} = \frac{11}{2}[2a + (11-1)d]$

$\Rightarrow 77 = \frac{11}{2}[2a + 10d]$

$\Rightarrow 7 = \frac{1}{2}.2[a + 5d]$

$\Rightarrow a + 5d = 7$

$\Rightarrow t_6 = 7$

7. Ans (d): a, b, c are in A.P $\Rightarrow b = \frac{a+c}{2}$

x, y, z are in G.P $\Rightarrow y^2 = xz$

Now, $x^{b-c}.y^{c-a}.z^{a-b} =$

$x^{\frac{a+c}{2}-c}.y^{c-a}.z^{a-\frac{a+c}{2}}$

$= x^{\frac{a-c}{2}}.y^{c-a}.z^{\frac{a-c}{2}}$

$= (xz)^{\frac{a-c}{2}}.y^{c-a}$

$= (y^2)^{\frac{a-c}{2}}.y^{c-a}$

$= y^0 = 1.$

8. Ans (c): $S_n = n^2 + 5$

We have, $t_n = s_n - s_{n-1}$

So, $t_{10} = s_{10} - s_9$

$\Rightarrow t_{10} = 105 - 86 = 19$

9. Ans (a): Let n be number of term of series 1 + 3 + 9 + 27 + ... so that the sum may exceed by 1000.

$\Rightarrow s_n \geq 1000$

$\Rightarrow \frac{1(3^n - 1)}{3-1} \geq 1000$

$\Rightarrow \frac{3^n - 1}{2} \geq 1000$

$\Rightarrow 3^n \geq 2001 \Rightarrow n \geq 7.$

10. Ans (c): $a = \frac{1}{18},\ l = \frac{81}{2},\ r = 3$

Now, $l = ar^{n-1}$

$\Rightarrow \frac{81}{2} = \frac{1}{18}.3^{n-1}$

$\Rightarrow 3^4 = 3^{n-3}$

$\Rightarrow n - 3 = 4$

$\Rightarrow n = 7$

11. Ans (d): t_2, t_n and t_8 are in G.P.

i.e. $\frac{t_4}{t_2} = \frac{t_8}{t_4}$

$\Rightarrow \frac{a+3d}{a+d} = \frac{a+7d}{a+3d}$

$\Rightarrow (a + 3d)^2 = (a + 7d)(a - d)$

$\Rightarrow a^2 + 6ad + 9d^2 = a^2 + 8ad + 7d^2$

$\Rightarrow 9d^2 - 7d^2 = 8ad - 6ad$

$\Rightarrow 2d^2 = 2ad$

$\Rightarrow a = d.$

So, ratio (r) = $\frac{t_4}{t_2} =$

$\frac{a+3d}{a+d} = \frac{a+3a}{a+a} = \frac{4a}{2a} = 2$

Geometry

1. Ans (d): Let x be the angle,
Then $x + 5x = 180^0$
$\Rightarrow 6x = 180^0$
$\Rightarrow x = 30^0$

2. Ans (b): Let x be the angle
$x + (4x - 20) = 90^0$
$\Rightarrow 5x = 110^0$
$\Rightarrow x = 22^0$

3. Ans (c): Let n be number of sides of polygon
Then $\frac{360^0}{n} = 60^0$
$\Rightarrow n = \frac{360^0}{60^0}$
$\Rightarrow n = 6$

4. Ans (a): In ΔBNC,
$105^0 + 55^0 + \angle NBC = 180^0$
$\Rightarrow \angle NBC = 20^0$
Also, $\angle MBC = 25^0 + \angle NBC$
$= 25^0 + 20^0 = 45^0$
$\therefore x = 45^0$ [Corresponding of $\angle MBC$]

5. Ans (d):$\angle ABD = 90^0$
$\therefore \angle BAD = 180^0 - (90^0 + 30^0) = 60^0$
Also, $x + \angle BAD = 180^0$ [Sum of opposite sides of cyclic quadrilateral]
$\Rightarrow x + 60^0 = 180^0$
$\Rightarrow x = 120^0$

6. Ans (c): $\angle C = \angle D = 30^0$
Also, $\angle BAD = 90^0$
So, $x + \angle BAD + \angle D = 180^0$
$\Rightarrow x + 90^0 + 30^0 = 180^0$
$\Rightarrow x = 60^0$

7. Ans (d): Join CB
So, $\angle ACB = 90^0$
Then, $\angle BCD = \frac{\angle BOD}{2}$
$\Rightarrow BCD = \frac{120^0}{2}$
$\Rightarrow BCD = 60^0$
So, $\angle ACD + \angle DCB = \angle ACB$
$\Rightarrow x + 60^0 = 90^0$
$\therefore x = 30^0$

8. Ans (b): $120^0 + \angle ABC = 180^0$ [co-interior angles]
$\Rightarrow \angle ABC = 60^0$
Also, $\angle ABC = \angle AEB = 60^0$ [base angles of isosceles triangle]
$\therefore \angle AEB = 60^0$

9. Ans (c): In triangle ABC,
$\angle B = \angle C$ [Being isosceles triangle]
Also, BD = EC, implies AED is an isosceles triangle
Let AED = ADE = x
$\therefore x + x + 25^0 = 180^0$
$\Rightarrow 2x = 155^0$
$\Rightarrow x = 77.5^0$

10. Ans (a): Here, AB $\perp$ BD.
Also, $\angle BAC = 1/2\angle BOD$
Now, $\angle BOD + OBD + \angle BDO = 180^0$
$\Rightarrow \angle BOD + 90^0 + 24^0 = 180^0$
$\Rightarrow \angle BOD = 66^0$
or, $\angle BAC = 1/2\angle BOD = 33^0$
Finally, $\angle BAC + \angle BCA + \angle ABC = 180^0$
$\Rightarrow 33^0 + x + 90^0 = 180^0$
$\Rightarrow x = 180^0 - 123^0 = 57^0$

11. Ans (b): Let, $\angle ABO = \angle OBC = a$, $\angle OCB = \angle OCA = b$
Here, in triangle ABC,
$2a + 2b + 80^0 = 180^0$
$\Rightarrow 2a + 2b = 100^0$
$\Rightarrow a + b = 50^0$ ..... (i)
So, $\angle BOC = 180^0 - 50^0 = 130^0$
& $x + 130^0 = 360^0 \Rightarrow x = 230^0$

Statistics

1. Ans (d): Cumulative frequency is represented using the curve known as ogive curve.

2. Ans (a): Let x be the 9th term let x_1 and x_2 are observations of first 8 items and last 8 items.

$\therefore \ \bar{x} = \frac{\sum x}{17} = 20 \Rightarrow \frac{\sum x}{17} \Rightarrow \sum x = 340$

$\bar{x}_1 = \frac{\sum x_1 + x}{9} \Rightarrow 23 = \frac{\sum x_1 + x}{9} \Rightarrow \sum x_1 = 207 - x$

$\bar{x}_2 = \frac{\sum x_2 + x}{9} \Rightarrow 18 = \frac{\sum x_2 + x}{9} \Rightarrow \sum x_2 = 162 - x$

$\therefore$ 340 = 207 – x + 162 – x

$\Rightarrow$ 2x = 369 – 340 = 29 $\Rightarrow$ x = 14.5

3. Ans (c): $100\% \sim 360^0$

$1\% \sim \frac{360^0}{100}$

For Group 0 – 45%

$45\% \sim \frac{360^0}{100} \times 45 = 160^0$

4. Ans (d): $N_1 = 20, \ \bar{x}_1 = 15, \ N_2 = 15, \ \bar{x}_1 = 20$

$\therefore$

$\bar{x}_{12} = \frac{N_1\bar{x}_1 + N_2\bar{x}_2}{N_1 + N_2} = \frac{20 \times 15 + 15 \times 20}{35}$

$\frac{300+300}{35} = 17.14$

5. Ans (a): $\bar{x} = \frac{30+36+p+40+44}{5}$

$\Rightarrow 35 = \frac{150+p}{5} \Rightarrow 175 - 150 = p$

$\Rightarrow p = 25$

6. Ans (d): $\bar{x} = \frac{\sum fx}{N}$, $N = \sum f = 23 + m$

$17 = \frac{10+50+150+20m+100+60}{23+m}$

$\Rightarrow 391 + 17m = 370 + 20m$

$\Rightarrow 3m = 21 \Rightarrow m = 7$

7. Ans (b): $\bar{x} = \frac{\sum fx}{N}$

$\Rightarrow 50 = \frac{\sum x}{200} \Rightarrow \sum x = 10{,}000$

So, corrected $\sum x = 10{,}000 - (80 + 8) + (150 + 88)$

$= 10{,}000 - 88 + 238$

$= 10150$

$\therefore$ corrected $\bar{x} = \frac{\sum x}{200} = \frac{10150}{200} = 50.75$

8. Ans (a): Consider, $x_1, x_2, x_3 \ldots x_n$ are the observed data

Then mean $(\bar{x}) = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{N} = A \text{ (say)}$

New data: $2x_1, 2x_2, 2x_3, \ldots 2x_n$

Then new mean $\bar{x} = \frac{2x_1 + 2x_2 + 2x_3 + \ldots + 2x_n}{N}$

$= \frac{2(x_1 + x_2 + x_3 + \ldots + x_n)}{N}$

$= 2A$

9. Ans (d): Adding all, x+y+z = 15

Average = $\frac{x+y+z}{3} = \frac{15}{3} = 5.$

10. Ans (a): $\sum x = 1 + 2 + 3 + 4 + 5 = 15$

$\sum x^2 = 1^2 + 2^2 + 3^2 + 4^2 + 5^2 = 55$

$\therefore \ \sigma = \sqrt{\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2}$

$= \sqrt{\frac{55}{55} - \left(\frac{15}{5}\right)^2} = \sqrt{11 - 32} = \sqrt{2}.$

Probability

1. Ans (b): S = {1, 2, 3, 4, 5, 6}, P(2 or 6) = P(2) + P(6) = 1/6 + 1/69 = 2/6 = 1/3

2. Ans (b): Face cards (Jack or Queen or King) = 12
   Total cards = 52
   $\therefore$ P(J or Q or K) = 12/52 = 3/13.

3. Ans (d): Let, P(A) = P(B) = 1/2P(C) = K, then P(A) = K, P(B) = K, 1/2 P(C) = K $\Rightarrow$ P(C) = 2K
   Since, P(A) + P(B) + P(C) = 1
   $\Rightarrow$ K + K + 2K = 1 $\Rightarrow$ 4K = 1
   $\Rightarrow$ K = 1/4.
   So P(C) = 2.K = 2.1/4 = 1/2

4. Ans (c): Let P(T) = K, then P(H) = 3K, But K + 3K = 1 $\Rightarrow$ 1/4
   So, P(H) = 3K = 3.1/4 = 3/4.

5. Ans (c): Here, $P(A \cup B) = P(A) + P(B)$
   $= [1-P(\overline{A})] + P(B)$
   = (1-5/6) + 1/4 = 1/6 + 1/4 = 15/2

6. Ans (a): P(A) = 1/3, P(B) = 2/3
   $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
   $= P(A) + P(B) - P(A).P(B)$
   = 1/3 + 2/3 – 1/3.2/3
   $= \frac{3+9-2}{9}$ = 7/9

7. Ans (d): S = {BBB, BBG, BGB, BGG, GBB, GBG, GGB, GGG}
   P(Exactly two boys) = 3/8

8. Ans (a): $P(\overline{A \cup B}) = 1 - P(A \cup B)$
   $= 1 - [P(A) + P(B - P(A \cap B)]$
   = 1 – [0.25 + 0.50 – 0.14]
   = 0.39

9. Ans (b): P(only one of them selected)
   = P(A and not B) or P(B and not A)
   $= P(A \cap \overline{B})$ or $P(B \cap \overline{A})$
   $= P(A).\ P(\overline{B}) + P(B).P(\overline{A})$
   = P(A). [1-P(B)] + P(B)[1-P(A)]
   = 1/3.(1 - 2/5) + 2/5(1 - 1/3)
   = 1/3.3/5 + 2/5.2/3
   = 1/5 + 4/15 = 7/15

10. Ans (a): Total number of balls = 5+4+3 = 12
    P(not being yellow) = P(red or blue)
    $\Rightarrow$ P(R) + P(B) $\Rightarrow$ 4/12 + 3/12 $\Rightarrow$ 7/12

11. Ans (d): S = {HHH, HHT, HTH, HTT, THH, THT, TTH, TTT}
    P(not more than two heads) = P(two heads or one head or no head)
    = P(two head) + P(one head) + P(No head)
    = 3/8 + 3/8 + 1/8 = 7/8

12. Ans (c): n(S) = 1000, P(E) = 0.85, n(E) = ?
    Since, $P(E) = \frac{n(E)}{n(S)} \Rightarrow 0.85 = \frac{n(E)}{1000}$
    $\Rightarrow$ n(E) = 850

13. Ans (a): n(S) = 30, $n(M_5) = 6$, $n(M_6) = 5$, $n(M_5 \cap M_6) = 1$
    So, P(Multiple of 5 or 6) = $P(M_5) + P(M_6) - P(M_5 \cap M_6) =$
    $\frac{6}{30} + \frac{5}{30} - \frac{1}{30} = \frac{10}{30} = \frac{1}{3}$

14. Ans (d): Total no. of balls = 4 + 6 = 10
    P(first ball white and second red without replacement) = $\frac{4}{10}.\frac{6}{9} = \frac{4}{15}$

15. Ans (b): Let, event A = a5 appears on at least one of dice

= {(5,1), (5,2), (5,3), (5,4), (5,5), (5,6), (1,5), (2,5), (3,5), (4,5), (6,5)}

Event B = sum 10 or greater

= {(5,5), (5,6), (6,5)}

$$P(B/A) = \frac{\text{number of events in } B \cap A}{\text{number of events in } A} = \frac{3}{11}$$

16. Ans (d): A leap year has 52 weeks and two day.

For remaining two days we have following possibilities (Sunday, Monday) or (Monday, Tuesday) or (Tuesday, Wednesday) or (Wednesday, Thursday) or (Thursday, Friday) or (Friday, Saturday) or (Saturday, Sunday)

Here, Sunday occurs in 2 pairs out of seven pairs

$\therefore$ P(53 Sunday) = 2/7.

Physics

Units and Measurements

Physics is the branch of science, which deals with nature and natural phenomena. We describe many natural phenomena quantitatively by measuring the physical quantities. So Lord Kelvin introduced physics as a science of measurement.

Physical quantities: All quantities, which can be measured directly or indirectly and can be expressed by a number, are called physical quantities. The examples are mass, length, charge, energy etc.

Units: A comparing with a reference standard of the same nature does the measurement. The standard is given a name and called as a unit of that quantity. The comparison of a given physical quantity with chosen standard is called the measurement. Hence, after measuring anything, we express it with a numerical value along with its unit.

Classification of units: All the physical quantities are classified into two categories:

(i) Fundamental or basic units: The physical quantities whose units are not related to one another are called fundamental quantities and their units are called fundamental or basic units. Mass, length, time, temperature, electric current, amount of substance and luminous intensity are considered as fundamental quantities. The units of these quantities are called fundamental units. Except these, two more supplementary units have been declared. They have been tabulated below in which the units are given in SI system of units.

Type of units	Quantity	Unit	Symbol
Fundamental units			
1	Mass	Kilogram	Kg
2	Length	Meter	M
3	Time	Second	S
4	Temperature	Kelvin	K
5	Electric current	Ampere	A
6	Amount of substance	Mole	Mol
7	Luminous intensity	Candela	Cd
Supplementary units			
1	Plane angle	Radian	rad
2	Solid angle	Steradian	Sr

(ii) Derived units: The units of physical quantities, which can be expressed in terms of fundamental units, are called derived units. For example, the unit of velocity is ms^{-1}, the unit of momentum is $kgms^{-1}$etc.

Machine

Those devices which make our work easier and convenient are known as simple machine. There are six types of simple machines. They are lever, inclined plane, screw, pulley, wheel and axle, and wedge. In simple machine, the force which has to be overcome is known as load and the force applied to overcome load is known as effort.

Mechanical advantage (MA): The ratio of load to the effort is known as the mechanical advantage of the machine. It does not have unit.

Velocity ratio (VR): It is the ratio of effort distance (distance travelled by the effort) to the load distance (distance travelled by the load). It does not have any unit.

Efficiency: It is the ratio of output to the input where output is product of load and load distance whereas the input is the product of effort and effort distance. It is expressed in percentage. If a machine has efficiency 100%, there will be no loss of energy and those machines, which have efficiency 100%, are known as ideal or perfect machines. If there is the presence of frictional force, it always makes the efficiency less than 100%.

Principles of simple machine: The principle of simple machine states that in the absence of frictional force, the output work will be equal to the input work i.e. the efficiency will be 100%.

Lever: It is a rigid, straight or bent bar, which is capable to rotate about a fixed axis called fulcrum. The distance of the point, where the force is applied from the fulcrum is known as effort distance and that of load is known as load distance.

Pulley: It is a metallic or wooden disc with a grooved rim. The rim rotates about a horizontal axis passing through its centre. If it has a single pulley, which may be single fixed pulley or single movable pulley. An ideal single fixed pulley has MA as well as VR unity since effort distance is equal to load distance. In single movable pulley effort distance is double to that the load distance, so VR is equal to 2. It also gains the MA. We can use a number of pulleys, which increases the VR of pulley. It is found that the VR is equal to the number of pulleys and it increases the MA also.

Inclined plane: Slanted plane is known as inclined plane. The VR is always greater than unity. The perpendicular distance of inclined plane whose hypotenuse is given by the inclined plane gives the load distance where the hypotenuse gives the effort distance. It also increases the MA.

Wheel and axle: It consists two coaxial cylinders of different diameters. Force is applied on the big cylinder called wheel and a small cylinder called axle overcomes the load. So the circumference of the big cylinder is known as the effort distance and that of the small cylinder is known as the load distance. It is also known as a continuous lever.

$$VR = \frac{\text{Circumference of big cylinder}}{\text{Circumference of small cylinder}}$$

Or,

$$VR = \frac{\text{Radius of wheel}}{\text{Radius of axle}}$$

Screw: It consists a circular disc and a linear rod with pointed tip. When the disc is rotated, it moves linearly. The linear distance moved by the screw when it is rotated through one complete rotation is called its pitch. The circumference of the disc is known as the effort distance and the pitch is known as the load distance.
So,

$$VR = \frac{\text{Circumference of disc}}{\text{Pitch}}$$

Wedge: It has the shape of prism. One edge is made sharp and another edge is made wide. It makes our work easy. The distance between the sharp edge and wide edge gives the effort distance and the width of wide edge gives the load distance. Axe is an example of wedge.

Moment of force: The turning effect produced by a force about an axis is called the moment of force. It is also known as the torque. It is a vector quantity and its unit is *Nm* in SI system of units. Mathematically it is the vector product of the distance of the point where the force is applied from the axis of rotation and the force. So it depends on the magnitude of force, its distance from the axis and the angle between the direction of force and the distance vector. It may be clockwise or anticlockwise. If it is anticlockwise, it is taken as positive and if it is clockwise, it is taken as negative.

Law of moment: It states that in equilibrium condition, the sum of clockwise moments is always equal to the sum of anticlockwise moments if the body is acted by a number of forces.

MCQs

1. Ratio of effort distance to the load distance is known as
   a. MA b. VR c. efficiency d. load
2. In an Ideal machine we have the efficiency
   a. 0% b. 50% c. 100% d. infinity
3. When the inclination of an inclined plane is 30^o, the VR of the inclined plane is
   a. 30 b. ½ c. 1/30 d. 2
4. If a pulley system has four pulleys, it has VR
   a. 2 b.4 c. 1 d.8
5. Which of the machine is also known as a continuous lever?
   a. screw b. wedge c. pulley d. wheel and axle
6. If a force of 2N is applied on a body on its axis of rotation, then the torque is produced in
   a. clockwise direction b. anticlockwise direction
   c. perpendicular direction to the force d. not in any direction

7. In a machine,
   a. total force is conserved
   b. total energy is conserved
   c. total load is conserved
   d. total effort is conserved
8. In wheel and axle
   a. the radius of wheel should be equal to the radius of the axle
   b. the radius of wheel should be smaller than the radius of the axle
   c. the radius of wheel should be greater than the radius of the axle
   d. does not have any relationship

Force

Force is an agent that produces or tends to produce acceleration in a body. It has both magnitude and direction. It is a vector quantity. Its unit is Newton in SI system of units and dyne in cgs system. The relationship between Newton and dyne is $1N=10^5$ *dyne*. It is measured by spring balance. If a body is acted by a number of forces but the net acceleration is zero, then the forces are said to be balanced forces but if the acceleration is not zero, then the forces are said to be unbalanced forces.

Inertia: The tendency of a body to maintain its state of rest or uniform motion in a straight line is called inertia. A body can neither come in motion from rest nor to rest from motion nor change its direction by itself without getting external force. Mass measures the inertia of a body. So it can be divided into three types as (i) inertia of rest (ii) inertia of motion and (iii) inertia of direction.

Vectors and scalars: The physical quantity, which has both magnitude and direction both and obeys all the laws of vector is known as vector quantity. So the total sum of the vectors may be either positive or negative or zero. Displacement, velocity, force, acceleration etc are the examples of vector. The physical quantity, which has magnitude and simple rules of algebra can be applied, is known as a scalar quantity. The sum of the scalar quantities is always positive. Current, speed, mass, distance etc. are the examples of scalar quantity.

Distance and displacement: The total length of the path between any two points is known as the distance. It is a scalar quantity. But the shortest distance between any two points is known as displacement. It is a vector quantity.

Speed and velocity: The rate of change of distance covered by a body in unit time is known as speed. It is a scalar quantity. Its unit is m/sec in SI system of units. If a body covers equal distance in equal interval of time whatever small that interval may be, then the speed is known as uniform speed but if it is not equal, it is known as non-uniform or variable speed.

The rate of change of displacement covered by a body in unit time is known as velocity. It is a vector quantity. Its unit is *m/sec* in SI system of unit. If a body covers equal displacement in equal interval of time, whatever small that interval may be, then the speed is known as uniform velocity but if it is not equal, it is known as non-uniform or

variable velocity. Velocity can be changed by either changing the magnitude of displacement or by changing the direction of displacement.

Acceleration: The rate of change of velocity of a body with respect to time is known as the acceleration. It is a vector quantity. Its unit is m/sec^2 in SI system of units. To produce acceleration, force should be applied on the body. It always takes the direction of net force applied on the body. If the change in velocity is negative, then the acceleration is known as retardation or deceleration.

Equation of motion: The equations which relate displacement, initial velocity, final velocity, acceleration and time of motion of a moving body are known as the equations of motion. They are:

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$
4. $S = \frac{1}{2}(u + v)t$

Where v , u , s , a and t are the final velocity of the body after t sec, initial velocity of the body, displacement of the body in t sec and the acceleration of the body and the time taken by the body respectively. It the body is moving under gravity, the acceleration is taken as acceleration due to gravity and denoted by g.

Newton's laws of motion: In 1687, Sir Issac Newton published a work called principia in which he gave the laws of mechanics. These laws are known as Newton's laws of motion.

Newton's first law of motion: It states that everybody continues its state of rest or motion in a straight, unless it is acted by an external force. This law is also called the law of inertia.

Linear momentum: It is defined as the total quantity of motion contained in a body in a straight line motion and is measured by the product of mass of the body and its linear velocity. It is denoted by ***P***. $P=mv$

Where m is the mass of the body and v is its velocity. It is a vector quantity and its direction is along the direction of velocity. Its unit is $kgms^{-1}$ in SI system of units. To change the momentum of a body or system, force should be applied on it. Unless it is done, the linear momentum of a system is always remains the same.

Newton's second law of motion: It states that the rate of change of linear momentum with respect to time is directly proportional to the net external force applied on it and the change takes place in the direction of force. i.e.$\boldsymbol{F}\alpha\frac{d\boldsymbol{P}}{dt}$

Or, $\boldsymbol{F} = k\frac{d\boldsymbol{P}}{dt}$where k is proportionality constant SI system of units, the unit of force and momentum are so chosen that k becomes unity.

Therefore, $\boldsymbol{F} = \frac{d\boldsymbol{P}}{dt}$

Hence force applied on a body is equal to the change in linear momentum per unit time.

Or, $\boldsymbol{F} = \frac{m\boldsymbol{dv}}{dt}$

Or, $\boldsymbol{F} = m\boldsymbol{a}$

This equation is known as equation of motion and it gives the measurement of force.

Newton's third law of motion: It states that every action has equal and opposite reaction. So for a system, the net force is always zero but for an individual body it is not zero because action and reaction are acted on different bodies.

MCQs

1. If 2N force is applied on 2 kg mass due east and same magnitude of force due west, the change in velocity of the body in 2 sec is
   a. 0 m/sec^2 b. 2m/sec^2 c. 4m/sec^2 d. 8m/sec^2
2. Which type of inertia we do not have in straight-line motion?
   a. inertia of rest b. inertia of direction
   c. inertia of color d. inertia of motion
3. If a body completes its motion in a circular track of radius 2m in 5 second, then the average velocity of the body is
   a. 4π/5 m/sec b. 2π/5 m/sec c. 5π/4m/sec d. 0m/sec
4. A body exerts a force of magnitude 5N and gets 5N as reaction. Then the total force the body experiences
   a. 10N b. 5N c.0N d. 25N
5. If a ball of mass m is dropped which hits the ground with the velocity v and it renounces vertically upward with the velocity v, then the change in momentum is
   a. 0kgm/sec b. 2vkgm/sec c. 2mv kgm/sec d. 1kgm/sec
6. If the displacement of two points is x which is 2m, what is the possible longest distance between the points?
   a. 2m b. infinity c. 2x d. none of above
7. Which one of the following is not a vector quantity?
   a. momentum b. acceleration c. current d. force
8. A body is moving with a velocity 4m/sec and a force applied on it in opposite direction to the velocity which produces an acceleration of 1m/sec^2. The time taken by the body to make its velocity of same velocity as initial but in opposite direction is
   a. 4 sec b. 8 sec c. 0 sec d. 1 sec
9. The value of 3N force in cgs system is
   a. 3 dyne b. 300dyne c. 30000dyne d. 300000dyne
10. Inertia of rest depends on
    a. mass of the body b. force applied on the body
    c. velocity of the body d. direction of the motion

Work, Energy and Power

Work: In science, work is said to be done by a force on a body if it displaces the body through some distance in the direction of force. It is the product of the magnitude of force and the displacement produced by it in the direction of force. So, $work(W) = force\ (F) \times displacement\ (d) in\ the\ direction\ of\ force$

Or, $W = Fd\ cos\theta$; where θ is the angle between the direction of force and displacement. It is a scalar quanity and its unit is Joule in SI system of units and erg in cgs system of units. Depending on the value of θ, work may either be positive or negative or zero. If θ is acute, work is said as positive. Example, the work done by gravitational force when a body is falling freely under gravity. Work is said to be negative if θ is obtuse. Example, the work done by frictional force. Work is said to be zero if θ is 90^o. Example, the work done by the weight of the body when he moves on a horizontal floor.

Energy: The capacity of doing work is known as energy. It is also a scalar quantity and its unit is Joule in SI system of units. There are different types of energies. They are

1. **Mechanical energy:** the energy possessed by a body by virtue of its motion or position or configuration is called mechanical energy. It is further divided into two types.

   (i) Kinetic energy:-The energy possessed by a body by virtue of its motion is called kinetic energy. It is given by $KE = \frac{mv^2}{2}$, where m and v are the mass of the body and its speed respectively.

   (ii) Potential energy:-The energy possessed by a body by virtue of its position or configuration is called potential energy of gravitational potential energy, it is given by $PE = mgh$, where m, g and h are the mass of the body, acceleration due to gravity and its height from the ground respectively.
2. **Heat energy:** Heat is a form of energy associated with molecular motion of a substance. It is also known as thermal energy.
3. **Sound energy:** The energy produced by a vibrating body is known as sound energy. It is a longitudinal wave. It needs elastic medium to propagate from one place to another.
4. **Chemical energy:** The energy possessed by a body which is released when it undergoes chemical change is called chemical energy.
5. **Light energy:** The energy which produces the sensation of sight is called light energy. It is an electromagnetic wave which is transverse in nature.
6. **Electrical energy:** The energy possessed by a body due to being charged or due to the flow of charge is called the electrical energy.
7. **Magnetic energy:** The energy possessed by a magnet or a current carrying conductor which effects the magnetic substances is called magnetic energy.
8. **Nuclear energy:** The energy which can be obtained from the nucleus of an atom is called the nuclear energy. It is obtained when nuclear fusion or nuclear fission process takes place. Here nuclear fusion is the process of combining two or more

nuclei to form a heavy single nucleus and fission is the process of splitting a heavy nucleus into light nuclei.

Principle of conservation of energy: It states that energy can neither be created nor be destroyed. It can only be transferred from one form to another. Doing work on a system means providing energy to it, so work done on a system is always equal to the increase in energy of the system.

Power: Power is the rate of doing work i.e. the amount of work done in unit time. Its unit is Watt in SI system of units. It is given by $Power = \frac{work\ done}{time}$

MCQs

1. To have the maximum positive work done by a force, the angle between the force and displacement should be
   a. 0^o b. 90^o c. 45^o d.180^o
2. If a body is given the kinetic energy of 100J, how much work is done to bring it into motion?
   a. 0J b. 100J
   c. depends on the speed given to body d. depends on the mass of body
3. The power of doing work of a man is 5kW. How much work is done by him in 30 seconds?
   a. 15J b. 1500J c. 15000J d. 150000J
4. A body is lifted to a height. Which of the following form of energy is given to it?
   a. Kinetic b. chemical c. nuclear d. potential
5. A mass 1kg has kinetic energy 100J and it is thrown vertically upward. What is the maximum height it can attain?
   a. 100m b.10m c.1000m d. 1m
6. If the efficiency of a motor is 30 percent and the work we can get from it is 50J, how much energy should be given to it?
   a. 50J b. 1500J c. 300/5J d. 500/3J
7. A jet plane is flying at constant altitude with increasing speed. Which form of energy is changing?
   a. Kinetic energy b. potential energy c. nuclear energy d. light energy
8. A bullet is flying with the energy of 900J and it is penetrated into a wall where it is stopped after travelling a displacement of 3m. How much force is applied by the wall to stop it?
   a. 900N b. 90N c. 30N d. 2700N
9. On walking on a horizontal surface, the work done by the gravitational force is
   a. Positive b. zero c. negative d. none of above
10. If there is no loss of energy in a machine, what is the efficiency of the machine?
    a. 0 percent b. 50 percent c. 25 percent d. 100 percent

Gravity and Gravitation

Newton's law of gravitation: Newton's law of gravitation states that the gravitational force between any two masses is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. If m_1 and m_2 are the two masses kept at r distance apart, then the gravitational force between them is given by $F = \frac{Gm_1m_2}{r^2}$; where G is the universal gravitational constant and its magnitude is taken as $6.67X10^{-11}Nm^2kg^{-2}$ which remain constant throughout the universe. This force is the weakest force in nature.

Gravity: If one of the body is earth or any heavenly body, the gravitational force is known as gravity i.e. gravity is the force of attraction by which the earth or other heavenly body pulls other objects towards its centre. So gravity of a mass m at a distance r from the centre of a heavenly body of mass M is given by $F = \frac{GMm}{r^2}$. Since the gravity depends on the distance of the body from the heavenly body's centre, its value depends on the location of the body.

Acceleration due to gravity: The rate of change of velocity of a body with respect to time due to gravity acted on it is called acceleration due to gravity. It is denoted by g. its unit is m/sec^2 in SI system of units. It is a vector quantity. It is always directed towards the centre of the heavenly body. Its value does not depend upon the shape, size and mass of the body but depends on the distance of the body from the centre of the heavenly body. It is maximum on the surface of the heavenly object but decreases as the altitude or depth from the surface of the heavenly body increases. Its value is zero at the centre of the heavenly body. In the case of earth, its value is also affected by the rotation of the earth about its own axis.

Gravitational field and its intensity at a place: The space around a mass where it can provide gravitational force to other masses is called its gravitational field and its intensity at a place is the gravitational force experienced by a unit mass when unit mass is kept at that place. Its value depends on the mass of the body whose gravitational field intensity has to be measured and the distance of the place from the centre of that body.

Mass and weight: The mass of a body is a measure of the quantity of matter contained in it. It is measured by a physical balance. It does not depend on the temperature, pressure or location of the body. Its unit is kg in SI system of units. It is a scalar quantity.

Weight of a body is the force exerted by earth on the body towards the centre of the earth. So gravity is the weight of the body. It is given by the product of the mass of the body and the acceleration due to gravity at that place. So it depends on the location of the body and the mass of the body. Its unit is Newton in SI system of units. It is a vector quantity. It is measured by a spring balance. It is maximum at the geographical

poles of the earth and minimum at the equator due to the shape of the earth. Since the acceleration due to gravity is zero at the centre of the earth, weight is also zero there.

Free fall: If a body is accelerating towards the centre of the earth with an acceleration equal to the acceleration due to gravity, then the body is said to have free fall.

Weightlessness: If a body has zero apparent weight or when the weight of a body seems to be zero, then the body is said to be weightlessness conditions. It can be experienced in the following conditions.

1. When a body is falling freely under gravity or it is having free fall.
2. When a body is in between two heavenly bodies where the gravity of the body is equal and opposite i.e. net gravitational force on the body due to the heavenly bodies is zero.
3. When the body is in satellite revolving in its orbit. In this case the true weight of the body is used to provide centripetal force to the body and the apparent weight will be zero.

MCQs

1. If a body of mass 2 kg is falling freely under gravity where acceleration due to gravity is 5m/sec^2, then its real weight is
   a. zero b. infinity c. 5 N d. 10 N
2. The apparent weight of a body in a satellite revolving round the earth is zero because
   a. weight is zero
   b. acceleration due to gravity is zero
   c. its mass becomes zero
   d. its weight is used to provide centripetal force
3. The value of acceleration due to gravity is
   a. maximum at the poles of the earth
   b. minimum at the poles of the earth
   c. maximum at the equator of the earth
   d. maximum at the centre of the earth.
4. To have free fall, the acceleration of the body is
   a. less than acceleration due to gravity
   b. more than acceleration due to gravity
   c. equal to the acceleration due to gravity
   d. none of above
5. The intensity of gravitational field produced by a body of the given volume does not depend on
   a. mass of the body which produces the field
   b. distance of the place from the centre of the body
   c. mass of the body which is used to measure the intensity
   d. density of the body

Fluid statistics

Fluids: Those substances which have the property of flowing are called fluids. Liquids and gases are fluids. They do not have definite shape as solids. It takes the shape of vessel in which it is kept.

Thrust: The total force exerted by a liquid on any surface in contact with it, is called thrust of the liquid. Its unit is Newton in SI system of units.

Pressure: The thrust exerted by a liquid at rest per unit area of the surface in contact with the liquid is called pressure. So, it depends on two factors. They are the normal force on the surface and its area. Mathematically it is given by $P = \frac{F}{A}$. Its unit is Newton/m^2 or Pascal in SI system of units. When the liquid is at rest, it is always normal to the surface.

Pascal's law: The Pascal's law states that the pressure exerted at any part of a confined liquid is transmitted equally and undiminished in all directions throughout the liquid. It is applied in hydraulic press, hydraulic brakes etc.

Buoyancy: When a body is body is immersed in a liquid, it experiences up thrust, which is equal to the weight of the liquid displaced. The force exerted by liquid on a body which is immersed in it is called buoyant force or force of buoyancy. It is denoted by B. Its unit is Newton in SI system of units. It depends on the volume of the submerged in liquid, density of the liquid and the acceleration due to gravity of that place.

Archimede's principle: It states that when a body is immersed partially or completely in a liquid, it experiences a loss in weight. The loss in weight of the body is equal to the weight of the liquid displaced i.e. up thrust provided by the liquid.

If m is the mass of the body which is immersed partially or completely in a liquid of densityρ, the weight of the body is mg and the up thrust provided by liquid given by the weight of the liquid displaced. Let it be B. then the apparent weight of the body is given by

$W' = mg - B = mg - V\rho g$ where V is the volume of the liquid displaced.

Law of floatation

1. When the density of the body is less than the density of liquid, it floats on the liquid surface keeping its some volume in the liquid.
2. When the density of the body is equal to the density of liquid. It floats in the liquid keeping its all volume in liquid.
3. When the density of the body is greater than the density of the liquid, it does not float but sinks completely in the liquid.

   Hence to make a body float, either its density should be less or equal to the density of liquid.

MCQs

1. Thrust exerted by the liquid depends on
   a. size of the surface of the container
   b. density of liquid
   c. acceleration due to gravity
   d. all of above
2. To make a body float ,
   a. the density of the body should be greater than that of liquid.
   b. the density of the body should be smaller than that of liquid.
   c. the density of the body should be equal that of liquid.
   d. both b and c
3. If a body is completely immersed in a liquid, it's -------- should be equal to that of displaced liquid.
   a. mass b. density c. volume d. weight
4. If the acceleration due to gravity is $10m/sec^2$ and the buoyant force on a body is 25N, what is the weight of liquid displaced?
   a. 2.5kg b.25kg c. 250kg d. 10/25kg
5. At the centre of the earth, what will be the pressure exerted by a liquid?
   a. infinity b. zero
   c. any value is possible d. none of above

Heat

Heat is a form of energy associated with molecular motion of a substance. It is also known as thermal energy. It can be transferred from one body to another. When a body loses it, its temperature decreases and when it gains, its temperature increases. Its unit is Joule in SI system of units and in cgs unit , it is calorie. One calorie heat is defined as the amount of heat required to change the temperature of 1 gm of water through 1^oC and 1 J heat is the amount of heat required to change the temperature of 1 kg of water through $\frac{1}{4200}$K.

Temperature: It is that physical quantity which determines the direction of heat flow. It measures the hotness or coldness of a body. Heat always flows from higher temperature. When they are at same temperature, there will be no flow of heat even they are in thermal contact and the bodies are said to be in thermal equilibrium. The unit of temperature is Kelvin in SI system of units and ^oC in cgs system of units.

Effect of heat: Heat can produce the following effects in a body

1. Change in temperature- When a body loses heat, its temperature decreases while when it gains it, it increases its temperature.
2. Change in volume-When heat is provided to a body, its volume increases or vice versa.

3. Change in state-When heat is given to a solid at its melting point, it is changed into liquid. When heat is absorbed from a liquid at its freezing point, it is changed into solid. Similarly when heat is given to a liquid at its boiling point, it is changed into vapor and vapor can be condensed into liquid by absorbing heat from it
4. Physical changes-The physical properties of a substance like color, elasticity, conductivity etc are found to change on heating a substance.
5. Chemical changes- Many chemical changes are caused by heat. For example, when potassium chloride is heated oxygen is found to be liberated.
6. Thermoelectric effect- When two wires of different materials are joined and one junction is heated keeping another at low temperature, electricity flows through it. So heat energy can be converted into electrical energy.
7. Physiological effect- Heat cause physiological changes and effects in plants as well as in animal life.

Specific heat capacity: Specific heat capacity of a substance is defined as the amount of heat required to change the temperature of a unit mass of substance through unit change in temperature. Its unit is cal $gm^{-1}{}^{o}C^{-1}$ in cgs system of units and $Jkg^{-1}K^{-1}$in SI system of units.

Thermal capacity: It is the total amount of heat to require to change the temperature of a given mass of substance through unit change in temperature. Its unit is cal$^{o}C^{-1}$ in cgs system of units and JK^{-1}in SI system of units.

Heat equation: When two substances at different temperature are kept in thermal contact, the object at higher temperature loses heat and the body at lower gains heat. If there is no loss of heat to the surrounding, the heat lost by the hot body is always equal to the heat gained by the cold body. This is the principle of calorimetry or the principle of mixture and may be written as

Heat gained by cold body = heat lost by hot body

This equation is known as the heat equation.

MCQs

1. A body A has 2000J energy at 20^{o}C and another body B has energy 200J at 200^{o}C, then when they are kept in thermal contact, heat flows from
   a. A to B b. B to A c. none of them d. both of them
2. The conversion of heat into electrical energy is known as
   a. chemical effect b. physical effect
   c. thermoelectric effect d. electromotive effect
3. Water is used to cool the hot substances because of its
   a. high density b. low density
   c. low specific heat capacity d. high specific heat capacity
4. Which of the following depends on the mass of the body?
   a. specific heat capacity b. thermal heat capacity
   c. latent heat of fusion d. latent heat of vaporization

5. When a cold body absorbs 4200J from one kg of water at 42K, what is the change in the temperature of water?
   a. 4200K b. 1000K c. *1K* d. 100K
6. To increase the length of rod, the --------- of the rod should be increased.
   a. temperature b. material c. density d. mass
7. If the specific heat capacity of water is *1 cal/gm°C* in cgs system of units, the total amount of heat required to raise the temperature of 1 kg of water through 1K is
   a. 1J b. 1cal c. 4.2J d. 4200J
8. If the kinetic energy of the molecules is high, it means it
   a. has high heat energy
   b. has more number of molecules
   c. has high temperature
   d. has more mass
9. When potassium chlorate is heated,
   a. hydrogen is liberated b. nitrogen is liberated
   c. potassium is liberated d. oxygen is liberated
10. If the bodies are in thermal equilibrium, they should have
   a. same amount of mass b. same amount of heat
   c. same dimension d. same temperature

Geometrical optics

The branch of physics in which we study about the visible light is called optics. The light is a form of energy which gives the sensation of vision to us i.e.it makes objects are visible to us. In geometrical optics light is denoted by a straight line with an arrowhead. The straight line shows that light travels in straight path in a straight path and the arrowhead shows the direction of light. A single line with an arrowhead is called a ray of light and its collection is called a beam. If the rays in a beam are parallel to each other, it is called parallel beam. If the distance between the rays goes on decreasing along their direction, it is called convergent beam but if it goes on increasing, it is called divergent beam. The figures for different types of beam are shown below.

The objects are visible to us only when the light coming from the objects enters our eye. If the objects emit its own light, the object is called luminous object. Sun and stars are the examples of the luminous objects. If the object does not emit its own light but visible due to the reflection of light falling on it, it is called non-luminous object. Earth, moon, houses, trees etc are the examples of non-luminous objects.

Reflection of light: The phenomenon of returning back of light in the same medium after it is incident on a surface is called the reflection of light. The ray of light before incidence is called the incident ray where as it is called the reflected ray after its incidence. The angle made by the incident ray with the normal at the point of incidence

is called the angle of incidence whereas the angle made by the reflected by with the normal is called the angle of reflection.

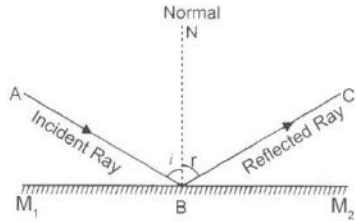


Fig: Reflection of light ray

If the angle of incidence is 0^o, it is called normal incidence but if it is 90^o, it is called grazing incidence.

Laws of reflection of light: The laws of reflection are

(i) The angle of incidence is equal to the angle of reflection

(ii) The incident ray, the reflected ray and the normal, all lie on the same plane at the same point.

Types of reflection of light: If parallel rays of light incident on a surface and it are reflected back to the same medium such that the reflected beam is also parallel, it is called regular reflection of light. If a parallel ray of light incident on a surface and it is reflected back to the same medium such that the reflected rays are not parallel to each other, it is called irregular reflection of light.

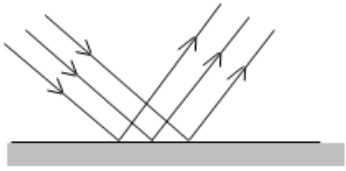


Fig: Regular reflection

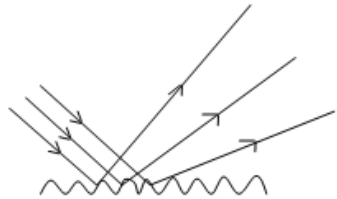
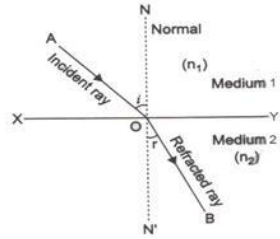


Fig: Irregular reflection

It should be noted that the laws of reflection of light are followed by each type of reflection.

Refraction of light: When a ray of light enters from one medium to another making an angle to the normal at the point of incidence, it deviates from its original path. This phenomenon of bending of light from its original path when it enters from one medium to another is called refraction of light. The ray travelling in the first medium is called incidence ray where as the incidence ray after its entrance in the second medium is called the refracted ray. The angle made by the incidence ray with the normal at the point of incidence is called the incidence angle where as the angle made by the

refracted ray with the normal is called the angle of refraction. When the refraction takes place, the speed of light and the wavelength of it changes but its frequency becomes constant.



Laws of refraction of light: The laws of refraction are

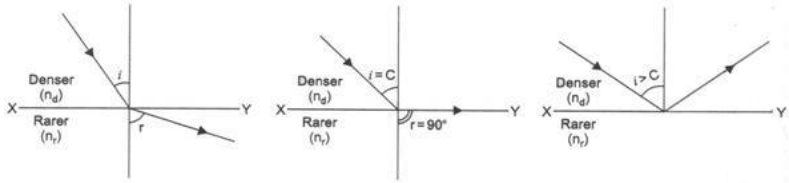
(i) The incident ray, refracted ray and the normal at the point of incidence all lie in the same plane

(ii) The ratio of sine of angle of incidence to the sine of angle of refraction for a given light is constant for any two given media i.e. ${}_1\mu_2$ =sin i/ sinr
Where, ${}_1\mu_2$ is the refractive index of the second medium with respect to first
i and r are the angle of incidence and angle of refraction respectively.

Absolute Refractive index of a medium: It is the ratio of the speed of light in the vacuum to the speed of light in the medium. It is denoted by μ. It is a pure number and it does not have any unit. Mathematically it is given by $\mu = c/v$; where c is the speed of light in vacuum and v is the speed of light in the medium. μ is the refractive index of the medium with respect to vacuum.

Relative refractive index: The relative refractive index of one medium with respect to another is the ratio of the speed of light in the first medium to the speed of light in the second medium.

Total internal reflection: When light enters from denser medium to rarer medium, light bends away from the normal. It means the angle of refraction is greater than the angle of incidence. If the angle of incidence goes on increasing, the angle of refraction also goes on increasing. At a certain value of incidence, the angle of refraction will exactly be equal to 90^o. This angle of incidence is known as critical angle. It is denoted by C. If the angle of incidence is further increased than the critical angle, instead of having refraction, the ray will be reflected in the same denser medium and the light is said to be internally reflected and this phenomenon is called the total internal reflection.



Conditions for total internal reflection

(i) The ray must passed from optically denser medium to rarer medium
(ii) The angle of incidence must be greater than the critical angle.

Lens: The homogeneous transparent medium enclosed by two spherical surfaces is called a lens. In general, the one surface may be plane but it should be noted that plane surface is considered as a part of a big sphere. There are two types of lenses.

(i) Convex lens (ii) Concave lens

Convex lens: If the lens has greater thickness in the middle and thinner at the edges, it is called convex lens. It is further divided into three types.

(i) Biconvex lens- It's both surfaces are convex.
(ii) Plano-convex lens- It's one surface is convex while another is plane.
(iii) Concavo-convex lens-Its one surface is convex while another is concave.

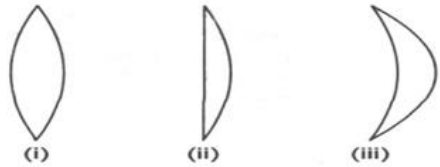
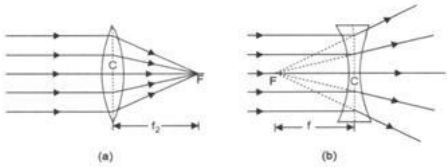


Fig: Biconvex Plano-convex Concavo convex lens

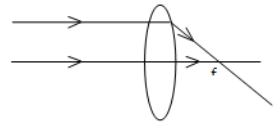
Some definitions concerning the lens

(i) Thickness of lens- It is the separation between the poles of the spherical refracting surfaces of a lens.
(ii) Principal axis- The straight line joining the centers of curvatures of both the spherical surfaces is called the principal axis.
(iii) Optical center- If a ray of light is incident on a lens in such a direction that after refraction, the emergent ray is parallel to the incident ray, and then the point of intersection of the refracted ray with the principal axis is called the optical center.
(iv) Principal focus-t is the point on the principal axis where all the light rays parallel to the principal axis after passing through the lens meet or from where all the rays appear to come from.
The plane passing through the principal focus and perpendicular to the principal axis of the lens is called the focal plane.
(v) Focal length- it is the distance between the principal focus and the optical center of a lens. It is denoted by f.



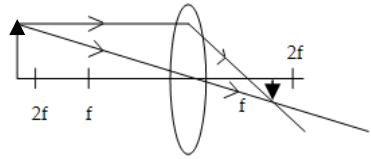
Images formed by lenses: Images formed by convex lens

(i) When the object is at infinite distance from the lens



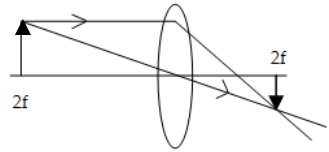
The image formed by the lens will be at focal plane which will be highly diminished, laterally inverted and real.

(ii) When the object is beyond 2f of the lens



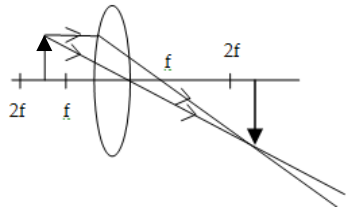
The image will formed at 2f at the another side of the lens which is equal in size as object, inverted and real.

(iii) When the object is at 2f of the lens.



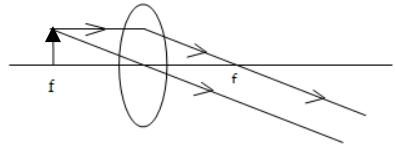
The image will also be formed at 2f in another side of the lens which is equal in size as object.

(iv) When the object is in between 2f and f of the lens



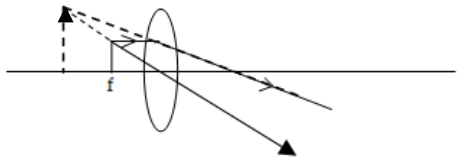
The image will be beyond 2f in another side of the lens which is magnified in size, inverted and real.

(v) When the object is at f of the lens



The image will be at infinity which is highly magnified and real.

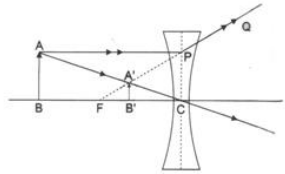
(vi) When the object is in between f and the optical center of the lens



The image will be formed at the same side of the lens which is virtual and magnified.

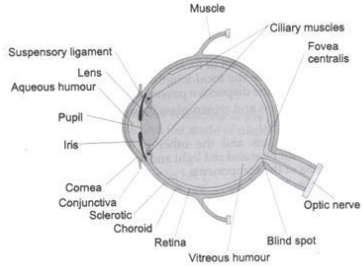
So we can conclude that a convex lens can form magnified as well as diminished image. Similarly it can form real as well as virtual image.

Image formed by concave lens: In the case of concave lens, wherever the object is kept the image is formed in between the focus and the optical center of the lens. If the object is at infinity, it is formed at the focal plane but if the object is at other places, it is formed in between focus and the optical center of the lens. Wherever the image is formed, it is always virtual and diminished in the case of real objects.



Uses of lens

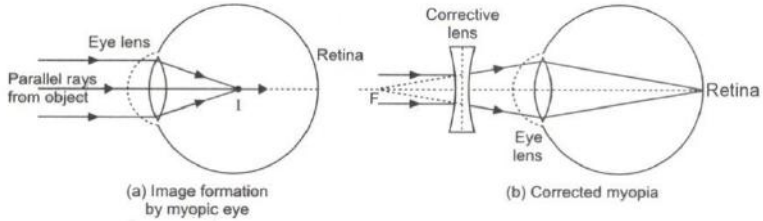
Defects of vision: Our eye has a convex lens which is held in position with the help of ciliary muscles. It forms the image of the objects at retina. To form the image at retina , it has ability to change its focal length depending on the object distance. The maximum distance at which an object can be seen distinctly by our eye is infinity and for a normal eye the minimum distance upto which an object can be seen clearly is 25 cm and this distance is called the least distance of distinct vision.



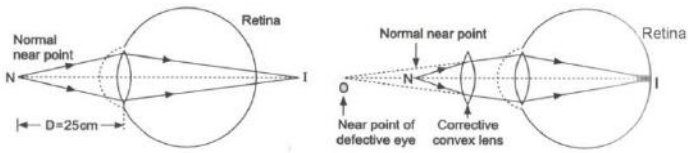
There are four types of defects of vision. They are:

(i) Myopia or shortsightedness- it is the defect of eye in which a person can see nearer objects but cannot see farther objects distinctly. The lens of the eye cannot form the

image of the object beyond a certain distance at the retina. The far distance of the eye is less than infinity. It forms the image of distant object before the retina. To correct this defect, concave lens should be used.



(ii) Hypermetropia or long sightedness- it is the defect of eye in which a person can see distant objects but can not see nearer objects distinctly. The lens of the eye can not form the image of the object before a certain distance at the retina. The near point of hypermetropic eye is more than 25 cm. it forms the image of nearer object beyond the retina. To correct this defect, convex lens should be used.



(iii) Presbyopia- as the age of the man increases, the eye lens loses its flexibility of changing the focal length. So,it's far point will be displaced nearer and the near point will be displaced farther which makes eye unable to see nearer as well as farther objects. This defect of eye is known as presbyopia. It can be corrected by using bifocal lens.

(iv) Astigmatism- it is the defect of eye in which horizontal and vertical objects at the same time at the same distance are not focused at retina clearly. It is due to the shape of cornea not having spherical in shape. It can be corrected by using cylindrical lens.

MCQs

1. When light enters from one medium to another, ------- of light remains the same.
   a. speed b. wavelength c. frequency d. path
2. If a lens makes an image which is equal in size as object, the lens must be
   a. concave b. convex c. Plano-concave d. convexo-concave
3. The speed of light in a medium is $1X10^8$m/sec, then its absolute refractive index is
   a. 1 b.3 c. 3×10^8 d. 1×10^8
4. What is the deviation produced when a ray of light is reflected back normally from a surface?
   a. 0^o b. 90^o c. 180^o d. 360^o

5. If a body has its near sight 10 cm, he is suffering from
   a. myopia b. hypermetropia c. presbyopia d. astigmatism
6. To treat astigmatism, we have to use
   a. Convex lens b. concave lens c. cylindrical lens d. bifocal lens
7. To have total internal reflection, the angle of incidence should be
   a. equal to the angle of refraction
   b. smaller than the angle of refraction
   c. smaller than the angle of refraction and equal to critical angle
   d. smaller than the angle of refraction and greater than critical angle
8. If a ray of light enters normally from vacuum to a medium which has the refractive index 5, then the speed of light in that medium will be
   a. 6×10^7m/sec b. 3×10^8m/sec c. 15×10^8m/sec d.15×10^7m/sec
9. Lens is used in
   a. camera b. binocular c. hand lens d. all of above
10. Eye lens changes its focal length with the help of
    a. retina b. cornea c. eye lens d. ciliary muscles

Sound

Wave is a continuous transfer of disturbance from one place to another through either successive vibrations of the particle or the variation of field vectors. There are two types of waves. They are mechanical wave or non mechanical wave.

Mechanical wave: It is the wave which requires elastic mechanical medium to propagate from one place to another. Sound wave, ripples on the water surface etc are the examples of the mechanical medium. To propagate the wave through a medium, inertia and elasticity are the two essential properties required in the medium. It is so also known as elastic wave.

Non mechanical wave: It is the wave which does not require any medium to propagate from one place to another. Electromagnetic wave is the example of non mechanical wave.

Types of wave depending on the wave motion: It is divided into two types. They are longitudinal wave and transverse wave.

Longitudinal wave – The wave in which vibration of the particles of the medium take place parallel to the direction of the propagation of the wave is called longitudinal wave. In this case, the pressure of the medium changes. The region where the pressure is increased is called the compression region and the region where the pressure decreases is called the rarefaction region. It is also known as pressure wave. Sound wave is an example of longitudinal wave.

Transverse wave – The wave in which the vibration of the particles of the medium or the variation in the field vectors takes place in perpendicular direction to the

propagation of the wave is called the transverse wave. When transverse waves propagate through a medium, crest and through are formed. Light wave or electromagnetic wave is an example of transverse wave.

Wave terminologies

1. Longitudinal wave-If the vibration of the particle of the medium takes place in parallel direction to the propagation of the wave, it is called longitudinal wave.
2. Transverse wave-If the vibration of the particle of the medium or the variation in the field vectors takes place in perpendicular direction to the propagation of the wave, it is called transverse wave.
3. Crest-The elevation of the medium when a transverse wave propagates through it is called crest.
4. Trough- The depression of the medium when a transverse wave propagates through it is called through.
5. Compression- The region of the medium where the pressure increases when a longitudinal wave propagates through it is called compression.
6. Rarefaction-The region of the medium where the pressure decreases when a longitudinal wave propagates through it is called rarefaction.
7. Wavelength-The distance between two adjacent crest or trough or compression or rarefaction of a wave is called the wavelength. It is the distance travelled by the energy given by a particle of the medium when it completes one vibration. It depends on the nature of the medium.
8. Wave velocity-The displacement of energy propagation per unit time is called the wave velocity.
9. Time period-It is the time taken by a particle of the medium to make one complete vibration.
10. Frequency- The number of vibrations made by a particle of the medium in unit time is called the frequency. It can also be defined as the number of wave sent through any particle of the medium in unit time. It is equal to the reciprocal of time period of the wave.
11. Amplitude- The maximum displacement of the particle of the medium from its mean position when a wave propagates through it is called the amplitude of the wave.

Relationship between wave velocity, frequency and wave length or wave equation

Let v,f and λ are the wave velocity, frequency and wave length of a wave respectively. Then the relationship between them is given by $v = \lambda f$. This equation is also known as wave equation.

Sound wave: The energy which produces the sensation of hearing in our ear is known as sound wave. It is a longitudinal wave.

Properties of sound wave

1. It requires elastic medium to propagate from one place to another.
2. It can be reflected and refracted as light wave.
3. It is produced by a vibrating body.
4. It speed depends on the nature of the medium.

Factors affecting the speed of sound in a medium: The velocity of sound in a medium is given by $velocity = \sqrt{\frac{elasticity}{density}}$

1. Density- Velocity of sound is inversely proportional to the square root of the density of the medium. So, it is expected to have maximum velocity in gaseous medium rather than in solid. But though the density of solid is high and it tries to reduce the velocity of sound, its elasticity is much greater than that of gas which increases the velocity of sound. Hence the velocity of sound is maximum in solid.
2. Temperature- It is found to be directly proportional to the square root of the temperature of the medium in Kelvin scale. So as the temperature increases, the velocity of sound also increases.
3. Humidity- As the presence of moisture in air at constant pressure increases, the density of the medium decreases, humidity increases the velocity of sound.
4. Effect of wind- Since the wind displaces the particles of the medium which transmit the energy, the wind affects the velocity of sound. If the wind has the effect in the direction of the propagation of wave, it increases the velocity of sound. If it has its effect in opposite direction of the propagation of wave, it decreases the velocity of sound but if the wind blows in perpendicular direction to the propagation of the wave, it does not affect the velocity of sound.

Range of audibility: The range of minimum frequency and maximum frequency of sound which can be heard is known as the range of audibility. For human being the minimum frequency is 20Hz and it is known as lower limit of audibility. The maximum frequency is 20kHz and it is known as the upper limit of audibility. The sound wave which has the frequency less than 20Hz is known as infrasonic sound and the wave which has frequency greater than 20kHz is known as ultrasonic sound.

Note: A single sound wave of certain frequency and duration made by a musical instrument or a voice is called a note. Different notes are compared in the aspects (i) pitch (ii) loudness and (iii) quality. These are the characteristics of wave.

Pitch: It measures the shrillness or hoarseness of sound wave. It depends on the frequency of the wave. If the sound wave has high frequency, it is said to have high pitch and low frequency

Wave had low pitch. Voice of women and children are the examples of high pitch sound and voice of male is the example of low pitch sound. It is effected by the relative motion between the source of sound and the listener.

Loudness: It is a subjective sensation which depends on listener. It depends on the intensity of sound where intensity is defined as the sound energy flowing per unit time per unit area held perpendicular to the direction of the propagation of sound wave. The minimum intensity of hearing for human being is 10^{-12}watt/m^2 for the sound of frequency of 1kHz. It is called the threshold of hearing.

Intensity level: The intensity level of a sound is the difference between the logarithm of the intensity of sound heard and the logarithm of the threshold of hearing. Its unit is Bel in SI system of units. In practical use, its unit is taken as decibel which is 10 times smaller than Bel. It is written as $\alpha = 10\, log_{10}\left(\frac{I}{I_0}\right)$, where I is the intensity of sound and I_o is the threshold of hearing.

Quality or timbre: The sound can be differentiated with the help of the shape of sound wave which is called the quality or timbre. It depends on the number of waves emitted by the source at the same time which determine the shape of the resultant wave.

Reflection of sound wave: When sound wave is incident on a surface then it obeys the laws of reflection just like the light wave. Echo and reverberation are the examples of the reflection of sound.

Echo: When the distance between the listener of sound wave and the reflecting surface is at least 17m, he/she hears repeated sound which makes confusion. The repetition of sound, which is reflected from the distant reflected surface, is called an echo.For this loudness of sound should also be high, and the surface of the reflector should be hard.

Reverberation: If the distance between the listener and the reflecting surface is less than 17m, the reflected sound mix with the direct sound from the source and the sound is prolonged. This phenomenon is known as reverberation. To minimize this effect, the sound absorbers should be used on the walls of the room and windows should be opened.

Refraction of sound: Just like light wave when sound enters from one medium to another medium making some angle with the normal, it bends either away from or towards the normal depending upon whether the second medium is rarer or denser with respect to the first one i.e. sound also gets refracted. In refraction, the speed and wavelength of sound wave changes keeping its frequency same.

Noise and musical sound: The sound which produces unpleasant effect on the listener is known as noise. The amplitude of noise may change suddenly and short duration. It does not contain quick, regular and periodic compression and rarefaction of low frequency. But the sound wave which produces pleasant effect on the listener is known

as musical sound. It consists regular, quick and periodic compression and rarefaction of high frequency, usually of long duration and not having sudden change in amplitude.

Sound pollution: The unwanted sound which produces unpleasant effect in our ears on hearing is called noise pollution. It is found that the sound wave of more than 80dB for more than one minute reduces the auditory sensitivity. The W.H.O has fixed 45dB as the safe noise level for a city. Factories, industries, fast moving jet planes, bombing etc are the examples of the source of noise pollution.

Effects of sound pollution: It causes auditory fatigue and deafness. It decreases the working efficiency. It may cause neurosis, hypertension, emotional stress etc,

Remedy of sound pollution

It can be controlled by the following ways.

1. By generating awareness about the cause of noise pollution.
2. By banning the air horns.
3. By using sound absorbers on the walls of the room.
4. By banning to play music loudly in public places, hospitals and schools.
5. By constructing cinema halls, noise producing factories etc outside the residential areas.

MCQs

1. Which one of the following is the non mechanical wave?
   a. sound wave b. water wave c. light wave d. ultrasonic wave
2. When sound wave enters from one medium to another, which of the factor of wave remains constant?
   a. frequency b. wavelength c. speed d. none of above
3. A sound wave of 20Hz having speed 300 m/sec and wavelength 15m enters in another medium where its speed becomes 600m/sec. what is the new wave length?
   a. 15m b.30m c. 7.5m d. 60m
4. If the intensity of sound wave is increased by 100 times the initial intensity, the intensity level is increased by
   a. 100dB b. 10dB c. 2dB d. 20dB
5. The loudness of sound depends on
   a. frequency b. intensity c. timbre d. pitch
6. Noise pollution may cause
   a. myopia b. typhoid c. hypertension d. astigmatism
7. The threshold of hearing for human being is
   a. $10^{12}\,Wm^{-2}$ b. $10^{22}\,Wm^{-2}$ c. $10^{2}\,Wm^{-2}$ d. $10^{-12}\,Wm^{-2}$
8. To have echo, the minimum distance between the listener and the reflecting surface is
   a. 17 m b. 15m c. 20m d. 27m

9. Which one is the infrasonic wave?
   a. 20Hz b. 20kHz c. 10Hz d. 200kHz
10. Which of the following depends on the distance of the listener and the source of sound?
   a. loudness b. pitch c. timbre d. quality

Current electricity

The branch of physics which deals with the study of flow of charge is known as current electricity.

Current: It is defined as the rate of flow of charge flowing through a cross section of a conductor in a unit time. It is denoted by I. Its conventional direction of flow is from positive terminal of the battery to negative. So, $I = \frac{q}{t}$; where I ,q and t are the current flowing through the conductor when q charges crosses it's any cross section in t sec. it is a scalar quantity and its unit is Ampere in SI system of units.

Potential difference: Potential difference across any resistor is the amount of energy required to cross that resistor by unit charge. It is denoted by V. It is also a scalar quantity and its unit is Volt in SI system of units.

Ohm's law: It states that the current flowing through a conductor is directly proportional to the potential difference across it, provided that the physical conditions like temperature, pressure etc of the conductor remain the same. If I and V are the current through a conductor and p.d. across it, then according to Ohm's law,

$I \propto V$

Or, $I = \frac{V}{R}$. Where, $1/R$ is a proportionality constant and R is known as the resistance of the conductor.

Resistance: The electrical resistance of a conductor is the ability to oppose the flow of electric charge through it. The conductor having resistance is known as resistor. It depends on the dimension of the conductor, temperature and nature of the material. Its unit is Ohm in SI system of units.

Series combination of resistors: If the resistors are connected end to end, the combination of resistors are known as series combination. In this case, the total resistance is given by the sum of individual resistances. So, it is always greater than individual resistance. In series combination of resistors, same current flows through each of the resistors.

Parallel combination of resistors: If the resistors are connected across the common points, the combination is called parallel combination. In this case, the reciprocal of total resistance is the sum of the reciprocal of individual resistances. So the reciprocal of

total resistance is greater than the reciprocal of individual resistance .i.e. total resistance is always smaller than the individual resistance. Here each resistor has same potential difference across them.

Resistivity or specific resistance: The resistance offered by a conductor of unit length and unit cross-section is called the resistivity of the body. It is independent of the dimension of the conductor but depends on the nature of the material and its temperature. Its unit is Ohm m in SI system of units.

Heating effect of current: When electric current is passed through a conductor, electrical energy is converted to heat energy. This effect is called heating effect of current. This effect was for the first time discovered by Joule. So it is called Joule's heating effect. From the experiment he performed, he gave us Joules law of heating.
Joules law of heating: It states that the amount of heat (H) produced in a conductor having resistance (R) when current (I) is passed through it for time (t) second is directly proportional to the square of the current, resistance and the time i.e. $H \propto I^2Rt$
Or, $H = \frac{I^2Rt}{J}$; where J is known as the mechanical equivalence of heat and its value is $4.2 J/cal$ but in SI system we have $H = I^2Rt$ only since we do not require conversion factor of unit.

Electric power: It is defined as the rate of conversion of electrical energy into heat energy with respect to time. It can also be defined as the rate of conversion of work done to maintain the steady current in an electric circuit.

$$P = \frac{I^2Rt}{t}$$

Or, $P = I^2R$ but from Ohm's law, $V=IR$
So,

$$P = \frac{V^2}{R}$$

Its unit is Watt in SI system of units.

Efficiency: It is the ratio of output power to the input power. It is denoted by η and given by $\eta = \frac{output\ power}{input\ power}$

Chemical effect: M. Faraday found that when electric current is passed through liquids like mercury, molten metal, *NaCl* solution etc., they are dissociated into ions. Such liquids are known as electrolytes and the phenomenon of the passage of the current through liquids and their decomposition into ions is called chemical effect of current. Faraday named the results of his experiment as the laws of electrolysis.

Electrolysis: The process of decomposition of an electrolyte into its constituent ions by the passage of electric current through it is called electrolysis. The vessel in which the electrolysis process is carried is called voltammeter. The metal rods which are used in voltammeter are called the electrodes. The rod which is connected to the positive terminal of the battery is called anode and the rod which is connected to the negative terminal of the battery is called the cathode.

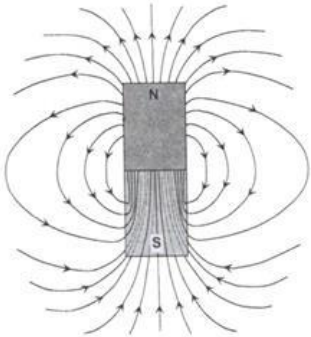
Magnetism: It is one of the phenomena by which materials exert an attractive or repulsive force on other materials like iron, nickel etc. Oersted found that an electric current can produce magnetic effect.

Some properties of magnet

1. Attractive property- it attracts the magnetic substances like iron, nickel etc.
2. Directive property- if a magnet is freely suspended about its centre of gravity, it aligns itself along the north-south direction of the earth.
3. Inducing property-when a piece of magnetic substance is kept near to a magnet, it also gains the magnetic property i.e. it can also attract the magnetic substances.
4. A pair of poles-if a magnet is cut into pieces, each piece will have both north and south pole. So magnetic pole always exists in a pair.
5. Force between poles- the magnetic poles exerts force on each other. Its nature depends on the nature of the poles. If they are similar poles, force is repulsive in nature but if they are opposite poles, it is attractive in nature.

Magnetic field: The region around a magnet where it can exert magnetic force to another magnet or magnetic substance is called the magnetic field of the magnet.

Magnetic lines of force: The magnetic lines of force are the continuous curves in a magnetic field along which a unit north pole of a magnet will move if it is free to do so.



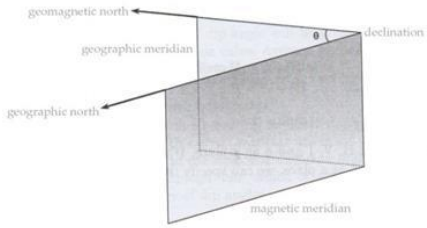
Properties of magnetic lines of force

1. It starts from North Pole of a magnet and ends at south pole outside the magnet but it is directed from south pole of the magnet to north pole inside the magnet.

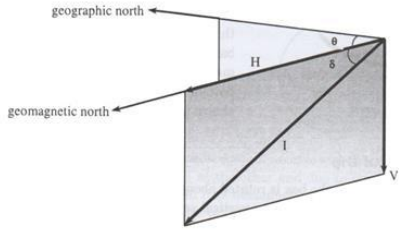
2. A tangent drawn at a point on the line of force gives the direction of magnetic field at that point.
3. Two lines of force can never intersect with each other.
4. The closeness of the lines of force shows the strength of the field in that region.

Elements of terrestrial magnetism: The quantities which are necessary to specify the earth's magnetic field at a place completely are called the elements of terrestrial magnetism. They are declination, inclination and the horizontal component of earth's magnetic field.

Declination: The declination at a place is the angle between the magnetic meridian and the geographical meridian of the place at that place. It varies from place to place. The magnetic meridian is the imaginary vertical plane passing through the magnetic poles of the earth through that place and the geographical meridian is the imaginary vertical plane which passes through the geographical poles of the earth.



Inclination: The angle of dip at a place is defined as the angle between the earth'smagnetic field and the horizontal direction in the magnetic meridian. It is 90^0 at the magnetic poles of the earth and 0^0 at the magnetic meridian.



Horizontal component of earth's magnetic field: The Horizontal component of earth's magnetic field, H is the component of the earth's magnetic field along horizontal direction in the magnetic meridian at a place.

Magnetic effects of current: Oersted discovered that a current carrying conductor produces magnetic field around it. Later different scientists gave different rules to find the direction of the magnetic field produced by current carrying conductors. They are:

1. Right hand thumb rule-according to rule , if the current carrying conductor is hold in our right hand such that the thumb shows the direction of current, then the tip of curl fingers shows the direction of magnetic field.

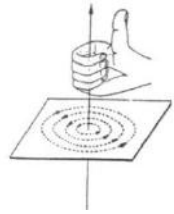


Fig: Right hand thumb rule

2. Maxwell's cork screw rule(right handed screw rule)- according to this rule, if a screw is rotated the direction of linear motion of the screw gives the direction of conventional direction of current and the direction of rotation of screw gives the direction of magnetic field produced by it.

Fig: Maxwell's cork screw rule

3. Right hand fist rule-this rule is used to find the direction of magnetic field produced due to a circular current carrying conductor. According to this rule, if we curl the fingers of our right hand in the direction of flow of current through the conductor, then the thumb shows the direction of magnetic field produced by it.

Fig: Right hand fist rule

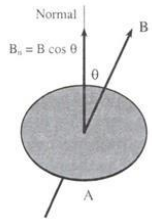
Electromagnetic induction

Oersted discovered that a current carrying conductor can produce magnetic field but in 1831. Faraday discovered that a varying magnetic field can produce electric field; this phenomenon is known as electromagnetic induction. According to it, when the magnetic lines of force (magnetic flux) linking a conductor or a coil changes, electro motive force (emf) is generated. It is based on the principle of conservation of energy.

Magnetic flux

The magnetic flux through any surface is defined as the number of magnetic lines of force crossing through that surface. Its unit is weber in SI system of unit. It is denoted by φ and given by $\phi = BA\,cos\theta$, where B is the strength of the magnetic field, A is the

area of the surface through which the flux is passed and θ is the angle between the direction of magnetic field and the perpendicular plane.
Its unit is Weber in SI system of units.



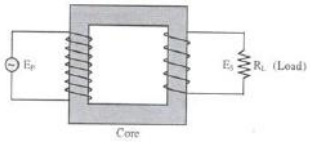
Magnetic flux density or magnetic field strength or magnetic induction
It is defined as the magnetic flux passing through unit area held perpendicular to the direction of the lines of force. It is denoted by B and given by $B = \phi A$. Its unit is Tesla or Weber/m^2 in SI system of units. It is a vector quantity.

Electric generator
An electrical device which converts mechanical energy into electrical energy is called electrical generator. The principle on which it works is the electromagnetic induction. Here the magnetic flux through the coil of the generator is changed by applying mechanical energy on it andemf is induced across it. This induced emf makes the current flow in the coil i.e. in the circuit. There are two types of electrical generators. They are:

1. Alternating Current Generator or A.C Dynamo- It is the device which converts mechanical energy into electrical energy which alters its magnitude and direction with respect to time.
2. Direct current Generator or D.C. Dynamo - It is the device which converts mechanical energy into electrical energy which makes the current flow always in the same direction.

Electric motor
An electric device which converts electrical energy into mechanical energy is called an electric motor. It works on the principle that when a current carrying coil is kept in a magnetic field, it experiences torque i.e the turning effect of force.

Transformer
A device which is used to convert low alternating voltage at high current into high alternating voltage at low current or vice-versa is called transformer. So it is the device which is used to alter the value of alternating voltage. It works on the principle of mutual induction i.e. when the magnetic flux linked with a coil is changed or current through is changed , emfis induced to the nearby coil.



The coil through which the current is changed is called the primary coil and the coil in which emf is induced is called the secondary coil. If there is no loss of energy, $E_p$and $E_s$represent primary and secondary voltage respectively, then the ratio of $E_p$and $E_s$will be equal to the ratio of their number of turns.i.e.$\frac{E_p}{E_s} = \frac{N_p}{N_s}$. If $N_p > N_s$, it is called step down transformer and it is used in electrical appliances like TV, radio etc. it is also used in substation to step down the voltage of ac before its transmission. But if $N_p < N_s$, it is called step up transformer and it is used in powerhouse to step up the voltage of ac before transmission over long distance. It is also used in television, X- ray tube to produce high voltage.

House wiring

In our country, for domestic use the main supply has 220V of 50 Hz. There are three core wiring. One which is connected to the supply of 220V is called live wire and red or brown color wire is used for this wire. The second wire is the neutral wire which is at 0V and black or blue color wire is used for this wire. The third wire is the earth- wire which may be taken from pole or a metal plate sunk deep in the earth. It is the safety measure and does not in any way affect the supply. Green or yellow color wire is used for earth-wire. Since the entire home appliances are connected in parallel combination, switch is used in live wire for individual appliances.

Electric Fuse

It is a device used in electrical circuit which protects the circuit and electrical appliances from damage due to the high flow of current in the circuit. It works on the principle of heating effect of current. It is made of an alloy of tin (60%) and lead (40%) which has very melting point. So when current in the circuit exceeds a certain value, the current through the circuit flows through the fuse wire which produces heat which is sufficient to melt it. After it melts, the circuit will break down and protects the appliances.

Electricity billing

In electrical billing, electrical energy consumed is taken in terms of unit. One unit of electrical energy is one kilowatt hour (*kWhr*).

So, $Total\ cost = number\ of\ units\ consumed\ x\ rate\ of\ each\ unit.$

MCQs

1. When two resistors of 2Ω are connected in parallel and one 1Ω is connected in series with this combination. The total resistance is
   a. 3Ω b. 2Ω c.1Ω d.1/2Ω
2. If a 2000W bulb is used continuously for 4 hours. What will be the cost that should be paid if Rs 1.50 has to be paid for a unit?
   a. Rs 2000 b Rs4 c. Rs3000 d. *Rs 12*
3. When the length of a conductor is doubled, its resistivity will be
   a. soubled b. halved c. same d. four times
4. Fuse wire is made of alloy because it has

a. low melting point b. high melting point
c. low specific heat capacity d. high specific heat capacity

5. Which color wire is used for earth wire in our house wiring?
   a. red b. black c. yellow d. brown
6. If the number of turns in primary coil is six times greater than the number of turns in secondary coil in a transformer and 6V dc voltage is applied in primary coil. What is the secondary voltage?
   a. 0V b. 6V c. 36V d. 1V
7. If a magnet A attracts B but repels C,
   a. both of B and C are surely magnets
   b. both of B and C are surely magnetic substances
   c. B is surely magnetic substance and C is a magnet.
   d. sure a B may be magnet or magnetic substance but C is magnet.
8. Angle of dip is maximum at
   a. the geographical poles of the earth b. the magnetic poles of the earth
   c. magnetic meridian of the earth d. no where
9. The chemical effect of electricity was discovered by
   a. M.Faraday b. Oerested c. Ohm d. Fleming
10. The heating effect of current in a conductor through which current is flowing, is due to
    a. loss of energy by positive ionsb.loss of electrons
    c. loss of positive ionsd. loss of kinetic energy by electrons

Answers & explanations:

Machine

1. **b** VR
2. **c** In an ideal machine, there will be no loss of energy. So the output will always be equal to the input. So efficiency is 100%.
3. **d** the VR= hypoteneous/perpendicular
   Or, $VR = {}^{1}/_{Sin30^0} = 2$
4. **b** The VR is equal to the number of pulleys used. So,VR = 4.
5. **d** In wheel and axle, the points of load and effort can vary continuously for 360^oon the circumference of the wheel and axle. So it is also known as a continuous lever.
6. **d** Here the angle between force and its distance from the axis is zero, so torque produced by it is zero.
7. **b** In any machine whether that is ideal or not, energy must be conserved in any process.
8. **c** In machines, to get more VR, effort distance should be greater than load distance and the force is applied on the circumference of the wheel.

Force

1. **a** two equal and opposite forces are applied on the same mass, so net force is zero which produces no change in velocity.
2. **c** we have only three types of inertia in straight line motion. They are inertia of rest, motion and direction.
3. **d** when the body completes its motion in circular track, the total displacement is zero. So velocity is zero.
4. **b** the action and reaction are experienced by different objects. A body experiences the reaction force in return of the force applied by it to other object which is 5N here.
5. **c** the initial and final momentum of the body has magnitude mv but they have opposite direction. Since the momentum is a vector quantity, to find the difference between two oppositely directed vectors they should be added in magnitude. So it is 2mv.
6. **b** there are infinite possible lines which joins any two points of any length. So it is infinity.
7. **c** current has direction but it does not obey the law of vector addition. So it is a scalar quantity.
8. **b** same magnitude but opposite direction in velocity means the change in velocity is 8 m/sec and we have the acceleration = change in velocity / time
   Or, time = 8/1 =8 sec
9. **d** we have $1N=10^5$ dyne. So, $3N = 3X10^5$=300000dyne

10. **a** inertia of rest means to ability of the body to remain in rest. To bring it into motion, force has to be applied which depends on mass of the body. So inertia of rest depends on mass.

Work, energy & power

1. **a** since, $W = Fd\ cos\theta$and $cos\theta$ as the maximum value when θ is 0^o.
2. **b** work done is the transfer of energy, so work should be equal to the energy.
3. **d** Work =Power x Time =5000×30=150000J
4. **d** potential energy depends on the position of the body and when a body is lifted, its position is changed.
5. **b** using principle of conservation of energy, we have KE=PE
   Or, 100=mgh
   Or, 100=1×10×h
   Or, h=10m
6. **d** efficiency = output / input
   Or, 30/100 = 50/input
   Or, input = 5000/30
   Or, input=500/3J
7. **a** the energy which depends on the speed of the body is the kinetic energy.
8. **c** using the work energy theorem, KE=work done
   Or, $900 = Fd\ cos\theta$but here θ is 180^o since frictional force is applied by the wall to stop the bullet. So,$cos\theta$ has magnitude 1.
   So, 900=Fx3
   Or, F=30N
9. **b** since the angle between vertical gravitational force and the horizontal displacement (θ) is 90^o and work done by a force depends on the value of cosθ, it is zero.
10. **d** no loss of energy means input and output are equal. So their ratio becomes unity i.e. in percentage it is 100 percent.

Gravity and gravitation

1. **d** the true weight is the product of mass and acceleration due to gravity. So it is 10N.
2. **d** to revolve in circular track centripetal force is necessary which is provided by its weight.
3. **a** the value of the acceleration due to gravity is maximum at the surface of the earth. Again due to the flatness of the earth at its pole, it is maximum at the poles.

4. **c** According to the definition of free fall, the acceleration should be equal to acceleration due to gravity.
5. **c** gravitational field intensity is the force experienced by unit mass. So it does not depend on the mass which is used to measure the force by the given body.

Fluid statistics

1. **d** the thrust = liquid pressure X area of the surface
   Or, thrust = density of liquid X acceleration due to gravityX height of liquid X area of the surface
   So it depends on density of liquid, size of the surface and acceleration due to gravity.
2. **d** when the density of the body is equal to that of liquid, it floats in the liquid but if it is smaller, it floats on the liquid surface.
3. **c** when a body is completely immersed in a liquid, it displaces liquid of volume equal to itself.
4. **a** the buoyant force is the weight of the liquid displaced which is equal to the product of mass of liquid displaced and the acceleration due to gravity. So
   Mass of liquid displaced=buoyant force/g=25/10=2.5kg
5. **b** the pressure exerted by liquid depends on the value of acceleration due to gravity and its value is zero at the centre of the earth. So the pressure is zero.

Heat

1. **b** heat flows from higher temperature to lower. So it flows from B to A.
2. **c** thermoelectric effects are defined as the conversion of heat energy into electrical energy.
3. **d** water absorbs more amount of heat to increase its temperature even through a small range due to its high specific heat capacity. So when it is come into contact with a hot body, it absorbs more hot body to come in equilibrium with that body which helps to decrease its temperature.
4. **b** thermal heat capacity is the heat required to raise the temperature of the given body through unit degree. So it depends on the mass of the body.
5. **c** according to the principle of calorimetry, heat gained by the cold body is equal to the heat lost by a cold body. So heat lost by water=4200J
   Or, $M_w s_w \Delta T$=4200 but s_w, for water=4200J/kgK.
   So, 4200= 1×4200×ΔT
   Or, ΔT = 1K
6. **a** when the temperature increases, the molecular vibration increases which increases the length of the rod.
7. **d** the specific heat capacity of water in SI system is 4200J/kgK.
8. **c** when the temperature of a body is increased, it increases the KE of the molecules.
9. **d** potassium chlorate on heating gives oxygen due to decomposition.

$$2KClO_3 \xrightarrow{\text{heat}} 2KCl + 3O_2$$

10. **d** thermal equilibrium means no flow of heat from one body to another and we know heat flows due to the temperature difference. So to make no flow of heat, they should have same temperature.

Geometrical optics

1. **c** the color of light depends on the energy which depends on its frequency. Since energy should be conserved, frequency should be same.
2. **b** concave lenses makes diminished image whereas convex lens can form diminished as well as magnified and equal in size as object.
3. **b** refractive index = speed of light in vacuum/speed of light in medium
   or, refractive index $=3\times10^8/1\times10^8$
   or, refractive index=3
4. **c** when a ray of light is reflected normally, it takes the opposite direction to the initial direction i.e. it reverses its direction. So the angle of deviation is 180^o.
5. **a** myopia is the defect of vision in which a person can see the nearer objects.
6. **c** astigmatism is the defect of eye in which the shape of cornea is not spherical. So, cylindrical lens should be used.
7. **d** for any value of angle of incidence greater than the angle of refraction, it is not possible to have total internal reflection. For this it should be greater than critical angle.
8. **a** refractive index= speed of light in vacuum/speed of light in medium
   Or, speed of light in medium= 3×10^8m/sec /5
   Or, speed of light in medium= 6×10^7m/sec
9. **d** camera, binocular and hand lens, all are made of convex lenses.
10. **d** ciliary muscles can contract and stretch itself depending on the distance of the object which changes the focal length of the eye lens.

Sound

1. **c** light wave is an electromagnetic wave. So it does not require any mechanical medium.
2. **c** since the energy is conserved and it depends on frequency, it remains the same.
3. **b** since the frequency remains constant and we have wave equation $v = \lambda f$, the speed and wavelength changes in the same ratio. So, the wavelength should also be doubled.
4. **d** the intensity level is given by $\alpha = 10\ log_{10}\left(\frac{I}{I_0}\right)$and here,$\frac{I}{I_0} = 100$. The $log_{10}100$ =2. So, it is 20dB.
5. **b** the loudness depends on the energy received by the ear which depends on intensity.
6. **c** noise pollution may affect our brain. So it is hypertension.

7. **d** the minimum intensity which can be detected by our ear is called the threshold of hearing. Since we can not detect the sound having intensity less than 10^{-12} Wm^{-2}, it is the threshold of hearing.
8. **a** to hear the echo, the reflected sound should be received after minimum 0.1 second because it is the persistence of hearing. When t=0.1 sec and v= 332 m/sec, using $v = \frac{2d}{t}$, we get d= 16.6m. Here, we take $2d$ because sound has to travel the distance between the listener and the reflecting surface d twice.
9. **a** the sound wave having frequency less than 20Hz is known as infrasonic wave.
10. **a** loudness depends on intensity of sound and intensity depends on the distance.

Current electricity

1. **b** the parallel combination of two 2 Ω resistors gives net 1 Ω and this 1 Ω in series with another 1 Ω gives 2 Ω.
2. **d** energy consumed= 2000×4=8000Whr=8kWhr=8 unit
   So, total cost=Rs1.5×8=Rs12
3. the resistivity of a conductor is independent of the dimension of the conductor.
4. **a** fuse should disconnect the circuit for high flow of current. For this it should have low melting point.
5. **c** green or yellow color wire is used for earth wire.
6. **a** since the transformer does work for dc supply, its output is 0V.
7. **d** a magnet can attract opposite pole of magnet as well as magnetic substance but to repel, they should have the same poles i.e. both of them should be magnets.
8. **b** it is 90^o at the magnetic poles of the earth but it is 0^o at the magnetic meridian and at other places it is in between $90^o$and 0^o.
9. **a** M.Faraday
10. **d** when current flows, electrons collide with other electrons and positive ions. During collision it loses its kinetic energy in the form of heat energy.

Chemistry

General Physical Chemistry

Atom: An atom is the smallest unit of an element that takes part in a chemical reaction. An atom may or may not have independent existence. Atoms of elements like Helium (He), Neon (Ne), Argon (Ar) can exist freely where as the atoms of elements like Hydrogen (H), Oxygen (O), Nitrogen (N) can't exist freely.

Molecule: A molecule is the smallest unit of a pure substance (element or compound) which can exist freely. H_2 is the molecule of hydrogen element which can exist freely where as the H_2O is the molecule of water that can exist freely.

Element: An element is the pure substance that can neither be created nor destroyed by any simple physical or chemical means.

Compound: A compound is also the pure substance that is formed by the combination of two or more than two elements in a fixed proportion.

Radical: An atom or group of atoms having +ve or –ve charge that behave as a single unit during chemical reaction. Examples: Na^+, Ca^{++}, Al^{+++}, Cl^- Br^-, NH_4^+ NO_3^- etc.

Valency: Valency of an element is the combining capacity of the element. It is measured in terms of number of hydrogen atoms (or its equivalent) with which one atom of that element combines (Classical concept).

Illustration: Valency of oxygen is 2 means 2 atoms of hydrogen combines with one atom of Oxygen.

Valency of nitrogen is 3 means 3 atoms of hydrogen combines with one atom of Nitrogen.

Valency of carbon is 4 means 4 atoms of hydrogen combines with one atom of Carbon and so on.

In terms of electronic concept, it is defined as the number of electron gained or lost or shared during chemical reaction.

Chemical Equation:- It is the symbolic representation of a chemical change.

Illustration:

Hydrogen + oxygen $\rightarrow$ water (chemical change)

$H_2 + O_2 \rightarrow H_2O$ (Chemical equation, Qualitative)

$2H_2 + O_2 \rightarrow 2\ H_2O$ (Chemical equation, Quantitative)

This chemical equation suggestion that

a) Hydrogen whenever combines with oxygen, water is formed.
b) Two molecules of hydrogen combine with one molecule of oxygen to give two molecules of water.
c) Two moles of hydrogen combines with one mole of oxygen to give two moles of water.

d) Four parts (2 x Mol.wt. of hydrogen) by weight of hydrogen combines with thirty two (Mol. Wt. of oxygen) parts by weight of oxygen to give thirty six (2 x Mol. Wt. of water) parts by weight of water.

Types of chemical reaction

i. Combination reaction/Synthesis reaction (A + B → C):- Two or more than two reactants combine to give a single product.
   $N_2 + 3H_2 \rightarrow 2\ NH_3$
   $C + O_2 \rightarrow CO_2$

ii. Decomposition reaction (A → B +C):- A single substance decomposes into two or more than two substances.
   $2KClO_3 \rightarrow 2KCl + 3O_2$
   $CaCO_3 \rightarrow CaO + CO_2$

iii. Single displacement reaction (A + BC → AC + B):- One of the reactant displaces a part from another reactant.
   $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
   $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

iv. Double displacement reaction (AB + CD → AD + BC):- Both of the reactants mutually displace from each other.
   $NaOH + HCl \rightarrow NaCl + H_2O$ (Acid - Base reaction/ Neutralization reaction)
   $AgNO_3 + NaCl \rightarrow AgCl \downarrow + NaNO_3$ (Precipitation reaction) where ↓ indicates the formation of insoluble product (precipitate).

v. Combustion reaction:- The reaction involves the burning of a substance in air.
   $CH_4 + O_2 \rightarrow CO_2 + H_2O$

Separation of mixture

Filtration is commonly the mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass.

Distillation is a process of separating the component substances from a liquid mixture by selective evaporation and condensation.

Fractional distillation is the separation of a mixture into its component parts, or fractions, such as in separating chemical compounds by their boiling point by heating them to a temperature at which one or more fractions of the compound will vaporize.

Sublimation is a process of separating the volatile component from a mixture of volatile and non volatile substance.

Isotope:-

Atoms of same element having same atomic number (No. of protons) but different mass number (No. of proton + No. of neutron). Examples $_1{}^1H$, $_1{}^2H$,$_1{}^3H$

Isobar:-

Atoms of different elements having same mass number. Examples: $_{18}{}^{40}Ar$, $_{19}{}^{40}K$, $_{20}{}^{40}Ca$

Isotone:-

Atoms of different elements having different neutron number. Examples: $_5{}^{12}B$ and $_6{}^{13}C$ both have 7 neutrons.

Isoelectronic

Atoms or group of atoms having same number of electrons. Examples: CO, CN^-, NO^+ are isoelctronic species.

Rate of a chemical reaction

It is defined as the change in concentration of reactant or product per unit time.

Mathematically,

Rate = Change in concentration/ Time taken

Therefore, unit of rate = mole $litre^{-1}$ $time^{-1}$

Factors affecting rate of reaction

i. Nature of reactant: The reaction involving ions are very fast where as the reaction involving covalent bond are slow.

$Ag^+NO_3^- + Na^+Cl^- \rightarrow AgCl\downarrow + Na^+NO_3^-$ (Very fast)

$N_2 + 3H_2 \rightarrow 2\ NH_3$ (Slow)

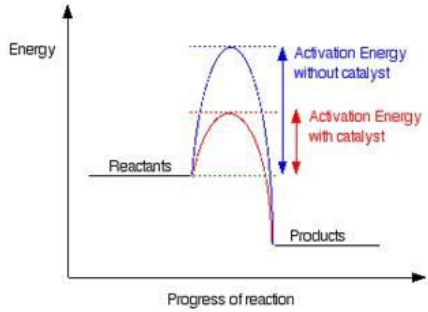
ii. Concentration of reactant: Higher the concentration of reactant, higher would be the rate of reaction.

$CaCO_3 + HCl$ (conc.) $\rightarrow$ $CaCl2 + H_2O + CO_2\uparrow$ (Fast evolution of gas)

$CaCO_3 + HCl$ (dil.) $\rightarrow$ $CaCl_2 + H_2O + CO_2\uparrow$ (Slow evolution of gas)

iii. Temperature: Usually, higher the temperature, higher would be the rate of a reaction. Experimentally, it has been observed that the rate of a reaction increases by 2 to 3 times with every 10^0C rise in temperature.

iv. Catalyst: A catalyst enhances the rate of a chemical reaction by providing an alternative path of lower activation energy (an additional energy required for reactants in order to give the products)



v. Surface area of reactant exposed: Higher the surface of reactants, higher would be the rate of a reaction

$CaCO_3$(powder) + HCl (dil.) → $CaCl_2$+ H_2O+ CO_2↑ (Fast evolution of gas)
$CaCO_3$(lump) + HCl (dil.) → $CaCl_2$+ H_2O+ CO_2↑ (Slow evolution of gas)

vi. Pressure: For reactions involving gases, an increase in pressure increases the rate of reaction by increasing the probability of collision among molecules. Pressure has little effect on rates of reaction involving solids and liquids. But, it does not alter the value of rate constant.

Acid and Base

Arrhenius concept:

Acid:- hydrogen containing substance which gives hydrogen ion in water.

$HCl + water \rightarrow H^+(aq.) + Cl^-(aq.)$

Base:- hydroxide containing substance which gives hydroxide ion in water.

$NaOH + water \rightarrow Na^+(aq.) + OH^-(aq.)$

Bronsted concept:

Acid:- Proton(H^+) donor species

Base:- Proton(H^+) acceptor species

$HCl + H_2O \rightarrow Cl^- + H3O^+$

Here, HCl donates proton to H_2O. Therefore, HCl is a **Bronsted** acid and H_2O is a **Bronsted** base.

Lewis concept:

Acid:- Lone pair electron acceptor species (Electrophiles)

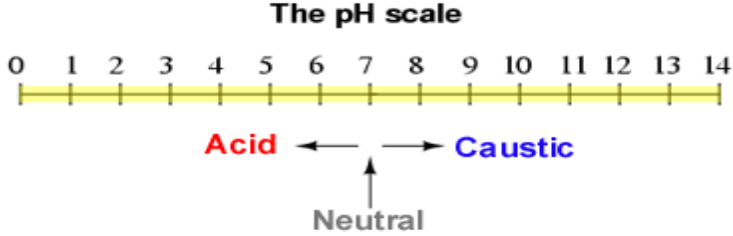
Base:- Lone pair electron donor species (Nucleophiles)

$H_3N: + H^+ \rightarrow NH_4^+$

Here, H^+ accepts lone pair electron from H_3N. Therefore, H^+ is a Lewis acid and H_3N is a Lewis base.

pH and pH scale:- The term pH is used to express concentration of H+ ion in dilute solution. According to Sorension, it is defined as:

$pH = - Log[H^+]$ where, $[H^+]$ = Molarity of hydrogen ion



Acid- Base indicator

Indicators are chemical substances that are used to find out whether a given solution is **acidic** or **alkaline** by showing a color change.

pH Indicator

The pH indicator indicates the **nature** as well as the **strength** of the given medium (solution).

Examples of pH Scale Readings

A pH scale reading of **less than 7** indicates an **acidic** medium.
A pH scale reading of **more than 7** indicates a **basic** medium.
A pH scale reading **equal to 7** indicates a **neutral** medium or solution (pure distilled water).
A pH scale reading of **2** indicates a **strong acid**.
A pH scale reading of **13** indicates a **strong base**.
A pH scale reading of **6** indicates a **weak acid**.
A pH scale reading of **8** indicates a **weak base**.

Litmus Indicator

Acids turn blue litmus paper **red**.
Bases turn red litmus paper **blue**.

Examples of Litmus Paper Color Changes

Sulfuric acid is obviously **acidic** in nature. It turns blue litmus paper **red**.
Sodium hydroxide is a **base**. It turns red litmus paper **blue**.

Other Indicators

Phenolphthalein solution is a **colorless** indicator.
Methyl orange solution is obviously an **orange-colored** indicator.

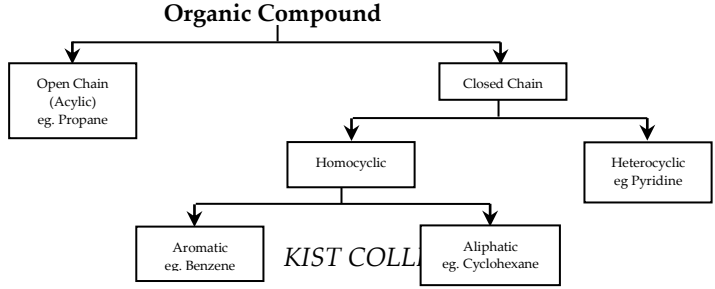
Examples of Color Changes using Other Indicators

Phenolphthalein solution causes **no color change** in **acids** whereas it turns **bases pink**.
Methyl orange solution turns **acids red** whereas it turns **bases yellow**.

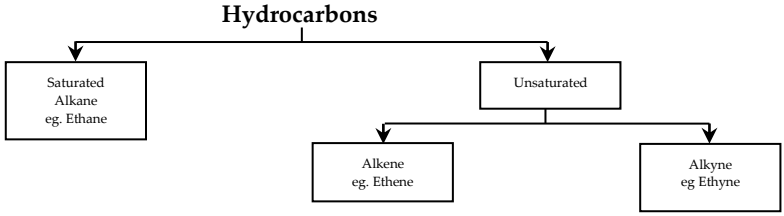
Organic Chemistry

Organic chemistry is the branch of chemistry which deals with hydrocarbons and their derivatives. Hydrocarbons means the compounds of hydrogen and carbon i.e. hydrogen + carbon = hydrocarbon. Derivatives means, those compounds prepared from hydrocarbons. For example, the simple hydrocarbon is methane (CH_4), when methane reacts with chlorine in the presence of diffused sunlight gives chloromethane. Chloromethane is derivatives of hydrocarbons methane.

Classification of organic compounds: Organic compounds can be classified into: (A) Open chain organic compounds & (B) closed chain organic compounds.



Classification of hydrocarbons: Hydrocarbons can be classified into: (A) Saturated hydrocarbons and (B) Unsaturated hydrocarbons:



Homologous Series:- A homologous series can be defined as a series of organic compounds having similar functional group, each member of which differs from the preceding member by one CH_2 unit. Each member of the series is called homologues.
Character of homologous series:

1. All the members of a particular series are represented by the similar general formula.
   For example,
   Alkanes are represented by C_nH_{2n+2}
   Alkenes are represented by C_nH_{2n}
   Alkynes are represented by C_nH_{2n-2}
   Alcohols are represented by $C_nH_{2n+1}.OH$
   Alkyl halides are represented by $C_nH_{2n+1}.X$
2. Each successive member of the series differs from each other by CH_2 unit or molecular weight 14.
3. All members are prepared by the similar general methods of preparation.
   Functional Group:- Functional group is an atom or a group of atoms which determines the activity of a given compound for example, $-NH_2$(amine), -OH (alcohol), -X (halide), –COOH(carboxylic acid), $\rangle C= O$(Ketone), -CHO (aldehyde) etc.

   Nomenclature of organic compounds:- The naming of organic compounds can be done according to the both common system and IUPAC system.
   Common system: It is also called trivial system. In this system organic compounds are named according to their source, origin, etc.
   IUPAC System: IUPAC system is systematic system of nomenclature of organic compounds. IUPAC means, International Union for Pure and Applied Chemistry.

   In this system, the naming of organic compounds can be done on the basis of prefix + word root + primary suffix + secondary suffix.
   Prefix: Prefixes are added before the word root for example, methyl, ethyl, cyclo, halo, Nitro, etc.

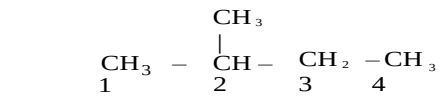
Word root: Word root indicates the nature of the basic carbon skeleton. For example,

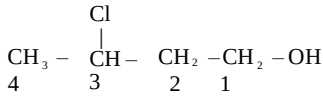
No of carbon atoms	Word root
1	Meth
2	Eth
3	Prop
4	But

Primary Suffix: Primary suffix indicates the degree of saturation or unstauration on organic compounds. For saturated C-C single bond in a chain, primary suffix is –ane.
For unsaturated C=C double bond in a chain, primary suffix is –ene similarly C≡C triple bond in a chain it is –yne.
Secondary suffix: Secondary suffix indicates the principal functional group in a chain.

Compound	Functional group	Secondary suffix
Alcohol	-OH	-ol
Aldehyde	-CHO	-al
Carboxylic acid	-COOH	-oic acid
Ketone	>C=O	- one

For examples:





2-Methyl butane
Prefix-Methyl
Word root- but
Primary suffix-ane

3-Chloro butan-1-ol
Prefix – Chloro
Word root – but
Primary suffix – ane
Secondary suffix - ol

Heterolytic Fission (Heterolysis):
Heterolytic fission is the process of breaking of covalent bond in such a way that the bonded electrons are placed in only one atom (i.e. electronegative atom).

$A - B \rightarrow A^{+} + B^{-}$

During heterolytic fission a positively charged ion and negatively charged ions are formed.

Homolysis (Homolytic fission):
Homolytic fission is the process of breaking of covalent bond in such a way that the bonded electrons are equally placed in both bonded atoms. During homolytic fission free radicals are formed.

$A - B \rightarrow A^{\cdot} + B^{\cdot}$

Materials used in Daily life

Cement: Cement can be defined as a mixture of fine powder of calcium, silicate and calcium aluminate.

Glass: An amorphous transparent homogenous mixture of silicates of alkali metals (Na and K) and silicates of alkaline earth metals (Pb & Ca) are called glass. It has no fixed composition and definite formula.

Types of Glass:

1) Quartz glass:
   Pure Silica $\xrightarrow{1600\ ^0C}$ Quartz Glass.
2) Water glass: It is sod or pot silicate
   Silica + sod/pot carbonate $\xrightarrow{\Delta}$ sod/pot silicate
3) Ordinary glass or soda lime glass: It is prepared from a mixture of 50% silica, 15% sod carbonate, 10% calcium carbonate and 25% glass pieces.
4) Hard glass: It is prepared by heating a mixture of silica, potassium carbonate and calcium carbonate. It is also called potash lime glass.
5) Lead crystal glass: It is prepared by heating silica, lead monoxide and potassium carbonate. It is also called optical glass or flint glass or potash lead glass.
6) Boro-silicate glass: It is prepared by heating a mixture of silica, sod carbonate, calcium carbonate and boron oxide at high temperature. It is also called Pyrex glass.

Colored glass: Following oxides are used to colored glass.

Cobalt oxide → Blue	
Nickel oxide → Black	Feric (III) oxide → Yellow or Brown
Chromium oxide → Green	Cuprous oxide → Red
Manganese oxide → Purple	Tin oxide → Milky white

Polymer: A large organic molecules obtained by the addition of large number of small molecules is called polymer. The process of formation of polymer from the small molecules under suitable condition is called polymerization and these small molecules are called monomers.

Polymers can be classified into natural polymer and synthetic polymer (artificial) eg.

$n(CH_2 = CH_2) \xrightarrow{\text{Polymerisation}} -(CH_2 - CH_2)_n-$

Monomer polymer

Plastic is a synthetic polymer. There are mainly two kinds of plastics i.e. thermosetting plastics and thermoplastics.

Thermosetting plastic: The plastic that does not become soft while heating and cannot be remoulded into desired shapes is called thermosetting plastics.

It is used in electric switches, plug, handles of pressure cooker, tea-kettle, radio, TV cabinets etc. For example: bakelite, melamine, teflon etc.

Thermoplastics:
Those plastic which becomes soft on heating and can be remoulded into desired shape is called thermoplastic. It is used in making bags, rope, bucket, pipe etc. For example: polythene, polyvinyl chloride, polystyrene and synthetic fibres.
Fertilizers:
Those substances which can used to increase the fertility and quality of soil are called fertilizers. That substance provides nutrients to the plants. Fertilizers can be classified into organic fertilizer and chemical fertilizer.

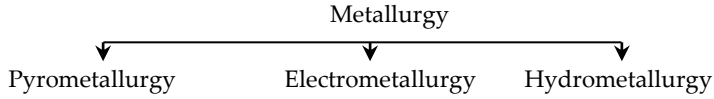
Chemical fertilizer: Chemical fertilizers are divided into three common types. ie. (i) Nitrogeneous fertilizers: ammonium sulphate $(NH_4)_2SO_4$, ammonium nitrate NH_4NO_3, urea $CO(NH_2)_2$, calcium Cyanamide $Ca(CN)_2$
(ii) Phosphorous fertilizers: ammonium phosphate $(NH_4)_3\ PO_4$, calcium super phosphate $Ca(H_2PO_4)_2$ and triple super phosphate $3Ca(H_2PO_4)_2.\ 2(CaSO_4)$.
(iii) Potassium fertilizers: potassium chloride KCl, potassium nitrate KNO_3, potassium sulphate K_2SO_4, potassium carbonate K_2CO_3.

Metals & Non-metals

Differences between metals and non-metals

Metals	Non-metals
Metals are generally solids at normal temperature. Exception mercury is liquid.	Non-metals are generally exists in all the three states of matters.
Metals are malleable and ductile.	Non-metals are usually brittle in nature.
They have high melting and boiling points	They have low melting and boiling points.
Metals have metallic lusture.	They are generally non-lustrous. For example, iodine and graphite are lustrous.
Metals conduct electricity.	Non metals are poor conductor of electricity. Exception graphite is a good conductor of electricity.
Metals generally form basic oxides.	Non-metals generally formed acidic oxides.

General principles of extraction of Metals



General Metallurgical process:

1. Preliminary treatment.
   Crushing and Grinding
   Concentration
   - Gravity separation
   - Froth flotation
   - Magnetic separation
   - Leaching

   Calcination and Roasting
2. Reduction
   - Smelting
   - Alumino thermit process
   - Metal displacement
3. Refining
   - Liquation
   - Distillation
   - Poling
   - Electrolytic refining

Minerals: The naturally occurring substance containing metals is called minerals.
Ores: The naturally occurring minerals from which metals can be extracted profitably and economically are called ores.
Gangue/Matrix: Unwanted earthy impurities present in the minerals/ores are called gangue/matrix.

Iron:

Symbol: Fe At. No: 26 Valency: 2 or 3 At. mass: 55.84 amu
Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
It is d block element, belongs to group VIII and period IV of periodic table.

Ores of iron

Haematite	Fe_2O_3	Red oxide
Magnetite	Fe_3O_4	Black Oxide
Siderite	$FeCO_3$	Iron carbonate
Limonite	$Fe_2O_3 3H_2O$	Brown Oxide
Iron Pyrite	Fe_2S_3	Iron tri-sulphide

Aluminium:

Symbol: Al At. No: 13 Valency: 3 At. mass: 27 amu
Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^1$
It is p-block element. It belongs to group III A and period III of the periodic table.

Ores of aluminium

Bauxite	$Al_2O_3.2H_2O$
Feldspar	$KAlSi_3O_8$
China clay	$Al_2O_3 2SiO_2.2H_2O$

Caryolite Na_3AlF_6

Copper:

Symbol: Cu At. No: 29 Valency: 1 or 2 At. wt. : 63.17 (64) amu

Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

It is d block element, belongs to group IB and period IV of periodic table. It is coinage metal.

Ores of copper

Cuprite Cu_2O

Copper pyrite $CuFeS_2$

Copper glance Cu_2S

Malachite green $Cu(OH)_2.\ CuCO_3$

Silver:

Symbol: Ag At. No: 47 Valency: 1 At. wt.: 107.88 amu

Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10}$

It is d block element; it belongs to the group IB of the periodic table. It is also a coinage metal.

Ores of Silver

Argentite or silver glance Ag_2S

Silver copper glance $(AgCu_2)_2S$

Horn silver $AgCl$

Pyrtile (Ruby silver) $3Ag_2S.Sb_2S_3$

Gold: Symbol Au At. No: 79 Valency: 1 or 3 At. wt.:197.2 amu

Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1 4f^{14} 5d^{10}$

It is d block element: belongs to group IB and period 6 of periodic table.

Non-Metals

Carbon dioxide

Molecular formula: CO_2 molecular wt.: 44 amu

Lab preparation:

$CaCO_3 + HCl \rightarrow CaCl_2 + H_2O + CO_2$

- dil H_2SO_4 is not used.
- CO_2 gas is collected in the gas jar by the upward displacement of air.
- It changes wet blue litmus paper into red.
- CO_2 gas change lime water into milky and on long passing milky color change into colorless.
- CO_2 reacts with burning magnesium to give magnesium oxide (white) and carbon (black)
- Solid CO_2 is called dry ice.
- It is used for the manufacture of urea.

Ammonia:

Moleculer formula: NH_3 moleculer wt.: 17 amu.

Lab Preparation:

$2NH_4Cl + Cu(OH)_2 \xrightarrow{\Delta} CaCl_2 + 2H_2O + 2NH_3$

- Ammonia is collected in a gas jar by the downward displacement of air.
- It is dried over lime (CaO) tower.
- It changes wet red litmus paper into blue.
- It forms fumes of NH_4Cl when passed through conc. HCl.
- It is manufactured by Haber's process.
- It is highly soluble in water.
- Sal ammonia is NH_4Cl

Classification of Elements

Mendeleev's periodic law: The physical and chemical properties of elements are the periodic functions of their atomic weights.

- Mendeleev's periodic table is based on the atomic weights of the elements.
- It is divided into horizontal seven rows called periods, as well as vertical eight columns called groups.
- Elements having identical properties are placed under same group.
- In this table Mendeleev's placed some gaps for those elements which can be discovered in the future.
- In the Mendeleev's periodic table there is no place for noble gases.

Modern periodic law: The physical and chemical properties of elements are the periodic functions of their atomic numbers.

Structural features of the long form periodic table.

Periods: Seven periods (seven horizontal rows). Short period is period 1 consists of 2 element; long period is period 6 consists of 32 elements.

Groups: Nine groups (18 vertical columns) group I to VII are subdivided into sub group A and B, Group VIII consists of three columns and group "o" consists of only one column.

Fourteen rare earth elements (At No: 58-71) are lanthanides, fourteen transuramium elements (At No 90-103) are actinides are placed at the bottom of the periodic table. The rare earth elements and transuramium elements are called inner-transitional elements.

The elements constituting sub-group A are called representative elements. as well as elements constituting sub-group B and group VIII are called transitional elements. Elements placed in group 'O' are called inert gases or noble gases.

S-block elements: In s-block elements, one or two elements are present in the s-orbital of outermost valence shell. S-block elements are present in group IA & II A.

p-block elements: In p-block elements p-orbitals are filled by electrons. P-block elements are present in group III A, IV A, VA VIA VII A and O group.

d-block elements: In d-block elements d-orbitals are filled by electrons. d-block elements are present in group IB, IIB, IIIB, IVB VB, VIB, VIIB & VIII.
f-block elements: In f-block elements f-orbitals are filled by electrons. f-block elements are present in lanthanides and actinides series.
Bohr's Classification
Noble gases: Noble gases are present in the group '0' of the periodic table. There are He, Ne, Ar, Kr, Xe and Rn.
Representative elements: Representative elements are present in s-block and p-block except noble gases. These elements have electronic configuration in which only one shell is incompletely filled.
Transitional elements: d-block elements represent transitional elements in the periodic table. The electronic configuration of outermost two shells are $(n-1)d^{0-10}$ ns^{1-2} where (n-1) is the penultimate shell.
Inner-transitional elements: f-block elements represent inner-transitional elements in the periodic table. The electronic configuration of inner-transitional elements in (n-2) f^{1-14}, (n-1) s^2, (n-1)p^6 (n-1)$d^{0-10}ns^2$
Important Points:

- Father of modern chemistry is **Lavoisier.**
- The term 'element' was proposed by **Robert Boyle.**
- The term 'atom' was proposed by **John Dalton.**
- The term 'molecule' was proposed by **Avogadro.**
- **Avogadro's number** (6.023×10^{23}) is the number of molecules present in 22.4 litres of a gas or vapour at STP.
- **Loschmidt number** is the number of molecules present in one cc of a gas or vapour at STP.
- The reciprocal of Avogadro number is called **Avogram.**
- **A mole** is the amount of any substance that contains one **Avogadro's number** (6.023×10^{23}) of particles.
- The balanced chemical equation is an expression of **law of conservation of mass.**
- The element mercury is also known as **quick silver.**
- The Latin name of **Mercury** is Hydrargyrum **(meaning liquid silver).**
- The subatomic particle **electron** was discovered by **J.J. Thomson**
- The subatomic particle **proton** was discovered by **Rutherford**. **Eugen Goldstein** (5 September 1850 – 25 December 1930) was a German physicist. He was an early investigator of discharge tubes, the discoverer of anode rays, and is sometimes credited with the discovery of the proton.
- The subatomic particle **neutron** was discovered by **James Chadwick**.
- The lightest metal is **Lithium.**
- The most abundant metal in earth crust is Al followed by Fe.
- The non metallic liquid element is **bromine.**
- The best conductor of heat and electricity is **Ag** followed by **Cu, Au, Al.**

- **Brass** is an alloy of **Cu + Zn.**
- **Bronze** is an alloy of **Cu + Sn.**
- **German silver** is an alloy of **Cu + Zn + Ni.**
- **Silver nitrate ($AgNO_3$)** is also named as **Lunar Caustic.**
- **Silver chloride (AgCl)** is also named as **Horn silver.**
- **Nitrous Oxide (N_2O)** is also named as **Laughing gas.**
- **Conc. Nitric acid (HNO_3)** is also known as **Aqua fortis.**
- **Copper pyrite ($CuFeS_2$)** is also known as **FOOL's gold**.
- The element **Pt** is also known as **white gold.**

MCQs

1. The difference between ammonia and ammonium is
   a. an electron b. a neutron c. a proton d. radioactivity
2. The most active non-metallic element is
   a. chlorine b. fluorine c. oxygen d. sulphur
3. The order of decreasing activity of the halogen is
   a. F, Cl, I, Br b. F, Cl, Br, I c. Cl, F, Br, I d. Cl, Br, I, F
4. Which of the following process is used to prepare ammonia commercially,
   a. ostwald process b. arc process c. contact process d. haber process
5. Which of the following is observed when ammonium chloride is heated with calcium hydroxide?
   a. no rxn b. odour of NH_3
   c. fruity smell of an ester d. fumes of nitric acid
6. Which of the following is formed when carbon dioxide gas is bubbled into line water?
   a. $CaCl_2$ b. H_2CO_3 c. $Ca(HCO_3)_2$ d. $CaCO_3$
7. Which of the following usually forms four covalent bonbs by sharing of electrons?
   a. C b. Na c. Mg d. N_2
8. Which of the following is functional group of alcohol?
   a. -CHO b. -OH c. – O - d. –COOH
9. The first member of alkyne series is
   a. ethene b. ethyne c. ethene d. ethanol
10. The number of electron of an atom having atomic number 17 is
    a. 17 b. 16 c. 19 d. 20
11. Which of the following substance act as a catalyst in the given chemical change?
    $PClO_3 + Q \rightarrow PCl + O_2(g) + Q$
    a. P b. Q c. $PClO_3$ d. PCl
12. The Correct formula of calcium hydrogen sulphate is
    a CaH_2SO_4 b. $CaHSO_4$ c. $Ca(HSO_4)_2$ d. Ca_2HSO_4
13. Ammonia gas can be collected in a gas jar by
    a. the downward displacement of air.
    b. the downward displacement of water.

c. the upward displacement of water.
d. the upward displacement of air.

14. Which of the following in used as a fire extinguisher?
a. NH_3 b. H_2 c. O_2 d. CO_2

15. Which of the following in organic compound?
a. NH_3 b. CO_2 c. Na_2CO_3 d. CCl_4

16. Which of the following general formula represent alcohol?
a. C_nH_{2n+2} b. C_nH_{2n-2} c. $C_nH_{2n+1}.OH$ d. C_nH_{2n}

17. Word "Eth" represent,
a. Prefix b. Word root c. Primary suffix d. Secondary suffix

18. –Ol is secondary suffix of
a. Alcohol b. Alkane c. Carboxylic acid d. Aldehyde

19. Which of the following is not ore of iron?
a. Haematite b. Limonite c. Bauxite d. Magnetite

20. Which of the following metallurgical process not describe the refining?
a. smelting b. leaching c. liquation d. both (a) and (b)

21. Following character represent the metals.
a. metals are malleable.
b. metals are good conductor.
c. metals generally forms basic oxides.
d. all of the above

22. The electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ represent
a. iron b. copper c. aluminium d. silver

23. Atoms constituting atomic number 58-71 represent.
a. d-block element
b. s- block element
c. p- block element
d. f- block element

24. "O" – group element represent
a. noble gases
b. representative elements.
c. transitional elements
d. inner-transitional elements.

25. The IUPAC name of the following organic compound is,
$CH_3 – CH(Cl) – CH_2 – CH_2 - OH$
1. 2-Chloro-butan - 4 – ol
2. 3-Chloro-butan-1 – ol
3. 1-hydroxy – 3 –chloro-butane
4. 4-hydroxy -2-chloro-butane

Answers & explanations:

1. **c** the ammonia molecule consist of an unshared pair of electron with formula NH_3. Due to the line pair of electron it attracts H^+ to form ammonium ion with formula NH_4^+.
2. **b** because, of its atomic structure and has the highest electronegativity value. It also requires only one electron to complete octet state.
3. **b** because of the smallest atomic radii of the element from top to bottom of the periodic table.
4. **d** because Haber process is used to prepare ammonia commercially.
5. **b** When ammonium chloride is hated with calcium hydroxide ammonia gas is formed. This is the process of laboratory preparation of ammonia gas.
6. **d** because of
   $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 \downarrow + H_2O$
7. **a** due to the carbon having four unpaired electrons in the outermost valence shell, so it fulfills octet by sharing four electrons with other atoms.
8. **b** because of the functional group of alcohol is –OH,
9. **b** because of the ethyne is the first member of alkyne, it consists of two carbon atoms with one triple bond.
10. **a** the atomic number indicate the total number of proton is an atom as well as in an atom no. of proton is equal to no. of electron so that the no. of electron present is an having atomic number 17 is 17.
11. **b** because Q is not change in the above reaction.
12. **c** The formula of calcium hydrogen sulphate.
13. **a** because ammonia is collected in a gas jar by the downward displacement of air. It cannot collect in a gas jar by the downward displacement of water because ammonia is highly soluble in water.
14. **d** because carbon dioxide in used as a fire extinguisher.
15. **d** because it is the tetrachloro derivatives of hydrocarbon methane. $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$
16. **c** because -OH represents the functional group alcohol so C_nH_{2n+1}.OH is general formula of alcohol.
17. **b** because Eth represent word root and indicates the two carbon atom present in a chain.
18. **a** the secondary suffix of alcohol can be represent by -ol.
19. **c** because bauxite is the ore of aluminium and it is represented by the formula $Al_2O_3.2H_2O$
20. **d** because smelting is reduction as well as leaching is the concentration steps of metallurgical process. Liquation is one of the melted of refining.
21. **d** because a, b and c are the general characters of metals.

22. **a** on the above configuration total no of electron are 26. The no. of electron and protons are equal is an neutral atom as well as proton indicate at no. of an atom so that atomic no. of iron is 26.
23. **d** because of atomic no. 58-71 are lanthanides and lanthanides are the f-block elements.
24. **a** noble gases are placed in a "O" group of the periodic table.
25. **b** According to the ICPAC system

MCQs for Practice

1. The smallest particle that takes part in a chemical change is
   a. atom b. molecule c. proton d. electron
2. A chemical substance which cannot be divided is
   a. compound b. element c. atom d. molecule
3. Which of the following is an element?
   a. quick silver b. quick lime c. marsh gas d. laughing gas
4. Which of the following contains only one element?
   a. marble b. graphite c. glass d. sand
5. Which of the following phrases would be incorrect to use?
   a. an atom of an element b. a molecule of an element
   c. a molecule of a compound d. an atom of a compound
6. Divide a piece of chalk into half. Divide it further and keep on dividing it many times. The smallest piece of chalk that can be obtained by this division is
   a. an atom b. a molecule c. a particle d. a crystal
7. Which of the following is not a diatomic molecule?
   a. oxygen b. nitrogen c. phosphorus d. iodine
8. Which of the following methods can be used to obtain pure water from a solution of salt in water?
   a. distillation b. filtration c. electrolysis d. centrifugation
9. Iron can be separated from non magnetic waste material by a technique called
   a. magnetic separation b. gravity separation
   c. fractional distillation d. extraction
10. Crude petroleum, gasoline, kerosene and diesel can be separated by a technique called
    a. distillation b. sublimation
    c. vacuum distillation d. fractional distillation
11. Camphor, sodium chloride and sand can be separated by
    a. Sublimation
    b. Dissolution followed by filtration and sublimation
    c. Filtration
    d. Sublimation followed by dissolution and filtration

12. The liquid metal is
    a. Na b. Cs c. Hg d. Ag
13. The liquid non metallic element is
    a. Cl b. Br c. I d. F
14. Chemical formula of a particular compound reflects
    a. shape of its molecule
    b. size of its molecule
    c. total number of atoms in a molecule
    d. number of different types of atoms in a molecule
15. Chemical reaction involves
    a. Protons b. Positrons c. Electrons d. Neutrons.
16. A balanced chemical equation represents
    a. reactants and products in the same physical state
    b. diatomic molecules on both sides
    c. equal number of molecules on both sides
    d. equal number of atoms on both sides
17. The composition of bronze is
    a. Cu + Zn b. Cu+ Zn+ Ni c. Cu + Sn d. Cu +Ni
18. The composition of german silver is
    a. Al + Zn b. Cu+ Zn+ Ni c. Cu + Al d. Cu +Ni
19. The non metallic electropositive radical is
    a. Na^+ b.NH_4^+ C. Cs^+ d. Sr^{++}
20. The formula of lunar caustic is
    a. $AgNO_3$ b. AgCl c. NaCl d. NaOH
21. Which one of the following metal is also known as white gold?
    a. Ag b. Hg c. Na d. Pt
22. The rate of reaction doesn't depends on
    a. concentration of reactant b. suitable catalyst
    c. temperature d. concentration of product
23. The factor which doesn't influence the rate of reaction is
    a. nature of reactant b. Concentration
    c. temperature d. molecularity
24. Higher the value of activation energy, -------- would be the reaction rate.
    a. fast b. slow c. instantaneous d. average
25. The rate of a chemical reaction
    a. increases as the reaction proceeds
    b. decreases as the reaction proceeds
    c. decreases at first and then increases
    d. remains constant as reaction proceeds
26. According to Arrhenius acid, acids are
    a. proton acceptors

b. compounds which give hydrogen ion
c. proton donor
d. compounds which give hydroxyl ion

27. Arrhenius theory of acid –base is not applicable in
    a. aqueous solution
    b. non aqueous solution
    c. polar solvent
    d. water
28. The solution which gives H_3O^+ ion in aqueous solution is
    a. acid b. base c. neutral d. amphoteric
29. According to Arrhenius theory, CO_2 cannot be considered as
    a. acid b. base c. gas d. amphoteric
30. HCl does not behave as acid in
    a. NH_3 b. H_2O c. C_6H_6 d. C_2H_5OH
31. According to Bronsted- Lowry concept, a base is a substance which acts as
    a. a proton donor b. an electron donor
    c. a proton acceptor d. an electron acceptor
32. Which is Bronsted- Lowry acid?
    a. Cl^- b.H_3O^+ c. OH^- d.SO_4^-
33. According to Bronsted- Lowry concept, the following are formed in the neutralization reaction.
    a. conjugate acid –base pair b. lone pairs
    c. electron pairs d. proton pairs
34. According to Bronsted- Lowry concept, water is
    a. an acid b. a base c. both acid and base d. an oxide
35. Which of the following does not act as Bronsted acid?
    a. NH_4^+ b. HSO_3^- c. HCO_3^- d. CH_3COO^-
36. According to Lewis concept, an acid is a substance which
    a. accepts proton b. donates proton
    c. accepts a lone pair of electron d. donates a lone pair of electron
37. BF_3 is an acid according to
    a. arrhenius b. lewis c. bronsted d. all of these
38. According to Lewis concept, which one of the following is not a base?
    a. OH^- b. H_2O c. Ag^+ d. NH_3
39. pH of a solution is defined as
    a. H^+ ion concentration b. –Log[H^+] ion concentration
    c. Log[H^+] ion concentration d. – Log 1/ H_3O^+ ion concentration
40. The pH of 10^{-3}M HCl is nearly equal to
    a. 1 b. 3 c. 2 d.10
41. The pH of a solution is 9.5. It is
    a. acidic b. basic c. neutral d. amphoteric

42. A solution of pH 3 as compared to a solution of pH 6 is
    a. more acidic b. more basic c. equally acidic d. equally basic
43. A solution of pH 9.0 is one thousand times as basic as a solution of pH
    a. 10 b. 7 c. 4 d.6
44. Phenolphthalein indicator shows pink colour in
    a. acidic solution b. alkaline solution
    c. neutral solution d. water
45. Methyl orange indicator shows red colour in
    a. acidic solution b. alkaline solution
    c. neutral solution d. water
46. Blue litmus paper turns into red in
    a. acidic solution b. alkaline solution
    c. neutral solution d. water
47. Red litmus paper turns into blue in
    a. acidic solution b. alkaline solution
    c. neutral solution d. water
48. No effect is seen on blue litmus paper when it is dipped into
    a. acidic solution b. alkaline solution
    c. neutral solution d. water

Answers of MCQs for Practice

1. a	17. c	33. a
2. b	18. b	34. c
3. a	19. b	35. d
4. b	20. a	36. c
5. d	21. d	37. b
6. b	22. d	38. c
7. c	23. d	39. b
8. a	24. b	40. b
9. a	25. b	41. b
10. d	26. b	42. a
11. d	27. b	43. d
12. c	28. a	44. b
13. b	29. a	45. a
14. d	30. c	46. a
15. c	31. c	47. b
16. d	32. b	48. b

Zoology

Characteristics of Living Organisms

Biology (Gr. *bios*: life; *logos*: study or knowledge) is a branch of natural science that deals with the study of life and living organisms. Life is something special and unique phenomenon which distinguishes the living organisms from non-living things or inanimate things. The following features of living organisms distinguish them from non-living matter:

1. **Cellular structure:** Living beings are made up of cells and their products. The cells of living beings contain protoplasm in them. Protoplasm is a distinctive material found only in living matter and possessed by all living matter.
2. **Metabolism:** The sum total of all the chemical changes inside the body is termed as metabolism. The metabolic activities may be constructive (anabolism) or destructive (catabolism).
3. **Growth:** Growth is a vital process of change in the size of a cell, organ or whole organism. Organisms grow from within by the intake of new materials from outside and their subsequent incorporation into the internal structure of the organism.
4. **Irritability:** All organisms have ability to respond the stimuli that they maximize their chances of survival. The animals respond to changes in light intensity, sound, touch, heat etc.
5. **Reproduction:** All living organisms are capable to produce members of their own kind which is essential for the continuity of generation.
6. **Homeostasis:** The inbuilt self-regulating system of living organisms to maintain a constant internal environment in spite of variations in the external environment is referred as homeostasis.
7. **Evolution:** Evolution is slow, continuous and irreversible process of change.

We can sum up all these by saying that a living organism is a self-reproducing system capable of growing and of maintaining its integrity by the expenditure of energy. Life is the sum total of all these things.

Animal Tissues

Tissue is a part of organism consisting of aggregate of cells having a similar structure and function which co-ordinate to perform a specific function. French anatomist Francois Xavier Bichat (1771- 1802) introduced the term tissue. Histology is the microscopic study of tissue. Mayer (1819) gave the name histology. Marcello Malpighi (1628-1694) is the founding father of histology.

The animal tissues are of four types based on the functions:

- **Epithelial tissue** (covers the internal and external surfaces of the body and lines body cavity)
- **Connective tissue** (binds and supports body parts)

- **Muscular (contractile) tissue** (serves for movement and locomotion)
- **Nervous tissue** (responds to stimuli and conducts nerve impulse).

Epithelial tissue: Covers the internal and external surfaces of the body of an organism, single or multilayered, cells held by carbohydrate based cementing substance and special junction, rest on a non-cellular basement membrane, no intercellular matrix, lack blood supply, may originate from any of the three primary germ layers, have the power of division and regeneration throughout life.

Depending upon the number of cell layers, epithelial tissues are of two types: Simple or Unstratified or Unilaminar epithelia & Compound or Multilaminar epithelia

Simple Epithelia: Cells arranged on a single layer, all rest on the basement membrane, cover the areas with less wear and tear, more effective as secretory or absorptive surface, not very effective as a protective lining.

Squamous or Pavement Epithelium: Occurs in the renal corpuscles of the kidney, the alveoli of lungs and the blood capillary wall (endothelium), lines the body cavities and covers visceral organs (mesothelium), descending limb of loop of Henle's and eyelids.

Cuboidal Epithelium: Lines salivary and pancreatic ducts and collecting ducts of kidney, also found in salivary, sweat and thyroid glands. **Ciliated cuboidal:** Occurs in some parts of the body of nephron, lines the central canal of spinal cord (ependyma). **Pigmented cuboidal:** Occurs in choroids and a part of retina of eye. **Germinal epithelium:** Lines seminiferous tubules of testes and ovaries. **Brush bordered cuboidal:** Occurs in the proximal convoluted tubules of nephron.

Columnar Epithelium: Lines the stomach, intestine and gall bladder, present in gastric and intestinal glands. **Ciliated columnar:** Occurs in oviducts, lines the bucco-pharyngeal cavity of frog. **Brush bordered columnar:** Occurs in intestinal mucosa. **Sensory columnar:** Occurs in nasal chambers and taste buds on tongue.

Pseudostratified Epithelium: Occurs in the lining of trachea, bronchi and bronchioles, part of nasal epithelium

Compound Epithelia: Made up of number of layers of cells and only lower layer rest on the basement membrane, found in the regions with rapid wear and tear.

Stratified Epithelium: Much thicker, relatively tough, resistant, protective, not very effective as a secretory or an absorptive layer.

Stratified Squamous Epithelium: Occurs in the areas or ducts that are delicate or have large flow of fluids. **Keratinized epithelium:** Occurs in external skin surface, lining of buccal cavity and vagina. Nails, hair, horns, claws and feathers are also derived from it.

Non-keratinized epithelium: Lines the cornea of eye, tongue, lower part of pharynx, oesophagus etc.

Stratified Cuboidal Epithelium: Lines conjunctiva of eye, female urethra and sweat, salivary and pancreatic ducts.

Stratified Columnar Epithelium: Lines the ducts of mammary glands, male urethra and epiglottis.

Stratified ciliated columnar Epithelium: Lines larynx and upper part of soft palate.

Transitional Epithelium: Occurs in ureter, urinary bladder and renal pelvis.

Muscular Tissue: Generally mesodermal in origin. 639 types of muscles are present in the body, forms about half of the body weight. Made up of highly specialized and elongated cells (muscle fibres or myoblasts), highly contractile in nature (due to myosin and actin protein filaments present in the cytoplasm). Sarcoplasm (muscle cytoplasm) contains numerous mitochondria (sarcosomes), a network of membranes (sarcoplasmic reticulum), numerous glycogen granules and large number of myofibrils. Highly specialized for movements and locomotion, have no power of division and regeneration, supplied with blood vessels and own nerve supply.

According to the structure, location and function, muscles may be of three types: 1. Striated or striped or skeletal or voluntary muscles, 2. Smooth or unstriated or visceral or involuntary muscles & 3. Cardiac muscles

Striated Muscles: Found in the limbs, tongue, abdominal wall, pharynx and upper part of oesophagus and attached to the skeleton in the head, trunk and limb region (so are called as skeletal muscles). Possesses distinct cross striations in the form of light (Isotropic- I-band) and dark (Anisotropic- A-band) bands. Muscle fibres arranged parallel to each other in bundles called fasciculi and are held together by connective tissue. Each muscle fibre (elongated, unbranched and cylindrical in shape) is bounded externally by special membrane called sarcolemma, multinucleate (syncytial), nuclei spindle shaped, peripheral in position and lie near the sarcolemma, richly vascular, supplied with CNS.

Each myofibril shows alternate I and A bands, light zone at the center of A- band (Hensen's disc or H-zone), dark membrane at the center of I-band (Krause membrane or Z-line). I-band has only actin filaments, A-band has both actin and myosin filaments, H-disc has only myosin filaments. Sarcomere (part of myofibril between two adjacent Z-lines): structural and functional unit of striated muscle fibre.

Smooth Muscles: Present in the walls of visceral organs like alimentary canal, blood vessels, urinary bladder, ureters, genital ducts, dermis of skin, iris and ciliary body of eye. Usually arranged in layers forming sheets in the wall of visceral organs. Each muscle fibre is spindle shaped with tapered ends, not covered externally by sarcolemma but by plasma membrane, uninucleate having single, oval centrally located nucleus. No dark and light bands (randomly arranged actin and myosin), less vascular, innervated with ANS.

Cardiac Muscles: Found in the wall of the heart, resemble structurally with striated muscles and functionally with unstriated muscles, show faint but regular cross striations. The fibres are uninucleate having nucleus deep at the center, branched, cylindrical, richly vascular and have numerous mitochondria and glycogen granules in the sarcoplasm, externally covered by sarcolemma. The cardiac muscle cells are connected to each other by special zig-zag junctions called intercalated discs (booster rings). Supplied both by CNS (vagus nerve) and ANS, undergo rhythmic contraction and can initiate their own waves of excitation.

Connective Tissue: Major supporting tissue of the body, composite material made up of variety of cells, several types of fibers (non-living products of cells) and a fluid or semi-fluid background material or matrix between the cells. Functions: binding different cells or tissues together, storing lipids or fat globules, insulation of the body against heat loss, providing hard surface for muscle attachment, formation of sheath around the body organs, defense against micro-organisms and toxic substances, providing supportive framework for the body and producing blood cells, transportation of materials from one part of the body to another etc.

Connective tissue is of the following three types on the basis of nature of matrix: 1. Connective tissue proper (having soft matrix), 2. Supportive connective tissue (dense mineralized matrix) & 3. Fluid connective tissue (fibre free, fluidy matrix)

Connective Tissue Proper: It is of following types:

i. **Areolar tissue:** Simplest and most widely distributed connective tissue, forms a continuous layer beneath the organs, fills up the spaces between many organs acts as packing between muscles, occurs in peritoneum and mesenteries and even surrounds blood vessels when they penetrate into the organs and body cavity.

ii. **Adipose tissue:** Found beneath the skin in the dermis region, the mesenteries, bone marrow and around the kidney, heart and eyeball. Camel's hump and thick tail of Merino sheep are formed of adipose tissue. Serves as insulating layer in mammals, as a fat reservoir and acts as cushions as in orbits or eye sockets.

iii. **Reticular tissue:** Found in spleen, thymus, tonsils, lymph nodes, liver, bone marrow, lamina propria of mucosa of stomach and intestine. The reticular cells act as phagocytes and form a part of defence system of the body.

iv. **White fibrous tissue:** Present at the joints between the skull bones, the perichondrium (in cartilage), periosteum (in bone) and sclerotic layer or white of an eye, connect skeletal muscles to the bones (Tendon).

v. **Ligament or Yellow fibrous tissue:** Connect bones to bones at the joints.

Supportive Connective Tissue or Skeletal Tissue

With dense and mineralized matrix, includes cartilages and bones, provide resistant materials for the attachment of the muscles and consequently have a considerable rigidity, important for movements of limbs and for the protection of vital organs like brain, heart, lungs etc.

Cartilage

Hard but flexible tissue consisting of few cells chondrocytes that lie within lacunae embedded in a matrix of protein chondrin. The sheath of white fibrous tissue called perichondrium encloses the cartilage. Depending upon the matrix, cartilage is of four types:

Hyaline cartilage (Gristle): Located at the ends of limb bones (called hyaline caps), and sternum, in the hyoid apparatus, nasal septum, larynx, trachea, sternal parts of ribs and bronchi in adults. It also forms the skeleton of the cartilaginous fishes and embryonic skeleton in bony vertebrates.

Elastic cartilage (Yellow fibrous cartilage): Found in external ear, at the tip of nose, wall of Eustachian tube and in epiglottis.

Fibro-cartilage (White fibrous cartilage): Toughest, strongest and less flexible. Located on discs between adjacent vertebrae (intervertebral discs), symphysis pubis (the region between the public bones of the pelvis) and ligamentous capsules surrounding joints.

Cacified cartilage: Occurs in suprascapula of pectoral girdle, in pelvis of old frogs and at the heads of humerus and femur.

Bone or Osseus tissue

Hardest tissue of the body, most abundant of all skeletal materials and provides support, protection and some metabolic functions. Osteocytes are embedded in solid, firm and calcified matrix formed of ossein protein. A thick, white fibrous tissue sheath, periosteum covers bone.

Types of Bone

1. **On the basis of texture**
   a. Spongy bone: Occur in the skull bones, centrum of vertebrae and epiphyses of long bones.
   b. Compact bone: Occur in the shaft of long bones.
2. **On the basis of osteogenesis or ossification (process of bone formation)**
   a. Cartilaginous (Endochondral or Replacing) bone: Formed by ossification of cartilages. E.g. Vertebrae, girdle bones, humerus, femur and fibula.
   b. Dermal (Intra-membranous) bone: Formed by ossification in the dermis of the skin. E.g. Skull bones, phalanges, clavicles.
   c. Sesamoid bone: Formed by ossification at the joints of the bones or on the tendon and ligament. E.g. Patella or kneecap.

Fluid connective tissue or Vascular tissue: Special type of connective tissue having fluidy and fibre free matrix. It circulates in the body and is responsible for the transportation of materials from one place to another within the body. It also has an important role in defence mechanism. The vascular tissues are of two types: Blood and Lymph.

Blood: Blood, chief circulating fluid of the body, viscous fluid (viscosity = 4.7), slightly heavier than water (sp. gr. 1.057 in males and 1.053 in females), slightly alkaline in nature (pH = 7.4). Blood forms about 6-10% of the body weight and about 30-35% of ECF. The volume of blood in adult person is about 5-6 litres. The blood is formed of 2 parts: plasma and blood corpuscles.

Plasma: 55% to 60% of the total blood, about 5% of the body weight, water alone forms 90-92% of the plasma, chloride and bicarbonate salts of sodium are the main inorganic constituents, 7-8% proteins, 2-3% salts, gases, glucose, amino acids, hormones, vitamins, excretory products.

Albumin (4.5-5% of plasma, maintains colloidal osmotic pressure of blood), globulin (2-3% of plasma, defensive function) and fibrinogen (helps in clotting) are the proteins in plasma.

Blood cells or Corpuscles: The blood cells are mainly of three kinds;
Red blood corpuscles or erythrocytes: small, anucleated, biconcave and circular discs in man, live for 120 days in man. 5 to 5.5 million per ml of blood in male and 4.5 to 5 million in female. Contain iron containing respiratory pigment, haemoglobin.
Leucocytes or WBC: Colourless, nucleated, produced in bone marrow and in lymph glands. Number varies from 5000 to 10000 per cubic mm of blood. Types: Granulocytes (Basophils, Eosinophils & Neutrophils) and Agranulocytes (Lymphocytes & Monocytes).
Thrombocytes (Spindle cells): Irregularly shaped bodies even smaller (2-3μ in diameter) than RBC, often without nucleus but cytoplasm contains distinct granules, about 250000 per cubic mm, life span about 7 days. Release certain chemicals called platelet factors, which initiate the mechanism of blood clotting.
Lymph: A clear fluid within the vessels of lymphatic system and derived from tissue fluid. It returns proteins from the fluids to the blood. It is similar in composition to blood plasma except it lacks RBCs, blood platelets, plasma proteins required for blood clotting other macromolecules found in the body.

Nervous Tissue: Ectodermal in origin, originated first in coelenterate in which nerve fibres are non-polar i.e. the impulse moves in any direction, forms the nervous system of the body, control and coordinates the body functions. Nervous system consists of millions of neurons (nerve cells). Neurology: study of nervous tissue.
Components of Nervous tissue
Nervous tissue is formed of four types of cells: Neurons (Nerve cells), Neuroglia, Ependymal cells and Neurosecretory cells.
Neurons: Nerve cell with all its branches, structural and functional unit of nervous system, longest cells of the body, permanently lost the power of division as have no centriole (so the number of neurons is the same) and have minimum power of regeneration. A neuron consists of two parts: Cell body or Cyton and Nerve processes.
Cell body or cyton or perikaryon or soma: Main body of nerve cell, variable in shape. The neuroplasm contains a nucleus, large number of mitochondria (provide energy for nerve impulse conduction), golgibodies, endoplasmic reticulum, some characteristic basophilic granules called Nissl's granules (excretory or nutritive) and numerous cytoplasmic strands called neurofibrillae (help in the passage of nerve impulse to and from the cell body).
Nerve Processes: One or more protoplasmic processes arising from the cell body. These are of two types: **Dendrites or Dendrons:** One or more small, branched processes, afferent in nature, have both Nissl's granules and neurofibrils, always non-myelinated.
Axon: Single long and cylindrical process, efferent in nature, longest nerve process of neuron. Terminal arborization with synaptic knob (button terminaux), which forms functional contact (synapse) with dendrites of another neuron. Two concentric sheaths

(inner thicker medullary or myelin sheath and outer thinner cellular sheath, the neurolemma) may surround the nerve fibre.

Types of nerve fibres

On the basis of functions

1. Sensory (Afferent) nerve: carry impulse from receptor cells to the CNS E.g. Olfactory nerve, Optic nerve etc.
2. Motor (Efferent) nerve: Carry impulse from CNS to the effector organs. E.g. Occulmotor nerve, Trochlear nerve etc.
3. Mixed nerve: Having both sensory and motor fibres. E.g. All spinal nerves

On the basis of structure

1. Medullated or Myelinated nerve fibres: Having myelin or medullary sheath. Found in the white matter of the brain and spinal cord; and cranial and spinal nerves.
2. Non-medullated or Non-myelinated nerve fibres: Without myelin or medullary sheath. Found in grey matter of brain and spinal cord, also form ANS.

MCQs

1. Characteristic of simple epithelium is that they
   a. are arranged indiscriminately b. make a definite layer
   c. continue to divide and help in organ function d. none of the above.
2. Basement membrane is made up of
   a. no cell product of epithelial cell b. epidermal cell only
   c. endodermal cell d. both b and c
3. Lymph differs from blood in possessing
   a. only WBC b. more RBC and WBC
   c. more RBC and few WBC d. more WBC and few RBC.
4. Mineral found in red pigment of vertebrate blood is
   a. magnesium b. iron c. calcium d. copper.
5. Histamine secreting cells are found in
   a. connective tissues b. lungs c. muscular tissue d. nervous tissue.
6. Characteristics of smooth muscle fibres are
   a. spindle-shaped, unbranched, nonstriated, uninucleate and involuntary
   b. spindle-shaped, unbranched, unstriped, multinucleate and involuntary
   c. cylindrical, unbranched, unstriped, multinucleate and involuntary
   d. cylindrical, unbranched, striated, multinucleate and voluntary.
7. Afferent nerve fibre carries impulses from
   a. effector to central nervous system
   b. receptor to central nervous system
   c. central nervous system to muscles
   d. central nervous system to receptors.

8. Which of the following is agranulocyte?
   a. basophil b. neutrophil c. lymphocyte d. eosinophil.
9. Protein present in cartilage is
   a. cartilagin b. ossein c. chondrin d. none of these.
10. Which of the following is not the main function of lymph glands?
   a. forming RBCs b. destroying bacteria
   c. forming WBCs d. forming antibodies.
11. Tendon is made up of
   a. yellow fibrous connective tissue b. modified white fibrous tissue
   c. areolar tissue d. adipose tissue.
12. Ligament is a/an
   a. inelastic white fibrous tissue b. modified white fibrous tissue
   c. modified yellow elastic fibrous tissue d. none of the above.
13. The joint between atlas and axis is called
   a. angular joint b. hinge joint c. pivot joint d. saddle joint.
14. What is sarcomere?
   a. part between two H-line b. part between two A-line
   c. part between two I-band d. part between two Z-line.
15. Collagen is
   a. fibrous protein b. globular protein c. lipid d. carbohydrate.
16. Four healthy people in their twenties got involved in injuries resulting in damage and death of few cells of the following. Which of the cells are least likely to be replaced by new cells?
   a. liver cells b. neurons
   c. malpighian layer of the skin d. osteocytes.

Protista (Unicellular Eukaryotes)

A link between prokaryotic kingdom Monera and complex eukaryotic multicellular kingdoms like Fungi, Plantae and Animalia. It includes unicellular, eukaryotic and microscopic organisms. The protists often bear cilia or flagella for locomotion and have various modes of nutrition like autotrophic and heterotrophic nutrition. Some are parasite in other animals and some live symbiotically in other animals. They fill all three niches in ecosystem and could be producers, consumers and decomposers. The kingdom Protista is broadly classified into three major groups:

1. Photosynthetic Protists (The protist algae: Dinoflagellates, Diatoms and Euglena like flagellates)
2. Slime Moulds (Consumer, decomposer protists: *Physarum*, *Dictyostelium*)
3. Protozoan Protists (detail discussion below)

Protozoa (Gr. *Protos*: first or primitive; *zoon*: animal)

Minute, usually microscopic acellular animalcules, without tissues and organs having one or more nuclei, simplest and most primitive of all animalcules, mark the beginning of animal life.

1. Free living (mostly aquatic; inhabit fresh or marine water or damp places) or parasitic or commensal.
2. Acellular or protoplasmic level of organization.
3. Locomotory organelles- pseudopodia or flagella or cilia or absent.
4. Nutrition- holozoic or saprophytic or parasitic. Digestion- intracellular occurs within the food vacuoles.
5. Respiration occurs through the general body surface.
6. Excretion occurs through general surface or through contractile vacuoles. Contractile vacuoles also serve for osmoregulation.
7. Reproduction occurs both asexually and sexually. Asexual: binary fission or multiple fission and budding and Sexual: conjugation of adults or fusion of gametes (syngamy).

E.g. *Amoeba, Entamoeba*. *Giardia, Trichomonas. Plasmodium* (The malarial parasite), *Monocystis. Paramecium* (The Slipper animalcule), *Vorticella, Ephelota, Podophrya.*

Kingdom: Animalia

Animal kingdom is a group of many celled organisms, which cannot manufacture their own food, and thus are adapted for securing and digesting food. About 1.2 million species of animals are recorded yet which account for almost three-quarters of living species. The animals could be mobile or sedentary. They may occur singly (solitary) or in-group with no obligatory interaction (gregarious) or in-group with obligatory interdependence (colonial). They show a great diversity in their heterotrophic mode of acquiring food like herbivorous, carnivorous or omnivorous. Some of the animals live on or within other organisms and obtain nourishment from them called parasites, some kill the others for food called predators, some feed on blood of other animals called sanguivorous while some feed upon faeces called coprophagous.

Porifera (Gr. *Poros*: pores; *ferre*: bearing)

Strange, apparently lifeless and plant like creatures bearing large number of pores in the body commonly called sponges. They mark the beginning of cellular (multicellular) animals and are therefore, the lowest among them.

1. Sponges are aquatic animals; all are marine except one freshwater family (family: Spongillidae).
2. Sessile or sedentary and solitary or colonial. Larvae: freeswimming.
3. Cellular level of organization, cell aggregate body plan, diploblastic, asymmetrical or radially symmetrical

4. Surface of the body is perforated by numerous minute inhalent apetures, the ostia (for the entry of water current) and one or few larger exhalent aperture, the oscula (for the exit of water current).
5. They have a peculiar canal system with central cavity called paragastral cavity or spongocoel. Canal system may be ascon (e.g. *Leucosolenia*), sycon (e.g. *Scypha*) or leucon (e.g. *Euspongia*) type.
6. Endoskeleton: calcareous spicules (made up of calcium carbonate) or siliceous spicules (made up of silica) or of spongin fibers (irregular proteinous fibers)
7. Nutrition: holozoic, digestion: intracellular
8. No organelles for respiration and excretion, which occur through the general body surface by diffusion. Nervous and sensory cells altogether absent.
9. Bisexual or hermaphrodite. Reproduction: asexually by buds and gemmules and sexually by typical ova and sperms.

E.g. The calcareous sponges: *Leucosolenia, Sycon.* The glass sponges: Venous's flower basket (*Euplectella),* Glass rope sponge *(Hyalonema).* Fresh water sponge (*Spongilla),* Bath sponge (*Euspongia*).

Coelenterata or Cnidaria (Gr. *Koilos*: hollow; *enteron*: cavity)

First multicellular animals to possess the tissues, the lowest metazoa.

1. Aquatic, mostly marine except few fresh-water forms e.g. *Hydra.*
2. Tissue grade of organization, blind sac body plan, diploblastic and radially symmetrical.
3. Coelenteron or gastrovascular cavity: a central cavity that helps in digestion and circulation of food, has single opening - mouth both for ingestion and egestion.
4. Sedentary or free swimming and solitary or colonial.
5. Tentacles serve for food capture, its ingestion and for defence. Nematoblasts or stinging cells which serve for paralyzing the prey, for holding the prey, or for adhesion.
6. Some show polymorphism (Gr. *Poly*: many; *morphe*: form). Two basic forms are the polyp and the medusa. Polyp is sessile, solitary or colonial and asexual zooid while medusa is free swimming, solitary and sexual zooid.
7. Nutrition: holozoic, digestion: partly is intracellular and partly intercellular.
8. No special organelles for respiration and excretion which occur through general body surface.
9. Nervous system: diffused type.
10. Unisexual or bisexual. Reproduction: asexual by budding and sexual by sperms and ova.

E.g. *Hydra,* Sea fur (*Obelia)*, Portuguese-man of war (*Physalia*), Jelly fishes; *Aurelia, Rhizostoma.* Sea anemone (*Metridium*), Mushroom coral (*Fungia*), Star coral (*Astraea*), Sea fan (*Gorgonia*).

Platyhelminthes (Gr. *Platys*: broad or flat; *helmins*: worms)

The first animals to acquire several distinctive features such as triploblastic condition, bilateral symmetry, organ system level of organization and cephalization, which are common to all the higher animals.

1. Free-living (terrestrial, fresh-water or marine) or parasites (ecto or endoparasites) or commensals (ecto or endocommensals).
2. Soft and generally worm like body, moderately elongated flattened to long flat ribbons or leaf like.
3. Organ system level of organization, blind sac body plan, triplobalstic, acoelomate, bilaterally symmetrical, dorsoventrally flattened and unsegmented or non-metamerically segmented.
4. Parasitic forms with external hooks, suckers, or both for attachment to the host.
5. The alimentary canal, if present, is incomplete consisting mouth, pharynx and blind intestine but no anus.
6. Respiratory and circulatory system: absent. Excretion: single or paired protonephridia with flame cells or bulbs. Nervous system: primitive and ladder like.
7. Sexes are united (hermaphrodite) with very few exceptions.

E.g. *Planaria, Convoluta*, Liver fluke (*Fasciola hepatica*), Blood fluke (S*chistosoma mansoni*), Pork tapeworm (*Taenia solium*), Dog tapeworm (*Echinococcus granulosus).*

Aschelminthes or Nemathelminthes

(Gr. *Askos*: cavity; *helmins*: worms. *Nema*: thread, *helmins*: worms)

A diverse assemblage of freely swimming and parasitic pseudocoelomates.

1. Mostly aquatic, freshwater or marine, some terrestrial, free living as well as parasitic.
2. These are commonly called roundworms or threadworms or cavityworms because the body is long, cylindrical, unsegmented and thread-like with no lateral appendages.
3. Organ-system level of organization, tube within the tube body plan, triploblastic, bilaterally symmetrical and pseudocoelomate.
4. First animals to have a straight and complete alimentary canal.
5. Respiratory and circulatory systems: absent. Excretion: excretory canals or protonephridia. Nervous system: simple.
6. Unisexual and always show sexual dimorphism. Males are usually smaller than the females.

E.g. Round worm (*Ascaris lumbricoides*), Filarial worm (*Wuchereria bancrofti*), Hook worm (*Ancylostoma duodenale*).

Annelida

(L. *annelus*: little ring; Gr. *eidos*: form)

Elongate, vermiform animals whose bodies are divided into similar rings or segments.

1. Mostly aquatic, marine as well as freshwater, some terrestrial, generally burrowing or living in tubes and some parasitic.
2. Organ-system level of organization, tube within the tube body plan, bilaterally symmetrical, triploblastic, metamerically segmented and coelomate.
3. Locomotory organs: setae (or chaetae) or parapodia or suckers.
4. Alimentary canal: complete. Digestion: extracellular. Respiration: either through the general body surface (cutaneous respiration) or through gills (brachial respiration). Blood vascular system: well developed and closed type Blood is red in colour due to the presence of haemoglobin or erythrocruorin in plasma.
5. Excretion: through nephridia. Nervous system consists of circum-pharyngeal nerve ring and a solid, ventral and ganglionated nerve cord.
6. Unisexual or bisexual.

E.g. Sand worm (*Nereis*), Sea mouse (*Aphrodite*), Earthworms; *Pheretima, Lumbricus.* Leech (*Hirudo*), Cattle leech (*Hirudinaria*).

Arthropoda (Gr. *arthros*: jointed, *podos*; foot)

Largest and most successful phylum in terms of number of species, distribution and adaptations. Only invertebrate phylum to have forms capable of flight.

1. Arthropods occur on land, in the soil, in the fresh water, in the seawater and on or in the bodies of animals as well as plants.
2. Triploblastic, bilaterally symmetrical, metamerically segmented, haemocoelomate, organ-system level of organization and tube within the tube body plan.
3. Body is divided into head, thorax and abdomen. In some cases head and thorax are fused with each other to form cephalothorax. Body segments usually bear paired lateral and jointed appendages.
4. Body is covered with a thick chitinous cuticle forming an exoskeleton.
5. Digestive tract: complete. Respiration: through general body surface or by special structures, like gills in aquatic forms and trachea and book lungs in terrestrial forms.
6. Circulatory system: open type. Blood: colourless without haemoglobin. Excretion: by coelomoducts or malpighian tubules or antennary glands or green or coxal glands.
7. Nervous system: annelidan type. Compound eyes with mosaic vision.
8. Unisexual often with distinct sexual dimorphism.

E.g. Prawn (*Palaemon*), Crab (*Cancer*), Centipede (*Scolopendra*), Millipede (*Julus*). Cockroach (*Periplaneta*), Housefly (*Musca*), Mosquitoes (*Anopheles, Culex*), Spider (*Aranea*), Scorpion (*Palamnaeus*), Walking worm (*Peripatus*).

Mollusca (L. *mollis* or *molluscs*: soft)

Second largest group of the animal kingdom which includes soft bodied animals.

1. Essentially aquatic animals, mostly marine, a few freshwater and some terrestrial.
2. Triploblastic and fundamentally bilaterally symmetrical, although some gastropods and cephalopods become secondarily asymmetrical.
3. Organ-system level of organization and tube within the tube body plan and haemocoelomate.
4. Body is soft, unsegmented without jointed appendages and made of four parts: head, visceral mass, foot and mantle.
5. Hard calcareous shell forms a protective covering of the body. Shell may be bivalved or univalved, spiral or cone like, internal or reduced or even absent in some.
6. Alimentary canal: simple and straight, often U-shaped or coiled. Respiration: by gills or ctenidia or body-surface, mantle or lung. Circulatory system: open and mostly lacunar.
7. Nervous system consists of paired cerebral, pleural, pedal and visceral ganglia, joined by connectives and commissures.
8. Unisexual or hermaphrodite.

E.g. *Chiton,* Apple snail (*Pila*), Garden snail (*Helix*), Gray slug (*Limax*). Fresh water mussel (*Unio*), sea mussel (*Mytilus*). Devil fish (*Octopus*), Cuttle fish (*Sepia*), Squid (*Loligo*).

Echinodermata (Gr. *Echinos*: spines; *derma*: skin)

Echinoderms or "spiny skinned" animals are a unique group of radially symmetrical, headless, brainless, slow moving, marine animals.

1. Exclusively marine, the most common and widely distributed marine animals.
2. Organ system level of organization, tube within the tube body plan, triploblastic and coelomate.
3. Without segmentation, head, cephalization and brain.
4. Adults: radially symmetrical, larvae: bilaterally symmetrical.
5. Only invertebrates having both exoskeleton and endoskeleton.
6. Water-vascular system. Organs of locomotion: tube feet or podia.
7. Alimentary canal: simple or coiled tube. Respiration: through papulae or skin gills, peristomial gills, genital bursae and cloacal respiratory tree. Circulatory system: reduced and lacunar. Heart absent. Blood has no pigment.
8. Nervous system: primitive, lacks a brain and includes a circum-oral nerve ring and radial nerves.

9. Always unisexual with no sexual dimorphism.

E.g. Sea star (*Asterias*), *Astropecten. Ophioderma, Ophiura.* Sea urchin (*Echinus*), *Clypeaster*, *Holothuria.* Sea cucumber (*Cucumaria*). Sea lily (*Antedon*), Feather star (*Neometra*).

Phylum: Chordata (Gr. *chorde*: a string or cord; *ata*: bearing)

Bilaterally symmetrical, metamerically segmented, triploblastic, coelomate animals, having a supporting skeletal rod i.e. notochord at some stage of their life history, a hollow dorsal nerve cord and paired pharyngeal gill slits which may persist, change or disappear in their adults. The following three diagnostic features are present in chordates:

a) Presence of notochord: An elastic solid, skeletal rod lying below the nerve cord and above the alimentary canal replaced by vertebral column in vertebrates.
b) Dorsal tubular nerve cord: Dorsal hollow fluid filled structure formed by infolding of mid dorsal strip of ectoderm that lies above the notochord and outside the coelom.
c) Pharyngeal gill slits: Paired openings leading from the pharynx to the exterior.

Besides these three features, presence of ventral heart, hepatic portal system, red blood corpuscles, post anal tail, triploblastic condition, bilateral symmetry, metamerism, closed circulatory system, coelom and cephalization are other important characters found in the chordates.

Phylum Chordata is divided into four sub-phyla: Hemichordata, Urochordata, Cephalochordata and vertebrata. The first three sub-phyla are considered primitive and often referred as protochordates or invertebrate chordates. All of them are marine and possess notochord but not the vertebral column. Subphylum Vertebrata or Craniata includes the chordates with vertebral column.

Vertebrata or Craniata

The vertebrates include chordates with vertebral column. On the basis of presence or absence of jaw, the vertebrata is sub-divided into two divisions: Agnatha (Lack jaws and paired appendages) and Gnathostomata (Possess jaws and paired apeendages). Agnatha is represented by only one living class Cyclostomata. All other vertebrates are included under Gnathostomata which is further divided into six classes: Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia.

Class: Cyclostomata (Gr. *Cyclos*: circular; *stoma*: mouth)

Soft, smooth skin without exoskeleton. Suctorial and circular mouth devoid of functional jaws. Single and median nostril. Absence of paired fins and lateral appendages. 6-14 pairs of gill slits present in their gill pouch. Cartilaginous skeleton. Persistent notochord. Two chambered heart, many aortic arches. E.g. Lamprey (*Petromyzon*), Hag fish (*Myxine*)

Class: Chondrichthyes (Gr. *chondros*: cartilage; *ichthyes*: fish)

Marine predaceous fishes. Cartilaginous endoskeleton. Streamlined body bearing paired fins and true jaws. Skin is covered with placoid scales. Mouth present on the ventral side. Five pairs of gill slits without any gill covering or operculum. Absence of

swim bladder or air bladder. Internal fertilization. E.g. Electric ray (*Torpedo*), Sting ray (*Trygon*), Dog fish (*Scoliodon*), Hammer headed shark (*Sphyrna*), Saw fish (*Pristis*)

Class: Osteichthyes (Gr. *osteon*: bone; *ichthyes*: fish)

Marine or brakish or fresh water fishes. Endoskeleton mostly bony. Streamlined or spindle shaped body with paired lateral and median fins. Four pairs of gills covered by operculum. Skin covered by dermal scales of cycloid, ctenoid or ganoid types. Many with air bladder or swim bladder. Two chambered heart with single circulation. Poikilothermal. Ten pairs of cranial nerves. Well developed lateral line system. External fertilization. Mostly oviparous. Direct development. E.g. Rohu (*Labeo rohita*), Katla (*Catla*), Sea horse (*Hippocampus*), Flying fish (*Exocoetus*), Mrigal (*Cirrhina*), Kalbasu (*Hilsa*), Climbing perch (*Anabas*), Sucker fish (*Remora*)

Class: Amphibia (Gr. *amphi*: dual or both; *bios*: life)

Aquatic, semiaquatic and terrestrial mode of life, never marine. Poikilothermal. Head and trunk distinct. Skin smooth or rough, rich in glands which keep it moist and is naked. Limbs tetrapodus pentadactyle type. Respiration by skin, lungs or buccal lining; gills present during larval stage. Heart 3-chambered. Cranial nerves 10 pairs. Fertilization external. Development indirect with tadpole larva that undergoes metamorphosis to become adult. E.g. Limbless amphibians (*Ichthyophis)*, Salamander (*Ambystoma*), Midwife toad (*Alytes*), Toad (*Bufo*), Tree frog (*Hyla*), Frog (*Rana*), Flying frog (*Rhacophorus*)

Class: Reptilia (L. *reptiles*: creeping)

First true land vertebrates; usually terrestrial, few aquatic. Poikilothermal. Body covered with horny scales or scutes of exoskeleton. Endoskeleton completely ossified. Respiration by lungs only. Heart 3-chambered with two auricles and partially divided ventricle except in crocodiles, alligators where it is four chambered. RBCs nucleated. Cranial nerves 12 pairs. Fertilization internal. E.g. Tortoise (*Testudo*), Turtle (*Chelone*), Cobra (*Naja*), Krait (*Bungarus*), Viper (*Crotalus*), Sea snake (*Hydrophis*), *Python*, water snake (*Natrix*), Tree lizard (*Chameleon*), Wall lizard (*Hemidactylus*), Garden lizard (*Calotes*), Flying lizard (*Draco*), Horned toad (*Phrynosoma*), Monitor (*Varanus*), Tuatara lizard (*Sphenodon*), Crocodiles, Alligators.

Class: Aves (L. *avis*: bird)

Stream lined body covered with feathers to help to reduce the resistance. Homoiothermal. Forelimbs modified into wings. Hind limbs adapted for walking, perching or swimming. The bones forming the skeleton are spongy, light in weight containing air cavities. Modern birds without teeth, jaw bones modified into beak. Lungs for respiration which are spongy and non-distensible but with extensive air sacs. Heart 4-chambered with two auricles and two ventricles. Cranial nerves 12 pairs. Fertilization internal. E.g. Pea fowl (*Pavo*), Pigeon (*Columba*), Owl (*Bubo*), Vulture (*Gypus*), Koel (*Eudynamys*), House sparrow (*Passer*), Crow (*Corvus*), fowl (*Gallus*), Ostrich (*Struthio*), Kiwi (*Apteryx*), Emu (*Rhea*)

Class: Mammalia (L. *mamma*: breast)

Tetrapod vertebrates with mammary glands. Homoiothermal. Sudoriporous (sweat) glands and sebaceous (oil) glands are present in the skin. External ear or pinna present in most mammals. Body provided with exoskeleton like hair, nail, hoof etc. Presence of seven cervical vertebrae. Presence of muscular diaphragm between thoracic and abdominal cavity. Well developed lungs for respiration. Heart 4-chambered with two auricles and two ventricles. RBCs anucleated except in camel. Cranial nerves 12 pairs. Fertilization internal, viviparous. E.g. Spiny ant eater (*Echidna*), Duck billed platypus (*Ornithorhynchus*), Kangaroo (*Macropus*), Lion (*Panthera leo*), Tiger (*Panthera tigris*), whales, dolphins, monkeys, horse, apes, man etc.

MCQs

1. Silk thread is obtained from silk moth during
   a. pupal stage b. larval stage c. nymph stage d. adult stage
2. Which is not a true amphibian animal?
   a. salamander b. toad c. tortoise d. frog.
3. Phenomenon of organisms resembling others for escaping from enemies is
   a. adaptation b. mimicry c. homology d. analogy.
4. Fish which can be used in biological control of mosquitoes/ Larvicidal fish is
   a. Eel b. carp c. cat fish d. *Gambusia*.
5. A chordate character is
   a. gills b. spiracles
   c. post-anal tail d. chitinous exoskeleton.
6. Blood of *Pheretima* is
   a. blue with haemocyanin in corpuscles b. blue with haemocyanin in plasma
   c. red with haemoglobin in corpuscles d. red with haemoglobin in plasma.
7. Malpighian tubules are
   a. excretory organs of insects b. excretory organs of annelids
   c. respiratory organs of insects d. respiratory organs of annelids.
8. An insect regarded as greatest mechanical carrier of diseases is
   a. *Pediculus* b. *Cimex* c. *Musca* d. *Xenopsylla*
9. Which one occurs in echinodermata?
   a. bilateral symmetry b. radial symmetry c. porous body d. soft skin.
10. Adult *Culex* and *Anopheles* can be distinguished with the help of
    a. mouth parts/colour b. sitting posture c. antennae/wings d. feeding habits.
11. What is common in whale, bat and rat?
    a. absence of neck
    b. muscular diaphragm between thorax and abdomen
    c. extra-abdominal testes to avoid high temperature of body
    d. presence of external ears.
12. In man and mammals, air passes from outside into the lungs through
    a. nasal cavity, larynx, pharynx, trachea, bronchi, alveoli

b. nasal cavity, larynx, pharynx, trachea, bronchioles, alveoli
c. nasal cavity, pharynx, larynx, trachea, bronchioles, bronchi, alveoli
d. nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli.

13. The nephridia in earthworm are analogous to
    a. nematoblasts of *Hydra* b. flame cells of *Planaria*
    c. gills of Prawn d. trachea of insects.
14. Pneumatic bone is found in
    a. shark b. *Rana* c.pigeon d. whale.
15. Temperature changes, in the environment, affect most of the animals which are
    a. poikilothermic b. homioiothermic c.aquatic d. desert living.
16. The animals with bilateral symmetry in young stage, and radial pentamerous symmetry in the adult stage, belong to the phylum
    a. annelid b. mollusca c. cnidaria d. echinodermata.

Origin & Evolution of Life

The origin of life in the universe is one of the most complicated problems for the biologists. The problem of creation resolves itself into two aspects: the origin of the forms of life and origin of life itself. Different biologists have proposed different theories concerning the origin of life. The major theories accounting for the origin of life are:

1. Life was created by a supernatural power at a particular time (Special Creation Theory)
2. Life arose from non-living matter on numerous occasions by a process of spontaneous generation. (Theory of Spontaneous Generation or Abiogenesis)
3. Life has no origin (Theory of Eternity of Present Condition or Steady State Theory)
4. Life arrived on this planet from elsewhere (Cosmozoan Theory or Theory of Panspermia)
5. Life arose according to chemical and physical laws (Biochemical Evolution)

Evolution (L. *e*: from; *volvere*: to roll) means act of unrolling or unfolding i.e. doctrine according to which complex forms of life gradually arisen from the simpler form. The change taking place in inorganic objects is called **inorganic evolution**. **Organic or biological evolution** includes the changes taking place in the properties of population of animals and plants over course of generations. English naturalist, **Charles Darwin** (1809-1882) coined term organic evolution and defined it as *"descent with modifications"*.

Evidence of Evolution

The entire organisms that exist today is the result of evolutionary process occurred for millions of years according to the doctrine of organic evolution which is supported by the evidences from different disciplines of biology like morphology and anatomy, taxonomy, embryology, paleontology, physiology and biochemistry, biogeographical distribution, cytology, genetics etc.

Homologous organs: Have common origin and are constructed on the same fundamental pattern, may differ in appearance and function due to the specific adaptations of the organism to their environment. E.g. limbs of different vertebrates (paddles of the whale, wings of bat, hands of man, feet of horse, and wings of birds)

Analogous Organs: Functionally similar structures. These organs resemble in external appearance but may have different origin and basic structure. E.g. Fins of the fishes and paddles of aquatic mammals like whales and dolphins.

Vestigial Organs: Normally nonfunctional structures with no any apparent function though present in the organisms. E.g. vermiform appendix, nictitating membrane, reduced caudal vertebrae, muscles of ear pinna, wisdom teeth.

Connecting Links: Organisms living or extinct which possess characters intermediate between two major groups of animals are called "missing links" or "connecting links". E.g. *Peripatus* (walking worm) is connecting link between Annelida and Arthropoda, *Archaeopteryx* (Fossil bird) connects Reptiles and Birds, *Ornithorhynchus* (Duck billed Platypus) and *Echidna* (Spiny ant eater) are connecting links between Reptiles and Mammals.

Comparative Embryology: Similarities in the basic steps of development (zygote, cleavage, morula, blastula, gastrula, organogenesis) in different groups of organisms indicate the interrelationship between them. Similarities in embryological source of organ systems also indicate common ancestry. **Von Baer** revealed striking structural similarities between vertebrate embryos especially during early stages of embryonic development (**recapitulation)**. **Ernst Haeckel** suggested that these similarities had an evolutionary significance and proposed Biogenetic Law (Ontogeny recapitulates Phylogeny).

Paleontological evidence: Paleontology is the study of fossils. Fossils (L. *fossilis or fodere*: to dig) are the remains or impressions of ancient organisms preserved in sedimentary rocks or in other media. The fossils may be entire organisms, hard skeletal structures like bones or teeth, impressions, moulds and casts, petrified fossils, imprints, gastroliths and coprolites. These fossils are found at various places in different geological periods; provide evidence for the support of evolution of different groups of animals and plants.

Rocks: The material forming the earth's crust is called rock by the aggregation of minerals. According to their origin, the rocks are of three types: Igneous or volcanic rocks (formed by solidification of molten material below the earth's surface), sedimentary or stratified rocks (formed by slow deposition of sand, clay, mud, lime formed by weathering of rocks as a result of action of heat, cold, wind and rains etc in water. The fossils are found only in these rocks) and metamorphic rocks (formed by the modification in the other types of rocks due to heat and pressure).

Importance of Fossil Records: The fossil records are preserved in successive layers that indicate the sequence in which the animals and plants were evolved. Fossil records help us to study the forms, structures and habits of extinct organisms. The presence of

intermediate forms in fossil records indicates the connecting link between two groups of organism. E.g. *Archaeopteryx* shows the characteristics of both reptiles and birds. Fossil records help us to reconstruct phylogeny i.e. evolutionary history of the organism. The phylogeny of horse is the best example.

Geological Time Scale

Geological time scale is the tabulated form showing the sequence and duration of the eras and the periods with their dominant form of life since the beginning of life on the Earth. Geological time scale is called calendar of earth's history. (Figure P 188 - 189)

Biogeography: The study of patterns of distribution of animals and plants in the different parts of the Earth is called Biogeography. The distribution of organism is governed by many factors as environment, temperature, availability of required type and amount of food, salinity, enemies, topography and barriers. **Wallace** (1823-1913) has suggested that the distribution of life on the Earth gives a clear understanding of the concept of organic evolution.

Theories of Evolution

Some of the important theories of evolution include Lamarckism, NeoLamarckism, Darwinism & NeoDarwinism.

Lamarckism (Theory of Inheritance of Acquired Characters)

Jean Baptiste De Lamarck (1744-1829), renowned French naturalist, published his views in Philosophie Zoologique in 1809. His theory states that "modifications that the organism acquire in adaptation to the environments which it meets during its lifetime are automatically handed down to its descendents, and so become part of heredity". His evolutionary ideas can be summarized as follows:

1. Tendency to increase in size: Internal forces of life tend to increase the size of the organism and its component parts.
2. Environmental effect: The environment causes change in their habits which brings changes in their structure.
3. Use and disuse of organs: The efficiency, structure and development of an organ or system are directly proportional to its use.
4. Inheritance of acquired characters: The characteristics gained during lifetime of an individual are acquired characters which are inherited to the offspring and become a part of heredity.

Examples in Support of Lamarckism: Elongation of neck and fore limbs of Giraffe, webbed feet and long legs in duck and other aquatic birds, reduced eyes in cave-dwellers etc.

Geological time scale (To be read from below upwards)

Continued in next page…..

Era	**Period** Age in million years	**Epoch** Age in million years	**Some Important Fauna** (Animals) and **Flora** (Plants)
Cenozoic (*cenos*, recent)	Quarternary	Recent (Holocene) 0.01	Modern man dominant, Modern mammals, birds, fishes, insects. Rise of herbaceous plants, decline of woody plants.
		Pleistocene 2	Ice ages, humans appear evolution of human society and culture.
	Tertiary	Pliocene (Age of mammals) 7	Ape-like ancestors of humans appear adaptive radiation of flowering plants.
		Miocene 26	Continued radiation of mammals and angiosperm.
		Oligocene 38	Origin of most modern mammalian order including apes.
		Eocene 54	Angiosperm dominance increase, further increase in mammalian diversity, origin of horse.
		Palaeocene 65	Major radiation of mammals, birds and pollinating insect Primitive primates appear.
Mesozoic (*mesos*, middle)	Cretaceous 135		Extinction of dinosaurs and toothed birds. Angiosperms (flowering plants) appear.
	Jurassic 195 (Age of Reptiles)		Dinosaurs dominant, origin of toothed birds (first birds).
	Triassic 225		Origin of dinosaurs and mammals.

… continued from previous page

Palaeozoic (*palaeos*, ancient)	Permian 280	Extinction of trilobites. Origin of mammal-like reptile and most modern orders of insects.
	Carboniferous 350 (Age of amphibians)	Origin of reptiles, amphibians dominant, extensive forest of vascular plants, first seed plants
	Devonian 400 (Age of fishes)	Origin of amphibians, diversification of bony fishes, origin of gymnosperm
	Silurian 440	Origin of jawed fishes, colonization of land by plants and arthropods, origin of vascular plants.
	Ordovician 500 (Age of invertebrates)	Origin of first vertebrates (jawless fishes), Invertebrates and marine algae abundant.
	Cambrian 544	Origin of most invertebrate phyla, origin of trilobites.
Precambrian	570 700 1500 2500 3500 4600	Diverse algae. Origin of first animals Oldest eukaryotic fossils. Oxygen begins accumulating in atmosphere. Oldest definite fossils known (prokaryotes). Approximate origin of earth.

Some authors divide Precambrian into three eras, namely **Proterozoic**, **Archaeozoic** and **Azoic**.

Darwinism (Theory of Natural Selection)

English naturalists, Charles Robert Darwin (1809-1882), & Alfred Russel Wallace (1832-1912), published a joint paper entitled "The theory of natural selection" in the proceeding of Linnean society in 1858. In 1859, Darwin published his findings in a book "*On the origin of species by means of natural selection*" or "*The Preservation of Favoured Races in the Struggle for Life*" on which he had been working for over 20 years. Darwin's theory of evolution by natural selection can be summarized as follows:

1. **Over-production:** Organisms are very fertile; they show an extensive rate of multiplication. All living organisms have a natural tendency to over reproduce, so that there are more offspring than what can possibly survive. But it is observed fact that the number of the organisms is maintained at relatively constant level. The number never approaches the size calculated from reproductive rate. The difference between the calculated rate and the observed number must be due to the severe struggle for existence.
2. **Struggle for existence:** The struggle for existence is the competition between individuals of both the same and different species for food and space. The struggle may be classified as: **Intra-specific struggle:** Struggle within the species. In most cases it is most severe because their needs are precisely the same. **Inter-specific struggle:** Competition between the different species. **Struggle with environment:** Struggle with the physical factors of the environment such as heat, cold, moisture, aridity, earthquake, volcanic eruptions, changing climatic conditions etc.
3. **Variation and Heredity:** During competition every individual tries to become better adapted by utilizing the resources, so as to survive successfully. Variations and heredity are intimately connected as different expressions of reproductive and developmental processes. Variations give rise to new characters and heredity passes them on to the next generation.
4. **Natural selection (Darwin) or Survival of fittest (Spencer):** The individuals with favorable variations have better chance of survival in the struggle. The organisms with unfavorable variations die out and so only the fittest individuals survive, reproduce and transmit their favorable characters to the next generation.
5. **Origin of species:** Continued and repeated action of natural selection of modified types generation after generation produces new species. Darwin called this the origin of species and argued that the same process of variations with heredity accompanied by natural selection was sufficient over the vast geological time to produce all the living organisms today.

Examples of natural selection: Natural selection formed the central idea of Darwin's theory. Some of the examples like industrial melanism, DDT resistance in mosquitoes clarify the mechanism of natural selection.

Neo-Darwinism: The theory of evolution as proposed by Darwin and Wallace has been modified in the light of modern evidence from genetics, molecular biology,

paleontology, ecology and ethology. This modified form of Darwinism is termed as Neo-Darwinism. At present, it is the most widely accepted theory of evolution. Neo-Darwinism accepts mutation, genetic recombination, natural selection, genetic drift, reproductive isolation etc as the major causes of evolution.

Animal Adaptation

Adaptation is the modification in a part or the whole animal that fits it better for its existence in its present environment or enables it to live in different environment so that it can secure food, protect itself and rear its young ones. Simply adaptation (L. *ad*: to; *aptare*: to fit) is the fitness or adjustment of animals or plants with their habitat.

Adaptations may be structural, physiological, protective and animal associated. Adaptation may be following types:

Aquatic adaptation: Adaptation in response to the watery medium. Aquatic adaptations are of two types: Primary aquatic adaptations, which includes primitive gill breathing vertebrates like fishes and Secondary aquatic adaptations, which includes lung breathers like turtles, whales, dolphins etc.

Cursorial adaptation: Adaptation for running. E.g. Lizards, snakes, flightless cursorial birds like emus, ostriches and rheas, kangaroos, hares and rabbits, horses, deer, giraffe, camel

Scansorial or Arboreal adaptation: Adaptation for climbing inclined or vertical surfaces such as trees, rocks, walls etc. E.g. Tree frogs (*Hyla*), Lizards esp. Geckoes and *Chameleon*, Tree snakes, Parrot, Woodpeckers, flying squirrels, monkeys, apes.

Aerial or Volant adaptation: Adaptation for flying. Flight may be of two sorts: Gliding or Passive flight E.g. flying frog (*Rhacophorus*), flying lizard (*Draco*), Flying foxes etc. and Active or True flight E.g. Bat & Birds.

Fossorial or Burrowing adaptation: Adapatation for digging. E.g. Limbless Amphibians, *Uromastix,* Burrowing owl, Spiny ant eater (*Echidna*), Common mole, Shrew etc.

Animal Behavior

Behavior is an outwardly expressed action of living beings in response to the stimulus at a given situation. The scientific study of behavior patterns is called ethology. There are two types of behavior: Stereotype or innate behavior (inborn adoptive mechanism with which animals face the environment) and Learned or acquired behavior (adaptive change in behavior as a result of previous experience).

Reflex action: Immediate involuntary motor response to any sensory stimulus without conscious involvement of brain. The nervous pathway taken by nerve impulses in reflex action is called reflex arc.

Reception → *Conduction* → *Modulation* → *Conduction* →
(Sensory organs) (Sensory nerve) (CNS: Brain or Spinal cord) (Motor nerve)

Effect
(Effector organs: muscles or glands)
Examples: Knee jerking, Eye blinking salivation, sneezing, withdrawal of hand when touching a hot body etc.

Taxis: Movement of animal towards, away from or at any angle of the direction of the stimulus and are classified according to the nature of the stimulus. Taxic movements may be towards the stimulus (positive) or away from the stimulus (negative) or at a particular angle to the stimulus. **Phototaxis:** Movement in relation to light is phototaxis. **Chemotaxis:** Movement of organisms in a definite direction in response to the chemicals. **Thermotaxis:** Movement of organisms in response to temperature. **Geotaxis:** Response of organisms to the stimulus of the gravity. **Rheotaxis:** Response to the stimulus of flowing water or resistance. **Aerotaxis:** It is a special kind of chemotaxis in which the movement of the organism is in response to air (Oxygen). **Magnetotaxis:** Response to the stimulus of magnetic field. **Hygrotaxis:** Movement in relation to moisture. **Thigmotaxis:** Response to the stimulus of touch. **Galvanotaxis:** Response to the stimulus of electric current.
Kinesis or Kinetic Response is a non-directional movement response in which the rate of movement is related to the intensity of the stimulus and not to the direction of stimulus.
Tropism is the turning movements by which whole body or a major part of the body of it becomes oriented.

MCQs

1. "Continuity of germplasm" theory was given by
   a. De Vries b. Weismann c. Darwin d. Lamarck.
2. Theory of inheritance of acquired characters was given by
   a. Wallace b. Lamarck c. Darwin d. De Vries.
3. 'Origin of Species' was written by
   a. Oparin b. Weismann c. Lamarck d. Darwin.
4. Which was absent in the atmosphere at the time of origin of life?
   a. NH_3 b. H_2 c. O_2 d. CH_4.
5. Correct order is
   a. palaeozoic —> archaeozoic —> coenozoic
   b. archaeozoic —> palaeozoic —> proterozoic
   c. palaeozoic —> mesozoic —> coenozoic
   d. mesozoic —> archaeozoic —> proterozoic.
6. The homologous organs are those that show similarity in
   (a) appearance b. function c. origin d. size.
7. Which of the following is the correct group of vestigial organs in man?
   a. nictitating membrane, ear muscles, eyelids and coccyx

b. appendix, coccyx, ear muscles and elbow joint
c. wisdom tooth, coccyx, body hair and ear muscles
d. wisdom tooth, body hairs, nictitating membrane and vermiform appendix.

8. Evolutionary convergence is characterized by
   a. development of dissimilar characteristics in closely related groups
   b. development of a common set of characteristics in groups of different ancestry
   c. development of characteristics by random mating
   d. replacement of common characteristics in different groups.
9. Which of the following are homologous organs?
   a. wings of bird and hands of human
   b. nails of human being and claws in animals
   c. wings of bird and wings of insect
   d. wings of bat and wings of cockroach.
10. There is no life on moon due to the absence of
    a. O_2 b. water c. light d. temperature.
11. In which era reptiles were dominant?
    a. coenozoic era b. mesozoic era c. palaeozoic era d. archaeozoic era.

Answers & explanations:

Animal tissues

1. **b** Simple epithelium consists of a single layer of cells resting on a basement membrane. This makes a definite layer.
2. **a** Basement membrane (basal lamina) is a thin sheet of fibrous proteins that underlies and supports the cells of an epithelium. Basement membranes are components of the extracellular matrix and help to regulate passage of materials between epithelial cells and adjacent blood vessels.
3. **a** Lymph is a colourless, fluid connective tissue. It consists of two parts: a fluid matrix, the plasma, in which float amoeboid cells, the white blood corpuscles, or leucocytes. The lymph differs from the blood in lacking red corpuscles, platelets and some plasma proteins, and in having less calcium and phosphorus than the blood.
4. **b** Red pigment of vertebrate blood is haemoglobin. Haemoglobin is a conjugated protein which consists of a basic protein globin joined to a nonprotein group heme.
5. **a** Histamine, involved in allergic and inflammatory reactions, is secreted by mast cells that are found in connective tissue. They are small oval cells having abundant large granules in the cytoplasm.
6. **a** The smooth muscle consists of long, narrow unbranched spindle-shaped fibres. Each fibre contains a single oval nucleus in its thick middle part. The cross-striations are absent so that the fibres look smooth, hence the name nonstriated. Its contraction is not under the control of the animal, therefore, also called involuntary muscle.
7. **b** Afferent nerve fibres carry impulses from the receptors to the central nervous system. Efferent nerve fibres conduct nerve impulses from the CNS to the effector organs such as muscles and glands.
8. **c** Agranulocytes are leucocytes that lack granules in the cytoplasm. Lymphocyte does not have granules in their cytoplasm. Lymphocytes are important in the body's defence and are responsible for immune reactions.
9. **c** Chondrin is a protein present in the matrix of cartilage. It forms a constituent of a compound called chondrin sulphate. Matrix of bone is made up of a protein called ossein.
10. **a** Formation of WBCs, antibodies and destruction of bacteria occur in lymph glands while formation of RBCs occur in bone marrow.
11. **b** White fibrous tissue has two forms : cords and sheets. The white fibres run parallel to form cords, called tendons. Tendon attaches a muscle to a bone. It consists of collagen fibres and is therefore inelastic.
12. **c** Ligament occurs in the form of cords in a modified yellow elastic fibrous tissue and connects bone with a bone. Modified white fibrous tissue is present in the tendons.

13. **c** Pivot joint is present between atlas and the axis in humans. In this joint articular end of one bone is fixed while the other can rotate over it.
14. **d** Sarcomere is the structural and functional unit of muscle fibre and is the part between two adjacent Z-lines.
15. **a** Collagen is an insoluble fibrous protein found extensively in the connective tissue of skin, tendons and bone. Collagen accounts for over 30% of the total body protein of mammals.
16. **b** Neurons are least likely to be replaced by new cells as they have least regeneration power.

Protista & Animalia

1. **b** The mulberry silk moth has been the most commercially important beneficial insect. The silk is obtained by killing the pupa inside the hot water. Then, the silk thread is wound.
2. **c** Tortoise belongs to the class reptilia. Its body is protected by a shell consisting of a dorsal carapace and ventral plastron.
3. **b** Mimicry is resemblance of one species with another in order to obtain advantage, especially, against predation.
4. **d** *Gambusia* is a species of freshwater fish being introduced as a biocontrol to control mosquitoes. It feeds on larval and pupal stages of mosquitoes.
5. **c** The diagnostic characters of chordates are notochord, dorsal tubular nerve cord, pharyngeal slits and post anal tail.
6. **d** The red respiratory pigment, haemoglobin (or erythrocruorin) occurs dissolved in plasma. It gives a red colour to blood and aids in the transportation of oxygen for respiration.
7. **a** In insects malpighian tubules are attached to the alimentary canal at the extreme anterior end of hindgut. These excrete out nitrogenous wastes from the body in the form of uric acid.
8. **c** *Musca* is the zoological name of house fly which is regarded as mechanical carrier of many diseases. It is very active and keeps on visiting on dirty things and eatables as well.
9. **b** All animals belonging to the coelenterata (e.g. jellyfish) and echinodermata (e.g. starfish) are radially symmetrical.
10. **b** *Anopheles* and *Culex* can be easily identified by their sitting postures. When sitting, the abdomen of *Anopheles* is always held at an angle to the surface while that of *Culex* is held parallel to the surface.
11. **b** Whale, bat and rat are mammals. Diaphragm is present in mammals. The diaphragm separates the thoracic cavity from the abdominal cavity.
12. **d** Air passes from the external nares into the nasal cavity then into pharynx which leads into trachea. Larynx is the upper part of trachea. Trachea divides into two primary bronchi which on entering the lungs divide into fine branches called bronchioles which enter the alveoli. Exchange of gases occurs in alveoli.

13. **b** The nephridia in earthworm are analogous to flame cells of *Planaria* since both of them have excretory functions.
14. **c** Pneumatic bone is present in birds to keep the bones light weight because the birds have to fly.
15. **a** Poikilothermic animals are those whose body temperature varies with the temperature of the environment. Although unable to maintain a constant body temperature, they can respond to compensate for very low or very high temperatures.
16. **d** Echinoderms are triploblastic animals with organ system level of organisation. Larval forms possess bilateral symmetry while adults have radial symmetry.

Origin & Evolution of Life

1. **b** According to germplasm theory, the characters influencing the germ cells are only inherited. There is a continuity of germplasm but the somatoplasm is not transmitted to the next generation hence it does not carry characters to next generation.
2. **b** According to Lamarckism modifications acquired by organisms in adaptation to their environment during their lifetime are automatically handed over to their offspring and become a part of heredity.
3. **d** Darwin published his observations and conclusions regarding evolution in the book "Origin of Species" in 1859.
4. **c** Primitive atmosphere was reducing atmosphere (without free oxygen) unlike the present oxidising atmosphere (with free oxygen).
5. **c** The history of the earth has been divided into a number of major divisions called eras. The correct sequence is Precambrian —> Palaeozoic (era of ancient life) —> Mesozoic (era of medieval life) —> Coenozoic (era of modern life).
6. **c** Homologous organs are similar in origin and basic structure but may be similar or dissimilar in functions.
7. **d** The organs which are present in reduced form and do not perform any function in the body but correspond to the fully developed functional organs of related animals are called vestigial organs.
8. **b** Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution. Analogous organs show convergent evolution (adaptive convergence).
9. **a** Wings of birds and hands of human have similar basic structure but different functions. Birds use their wings for flying while humans use their hands for grasping.
10. **b** Water is the most essential material to survive. One can thrive without 0_2 (anaerobic bacteria) and light and in a wide range of temperatue but one cannot live without water which is the most important component of the body.
11. **b** Mesozoic era is the era during which reptiles were dominant. Dinosaurs; became large and reptiles were dominant during Jurassic period. During cretaceous period, dinosaurs got extinct.

Botany

Introduction

Biology (Gr. *Bios*=life + *logos*= study) is the branch of science that deals with the **study of living organisms**. The term '**Biology'** was first used by **Lamarck** and **Treviranus. Aristotle** the Greek philosopher is regarded as the '**father of biology'**.

The study of plants is called **botany or phytology** (Gr. *Botane*= herb). The word *Botane* itself originated from *Boskein*, which means grazing. **Theophrastus** (370-287B.C.) is known as the '**father of botany**'.

Nutrition

Organisms having autotrophic nutrition prepare their own food. Heterotrophs do not prepare their own food but depend on others for organic substances or food. Heterotrophic nutrition is of three types – **parasitic, saprophytic** and **symbiotic**.

Some selected branches of botany

Branch	**Area of study/concerned with**
Anatomy	Internal structures (also called internal morphology)
Cell biology	Structure, function, reproduction and life cycle of cells.
Cytology	Detailed structure of cell
Genetics	Heredity and variations
Morphology	Forms and external structure
Mycology or Mycetology	Fungi
Pathology or Nosology	Diseases – their causes, symptoms, spread, and control
Physiology	Processes and functions associated with life
Spermology	Seeds

MCQs

1. The study of nuclear cytology is called
   a. cell biology b. neurology c. anatomy d. karyology
2. Biology is widely known as science of exceptions. Which of the following dicot plant is exceptional in having no distinct cotyledons?
   a. Cuscuta b. maize *c. Cycas* d. rice
3. *"I* have same color of my eyes as my father does". Which branch of biology most probably explains the cause of the above mentioned statement?
   a. morphology b. genetics c. taxonomy d. physiology
4. What is the mode of nutrition in mushrooms?
   a. autotrophic b. parasitic c. saprophytic d. symbiotic
5. Which of the following plant group is composite, formed by symbiotic association of algae & fungi, and widely called biological indicators of pollution?
   a. legumes b. virus c. bryophytes d. lichen

Cell Biology

Cell is the unit of biological activity (life) bound by a selectively permeable membrane and capable of self-reproduction in a medium free of any other living system.

The cell of Mycoplasma is considered to be the smallest one. Ostrich egg is the largest animal cell (approx. 8 cm in diameter). The nerve cells are the longest cells (90-110 cm long). In plants, the longest cells are fiber of Boehmeria nivea (55cms).

Prokaryotic cell (pro = primitive, karyon = nucleus) lacks a well organized nucleus. Such a cell has no membrane bound cell organelles like mitochondria and plastids. The ribosome is 70S type. Nucleus is represented by naked DNA. Examples: Cells of Mycoplasma, bacteria, blue-green algae.

Eukaryotic cell (eu = true, karyon = nucleus) has well organized nucleus, contains membrane bound cell organelles, and 80S ribosome. Examples: cell of man and pea.

Structure and function of different parts of cell

Part	**Structure**	**Functions**
Cell membrane	Trilamellar (3 layers) made of protein and lipids (lipoproteins)	Selectively permeable, controls exchange of materials
Nucleus	Contains chromatin, extended form of chromosomes in interphase.	Controls all the activities of the cell. Nucleolus makes ribosomes.
Endoplasmic Reticulum	A system of flattened membrane	Rough ER (with ribosomes) transports proteins; smooth (without ribosome) is the site of lipid & steroid synthesis.
Ribosomes	Smallest organelles made of RNA and protein.	'**protein factory of cell**'.
Mitochondria	Surrounded by the envelope of two membranes where the inner is infolded to form fingerlike cristae, encloses matrix with ribosomes, DNA, etc.	Powerhouse of the cell; energy produced in respiration stored in the form of ATP (adenosine tri phosphate), matrix is the site of Krebs cycle.
Golgibody or Dictyosome	Stack of flattened membrane-bounded sacs called cisternae	Internal transport, makes lysosomes, cell wall formation
Lysosomes	Single membrane containing sac with digestive enzymes	'Suicidal bag'; phagocytosis & intra-cellular digestion
Centrosome	Have a pair of centrioles active in cell division, absent in plants	Take part in the formation of spindle fiber
Cell wall	Rigid non living wall made of cellulose. Fungal cell wall made of chitin & prokaryotes have murein.	Protection of cell from mechanical injury & osmotic bursting. Contains pores or gaps called plasmodesmata.
Chromoplast	Variously colored with different pigments. Common in petals of flowers and ripe fruits.	Attract animals for pollination and dispersal of fruit.

Leucoplast	White or colorless plastid in roots. Present in parts not exposed to light. Contains no pigments.	Amyloplast store starch & carbohydrates; aleuroplast store protein; elaioplast or oleosome store lipid.
Chloroplast	Green plastid with chlorophyll. Common in leaves and other green parts of plants.	Trap the energy of sunlight and utilize for manufacture of food (glucose) during photosynthesis.
Vacuole	Fluid filled sac covered by single membrane tonoplast. The fluid inside the vacuole is called cell sap.	Stores water, food and other chemicals. Contractile vacuoles help in excretion and osmoregulation.

Number of chromosomes in somatic/vegetative cells of some organisms

Organism	2n Chromosome	Organism	2n Chromosome
Mosquito	6	Mice, Mango	40
Fruit fly (*Drosophila*)	8	Human	46
Housefly	12	Chimpanzee	48
Pea	14	Cow, Buffalo	60
Corn/Maize	20	Horse	64
Rice, Toamato,Pines	24	Dog,chicken	78
Frog	26	*Ophioglossum*	1260
Cat	38	*Aulacantha*	1600

Cell Division

Amitosis is also called direct cell division. Bacteria and mega-nucleus of *Paramecium* divide by this method. Prokaryotic cells divide by amitosis only.

Mitosis (equational or somatic division) is the process by which a cell divides into two daughter cells, each having a nucleus with sets of chromosome exactly identical to the parent cell.

Cell division consists of two parts: karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm or cell).

Interphase is the preparatory phase of cell division. It is physiologically the most active stage. Replication of DNA and RNA takes place during interphase.

Prophase is the longest phase. Chromatin network condenses and chromosomes become clear. Nuclear membrane and nucleolus disappear at the end of prophase.

Chromosomes are arranged at equatorial plane in metaphase. Splitting of centromeres or division of chromosomes occurs during anaphase. Chromosomes move to opposite poles. Anaphase is the shortest phase of cell division. Chromosomes reach the poles of the cell in telophase. It is often called 'opposite of prophase'.

Cytokinesis in animals occurs by furrowing and by the formation of cell plate in plants.

Meiosis is the cell division resulting in the formation of daughter cells, each with a nucleus containing half the number of chromosomes as compared with the parent cell. It is also called **reduction division**. It takes place in germ cells.
Meiosis I is termed reduction division and meiosis II is called equational division.
Prophase I is divided into leptotene, zygotene, pachytene, diplotene, and diakinesis.
The pairing of homologous chromosomes is called synapsis. It occurs in zygotene. Longitudinal splitting of homologous chromosomes and crossing over takes place during pachytene. Points of crossing over are called chaismata. The process of movement of chaismata from the centromeres towards the ends of chromosomes is called terminalization. It starts from diplotene and continues through diakinesis.

MCQs

1. What is process by which the cytoplasm of a cell divides to form two daughter cells?
   a. cytokinesis b. interphase c. prophase d. karyokinesis
2. Which of the following is human haploid chromosome number?
   a. 10 b. 23 c. 46 d. 92
3. A student studied two different groups of cells and made the following notes:

Trait	Cell I	Cell II
Cell wall	Present	Present
Ribosomes	Present	Present
Nucleus	Absent	Present
Ability to photosynthesize	Present	Present

   Which of the following conclusions is best supported by these observations?
   a. cell I is more complex b. cell I is a prokaryote
   c. the ancestors of cell II appeared earlier d. cell II does not have a nucleus
4. Which one of the following is *not* a dividing stage?
   a. prophase b. interphase c. metaphase d. telophase
5. An organelle in which respiration occurs is
   a. golgi bodies b. ribosome c. mitochondria d. chloroplast
6. Ability of a plant or animal cell to repeatedly divide and differentiate into a complete organism is
   a. cloning b. breeding c. totipotency d. mitosis
7. Reduction of chromosomes into half occurs in which of the following stages?
   a. anaphase I b. anaphase II c. prophase I d. telophase II
8. The cell of a corn plant has a diploid number of 20 chromosomes. When it divides by mitosis, what is the number of chromosomes in each of the daughter cells?
   a. 10 b. 20 c. 30 d. 40
9. Chromatin is to chromosomes as DNA is to
   a. daughter cells b. meiosis c. genes d. mitosis
10. Spindle fibers are attached to the chromosomes at
    a. chromatids b. interphase c. metaphase d. centromere

Taxonomy

Taxonomy is the branch of biology that deals with the identification, nomenclature and classification of organisms.

- So far, biologists have been able to describe and give names of about 1.7 million types of organisms (1.2 million animals and 0.5 million plants).
- **Aristotle** and other Greek philosophers divided living organisms into two groups- plants and animals. **John Ray** introduced the term '**species**'. **Carolus Linnaeus** put forward a classification based on similarities of structure and function in his book '**Systema Naturae'** published in 1737. His contribution is **binomial system of nomenclature** published in his book '**Species plantarum'**. He is called the **father of taxonomy**.

Thallophyta: Algae

Algae are non-embryonic chlorophyllous autotrophs with cellulosic cell wall. Their body is not differentiated into root, stem, and leaves (thalloid body). The study of algae is called p**hycology**. Example: *Spirogyra, Polysiphonia*

Bryophyta: Bryophytes (Gr. *Bryon* = moss) are non-vascular cryptogams whose dominant phase or the plant body is free living gametophyte. Roots are absent, instead rhizoids occur. Sex organs are multicellular and jacketed. An external layer of water is essential for the swimming of male gametes to the archegonia. As water is required for fertilization, bryophytes are called '**amphibians of plant kingdom**'. Example: Liverworts (*Marchantia, Riccia*) & Mosses (*Funaria, Polytrichum*)

Pteridophyta: First group of tracheophytes (plants with vascular bundles) with sporophytic (2n) plant body. Also known as vascular cryptogams, vascular amphibians, snake of the plant kingdom, and seedless tracheophytes. True vessels are absent in xylem. Companion cells are absent in phloem. Sperms (antherozoids) are multiflagellate. Example: Fern (*Dryopteris, Adiantum*), Horsetail (*Equisetum*)

Gymnosperms (Gr. Gymnos=naked, sperma=seeds**):** Gymnospems are naked seeded spermatophytes. Vascular bundle generally does not have vessels and companion cells. Flowers are absent. Sporophylls are generally aggregated to form distinct cones or strobilli – pollen cones (male cones) and seed cones (female cones). Seeds do not occur inside a fruit. External water is not required for transport of male gametes. Example*: Cycas, Pinus, Sequoia* (Coast redwood)

Angiosperms (Gr Angio = vessel, sperma = seed)**:** Angiosperms are seed plants in which the sporophylls are organized into flowers. These are the most recent & highly evolved plants. Archegonia are absent. Double fertilization & triple fusion is found in angiosperms only. Fertilized ovules ripen into seeds. The seeds are covered by fruits. A fruit is technically a ripened ovary. Xylem contains vessels & phloem possesses sieve tubes and companion cells.

Differences between monocot and dicot plants

Monocot	Dicot
1. They have single cotyledon.	1. They have two cotyledons.
2. They are characterized by the presence of fibrous root.	2. They have tap root system.
3. Parallel venation in leaves.	3. Reticulate venation in leaves.
4. They have trimerous flower.	4. Flowers are tetramerous or pentamerous.
5. The vascular bundles in the stem are scattered.	5. Vascular bundles in stem are arranged in a ring.
Example: Rice, Wheat, Onion, Garlic	Beans, Sunflower, Mustard, *Dahlia*

Five Kingdom Classification

The five kingdom system of classification was proposed by R. H. Whittaker in 1969. According to his classification organisms are classified into five kingdoms – i) Monera ii) Protista iii) Mycota (fungi) iv) Plantae and v) Animalia.

MCQs

1. Double fertilization and triple fusion is characteristic of
   a. all plants b. angiosperms c. gymnosperms d. pteridophytes
2. Of the following terms, which one includes others?
   a. species b. genus c. class d. order
3. Which of the plants mentioned below is not characterized by the presence of reticulate veins in its leaves?
   a. sunflower b. tomato c. maize d. *Cuscuta*
4. All of the following are true for bryophyta *except*
   a. have no vascular bundles b. need water for fertilization
   c. have independent sporophyte d. sperms are motile
5. In which of the following groups would you place a plant that produces spores, has vascular tissues but lacks seeds?
   a. thallophyta b. bryophyta c. pteridophyta d. gymnosperm
6. Which one of the following plants is odd?
   a. *Marchantia* b. *Selaginella* c. Horsetail d. *Adiantum*
7. Algae are different from fungi
   a. presence of roots b. saprophytic mode of nutrition
   c. autotrophic nutrition d. production of seeds
8. The zygote forms embryo in all plants *except*
   a. algae b. gymnosperm c. bryophyta d. angiosperm
9. Vessels and companions cells are present in the vascular bundles of
   a. moss b. fern c. mango d. *Cycas*
10. Which of the following is a true moss?
    a. reindeer moss b. club moss c. Iceland moss d. peat moss

Bacteria

Bacteria (Greek *bacterion*=small staff, stick) were first discovered by Antony **Von Leeuwenhoek**. **Louis Pasteur** observed that bacteria are the cause of some diseases. This fact was called '**Germ Theory of Disease'**. Almost at the same time **Robert Koch**, a German physician, discovered bacteria causing anthrax and tuberculosis. He was awarded the Nobel Prize in 1905. He is also called the father of **bacteriology**.

- Bacteria are very small; their size generally ranges from 0.2-1.5μm in diameter and 2-10μ in length. *Dialister pneumosintes* is the smallest bacterium (0.15-0.3μ long); *Beggiota mirabilis* is largest bacterium.
- They have prokaryotic cell. They lack nuclear membrane, nucleolus, and membrane bound organelles like mitochondria & plastids. Possess a rigid cell wall made of mucopetides or peptidoglycans. Most bacteria do not have chlorophyll, hence, they are heterotrophic. However, few bacteria possess chlorophyll & are autotrophic. Genetic material is represented by histone free DNA.

Some Bacterial Diseases

Disease	Casual organism	Disease	Casual organism
Bacillary dysentery	*Shigella dysentery*	Pneumonia	*Diplococcus pneumonae*
Meningitis	*Neisseria meningitides*	Citrus canker	*Xanthomonas citrii*
Cholera	*Vibrio cholera*	Blight of rice	*Xanthomonas oryzae*
Diphtheria	*Corynebacterium diptheriae*	Potato wilt	*Pseudomonas solanacearum*
Gastroenteritis	*Escherichia coli, Salmonella*	Red stripe of sugarcane	*Pseudomonas rubrilineans*

Bacteria occur in four basic forms or shapes. These are either spherical (**cocci**), rod shaped (**bacilli**), spiral (**spirilla**) or coma-shaped (**vibrio**). Though most bacterial species are of a fairly constant and characteristic shape, some species are **pleomorphic** (i.e. these can exhibit a variety of shapes).

Virus

A virus is a small non-cellular infectious agent that replicates only inside the living cells of other organisms.

Virus was discovered by D. J. Ivanovsky from Tobacco leaf (TMV – Tobacco mosaic virus). 'Virus' means poison in Latin. Viruses consist of the genetic material made from either DNA or RNA and a protein coat (capsid) that protects these nucleic acids. Nucleic acid can be double-stranded DNA, single-stranded DNA, single-stranded RNA, or double- stranded RNA. Viruses have been described as "**organisms at the edge of life**".

Viruses are inactive macromolecules outside the host cell and active only inside host cells. They lack enzymes for most metabolic processes & machinery for synthesizing proteins. The viruses that infect bacteria are called **bacteriophage**.

Some Viral Diseases

Disease	Pathogen	Host	Nucleic Acid
Wheat mosaic	Rhabdovirus	Wheat	RNA
Influenza	Myxovirus	Human	RNA
Small pox	Variola virus	Human	DNA
Mumps	Paramyxovirus	Human	RNA
Measles	Paramyxovirus	Human	RNA
Bird Flu	H_5N_1 – Influenza A virus	Human, aves	RNA
Swine Flu	H_5N_1 – Swine Influenza Virus	Human, pigs	RNA

MCQs

1. An organism which is generally without plastids and can synthesize its food
   a. fungi b. bacteria c. algae d. lichen
2. The organism capable of destroying bacterial colonies is
   a. virus b. tadpole c. lysosome d. bacteriophage
3. Rod-shaped bacteria are called
   a. bacilli b. spirilla c. cocci d. pleomorphic
4. All bacteria are classified as
   a. algae b. monera c. parasite d. virus
5. Which one of the following diseases is caused by bacteria?
   a. small pox b. rabies c. AIDS d. tetanus
6. Viruses do not fit into biological concept of cell because they
   a. lack cytoplasm b. cannot reproduce c. contain DNA d. are small

Fern (*Dryopteris*)

Dryopteris is a common fern. Leaflets of a mature leaf bear sporangia in clusters called **sori**. The leaflets and leaves having sori or sporangia are called **sporophylls**. The covering of sori is called **true indusium**. Each sporangium encloses **12-16 diploid spore mother cells**. A marginal row of cells are differentially thickened to form annulus. The remaining marginal cells constitute stomium. The diploid spore mother cells divide meiotically to form haploid spores. Spore is the first cell of gametophytic generation.

After falling on a suitable soil, each spore germinates and form haploid thalloid gametophyte called prothallus. Prothallus is cordate (heart shaped), green and flat structure. Prothallus bears antheridia and archegonia at ventral surface. Sperms are attracted to the opened archegonia by malic acid present in their mucilage.

The sperm and the ovum fuse to form a diploid zygote or oospore. The zygote is the first cell of sporophytic generation. The oospore gives rise to an embryo which grows in size to form the fern plant.

MCQs

1. During the life history of a fern, the fern plant is
   a. sporophyte b. gametophyte c. prothallus d. zygote

2. Male gamete of fern is
   a. monoflagellated b. biflagellated c. multiflagellated d. aflagellated
3. The male gametes of fern are attracted towards the archegonium by
   a. malic acid b. sugar c. aspartic acid d. protein
4. The first cell of gametophytic generation is
   a. zygote b. gamete c. spore d. prothallus

Anatomy & Physiology

Plant Anatomy

The study of the gross internal structure of plants is called **plant anatomy.** The study of tissues is called **Histology.**

Meristematic Tissues

The localized group of young cells and with the ability of continuous division is known as meristematic tissue and the region is called meristem. Metabolically these are the most active cells.

Apical meristem is situated at the tips of the root & the stem. Plants elongate and increase in height as a result of divisions in this meristem. The vascular cambium and the cork cambium are the two examples of lateral meristems being placed along the side of the central longitudinal axis of the plant. The activity of this type of meristem increases the diameter or thickness of plants. Intercalary meristem is located away from the apical meristem, between the two differentiated regions. It occurs in the leaves and internodes of many monocotyledons. The grass stem elongates due to the activity of apical meristem.

Permanent Tissues

Permanent tissues may be defined as a group of cells which have lost the capacity of division. Permanent tissues can be divided into three groups: simple tissues, complex tissues, and secretory tissues.

Simple Tissues are composed of only one type of cells. These occur in homogeneous groups. Simple tissues include parenchyma, collenchymas, and sclerenchyma.

- Chlorenchyma or assimilatory parenchyma possess abundant chloroplast and make food by photosynthesis.
- Aerenchyma with well developed intercellular spaces which forms a connected system throughout the entire plant is known as aerenchyma. It is common in submerged hydrophytes.
- Photosynthesis, respiration, storage, secretion, assimilation etc. are some of the important processes which occur in parenchymatous cells.
- Collenchyma is a mechanical tissue that consists of living cells.
- Scelerenchyma is made up of dead and lignified cells which do not perform any metabolic function. Scelerenchyma is of two types- sclerids and sclerenchymatous fibres. Sclerenchyma is mainly mechanical in function and it provides support to plants.

- Xylem is composed of tracheids, vessels, xylem fibre or wood fibres and xylem parenchyma. Tracheids and vessels are together known as tracheary elements. The major function of xylem is to transport water and minerals from the root to the leaves of plants.
- Phloem is mainly responsible for the conduction or transport of organic food synthesized by the plant. Together with xylem it forms the vascular tissue. The constituent cells of phloem are sieve tubes or sieve cells, companion cells, bast fibers and phloem parenchyma. Companion cells are absent from most pteridophytes and gymnosperms.
- Ficus, Euphorbia (Lalupate), Rubber plant, poppy, papaya, etc. are plants that secrete latex. Latex from Achras zapota is the original source of chicle from which chewing gum is made.

Plant Physiology

The study of life processes is called physiology.

- The process of movement of solvent molecules from the region of their higher concentration to the region of their lower concentration through semi permeable membrane is called **osmosis or osmotic diffusion**. In the process of osmosis water molecules move from a region of their higher concentration (weak solution) to a region of their lower concentration (a more concentrated solution).
- The membrane which allows only solvent and not the solute to pass through it is called **semi-permeable membrane.**
- The loss of water in the form of vapors from the aerial parts of the living plant is called **Transpiration**.
- Most of the biologists believe that transpiration as such is not of any significance to plants. Curtis called ***transpiration as a necessary evil***. Excess transpiration causes wilting which may lead to the death of the plant.
- There are three types of transpiration – stomatal, cuticular, and lenticular transpiration. Aerating pores in woody stem are called lenticels.
- **Photosynthesis** is the synthesis of carbohydrates, especially sugars, by green plants in the presence of light by utilizing carbon dioxide and water. Photosynthesis takes place in the cells of green plants containing chlorophyll. The oxygen evolved as bi-product of photosynthesis comes from water.

$$6CO_2 + 12\,H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

- Photosynthesis occurs in two phases – **Light (photochemical) reaction & Dark reaction.** Solar energy is trapped by chlorophyll, and is stored in the form of chemical energy (ATP) and as a reducing power (NADPH) during light reaction. Reducing capacity of NADPH and the energy of ATP are utilized in the conversion of CO_2 to carbohydrates during the dark reaction.

ATP = Adenosine tri phosphate

NADP = Nicotinamide adenine dinucleotide phosphate

- **Respiration** is the process of oxidation and decomposition of organic compounds, particularly simple carbohydrates such as glucose, in the living cells with the release of energy. There are two types of respiration – **Aerobic & Anaerobic respiration.**
- Aerobic respiration takes place in the presence of oxygen. Complete oxidation of glucose or substrate results in the formation of CO_2 and water accompanied by the release of energy.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy (686 kcal)}$$

Anaerobic respiration takes place in the absence of molecular oxygen. It results in incomplete breakdown of the substrate (food). CO_2 and organic compounds like ethyl alcohol, lactic acid etc. are produced accompanied by the release of some energy.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + \text{energy}$$

(Ethyl alcohol)

Plant Movement

Movement in plants are chiefly in response to certain stimuli. The ability of the protoplasm to respond to stimulus is called sensitiveness or irritability.

Tactic Movements or Taxism: A taxis differs from tropism (turning response, often growth towards or away from a stimulus) in that the organism has motility and demonstrates guided movement towards or away from the stimulus source.

- **Phototactic movement**: *Chlamydomonas* swim towards light.
- **Thermotactic movement**: Flagellated organisms show movement from cold to warm places. Example *Volvox*
- **Chemotactic movements**: Male gametes of bryophytes and pteridophytes move towards the archegonium due to the attraction of sugars and malic acid secreted by the archegonium.

Tropism: Turning, or growing, away from or towards a particular stimulus is called tropism. It is said to be positive when the growth or bending is towards the stimulus and negative when the bending is away from stimulus.

Type	Stimulus	Example
Phototropism	Light	Positive: Stem, Negative: Root
Geotropism	Gravity	Positive: Root, Negative: Stem
Hydrotropism	Water	Root
Chemotropism	Chemicals	Growth of pollen tube on stigma
Thigmo or Haptotropism	Touch	Tendril of climbers

Nastic movements, like tropic movement, also occur in response to some external stimulus but here the direction of the response and the stimulus are not same. These are non-directional response to stimuli.

Photonasty: The opening and closing of the flowers due to variation in light intensity.
Seismonasty: The movement shown by the leaves of Touch-me-not plant (*Mimosa pudica*) due to turgor variations. The movement is often confused with thgmotropism.
Thigmonasty or **Haptonasty**: Movement shown by insectivorous plants.

MCQs

1. The most common function of xylem is
   a. buoyancy b. photosynthesis
   c. storage d. conduction of water & mineral salts
2. Anaerobic respiration in yeast produces
   a. alcohol and CO_2 b. CO_2 only c. lactic acid d. formic acid
3. The exchange of gases between a leaf and its environment takes place through special structures known as the
   a. lenticels b. xylem c. stomata d. phloem
4. The correct order of arrangement, in terms of increasing complexity, of the following: 1- organ 2 – tissue 3 – cell 4 – system 5 – organism
   a. 1-2-3-4-5 b. 5-4-3-2-1 c. 2-3-4-5-1 d. 3-2-1-4-5
5. The growing region of a plant stem is called
   a. bark b. meristem c. wood d. phloem
6. The food made during photosynthesis may be used for all of the following purposes *except*
   a. protein synthesis b. fat synthesis c. storage d. transpiration
7. The response of a plant stem in growing upward in the dark is known as
   a. positive geotropism b. negative geotropism
   c. positive phototropism d. negative phototropism
8. The process of loss of water vapor from the aerial parts of plants is called transpiration. The opening and closing of stomata is controlled by
   a. stomata cells b. guard cells c. xylem cells d. phloem cells
9. Sieve tubes, parenchyma, bast fibers, and _____ are the elements of phloem.
   a. vessels b. companion cells c. wood fibers d. tracheids
10. The vascular bundles in monocot stem are arranged in
    a. ring b. scattered form c. mixed d. tubular form

Genetics

Genetics is the branch of biology that deals with the study of heredity and variation.
Heredity is the transmission of characters from parent to offspring.
Morphological and physiological differences amongst the individuals of the same species and the offspring of the same parents is termed **variation.**

Genetic Materials: Nucleic acids

Nucleic acid is macromolecule, made of many (polymer) monomer units, called nucleotides.

Nucleic acid = many nucleotides

Nucleotide = nucleosides+ phosphate
Nucleoside= sugar+ nitrogenous base

- Ribose sugar is present in RNA while deoxyribose sugar is found in DNA.
- There are total five bases belonging to two types - **Purines & Pyrimidine.** Adenine and guanine are purine bases. Cytosine, thymine and uracil are pyrimidine bases.
- DNA contains adenine, guanine, cytosine and thymine. Uracil is present in place of thymine in RNA.
- In 1953 J.D. Watson and F.H.C. Crick proposed double helical structure of DNA based on the results of M.H.F. Wilkins and co-workers.
- Double stranded DNA molecule has a diameter of 20 A^0, i.e., the distance between the two polynucleotide strands is 20 A^0.
- There are 10 base pairs per turn, each placed at a distance of 3.4 A^0.
- RNA or ribonucleic acid is present in all the living cells. It is found in cytoplasm as well as nucleus. RNA is generally involved in protein synthesis but in some viruses it also serves as genetic material. There are three types of RNA.
- Messenger RNA (mRNA carries the genetic information present in the DNA. It forms about 3-5% of the total RNA present in the cell.
- Transfer RNA (tRNA) are also known as soluble RNA (sRNA). These are the smallest molecules which carry amino acids to the site of protein synthesis.
- Ribosomal RNA (rRNA) is the most stable type of RNA. It was the first RNA to be identified and is the most abundant RNA.

Mendelism

The first and the most important contribution to the studies of heredity was made by Gregor Johann Mendel in 1866 AD. He is also known as **'Father of Genetics'**. He selected garden pea (*Pisum sativum*) for his hybridization experiments.

Terminologies related to Mendelism

Gene: The basic unit of inheritance for a given character (trait).

Allele: Alternative forms of the same gene that determines contrasting characters. Example: Tall (T) or Dwarf (t).

Homozygous: Diploid condition where both the alleles are identical. Example: TT

Heterozygous: Diploid condition where both the alleles are different. Example: Tt

Phenotype: Physical or external visible expression of a character. Example: Tall, dwarf, round

Genotype: The genetic expression of a character in terms of alleles. Example: Rr

Dominant: An allele which expresses itself externally both in homozygous and heterozygous conditions.

Recessive: An allele which expresses itself externally only when homozygous.

Monohybrid: When only one pair of alleles is considered during hybridization.

Dihybrid: A breeding experiment considering two characters at the same time.

F1 generation (first filial generation): The generation produced by crossing two parental stocks.

F2 generation: The generation produced by crossing two individuals of F1 generation.

Mendel's Laws

Dominance: A dominant allele completely masks the effects of a recessive allele. A dominant allele produces the same phenotype in heterozygotes and in homozygotes.

Segregation: In diploid organisms, chromosome pairs (and their alleles) are separated into individual gametes (eggs or sperm) to transmit genetic information to offspring. It is also called the law of purity of gametes or Mendel's first law.

Independent assortment: Alleles on different chromosomes are distributed randomly to individual gametes. Also know as Mendel's second law.

The laws of dominance and segregation are explained through monohybrid cross whereas the law of independent assortment is explained with the aid of dihybrid cross.

MCQs

1. Which of the following has a clover leaf shaped structure?
   a. DNA b. tRNA c. rRNA d. mRNA
2. The molecule which contains all the information for carrying all the life processes
   a. rRNA b. tRNA c. DNA d. mRNA
3. A gene is said to be dominant if
   a. it expresses its effect only in homozygous state
   b. it expresses its effect both in homozygous and heterozygous state
   c. it expresses its effect only in heterozygous state
   d. it never expresses
4. A pure tall pea plant can be distinguished from a hybrid tall pea plant by
   a. measuring its height
   b. gibberellins treatment
   c. selfing and noting that all progeny are tall
   d. selfing and noting that all progeny are dwarf
5. During the process of respiration, energy is transferred from glucose molecules to molecules of
   a. ATP b. ADP c. DNA d. RNA
6. When hybrids are crossed with each other, the genotype ratio in the F1 generation
   a. 3:1 b. 1:1 c. 1:2:1 d. 2:1
7. One similarity of DNA and RNA molecules is that they contain
   a. nucleotides b. thymine c. uracil d. ribose sugar
8. In a monohybrid cross, the two parental genotypes are AA and aa. The genotype of all F1 plants is Aa. If the F1 plants are crossed to get F2 generation, what percentage of the F2 generation will have the dominant phenotype?
   a. 100% b. 75% c. 50% d. 25%
9. Mendel's dihybrid cross ratio is
   a. 1:2:1 b. 9:3:3:1 c. 3:1 d. 1:2:1:4:3:2
10. What is present instead of thymine in RNA?
    a. adenine b. guanine c. cytosine d. uracil

Reproduction in Plants

Plants reproduce by fusion of gametes (sexual reproduction) or even without fusion (asexual reproduction). Regeneration of new plants from vegetative parts (root/stem /leaf) is called vegetative propagation.

Vegetative propagation by root: *Dahlia*, Sweet potato, *Asparagu*s, Sisoo, Siris

Vegetative propagation by stem

Runners: Doob grass (*Cyanodon*), *Oxalis* **Tubers**: Potato **Bulbs**: Onion, Tulip

Offset: Water hyacinth (*Eichhornia)* **Rhizome**: Ginger, Fern **Corm**: *Colocasia*

Vegetative propagation by leaf: *Bryophyllum, Begonia*

Artificial Vegetative Propagation

Cutting: Sugarcane, Rose, Bougainvillea **Layering**: Strawberry, Jasmine, Grapevine

Grafting: A shoot or a part of the plant (scion) is inserted into another plant (stock). Rubber, Apple, Pear, Citrus, Mango, Guava

Sexual Reproduction

The flower and its parts are involved in sexual reproduction. A typical flower is made of calyx, corolla, androecium, and gynoecium. Calyx & corolla only help the process of sexual reproduction.

Androecium is the male reproductive part. Its units are stamens with filament & anther. Gynoecium is the female reproductive whorl made of carpels. A carpel is composed of stigma, style, & ovary. The ovule produces megaspore which forms the female gametophyte with an egg or female gamete.

The anther produces pollen grains or microspores which on germination produce two male gametes. Double fertilization and triple fusion takes place in angiosperms only.

MCQs

1. The uniting cells in sexual reproduction are called
   a. zygotes b. zygospores c. spores d. gametes
2. A fruit develops from the part of a plant called
   a. embryo sac b. ovary c. egg d. pollen tube
3. A tuber is an underground
   a. root b. leaf c. stem d. flower
4. All of the following are advantages of asexual reproduction except
   a. the offspring are same as parents b. cross-pollination is easier
   c. increased number of progeny d. reproduction is faster
5. Ovules develop within
   a. calyx b. corolla c. anther d. ovary
6. Morphologically onion is
   a. root b. stem c. tuber d. fruit
7. Vivipary is a type of
   a. germination b. pollination c. fertilization d. respiration

8. Which of the following is not an artificial method of vegetative reproduction?
   a. tuber b. grafting c. layering d. cutting
9. The plant propagated through roots is
   a. sweet potato b. *Asparagus* c. *Dahlia* d. all of the above

Ecology

(*Oikos* = house or dwelling place, *logos* = study of)

Ecology is the study of interactions among organisms and their environment. An **ecosystem** is dynamic community of plants, animals, & microorganisms in relation to their physical environment. The interrelationship of an individual species and its environment is called **autecology**. The ecology of community is called **synecology**.

Biosphere is the thin layer of life at the surface of earth, including the biologically inhabited soil, water, and air. It includes system or relationship between the living things and the materials & energy surrounding them.

A geographically localized group of individuals of the same kind at a given time represent **population**. The study of population is called **demography**.

The rivalry between two or more organisms for obtaining the same resources is called **competition**. Competition may be intra-specific (within the members of the same species) or inter-specific (between organisms of different species).

An association of a number of different inter related populations belonging to different species in a common environment is known as **biotic community**.

Commensalism is an association of two species in which one lives attached to another but does not harm it. Example; Orchids or ferns growing on branches of trees, Hermit Crab & Sea Anemone

An association of two species of organisms where both the partners derive mutual benefit from each other is called **symbiosis** or **mutualism**. Example; Algae & fungi in lichen, *Rhizobium* in legume root nodules.

Plants living in abundance of water are called **hydrophytes**. Example: *Hydrilla*, Lotus, *Wolffia.* Plants adapted to grow in dry habitats are called xerophytes. Example: *Cactus, Opuntia, Pinus.* Special type of xerophytic plants which grow on saline soils with high concentration of mineral salts are called **halophytes**. Example: Mangroves

The **biotic component** of the ecosystem includes the kinds, numbers, and distribution of living organisms. The **abiotic component** consists of physical and chemical factors like light, temperature, water, gases, and minerals.

Green plants and other photosynthetic microorganisms are the **producers** of ecosystem.

The animals that consume the energy as food from producers are called **consumers**.

Non-green organisms like fungi and some bacteria, which are incapable of producing their food, live on dead and decaying plants or animal parts, are called **decomposers**.

Herbivores like deer and cattle that derive their food directly from producers are called **primary consumers** or **first order consumers**.

The carnivorous organisms such as the tiger and the lion are **second order consumers** (Secondary or tertiary consumers).

Food chain is a series of organisms in an ecosystem that are linked to each other through the transfer of energy and nutrients, beginning with an autotrophic organism and continuing with each organism being consumed by one higher in the chain. The flow of energy in an ecosystem is always **unidirectional**.

Each step of food chain is called **trophic level.** Example: Producers, primary consumer, decomposer. A network formed by interconnecting food chains is called **food web**.

An **ecological pyramid** is a graphical representation designed to show the biomass or bio productivity at each trophic level in a given ecosystem. **Biomass** is the amount of living or organic matter present in an organism.

There are three basic types of pyramids – pyramid of energy, pyramid of number, and pyramid of biomass. Most ecological pyramids are upright but the **pyramid of biomass in pond ecosystem is inverted**.

The cycling of nutrients (chemical) between the earth and the biotic components is called **biogeochemical cycle**.

The Nitrogen Cycle

Nitrogen is an important component of many compounds, particularly proteins and nucleic acids. Atmosphere is the reservoir of gaseous nitrogen (about 78% of the air is nitrogen) and nitrogen compounds are found in bodies of organisms & in the soil.

Living organisms cannot pickup gaseous nitrogen directly from the atmosphere (except for nitrogen fixing bacteria). It has to be converted into nitrates to be utilized by plants. The process of conversion of free nitrogen into nitrogen compounds that can be used by plants is called **nitrogen fixation**. *Azotobacter, and Rhizobium* are important nitrogen-fixers. The nitrogen absorbed by producers is assimilated in the form of amino acids and proteins. A part of plant proteins is consumed by animals; rest of the nitrogen is released in the surrounding environment. The conversion of proteins of dead bodies into ammonia is called **ammonification** or **putrefaction**. *Bascillus ramosus, and Bascillus mycoides* are common ammonifying bacteria. Ammonia is converted into nitrites and nitrates by **nitrifying** bacteria like *Nitrosomonas* and *Nitrobacter*. Nitrogen is lost from the cycle through biological process of **denitrification**. Some bacteria and fungi use nitrites and nitrates as sources of oxygen under anaerobic conditions. Bacteria like *Bascillus subtilis* and *Micrococcus denitrificans* reduce nitrates to molecular nitrogen.

MCQs

1. Which of the following is the richest source of vegetarian protein?
   a. rice b. barley c. soybean d. gram
2. Which of the following would be most likely to occur in a terrestrial ecosystem?
   a. as the number of prey decreases, the number of predators increases
   b. as the number of predators increases, the number of prey increases
   c. as the number of prey increases, the number of predators decreases
   d. as the number of prey increases, the number of predators increases

3. Nitrogen compounds in nitrogen cycle are broken down by decomposers to release
   a. methane b. ammonia c. urea d. nitrogen gas
4. An empty space is inhabited by grass, trees, ants, soil bacteria, earthworms, and mice. Together, all of these organisms comprise a
   a. population b. biome c. community d. species
5. Japanese beetles are a worse pest in America than in Japan because here
   a. the soil is more fertile b. there are fewer natural enemies
   c. there are more plants d. there is longer winter
6. Which organism in this food chain can transform light energy to chemical energy?
   a. lizard b. beetle c. aphid d. apple tree
7. In a plain community, the population with greatest biomass would be
   a. foxes b. hawks c. grasses d. beetles
8. What is the association between two organisms called if both get advantage from each other?
   a. mutualism b. commensalism c. predation d. Parasitism
9. In an ecosystem, the flow of energy is always
   a. unidirectional b. bidirectional c. multidirectional d. tridirectional
10. Which of the following can explain the energy stored in an ecosystem?
   a. trophic level b. food chain
   c. food web d. pyramid of biomass

Answers & explanations:

Introduction

1. **d** Karyo or karyos in Greek refers to nucleus of the cell. The study of a nucleus is thus called karyology.
2. **a** *Cuscuta* (Dodder) is a root parasite that belongs to dicot but the embryo is linear without differentiated cotyledons. *Cycas* has two cotyledons in its embryo but does not belong to dicot as it has naked seeds.
3. **b** Traits from parents to offsprings are transmitted through gametes during sexual reproduction. The probability and pattern of such a transfer is studied in genetics.
4. **c** Mushrooms obtain nutrients from dead and decaying organic matter; such a mode of heterotrophic nutrition is saprophytic.
5. **d** Lichens are composite plants formed by symbiotic association of algae and fungi. They do not grow in air polluted areas. Hence, lichens are also called biological indicators of pollution.

Cell Biology

1. **a** The process of division of a cell or its cytoplasm after nuclear division (karyokinesis) is termed cytokinesis. It is the final stage of cell cycle.
2. **b** Total number of chromosomes in each cell inherited from a single parent through gametes is called haploid (n). Human gametes contain 23 chromosomes. The number of chromosomes in zygote is called diploid (2n).

3. **b** On the basis of information provided in the question, cell I is a prokaryote (organism with prokaryotic cell) and cell II is a eukaryote that belongs to plant kingdom. Prokaryotes lack true nucleus.
4. **b** Interphase is often called resting stage. It is the phase of cell cycle when the cell prepares itself for division.
5. **c** Mitochondria are the cell organelle in eukaryotes where cellular respiration occurs. They are also called 'powerhouse of the cell'. In many prokaryotes there are mesosomes for cellular respiration.
6. **c** Totipotency is the ability of a single cell to divide and produce all of the differentiated cells in an organism. Spores and zygotes are totipotent cells.
7. **a** During anaphase of meiosis I, entire chromosomes move to the poles – one chromosome in each pair goes to one side of the cell & the other chromosome in the pair goes to the other side. Thus, the number of chromosomes at each end is halved and the ultimate number of chromosomes in the daughter cells is reduced to half as compared to that of chromosome number of the mother cell.
8. **b** Each of 20 chromosomes of the cell divides into two identical chromosomes. These chromosomes separate from each other and move to opposite poles of the cell, while the cell divides into two cells, each now containing the same number, 20, as the mother cell.
9. **c** The chromosomes are made of chromatin material; similarly the genes are segments of DNA.
10. **d** After the late prophase stage, spindle fibers get attached to the centromeres of the chromosome.

Taxonomy

1. **b** Double fertilization and triple fusion is characteristic of angiosperm.
2. **c** In the system of classification, of the groups mentioned the largest is the class, followed by order; genus; species.
3. **c** Dicot plants are characterized by reticulate venation (net veined) and monocot leaves have parallel venation. Sunflower, tomato, and *Cuscuta* is dicot plant with reticulate venation. Maize is a monocot plant with parallel venation.
4. **c** The sporophyte of bryophytes is dependent on the gametophyte.
5. **c** Pteridophytes are tracheophytes with vascular tissues.
6. **a** *Selaginella*, horsetail, & *Adiantum* are pteridophytes; *Marchantia* is a bryophyte.
7. **c** Algae have autotrophic nutrition and fungi have heterotrophic nutrition.
8. **a** Bryophytes, gymnosperms, and angiosperms are embryophytes. The zygote in algae does not produce embryo.
9. **c** Vessels and companion cells are present in the vascular bundles of angiosperms only. Mango in the given list of plants is angiosperm.
10. **d** Peat moss is true moss as it belongs to bryophyta. Reindeer moss and Iceland moss are lichen, whereas club moss is a pteridophyte.

Bacteria & Virus

1. **b** Most bacteria can synthesize organic food but do not have plastids.
2. **d** Bacteriophages are viruses that are parasitic over bacteria.
3. **a** Bacilli are rod-shaped bacteria. spirilla are spirally curved bacteria. Cocci are spherical bacteria and pleomorphic bacteria do not have a fixed shape.
4. **b** Bacteria are single celled monera with a cell wall. They do not have organized or true nucleus.
5. **d** Tetanus is caused by bacilli. The remaining diseases are caused by virus.
6. **a** Viruses contain a central core of nucleic acid (DNA or RNA) covered by a protein coat, but do not contain cytoplasm.

Fern

1. **a** The fern plant is diploid, produces spores for reproduction, thus it is a sporophyte.
2. **c** The male gametes of fern are multiflagellated. They swim into the archegonium with the help of these flagella.
3. **a** Malic acid is special chemical secreted by the archegonium.
4. **c** Gametophytic generation starts with the formation of haploid spore by the reduction division of spore mother cells inside the capsule of sporangium. Zygote is the first cell of sporophytic generation.

Anatomy & Physiology

1. **c** Xylem is a complex permanent tissue of plants that conducts water and minerals from to the root to the shoot.
2. **a** Ethyl alcohol, carbon dioxide, and energy are produced during anaerobic respiration in yeast.
3. **c** Stomata are tiny opening in the leaf epidermis that help in transpiration and gaseous exchange.
4. **d** Cells (3) are organized into tissues (2), which make up organs (1). A system (4) consists of organs. All systems in coordination comprise into an organism (5).
5. **b** The meristem contains actively growing cells and is contained in the growing tips of a stem.
6. **d** Some of the glucose made during photosynthesis is used for energy; some is stored as starch; some is converted into proteins and fats. Transpiration is the evaporation of water from the surface of plants.
7. **b** Plant stems grow away from gravity. This response is an example of negative geotropism. The stem does this in the dark, without their growth being influenced by light.
8. **b** Stoma (the opening or pore) is surrounded by two specialized epidermal cells called guard cells which control the opening and closing of stomata.
9. **b** A completely developed phloem of an angiosperm consists of sieve tubes, companion cells, phloem parenchyma, and bast fibers.

10. **b** The vascular bundles in monocot stem are scattered and those of dicot stem are arranged in a ring.

Genetics

1. **b** Transfer RNA (tRNA) are the smallest RNA that have clover leaf-shaped structure. tRNA are also called soluble RNA.
2. **c** The basic information of life is contained in the genes in DNA.
3. **b** A dominant gene expresses itself in both homozygous & heterozygous states. The gene for tall character (T) is dominant over the gene for dwarf character (t).
4. **c** On selfing pure tall pea plant produce tall progeny. Hybrid pea plant produces 75% tall and 25% dwarf progeny.
5. **a** During cellular respiration, energy is released from glucose by a series of complex steps. When glucose is broken down, some of the energy is used in the formation of ATP from ADP and phosphate.
6. **c** A cross of hybrids yields a genotype ratio of 1:2:1, in which the offspring are 25% homozygous dominant, 50% are heterozygous dominant, and 25% homozygous recessive.
6. **a** Nucleotides are the repeating units in the structure of nucleic acids. A nucleotide consists of five carbon sugar, nitrogen base, and a phosphate group.
7. **b** Genotype refers to internal genetic (allelic) makeup of organisms; phenotype means the outward appearance. The possible results are arrived in this way:

   F2 Genotypes

	A	a
A	AA	Aa
a	Aa	aa

   AA 1 Pure dominant (Homozygous)

   Aa 2 Dominant but hybrid (Heterozygous)

   Aa 1 Recessive

   Three out of four offspring show dominant phenotype, i.e. 75% of the F2 generation will have dominant phenotype.
8. **b** 9:3:3:1 is phenotypic ratio for a dihybrid cross. 3: 1 is phenotypic ratio for a monohybrid cross. 1:2:1 is the genotypic ratio for a monohybrid cross.
10. **d** Uracil is a pyrimidine base found only in RNA. Adenine & guanine are purine bases; cytosine, thymine, and uracil are pyrimidine bases.

Reproduction

1. **a** The cells that unite to form single diploid zygote are called gametes.
2. **b** The pistil contains an enlarged portion at the base, the ovary. When the flower matures and is fertilized, the ovary becomes fruit.
3. **c** A fleshy, modified underground stem is known as tuber. Potato is an example of tuber.

4. **b** Since cross-pollination involves the fusion of gametes, it cannot be considered as asexual reproduction.
5. **d** Ovules develop with the ovary of a carpel.
6. **b** Onion bulb is a modification of stem with fleshy leaves.
7. **a** Vivipary is a special type of germination where seeds germinate while still within the fruits.
8. **a** Tuber is modified underground stem that helps in natural vegetative propagation. Cutting, layering, and grafting are common methods of artificial vegetative propagation.
9. **d** Sweet potato, *Dahlia*, and *Asparagus* are plants that propagate naturally through root.

Ecology

1. **c** Soybean has nodulated root containing nitrogen fixing bacteria. As a result of nitrogen fixation in its roots, it is a rich source of vegetarian protein.
2. **d** The number of predators depends on their ability to catch prey. If more prey are available, the predators will be more successful in getting food and their numbers will increase.
3. **a** In one part of nitrogen cycle (ammonification), bacteria of decay in soil decompose dead plants and animals that contain nitrogen compounds into ammonia.
4. **c** The population of all the plants, animals, and other organisms living together in a given environment comprise a community.
5. **b** Japanese beetles are worse pest in America than in Japan because they have lesser natural enemies.
6. **d** The apple tree has chlorophyll, which can use the energy of light to make organic compounds containing chemical energy.
7. **c** Biomass is the total dry weight of organisms. In a stable ecosystem the greatest biomass is that of producers. Grasses represent producer in the above mentioned biotic components. Rest three animals represent consumers.
8. **a** Mutualism or symbiosis is a positive interaction where both partners get mutual advantage from each other. In commensalism one of the partners gets advantage from the other without harming the partner in association. Parasite gets advantage by harming its host in parasitism. A predator (an organism that is hunting) feeds on its prey (the organism that is attacked).
9. **a** The radiant energy of sun is trapped by green plants (producers). The energy flows from producers to consumers to decomposers.
   Sunlight ⟶ consumer ⟶ decomposer
10. **d** The pyramid of biomass shows the amount of biomass present in the organisms at each trophic level. It represents the chemical energy available at each step of food chain.

Practice Test - 1

1. "Killing of one's brother" is called…
   A. fratricide B. homicide C. patricide D. genocide
2. If you add 2+2, it … 4.
   A. will be B. will become C. becomes D. was
3. Only the blood-stained road was a witness … his assassination.
   A. of B. to C. at D. on
4. Shyam has no control … his temper.
   A. at B. after C. in D. over
5. Mr. John is … European teacher.
   A. an B. a C. the D. no article
6. The man is … LLB.
   A. a B. an C. the D. no article
7. He plays … football very well.
   A. a B. an C. the D. no article
8. Stop that noise, …?
   A. will you B. won't you C. can't you D. don't you
9. The antonym of 'heredity' is ….
   A. environment B. gene C. inheredity D. none
10. The synonym of 'postpone' is ….
    A. defer B. stop C. wait D. none
11. The indirect form of *He said, "Let's leave the case in the station."* is….
    A. He suggested leaving the case at the station.
    B. He said that they had to leave the case in the station.
    C. He said that they left the case in the station.
    D. None of the above.
12. The passive form of "People said that he was jealous of her." is….
    A. He was jealous of her.
    B. He was said to be jealous of her.
    C. People said he had been jealous of her.
    D. None of the above
13. The horse and carriage … ready.
    A. is B. am C. are D. none
14. Do not copy the answer ….
    A. word by word B. word to word
    C. word for word D. none of these
15. He was no … than a thief.
    A. other B. others C. an other D. the other

Read the following passage and answer the questions given.

The greatest enemy of mankind, as people have discovered, is not science, but war. Science merely reflects the prevailing social forces. It is found that, when there is peace, science is constructive; when there is war, science is perverted to destructive ends. The weapons which science gives us do not necessarily cause war, they make war increasingly terrible. Till now, it has brought us to the doorstep to doom. Our main problem, therefore, is not to curb science, but to stop war to substitute law for force, and international government for anarchy in the relations of one nation with another. That is a job in which everybody must participate, including scientists. But the Bombing of Hiroshima suddenly woke us up to the fact that we have very little time. The hour is late and our work has scarcely begun. Now we are face to face with an urgent question "Can education and tolerance, understand and creative intelligence run fast enough to keep us abreast with our own mounting capacity to destroy?" that is the question which we shall have to answer one way or the other in this generation. Science must help us in arriving at the answers, but the main decision lies within ourselves.

Questions:

16. According to the writer, the real enemy of mankind is not science but war, because
    A. Science merely invents the weapons with which war is fought
    B. Science during war become destructive
    C. The weapons that science invents necessarily lead to war.
    D. The weapons invented by science do not cause war, though these make it more destructive.
17. According to the writer, the main problem we are faced with is to ….
    A. Stop science from reflecting social forces.
    B. Stop scientific activities everywhere.
    C. Abolish war.
    D. Prevent scientists from participating in destructive activities.
18. The expression "bring to the doorstep of doom" means ….
    A. Carry close to death and destruction
    B. Lead to the threshold of new destiny
    C. Indulge in ruinous activity
    D. Introduces to an unpredictable destiny
19. Which of the following is opposite in meaning to the word 'anarchy'?
    A. Law and order B. Political dominance
    C. Economic prosperity D. Communal harmony
20. Which of the following would be the most suitable title for the passage?
    A. Science and social forces
    B. Science and horrors of war
    C. Science and the new generation
    D. Science and world peace

21. In a jar, 1/2 of the marbles are red, 1/4 are white, and 1/5 are blue. What fraction of the marbles are neither red, white nor blue?
A. 19/20 B. 1/20 C. 15/20 D. 1/10
22. What is 10% of 20% of 30%?
A. 0.006% B. 0.6% C. 6% D. 60%
23. If x+ y=6, y+ z=7, and z +x=9, what is the arithmetic mean of x, y, and z?
A. 11/3 B. 11/2 C. 11 D. 22/3
24. A square of area 2 is inscribed in a circle. What is the area of the circle?
A. $\pi/4$ B. $\pi/2$ C. π D. 2π
25. When a digital clock reads 3:47, the sum of the digits is 14. How many minutes after 3:47 will the sum of the digits be 20 for the first time?
A. 42 B. 132 C. 192 D. 251
26. The value of $9^{1/3} .9^{1/9} .9^{1/27}\ldots\ldots\ldots\ldots\ldots\infty$ is
A. 9 B. 1` C. 3 D. None of these
27. If $\tan\alpha=1/2$, $\tan\beta=1/3$, then $\alpha + \beta$ is equal to
A. $\pi/2$ B. $\pi/3$ C. $\pi/4$ D. $\pi/6$
28. The distance between the lines $3x +4y =6$ and $6x +8y =15$ is
A. 3/2 B. 6 C. 3/10 D. 7/9
29. The acute angle between the lines $3x^2 – 7xy-3y^2 =0$ is
A. $\pi/2$ B. $\pi/4$ C. $\pi/6$ D. None of the above
30. Which of the following is the value of P, if one root of $x^2 – Px + 1 = 0$ is square of other
A. -1 B. -2 C. 1, -2 D. 2, -1
31. The point of concurrency of three internal angles bisectors of a triangle is called
A. Orthocenter B. Circumcentre
C. Incentre D. Excentre
32. From a set of number cards numbered from 1 to 20, a card is drawn randomly. Find the probability of getting a card exactly divisible by 3 or 4.
A. 11/20 B. 1/2 C. 9/20 D. 1/20
33. The median of the data: 8, 12,35,40,15,10,11,14 is
A. 4.5 B. 12 C. 13 D. 14
34. If A is any square matrix, then $A + A^T$ will be
A. A diagonal matrix B. A symmentric matrix
C. A skew-symmetric matrix D. Identity matrix
35. If the equation $x2 + 2(K+2)x + 9k = 0$ has equal roots, then the value of K is
A. 1 B. 2 C. 3 D. 0
36. If $\vec{a} = \vec{i} + \vec{j} - 2\vec{k}$ and $\vec{b} = 2\vec{i} - \vec{j} - \vec{k}$ are any two vectors, then the angle between $\vec{a}$ and $\vec{b}$ is
A. $\frac{\pi}{6}$ B. $\frac{\pi}{3}$ C. 0 D. $\frac{\pi}{2}$

37. If SinA, SinB, SinC are in A.P. then a,b,c are in
A. A.P. B. G.P. C. H.P. D. None

38. The length of the perpendicular from origin on the line joining (a,b) and (b,a) is
A. $\frac{a+b}{2}$ B. $\frac{a+b}{\sqrt{2}}$ C. $\frac{a-b}{\sqrt{2}}$ D. $\frac{a-b}{2}$

39. How many integers are solutions of the inequality $3|x| + 2 < 17$?
A. 0 B. 8 C. 9 D. 5

40. 30 men work 10 hours a day to complete a piece of work in 25 days. How many men will be required to complete a piece of work twice as great in 15 days working 8 hours a day?
A. 130 B. 125 C. 12.5 D. 75

41. In a monohybrid cross, the two parental genotypes are AA and aa. The genotype of all F_1 plants is Aa. If the F_1 plants are crossed to get F_2 generation, what percentage of the F_2 generation will have the dominant phenotype?
A.100% B. 75% C. 50% D. 25%

42. What is the name of the process by which the cytoplasm of a cell divides to form two daughter cells?
A. Cytokinesis B. Interphase C. Prophase D. Karyokinesis

43. In a plain community, the population with greatest biomass would be
A. Foxes B. Hawks C. Grasses D. Beetles

44. The process of loss of water vapour from the aerial parts of plants is called transpiration. The opening and closing of stomata is controlled by
A. Stomatal cells B. Guard cells C. Xylem cells D. Phloem cells

45. Which of the following plants mentioned below is not characterized by the presence of reticulate veins in its leaves?
A. Sunflower B. Tomato C. Maize D. *Cuscuta*

46. What the association between two organisms called if one gets advantage from the other without harming it?
A. Mutualism B. Commensalism
C. Predation D. Parasitism

47. What is the branch of biology dealing with the study of algae called?
A. Phycology B. Mycology C. Ornithology D. Myology

48. Which of the following is human diploid chromosome number?
A. 10 B. 23 C. 46 D. 92

49. Sieve tubes, phloem parenchyma, bast fibers, and ……. are the elements of phloem.
A. Vessels B. Tracheids C. Wood fibers D. Companion cells

50. A student studied two different groups of cells and made the following observations:

Trait	Cell I	Cell II
Cell wall	Present	Present
Ribosomes	Present	Present
Nucleus	Absent	Present
Ability to photosynthesize	Present	Present
Cell respiration	Present	Present

Which of the following conclusions is best supported by these observations?

A. Cell I is more complex in its organization than cell II

B. Cell I is a prokaryote

C. Cell II does not have a nucleus

D. The ancestors of cell II appeared earlier in the fossil record than the ancestors of cell II

51. A part of digestive system that is not in contact with food is the

A. Small intestine B. Stomach C. Large intestine b D. Liver

52. Although the Duckbilled Platypus lays eggs, it is classified as

A. Amphibia B. Reptilia C. Aves D. Mammal

53. Epithelial cells may have all of the following functions except

A. Protection B. Absorption C. Contraction D. Secretion

54. One of the characteristics of all living things is that they

A. Require oxygen for respiration

B. Originate from pre-existing life

C. Carry on heterotrophic nutrition

D. Carry on autotrophic nutrition

55. All of the following are examples of a reflex except

A. Sneezing B. Blinking C. Thinking D. Knee Jerking

56. Two wastes resulting from the oxidation of food are

A. Oxygen & water B. Carbon dioxide & water

C. Oxygen & Carbon dioxide D. Oxygen & ATP

57. Which of the following is not an attribute of enzyme?

A. They are specific in nature

B. They are proteinous in nature

C They are used up in the reaction

D. They speed up rate of biochemical reactions

58. Short sightedness of myopic vision is corrected by wearing

A. Convex lens B. Concave lens

C. Concave mirror D. Convex mirror

59. *Hydra* is

A. Asymmetrical B. Radially Symmetrical

C. Spherically Symmetrical D. Bilaterally Symmetrical

60. If a bird is transferred from 20^0C to 10^0C. The body temperature will change to
A. 15^0C B. 5^0C C. 10^0C D. No change
61. A mixture of sand, common salt and camphor can be separated by
A. Filtration B. Evaporation
C. Sublimation D. Filtration followed by Sublimation
62. The atomic numbers of two elements A and B are 30 and 15 respectively. What is the possible formula of the compound?
A. A_3B_2 B. A_2B_3 C. AB_2 D. AB
63. Which of the following is natural polymer?
A. Starch B. Plastic C. Protein D. Both A & C
64. Which of the following is covalent solid?
A. copper B. Diamond C. Sodium Chloride D. Methane
65. Divide a piece of chalk into half. Divide it further and keep on dividing it many times. The smallest piece of chalk that can be obtained by this division is
A. An atom B. A molecule C. A particle D. A crystal
66. The compound AgCl is composed of
A. AgCl molecule
B. Atoms of silver and chlorine
C. Polymerized AgCl molecules
D. Ag^+ and Cl^-
67. The compound which gives chlorine like smell is
A. $CaOCl_2$ B. $CHCl_2$ C. $CaCl_2$ D. both b and c
68. Which of the following is characteristic of both mixtures and compounds?
A. Energy is absorbed when they are made
B. Their properties are same as those of their components
C. They contain components in fixed ratios
D. Their mass equals the sum of mass of their components
69. Which of the following is not a solution?
A. Smoke B. Air C. Brass D. A gold ring
70. In the nucleus of $_{20}Ca^{40}$, there are
A. 40 protons and 20 electrons
B. 20 protons and 40 electrons
C. 20 protons and 20 electrons
D. 20 protons and 20 neutrons
71. The reverse process of neutralization is also known as
A. Hydrolysis reaction B. Rearrangement reaction
C. Precipitation reaction D. Red ox reaction
72. The general formula of cycloalkane is
A. C_nH_{2n+2} B. C_nH_{2n} C. C_nH_{2n-2} D. C_nH_{2n-1}
73. The absolute mass of one atom of hydrogen is
A. 1.008 amu B. 1.008gm C.1 amu D. $1.66x10^{-24}$gm

74. Which of the following is organic compound?
A. CO_2 B. CO C. Na_2CO_3 D. $CO(NH_2)_2$
75. Which of the following pairs of elements are chemically most similar?
A. Hf and Zr B. Na and Al C. Cu and Cl D. B and Be
76. Which of the following have the same unit?
A. Energy and force B. Work done and energy
C. Momentum and velocity D. Acceleration and velocity
77. Which of the following has unit but no dimension?
A. Plane angle B. magnetic field
C. Momentum D. Current
78. Which of the following relation is true?
A. $1N = 10^{13}$ dynes B. 1 Joule = 10^5 ergs
C. $1N = 10^5$ dynes D. 1 Joule = 10^6 ergs
79. A bullet having mass 1Kg and moving with a velocity of $2ms^{-1}$ penetrates in a wooden block which is at rest. After its penetration, both of them remain at rest. The amount of heat generated in the wooden block is equal to
A. 0J B. 1J C. 4J D. 2J
80. The value of 'g' will be exactly zero at
A. the pole of the earth B. the center of the earth
C. the Equator of the earth D. infinity
81. The mass of A is found to be greater than the mass of B. But the kinetic energy of A is found to be smaller than that of B. Then the velocity of A is ----------that of B.
A. smaller than B. greater than
C. equal to D. depends upon the size of the bodies
82. When we touch ice, we feel cool because of----------
A. the gain of heat energy B. the loss of heat energy
C. the gain of momentum D. none of the above
83. Which of the following process takes place faster than the others?
A. Conduction B. Convection
C. Radiation D. Propagation of sound
84. The full form of Emf in electricity is----------
A. Electromotive force B. Electromagnetic force
C. Electro motion force D. Electricity motion force
85. For a normal eye, ciliary muscles will be strained maximum when it views an object at
A. infinity B. anywhere
C. the least distance of distinct vision D. far distance of distinct vision
86. Sound wave can be propagated through
A. gas medium only B. Vacuum only
C. liquid medium only D. Solid, liquid and gas medium

87. Which of the following statement is false?
A. We can have an isolated charge
B. We can have an isolated magnetic pole
C. We c an have an isolated eye lens
D. We can have an isolated electron
88. Sure test of electrification is
A. repulsion between unlike charges B. attraction between unlike charges
C. repulsion between like charges D. attraction between like charges
89. The unit of intensity level of sound is
A. Wbm^{-2} B. dB C. Wb D. Joule
90. There will be a full moon when
A. the moon lies in between the earth and the sun
B. the sun lies in between the earth and the moon
C. the earth lies in between the sun and the moon not in one plane
D. the earth lies in between the sun and the moon
91. The first reasonably valid IQ test in the world was developed by
A. Alfred Binet B. Lewis Terman
C. David Wechsler D. William Stern
92. Who is the Author of 'Around The World In Eighty Days'?
A. Herman Melville B.Jules Verne C. Jonathan Swift D. Graham Greene
93. Which of the following works is not related with Louis Pasteur?
A. Germ theory of diseases B. Anti rabies vaccine
C. Pasteurization D. Discovery of Tuberculosis
94. The largest and smallest districts of Nepal are
A. Dolpa and Lalitpur B. Kailali and Nuwakot
C. Dolpa and Bhaktapur D. Syanja and Pyuthan
95. _____ controls the way in which the computer system functions and provides a means by which users can interact with the computer.
A. The operating system B. The motherboard
B. The platform D. Application software
96. If SYSTEM is written as SYSMET and NEARER is written as AENRER, then FRACTION will be coded as
A. Carfnoit B. Carftion C. Noitfrac D. Fracnoit
97. Choose the correct alternative that will continue the same pattern and fill in the blank spaces. 1, 4, 27, 16, ?, 36, 343
A. 125 B. 50 C. 78 D. 32
98. When a ship enters a sea from a river, its portion under water will
A. Increase B. Decrease
C. Show no change D. Increase and decrease alternatively

99. Liberty, Equality and Fraternity, this inspiration was derived from
A. American Revolution B. French Revolution
C. Russian Revolution D. None of the above

100. Which country leads in the production of rubber?
A. Australia B. India C. Thailand D. Myanmar

Practice Test - 2

1. Jason, the only intrepid one, struggled barehanded with the beast. It means Jason is _____.
A. frightened B. masculine C. thoughtful D. fearless
2. That is the town _____we will have to drive to reach the destination.
A. from which B. of which C. at which D. through which
3. What does the word 'aural' correspond to?
A. Hearing B. Speech C. Air D. Heat
4. Find the odd man out in the given set of words
A. eleven B. nine C. thirteen D. eighteen
5. 'Incredible' means what is _____.
A. not excitable B. not true C. trustworthy D. not believable
6. His _____ handwriting resulted from haste and carelessness.
A. careful B. beautiful C. unreadable D. lucid
7. Microscopically thin means:
A. as slender as a microscope
B. so thin that they can be just seen by the naked eye
C. so slender that they have to be seen through a microscope
D. all of these
8. When people suffer from a sense of doom, they think that
A. the world is coming to an end
B. the world is progressing day by day
C. people are getting more and more intelligent
D. the gap between the poor and rich is widening
9. Science has given the nations new occasions for falling out. Falling out means
A. quarrelling B. making friends
C. disintegrating into smaller parts D. becoming poorer and poorer
10. A war of nerves means:
A. an attempt to defeat enemies by putting pressure for losing courage or confidence
B. war bought with nuclear weapons
C. a guerrilla war D. nervous system
11. Expectation of life means
A. their life time achievements B. their average life span
C. the number of years people lived D. the things people hope to achieve

12. An insomniac is a person who:
    A. enjoys sleeping
    B. lacks respect for maniacs
    C. finds it difficult to sleep
    D. Sleeps more than others
13. Hamlet was reluctant to _____ the murder of his father.
    A. avenge B. revenge C. vengeance D. none

14. Predictable means
    A. we are not at all sure what will happen
    B. it is cautious
    C. it is safe
    D. we can guess what will happen
15. Silver is a good investment. _____, gold is a better one
    A. Although B. However C. While D. On the other hand
16. The conditional clause 'If she were rich, _____? is completed by
    A. She would buy that car.
    B. She will buy the car.
    C. She was going to buy that car.
    D. She bought that car.

Read the following passage and answer the questions given:

I believe that both these feelings do equal harm: the feeling of marvel as much as the fear. Because they have this in common that they both want to persuade the layman that there is nothing he can do for himself. Science is the new magic, they whisper; it is out of your hands; for good or ill, your salvation or your doom is the business of others.

17. What makes us think that science is the new magic?
    A. The harm
    B. Belief
    C. The feeling of marvel and fear
    D. Our stupidity
18. Why does a layman think that he can do nothing for himself?
    A. Lack of experience
    B. Lack of education
    C. Helplessness
    D. Influence of feeling marvel and fear
19. Why do they have to whisper?
    A. Because they are cunning.
    B. Because they do not want others to know it
    C. The sense of marvel and fear overpower them
    D. It is a great secret
20. The author seems to suggest that _____
    A. our doom is the business of others
    B. Our salvations is the business of others
    C. science is the new magic
    D. our irrational feelings cause the loss of faith in science
21. Grace has 16 jellybeans in her pocket. She has 8 red ones, 4 green ones, and 4 blue ones. What is the minimum number of jellybeans she must take out of her pocket to ensure that she has one of each color?

A. 4 B. 8 C. 12 D. 13

22. The function f(x) = –3x + 12 on R is
A. increasing B. decreasing C. constant D. none of these

23. The system of the equation x + 2y = –1, –2x – 4y = 2 has
A. only one solution B. finitely many solutions
C. no solution D. infinitely many solutions

24. The area of the triangle formed by the lines y – x = 0, y + x = 0 and x = c is
A. c sq. units B. c^2 sq. units C. ½ c sq. units D. ½ c^2 sq. units

25. If A is an m × n matrix and B is a matrix given in such a way that AB and BA are both defined, then the size of the B matrix is
A. m × n B. n × n C. m × n D. n × m

26. Let $\vec{a}$ and $\vec{b}$ be two given vectors such that $|\vec{a}| = \sqrt{3}$, $|\vec{b}| = 2$ and $\vec{a} \cdot \vec{b} = \sqrt{6}$, then the angle between $\vec{a}$ and $\vec{b}$ is
A. $\frac{\pi}{3}$ B. $\frac{\pi}{4}$ C. $\frac{\pi}{2}$ D. 0

27. The value of p for which the vectors $\vec{a} = p\vec{i} + \vec{j} - 2\vec{k}$ and $\vec{b} = \vec{i} + \vec{j} - 3\vec{k}$ are perpendicular to each other is
A. 9 B. –9 C. 7 D. –7

28. A can solve 90% of the problems given in a book and B can solve 70%. What is the probability that at least one of them will solve a problem selected at random from the book?
A. 0.63 B. 0.16 C. 0.97 D. 1.60

29. The number of non-empty proper subsets of order 6 is
A. 64 B. 63 C. 62 D. 60

30. If common difference is 5, then the total number of arithmetic means between 10 and 50 is
A. 8 B. 9 C. 5 D. 7

31. The area of triangle formed by the line 2x + 3y = 12 with the co-ordinate axes is
A. 24 B. 12 C. 6 D. 3

32. In a race of 1 km. A beats B by 100m. B beats C by 50 m. C beats D by 40 m then A beats D by
A. 190 m B. 820.8 m C. 179.2 m D. none

33. If m times of m^{th} term and n times of n^{th} term of an AP are equal then $(m + n)^{th}$ term is .....
A. mn B. $\frac{1}{mn}$ C. 1 D. 0

34. If the AM and GM of the roots of a quadratic equation be 8 and 5 respectively then the equation is
A. $x^2 + 6x + 25 = 0$ B. $x^2 - 16x + 25 = 0$
C. $x^2 - 16x - 25 = 0$ D. $x^2 - 13x + 40 = 0$

35. The value of $\frac{\cos 11^0 + \sin 11^0}{\cos 11^0 - \sin 11^0}$ is equal to the value of

A. $\tan 56^0$ B. $\sin 56^0$ C. $\cot 56^0$ D. $\tan 79^0$

36. Two cyclists start biking from a trail's start 3 hours apart. The second cyclist travels at 10 miles per hour and starts 3 hours after the first cyclist who is traveling at 6 miles per hour. How much time will pass before the second cyclist catches up with the first from the time the second cyclist started biking?

A. 2 hours B. 4 ½ hours C. 5 ¾ hours D. 6 hours

37. By how much the area of sphere is changes when its radius is doubled?

A. 100% B. 200% C. 300% D. 800%

38. The sum of the first n terms of the series: $\frac{n-1}{n}, \frac{n-2}{n}, \frac{n-3}{n}, \ldots\ldots\ldots$ is

A. $\frac{n-1}{2n}$ B. $\frac{n-1}{2}$ C. $\frac{n(n+1)}{2}$ D. $\frac{n}{2}$

39. If (a+b+c) (a – b + c) = 3ac, then angle B is equal to

A. $\frac{\pi}{9}$ B. $\frac{\pi}{2}$ C. $\frac{\pi}{3}$ D. $\frac{\pi}{4}$

40. The circles $x^2 + y^2 + 2ax + c = 0$ and $x^2 + y^2 + 2by + c = 0$ will touch each other if

A. $\frac{1}{a^2} - \frac{1}{b^2} = \frac{1}{c^2}$ B. $\frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2} = 0$ C. $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c^2}$ D. $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$

41. At a height of 9m from ground if a body of mass 2 kg has gravitational potential energy 36J, what will be its final velocity with which it strikes the ground if it is dropped from there?

A. 4m/sec B. 6 m/sec C. 2m/sec D. 8 m/sec

42. Which of the following is a vector quality?

A. Time B. Speed C. Mass D. Plane area

43. A body has K E of 10 J. How much work has to be done on it to stop it?

A. 5 J B. 1 J C. 10 J D. 100 J

44. When a force is applied on 2 kg and 4 kg masses one after another, the acceleration produced on them are 2 m/s^2 and 1 m/s^2 respectively. What is the magnitude of that force?

A. 4 N B. 1 N C. 3 N D. 2 N

45. Which of the following statement is false?

A. A magnet can not have two opposite poles

B. A magnet can have an isolated pole

C. A magnet cannot have an isolated pole D. None of above

46. A convex lens can _____ the light.

A. only converge B. only diverge

C. neither converge nor diverge D. converge as well as diverge

47. Sound wave is _____
    A. a longitudinal wave. B. a transverse wave.
    C. an electromagnetic wave. D. not a wave.
48. The work done on bringing a unit positive test charge from one end of a resistor to another is called ____
    A. resistance B. potential difference C. emf D. power
49. Conductivity depends upon
    A. resistivity B. temperature
    C. nature of the material D. all of the above
50. For a normal eye, the far distance of distinct vision is
    A. 25 cm B. infinity C. 50 cm D. 75 cm
51. The lower limit of auditory for human beings is
    A. 10 Hz B. 100 Hz C. 20 Hz D. 20 KHz
52. To cool a hot body, we use liquid having
    A. low specific heat capacity B. low thermal heat capacity
    C. high thermal heat capacity D. high specific heat capacity
53. Volume of water will be minimum at
    A. 0^0C B. 4^0C C. 1^0C D. 2^0C
54. The time period of spin of the earth about its own axis is
    A. 1 year B. 366 days C. 29 days D. 24 hours
55. When a body is negatively charged, its____
    A. no. of electrons increases B. no. of electrons decreases
    C. mass increases D. both a and c
56. Which of the following is false in case of an electron?
    A. It is a particle B. It has wave property
    C. It emits energy while moving in orbits
    D. Its motion is affected by magnetic field
57. Which of the following forms a colloidal solution in water?
    A. Glucose B. Starch C. Sodium Chloride D. Urea
58. A compound was found to contain nitrogen and oxygen in the ratio 28 : 64. The formula of the compound is
    A. NO B. N_2O_3 C. N_2O_4 D. N_2O_5
59. Chemical formula of a particular compounds reflects
    A. shape of its molecule
    B. size of its molecule
    C. total number of atoms in a molecule
    D. number of different types of atoms in a molecule
60. Electronic configuration of M^{2+} ion is 2, 8, 14 and its atomic weight is 56 amu. The number of neutrons in its nucleus are
    A. 30 B. 32 C. 34 D. 42

61. Atoms combine in a small whole number ratio, this concept was proposed by
A. Dalton B. Avogadro C. Gay Lussac D. Berzelius
62. Two substance P and Q combine to give a third substance R. The process is exothermic and R has properties different from those of P and Q. Is the substance R
A. an element B. a mixture C. a compound D. an atom
63. Which of the following is called Sylvine?
A. KCl B. NaCl C. $CaCl_2$ D. $MgCl_2$
64. Liquid metal is .....
A. Ag B. Mg C. Hg D. none
65. The general formula of Paraffin is
A. C_nH_{2n+1} . X B. C_nH_{2n} C. C_nH_{2n-2} D. C_nH_{2n+2}
66. In IUPAC system of nomenclature, But in hydrocarbon indicates
A. prefix B. word root C. primary suffix D. secondary suffix
67. Which of the following reaction is acid-base reaction?
A. $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$ B. $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
C. $HCl + NaOH \rightarrow NaCl + H_2O$ D. $FeCl_3 + NaOH \rightarrow NaCl + Fe(OH)_3$
68. You are given a mixture of sand and common salt. Which process should apply to get pure common salt?
A. Dissolution and Evaporation B. Evaporation and Crystallization
C. Evaporation and Sublimation D. Sublimation and Crystallization
69. Two isotonic elements X and Y have atomic masses 54 and 56 respectively. If atomic number of X is 26, the atomic number of Y will be
A. 26 B. 27 C. 28 D. 30
70. German silver is an alloy of
A. Fe, Cr, Ni B. Cu, Zn, Ag C. Cu, Zn, Ni D. Cu, Sn, Al
71. A gymnosperm is a plant which
A. Bears flowers B. Produces seeds in cones
C. Does not produce seeds D. Exhibits no vascular tissues
72. Centromere is the part of a chromosome which helps in
A. Division of the centrosomes B. formation of spindle fibres
C. Movement of chromosomes D. Reappearance of nuclear membrane
73. When peacock eats snakes which eat insects thriving on green plants the peacock is
A. A primary consumer B. A primary decomposer
C. Final decomposer D. The apex of the food pyramid
74. A pure tall pea plant can be distinguished from a hybrid tall pea plant by
A. Selfing and noting that all progeny are dwarf
B. Gibberellins treatment
C. Selfing and noting that all progeny are tall
D. Measuring its height
75. Germinations of seed within fruit is
A. Ovipary B. Vivipary C. Hypogeal D. Epigeal

76. Double fertilization and triple fusion is characteristic of
A. All Plants B. Angiosperms C. Gymnosperms D. Pteridophytes
77. Which one of the following is not found in DNA?
A. Cytosine B. Guanine C. Adenine D. Uracil
78. Lysosomes are the
A. Digestive centres B. Respiratory centres
C. Excretory centres D. Energy centres
79. Regarding mitosis and cytokinesis, one difference between higher plants and animals is that in plants
A. Sister chromatids are identical, whereas in animals they differ from one another
B. A cell plate begins to form at telophase, whereas in animals a cleavage furrow is initiated at that stage
C. Chromosomes become attached to the spindle at prophase, whereas in animals chromosomes do not become attached until anaphase
D. Spindle poles contain centrioles, whereas spindle poles in animals do not
80. An antiviral substance produced in cell in response to viral infection to prevent the replication of new virus is
A. antibody B. interferon C. vitamin c D. antigen
81. One of the characteristics of all living beings is that they
A. Require oxygen for respiration B. Originate from pre-existing life
C. Carry on heterotrophic nutrition D. Carry on autotrophic nutrition
82. Clotting of blood inside the blood vessels is prevented by
A. Fibrinogen B. Platelets C. Heparin D. Prothrombin
83. Evolution is best defined as
A. Inheritance of acquired characters B. Descent with modifications
C. Spontaneous generation D. Struggle for existence
84. When an organism is benefitted without affecting the other, the phenomenon is known as
A. Parasitism B. Commensalism C. Symbiosis D. Predation
85. You are riding a bicycle and take a sudden turn around a sharp corner. The organs involved in the maintenance of balance is
A. Medulla oblongata B. Semicircular canals
C. Cerebrum D. Optic chiasma
86. Metabolic processes in the body are catalyzed by
A. Enzymes B. Hormones C. Proteins D. Lipids
87. The intestine of man is very long because
A. It provides larger area for food storage
B. The digestive juices are secreted all through its length
C. The bacteria contained in the food may gradually be killed
D. Its length enables greater scope for food absorption

88. All of the following are examples of reflex except
A. Sneezing B. Blinking C. Thinking D. Knee jerking
89. Scientific evidence indicates that an element needed to prevent tooth decay is
A. Chlorine B. Iodine C. Bromine D. Fluorine
90. All of the following are mammals except
A. Porpoise B. Walrus C. Seal D. Shark
91. Jack is taller than Peter, and Bill is shorter than jack. Which of the following statements would be most accurate?
A. Bill is taller than Peter
B. Bill is shorter than Peter
C. Bill is as tall as Peter
D. It is not possible to tell whether Bill or Peter is taller
92. Which of the following is the capital of a SAARC country?
A. Tokyo B. Sanghai C. Thimpu D. Bangkok
93. S.L.C. examination was for the first time started in the year…….B.S.
A. 2007 B. 1990 C. 2017 D. 2046
94. Amsterdam is the capital of
A. Denmark B. the Netherlands
C. Myanmar D. Belgium
95. The largest river of Nepal is
A. Gandaki B. Koshi C. Karnali D. Mechi
96. Which is the uppermost part of the atmosphere?
A. Troposphere B. Exposphere C. Stratosphere D. Mesosphere
97. A person who travels to work and back by car, bus or train.
A. Commuter B. Computer C. Carrier D. Pedestrian
98. Name the organization which was the forerunner of the U.N.O.
A. The League of Nations B. Benelux Union
C. Amnesty International D. The Commonwealth
99. Pointing towards a person, a man said to a woman, "His mother is the only daughter of your father." How is the woman related to that person?
A. Sister B. Daughter C. Mother D. Wife
100. Which of the following gases is used for refrigeration ?
A. Phosphine B. Chlorine
C. Sulphur dioxide D. Ammonia

Practice Test - 3

1. I gave him _____.
   A. one and a half rupees B. one and a half rupee
   C. one and half rupee D. one and half rupees
2. When I entered the bed room I saw a snake _____.
   A. on the ground B. on the floor
   C. on ground D. on floor
3. My brother and _____.
   A. myself will go B. myself will be go
   C. I will go D. I will be gone
4. You must see him after _____.
   A. dinner B. the dinner C. a dinner D. an dinner
5. One must learn to distinguish_____.
   A. good from bad B. good to bad
   C. the good from the bad D. good from worse
6. He walks as if _____.
   A. the world belongs to him B. the world is belonging to him
   C. the world had belonged to him D. the world belonged to him
7. I went there_____.
   A. with a view to buy a book B. with view to buy a book
   C. with a view to buying a book D. with a view to book
8. You_____.
   A. better revise this essay B. had better revised this essay
   C. had better revise this essay D. revise this essay better
9. I did nothing but _____.
   A. cried B. cry C. crying D. did cry
10. The thief_____.
    A. escaped before the police came B. escaped before the police had came
    C. had escaped before the police came D. had escaped before the police had came
11. He asked her _____.
    A. what was the matter B. what the matter was
    C. what the matter D. about what was the matter
12. I _____last night.
    A. had finished my letter B. have finished my letter
    C. finished my letter D. was finishing my letter
13. They will write_____.
    A. as soon as they will arrive home B. as soon as they arrive home
    C. as soon as they have arrived home D. as soon as they arrived home

14. I _____in Nepal.
    A. was born B. am born
    C. have been born D. had been born
15. I _____before I do anything.
    A. often think twice B. am often thinking twice
    C. often will think twice D. have often thought twice
16. The chief _____there.
    A. with his flowers, were present B. with his flowers, was present
    C. with his flowers, be present D. with his flowers, have present

Read the following passage and answer the questions given (87- 90):

We live in a curious age. We are offered glimpses of a genuine world civilization slowly emerging – the U.N. special agencies, organizations like Oxfam, and here and there, as I have seen for myself, remote enterprises, dedicated to healing or education, with international staff of selfless enthusiasts. And such glimpses warm the heart and brighten hope. But along with these are sight and sounds that suggest that the whole fabric of civilization, the work of centuries, is rapidly being torn apart.

17. Such glimpses warm the heart and brighten the hope. It means
    A. people can't help being optimistic and hopeful.
    B. such glimpses are good for heart patient.
    C. such glimpses are want of warmth and hope.
    D. such glimpses are lacking hope.
18. The writer thinks that we live in a curious age,
    A. because we have a lot of curiosity about the age.
    B. because we find great things everywhere.
    C. Because we are better than our forefathers.
    D. Because this age offers both the glimpses of construction and destruction.
19. We are offered glimpses of a genuine world civilization slowly emerging,
    A. because there are many civilized people in the world who work for the welfare of the mankind.
    B. because we want to have such glimpses.
    C. because the world is highly civilized.
    D. because we pay for such glimpses.
20. The author seems to suggest that
    A. it is an age of progress. B. the civilization is at end.
    C. it is an age of crisis . D. it is an age of contradiction in values.
21. Which of the following are equations of straight line with slope $-\frac{3}{4}$ and forming a triangle of area 24 sq. units with coordinate axes?

    A. $y = \frac{3x}{4} \pm 6$ B. $y + \frac{3x}{4} = \pm 6$ C. $y = x \pm 6$ D. None

22. Which of the following is the angle between the lines $x\sec\theta + y\cos\theta = a$ and $x\cos\theta - y\sin\theta = a\cos 2\theta$?

A. 30^0 B. 60^0 C. 90^0 D. 120^0

23. If the fourth term of G.P is 54 and 6th term is 24, which term of the following is $7\frac{1}{9}$?

A. 7 B. 8 C. 9 D. 10

24. The probability that a boy will get a scholarship is 0.75 and that a girl will get is 0.80. What is the probability that at least one of them will get the scholarship?

A. 0.20 B. 0.05 C. 0.95 D. 0.25

25. If f(x) =3x - 4 and g(x) = 3 - 2x.Which of the following is the value of fog(2) ?

A. 7 B. -7 C. 9 D. 8

26. In a right angle ΔABC, $\angle B = 30^0$, BC = 12cm and area of ΔABC = 27sq. cm. What is the measurement of AB?

A. 9 B. 7 C. 10 D. 18

27. If $\tan\theta = \frac{5}{6}$ and $\tan\beta = \frac{1}{11}$, which of the following is the value of $\theta+\beta$?

A. $\frac{\pi}{6}$ B. $\frac{\pi}{3}$ C. $\frac{\pi}{2}$ D. $\frac{\pi}{4}$

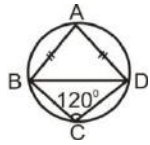
28. Which of the following is the length of each side of equilateral triangle of area 196 $\sqrt{3}\,cm^2$?

A. $7\sqrt{3}\,cm$ B. $14\sqrt{3}\,cm$ C. 28 cm D. 7 cm

29. The root of quadratic equation $ax^2 + bx + c = 0$ are in the ratio of 3:4. Then which one is true?

A. $b^2 = 4ac$ B. $4b^2 = 25ac$ C. $12b^2 = 49ac$ D. None

30. In adjoining figure AB =AD and $\angle BCD = 120^0$ .Then which one is $\angle ADB$?



A. 45^0 B. 30^0 C. 60^0 D. 15^0

31. Which of the following is the property of Skew Symmetric Matrix A?

A. $A = A^T$ B. $A = -A^T$ C. $[aij] = [aji]$ D. None

32. If three consecutive vertices of a parallelogram are (-2, -1), (1, 0) and (4, 3) then the fourth vertex is

A. (1, 2) B. (5, 3) C. (2, 1) D. (3, -1)

33. If prices are reduced by 25% and the sales increase by 20%, what is the net effect on gross receipts?

A. increase by 5% B. decrease by 5%
C. increase by 10% D. decrease by 10%

34. The equation of the circle whose ends of diameter are (-2, 3) and (-3, 6) is

A. $x^2+y^2 + 5x - 9y + 24 = 0$ B. $x^2 + y^2 - 5x + 9y + 24 = 0$
C. $x^2 + y^2 - 5x - 9y + 24 = 0$ D. $x^2 + y^2 - 5x - 3y + 12 = 0$

35. A bus travels at an average speed of 50 miles per hour for 2.5 hours and then travels at a speed of 70 miles per hour for 1.5 hours. How far did the train travel in the entire 4 hours?
A. 150 miles B. 130 miles C. 125 miles D. 230 miles

36. A man deposits Rs. 1 on a day, Rs. 2 on the next day, Rs. 3 on the third day and so on for 60 days. Total collection at the end of 60 days will be:
A. Rs. 183 B. Rs. 1830 C. Rs. 3660 D. Rs. 5460

37. A man buys 100 apples at 50 paisa each and 50 oranges at 60 paisa each. 10% of the apples and oranges are spoiled. The man sells the remaining apples at 70 paisa each and oranges at Rs. 1 each. The profit made as percentage of the cost is:
A. 50% B. 35% C. 33.3% D. 26%

38. A circle whose centre at the origin passes through the point (1, 1). What is the area of this circle?
A. π B. 2π C. $\sqrt{2}\,\pi$ D. 4π

39. If a triangle of base 6 has the same area as a circle of radius 6, what is the attitude of the triangle?
A. 6π B. 8π C. 10π D. 12π

40. For what value of m the pairs $-3\vec{i}+5\vec{j}+m\vec{k}$ and $4\vec{i}+6\vec{j}+3\vec{k}$ are orthogonals.
A. 6 B. -6 C. 1 D. None

41. A body completes its motion in a circular path of radius 2m in 1 second .What is its average velocity?
A. 2π m/sec B. 4π m/sec C. 0 m/sec D. 1m/sec

42. The relationship between velocity ratio (VR), effort distance (ED) and the load distance (LD) is
A. VR= $\frac{ED}{LD}$ B. VR= $\frac{LD}{ED}$ C. ED= $\frac{VR}{LD}$ D. ED= $\frac{VR}{LD}$

43. According to the conservation of energy when a ball falls freely under gravity, its gravitational potential energy is converted into
A. electrical potential energy B. kinetic energy
C. sound energy D. chemical energy

44. When the distance of a person from the source is doubled to its initial value, the intensity of sound is
A. increased to 2 times C. increased to 4 times
B. decreased to $\frac{1}{2}$ times D. decreased to $\frac{1}{4}$ times

45. The real depth of a pond is 3m. If the refractive index of water is 1.33, find its apparent depth.
A. $\frac{3}{1.33}$ B. $\frac{1.33}{3}$ C. 1.33×3 D. $\frac{1}{1.33\times3}$

46. Refraction of light is due to the change in its
A. frequency B. wavelength C. colour D. nature
47. When the current is 1A, the flow of charge in 1 sec is equal to
A. 1.6×10^{19}C B. 3×10^{8} C C. 1 C D. 1×10^{8} C
48. A man standing on a platform feels the weightless when the platform moves with
A. uniform speed in downward direction
B. acceleration equal to 'g' in downward direction
C. acceleration equal to 'g' in upward direction
D. uniform speed in upward direction
49. When a body floats in a liquid,
A. its weight is greater than the upthrust B. its weight is less than the upthrust
C. its weight is equal to the upthrust D. its density is greater than the upthrust
50. A lens always forms a diminished image then it should be a
A. Convex lens B. Plano convex lens
C. Concavo-convex lens D. Concave lens
51. A transformer converts
A. AC to AC B. AC to DC C. DC to AC D. DC to DC
52. When the temperature of water is changed, its density will be maximum at
A. 0^{o}C B. 1^{o}C C. 2^{o}C D. 4^{o}C
53. The heat equation is
A. $Q = ms\Delta\theta$ B. $m_1s_1\Delta\theta_1 = m_2s_2\Delta\theta_2$
C. $Q = \frac{ms}{\Delta\theta}$ D. $Q = \frac{m\,\Delta\theta}{s}$
54. The magnetic lines of force
A. starts from South Pole of the magnet B. starts from positive charge
C. starts from negative charge D. starts from North Pole of the magnet
55. Which one of the following is not a renewable energy source?
A. biogas B. wind energy
C. nuclear energy D. tidal energy
56. A baking powder can carries the statement, "Ingredients: corn starch, sodium bicarbonate, calcium acid phosphate, and sodium aluminium sulphate." Therefore, this baking powder is
A. a compound B. a molecule
C. a mixture D. a mixture of elements
57. Which of the following is a physical property of sugar?
A. It is a white crystalline solid
B. It can be decomposed with heat
C. Its composition is carbon, hydrogen & oxygen
D. It turns black with concentrated H_2SO_4

58. An electron-dot notation consists of the symbol representing the element and an arrangement of dots that usually shows
A. the atomic number B. the total number of electrons
C. the atomic mass D. the valence electrons

59. When hydrogen combines with an element to form a compound, the resulting compound is
A. a salt B. an acid C. a hydride D. a reduction

60. A compound that can be decomposed to produce oxygen gas in the lab is
A. MnO_2 B. $KMnO_4$ C. Na_2CO_3 D. $KClO_3$

61. The reaction of aluminium with dilute H_2SO_4 can be classified as
A. synthesis B. single displacement
C. decomposition D. double displacement

62. The reaction of an acid like H_2SO_4 and a base like CuO always
A. forms a blue precipitate B. forms a volatile salt and water
C. forms an insoluble salt and water D. forms a soluble salt and water

63. The correct formula for calcium hydrogen sulphate is
A. CaH_2SO_4 B. $CaHSO_4$ C. $Ca(HSO_4)_2$ D. Ca_2HSO_4

64. All of the following involve a chemical change EXCEPT
A. the formation of HCl from H_2 & Cl_2
B. the colour change when NO is exposed to air
C. the formation of CO_2 from burning coal
D. the evaporation of water at room temperature

65. Which of the following define(s) an acid according to conventional acid theories?
I) It is a good proton donor II) It is a good electron pair acceptor
III) It gives excess of H_3O^+ in solution
A. I only B. III only C. I & II only D. I, II & III

66. The placement of the halogen family in the periodic table explains which of the following statements?
I) The most active non-metallic element in the periodic table is fluorine
II) The normal physical state of the halogen goes from a solid to a gaseous state as you go down the family
III) The halogen element becomes ions by filling the outermost d-orbital
A. I only B. II only C. I & II D. II & III

67. Ethene is the first member of the
A. alkane series B. alkyne series C. alkene series D. alcohol series

68. Complete the following chemical change. $Mg + CO_2 \rightarrow$ ……. + C
A. MgO_2 B. MgO C. Mg_2O D. $(MgO)_2$

69. Which of the following is the correct ground state configuration of chromium?
A. $3d^5\ 4s^1$ B. $3d^6\ 4s^0$ C. $3d^4\ 4s^2$ D. $3d^3\ 4s^3$

70. Which of the following is not a precipitation reaction?
A. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$ B. $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

C. $HgCl_2 + 2KI \rightarrow 2KCl + HgI_2$ D. $NaOH + HCl \rightarrow NaCl + H_2O$

71. All of the following are correct about human red blood cells EXCEPT
    A. they are called leucocytes B. they do not have nucleus
    C. they are formed in the bone marrow D. they carry oxyhemoglobin
72. Silver fish is
    A. a fish B. an insect C. a bone D. none of the above
73. The famous book "Origin of Species" was written by
    A. C Darwin B. A R Wallace C. C Linnaeus D. J B D Lamarck
74. In reptiles, heart is
    A. mostly 3 chambered B. always 3 chambered
    C. 2 chambered D. 4 chambered
75. The part of an eye which acts like a diaphragm of a photographic camera is
    A. cornea B. iris C. pupil D. lens
76. The process of respiration is concerned with
    A. intake of oxygen B. liberation of oxygen
    C. liberation of carbon dioxide D. liberation of energy
77. All of the following are true of vitamin A EXCEPT
    A. it prevents night-blindness B. it is formed from carotene
    C. it is used in making visual purple D. it is used in making hemoglobin
78. One of the characteristics of all living beings is that they
    A. require oxygen for respiration B. originate from pre-existing life
    C. carry on heterotrophic nutrition D. carry on autotrophic nutrition
79. In man, cellulose is digested in
    A. colon B. appendix C. stomach D. none of the above
80. Of the following terms, which one includes all the others?
    A. Species B. Order C. Class D. Phylum
81. The scientific name of mustard is *Brassica campestris* and that of turnip is *Brassica rapa*. This indicates that both mustard and turnip are members of the
    A. same genus but different species B. same species but different genera
    C. same genus but different classes D. same class but different genera
82. Which one is the smallest oranism capable of autonomous growth and reproduction?
    A. Bacteria B. Virus C. Mycoplasma D. Blue-green algae
83. At what phase of meiosis are homologous chromosomes separated?
    A. Anaphase I B. Anaphase II C. Prophase I D. Prophase II
84. When green tomatoes turn red then
    A. new chloroplast are made
    B. chromoplast are changed into chloroplasts
    C. chloroplasts are disintegrated and get converted into chromoplast
    D. none of these

85. Why do legume plants enrich soil?
    A. They remove poisonous heavy metals
    B. They encourage the breeding of earthworm
    C. Their roots contain symbiotic nitrogen fixing bacteria
    D. Their root system penetrate 2 meters below the surface
86. Which of the following would be most likely to occur in an ecosystem?
    A. As the number of prey decreases, the number of predators increases.
    B. As the number of predators increases, the number of prey increases.
    C. As the number of prey increases, the number of predators increases.
    D. As the number of prey increases, the number of predators decreases.
87. In the nitrogen cycle, nitrogen compounds are broken down by decomposers to release
    A. ammonia B. vinegar C. urea D. nitrate
88. Which of the following is illustrated by an organism that exists in a helpful relationship with another organism?
    A. photosynthesis B. autotropism C. saprophytism D. mutualism
89. A vacant lot may have organisms such as grass, dandelions, ants, soil bacteria, earthworms, trees, and mice living in it. Together all of these organisms comprise a
    A. population B. biome C. community D. biosphere
90. Most cells lacking a cell wall also lack
    A. mitochondria B. a vacuole C. chloroplasts D. a cell membrane
91. Which one of the following makes best comparison? Milk is to glass as letter is to:
    A. Stamp B. Pen C. Envelope D. Mail
92. What is the world's largest desert?
    A. The Sahara B. The Kalahari C. The Death Valley D. The Thar
93. What is the last letter of Greek alphabet?
    A. Pi (π) B. Alpha (α) C. Beta (β) D. Omega (ω)
94. Who is known as 'Yubak Kabi' of Nepal?
    A. Bhanubhakta B. Moti Ram Bhatta
    C. Shambhu Prasad Dhungel D. Madhav Prasad Ghimire
95. Name the country which contains all the vowels of the English alphabet only once.
    A. Australia B. Indonesia C. England D. Mozambique
96. "Bullish Trend" is related to
    A. Bull fight B. Stock market C. Economic survey D. Speed of plane
97. Who is considered as the father of medicine?
    A. Hippocrates B. Herodotus C. Lincoln D. Rehman
98. The longest river in the world is
    A. Ganga B. Nile C. Amazon D. Bagmati
99. Find the odd one out
    A. Hostel B. Club C. Inn D. Hotel
100. The first metal used by the man was
    A. Iron B. Copper C. Silver D. Gold

Practice Test - 4

1. The word …….. has four syllables.
   A. likelihood B. beautiful C. biology D. sociology
2. Although he is educated …….
   A. but he is rude B. however he rude
   C. he is rude D. I am educated too.
3. He is senior……..
   A. to me B. than me C. of me D. above me
4. It's high time ……
   A. you clean the room B. you cleaned the room
   C. you will clean the room D. you need to clean the room.
5. I …… why you are complaining.
   A. am understanding B. will be understanding
   C. understand D. understood
6. Had I known about it, …….
   A. I would do something B. I could do something
   C. I should have done something D. I would have done something
7. The house has been empty ……. ages.
   A. for B. since C. No preposition D. around
8. If I …… I would have bought a car.
   A. were rich B. am rich C. had been rich D. could be rich
9. You can meet me …… noon.
   A. in B. on C. at D. during
10. I haven't read ……. of his poetry.
    A. much B. many C. few D. little
11. A car drove …… the gate.
    A. on B. past C. at D. into
12. He is one of …….. in our college.
    A. the best students B. best students C. the best student D. best student
13. He is …….. M.A. student from Tribhuvan University.
    A. a B. the C. an D. no article
14. He has been working here ……. 10 years.
    A. since B. past C. no preposition D. for
15. I am six ……
    A. foot B. feet C. footed D. feeted
16. He is five ……. tall.
    A. foot B. feet C. footed D. feeted

Read the following passage and answer the questions given below (17-20):

Psychologists divide extra-sensory perception (ESP) into four types. The first is telepathy. In telepathy a person is able to communicate with another who may be far away. A soldier on the battle front receives a message from his wife. Another type of ESP is clairvoyance, the ability to see events, persons and things not known to anyone else. The third type of ESP is precognition, the ability to foresee what is going to happen in the future. Finally there is psychokinesis, the power of mind over matter : a person having this ability will be able to move objects without touching them.

17. What does ESP refer to
    A. ESP refers to extra-sensory perception
    B. ESP refers to science
    C. ESP refers to the ability to communicate without using senses.
    D. ESP refers to senses
18. The author seems to suggest that
    A. We should develop ESP
    B. ESP is better than science
    C. ESP is the gift of God
    D. Extra-sensory perception cannot be explained by the law of nature
19. Telepathy means
    A. system of communication by the use of telephone
    B. ability to communicate
    C. mechanism of communication during the time of war
    D. direct communication of thoughts from one person to another without using senses
20. Is there any difference between science and ESP?
    A. Science depends on five senses unlike ESP
    B. There is no difference at all
    C. Science depends on experiments and ESP on five senses
    D. ESP depends on experiments and science on five senses
21. What will be the remainder of $4x^3 + 6x^2 + 3x - 1$, when it is divisable by $x + 2$.
    A. -1 B. -15 C. 61 D. -52
22. For what value of k the equation $3x^2 + 7x + 6 - k = 0$ has one root equals to zero.
    A. 3 B. 7 C. 6 D. -6
23. Value of $\cos 67\frac{1^0}{2}$ = …….
    A. $-\frac{1+\sqrt{5}}{4}$ B. $\frac{\sqrt{2}-1}{4}$ C. $-\frac{\sqrt{2-1}}{4}$ D. $\sqrt{\frac{\sqrt{2}-1}{2\sqrt{2}}}$
24. Value of $\cos^2 5^0 + \cos^2 10^0 + \ldots + \cos^2 90 = \ldots..$
    A. 1 B. 7 C. $8\frac{1}{2}$ D. $9\frac{\sqrt{3}}{2}$

25. The slope of the line $x\cos\alpha + y\sin\alpha = p$ is ……..
A. $\tan\alpha$ B. $\cot\alpha$ C. $-\tan\alpha$ D. $-\cot\alpha$

26. The perpendicular distance between the lines $2x + 3y = 5$ and $8x + 12y - 7 = 0$ is…….
A. 2 B. $\frac{\sqrt{13}}{4}$ C. $\frac{13}{4}$ D. none

27. The equation of the line passing through (1, -2) and parralel to y – axis is ……
A. $y = 1$ B. $y = 2$ C. $x = -1$ D. $x = 1$

28. If $\vec{a}$ and $\vec{b}$ are two unit vectors such that $\left|\vec{a} - \vec{b}\right| = \left|\vec{a} + \vec{b}\right|$, then the angle between $\vec{a}$ and $\vec{b}$ is …..
A. $\frac{\pi}{2}$ B. $\frac{\pi}{3}$ C. $\frac{\pi}{4}$ D. $\frac{\pi}{6}$

29. The area of symboi $\Delta ABC = 12\sqrt{3}$, side $\alpha = 6$, and side $b = 8$ then side c = ...
A. 10 or 12 B. 10 C. $2\sqrt{37}$ or $2\sqrt{13}$ D. $2\sqrt{37}$

30. Three coins are tossed together. Find the probability of getting at least two heads?
A. $\frac{1}{8}$ B. $\frac{3}{8}$ C. $\frac{1}{2}$ D. $\frac{1}{4}$

31. If 13, p, q, r, 29 are in A.P. Find the value of r.
A. 25 B. 17 C. 21 D. 24

32. Find the value of $\sqrt{20+\sqrt{20+\sqrt{20+.....\infty}}}$
A. ∞ B. 20 C. 5 D. 4

33. The surface area of a cube is 150 square feet. Calculate volume of the cube.
A. 30 cft B. 50 cft C. 100 cft D. 125 cft

34. If $x^a = y^b = z^c$ and $y^2 = xz$, then the value of b is ……..
A. $\frac{a+c}{2}$ B. ac C. $\sqrt{ac}$ D. $\frac{2ac}{a+c}$

35. Choose the pair numbers which come next to 75, 65, 85, 55, 45, 85, 35, ……
A. 25, 15 B. 25, 85 C. 35, 25 D. 35, 85

36. What single discount is equivalent to two successive discounts of 10% and 15%?
A. 25% B. 24% C. 24.5% D. 23.5%

37. If price is reduced by 25% and sales increase by 20%, what is the net effect on gross receipts?
A. increase by 25% B. decrease by 5%
C. increase by 10% D. decrease by 10%

38. A shopkeeper sales 25 item and receive the C.P. after selling 20 items. Then what will be his profit %?
A. 25% B. 4.5% C. 5% D. 15%

39. A pipe can fill a cistern in 45 minutes and the waste pipe empties it in 1 hour. If both the pipes are opened at the same time, in how many hours will the cistern be filled?
A. 3 hours B. 4 hours C. 6 hours D. 2 hours

40. If two diagonals of a rhombus are 14 cm and 12 cm then its area is.... $\frac{1}{2}(d_1 \times d_2)$
A. 36 cm^2 B. 84 cm^2 C. 28 cm^2 D. 7 cm^2

41. All of the following are mammals EXCEPT
A. Shark B. Seal C. Porpoise D. Bat

42. Bats and birds are good fliers but the bat differs from bird in having
A. Diaphragm B. Four-chambered heart
C. Wings D. Warm bloodedness

43. By the statement 'survival of the fittest', Darwin meant that
A. The strongest of all species survives
B. The most intelligent of the species survives
C. The cleverest of the species survives
D. The most adaptable of the species to changes survives

44. Most of the endangered species are the victims of
A. Habitat destruction B. Over-hunting
C. Acid rain D. Competition with introduced species

45. During heart attack, a doctor may inject
A. Thyroid B. Prolactin C. Insulin D. Adrenaline

46. The autonomic nervous system controls all of the following EXCEPT
A. Secretion of digestive juice B. Sweating
C. Thought D. Peristalsis

47. Which one of the following human cells do not contain mitochondria?
A. Nerve cell B. Red blood cell
C. Liver cell D. White blood cell

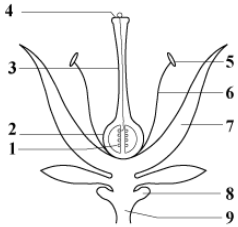
48. Which of the following is NOT correctly matched?
A. *Sycon* – Canal system B. Star fish – Radial symmetry
C. Round worm – Pseudosegmentation D. Insect – Metameric segmentation

49. A balanced diet does NOT include
A. Carbohydrates and fats B. Nucleic acids and enzymes
C. Proteins and vitamins D. Minerals and salts

50. Which one of the following is NOT the period of Mesozoic era?
A. Triassic B. Permian C. Jurassic D. Cretaceous

51. If a new plant were to be discovered with parallel-veined leaves, and brightly colored flowers each with 6 stamens, the plant would most precisely be classified as
A. Gymnosperm B. Angiosperm C. Monocotyledon D. Dicotyledon

52. Fruits are not formed in gymnosperms because
A. they have no ovary B. they are not pollinated
C. they are seedless plants D. process of fertilization doesn't take place
53. A nitrogenous base that occurs in DNA in equal quantities with guanine is
A. adenine B. cytosine C. uracil D. thymine
54. Organisms that convert nitrogen containing organic molecules into nitrates are
A. decomposers (e.g., bacteria) B. producers (e.g., grasses)
C. primary consumers (e.g., mice) D. tertiary consumers (e.g., hawk)
55. Which of the following statement is NOT true for viruses?
A. have protoplasm B. obligate parasites
C. have nucleic acid D. can respond to stimuli
56. The branch of biology deals with the study of mushrooms is
A. Phycology B. Mycology C. Ornithology D. Myology
57. Pollination involves a transfer of pollen from



A. 1 to 2 B. 3 to 5 C. 4 to 5 D. 5 to 4
58. Which of the following is human haploid chromosome number?
A. 10 B. 23 C. 46 D. 92
59. Daughter chromosomes start to move towards the opposite poles of a dividing cell during
A. prophase B. metaphase C. anaphase D. telophase
60. Organisms that comprise the greatest mass of living substance (biomass) in terrestrial food chain are
A. decomposers (e.g., bacteria) B. producers (e.g., grasses)
C. primary consumers (e.g., mice) D. tertiary consumers (e.g., hawk)
61. The constant related to the gravitational force has unit in SI system of units
A. m sec^{-2} B. kg m sec^{-1} C. N m^2 kg^{-2} D. J m sec^{-1}
62. The physical quantity related to the height of liquid is
A. pressure B. mass C. weight D. density
63. A body of volume 1 m^3 is wholly immersed in a liquid of density 13600 kg / m^3 at the sea level. The loss in weight of the body in liquid is equal to
A. 1360 N B. 13.6 N C. $\left(\frac{1}{13600}\right)$ N D. 136000 N

64. An atom has 11 protons and 12 neutrons. Then the number of electrons in this atom is
A. 12 B. 11 C. 23 D. 1

65. 100 J of mechanical energy is supplied to 1kg water which raises its temperature through
A. 100 K B. 4200 K C. $\left(\frac{1}{4200}\right)$K D. $\left(\frac{1}{42}\right)$ K

66. A person suffering from myopia has to use
A. biconvex lens B. planoconvex lens
C. biconcave lens D. concavoconvex lens

67. An object is placed at a distance of 20 cm from a convex lens of focal length 10 cm. The image formed by the lens will be
A. at 20 cm from the lens, inverted and real
B. at 20 cm from the lens, inverted and virtual
C. at 20 cm from the lens, erect and real
D. at 20 cm from the lens, erect and virtual

68. To find the direction of induced current in an electromagnetic induction,
A. Maxwell's cork screw rule is used B. Right hand thumb rule is used
C. Fleming's right hand rule is used D. Fleming's left hand rule is used

69. If an electric heater of voltage 220 V draws 5 A current, what is its electric power?
A. 44 watt B. 880 watt C. 1100 watt D. $\left(\frac{1}{44}\right)$watt

70. In uniform velocity,
A. both magnitude and direction of velocity remain constant
B. only magnitude remains constant
C. only direction remains constant
D. neither magnitude nor direction remains constant

71. Which one of the followings is a vector quantity?
A. work B. power C. speed D. moment of force

72. The unit of intensity of sound is
A. Cd B. dB C. Joule D. Watt m^{-2}

73. _____ is used to detect the flow of electric current in an electric circuit.
A. Voltmeter B. Ammeter C. Galvanometer D. Ohmmeter

74. The angle between the magnetic meridian and the geographical meridian at a place is known as
A. angle of declination B. angle of dip
C. angle of inclination D. angle of friction

75. When a ray of light enters from one medium to another medium, it increases its angle with the normal to the surface at the point of entrance, then the second medium must be …. than first medium .
A. rarer B. denser C. not other D. none of above

76. Which solution will change red litmus to blue?
A. HCl (aq.) B. NaCl (aq.) C. CH_3OH (aq.) D. NaOH (aq.)

77. Given the equation: $H^+ + OH^- = H_2O$, which type of the reaction does the equation represent?
A. Esterification B. Decomposition
C. Hydrolysis D. Neutralization

78. Which of the following element is essential in all organic compounds?
A. Nitrogen B. Hydrogen C. Oxygen D. Carbon

79. Naturally occurring polymers are
A. starch and nylon B. starch and cellulose
C. protein and nylon D. protein and plastic

80. Which of the following compound is represented by the general formula C_nH_{2n+2} ?
A. Butane B. Butene C. Butyne D. Benzene

81. Compare to the charge and mass of a proton, an electron has
A. the same charge and a smaller mass
B. the same charge and the same mass
C. an opposite charge and a smaller mass
D. an opposite charge and the same mass

82. Which of the following atom consists of exactly fifteen protons?
A. P-32 B. S-32 C. O-15 D. N-15

83. Which of the following three groups represent, the most elements classified as metalloids in the periodic table?
A. 1, 2 & 3 B. 2, 13 & 14 C. 14, 15 & 16 D. 16, 17 & 18

84. When a metallic atom combines with a non-metallic atom, the non-metallic atom will …….
A. lose electrons and its size will decrease
B. lose electrons and its size will increase
C. gain electrons and its size will decrease
D. gain electrons and its size will increase

85. Which of the following is a binary compound?
A. Hydrogen sulphide B. Hydrogen sulphite
C. Ammonium sulphide D. Ammonium sulphate

86. Some students are asked to describe differences between gases and liquids. Three of their suggestions are:
I) Gas molecules are further apart
II) Gas molecules are smaller
III) Liquid molecules vibrate around fixed positions
Which suggestions are correct?
A. I only B. II only C. III only D. All of the above

87. Which method can be used to obtain crystals of sodium chloride from aqueous sodium chloride solution?
A. Neutralization B.Crystallization C. Evaporation D. Electrolysis

88. An element S has the proton number 18. The next element in the periodic table is an element T. Which statement is correct?
    A. Element T has one more electron in its outermost shell than element S.
    B. Element T has one more electron shell than element S.
    C. Element T is in the same group of the periodic table as element S.
    D. Element T is in the same period of the periodic table as element S.
89. Substance 'E' when reacts separately with zinc, sodium hydroxide and marble pieces, the respective products formed are hydrogen, sodium chloride and carbon dioxide. Identify the substance 'E'.
    A. An alkali B. An acid C. An element D. A salt
90. A yellow colored energy drink consists of a dissolved mixture of red and orange coloring agents. Suggest a suitable mean to separate these coloring agents.
    A. Distillation B. Evaporation
    C. Filtration D. Chromatography
91. What is the minimum age requirement of a person in Nepal to be eligible to vote in the national election?
    A. 16 years B. 18 years C. 19 years D. 21 years
92. The headquarter of World Trade Organization is located at
    A. Washington D.C. B. New York B. Geneva C. London
93. The World Environment Day is celebrated on
    A. June 5 B. December 10 C. April 23 D. January 1
94. What do we know Rontgen rays as?
    A. α- rays B. β-rays C. γ-rays D. X-rays
95. Which is the Largest Ethnic group in Nepal?
    A. Brahmin B. Tharu C. Tamang D. Chhettri
96. Which Hindu God is considered to be the 'God of Good fortune,' the one who removes obstacles?
    A. Lord Rama B. Lord Ganesha C. Lord Krishna D. Lord Kartikeya
97. Which branch of science is related to the study of blood, the blood-forming organs and blood diseases?
    A. Hematology B. Nephrology C. Rheumatology D. Pulmonology
98. In which language did Buddha preach his teachings?
    A. Nepali B. Aramaic C. Pali D. Sanskrit
99. AUTHOR : MANUSCRIPT ::
    A. optician : spectacles B. engineer : bridge
    C. architect: blueprint D. doctor : stethoscope
100. The first Asian Games were held at
    A. New Delhi in 1950 B. Bangkok in 1952
    C. Singapore in 1952 D. Kuala Lumpur in 1952

Practice Test - 5

1. Although she is not rich, she always wears……..clothes.
   A. respective B. respected C. respectable D. respectful
2. The clients were served…….at the party last night.
   A. in a courteous manner B. courteous mannerly
   C. with courteous in their manner D. courteously
3. . ……so many people been out of work as today.
   A. More than ever before B. Never before have
   C. In the past, there never was D. Formerly, they were never
4. I will talk to him if……..
   A. he comes B. he would come C. he has come D. he will come
5. His company is greatly sought……
   A. at B. after C. for D. out
6. I wish I……you.
   A. am B. was C. had been D. were
7. Prices have……..so rapidly in the last few months.
   A. raised B. rise C. raising D. risen
8. I'd rather stay here,……..?
   A. hadn't I B. don't I C. wouldn't I D. didn't I
9. They aren't happy and……..
   A. so am I B. I am too C. neither is I D. I am not either
10. They…….to the USA by December.
    A. will fly B. will be flying C. will have flown D. may fly
11. Which word is incorrectly spelt?
    A. preferable B. nupital C. nuisance D. hygiene
12. He works hard in order to **keep the pot boiling**. The meaning of the phrase in bold type is:
    A. To keep the machine working
    B. to boil the pot
    C. to earn enough money to buy one's food.
    D. to lead a comfortable life
13. It is time you……home.
    A. go B. went C. have gone D. are going
14. One who hates women is:
    A. misogamist B. misogynist C. masochist D. misanthrope
15. The passive of "She pleased me." is:
    A. I was pleased by her sincerity. B. I was pleased at her sincerity.
    C. I was pleased with her sincerity. D. I was pleased to her sincerity.

16. The indirect speech of: The teacher said, "Be quiet boys."
    A. The teacher said that the boys should be quiet.
    B. The teacher called the boys and told them to be quiet.
    C. The teacher urged the boys to be quiet.
    D. The teacher ordered the boys to be quiet.

Read the following passage and answer the questions that follow:

I know that only one person in a thousand knows the trick of really living in the present. Most of spend 59 minutes an hour living in the past, with regret for lost joys, or shame for the things badly done-or in a future which we either long for or dread. Yet the past is gone beyond repair, and every minute you spend in the vain effort to anticipate the future is a moment lost. There is only one world, the world pressing against you at this minute. There is only one minute in which you are alive, this miracle- here and now. The only way to live is by accepting every minute as an unrepeatable miracle. Which is exactly what it is- a miracle and unrepeatable.

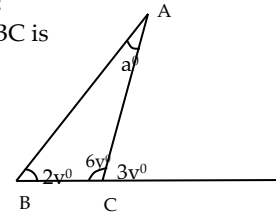
17. People live either in the past or in the future because:
    A. They are in the habit of chewing the curd
    B. They are prey to imaginary fears
    C. They are chained to memory and desire
    D. None of these
18. What is an unrepeatable miracle?
    A. Every moment that we live and spend B. To repair the past
    C. To crave for what is not D. None of these
19. The attitude of the author is:
    A. Romantic B. classical C. political D. pragmatic
20. The most suitable title for the passage will be:
    A. Past is dynamic B. the art of living
    C. Importance of the present D. Importance of the past
21. A train went 300 miles from city X to city Y at an average speed of 80 mph. At what speed did it travel on the way back if its' average speed for the whole trip was 100 mph?
    A. 120 mph B. 125 mph C. 133 $\frac{1}{3}$ mph D. 137 $\frac{1}{3}$ mph
22. If a wheel travels 1 km in 1 min at the rate of 600 revolutions per min., then diameter of the wheel is
    A. $\frac{2}{3\pi}$ B. $\frac{3}{5\pi}$ C. $\frac{5}{3\pi}$ D. $\frac{6}{5\pi}$
23. The co-ordinates of a triangle are (0, 2), (2, 4) and (1, 6). Then the area of triangle in sq. unit is
    A. 2 B. 3 C. 4 D. 5

24. If $7^{x+1} - 7^{x-1} = 336\sqrt{7}$, then value of x is

A. $\frac{5}{2}$ B. $\frac{3}{2}$

C. $-\frac{3}{2}$ D. $\frac{7}{2}$

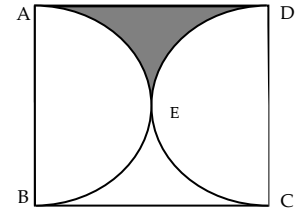
25. In the adjoining figure, side BC of triangle ABC is extended to D. What is value of a?



A. 20 B. 17

C. 25 D. 20

26. If ABCD is a square, with side AB = 4 ft. and AED and CED are semicircles, what is the area of shaded part of the diagram in sq. feet?



A. $8 - \pi$ B. $8 - 2\pi$

C. $16 - 2\pi$ D. $16 - 4\pi$

27. If $\sin\theta = -\frac{1}{2}$ and $\cos\theta = \frac{\sqrt{3}}{2}$ then which one of the following satisfies for θ?

A. 210^0 B. 120^0

C. 330^0 D. 300^0

28. Value of $\text{Cos}22\frac{1}{2}^{o}$ = ……

A. $\sqrt{\frac{\sqrt{2}-1}{2\sqrt{2}}}$ B. $\sqrt{\frac{1+\sqrt{2}}{2\sqrt{2}}}$ C. $\frac{\sqrt{5}-1}{4}$ D. $\frac{\sqrt{2}-1}{4}$

29. If the area of triangle formed by a line $2x + 3y - k = 0$ is 12 sq. units then value of k is

A. ± 6 B. ±8 C. ± 12 D. ± 18

30. The equation of the circle having center (5, 4) and touching y-axis is

A. $x^2 + y^2 - 10x - 8y + 25 = 0$ B. $x^2 + y^2 - 5x + 4y + 8 = 0$

C. $x^2 + y^2 - 5x + 4y + 8 = 0$ D. $x^2 + y^2 - 42 - 5y + 10 = 0$

31. What is the value of k the equation $9x^2 - kx + 18 = 0$ has equal roots

A. $\pm 24\sqrt{2}$ B. $\pm 18\sqrt{2}$ C. ± 54 D. ± 46

32. If $x = \begin{bmatrix} 1 & a \\ 0 & 1 \end{bmatrix} and\ 3x - \begin{bmatrix} 2 & 3 \\ 0 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix}$ then the value of a is

A. 0 B. 2 C. –2 D. 3

33. For an A.P. if $t_{25} - t_{15} = 170$ then the value of d is

A. 17 B. – 17 C. 10 D. 34

34. If f(x) = x+2 then f(x-1) is
A. x^2 B. x C. x-1 D. x+1

35. A and B are any two sets then A ∩ (B – A) is equal to
A. A B. B C. B – A D. ϕ

36. The angle between the vectors $\vec{a}=\hat{i}+2\hat{j}$ and $\vec{b}=6\hat{i}-3\hat{j}$.
A. 0 B. $\pi/3$ C. $\pi/4$ D. $\pi/2$

37. Two cards are drawn one after another from a regular deck of 52 cards with replacement. What is the probability that the cards will be an ace and a 10?
A. $\frac{1}{39}$ B. $\frac{2}{13}$ C. $\frac{8}{13}$ D. $\frac{5}{26}$

38. In a class of 20 students in MATH examination 2 students scored 100 marks each, 3 students got zero each, and the average score of rest of the students was 40. What is the average score of the whole class?
A. 10 B. 20 C. 30 D. 40

39. A shopkeeper fixed the price of his articles 30% above the cost price. If he sold an article allowing 10% discount, then his profit percentagewill be
A. 20% B. 17% C. 23% D. 40%

40. If m and p are positive integers and (m+p)×m is even, which of the following must be true.
A. If m is odd, then p is odd
B. If m is even, then p is even
C. If m is odd, then p is even
D. If m is even, then p is odd

41. In the past, fungi were often grouped with plants because of alleged similarities between the two groups. Which of the following are characteristics of the fungi that are **NOT** seen in plants?
A. Food reserve consists of glycogen
B. Cell wall contains chitin
C. Organism is eukaryotic
D. Absorptive heterotrophy is chief mode of nutrition

42. Tube like cells that carry food from leaves to other parts of a plant are
A. Xylem cells B. Chloroplasts C. Phloem cells D. Bast fibres

43. Which of this organelle is visible only to an electron microscope?
A. Nucleus B. Mitochondria C. Ribosome D. Chloroplast

44. The process that best separates plants from animals is
A. Respiration B. Reproduction C. Photosynthesis D. Osmosis

45. One of the salient features of hydrophytes is a very weak root system. Which of the given plants has no roots?
A. Water fern B. *Wolffia* C. *Hydrilla* D. Lotus

46. Which of the following character is not a true attribute of a fern?
A. Circinate vernation
B. Ramenta
C. Reproduction by seed
D. Rhizome

47. Natural vegetative propagation by root is a common method of asexual reproduction in
A. Sugarcane B. Rose C. Potato D. *Dahlia*

48. Thermotropism is a response shown by plants to heat stimulus. Which of the following plants is characterized by this response?
A. Rose B. *Mimosa pudica*
C. Tulip D. *Chlamydomonas*

49. The shape of a DNA molecule is
A. Straight B. Circular C. Flat D. Spiral

50. Which of the following is not a good source of carbon?
A. Coal B. Petroleum fuel
C. Ammonia D. Dead body of organisms

51. Blood cells from the blood are eliminated and the liquid left is
A. Serum B. Plasma
C. Almost water D. Only RBC and Hemoglobin

52. The larva silkworm is .....
A. Butterfly B. Scorpian C. Moth D. Grass hoppers

53. Autotrophic component of ecosystem is
A. Sunlight B. Green plants C. Herbivores D. Fungi

54. Which of the following is a matching set in animal taxonomy?
A. Silver fish, Cuttle fish, Devil fish B. Flatworm, Round worm, Earthworm
C. Butterfly, Mosquito, Cockroach D. Shark, Whale, Dolphin

55. Rods and cones are located in
A. Cochlea of ear B. Choroid of eye C. Retina of eye D. Taste buds of tongue

56. Ascorbic acid is a/an
A. Lipid B. Protein C. Vitamin D. Carbohydrate

57. All of the following organic compounds are carbohydrates EXCEPT
A. Glycogen B. Maltose C. Glycerol D. Starch

58. Special structures for absorption in small intestine are called
A. Alveoli B. Villi C. Epiglottis D. Muscles

59. Of the following terms, which one includes all the others?
A. Species B. Class C. Phylum D. Kingdom

60. Which pair of animal groups, has oxygenated and deoxygenated blood in the heart separately?
A. Amphibians & Reptiles B. Birds & Mammals
C. Reptiles & Birds D. Reptiles & Mammals

61. The king of chemical is :
A. HCl B. H_2SO_4 C. HNO_3 D.H_2CO_3

62. In alkaline medium, the phenolphthalein indicator turns into
A. Colorless B. Yellow C. Red D.Pink

63. Which one of the following salts gives alkaline solution when dissolved in water?
A. Na_2CO_3 B. $CuSO_4$ C. NH_4Cl D. NaCl
64. The salts of which one of the following metals are colored?
A. Na B. Ca C. Al D. Cr
65. The aquaregia is a mixture of conc. HCl and conc. HNO_3 in the ratio of
A. 2:6 B. 6:2 C. 3:2 D. 2:3
66. The general formula of alkyne is
A. C_nH_{2n} B. C_nH_{2n+2} C. C_nH_{2n-2} D. $C_nH_{2n+1}OH$
67. The functional group of ether is
A. – OH B. – CHO C. – CO – D. – O –
68. The oxide used to impart the green color into glass is
A. CoO B. NiO C. Cr_2O_3 D. Fe_2O_3
69. The chemical fertilizer "UREA" is the major source of
A. Phosphorus B. Potassium C. Nitrogen D. Sodium
70. BHC is a/an
A. Germicide B. Insecticide C. Pesticide D. Fungicide
71. Which of the following is not ore of iron?
A. Hematite B. Magnetite C. Limonite D. Bauxite
72. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$. The element belongs to which group of the periodic table?
A. s- block B. p- block C. d-block D. f- block
73. Which two elements will display the most similar chemical properties?
A. Iron and Phosphorus B. Chlorine and Oxygen
C. Carbon and Boron D. Potassium and Sodium
74. The dry ice is
A. Solid water B. Solid carbondioxide
C. Solid camphor D. Solid ammonia
75. Which one of the followings is decomposition reaction?
A. $C + O_2 \rightarrow CO_2$ B. $2C + H_2 \rightarrow C_2H_2$
C. $C + 2S \rightarrow CS_2$ D. $2KClO_3 \rightarrow 2KCl + 3O_2$
76. The ratio of the gravitational force of attraction between masses of two bodies when their masses are doubled and distance between them is halved, before and after the change will be
A. 2:1 B. 1:2 C. 1:16 D. 4:1
77. The unit of pressure is
A. Pa B. Pam^{-2} C. Pam^{-1} D. Pam
78. Which one of the followings is the source of renewable energy?
A. Solar energy B. Coal C. Oil D. Natural gas
79. The specific heat capacity of a substance depends on
A. Quantity of matter B. Temperature of matter
C. Nature of matter D. Shape of matter

80. Which type of lens is used in camera?
A. Plano-concave B. Convex C. Biconcave D. Convexo-concave
81. When a man suffers from long sightedness, his eyelens makes the image of a distant object
A. Before his retina B. Beyond his retina
C. At his retina D. Nowhere
82. What will be the total cost of electricity to be paid in a month when three bulbs each of 40 Watt are used for 4 hours in a day at the rate of Rs 7 per unit?
A. Rs. 14.4 B. Rs. 100.8 C. Rs.0.48 D. Rs. 144
83. According to Fleming's right hand rule, the fore finger shows the direction of
A. Motion B. Magnetic field
C. Electric current D. None of above
84. If a body is moving with constant linear positive acceleration,
A. It moves with constant velocity B. It remains at rest
C. It decreases its velocity at constant rate D. It increases its velocity at constant rate
85. Transformation of energy is based on the principle of conservation of
A. Linear momentum B. Angular momentum
C. Energy D. Charge
86. A ray of light enters normally from air medium to water medium. Its speed
A. Increases B. Remains the same
C. Decreases D. Either increases or decreases
87. If the frequency of sound wave is 100Hz and wavelength 3.3m, what will be its speed?
A. 330m/sec B. 660m/sec C. 165m/sec D. 3300m/sec
88. Which is not the unit of potential difference?
A. Volt B. Joule/coulomb C. Nm/coulomb D. Kgm/coulomb
89. At neutral point, the magnitude of resultant magnetic field will be
A. Maximum
B. Equal to the algebric sum of the magnitude of individual magnetic fields
C. Zero D. Neglected
90. Alloy is a mixture of
A. Conductors B. Insulators
C. Semiconductors D. Conductor and insulator
91. One tola of gold is equivalent to
A. 10 grams B.10.54 grams C. 12.353 grams D. 11.664 grams
92. Cartography is
A. Science of vehicles B. Art of beautiful handwriting
C. Science of palmistry D. Art of making maps
93. Who gave the famous quotations "The child is father of the man".
A. Alexander Pope B. Julius Caesar C. Wordsworth D. Roseau

94. Which country is known as land of Kangaroos?
A. India B. Japan C. Australia D. New Zealand
95. Which of the following book was not written by Diamond Shumsher Rana?
A. Basanti B. Seto Bagh C. Anita D.Mayur Times
96. In cricket the length of pitch between the two wickets is
A. 24 yards B. 23 yards C. 22 yards D. 21 yards
97. Nick name of New York city is
A. Big Apple B. Black sugar C. Small Apple D. Nippon
98. Which famous painter's middle names were Diego Jose Fransico de Paula Juana Neponuceno Madrid de Los Remedios Cipriano de Santisima Trinidad Ruoz?
A. Pablo Picasso B. Van Gogh
C. Henri Rousseau D. Leonardo da Vinci
99. Which is the odd man out ?
A. POKI B. MIEA C. SOKG D. YUQM
100. Which one of the following is a fast growing tree ?
A. Teak B. Eucalyptus C. Banyan D. Coconut

Answer Key: Practice Test 1

1. A	18. A	35. A	52. D	69. D	86. D
2. C	19. B	36. B	53. C	70. D	87. B
3. A	20. A	37. A	54. B	71. A	88. C
4. D	21. B	38. B	55. C	72. B	89. B
5. B	22. B	39. C	56. B	73. A	90. C
6. D	23. A	40. B	57. C	74. D	91. D
7. A	24. C	41. B	58. B	75. A	92. B
8. A	25. C	42. A	59. B	76. B	93. D
9. A	26. C	43. C	60. D	77. A	94. A
10. D	27. C	44. B	61. D	78. C	95. A
11. A	28. C	45. C	62. A	79. D	96. A
12. A	29. D	46. B	63. D	80. B	97. A
13. D	30. A	47. A	64. B	81. A	98. B
14. B	31. C	48. C	65. B	82. B	99. B
15. B	32. B	49. D	66. D	83. C	100. C
16. B	33. C	50. B	67. A	84. A	
17. C	34. B	51. D	68. D	85. C	

Answers Key: Practice Test 2

1. D	18. D	35. A	52. D	69. C	86. A
2. D	19. C	36. B	53. A	70. C	87. D
3. A	20. D	37. C	54. D	71. B	88. C
4. D	21. D	38. B	55. D	72. C	89. D
5. D	22. B	39. C	56. C	73. D	90. D
6. C	23. B	40. C	57. B	74. B	91. D
7. C	24. B	41. B	58. C	75. A	92. C
8. A	25. D	42. D	59. D	76. B	93. B
9. A	26. B	43. C	60. A	77. D	94. B
10. A	27. D	44. A	61. A	78. A	95. B
11. D	28. C	45. B	62. C	79. C	96. B
12. C	29. C	46. D	63. A	80. A	97. A
13. A	30. D	47. A	64. C	81. B	98. A
14. D	31. B	48. B	65. D	82. C	99. C
15. B	32. C	49. D	66. B	83. B	100. D
16. A	33. D	50. B	67. C	84. B	
17. B	34. B	51. C	68. A	85. B	

Answers Key: Practice Test 3

1. C	18. D	35. D	52. D	69. A	86. C
2. B	19. A	36. B	53. A	70. D	87. A
3. C	20. D	37. b	54. D	71.	88. D
4. A	21. B	38. B	55. A	72. B	89. C
5. A	22. C	39. D	56. C	73. A	90. C
6. D	23. C	40. B	57. A	74. A	91. C
7. C	24. C	41. C	58. D	75. B	92. A
8. C	25. B	42. A	59. C	76. D	93. D
9. A	26. A	43. B	60. D	77. D	94. B
10. C	27. D	44. D	61. B	78. B	95. D
11. B	28. C	45. A	62. D	79. D	96. B
12. C	29. C	46. B	63. C	80. D	97. A
13. B	30. D	47. C	64. D	81. A	98. B
14. A	31. B	48. B	65. A	82. C	99. B
15. A	32. A	49. C	66. A	83. A	100. B
16. B	33. D	50. D	67. C	84. C	
17. A	34. A	51. A	68. B	85. C	

Answers Key: Practice Test 4

1. C	18. D	35. B	52. A	69. C	86. A
2. C	19. D	36. D	53. B	70. A	87. C
3. A	20. A	37. D	54. A	71. D	88. D
4. B	21. B	38. A	55. A	72. D	89. B
5. C	22. C	39. A	56. A	73. C	90. D
6. D	23. D	40. B	57. D	74. A	91. B
7. A	24. C	41. A	58. B	75. A	92. C
8. C	25. D	42. A	59. C	76. D	93. A
9. C	26. B	43. D	60. B	77. D	94. D
10. A	27. D	44. A	61. C	78. D	95. D
11. B	28. A	45. D	62. A	79. B	96. B
12. A	29. C	46. C	63. A	80. A	97. A
13. C	30. C	47. B	64. B	81. C	98. C
14. D	31. A	48. C	65. C	82. A	99. C
15. C	32. C	49. B	66. C	83. C	100. A
16. B	33. D	50. B	67. A	84. D	
17. A	34. D	51. C	68. C	85. A	

Answers Key: Practice Test 5

1. C	18. A	35. D	52. C	69. C	86. C
2. D	19. D	36. D	53. B	70. B	87. A
3. B	20. B	37. A	54. C	71. D	88. D
4. A	21. C	38. D	55. C	72. C	89. C
5. B	22. C	39. B	56. C	73. D	90. A
6. D	23. A	40. A	57. C	74. B	91. D
7. D	24. A	41. D	58. B	75. D	92. D
8. C	25. A	42. C	59. D	76. C	93. C
9. D	26. D	43. C	60. B	77. A	94. C
10. C	27. C	44. C	61. B	78. A	95. D
11. B	28. B	45. B	62. D	79. C	96. C
12. D	29. C	46. C	63. A	80. B	97. A
13. B	30. A	47. D	64. D	81. A	98. A
14. B	31. C	48. B	65. B	82. B	99. A
15. C	32. B	49. D	66. C	83. B	100. B
16. D	33. A	50. C	67. D	84. D	
17. C	34. D	51. B	68. C	85. C	

Answer Sheet: Practice Test 1

	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
16	☐	☐	☐	☐
17	☐	☐	☐	☐
18	☐	☐	☐	☐
19	☐	☐	☐	☐
20	☐	☐	☐	☐
21	☐	☐	☐	☐
22	☐	☐	☐	☐
23	☐	☐	☐	☐
24	☐	☐	☐	☐
25	☐	☐	☐	☐
26	☐	☐	☐	☐
27	☐	☐	☐	☐
28	☐	☐	☐	☐
29	☐	☐	☐	☐
30	☐	☐	☐	☐
31	☐	☐	☐	☐
32	☐	☐	☐	☐
33	☐	☐	☐	☐
34	☐	☐	☐	☐
35	☐	☐	☐	☐
36	☐	☐	☐	☐
37	☐	☐	☐	☐
38	☐	☐	☐	☐
39	☐	☐	☐	☐
40	☐	☐	☐	☐
41	☐	☐	☐	☐
42	☐	☐	☐	☐
43	☐	☐	☐	☐
44	☐	☐	☐	☐
45	☐	☐	☐	☐
46	☐	☐	☐	☐
47	☐	☐	☐	☐
48	☐	☐	☐	☐
49	☐	☐	☐	☐
50	☐	☐	☐	☐
51	☐	☐	☐	☐
52	☐	☐	☐	☐
53	☐	☐	☐	☐
54	☐	☐	☐	☐
55	☐	☐	☐	☐
56	☐	☐	☐	☐
57	☐	☐	☐	☐
58	☐	☐	☐	☐
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79	☐	☐	☐	☐
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82	☐	☐	☐	☐
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86	☐	☐	☐	☐
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90	☐	☐	☐	☐
91	☐	☐	☐	☐
92	☐	☐	☐	☐
93	☐	☐	☐	☐
94	☐	☐	☐	☐
95	☐	☐	☐	☐
96	☐	☐	☐	☐
97	☐	☐	☐	☐
98	☐	☐	☐	☐
99	☐	☐	☐	☐
100	☐	☐	☐	☐

Answer Sheet: Practice Test 2

	A	B	C	D		A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	36	☐	☐	☐	☐	71	☐	☐	☐	☐
2	☐	☐	☐	☐	37	☐	☐	☐	☐	72	☐	☐	☐	☐
3	☐	☐	☐	☐	38	☐	☐	☐	☐	73	☐	☐	☐	☐
4	☐	☐	☐	☐	39	☐	☐	☐	☐	74	☐	☐	☐	☐
5	☐	☐	☐	☐	40	☐	☐	☐	☐	75	☐	☐	☐	☐
6	☐	☐	☐	☐	41	☐	☐	☐	☐	76	☐	☐	☐	☐
7	☐	☐	☐	☐	42	☐	☐	☐	☐	77	☐	☐	☐	☐
8	☐	☐	☐	☐	43	☐	☐	☐	☐	78	☐	☐	☐	☐
9	☐	☐	☐	☐	44	☐	☐	☐	☐	79	☐	☐	☐	☐
10	☐	☐	☐	☐	45	☐	☐	☐	☐	80	☐	☐	☐	☐
11	☐	☐	☐	☐	46	☐	☐	☐	☐	81	☐	☐	☐	☐
12	☐	☐	☐	☐	47	☐	☐	☐	☐	82	☐	☐	☐	☐
13	☐	☐	☐	☐	48	☐	☐	☐	☐	83	☐	☐	☐	☐
14	☐	☐	☐	☐	49	☐	☐	☐	☐	84	☐	☐	☐	☐
15	☐	☐	☐	☐	50	☐	☐	☐	☐	85	☐	☐	☐	☐
16	☐	☐	☐	☐	51	☐	☐	☐	☐	86	☐	☐	☐	☐
17	☐	☐	☐	☐	52	☐	☐	☐	☐	87	☐	☐	☐	☐
18	☐	☐	☐	☐	53	☐	☐	☐	☐	88	☐	☐	☐	☐
19	☐	☐	☐	☐	54	☐	☐	☐	☐	89	☐	☐	☐	☐
20	☐	☐	☐	☐	55	☐	☐	☐	☐	90	☐	☐	☐	☐
21	☐	☐	☐	☐	56	☐	☐	☐	☐	91	☐	☐	☐	☐
22	☐	☐	☐	☐	57	☐	☐	☐	☐	92	☐	☐	☐	☐
23	☐	☐	☐	☐	58	☐	☐	☐	☐	93	☐	☐	☐	☐
24	☐	☐	☐	☐	59	☐	☐	☐	☐	94	☐	☐	☐	☐
25	☐	☐	☐	☐	60	☐	☐	☐	☐	95	☐	☐	☐	☐
26	☐	☐	☐	☐	61	☐	☐	☐	☐	96	☐	☐	☐	☐
27	☐	☐	☐	☐	62	☐	☐	☐	☐	97	☐	☐	☐	☐
28	☐	☐	☐	☐	63	☐	☐	☐	☐	98	☐	☐	☐	☐
29	☐	☐	☐	☐	64	☐	☐	☐	☐	99	☐	☐	☐	☐
30	☐	☐	☐	☐	65	☐	☐	☐	☐	100	☐	☐	☐	☐
31	☐	☐	☐	☐	66	☐	☐	☐	☐					
32	☐	☐	☐	☐	67	☐	☐	☐	☐					
33	☐	☐	☐	☐	68	☐	☐	☐	☐					
34	☐	☐	☐	☐	69	☐	☐	☐	☐					
35	☐	☐	☐	☐	70	☐	☐	☐	☐					

Answer Sheet: Practice Test 3

	A	B	C	D		A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	36	☐	☐	☐	☐	71	☐	☐	☐	☐
2	☐	☐	☐	☐	37	☐	☐	☐	☐	72	☐	☐	☐	☐
3	☐	☐	☐	☐	38	☐	☐	☐	☐	73	☐	☐	☐	☐
4	☐	☐	☐	☐	39	☐	☐	☐	☐	74	☐	☐	☐	☐
5	☐	☐	☐	☐	40	☐	☐	☐	☐	75	☐	☐	☐	☐
6	☐	☐	☐	☐	41	☐	☐	☐	☐	76	☐	☐	☐	☐
7	☐	☐	☐	☐	42	☐	☐	☐	☐	77	☐	☐	☐	☐
8	☐	☐	☐	☐	43	☐	☐	☐	☐	78	☐	☐	☐	☐
9	☐	☐	☐	☐	44	☐	☐	☐	☐	79	☐	☐	☐	☐
10	☐	☐	☐	☐	45	☐	☐	☐	☐	80	☐	☐	☐	☐
11	☐	☐	☐	☐	46	☐	☐	☐	☐	81	☐	☐	☐	☐
12	☐	☐	☐	☐	47	☐	☐	☐	☐	82	☐	☐	☐	☐
13	☐	☐	☐	☐	48	☐	☐	☐	☐	83	☐	☐	☐	☐
14	☐	☐	☐	☐	49	☐	☐	☐	☐	84	☐	☐	☐	☐
15	☐	☐	☐	☐	50	☐	☐	☐	☐	85	☐	☐	☐	☐
16	☐	☐	☐	☐	51	☐	☐	☐	☐	86	☐	☐	☐	☐
17	☐	☐	☐	☐	52	☐	☐	☐	☐	87	☐	☐	☐	☐
18	☐	☐	☐	☐	53	☐	☐	☐	☐	88	☐	☐	☐	☐
19	☐	☐	☐	☐	54	☐	☐	☐	☐	89	☐	☐	☐	☐
20	☐	☐	☐	☐	55	☐	☐	☐	☐	90	☐	☐	☐	☐
21	☐	☐	☐	☐	56	☐	☐	☐	☐	91	☐	☐	☐	☐
22	☐	☐	☐	☐	57	☐	☐	☐	☐	92	☐	☐	☐	☐
23	☐	☐	☐	☐	58	☐	☐	☐	☐	93	☐	☐	☐	☐
24	☐	☐	☐	☐	59	☐	☐	☐	☐	94	☐	☐	☐	☐
25	☐	☐	☐	☐	60	☐	☐	☐	☐	95	☐	☐	☐	☐
26	☐	☐	☐	☐	61	☐	☐	☐	☐	96	☐	☐	☐	☐
27	☐	☐	☐	☐	62	☐	☐	☐	☐	97	☐	☐	☐	☐
28	☐	☐	☐	☐	63	☐	☐	☐	☐	98	☐	☐	☐	☐
29	☐	☐	☐	☐	64	☐	☐	☐	☐	99	☐	☐	☐	☐
30	☐	☐	☐	☐	65	☐	☐	☐	☐	100	☐	☐	☐	☐
31	☐	☐	☐	☐	66	☐	☐	☐	☐					
32	☐	☐	☐	☐	67	☐	☐	☐	☐					
33	☐	☐	☐	☐	68	☐	☐	☐	☐					
34	☐	☐	☐	☐	69	☐	☐	☐	☐					
35	☐	☐	☐	☐	70	☐	☐	☐	☐					

Answer Sheet: Practice Test 4

	A	B	C	D		A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	36	☐	☐	☐	☐	71	☐	☐	☐	☐
2	☐	☐	☐	☐	37	☐	☐	☐	☐	72	☐	☐	☐	☐
3	☐	☐	☐	☐	38	☐	☐	☐	☐	73	☐	☐	☐	☐
4	☐	☐	☐	☐	39	☐	☐	☐	☐	74	☐	☐	☐	☐
5	☐	☐	☐	☐	40	☐	☐	☐	☐	75	☐	☐	☐	☐
6	☐	☐	☐	☐	41	☐	☐	☐	☐	76	☐	☐	☐	☐
7	☐	☐	☐	☐	42	☐	☐	☐	☐	77	☐	☐	☐	☐
8	☐	☐	☐	☐	43	☐	☐	☐	☐	78	☐	☐	☐	☐
9	☐	☐	☐	☐	44	☐	☐	☐	☐	79	☐	☐	☐	☐
10	☐	☐	☐	☐	45	☐	☐	☐	☐	80	☐	☐	☐	☐
11	☐	☐	☐	☐	46	☐	☐	☐	☐	81	☐	☐	☐	☐
12	☐	☐	☐	☐	47	☐	☐	☐	☐	82	☐	☐	☐	☐
13	☐	☐	☐	☐	48	☐	☐	☐	☐	83	☐	☐	☐	☐
14	☐	☐	☐	☐	49	☐	☐	☐	☐	84	☐	☐	☐	☐
15	☐	☐	☐	☐	50	☐	☐	☐	☐	85	☐	☐	☐	☐
16	☐	☐	☐	☐	51	☐	☐	☐	☐	86	☐	☐	☐	☐
17	☐	☐	☐	☐	52	☐	☐	☐	☐	87	☐	☐	☐	☐
18	☐	☐	☐	☐	53	☐	☐	☐	☐	88	☐	☐	☐	☐
19	☐	☐	☐	☐	54	☐	☐	☐	☐	89	☐	☐	☐	☐
20	☐	☐	☐	☐	55	☐	☐	☐	☐	90	☐	☐	☐	☐
21	☐	☐	☐	☐	56	☐	☐	☐	☐	91	☐	☐	☐	☐
22	☐	☐	☐	☐	57	☐	☐	☐	☐	92	☐	☐	☐	☐
23	☐	☐	☐	☐	58	☐	☐	☐	☐	93	☐	☐	☐	☐
24	☐	☐	☐	☐	59	☐	☐	☐	☐	94	☐	☐	☐	☐
25	☐	☐	☐	☐	60	☐	☐	☐	☐	95	☐	☐	☐	☐
26	☐	☐	☐	☐	61	☐	☐	☐	☐	96	☐	☐	☐	☐
27	☐	☐	☐	☐	62	☐	☐	☐	☐	97	☐	☐	☐	☐
28	☐	☐	☐	☐	63	☐	☐	☐	☐	98	☐	☐	☐	☐
29	☐	☐	☐	☐	64	☐	☐	☐	☐	99	☐	☐	☐	☐
30	☐	☐	☐	☐	65	☐	☐	☐	☐	100	☐	☐	☐	☐
31	☐	☐	☐	☐	66	☐	☐	☐	☐					
32	☐	☐	☐	☐	67	☐	☐	☐	☐					
33	☐	☐	☐	☐	68	☐	☐	☐	☐					
34	☐	☐	☐	☐	69	☐	☐	☐	☐					
35	☐	☐	☐	☐	70	☐	☐	☐	☐					

Answer Sheet: Practice Test 5

	A	B	C	D		A	B	C	D		A	B	C	D
1	☐	☐	☐	☐	36	☐	☐	☐	☐	71	☐	☐	☐	☐
2	☐	☐	☐	☐	37	☐	☐	☐	☐	72	☐	☐	☐	☐
3	☐	☐	☐	☐	38	☐	☐	☐	☐	73	☐	☐	☐	☐
4	☐	☐	☐	☐	39	☐	☐	☐	☐	74	☐	☐	☐	☐
5	☐	☐	☐	☐	40	☐	☐	☐	☐	75	☐	☐	☐	☐
6	☐	☐	☐	☐	41	☐	☐	☐	☐	76	☐	☐	☐	☐
7	☐	☐	☐	☐	42	☐	☐	☐	☐	77	☐	☐	☐	☐
8	☐	☐	☐	☐	43	☐	☐	☐	☐	78	☐	☐	☐	☐
9	☐	☐	☐	☐	44	☐	☐	☐	☐	79	☐	☐	☐	☐
10	☐	☐	☐	☐	45	☐	☐	☐	☐	80	☐	☐	☐	☐
11	☐	☐	☐	☐	46	☐	☐	☐	☐	81	☐	☐	☐	☐
12	☐	☐	☐	☐	47	☐	☐	☐	☐	82	☐	☐	☐	☐
13	☐	☐	☐	☐	48	☐	☐	☐	☐	83	☐	☐	☐	☐
14	☐	☐	☐	☐	49	☐	☐	☐	☐	84	☐	☐	☐	☐
15	☐	☐	☐	☐	50	☐	☐	☐	☐	85	☐	☐	☐	☐
16	☐	☐	☐	☐	51	☐	☐	☐	☐	86	☐	☐	☐	☐
17	☐	☐	☐	☐	52	☐	☐	☐	☐	87	☐	☐	☐	☐
18	☐	☐	☐	☐	53	☐	☐	☐	☐	88	☐	☐	☐	☐
19	☐	☐	☐	☐	54	☐	☐	☐	☐	89	☐	☐	☐	☐
20	☐	☐	☐	☐	55	☐	☐	☐	☐	90	☐	☐	☐	☐
21	☐	☐	☐	☐	56	☐	☐	☐	☐	91	☐	☐	☐	☐
22	☐	☐	☐	☐	57	☐	☐	☐	☐	92	☐	☐	☐	☐
23	☐	☐	☐	☐	58	☐	☐	☐	☐	93	☐	☐	☐	☐
24	☐	☐	☐	☐	59	☐	☐	☐	☐	94	☐	☐	☐	☐
25	☐	☐	☐	☐	60	☐	☐	☐	☐	95	☐	☐	☐	☐
26	☐	☐	☐	☐	61	☐	☐	☐	☐	96	☐	☐	☐	☐
27	☐	☐	☐	☐	62	☐	☐	☐	☐	97	☐	☐	☐	☐
28	☐	☐	☐	☐	63	☐	☐	☐	☐	98	☐	☐	☐	☐
29	☐	☐	☐	☐	64	☐	☐	☐	☐	99	☐	☐	☐	☐
30	☐	☐	☐	☐	65	☐	☐	☐	☐	100	☐	☐	☐	☐
31	☐	☐	☐	☐	66	☐	☐	☐	☐					
32	☐	☐	☐	☐	67	☐	☐	☐	☐					
33	☐	☐	☐	☐	68	☐	☐	☐	☐					
34	☐	☐	☐	☐	69	☐	☐	☐	☐					
35	☐	☐	☐	☐	70	☐	☐	☐	☐					