SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME			
CG		**INDEX NO.**	

PHYSICS 8866

Preliminary Examination **28th August 2014**
Multiple Choice Questions **1 hr**

Additional Materials: OMS.

READ THIS INSTRUCTIONS FIRST

Write your name, civics group and index number in the spaces at the top of this page.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions in this section. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

DATA AND FORMULAE

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

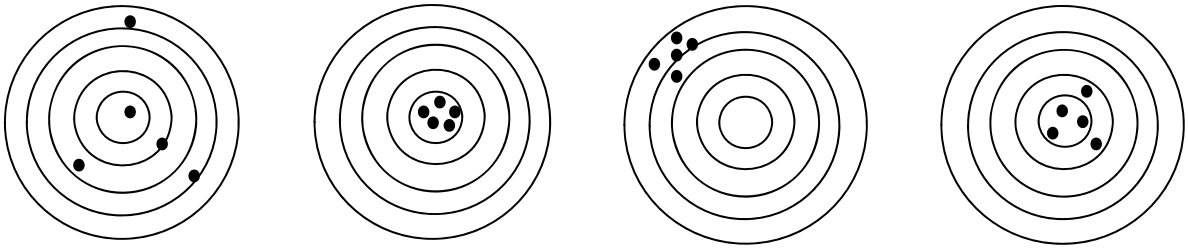
uniformly accelerated motion,	s	=	$ut + \frac{1}{2} at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	ρgh
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Answer all questions

1 Shown below are four target boards from a shooting competition (the centre is awarded the highest points).

Which one of them best indicates a small random error but large systematic error?

A **B** **C** **D**



Ans: C
Large systemic error and small random error means that shots are not close to actual target but are close to each other.

2 In the determination of the electro-chemical equivalent, *z*, of copper by electrolysis, the following equation is employed:

$$z = \frac{m_1 - m_2}{It}$$

$m_1 \pm \Delta m_1$ = (47.66 ± 0.01) x 10^{-3} kg
$m_2 \pm \Delta m_2$ = (43.67 ± 0.01) x 10^{-3} kg
$I \pm \Delta I$ = (2.00 ± 0.05) A
$t \pm \Delta t$ = (6000 ± 1) s

The value of z calculated from these readings will have a percentage uncertainty of

A 2.5% **B** 2.8% **C** 3.0% **D** 3.3%

Let A = $m_1 - m_2$
Let B = It **Ans: C**

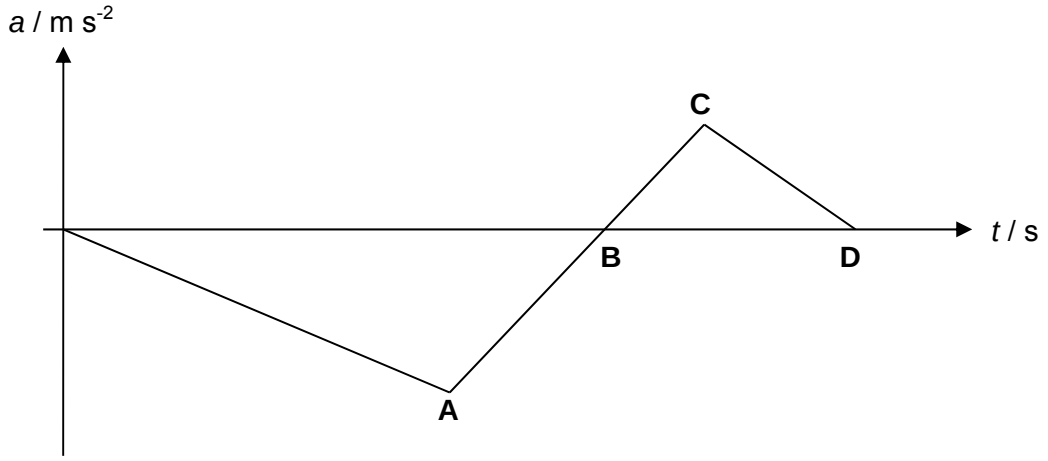
$$\frac{\Delta z}{z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

$$\frac{\Delta A}{A} = \frac{\Delta m_1 + \Delta m_2}{m_1 - m_2} \qquad \frac{\Delta B}{B} = \frac{\Delta I}{I} + \frac{\Delta t}{t}$$

$$\frac{\Delta z}{z} = \frac{\Delta m_1 + \Delta m_2}{m_1 - m_2} + \frac{\Delta I}{I} + \frac{\Delta t}{t} = \frac{0.02}{47.66 - 43.47} + \frac{0.05}{2} + \frac{1}{6000} = 0.03$$

$$\frac{\Delta z}{z} \times 100\% = 0.03 \times 100\% = 3.0\%$$

3 The acceleration-time graph of an object in a straight line is as shown. The object started its motion from rest.



At which point is the object moving with the largest speed?

Area under a-t graph represents the change in velocity. Hence, the speed at point B will be greatest.

Ans: B

4 A wingsuit flyer jumps off a building with a constant speed of 100 m s^{-1} at an angle of 30° below the horizontal. After falling for 3.0 s, he drops an object. Air resistance is negligible.

What is the time taken for the object to fall onto the ground from the time he drops it?

A 1.59 s **B** 2.02 s **C** 2.42 s **D** 3.00 s

After 3 s,
Distance fallen by flyer is 100 sin30° x 3 = 150 m (acceleration is zero since speed of wingsuit flyer is constant)

By using $s_y = u_y t + 1/2\ at^2$

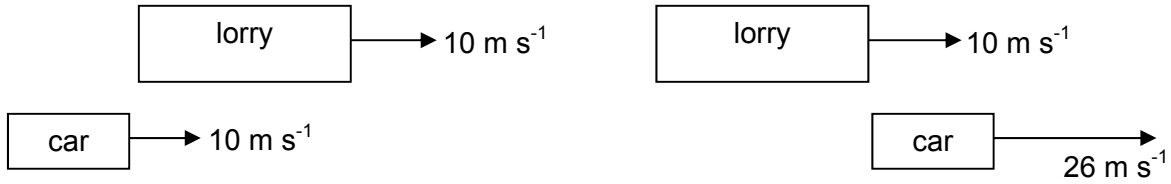
Taking downward as positive,
$150 = (100 \sin 30°)t + ½ (9.81)(t^2)$
t = 2.42 s

Ans: C

5 A lorry is moving forward at a constant speed of 10 m s^{-1}. At the same time, a car with a starting speed of 10 m s^{-1} is behind it; with its front in level with the rear of the lorry. The car is speeding up with a constant acceleration.

The minimum time *T* is the time required for a car to overtake a lorry on the motorway such that the rear of the passing car is ahead of the lorry as shown in the diagram. At time *T*, the speed of the car is 26 m s^{-1}.

The car is 3.5 m long and the lorry is 17.0 m long.



At time = 0 s
(car begins to overtake)

At time = *T* s
(car overtakes lorry with rear in line with the front of the lorry)

What is the value of *T*?

A 0.43 s **B** 2.1 s **C** 2.6 s **D** 3.0 s

By drawing the v-t graph, the difference in the areas of the two vehicles is 3.5 + 17.

Hence, ½ (16) (T) = 20.5
T= 2.6 s

Ans: C

6 A truck of mass 2300 kg has broken down on a road. A car of mass 1200 kg decides to give it a push from the back and accelerates at a rate of 3.0 m s^{-2}. The average frictional force that the car and truck experience is 350 N and 800 N respectively.

What is the driving force of the car?

A 3750 N **B** 3950 N **C** 11300 N **D** 11650 N

For the truck,
$F_{ct} - f_t = m_t a$
F_{ct} = 2300 (3) + 800 = 7700 N

For the car
$F_d - F_{tc} - F_c = m_c a$
F_d = 1200 (3) + 350 + 7700 = 11650 N **Ans: D**

7 A ball of mass 300 g is being kicked and it leaves a table horizontally with a speed of 10 m s^{-1}. The falling ball then enters a stationary cart of mass 1.2 kg at an angle of 30° below the horizontal. After the ball lands into the cart, the cart immediately moves off with the ball horizontally at a particular speed. Air resistance is considered to be negligible.

What is the final speed and momentum of the ball and cart?

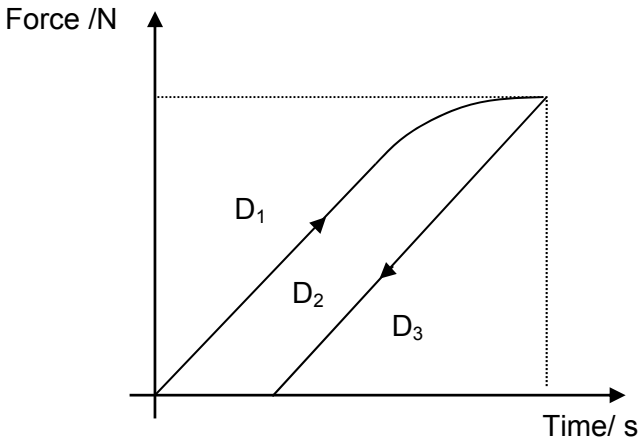
	Final speed/ m s^{-1}	Final momentum / kg m s^{-1}
A	1.7	2.6
B	2.0	3.0
C	5.8	7.0
D	5.8	8.7

By COLM (horizontally),

10 (0.3) + 0 (1.2) = v (1.2 + 0.3)
v = 2 m s^{-1}
Final momentum = (1.5) (2) = 3 kg m s^{-1}

Ans: B

8 The stretching of a particular material and the easing of the stretched material take different paths in a force-extension graph as shown below.



The area D_2 and D_3 represent the amount of energy that is needed to extend the elastic material.

Ans: C

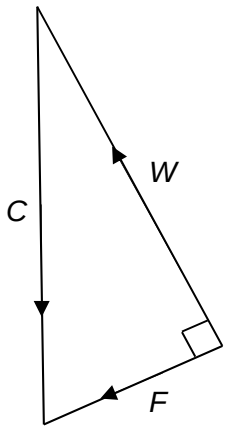
Which of the following represents the work done to extend the elastic material?

A $D_1 + D_2$ only
B D_2 only
C $D_2 + D_3$ only
D D_3 only

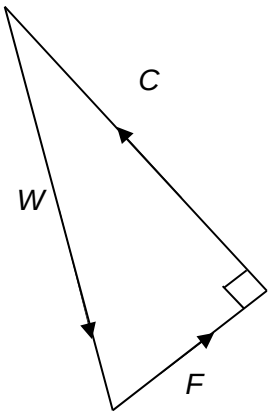
9 A book slides down a slope at a constant velocity. The three forces that act on the book are the normal contact force *C*, the weight *W* and a constant frictional force *F*.

Which diagram represents these forces acting on the book?

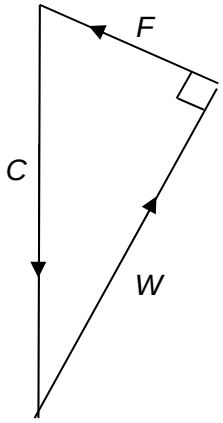
A



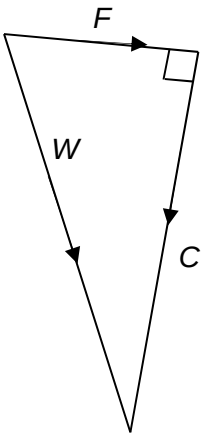
B



C



D

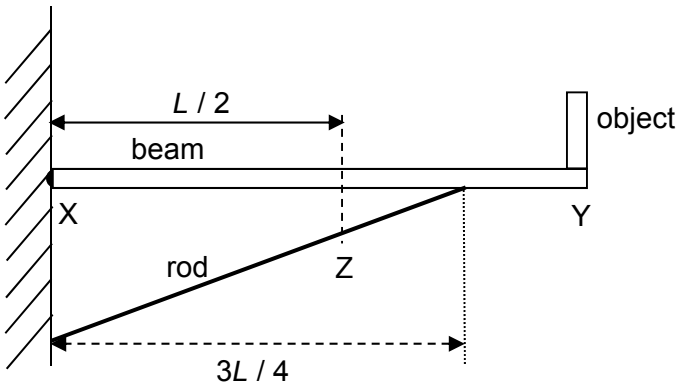


Since object slides down at constant velocity, the object is in equilibrium (acceleration = 0 m s^{-2}) Hence, the force triangle is either B or C.

The angle between the frictional force and the normal contact force is 90°. Hence, the answer is B.

Ans: B

10 A uniform beam of length *L* is hinged at X and is supported by a rod. An object that has the same mass as the beam is placed at Y as shown.



Since the object and beam has the same mass, the combined CG of the object and beam is at 3L/4.

As the rod is under compression and by concurrent forces, the direction of force exerted by wall on beam is YX

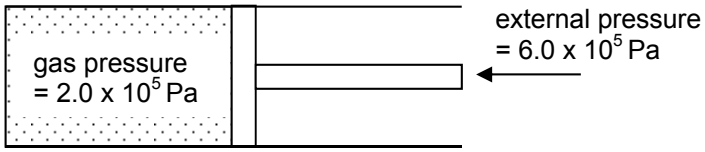
Ans: B

What is the direction of the force exerted on the beam by the wall?

A XZ **B** XY **C** YX **D** ZX

11 A gas at a pressure of 2.0 x 10^5 Pa is enclosed in a cylinder fitted with a frictionless piston of cross-sectional area 3.0 × 10^{-3} m^2. The gas contracts and the piston is pushed back 80 mm by a constant external pressure of 6.0 x 10^5 Pa.

How much work is done by the external pressure against the gas pressure?

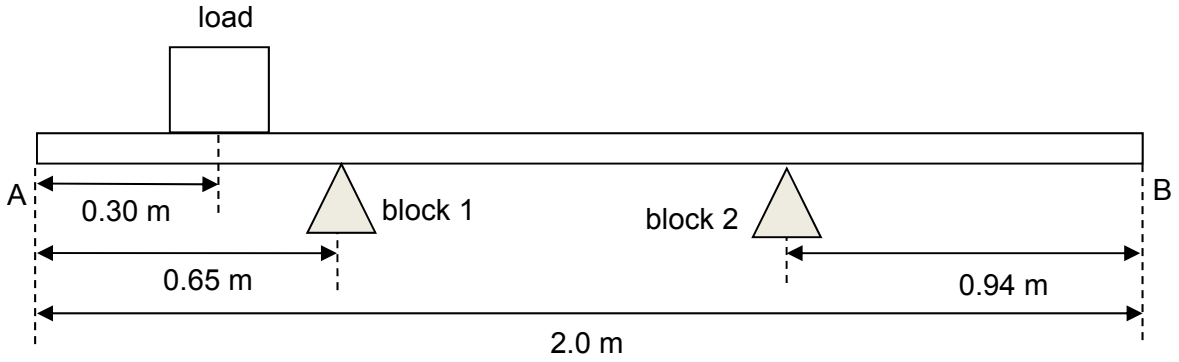


A 48 J **B** 96 J **C** 144 J **D** 192 J

Work done by external pressure = p ΔV
= 2.0 x 10^5 x 3.0 x 10^{-3} x 0.08
= 48 J

Ans: A

12 As shown in the figure below, a load of mass 2.0 kg is placed at 0.30 m from end A of a uniform plank AB. The plank has a weight of 80 N and a length of 2.0 m. Two blocks, block 1 and block 2, are placed beneath the plank to support it. The plank is in equilibrium.



The load is then slowly moved a distance *x* along the plank, what is the value of *x* such that the plank first lose contact with block 1?

A 0.24 m **B** 0.76 m **C** 1.0 m **D** 1.3 m

Taking moments about block 2,
80 (0.06) = 2 (9.81) a (when lose contact, no force due to block 1)
a = 0.24 m

Distance moved by load = (2 – 0.30 – 0.94) + 0.24 = 1.00 m

Ans: C (Note: the load will be on the **right** of block 2)

13 A motor driving a pump raises water through a vertical height of 7 m. If the percentage of wasted power in the motor is 40% and the input power of the motor is 3 kW, what is the volume flow rate of water pumped up by the motor?
(Take density of water to be 1000 kg m^{-3})

A 0.03 kg m^3 s^{-1} **B** 0.04 kg m^3 s^{-1} **C** 0.07 kg m^3 s^{-1} **D** 0.10 kg m^3 s^{-1}

Efficiency = 100 – 40 = 60 %
Output power = 3000 x 0.6 = 1800 W

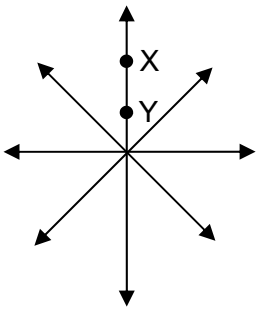
1800 = mgh/t
1800 = (1000)(9.81)(7) (V/ t)

V/t = 0.03 kg m^3 s^{-1}

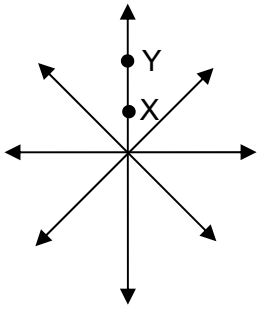
Ans: A

14 In each electric field diagram, a positively charged particle is moved from X to Y. In which diagram(s) would the particle experience (i) an increasing force and (ii) decreasing potential energy ?

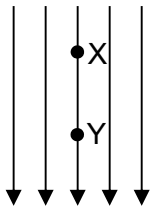
I



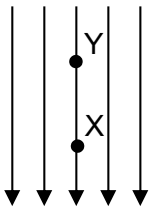
II



III



IV



	Increasing force	Decreasing potential energy
A	I & IV	II only
B	I only	II & III
C	II & III	II only
D	I only	II & IV

Ans: B
For diagram I & II, field strength is not uniform and increases in diagram I as X moves towards Y. Hence the force increases.
Since force points towards decreasing potential energy, diagrams II & III represents that of decreasing potential energy.

SR

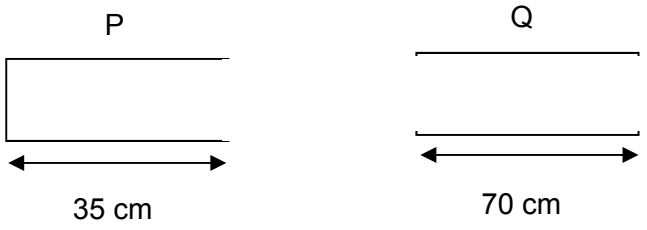
15 A light wave of amplitude *A* is incident normally on a surface area *S*. The power per unit area reaching the surface is *P*. The amplitude of the light wave is increased to 2*A*. The light is then refocused on to a smaller area ¼ *S*.

What is the power per unit area on this smaller area?

A *P* **B** 8 *P* **C** 12 *P* **D** 16 *P*

Ans : D
When light wave has amplitude A, energy reaching surface area is proportional to A^2 and hence P, power per unit area is proportional to A^2/S.
When light wave has amplitude 2A, energy reaching surface area is proportional to $4A^2$ and power per unit area is proportional to $4A^2/(¼S) = 16\ A^2/S$.

16 Travelling waves of wavelength 20 cm are created in air columns in a closed pipe P and an open pipe Q. The lengths of the pipes are shown.

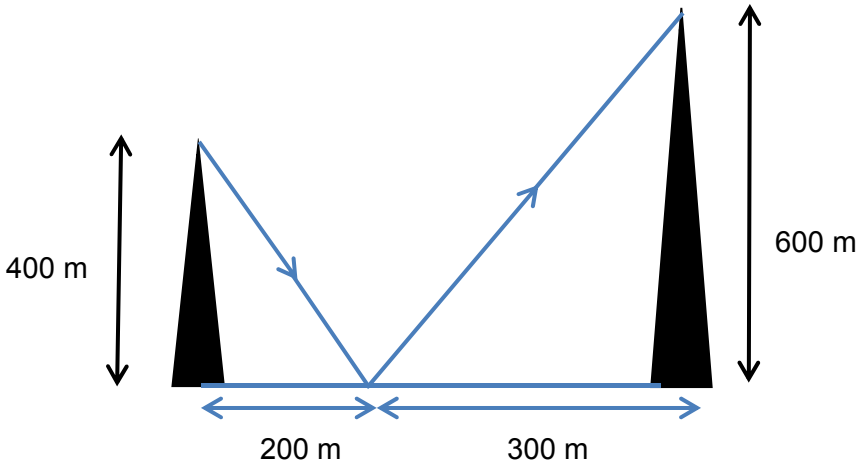


In which pipe(s) is/are stationary waves formed ?

A P and Q **B** P only **C** Q only **D** Neither P nor Q

Ans : A
For closed pipe P, length of pipe is 1.75λ, so a stationary wave can be formed.
For open pipe Q, length of pipe is 3.5λ, so a stationary wave can be formed.

17 The figure below shows a radio wave transmitter at a height of 400 m above ground and a receiver 600 m above the ground. The transmitter and receiver are at a distance of 500 m apart. The receiver can receive signals directly from the transmitter, and indirectly from signals that bounce off the ground as shown in the diagram. The ground is level between the transmitter and receiver and the wave undergoes a 180^o phase change upon reflection.

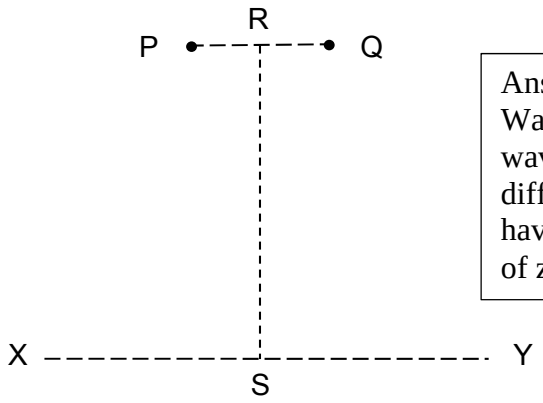


What is the longest wavelength that can cause constructive interference at the receiver?

A 580 m **B** 618 m **C** 1 160 m **D** 1 240 m

Ans : B
Path difference should be (n + ½)λ.
For longest wavelength, n should be 0.
Path taken by the wave that rebounded from the ground is $\sqrt{(400^2 + 200^2)} + \sqrt{(300^2 + 600^2)} = 1{,}118$ m,
Path taken by wave that reach the receiver directly is $\sqrt{(200^2 + 500^2)} = 539$
Hence path difference is 1,118 – 539 = 579 m.
½ λ = 579, λ = 1,160 m

18 Coherent waves of equal amplitude are produced at P and Q and travel outwards in all directions. The line RS is halfway between P and Q and perpendicular to the line joining P and Q. The distance RS is much greater than the distance PQ.



Ans: D
Waves in opp. direction for PQ, waves intersecting with diff. path difference along XY. Waves having a constant path difference of zero along RS.

Along which line can we observe (i) a stationary wave (ii) an interference pattern (iii) an antinodal line?

	stationary wave	interference pattern	antinodal line
A	PQ	RS	XY
B	XY	RS	PQ
C	RS	XY	PQ
D	PQ	XY	RS

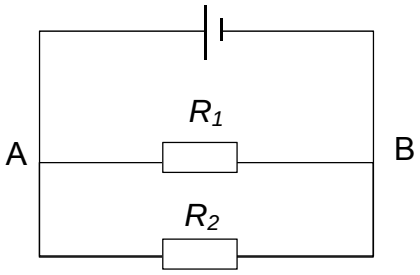
19 Electrons incident on a carbon film shows the most significant diffraction when electrons are accelerated from rest through a potential difference of 13 V.

Which of the following statements about this experiment is correct?

A It shows that electron has a particle-like behaviour.
B The De Broglie wavelength of the electron decreases after it is diffracted by the carbon film because it slows down after colliding with the carbon film.
C Diffraction occurs because the De Broglie wavelength of the electrons is approximately the same as the spacing between the carbon atoms.
D There will be a larger diffraction if the carbon film is replaced by a less dense material with larger spacing between atoms.

Ans: C
A is wrong. Should be particle has wave-like behavior.
B is wrong because wavelength does not change after diffraction.
C is correct.
D is wrong because larger spacing means lesser diffraction.

20 A cell is connected to resistor R_1 and R_2 in an electrical circuit as shown below.



Which of the following statements is true about power output?

A The total power output remains the same when more resistors are added parallel to the circuit as the e.m.f. which is the amount of energy converted from other forms of energy to electrical energy remains the same.

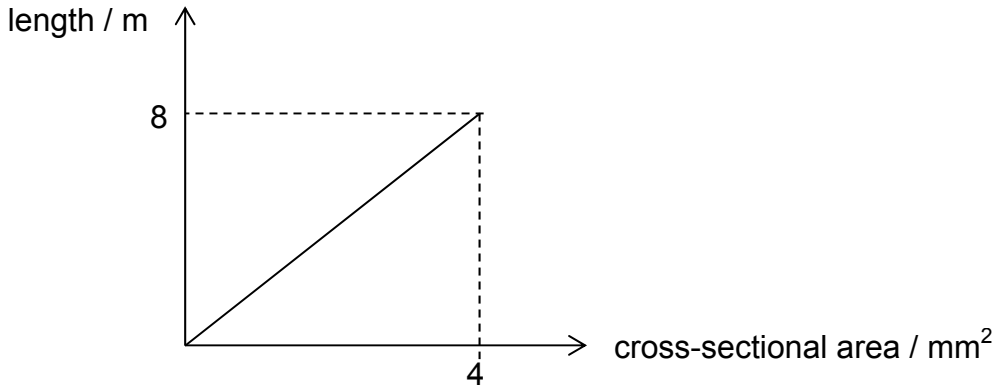
B The power output of each resistor reduces as more resistors are added parallel to the circuit because each resistor now has less current passing through it.

C When an additional resistor is added in series with R_1 between points A and B, the power output of R_2 increases because less current flows through R_1 and hence more current flows through R_2.

D The power output from the cell increases when more resistors are added in parallel to AB because each addition of resistor will cause a larger current flow to be supplied by the cell.

Ans: D
A is wrong because power output increases since every additional resistor adds power supplied by cell by E/R^2.
B is wrong because power output of each resistor remains the same since it is always E/R^2.
C is wrong and reason as per B.
D is correct.

21 The length and cross-sectional area of a wire is varied to maintain a constant resistance of 10 Ω and the graph of the variation of length with respect to cross-sectional area is as shown below.



What is the resistivity of the material that made up this wire?

A 2 Ω m **B** 5 Ω m **C** 2 x 10^{-6} Ω m **D** 5 x 10^{-6} Ω m

Ans: D

$$R = \rho \frac{l}{A}$$

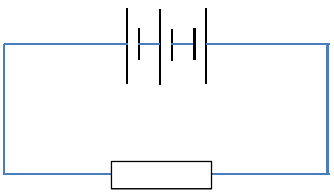
$$l = \frac{R}{\rho} A$$

$$Grad = \frac{R}{\rho} = \frac{8}{4 \times 10^{-6}} = 2 \times 10^{6}$$

$$\rho = \frac{R}{Grad} = \frac{10}{2 \times 10^{6}} = 5 \times 10^{-6} \ \Omega \text{ m}$$

Those who chose A and C could be because they take grad = resistivity
Those who chose A or B could have missed out converting area to m^2.

22 Three identical cells of e.m.f. 12 V are connected to a resistor of resistance 5.0 Ω as shown in the diagram below. The potential difference across the 5.0 Ω resistor is 5.5 V.



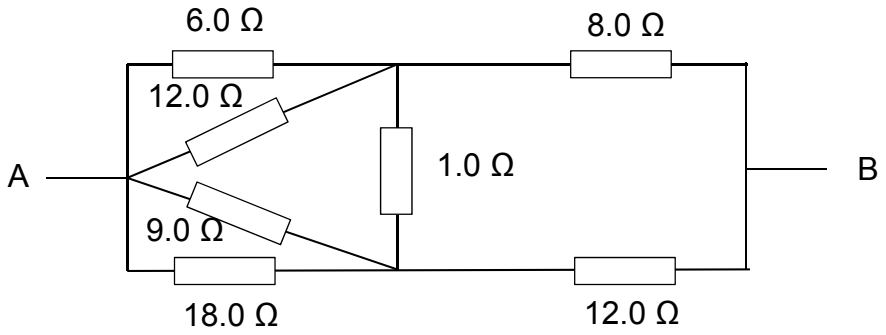
5.0 Ω

What is the internal resistance of the each cell?

A 2.0 Ω **B** 5.6 Ω **C** 5.9 Ω **D** 9.2 Ω

Ans: A
By potential divider principle,
$\frac{5}{5+3r} \times 12 = 5.5$
$r = 1.97\ \Omega$
Those who chose B could have assumed net e.m.f. is 24 V
Those who chose C could have calculated the total internal resistance instead of internal resistance of each cell.
Those who chose D could have taken e.m.f. as 36 V.

23 A set of fixed resistors are arranged as shown below between point A and B.



What is the effective resistance between AB?

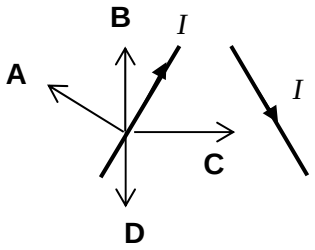
A 7.2 Ω
B 7.4 Ω
C 8.2 Ω
D Cannot be determined.

Ans: A
Effective resistance of 6 and 12 ohm resistor
$R_{eff} = \frac{6(12)}{6+12} = 4.0\ \Omega$
Effective resistance of 9 and 18 ohm resistor
$R_{eff} = \frac{9(18)}{9+18} = 6.0\ \Omega$
As the ratio of resistance of the upper branch and that of the lower branch are both 1:2, the p.d. across the 1 ohm resistor is zero.

Hence, total effective resistance
$R_{eff} = \frac{12(18)}{12+18} = 7.2\ \Omega$
Those who chose B could have considered the 6, 12, 9 and 18 ohm resistor as a parallel setup, and 1 ohm resistor as in series with the 12 ohm resistor on the left and consider the 8 ohm resistor as another parallel setup.
Those who chose C could have considered the 6, 12, 9 and 18 ohm as a parallel setup that is in series with the 1 ohm resistor and the 8 and 12 ohm as a parallel setup that is in series with the 1 ohm resistor.
Those who chose D may think that the 1 ohm resistor is neither parallel or in series and hence cannot be determined.

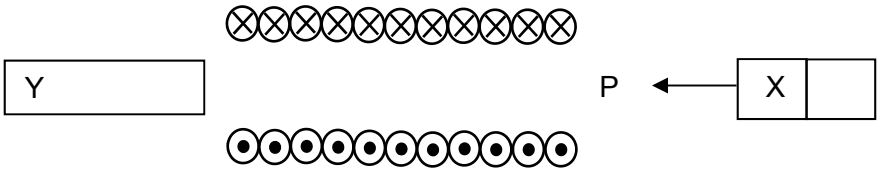
24 Two straight wires carrying an identical current I is arranged as shown below.

What is the direction of the net magnetic force on the wire on the left?



Ans: A
There is an upward and outward component acting on the wire.

25 Positive work is done by hand to move a magnet X towards point P, near the end of a solenoid which is carrying a steady current as shown. The magnet is held stationary at P.

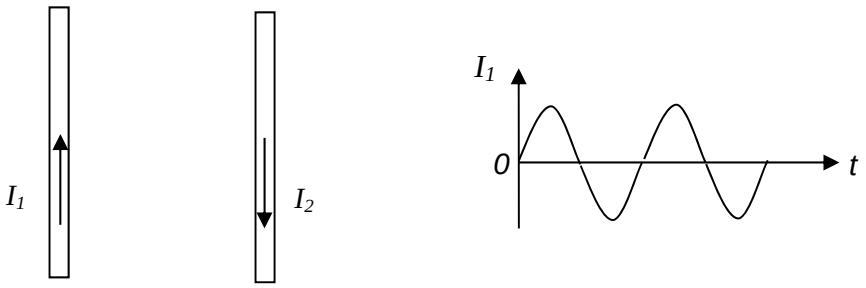


An iron core Y is then inserted into the solenoid. Which of the following correctly describes the reaction of the magnet when it is released?

A It moves towards the solenoid only.
B It moves towards the solenoid and rotates through 180^{o}.
C It moves away from the solenoid only.
D It remains stationary.

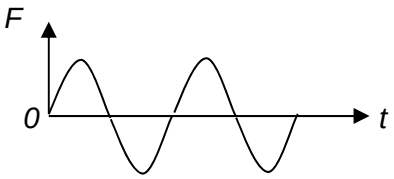
Ans: C
RHS of solenoid is S-pole, and LHS of magnet is also S-pole since positive work is done against repulsive force. Inserting iron core strengthens the magnetic flux of the solenoid and thus the magnet moves away.

26 Two parallel conductors carry sinusoidal alternating currents that differ in phase by π radian. The diagram shows the flow of current at one particular instance in time and the graph shows how current I_1 varies with time.

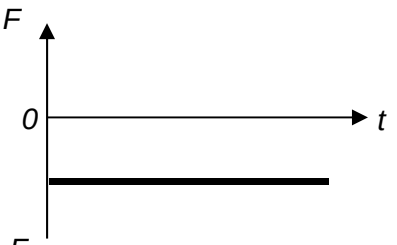


Which of the following graphs shows a possible variation of the force, with respect to time, experienced by one of the conductors?

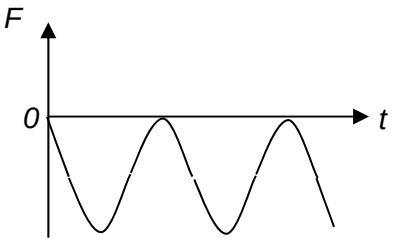
A



B



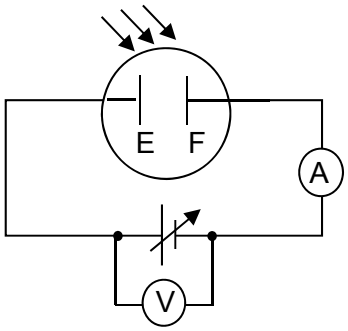
C



D

Ans: C
Currents in opposite direction repel. Since current is sinusoidal, the force should also varies sinusoidally. Since it consistently repels, the force should always be positive or negative (depending on the sign convention used). Option A suggests that sometimes it repels, sometimes attracts, due to a change in signs for F.

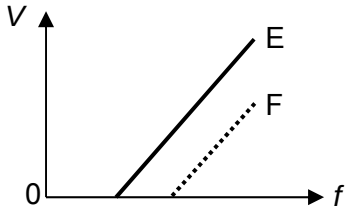
27 The diagram shows a circuit used for photoelectric emission experiments.



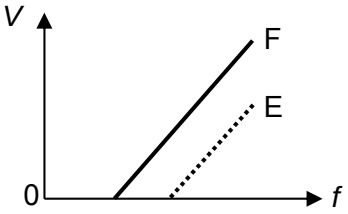
The two electrodes E and F are illuminated with light of frequency *f*. The variable p.d. can be adjusted so that E can either be positive or negative with respect to F. The potential differences *V* required to stop the electrons emitted from electrode E and from electrode F are measured for various frequencies. F has a greater work function than E.

Which graph illustrates the expected results?

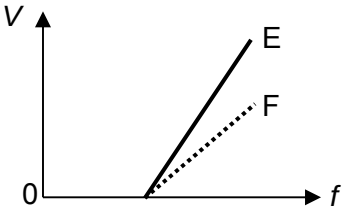
A



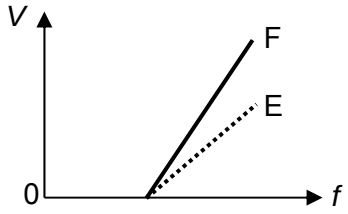
B



C



D



Ans: A

$E_{photon} = \phi + KE_{max}$

$hf = \phi + eV_s$

$V_s = \frac{h}{e}f - \phi$

Since **F** has greater work function than **E**, the stopping potential for photoelectrons from **F** is larger (y-intercept is more negative). Also, both graphs have a constant gradient of h/e.

28 When a metal is irradiated with monochromatic radiation, electrons are emitted. Which of the following will increase if the intensity of the radiation is increased?

A rate of emission of electrons
B threshold frequency of the metal
C energy of the individual photons
D maximum speed of the photoelectrons

Ans: A
Intensity depends on the number of photons incident per unit time. Increased intensity means there are more incident photons which will result in greater number of photoelectrons. If there is no change in the metal surface, then threshold frequency is constant. If there is no change in the colour (wavelength) of the radiation, then the energy of photons (hf) is constant. Also, the max KE (and speed) of photoelectrons is constant.

29 A surface is bombarded normally by photons of frequency ν. On average, n photons strike a unit area of the surface each second. Assuming that the photons are reflected by the surface, what is the pressure exerted on the surface? (h is the Planck constant, c is the speed of light)

A $2nh\nu$ **B** $\frac{2nh\nu}{c}$ **C** $\frac{nh\nu}{c}$ **D** $n\nu$

Ans: B

$$p = \frac{h}{\lambda} = \frac{h\nu}{c}$$

$$\Delta p = p - (-p) = \frac{2h\nu}{c}$$

$$\therefore P = \frac{F}{A} = \frac{\left(\frac{N}{t}\right)}{A}\Delta p = n\left(\frac{2h\nu}{c}\right)$$

30 When an atom absorbs radiation of wavelength λ_1, it makes a transition from its ground state of energy E_1 to an excited state of energy E_3. Then it makes a second transition to a state of lower energy E_2 emitting radiation of wavelength λ_2. Finally, it makes a third transition back to the ground state, emitting radiation of wavelength λ_3.

What is the wavelength of the radiation emitted by the atom when it makes the transition from E_3 *to* E_2?

A $\lambda_1 - \lambda_3$ **B** $\lambda_3 - \lambda_1$ **C** $\dfrac{\lambda_1\lambda_3}{\lambda_1 - \lambda_3}$ **D** $\dfrac{\lambda_1\lambda_3}{\lambda_3 - \lambda_1}$

Ans: D

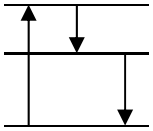
E_1 (photon absorbed) = E_2 + E_3 (photons emitted)

$h c / \lambda_1 = h c / \lambda_2 + h c / \lambda_3$

$1 / \lambda_2 = 1 / \lambda_1 - 1 / \lambda_3$

$1 / \lambda_2 = (\lambda_3 - \lambda_1) / \lambda_1 \lambda_3$

$$\lambda_2 = \frac{\lambda_1\lambda_3}{\lambda_3 - \lambda_1}$$



End of Paper