INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS 8866/01

Paper 1 Multiple Choice **21 September 2015**

1 hour

Additional Materials: Multiple choice answer sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, civics group and index number on the Answer sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. 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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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.
The use of an approved scientific calculator is expected, where appropriate.

Data

speed of light in free space,	c	$= 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	e	$= 1.60 \times 10^{-19}$ C
the Planck constant,	h	$= 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	u	$= 1.66 \times 10^{-27}$ kg
rest mass of electron,	m_e	$= 9.11 \times 10^{-31}$ kg
rest mass of proton,	m_p	$= 1.67 \times 10^{-27}$ 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	$= \rho gh$
resistors in series,	R	$= R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	$= 1/R_1 + 1/R_2 + \ldots$

1 Which of the following shows the SI base units for power?

A $J\ s^{-1}$ **B** $kg\ m^2\ s^{-2}$ **C** $I\ V$ **D** $kg\ m^2\ s^{-3}$

2 A student finds the density of a liquid by measuring its mass and its volume. The following is a summary of his measurements.

mass of empty beaker = (20 ± 1) g

mass of beaker + liquid = (70 ± 1) g

volume of liquid = (10.0 ± 0.6) cm^3

He correctly calculates the density of the liquid as 5.0 $g\ cm^{-3}$.

What is the uncertainty in this value?

A 0.4 $g\ cm^{-3}$ **B** 0.5 $g\ cm^{-3}$ **C** 0.6 $g\ cm^{-3}$ **D** 2.6 $g\ cm^{-3}$

3 Which estimate is *realistic*?

A The kinetic energy of a bus with 10 passengers travelling on an expressway is 30 kJ.

B The mass of an adult elephant is 500 kg.

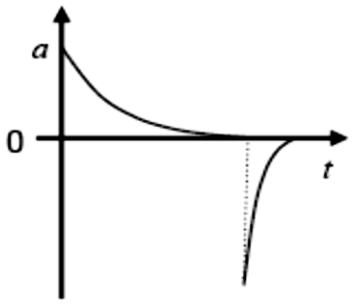
C The temperature of a hot oven is 300 K.

D The volume of air in a car tyre is 0.030 m^3.

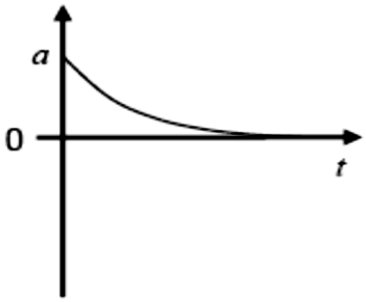
4 While watching the National Day Parade, David witnessed a parachutist jump out of an aeroplane. After some time, the parachutist pulls the cord to release his parachute. Applying what he learnt in his Physics lesson, David sketched the vertical acceleration – time graph of the parachutist.

Which graph best represents the variation with time *t* of vertical acceleration *a,* during the entire descent?

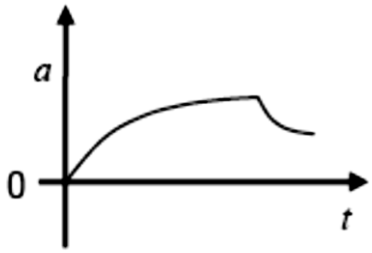
A



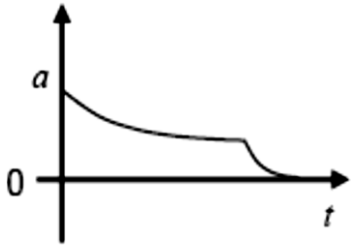
B



C



D



5 In order for a train to stop safely, it must pass a signal showing yellow light before it reaches a signal showing red light. Drivers apply the brakes at the yellow light which results in a uniform deceleration to stop exactly at the red light.

The distance between the red and yellow lights is *x*.

What is the minimum distance between the lights, if the train speed is increased by 20 %, without changing the deceleration of the trains?

A 1.20 *x* **B** 1.25 *x* **C** 1.44 *x* **D** 1.56 *x*

6 An aeroplane flying in a straight line at a constant height of 500 m with a speed of 200 m s^{-1} drops an object. The object takes time *t* to reach the ground and travels a horizontal distance *d* in doing so.

Ignoring air resistance, which of the following gives the values of *t* and *d*?

	t / s	*d* / km
A	10	2
B	10	5
C	25	5
D	25	10

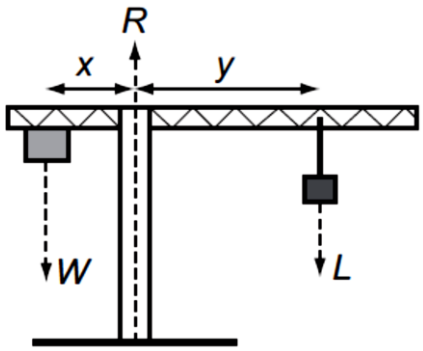
7 The diagram shows two identical spheres X and Y.

Initially, X moves with speed *v* directly towards Y. Y is stationary. The spheres collide elastically.

What happens?

	X	Y
A	moves with speed ½ *v* to the right	moves with speed ½ *v* to the right
B	moves with speed *v* to the left	remains stationary
C	stops	moves with speed *v* to the right
D	moves with speed ½ *v* to the left	moves with speed ½ *v* to the right

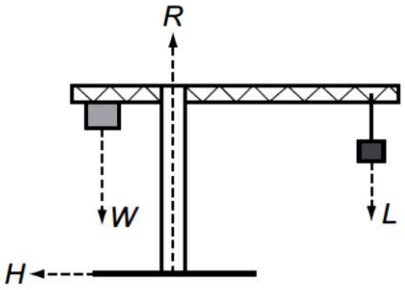
8 The diagram shows a crane supporting a load *L*.



A mass provides a balancing load *W*. The position of the load is such that the system is perfectly balanced with $Wx = Ly$. The ground provides a reaction force *R*. The distance *x* does not change.

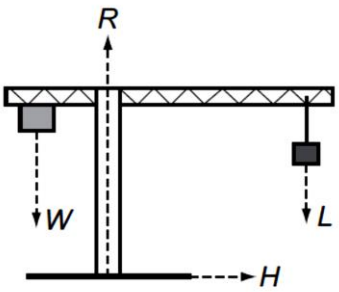
If the load is moved further out so that the distance *y* increases and the crane does not topple, which statement is correct?

A



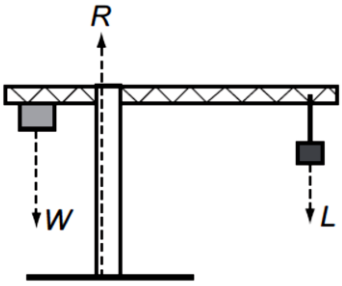
A horizontal force *H* acts on the base of the support column towards the left.

B



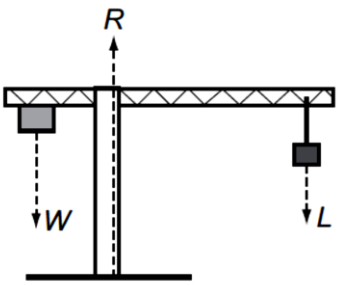
A horizontal force *H* acts on the base of the support column towards the right.

C



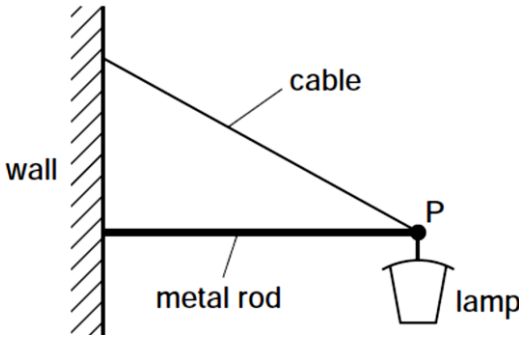
The reaction force *R* moves to the left.

D



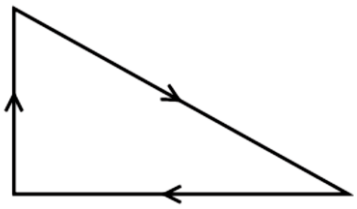
The reaction force *R* moves to the right.

9 A street lamp is fixed to a wall by a metal rod and a cable.

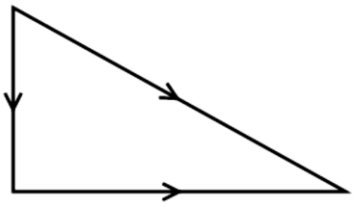


Which vector triangle represents the forces acting at point P?

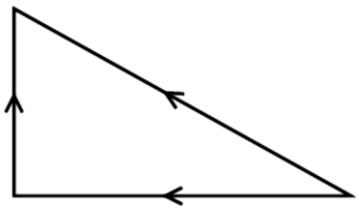
A



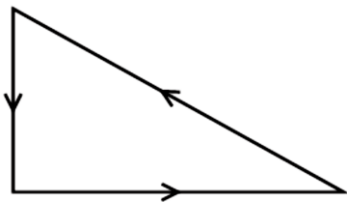
B



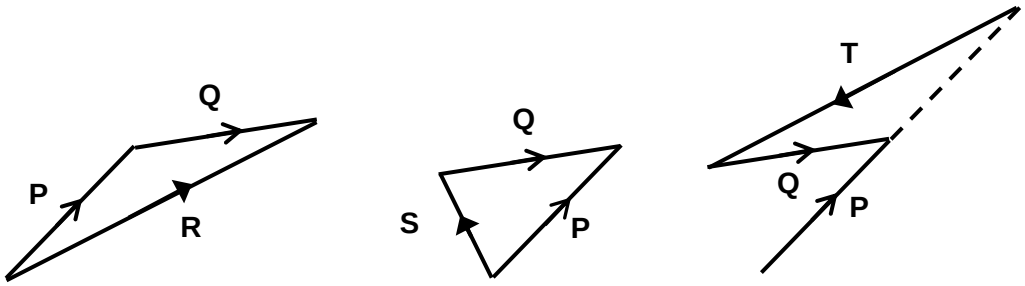
C



D



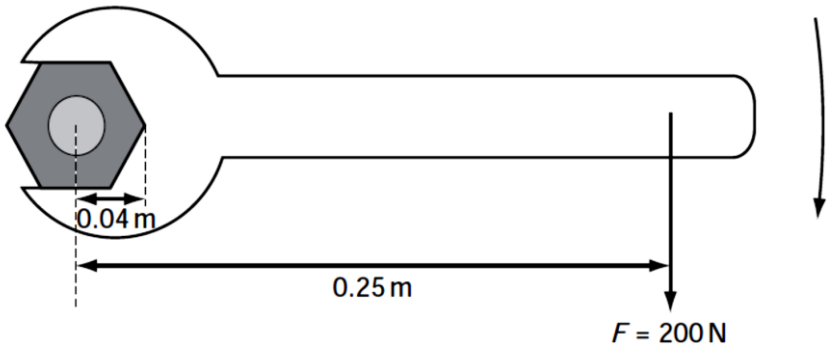
10 The diagrams below show a combination between two vectors P and Q to form new vectors R, S and T.



Which of the following represent vectors **R**, **S** and **T**?

	R	S	T
A	P - Q	- Q + P	Q - P
B	P + Q	P - Q	Q - P
C	P + Q	P - Q	- Q - P
D	P - Q	Q - P	- Q - P

11 A spanner is used to tighten a nut as shown.

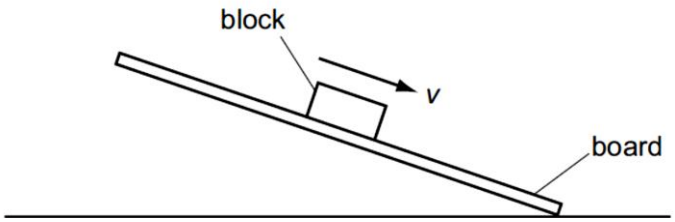


A force *F* is applied at right-angles to the spanner at a distance of 0.25 m from the center of the nut. When the nut is fully tightened, the applied force is 200 N.

What is the resistive torque, in an anticlockwise direction, preventing further tightening?

A 8 N m **B** 42 N m **C** 50 N m **D** 1250 N m

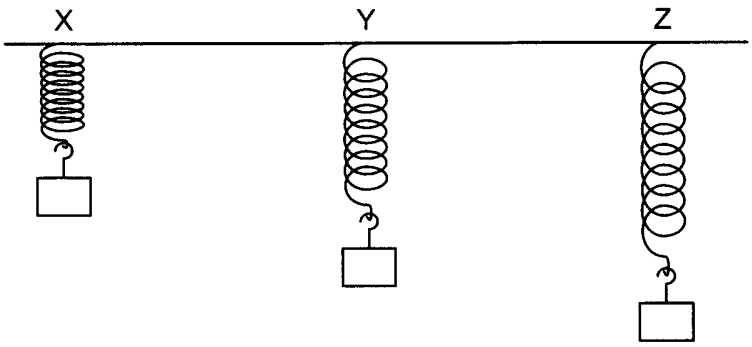
12 A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity *v*.



Which row describes the forces acting on the block when sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the plane	down the plane
B	down the plane	zero
C	up the plane	down the plane
D	up the plane	zero

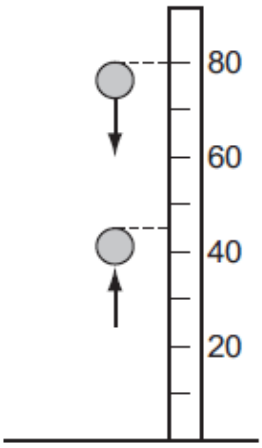
13 A spring fixed at one end, has a mass attached to the other end. The mass bounces up and down. It is shown in the diagram at three positions X, Y and Z.



Which line gives the kinetic and gravitational potential energies for the mass and the elastic potential energy stored in the spring?

	kinetic energy	gravitational potential energy	elastic potential energy
A	zero for X	maximum for X	maximum for X
B	maximum for Y	minimum for Z	maximum for Y
C	zero for Z	minimum for Z	zero for X
D	maximum for Y	maximum for X	maximum for Z

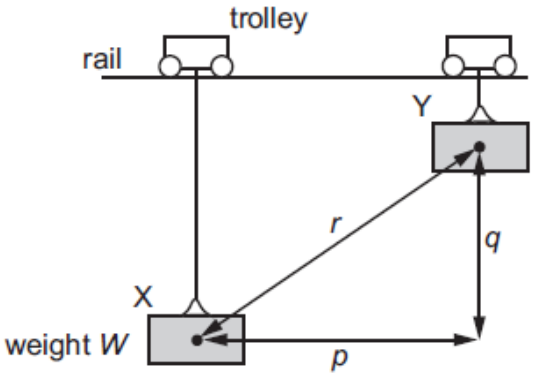
14 A solid rubber ball has a diameter of 8.0 cm. It is released from rest with the top of the ball 80 cm above a horizontal surface. It falls vertically and then bounces back up so that the maximum height reached by the top of the ball is 45 cm, as shown.



If the kinetic energy of the ball is 0.75 J just before it strikes the surface, what is its kinetic energy just after it leaves the surface?

A 0.36 J **B** 0.39 J **C** 0.40 J **D** 0.42 J

15 A weight *W* hangs from a trolley that runs along a rail. The trolley moves horizontally through a distance *p* and simultaneously raises the weight through a height *q*.



As a result, the weight moves through a distance *r* from X to Y. It starts and finishes at rest. How much work is done on the weight during this process?

A *Wq* **B** *W(p+q)* **C** *Wp* **D** *Wr*

16 Which line in the table summarizes the change in wave characteristics in going from infra-red to ultraviolet in the electromagnetic spectrum?

	frequency	speed in a vacuum
A	increase	decrease
B	decrease	no change
C	increase	no change
D	decrease	decrease

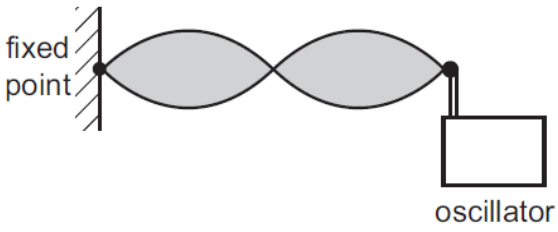
17 A light wave of amplitude A is incident normally on a surface of area S. The power per unit area reaching the surface is P.

The amplitude of the light wave is increased to $2A$. The light is then focused on to a smaller area $\frac{S}{3}$.

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

A $6P$ **B** $12P$ **C** $18P$ **D** $36P$

18 The speed of a transverse wave on a stretched string can be changed by adjusting the tension of the string. A stationary wave pattern is set up on a stretched string using an oscillator set at a frequency of 650 Hz.



How must the wave be changed to maintain the same stationary wave pattern if the applied frequency is increased to 750 Hz?

A Decrease the speed of the wave on the string.

B Decrease the wavelength of the wave on the string.

C Increase the speed of the wave on the string.

D Increase the wavelength of the wave on the string.

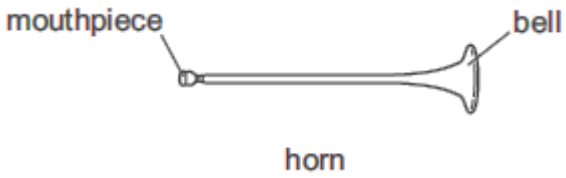
19 Noise reduction headphones actively produce their own sound waves in order to cancel out external sound waves.

A microphone in the headphones receives waves of one frequency. A loudspeaker in the headphones then produces a wave of that frequency but of a different phase.

What is the phase difference between the external sound wave and the wave produced by the loudspeaker in the headphones?

A 90° **B** 180° **C** 270° **D** 360°

20 The basic principle of note production in a horn is to set up a stationary wave in an air column.



For any note produced by the horn, a node is formed at the mouthpiece and an antinode is formed at the bell. The frequency of the lowest note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

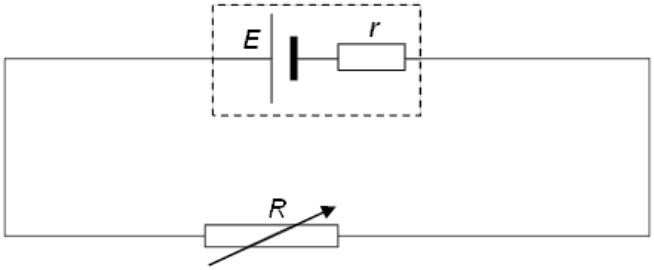
21 The belt in an electrostatic machine has width w and travels with velocity v. The amount of charge per unit area on the surface of the belt is ε. As the belt passes a certain point, all the charge is removed and carried away as an electric current.

Which of the following expressions gives the magnitude of this current?

A $wv\varepsilon$ **B** $wv^2\varepsilon$ **C** $\frac{w\varepsilon}{v}$ **D** $\frac{v\varepsilon}{w}$

For questions 22 and 23, refer to the diagram below.

A battery of e.m.f *E* and internal resistance *r* is connected to a variable resistor *R* as shown below. When *R* = 16 Ω, the current in the circuit is 0.50 A. It is found that the battery supplies 4500 J of energy for a duration of 1.0×10^3 s.



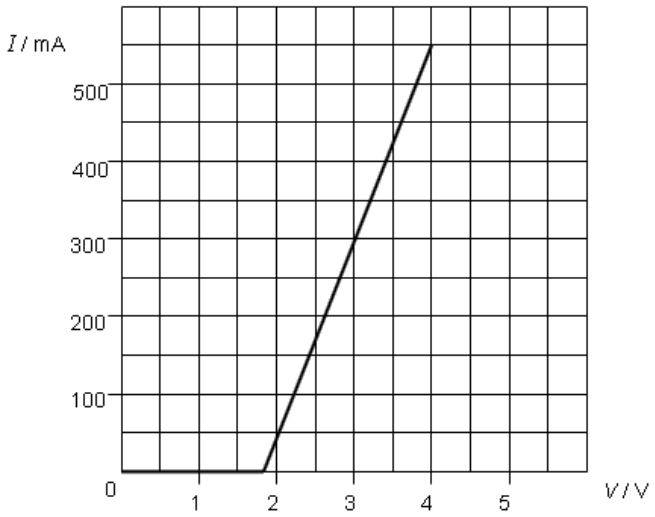
22 What is the e.m.f of the battery?

A 9.0 V **B** 10.0 V **C** 11.0 V **D** 12.0 V

23 What is the internal resistance *r*?

A 1.0 Ω **B** 2.0 Ω **C** 4.5 Ω **D** 9.0 Ω

24 The diagram shows the relation between the current I in a circuit element and the potential difference *V* across it.



Which statement about the circuit element is correct?

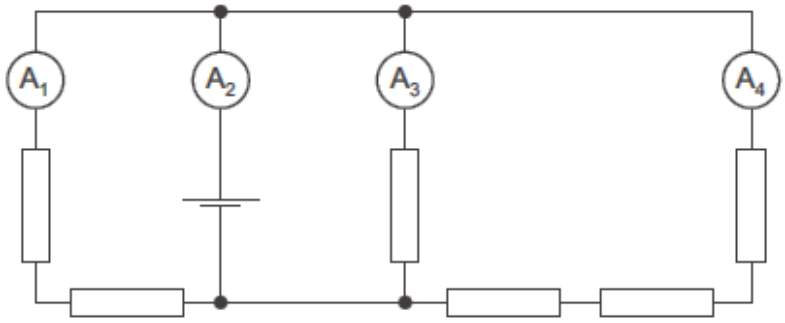
A It does not obey Ohm's law but when *V* > 1.8 V, its resistance is constant.

B It does not obey Ohm's law and when *V* > 1.8 V, its resistance is not constant.

C It obeys Ohm's law and when *V* > 1.8 V, its resistance is constant.

D It obeys Ohm's law but when *V* > 1.8 V, its resistance is not constant.

25 In the circuit shown, all the resistors are identical and all the ammeters have negligible resistance.

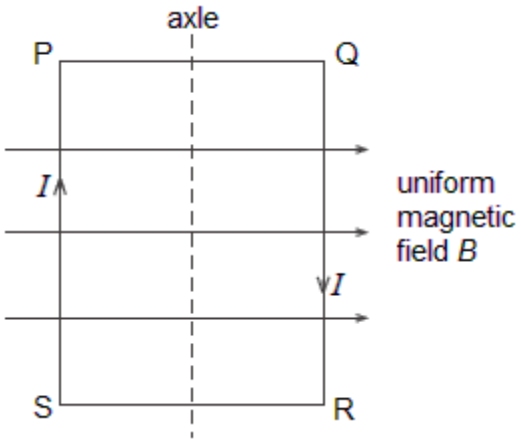


The reading on ammeter A_1 is 0.60 A.

What are the readings on the other ammeters?

	reading on ammeter A_2 / A	reading on ammeter A_3 / A	reading on ammeter A_4 / A
A	1.0	0.3	0.1
B	1.4	0.6	0.2
C	1.8	0.9	0.3
D	2.2	1.2	0.4

26 A coil, mounted on an axle, has its plane parallel to the flux lines of a uniform magnetic field *B*, as shown.



When a current I is switched on, and before the coil is allowed to move,

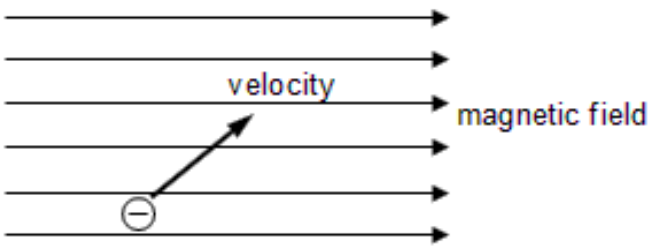
A there are no forces due to *B* on the sides PQ and RS.

B there are no force due to *B* on the sides SP and QR.

C sides SP and QR attract each other.

D sides PQ and RS attract each other.

27 An electron enters a uniform magnetic field at an angle to the magnetic field as shown in the diagram below.



In which direction is the electron initially deflected?

A into the plane of the paper

B out of the plane of the paper

C to the left of its incoming path

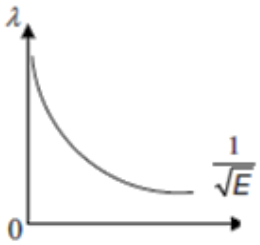
D to the right of its incoming path

28 A clean plate, made of metal with work function energy of 2.36 eV, is illuminated with ultra violet light of wavelength 370 nm. What is the maximum energy of emitted photoelectrons?

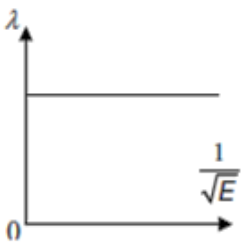
A 1.00 eV **B** 3.36 eV **C** 5.38 eV **D** 5.72 eV

29 An electron with kinetic energy E has a de Broglie wavelength of λ. Which of the following graphs correctly represents the relationship between λ and E?

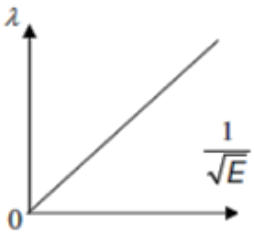
A



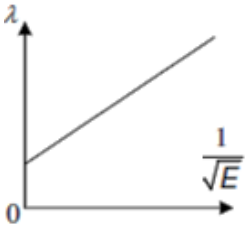
B



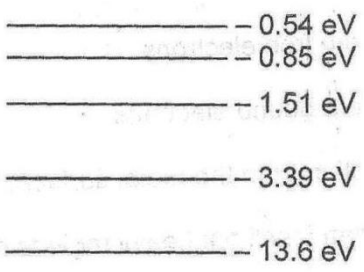
C



D



30 Some of the energy levels of the hydrogen atom are shown below (not drawn to scale).



Electrons are excited to the – 0.85 eV level. How many different photon frequencies in the visible region will be observed in the emission spectrum of hydrogen?

A 1 **B** 2 **C** 3 **D** 6

Solution

Qn	Ans	Qn	Ans	Qn	Ans
1	D	11	C	21	A
2	B	12	D	22	A
3	D	13	D	23	B
4	A	14	B	24	B
5	C	15	A	25	D
6	A	16	C	26	A
7	C	17	B	27	B
8	D	18	C	28	A
9	D	19	B	29	C
10	C	20	D	30	B

1 *[Ans: D]*

As Power = Work Done / time
Base unit for work done : Kg m^2 s^{-2}
Thus, base unit for power is Kg m^2 s^{-3}
Note: J, I and V are not Base units.

Comments

2 *[Ans: B]*

Uncertainty for mass of liquid = 2 g

$$\frac{\Delta p}{p} = \frac{\Delta m}{m} + \frac{\Delta V}{V}$$

$$\frac{\Delta p}{5} = \frac{2}{50} + \frac{0.6}{10}$$

Δp = 0.5 g cm^3

Comments

3 *[Ans: D]*

Average speed on expressway for bus = 70 km h^{-1} = 19.4 m s^{-1}
Mass of bus plus 10 passengers is about 8600 kg
K.E > 30 kJ

Mass of Elephant is about 2500 kg – 6000 kg

300 K is near room temperature

Comments

4 *[Ans: A]*

Comments

After opening the parachute, the parachutist experience a net upwards force in order to slow down. So, there must be a negative acceleration after opening the parachute.

5 *[Ans: C]*

Comments

Using the equation $v^2 = u^2 + 2as$,

The initial speed = $(2ax)^{1/2}$

New initial speed = $1.2(2ax)^{1/2}$

Using the equation $v^2 = u^2 + 2as$,

$0 = [1.2(2ax)^{1/2}]^2 + 2as$

$1.44(2ax) = 2as$

$s = 1.44x$

6 *[Ans: A]*

Comments

The object will have an initial speed of 200 m s^{-1} to the horizontal with initial height of 500 m.

Using equation $s = ut + 1/2at^2$ for the vertical component,

$-500 = 0 + 1/2(-9.81)t^2$

$t = 10$ s

$d = 10 \times 200 = 2$ km

7 *[Ans: C]*

Comments

An elastic collision between X and Y of equal masses, will cause X to transfer all of its KE to Y. Hence, X will stop and Y move off to the right with the speed of X.

8 *[Ans: D]*

Comments

In order for the crane to not topple, when the load *L* is moved to the right, the additional clockwise moment provided by the load about the crane's tower must be balanced by an anti-clockwise moment about the same axis. Hence, the reaction force *R* must move to the right in order for it to provide the required balancing moment. Hence, option D is correct.

9 *[Ans: D]*

When in equilibrium, force vector diagram acting at point P must form a closed loop.
Hence, option D is the only possible choice.

Comments

10 *[Ans: C]*

Comments

11 *[Ans: C]*

At equilibrium,
Resistive torque = Tightening torque
= 200(0.25)
= 50 N m (ACW)

Comments

12 *[Ans: D]*

Block is sliding down the rough plane. Hence, friction force ON the block is directed upwards along the plane. Since, the block slides down at constant velocity, it is not accelerating. Hence, there should not be any resultant force acting on the block.

Comments

13 *[Ans: D]*

- Kinetic energy (KE) is zero for X and Z being the highest and lowest points respectively and maximum for Y since the mass has the highest speed at equilibrium. All options are correct for KE.
- Gravitational potential energy (GPE) is maximum for X and minimum for Z being the highest and lowest points respectively. All options are correct for GPE.
- The spring for Y being the equilibrium point has an extension. Hence, spring Z would have the largest extension and hence maximum Elastic potential energy (EPE), compared to the compression for X. So the EPE for X is less than for Z. Hence option D is correct.

Comments

14 *[Ans: B]*

Comments

Ball has fallen by 0.72 m, it gains a KE of 0.75 J:
loss in gpe = gain in KE
$mg(\Delta h) = 0.75$
$mg(0.72) = 0.75$
$mg = 1.0416$ N

If ball rises by 0.37 m:
gain in gpe $= 1.0416 \times 0.37$
$= 0.385$ J

Hence, KE of ball when it just rebounded from surface: 0.385 J

15 [Ans: A]

Comments

Total work done on weight = change in kinetic energy + change in gpe
$= 0 + (mg)(q)$
$= Wq$

16 [Ans: C]

Comments

Refer to EM spectrum in notes. Simple recall.

17 [Ans: B]

Comments

Intensity $\propto$ Amplitude^2

Since amplitude is doubled, the intensity will be multiplied by 4.

Intensity $= \dfrac{\text{Power}}{\text{Area}}$

Since Area is now $\dfrac{1}{3}$ of original, intensity will be multiplied by 3

$\therefore$ In the intensity will be multiplied by $4 \times 3 = 12$ times original

18 [Ans: C]

Comments

To maintain same wave pattern, with distance between fixed point and oscillator unchanged, λ must remain unchanged.

$\lambda = \frac{v}{f}$. Since frequency is increased, v has to increase as well.

19 [Ans: B]

Comments

To cancel out, the two waves must interfere destructively i.e. they have to meet completely out of phase i.e. phase difference = 180^o.

20 [Ans: D]

Comments

For the fundamental frequency, the distance between the mouthpiece (node) and the bell (antinode) is $0.25\lambda_1$.
As for the frequencies of the next two higher notes, the distance between the mouthpiece and the bell is $0.75\lambda_2$ and $1.25\lambda_3$.
i.e. $L = 0.25\lambda_1 = 0.75\lambda_2 = 1.25\lambda_3$
$\lambda_1 = 3\lambda_2 = 5\lambda_3$

Since $v = f\lambda$ with the speed of the note constant,
$v = 75 \times \lambda_1 = f_2 \times 1/3\ \lambda_1 = f_3 \times 1/5\ \lambda_1$
$f_2 = 225$ Hz
$f_3 = 375$ Hz

21 [Ans: A]

Comments

In 1 second, the area of belt that passes by the point = wv
The amount of charge on this area is $wv\varepsilon$
Current = charge collected in 1 second = $wv\varepsilon$

22 [Ans: A]

Comments

$$E = \frac{workdone}{\Delta Q} = \frac{4500}{0.5 \times 1000}$$

= 9.0 V

23 [Ans: B]

Comments

$P = I^2R + I^2r$

$$\frac{4500}{1.0\ x10^3} = (0.50)^2(16) + (0.50)^2 r$$

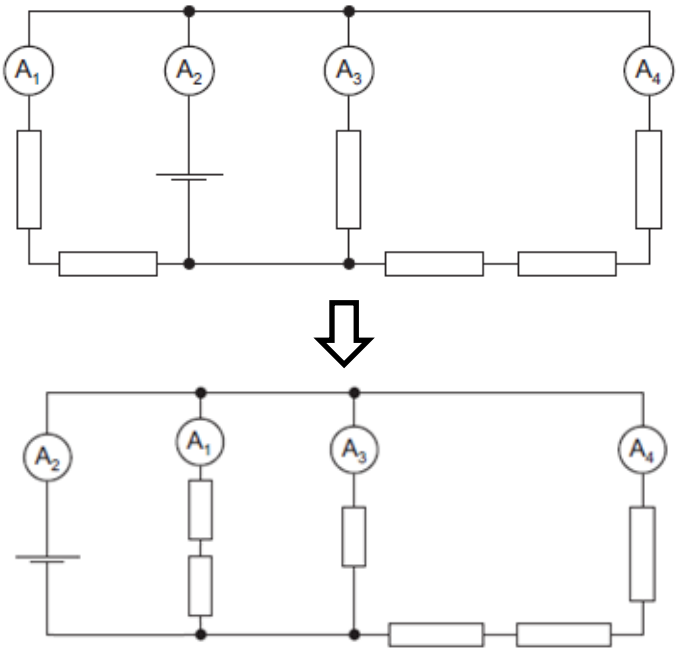
$r = 2\Omega$

24 [Ans: B]

Does not obey Ohm's law as it is not a straight line passing through origin.
When V > 1.8 V, its resistance is not constant.

Comments

25 [Ans: D]



Based on the circuit diagram, there are three branches connected in parallel to the e.m.f. Thus these three branches would have the same p.d. across it.
i.e. $E = I_1 2R = I_3 R = I_4 3R$
Since $I_1 = 0.6$ A,
$I_3 = 1.2$ A and $I_4 = 0.4$ A
$I_2 = I_1 + I_3 + I_4 = 0.6 + 1.2 + 0.4$
$= 2.2$ A

Comments

26 [Ans: A]

When the current is switched on, there are magnetic forces acting on PS and QR in and out of the page (i.e. not attractive or repulsive) according to Fleming's Left Hand rule. However, there is no magnetic force acting on PQ and SR since the currents are acting along the direction of the magnetic field.

Comments

27 [Ans: B]

Since the charge is an electron, the direction of current is opposite to that of its velocity. Hence, according to Fleming's left hand rule, the magnetic force and hence the deflection is out of the plane of the paper.

Comments

28 [A]

$KE_{max} = hf - \phi = (hc/\lambda)/(1.6\times10^{-19}) - 2.36 = 1.00$ eV

Comments

29 [C]

Momentum p = $\sqrt{2mE}$

De Broglie wavelength $\lambda = h/p = h/\sqrt{2mE}$

Thus to obtain a straight line graph through the origin, one needs to plot a graph of λ against $1/\sqrt{E}$.

Comments

30 [B]

Photons in the visible region have energies ranging from 1.8 eV to 3.1 eV.

When the electrons are excited to the -0.85 eV, they emit photons when they move to a lower energy level.

From $4 \rightarrow 2$, $\Delta E = 2.54$ eV

From $4 \rightarrow 3$, $\Delta E = 0.66$ eV

From $3 \rightarrow 2$, $\Delta E = 1.88$ eV

Excitation to ground state will give rise to ultraviolet rays.

Number of emission lines in the visible region = 2

Comments