SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME			
CG		**INDEX NO.**	

PHYSICS 8866/01

Preliminary Examination **22nd Sept 2016**
Paper 1 Multiple Choice **1 hour**

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 soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** 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.
The use of an approved scientific calculator is expected, where appropriate.

For Examiners' Use	
MCQ	/ 30

DATA AND FORMULAE
Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_0	=	8.85×10^{-12} F m^{-1}
		=	$(1/(36\ \pi)) \times 10^{-9}$ F m^{-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
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23}J K^{-1}
gravitational constant,	G	=	6.67×10^{-11}N m^2 Kg^{-2}
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, $p = \rho gh$

gravitational potential, $\phi = -\frac{GM}{r}$

displacement of particle in s.h.m., $x = x_0 \sin \omega t$

velocity of particle in s.h.m., $v = v_0 \cos \omega t$

$= \pm\omega\sqrt{x_0^2 - x^2}$

mean kinetic energy of a molecule of an ideal gas, $E = 3/2\ kT$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

electric potential, $V = Q/ 4 \pi \varepsilon_0 r$

alternating current/ voltage, $x = x_0 \sin \omega t$

transmission coefficient, $T \alpha \exp(-2kd)$

where $k = \sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$

radioactive decay, $x = x_0 \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

Answer all questions

1 A quantity R is found using the following expression

$$P = \frac{1}{8}Q - 2R$$

where $P = 0.70 \pm 0.03$
$Q = 25.0 \pm 0.5$

What is the value of R, together with its uncertainty?

A 1.21 ± 0.02
B 1.21 ± 0.05
C 1.213 ± 0.05
D 1.2 ± 0.5

Ans: **B**

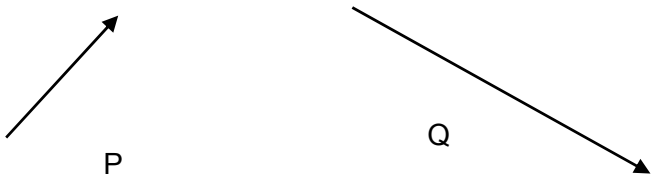
$$R = \frac{1}{2}\left(\frac{1}{8}Q - P\right) = \frac{1}{2}\left(\frac{1}{8} \times 25.0 - 0.7\right) = 1.2125$$

$$\Delta R = \frac{1}{2}\left(\frac{1}{8} \times 0.5 + 0.03\right) = 0.04625 \approx 0.05$$

$$R + \Delta R = 1.21 \pm 0.05$$

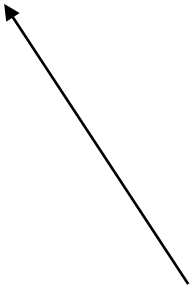
A: If subtract uncertainty, uncertainty = 0.02
C: Wrong DP for R.
D: Ignored coefficients when calculating uncertainty, uncertainty = 0.5

2 Vectors P and Q are drawn to scale.

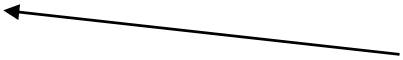


Which diagram represents the vector (P – Q)?

A

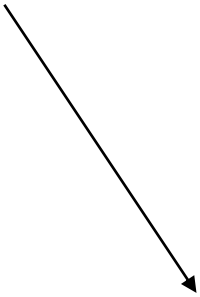


B



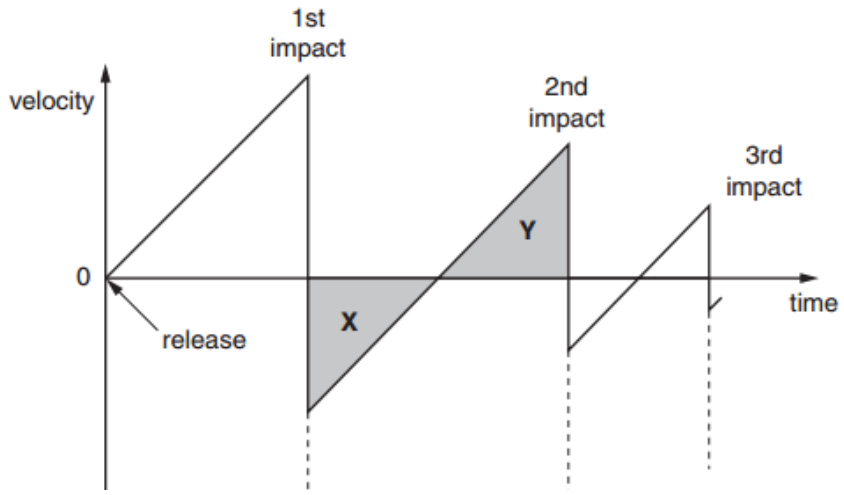
C

D



Ans: **A**

3 A ball is released from rest above a horizontal surface. The graph shows the variation with time of its velocity.



Areas **X** and **Y** are equal.

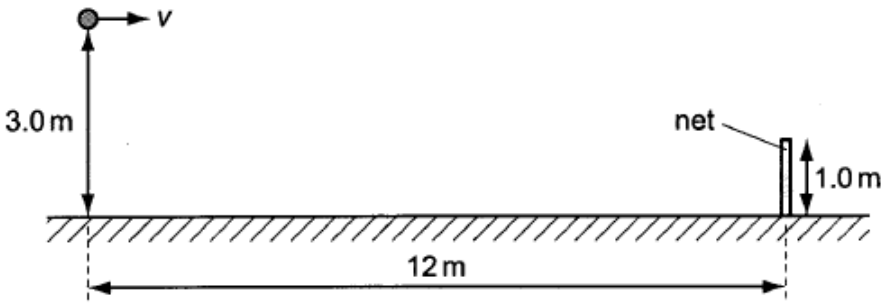
This is because

A the ball's acceleration is the same during its upward and downward motion.
B the speed at which the ball leaves the surface after an impact is equal to the speed at which it returns to the surface for the next impact.
C for one impact, the speed at which the ball hits the surface equals the speed at which it leaves the surface.
D the ball rises and falls through the same distance between impacts.

Ans: **D**

A: This is true but it accounts for the fact that the gradient is the same from the 1st impact to 2nd impact.
B: This is true but it accounts mainly for the speed after impact = speed just before next impact.
C: This is not true, as seen from the speed just before 1st impact (1st positive peak) differing from the speed just after 1st impact (1st negative peak).
D: Area under graph gives the displacement of the ball between 1st impact and 2nd impact.

4 A tennis ball is hit horizontally with speed *v* from a height of 3.0 m such that it just clears a net which is 1.0 m high. The ball is at a horizontal distance of 12.0 m from the net initially.



What is the value of *v*? Neglect the effects of air resistance.

A 16 m s^{-1} **B** 19 m s^{-1} **C** 30 m s^{-1} **D** 38 m s^{-1}

Ans: **B**

Vertically, $2.0 = (0) + ½ (9.81) t^2$
$t = 0.6386$ s

Horizontally, $12 \text{ m} = u \times 0.6386$
$v = 19 \text{ m s}^{-1}$

5 A platform is accelerating upwards with a constant acceleration of 3.6 m s^{-2}. A ball held 5.0 m above the platform and at rest with respect to the platform, is released.

How long does it take for the ball to reach the platform?

A 0.86 s **B** 1.01 s **C** 1.67 s **D** 1.27 s

Ans: **A**

$s = ut + \frac{1}{2}at^2 = \frac{1}{2}at^2$ because initial speed is zero.

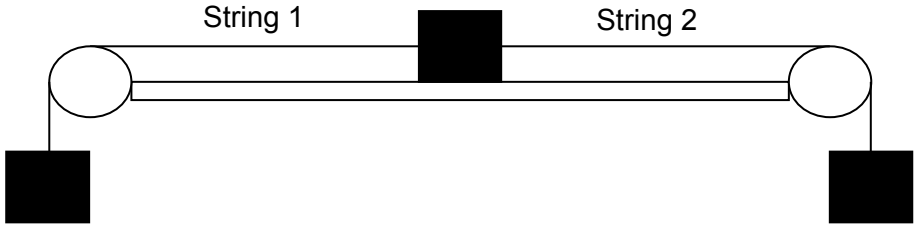
A: $5 = \frac{1}{2}(9.81+3.6)t^2 \Rightarrow t = 0.86\,\text{s}$

B: $5 = \frac{1}{2}(9.81)t^2 \Rightarrow t = 1.01\,\text{s}$

C: $5 = \frac{1}{2}(3.6)t^2 \Rightarrow t = 1.67\,\text{s}$

D: $5 = \frac{1}{2}(9.81-3.6)t^2 \Rightarrow t = 1.27\,\text{s}$

6 Three identical blocks are connected by two strings through frictionless pulleys, as shown below. The middle block rests on a smooth table.



What is the ratio of $\frac{\text{tension in String 2 after String 1 was cut}}{\text{tension in String 2 before String 1 was cut}}$?

A 0.25 **B** 0.5 **C** 1 **D** 2

B
Tension in string 2 before string 1 cut = mg
After string 2 was cut,
considering FBD of middle mass and mass on the right,
T=ma mg-T=ma
Solving T= 0.5 mg ➔Ratio = 0.5

7 A cart X, moving along a horizontal frictionless track, collides with a stationary cart Y. The two carts become attached and move off together.

Which statement about this interaction is correct?

A Cart X loses some of its momentum as heat in the collision.

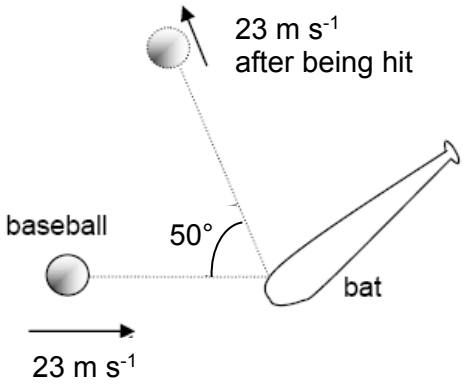
B Cart X shares its momentum with Cart Y but some of its kinetic energy is lost.

C Some of the momentum of trolley X is changed to kinetic energy in the collision.

D Some of the kinetic energy of trolley X is changed to momentum in the collision.

B	Inelastic collision. Momentum of the system is conversed but KE is not

8 A 0.15 kg baseball moving horizontally with a speed of of 23 m s^{-1} is struck by a batter such that after the impact, it moves off with same speed in the direction 50° above the horizontal as shown in the diagram below.



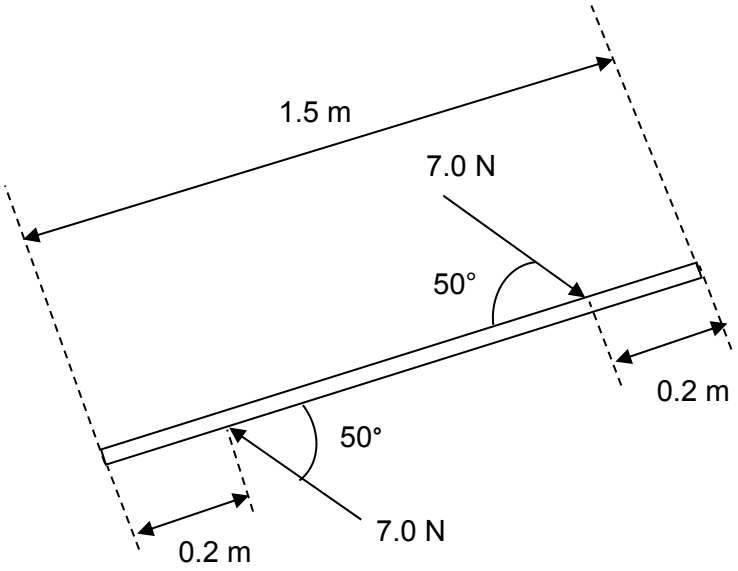
The baseball and the bat are in contact for 0.040 s.

What is the magnitude of the average force exerted on the ball by the bat?

A 73 N **B** 156 N **C** 486 N **D** 1042 N

B
Change in momentum = Impulse
$m\Delta v = F\Delta t$
$0.15\sqrt{23^2+23^2-2(23\times23)\cos130°} = F(0.04)$
F=156 N

9 Two 7.0 N forces act on a beam of length 1.5 m. The forces are parallel and act in opposite directions at a distance of 0.2 m from each end of the beam. The angle between the forces and the beam is 50°.



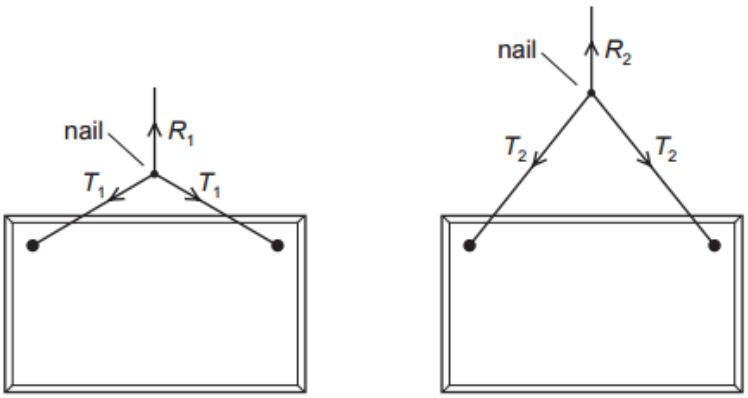
What is the torque of the couple exerted on the beam?

A 4.95 Nm **B** 5.90 Nm **C** 6.75 Nm **D** 8.04 Nm

Ans: **B**
$\tau = F \times d = 7.0 \sin 50 \times 1.1$
$\tau = 5.90 \text{Nm}$

A: $\tau = F \times d = 7.0 \cos 50 \times 1.1 = 4.95$
B: $\tau = F \times d = 7.0 \cos 50 \times 1.5 = 6.75$
C: $\tau = F \times d = 7.0 \sin 50 \times 1.1 = 8.04$

10 The diagram shows two ways of hanging the same picture.



In both cases, a string is attached to the same points on the picture and looped symmetrically over a nail in a wall. The forces shown are those that act on the nail.

In diagram 1, the string looped is shorter than in diagram 2.

Which information about the magnitude of the forces is correct?

A $R_1 = R_2$ $T_1 = T_2$
B $R_1 = R_2$ $T_1 > T_2$
C $R_1 > R_2$ $T_1 < T_2$
D $R_1 < R_2$ $T_1 = T_2$

Ans: **B**

Since picture is the same, weight is the same. Therefore, $R_1 = R_2$.
Taking θ as the angle between the string and the horizontal.

$2T_1 sin\theta_1 = 2T_2 sin\theta_2$

$\frac{T_1}{T_2} = \frac{sin\theta_2}{sin\theta_1}$

$\theta_1 < \theta_2$

Therefore, $\sin\theta_1 < \sin\theta_2$

Therefore, $T_1 > T_2$

11 Newton's Third Law concerns the forces of interaction between two bodies.

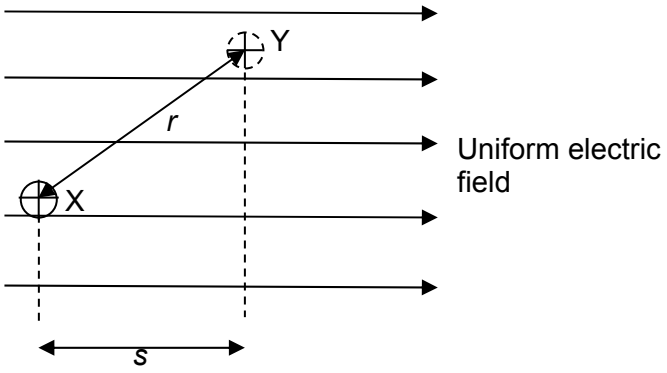
Which of the following statements relating to the third law is not correct?

A The two forces must be of the same type.
B The two forces must act on different bodies.
C The two forces are always opposite in direction.
D The two forces are equal and opposite so that the bodies are in equilibrium.

Ans: **D**

D: The two bodies may not be in equilibrium.

12 A positive ion is placed at point X in a uniform electric field. Due to the electric field, it experienced an electric force *F* and it is moved from point X to point Y.



What is the change in the electric potential energy of the ion?

A decreases by *Fs*
B increases by *Fs*
C decreases by *Fr*
D increases by *Fr*

The electric force is pointing in the same direction as the electric field for a positive charge. Since force always acts in the direction of decreasing potential energy, the EPE is decreasing by *Fs* as ion moves from X to Y.

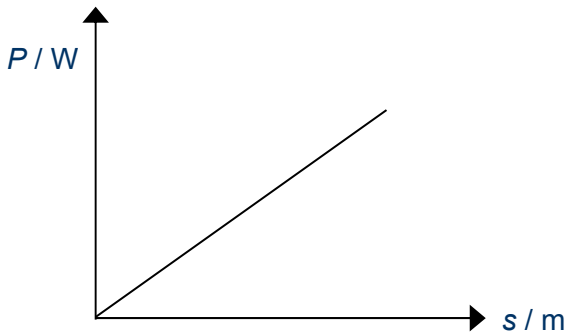
Ans: A

13 A car starts from rest and its driving force causes its speed to increase at a constant rate.

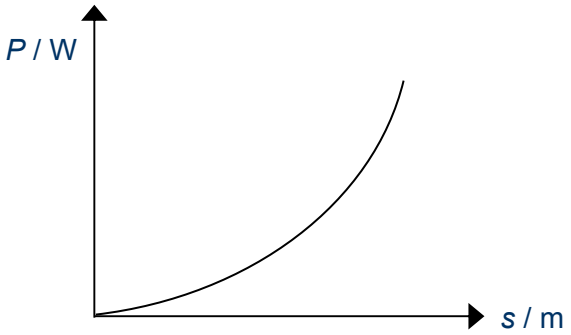
Which graph shows the variation of the power output of the vehicle *P* with the distance travelled by the car *s*?

A

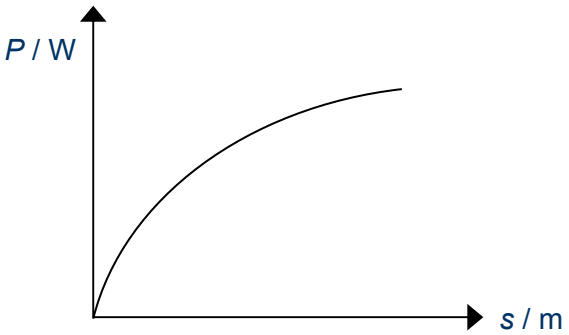
B



C



D



P = Fv.
Since speed increases at a constant rate, the car has a constant acceleration.

Using equation of kinematics , $v^2 = u^2 + 2as$

Since start from rest, u = 0
$v^2 = 2as$
$v = (2as)^{1/2}$

$P = ma(2as)^{1/2}$

Since m and a are constants, the graph of P against s would be a graph of $P \alpha s^{1/2}$

Ans: D

14 The energy carried by a wave is proportional to

A the square of the wave's amplitude as well as the square of intensity.

B the square of the wave's amplitude as well as the intensity.

C the wave's amplitude as well as the square of intensity.

D the wave's amplitude as well as the intensity.

B intensity $\propto$ Amplitude^2 $\propto$ Energy

15 A point source of sound radiates energy uniformly in all directions. The amplitude of oscillation of the air molecules at a distance of 3.2 m from the source is 64 μm.

Assuming that the sound is propagated without energy loss, what is the distance from the source when the amplitude of the oscillation of the air molecules is 8 μm?

A 26 m **B** 82 m **C** 205 m **D** 655 m

A Since $I \propto A^2$ and $I \propto \frac{1}{r^2}$

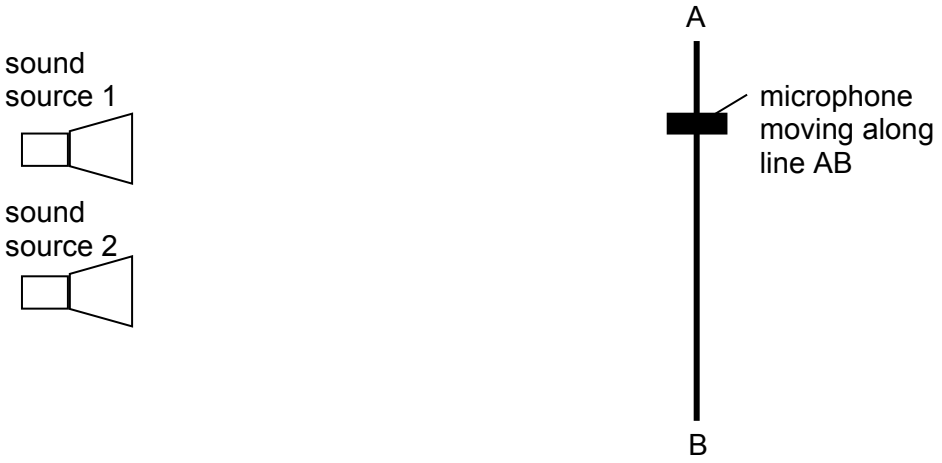
$$A^2 \propto \frac{1}{r^2}$$

$$\left(\frac{r_{3.2\,m}}{r}\right) = \left(\frac{A}{A_{3.2\,m}}\right)$$

$$\left(\frac{3.2}{r}\right) = \left(\frac{8}{64}\right)$$

$$r = 25.6m$$

16 A student set up a two-source interference experiment with sound sources positioned as shown below. However, there was no observable interference pattern when a microphone is moved along line AB.



Which of the following could be a likely cause for the lack of observable interference pattern?

A The distance from sound sources to detector is not much larger than the spacing between the sources.

B The intensities of sound from the two sources are not approximately the same.

C The sound sources are coherent but not in phase.

D Waves from the sound sources always meet antiphase along line AB.

Answer: B
Fact.

17 Which of the following statement is a correct description of the diffraction of waves/particles when they passed through narrow slits/spacing?

A As the wave passes through the slits, wavelength increases thus causing it to spread.

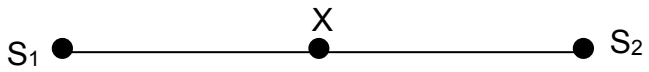
B Particles with momenta p such that $\frac{p}{h}$ where h is the Planck's constant, is approximately the same as the spacing between particles, diffract when it passes through these spacings.

C As sound waves passes through a window, it diffracts because it has a wavelength close to the width of the window.

D Diffraction is the bending of light when it passes through different medium.

Answer: C
Fact.

18 Waves of the same wavelength λ from 2 different sources S_1 and S_2 are constantly out of phase by $\frac{\pi}{2}$. The waves travel in opposite directions and overlap along a line joining S_1 and S_2 as shown below.



The mid-point between S_1 and S_2 is X.

What is the shortest distance from X where a constructive interference occurs?

A 0 **B** $\frac{1}{8}\lambda$ **C** $\frac{1}{4}\lambda$ **D** $\frac{1}{2}\lambda$

Answer: B

Waves meet $\frac{\pi}{2}$ out of phase at X where path difference is zero.

For constructive interference, they should meet with phase difference of 0 or 2π.

To compensate for $\frac{\pi}{2}$ out of phase at source, path difference has to be $\frac{1}{4}\lambda$, hence, need to shift to a new position of X_1 where S_1X_1 shortens by $\frac{1}{8}\lambda$ and S_2X_1 lengthens by $\frac{1}{8}\lambda$.

19 The potential difference between point X and point Y in a circuit is 20 V. Within 15 s, the energy of the charge carriers changes by 12 J.

What is the current betweeen X and Y?

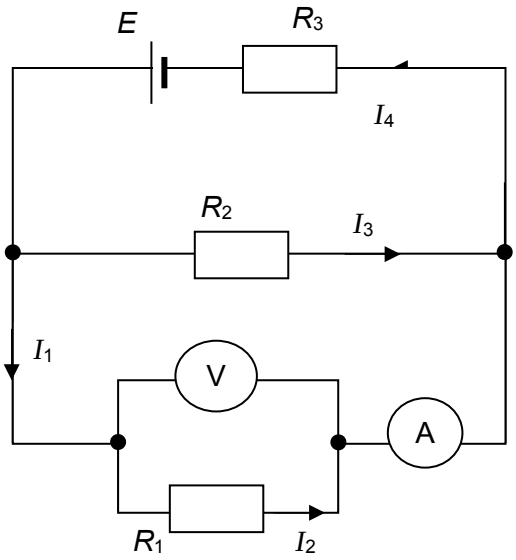
A 0.040 A **B** 0.11 A **C** 9.0 A **D** 25 A

Since V = W/ Q
Q = W / V
= 12 / 20 = 0.6 C

Since Q = It
I = 0.6 / 15 = 0.04 A

Ans: A

20 The figure below shows a circuit that comprises of a battery, 3 resistors, a voltmeter and an ammeter. The e.m.f. of the battery is *E*.



No current flows through voltmeter. Hence $I_1 = I_2$.

Current through ammeter = $I_1 = I_2$

Voltmeter reading = R_1I_2
= R_2I_3
= E - I_4R_3

Ans: C

Which of the following shows the correct expression for the voltmeter reading and ammeter reading?

	Ammeter reading / A	Voltmeter reading / V
A	I_2	$I_4R_3 + I_3 R_2$
B	$I_3 + I_4$	E
C	I_1	$E - I_4R_3$
D	$I_1 + I_3$	I_2R_1

21 The wire of a heating element has resistance *R*. The wire breaks and is replaced by a different wire.

Data for the original wire and replacement wire are shown in the table below.

	Length	Diameter	Resistivity
Original wire	*L*	*d*	*ρ*
Replacement wire	2*L*	2*d*	2*ρ*

What is the resistance of the replacement wire?

A $8R$ **B** R **C** $\frac{R}{2}$ **D** $\frac{R}{4}$

Since R = ρl /A

$$\frac{R'}{R}=\frac{\frac{(2\rho)(2l)}{\pi(\frac{2d}{2})^2}}{\frac{\rho l}{\pi(\frac{d}{2})^2}}=1$$

Ans: B

22 When a 4 Ω resistor is connected between the terminals of a certain cell, a 2A current flows through the circuit. When the 4 Ω resistor is replaced by a 2 Ω resistor, the current changes to 3 A.

Which of the following show the correct values of the e.m.f. and internal resistance of the cell?

	e.m.f / V	internal resistance / Ω
A	15	4
B	12	2
C	10	1
D	8	zero

By $V = E - Ir$

Equation 1: (4)(2) = E – 2r

Equation 2: (2)(3) = E – 3r

Solving equation 1 and 2,
r = 2 Ω and E = 12 V

Ans: B

23 When four identical lamps P, Q R and S are connected as shown in diagram 1, they have normal brightness.

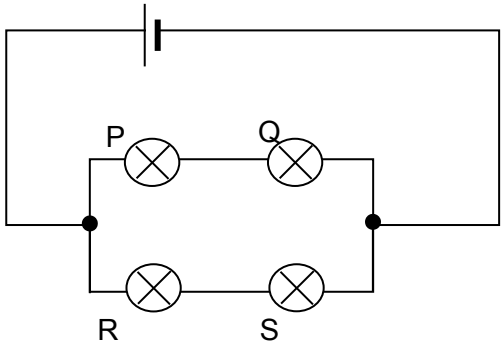


Diagram 1

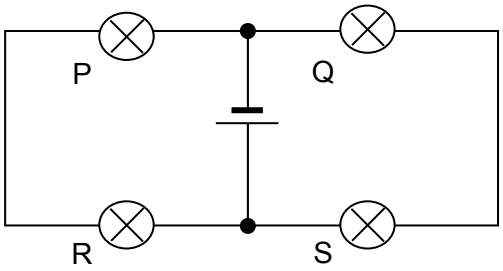


Diagram 2

When the four lamps are connected with the same battery as shown in diagram 2, which statement is correct?

A The lamps do not light up.
B The lamps are less bright than normal.
C The lamps are brighter than normal.
D The lamps have normal brightness.

In diagram 1 and 2, the effective resistance of the circuit is given by R.

Since the potential drop across each lamp is the same for both diagrams, the lamps will be as bright.

Ans: D

24 As seen in Fig. (a), 4 diodes are placed in a circuit with a resistor *R* and alternating current (AC) source that changes the direction of current after each cycle. The positions of the 4 diodes are represented by the dotted boxes.

When a CRO is placed across the resistor R to observe the variations of the current. The graph in Fig. (b) is obtained.

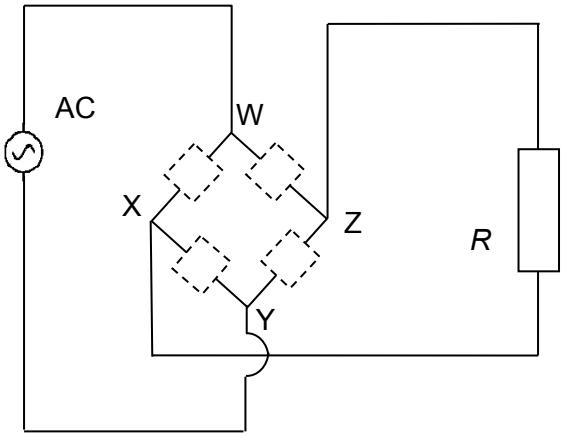


Fig. (a)

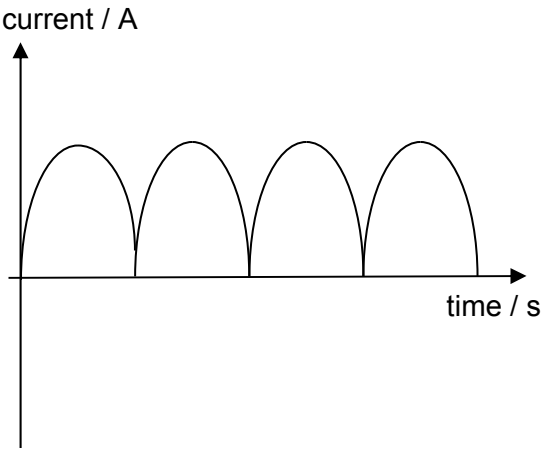
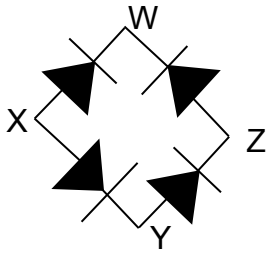


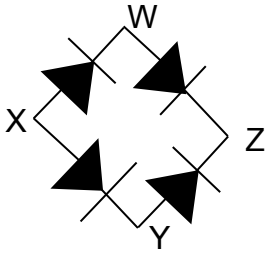
Fig. (b)

Which of the following shows the correct placement of the diodes?

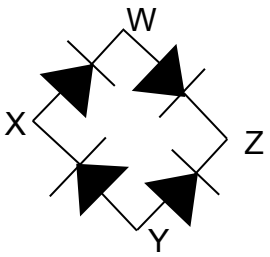
A



B



C



D

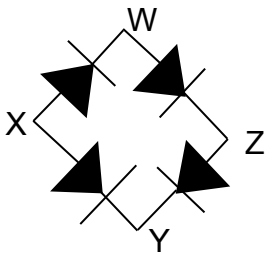
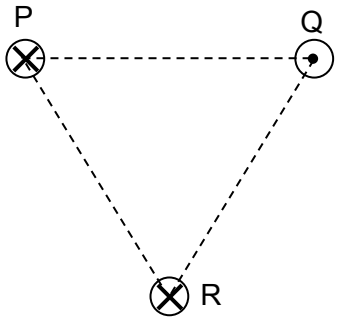


Fig. (b) shows full wave rectification. Hence current must "enter" R from the same way regardless of the changing direction of the current from the AC source.

Ans: B

25 The figure shows the cross-sections of three long vertical wires that pass through the corners of an equilateral triangle PQR. They carry equal currents into or out of the paper as shown.



If the force by P on R is *F*, what is the resultant force on wire R?

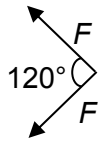
A *F* to the right

B *F* to the left

C $\sqrt{3}\,F$ to the left

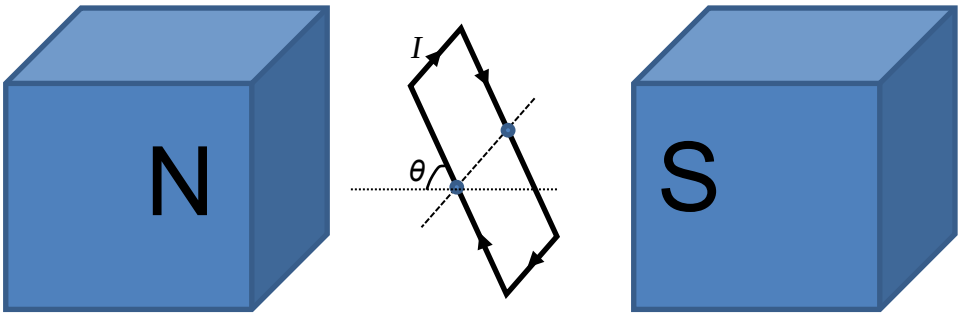
D $\sqrt{3}\,F$ to the right

B
FBD



$F_{net} = F$

26 A rectangular coil with *N* turns is placed in a uniform horizontal magnetic field *B* which makes an angle θ with the plane of the coil as shown below. The coil carries a current I and has an area *A*.



What is the torque of the couple experienced by the coil?

A *NBAI* cosθ

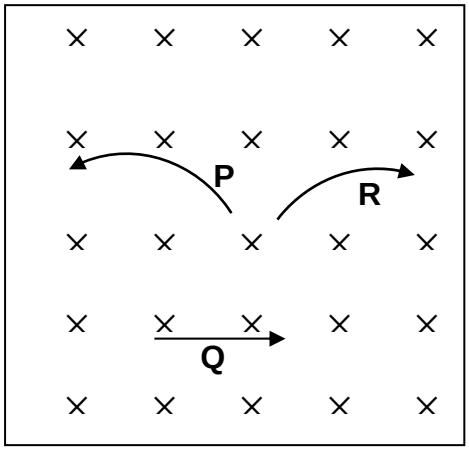
B 2*NBAI* cosθ

C *NBAI* sinθ

D 2*NBAI* sinθ

A
F = *NBIL*
Torque of couple = *NBIL* (A/L) cosθ = *NBAI* cosθ

27 The figure below shows the paths of three particles P, Q and R in a region of space where the magnetic field is directed into the page.

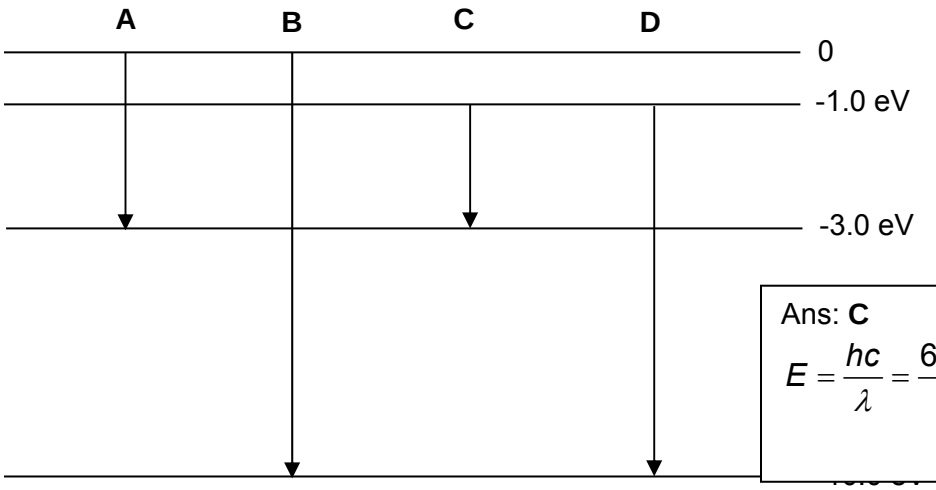


What is the electric charge of each of the three particles?

	P	Q	R
A	negative	neutral	positive
B	negative	positive	positive
C	positive	negative	negative
D	positive	neutral	negative

D
By FLHR, direction of v and I the same implies positive charge. Path of Q not affected by B-field hence it is neutral.

28 The energy levels of an atom of an element are shown in the following diagram. Which energy transitions will produce photons of wavelength 620 nm?



Ans: **C**

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^{8}}{620\times10^{-9}}$$
$$= 2.0 \text{ eV}$$

29 An electron is moving at 10^{-4} times that of the speed of light.
What is the region of the electromagnetic spectrum of its wavelength?

A Microwave
B X-ray
C Visible light
D Radio waves

Ans: **B**

$$\lambda = \frac{h}{p} = \frac{6.63\times10^{-34}}{9.11\times10^{-31}\times10^{-4}\times3\times10^{8}} = 24\text{nm}$$

→ In the range of X-rays.

30 Light quanta of wavelength 276 nm fall on the cathode of a photocell. The work function energy of the cathode is 2.1 eV. The current through the cell is just reduced to zero when a stopping potential V_s is applied.

What is the value of V_s?

A 2.1 V **B** 2.4 V **C** 4.5 V **D** 6.6 V

Ans: **B**

$$eV_S = E_P - \phi$$

$$eV_S = \frac{hc}{276\times10^{-9}} - 2.1\times1.6\times10^{-19} = 3.85\times10^{-19} \Rightarrow V_S = 2.4\,\mathbf{V}$$

A: $eV_S = 2.1\times1.6\times10^{-19} \Rightarrow V_S = 2.1\text{V}$

C: $eV_S = \frac{hc}{276\times10^{-9}} - - = 7.21\times10^{-19} \Rightarrow V_S = 4.5\,\mathbf{V}$

D: $eV_S = \frac{hc}{276\times10^{-9}} + 2.1\times1.6\times10^{-19} = 1.06\times10^{-19} \Rightarrow V_S = 6.6\,\mathbf{V}$

END OF PAPER