SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME			
CG		**INDEX NO.**	

PHYSICS 8866

Preliminary Examination **27 August 2015**
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 **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.

DATA AND FORMULAE

Data

speed of light in free space,	c	=	3.00×10^{8} ms^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} Js
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 ms^{-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 Which of the following is a *random* error?

A Error as a result of using g = 10 m s^{-2}, instead of g = 9.81 m s^{-2}
B Error due to the recording of time using a stopwatch
C Error due to a stopwatch running too fast
D Zero error of a measuring instrument

Ans: B

A, C and D are systematic errors.

2 The relation between the velocity v of waves in the sea with its wavelength λ, the surface tension γ and density ρ of sea water is given by :

$$v = k\sqrt{\frac{\gamma}{\lambda\rho}}$$

where k = constant of proportionality.

If γ = (4.30 $\pm$ 0.05) N m^{-1}, ρ = (1450 $\pm$ 20) kg m^{-3} and the uncertainty in λ is 5 %, what is the percentage uncertainty in the velocity of the waves?

A 2 % **B** 3 % **C** 4 % **D** 8 %

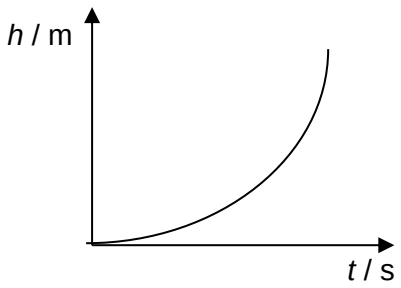
Ans: C

Percentage uncertainty in $v = \frac{1}{2}\left[5 + \left(\frac{0.05}{4.3}\times 100\right) + \left(\frac{20}{1450}\times 100\right)\right] \approx 4\%$

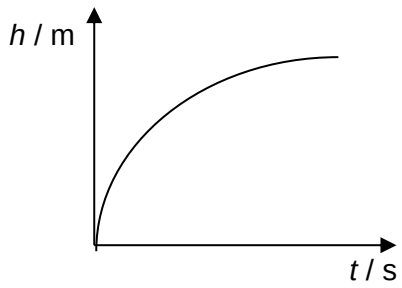
3 A heavy metal ball falls freely under gravity after being released from rest.

Which graph best represents the variation of height h of the ball from the ground with time t?

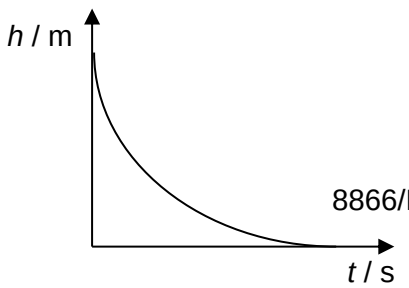
A



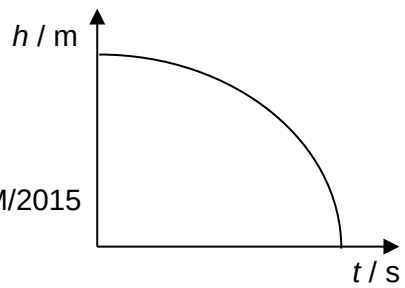
B



C



D



Ans: D
Let h_o be the initial height of the ball above the ground.

$$h_o - h = ut + \frac{1}{2}gt^2 = \frac{1}{2}gt^2$$

$$h = h_o - \frac{1}{2}gt^2$$

4 A ball is fired horizontally from the top of a cliff with a speed of 30 m s^{-1}. Air resistance is negligible. What will be its speed 3.0 s later?

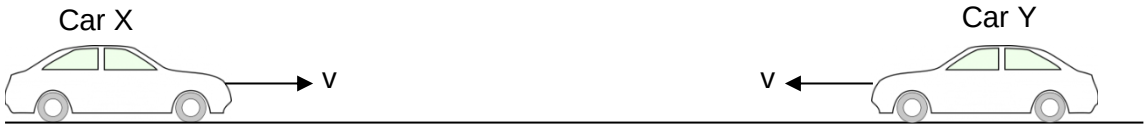
A 29 m s^{-1} **B** 42 m s^{-1} **C** 54 m s^{-1} **D** 60 m s^{-1}

Ans: B

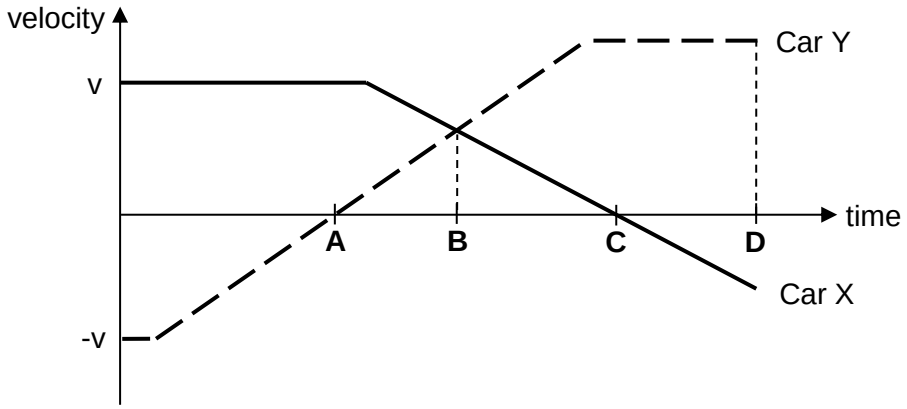
$$v_y = u_y + at = 0 + (9.81)(3) = 29.4 \text{ m s}^{-1}$$

$$v = \sqrt{{v_x}^2 + {v_y}^2} = \sqrt{30^2 + 29.4^2} = 42 \text{ m s}^{-1}$$

5 Car X and Car Y are at a distance apart and they move towards each other with the same initial speed v.

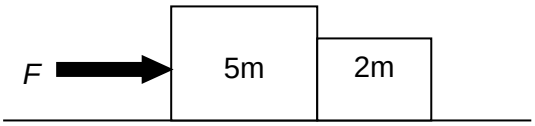


The graph shows the variation of velocity of the cars with time. At which time are the cars at their distance of closest approach?



Ans: B
Taking rightwards as positive.
At time A, Car Y changes direction and moves rightwards
Between time A to C, both Car X and Car Y are moving in the same direction (rightwards).
At time B, Relative velocity $v_Y - v_X = 0$
Distance of closest approach

6 Two blocks with masses 5m and 2m are pushed along a horizontal frictionless surface by a horizontal applied force F as shown. What is the magnitude of the force exerted by 2m on 5m?



A $\frac{2}{7}F$ **B** $\frac{2}{5}F$ **C** $\frac{5}{7}F$ **D** $\frac{5}{2}F$

Ans: A
F = 5ma + 2ma = 7ma
Let force acted on 5m by 2m be F_X.
Considering 5m block,
$F - F_X = 5ma$
$7ma - F_X = 5ma$
$F_X = 2ma$

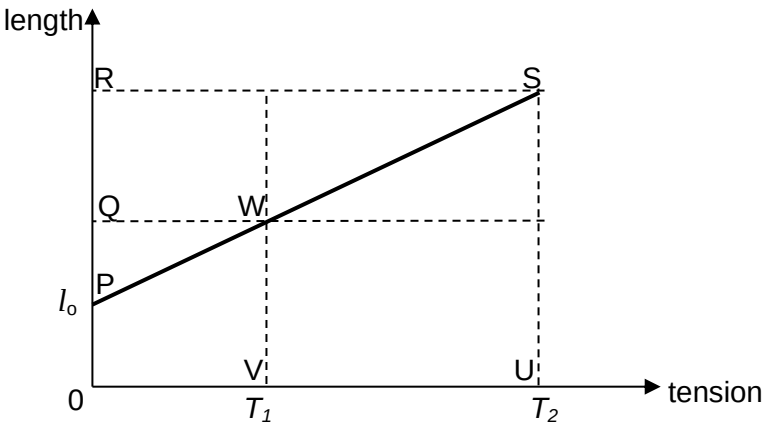
7 A 1.5 kg clay target is fired at 10 m s^{-1} into the air at an angle 30° to the horizontal. At its maximum height, it is hit by a 40 g pellet that was travelling at 50 m s^{-1} vertically upwards. If the pellet was embedded after it hits the clay target, what is the horizontal speed of the combined mass immediately after collision?

A 1.30 m s^{-1} **B** 6.17 m s^{-1} **C** 8.44 m s^{-1} **D** 8.53 m s^{-1}

Ans: C
By conservation of momentum,

Horizontal direction
$M u_{x1} + m u_{x2} = (M + m)v_x$
$1.5 (10 \cos 30°) + 0 = (1.5 + 0.040) v_x$
$v_x = 8.435$ m s^{-1}

8 The tension in a spring of natural length l_o is first increased from zero to T_1, and is then increased to T_2.

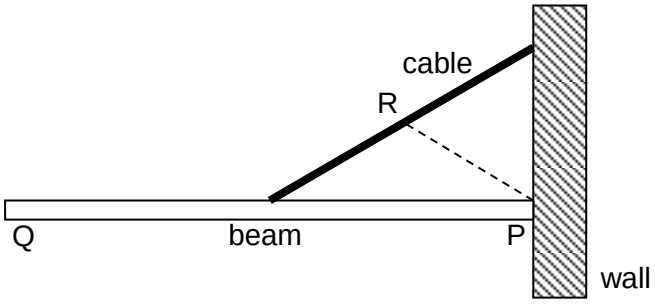


Which area of the graph represents the work done by the spring during when the tension increases from T_1 to T_2?

A PQW
B PRS
C QRSW
D SUVW

Ans: C
Work done by spring
= Elastic potential energy stored in spring
=Area under force-extension graph

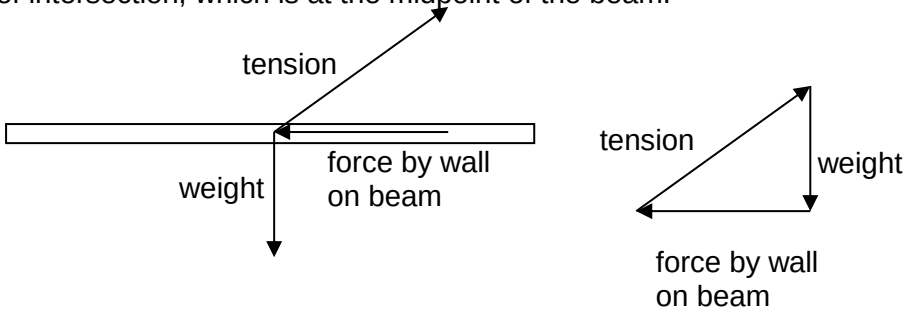
9 A uniform beam is hinged at P and is supported by a cable attached to the mid-point of the beam.



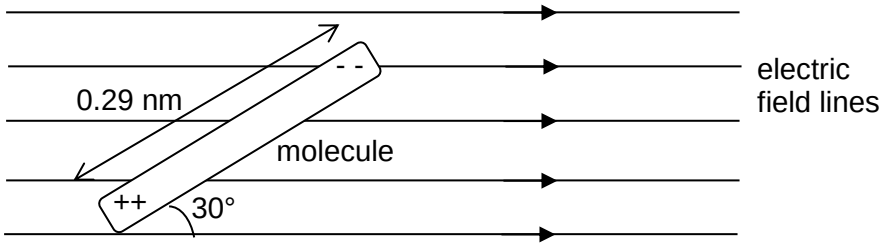
What is the direction of the force exerted by the wall on the beam?

A PQ **B** QP **C** PR **D** RP

Ans: A
All 3 forces (tension, weight and force by wall on beam) should pass through a common point of intersection, which is at the midpoint of the beam.



10 A dipolar molecule of length 0.29 nm is placed in a uniform electric field at an angle of 30°. The ends of the molecule have equal but opposite charges, and a force of 1.2×10^{-10} N is acted on each end.

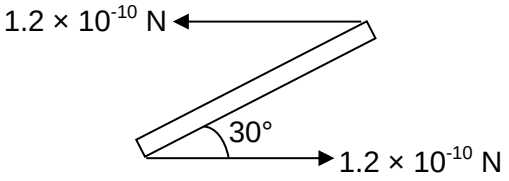


What is the magnitude and direction of the torque acting on the molecule?

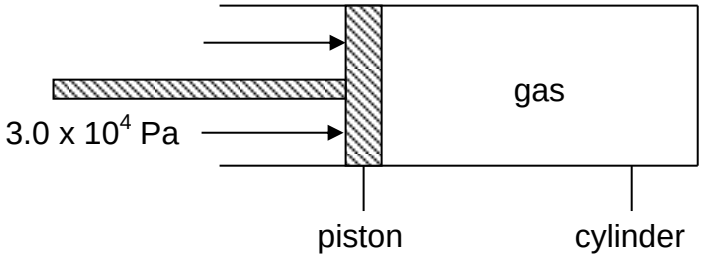
	Magnitude of the torque / Nm	Direction of the torque
A	1.74×10^{-20}	Clockwise
B	1.74×10^{-20}	Anti-clockwise
C	3.01×10^{-20}	Clockwise
D	3.01×10^{-20}	Anti-clockwise

Ans: B

Torque due to the couple
$=1.2 \times 10^{-10} (0.29 \times 10^{-9} \sin 30°)$
$=1.74\times10^{-20}$ Nm
Anti-clockwise



11 Air is enclosed in a cylinder by a gas-tight, frictionless piston of cross-sectional area 25.0 cm^2. When an constant external pressure of 3.0×10^4 Pa is exerted on the piston, it settles at a distance from the end of the cylinder.



The gas is then heated and the piston moves 5.0 mm as a result. The work done on the gas is

A - 380 J **B** - 0.38 J **C** 0.38 J **D** 380 J

Ans: B

Gas is expanding, hence work is done by the gas.

Work done by gas = $p \Delta V = 3.0 \times 10^4 \times 25 \times 10^{-4} \times 5 \times 10^{-3} = 0.38$ J

Work done on gas = - Work done by gas = - 0.38 J

12 A body of mass 5.0 kg is initially travelling at a constant speed of 2.0 m s^{-1} on a horizontal frictionless surface. A force of 15 N acts on it and accelerates it to a final velocity of 12.0 m s^{-1}.

What is the work done by the force?

A 150 J **B** 180 J **C** 250 J **D** 350 J

Ans: D
WD by force = gain in KE = ½ mv^2 - ½ mu^2 = ½ (5)$(12)^2$ - ½ (5)$(2)^2$ = 350 J

13 A weight of 2.0 N is raised through a vertical height of 80 cm in 4.0 s using an electric motor.

If the efficiency of the motor is 20%, what is the electrical power supplied to the motor?
A 0.080 W **B** 0.80 W **C** 2.0 W **D** 200 W

Ans: C
Electric power supplied to motor = useful output power / efficiency
= [(2.0)(0.80)/(4.0)]/0.20 = 2.0 W

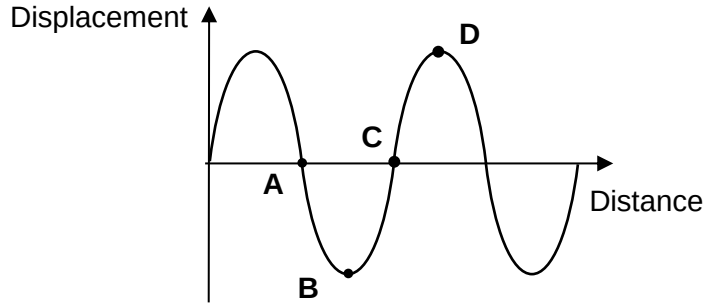
14 In a two-slit interference experiment, one slit transmits twice the amplitude of the other slit. If the maximum intensity of the interference pattern is I_o, what would be the minimum intensity in the pattern?

A $I_o/9$ **B** $I_o/4$ **C** $I_o/3$ **D** $I_o/2$

Ans: A

I α A^2
For maximum intensity, I_o α $(3A)^2$
For minimum intensity, I α $(A)^2$
$I/I_o = (A/3A)^2$
$I = I_o/9$

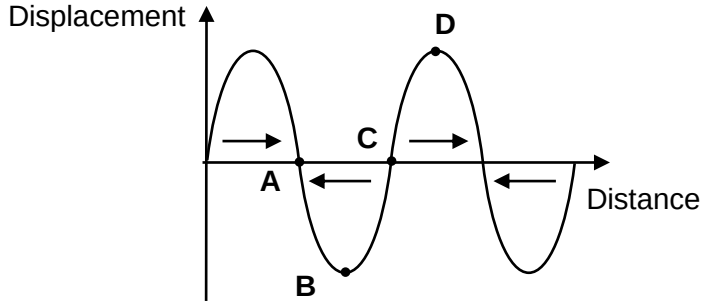
15 A sound wave travelling towards the right through air causes the air molecules to be displaced from their original positions. The graph below shows the variation with distance of the displacement of air molecules at a particular instant of time.



Taking the displacement towards the right as positive, at which point is the pressure maximum?

Ans: A

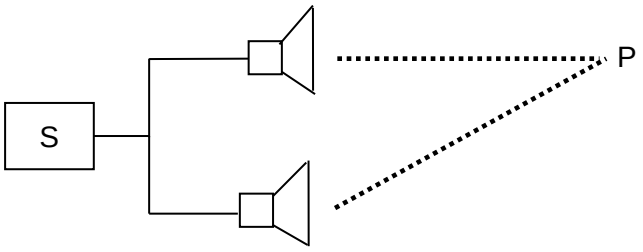
Since displacement towards the right is taken as positive, we can label the directions of displacement of air molecules as follows:



It can be seen from the figure that at point **A**, it is a region of compression as air molecules on the left side of **A** is displaced to the right and on the right side of **A**, they are displaced to the left. Hence **A** has the maximum pressure.

16 A signal from source S is emitted through two separate speakers as shown below. The sound waves from the speakers reach a point P by two paths which differ in length by 1.4 m. When the frequency of the sound is gradually increased, the result intensity at P goes through a series of maxima and minima. A maximum occurs when the frequency is 1000 Hz and the next maximum occurs at 1200 Hz.

What is the speed of the sound waves?



A 200 m s^{-1}

B 240 m s^{-1}

C 280 m s^{-1}

D 330 m s^{-1}

Ans: C

For constructive interference,

$$n\lambda = 1.4$$

$$n\left(\frac{v}{f_1}\right) = 1.4 \Rightarrow n\left(\frac{v}{1000}\right) = 1.4 \Rightarrow n = \frac{1400}{v} \quad --(1)$$

$$(n+1)\left(\frac{v}{f_2}\right) = 1.4 \Rightarrow (n+1)\left(\frac{v}{1200}\right) = 1.4 \quad --(2)$$

Solving (1) and (2), v = 280 m s^{-1}

17 Interference maxima produced by a double source are observed at a distance of 1.0 m from the sources. In which one of the following cases are the maxima closest together?

A sound waves of wavelength 20 mm from sources 50 mm apart

B surface water waves of wavelength 10 mm from sources 200 mm apart

C blue light from sources 2.0 mm apart

D red light from sources 4.0 mm apart

Ans: D

Maxima closest = Fringe separation, x, is the smallest

Using $x = \frac{\lambda D}{a}$

For same D, x $\propto \frac{\lambda}{a}$

Smallest $\frac{\lambda}{a}$ ratio is option D

18 Sound waves can be detected behind an obstacle rather than light waves because

A sound is a pressure wave whereas light is an electromagnetic wave.

B sound travels much more slowly than light.

C sound waves are longitudinal whereas light waves are transverse.

D sound waves have a much longer wavelength than light waves.

Ans: D
Waves tend to diffract (or bend) round an obstacle (e.g. corner) more if its wavelength is in the same order of magnitude as the size of the obstacle. Wavelength of light is much smaller than the size of the obstacle, thus diffraction of light is insignificant. For the same obstacle, sound waves, which have a much longer wavelength than that of light, tend to diffract (bend) more than light waves.

19 A 24 Ω resistor dissipates energy at the rate of 12 W. What is the rate of dissipation of energy of a 16 Ω resistor connected in parallel with it?

A 8 W
B 12 W
C 18 W
D 24 W

Ans: C

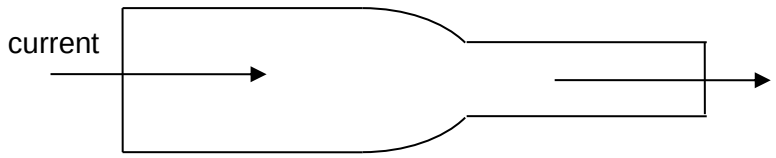
$$P = \frac{V^2}{R}$$

For parallel connection, V remains the same for both resistor

$$\Rightarrow P \alpha \frac{1}{R}$$

$$\frac{P_1}{P_2} = \frac{R_2}{R_1} \Rightarrow P = 18W$$

20 The figure below shows the top view of a metal strip of uniform thickness. The width of the narrow section is half the width of the wider section.



Which of the following statements is correct?

A The potential difference per unit length of the narrower section is the same as the potential difference per unit length of the wider section.

B The potential difference per unit length of the narrower section is smaller than the potential difference per unit length of the wider section.

C The resistance of the narrower section will be smaller and hence more current will flow through as compared to the wider section.

D The resistance per unit length of the narrow section is twice that of the wide section.

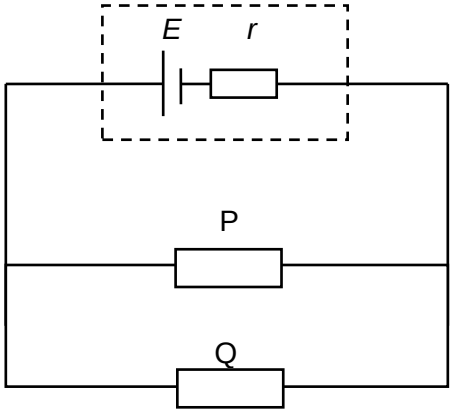
Ans: D

- Since $R = \frac{\rho l}{A} \Rightarrow \frac{R}{l} = \frac{\rho}{A} \Rightarrow \frac{R}{l} \propto \frac{1}{A}$ (ρ is constant for same material), resistance per unit length of the narrow section is twice that of wide section since the constant current flows through the narrower section.

- Since $V \propto R$ for constant I, the resistor with the larger resistance has a larger p.d. across it. Hence, the narrower section (with larger resistance per unit length), has larger p.d. per unit length across it. Hence option A and B are wrong

- Same current flows through the strip by Kirchoff's 1st Law, hence D is incorrect.

21 A battery of e.m.f *E* with internal resistance *r,* supplies a current of 0.025 A for 80 s. During this time, it produces 18 J of electrical energy while the resistor P receives 11 J and resistor Q receives 4 J.



What are the values for *r* and *E* ?

	r	*E*
A	60 Ω	360 V
B	60 Ω	9.0 V
C	300 Ω	9.0 V
D	300 Ω	360 V

Ans: B

$W = IEt$

$18 = 0.025E(80)$

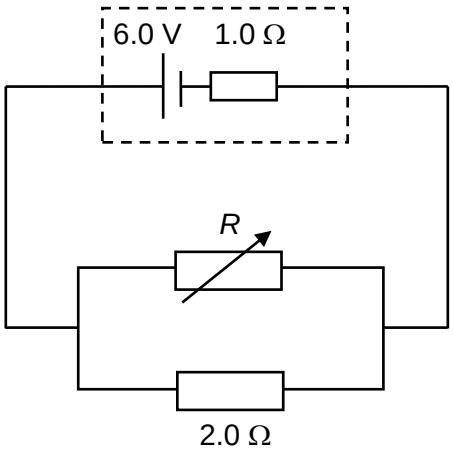
$E = 9.0V$

Energy dissipated by r = 18-11-4=3J

$\Rightarrow \frac{3}{t} = I^2 r$

$\Rightarrow \frac{3}{80} = (0.025)^2 r \qquad \Rightarrow r = 60\Omega$

22 An e.m.f source of 6.0 V, with internal resistance 1.0 Ω is connected across a load which consists of two resistors in parallel. The resistance of the variable resistor *R* may be varied from 1.0 Ω to 6.0 Ω.

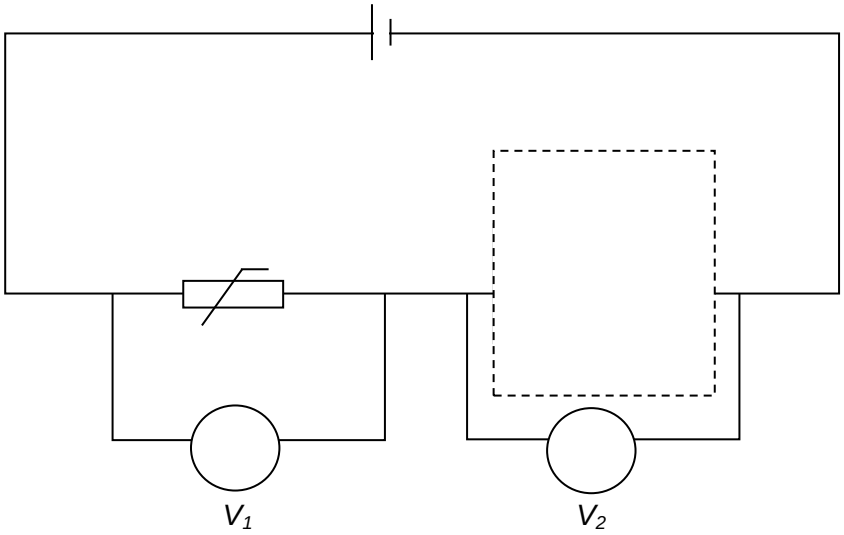


What is the resistance of *R* for maximum power to be delivered to the load?

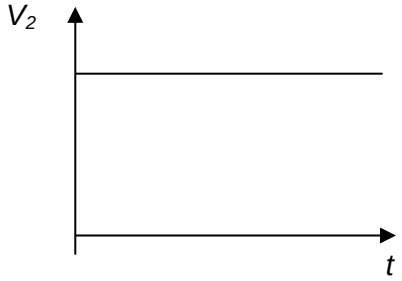
A 1 Ω **B** 2 Ω **C** 3 Ω **D** 6 Ω

Ans: B
For maximum power to be delivered to the load, the effective resistance is 1 Ω and hence R = 2 Ω.

23 An electrical circuit as shown is set up as shown.

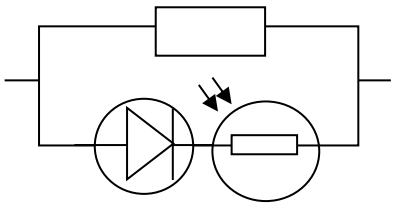


The temperature was decreased and the intensity of light increased. The variation of V_2 with time t is as shown.

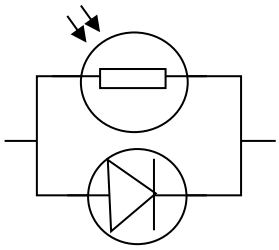


Which of the following could have been a possible set up in the dotted box?

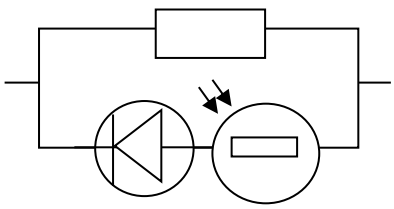
A



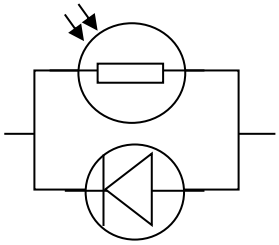
B



C



D



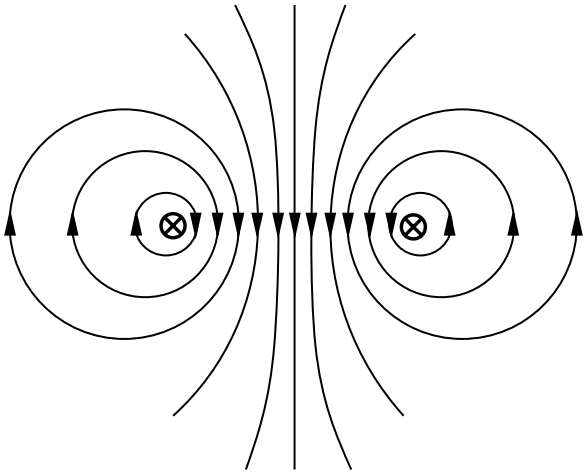
Ans: B

The decrease in temperature will cause an increase in the resistance of the thermistor while the increase in light intensity will cause a drop in the resistance of the LDR. As a result, the p.d. across the thermistor will increase while the p.d. across the LDR should decrease.

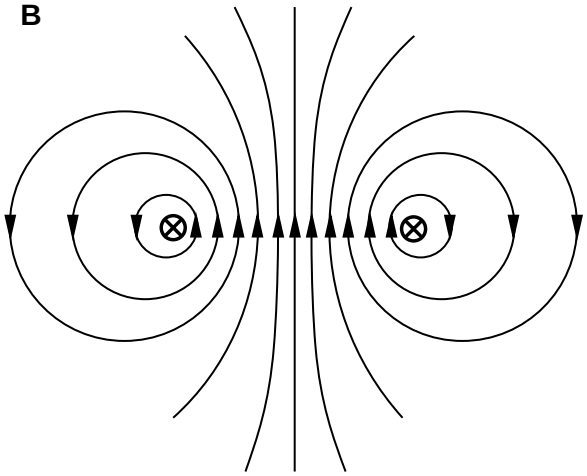
B because the current would have passed through the diode instead of the LDR and hence, the changes in the resistance of the LDR will not have a significant effect on the potential difference reading V_2.

24 Two wires carry the same amount of current flowing into the page. Which of the following diagrams shows the resultant magnetic field pattern in the region?

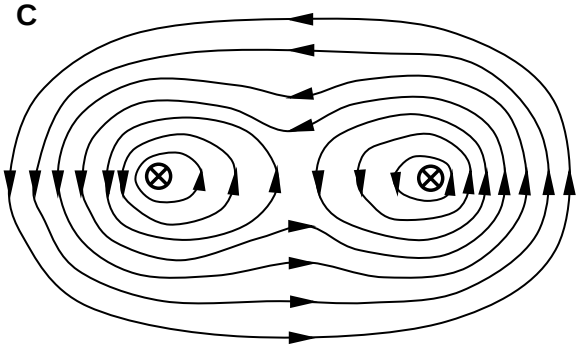
A



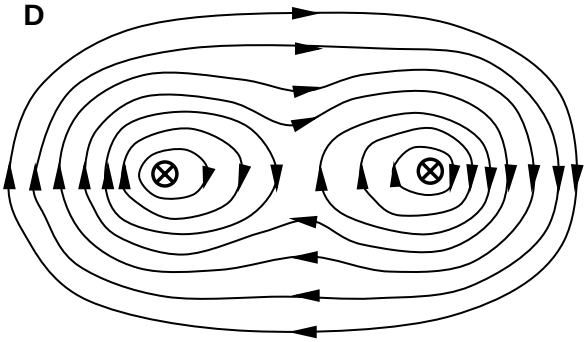
B



C

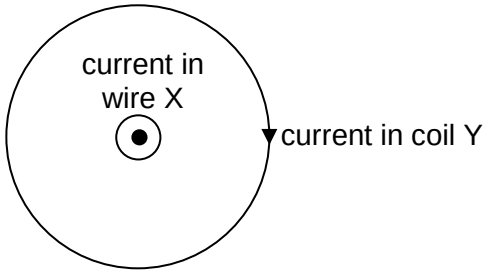


D



Ans: D
Using Right Hand Grip rule, the magnetic field around each wire is in clockwise direction.
There is a neutral point between the wire.

25 A long straight wire X is placed along the axis of a flat circular coil Y. The wire and the coil each carry a current as shown.

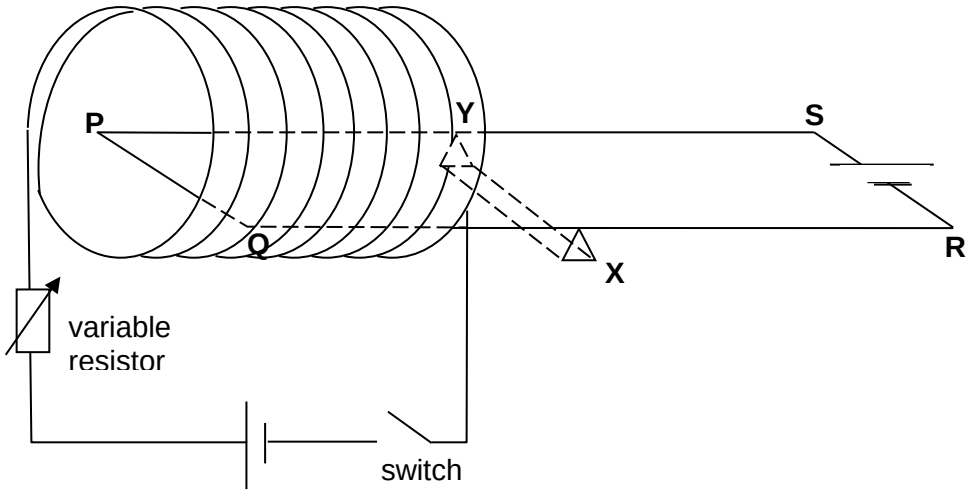


What can be deduced about the force acting on each part of Y due to the current in X?

A The force is away from X.
B The force is towards X.
C The force is perpendicular to the plane of the diagram.
D There is no force in any direction.

Ans: D
The current in X produces a magnetic field in the plane of the diagram (using Right Hand Grip), which is parallel to the current in each part of coil Y. Therefore no force is experienced by coil Y due to wire X.

26 A light, uniform and insulated wire frame PQRS is partially placed inside a solenoid with magnetic field strength of 0.8 mT, and the current passes through it is 0.4 A. Side PQ of the frame is 7.0 cm and side QR is 18.0 cm. A pivot XY is placed at the midpoint along the length of the frame.

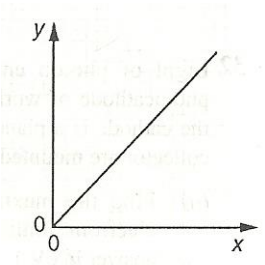


When the switch is closed, what is the direction of the electromagnetic force acting on side PQ and the magnitude of the moment about X due to this force?

	Direction of the force	Moment about X / N m
A	Upward	2.02×10^{-6}
B	Downward	2.02×10^{-6}
C	Upward	4.03×10^{-6}
D	Downward	4.03×10^{-6}

Ans: A
Using Right Hand Grip rule, the direction of magnetic field is rightwards.
Using Fleming's Left Hand Rule, the direction of the electromagnetic force is upwards.
Moment due to the force about X
$= BIl_{PQ}\ (0.5l_{QR})$
$= 0.8 \times 10^{-3} \times 0.4 \times 0.07 \times (0.5 \times 0.18)$
$= 2.02 \times 10^{-6}$ Nm

27 In a photoelectric emission experiment on a certain metal surface, two quantities, when plotted as a graph of *y* against *x*, give a straight line passing through the origin.



Which of the following correctly identifies *x* and *y* with the photoelectric quantities?

	x	*y*
A	photocurrent	threshold frequency
B	light intensity	maximum kinetic energy of photoelectrons
C	light intensity	photocurrent
D	frequency of incident light	maximum kinetic energy of photoelectrons

Ans : **C**
As light intensity increases, the rate of incidence of photons increases. As rate of incidence of photons is proportional to the rate of emission of photoelectrons, the photocurrent increases proportionally as well.

28 Light photons of energy 3.5 x 10^{-19} J fall on the cathode of a photocell. The current through the cell is just reduced to zero by applying a positive voltage of 0.25 V to the cathode with respect to the anode. What is the threshold wavelength of the photocell?

A 510 nm
B 570 nm
C 640 nm
D 690 nm

Ans : **C**

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_o} + eV$$

$$3.5 \times 10^{-19} = \frac{hc}{\lambda_o} + (1.6 \times 10^{-19})(0.25)$$

λ_0 = 640 nm

29 A proton and an electron are accelerated from rest through a potential difference of 2,000 V. What is the ratio of the proton's de Broglie wavelength to that of the electron?

A 0.023 **B** 0.23 **C** 1.02 **D** 42.8

Ans : **A**
Since ½ $mv^2 = eV$, $p^2/2m = eV$, $p^2 = 2meV$

$$\lambda = \frac{h}{p} \ \& \ \lambda^2 = \frac{h^2}{p^2}$$

$$\lambda^2 = \frac{h^2}{2meV}$$

$$\lambda \propto \frac{1}{\sqrt{m}}$$

Therefore, $\lambda = \sqrt{\left(\frac{m_e}{m_p}\right)} = 0.023$

30 Three spectra lines of wavelengths λ_1, λ_2, and λ_3 (in increasing magnitude) are produced by transitions between three energy levels in a certain atom. Which equation correctly relates λ_1, λ_2, and λ_3?

A $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$

B $\frac{1}{\lambda_1} = \frac{1}{\lambda_3} - \frac{1}{\lambda_2}$

C $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} - \frac{1}{\lambda_3}$

D $\lambda_1 = \lambda_2 + \lambda_3$

Ans : **A**
Since the wavelength λ_1 is the shortest, it means the energy of the photon emitted is the largest.
Hence $\frac{hc}{\lambda_1} = \frac{hc}{\lambda_2} + \frac{hc}{\lambda_3}$

$$\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$$

End of Paper