H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME			
CLASS		TUTOR'S NAME	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS 8867/01

Paper 1 Multiple Choice **17 September 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class, Centre number and index number in the spaces at the top of this page.

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.

This document consists of **14** printed pages.

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
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
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
acceleration of free fall	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 The base units of the SI system include those of The base units of the SI system include those of

mass, kg; length, m; time, s; electric current, A.

Which base units would be needed to express the SI unit of potential difference (the volt)?

A m and A only.

B s and A only.

C m, s and A only.

D kg, m, s and A.

(D)

2 A car travelling at a speed of 15.0 m s^{-1} can be brought to rest in 1.20 s when a uniform braking force is applied. The reaction time of the driver is 0.100 s.

What is the minimum distance at which the driver must notice a stationary object in order to avoid hitting it?

A 1.50 m **B** 7.50 m **C** 9.00 m **D** 10.5 m

$v = u + at \Rightarrow 0 = 15.0 + a(1.20) \Rightarrow a = -\frac{15.0}{1.20}$ m s^{-2}

$v^2 = u^2 + 2as \Rightarrow 0 = 15.0^2 + 2\left(-\frac{15.0}{1.20}\right)s \Rightarrow s = 9.00$ m

Thinking distance = 15.0×0.100 m = 1.50 m

Total dist = 9.00 + 1.50 = 10.50 m

3 Which pair contains one vector and one scalar quantity?

A displacement and acceleration

B force and kinetic energy

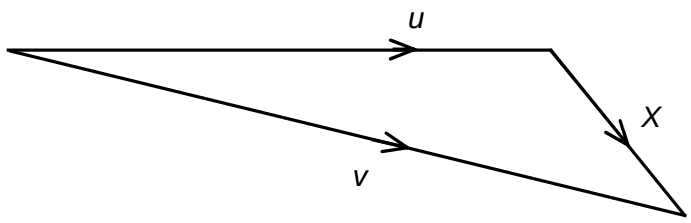
C momentum and velocity

D power and speed

(B)

4 An object has an initial velocity *u*. It is subjected to a constant force that is not in the same direction as *u*, resulting in acceleration *a*.

The vector diagram below is drawn to determine the object's final velocity *v* after time *t.*



What is the length of the vector *X* in the diagram?

A $v - u$ **B** $v + u$ **C** at **D** $u + at$

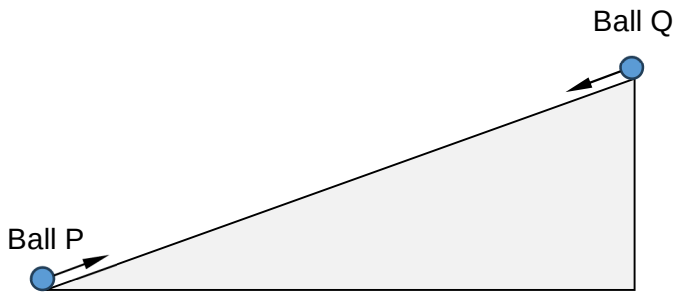
(C)

The vectors all represent the same quantity for the equation to be homogeneous and hence correct.
We need to find the change in velocity that that acceleration causes in time t. Hence, we add this change to the initial velocity.

Since v = u + at, and the change $\Delta v = v - u = X = at$.

5 Ball P is projected upwards from the bottom of a smooth inclined plane with an initial speed that is just sufficient for it to reach the top of the plane.

At the same time that Ball P is projected, Ball Q is projected downwards from the top of the plane with the same initial speed as Ball P.



What is the ratio of the distance travelled by Ball 2 to the distance travelled by Ball 1 when they collide?

A 0.78 **B** 1.0 **C** 1.3 **D** 3.0

(C)

From $s_1 = ut - \frac{1}{2}at^2$ and $s_2 = ut + \frac{1}{2}at^2$, where $a = g \sin\theta$

$\Rightarrow s_1 + s_2 = 2ut$ (1)

From $v^2 = u^2 - 2as$,

$\Rightarrow s_1 + s_2 = \frac{u^2}{2a}$ (2)

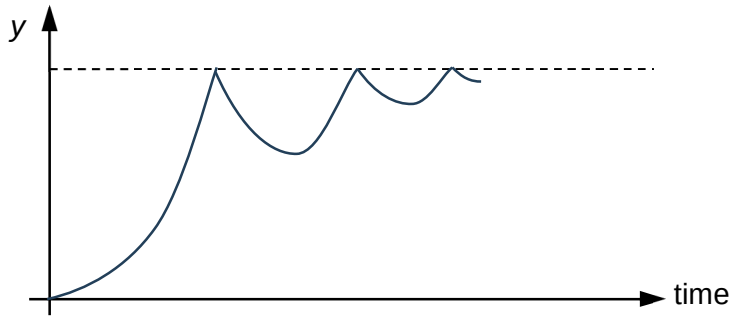
From (1) & (2),

$\Rightarrow 2ut = \frac{u^2}{2a}$

$\Rightarrow t = \frac{u}{4a}$

$$\frac{s_2}{s_1} = \frac{ut + \frac{1}{2}at^2}{ut - \frac{1}{2}at^2} = \frac{u + \frac{1}{2}a\left(\frac{u}{4a}\right)}{u - \frac{1}{2}a\left(\frac{u}{4a}\right)} = \frac{\frac{9}{8}}{\frac{7}{8}} = 1.3$$

6 The sketch graph below describes the motion of a ball rebounding from a horizontal surface after being released from a point above the surface.



The quantity represented on the *y*-axis is the ball's

A velocity.

B kinetic energy.

C acceleration.

D displacement.

(D)

Gradient of s-t graph gives velocity

7 The rate of change of momentum experienced by a free-falling ball when it hits the ground is equal to

A its weight.

B the net force acting on it.

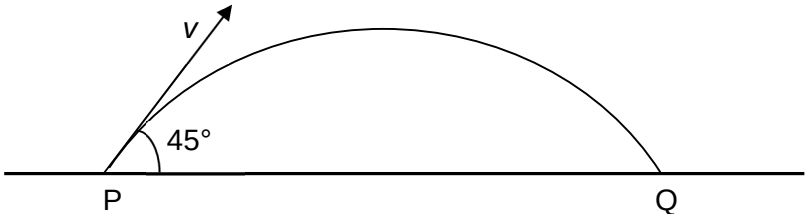
C the force exerted on it by the ground.

D the impuse on the ball due to the ground.

(B)

By Newton's second law.

8 A stone of mass m is projected with velocity v from a point P as shown below.

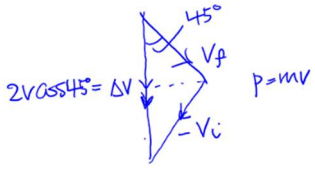


Neglecting the effects of air resistance, what is the magnitude of the change in momentum between leaving P and arriving at Q?

A zero **B** mv **C** $mv\sqrt{2}$ **D** $2mv$

(C)

$$m\Delta v = m(v_f - v_i) = m(v_f + (-v_i))$$
$$= 2 \times mv\cos 45°$$
$$= mv\sqrt{2}$$



9 Two blocks, X and Y, of masses *m* and *2m* respectively, are accelerated along a smooth horizontal surface by a force *F* as shown in the diagram below.

What is the magnitude of the force exerted by block Y on block X during the acceleration?

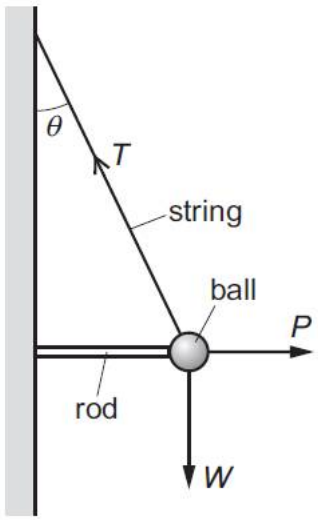
A $\frac{F}{6}$ **B** $\frac{F}{3}$ **C** $\frac{2F}{3}$ **D** $\frac{5F}{6}$

(C)

Acceleration of system $= \frac{F}{3m}$

$F_{YX} = F_{XY} = 2m\left(\frac{F}{3m}\right) = \frac{2F}{3}$

10 The diagram shows a ball of weight *W* hanging in equilibrium from a string.



The string is at an angle θ to the vertical. The tension in the string is *T*. The ball is held away from the wall by a horizontal force *P* from the metal rod.

Which relationship between the magnitudes of *T*, *P* and *W* is correct?

A $P = T\cos\theta$ and $W = T\sin\theta$

B $T = P + W$

C $T^2 = P^2 + W^2$

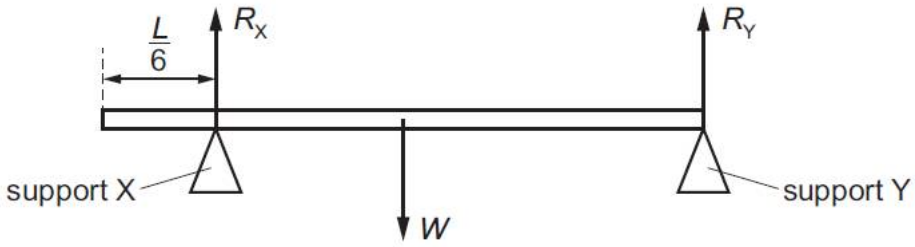
D $W = P\tan\theta$ and $W = T\cos\theta$

(C)

$T\cos\theta = W$ and $T\sin\theta = P$

$W^2 + P^2 = T^2$ (by Pythagoras theorem)

11 A uniform bar of length L and weight W rests horizontally on two supports X and Y.



Support X exerts a vertical force R_X at a distance of $\frac{L}{6}$ from one end of the bar.

Support Y exerts a vertical force R_Y at the other end of the bar.

The bar is in equilibrium.

What is the ratio $\frac{R_X}{R_Y}$?

A $\frac{3}{2}$ **B** $\frac{2}{3}$ **C** $\frac{3}{5}$ **D** $\frac{2}{5}$

(A)

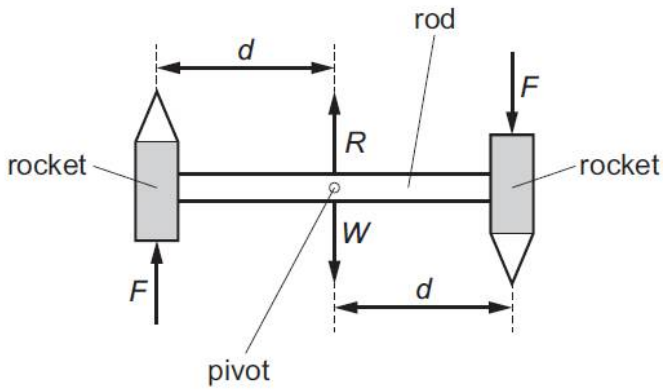
Taking moments about C.G.

$$R_X\left(\frac{L}{3}\right) = R_Y\left(\frac{L}{2}\right)$$

$$\frac{R_X}{R_Y} = \frac{3}{2}$$

12 A type of firework is made by connecting two rockets, facing opposite directions, to a rod as shown.

The rod is attached to a frictionless pivot so that the firework can rotate in a vertical plane. The firework has weight W. The pivot exerts a force R on the rod that is equal and opposite to W.



Each rocket exerts a force of magnitude F on the rod at a perpendicular distance d from the pivot. The forces exerted by the rockets are always in oppsite directions.

Air resistance is negligible.

Which statement is correct?

A The firework is in equilibrium because the resultant force acting on it is zero.

B The firework is in equilibrium because the resultant torque acting on it is zero.

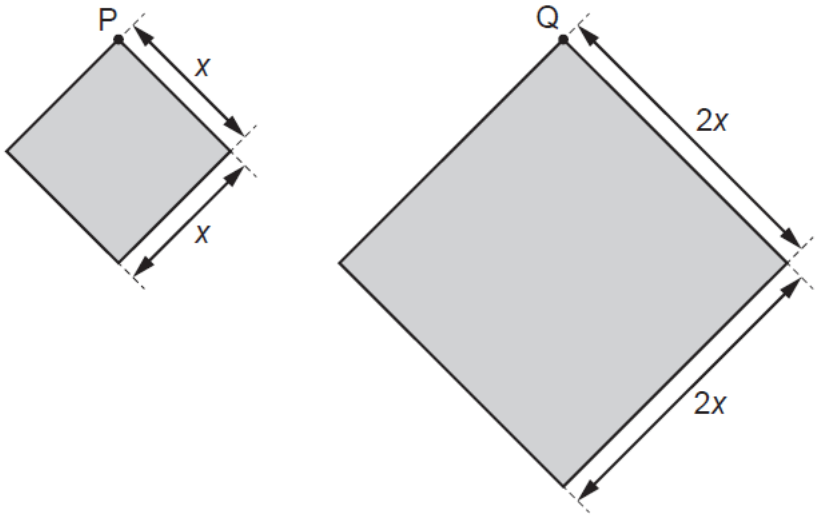
C The firework is not in equilibrium because the resultant force acting on it is not zero.

D The firework is not in equilibrium because the resultant torque acting on it is not zero.

(D)

13 A square board, of side length x, hangs freely from a nail P, as shown.

The board has uniform thickness and is made from material of uniform density.



A second square board, of side length $2x$, is made of the same material and has the same thickness as the original board. This second board is then hung from a nail Q. Nails P and Q are at the same height.

What is the vertical distance between the positions of the centres of gravity of the two boards?

A 0 **B** $\frac{x}{\sqrt{2}}$ **C** x **D** $x\sqrt{2}$

(B)

diagonal of small square $= \sqrt{x^2 + x^2} = \sqrt{2}x$

diagonal of big square $= \sqrt{(2x)^2 + (2x)^2} = 2\sqrt{2}x$

$\Delta h = \frac{2\sqrt{2}x}{2} - \frac{\sqrt{2}x}{2}$

$= \frac{\sqrt{2}}{2}x$

$= \frac{x}{\sqrt{2}}$

14 A machine is used to move a body of mass 50 kg up a rough track with a constant velocity of 20 m s^{-1}. The track is inclined at an angle of 30° to the horizontal and the frictional force between the track and the body is 100 N.

If the efficiency of the machine is 40%, what is the power supply to the machine?

A 3 kW **B** 7 kW **C** 12 kW **D** 17 kW

Ans: B

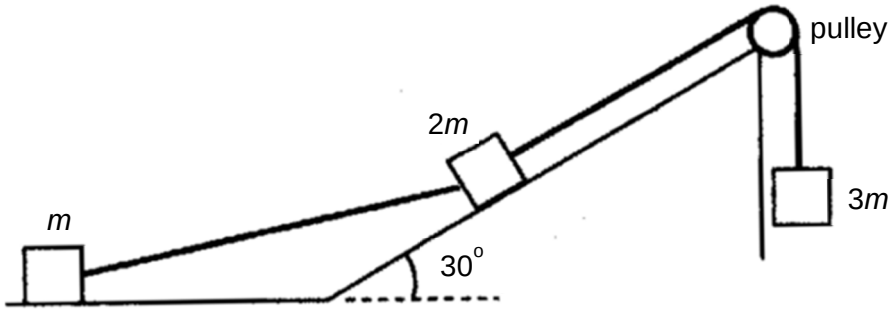
$F_D - mg \sin 30^o - f = 0$

$F_D = mg \sin 30^o - f = 50 \times 9.81 \times \sin 30^o - 100 = 145$ N

Power output, $P_o = F_D v = 145 \times 20 = 2.9$ kW

Power input, $P_i = 2900 / 0.40 = 7.3$ kW

15 The diagram shows three objects of mass *m*, 2*m* and 3*m* connected by light strings over a light, free-running pulley. When the objects are released from rest, the object of mass m moves horizontally along the smooth floor and the object of mass 2*m* moves along a smooth plane inclined at 30° to the horizontal.



What will be the total kinetic energy of the three objects when the object of mass *m* has travelled distance *x* along the floor from rest?

A *mgx* **B** 2*mgx* **C** 3*mgx* **D** 4*mgx*

(B)

$GPE_i + KE_i = GPE_f + KE_f$

$3mgx + 0 = 0 + 2mgx \sin 30^o + KE_f$

$KE_f = 2mgx$

16 The Earth rotates about its axis and orbits about the Sun. What is the ratio

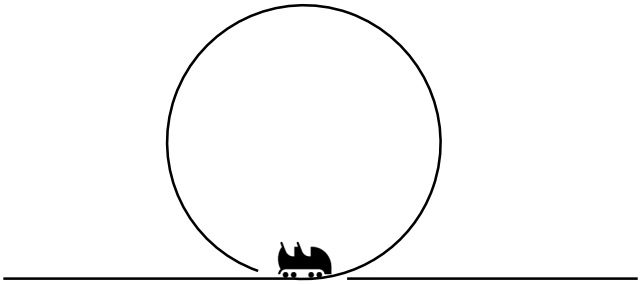
$$\frac{\text{angular frequency of rotation}}{\text{angular frequency of orbit}}?$$

A 0.0027 **B** 0.052 **C** 15 **D** 365

(D)

$\omega = \frac{2\pi}{T} \rightarrow \frac{\omega_{rotation}}{\omega_{orbit}} = \frac{T_{orbit}}{T_{rotation}} = \frac{365\ day}{1\ day}$

17 When the car of a roller coaster enters a vertical loop of height 20 m with speed 60 km h^{-1}, the passengers experience a sudden upward jolt.



What is the magnitude of the jolt of force on a 80 kg passeger?

A 1.1 kN **B** 1.4 kN **C** 1.9 kN **D** 2.2 kN

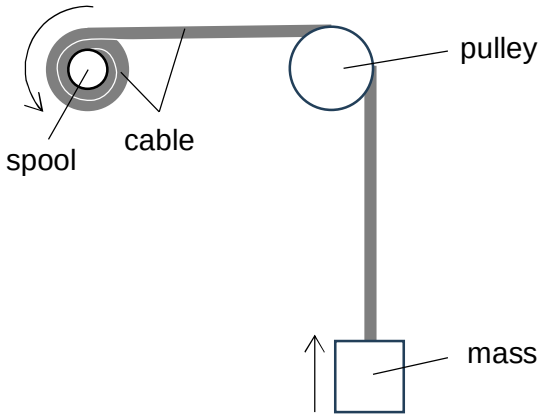
(D)

v = 60 km h^{-1} = 16.7 m s^{-1} and r = 20/2 = 10 m

Sudden jolt of force is due to increase in force by the seat = $m\,a_C$

$$= 80 \times \frac{16.7^2}{10} = 2.2\times10^3 \text{ N}$$

18 A spool with a thick cable is attached to a mass through a fixed pulley. The spool is rotated at a constant angular frequency to raise the mass. As the cable winds on the spool, the diameter of the spool with the cable increases as shown below.



Which of the following correctly describes how the angular frequency of the pulley and the linear speed of the mass will change as the spool rotates?

	angular frequency of the pulley	linear speed of speed of the mass
A	unchanged	increase
B	increase	increase
C	unchanged	unchanged
D	increase	unchanged

(B)

$v = r\omega$

Spool: At constant angular frequency, as r increase then v increase.

Pulley: Since v increase and r is unchanged, then constant angular frequency increase.

19 A high electric potential is applied between two electrodes of a hydrogen discharge tube so that the gas is ionised. Electrons then move towards the positive electrode and protons move towards the negative electrode. In each second, 5.0×10^{18} electrons and 2.0×10^{18} protons pass a cross-section of the tube. What is the current, in amperes, flowing in the discharge tube?

A 0.16 **B** 0.48 **C** 0.80 **D** 1.1

(D)

$I = I_e + I_p$

$= n_e(e) + n_p(p)$ charge on proton,p = charge on electron, e = 1.6×10^{-19} C

$= (5.0 \times 10^{18})(1.6 \times 10^{-19}) + (2.0 \times 10^{18})(1.6 \times 10^{-19})$

$= 1.1$ A

20 Which of the following statements is true regarding the variation of resistance of pure metals with temperature?

A Resistance decreases with increase with temperature as more electrons are available for conduction.

B As temperature decreases, the resistance decreases since the frequency of collisions of electrons with lattice ions decreases.

C Although scattering of electrons by lattice ions increases with temperature, increase in free electrons is more significant to cause the decrease in resistance.

D At constant temperature, the resistance can be decreased by applying a greater potential difference.

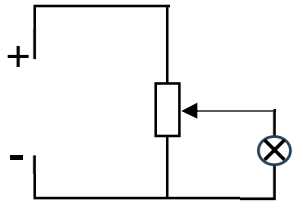
(B)

KE of electrons is proportional to absolute temp. As temp decrease so does the KE. Less random collisions with lattice ions hence resistance decreases.

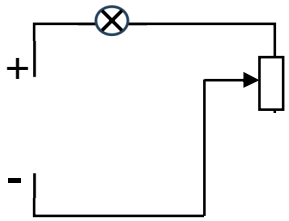
21 A lamp is connected to a power supply of negligible internal resistance.

Which circuit could not be used as a practical means to vary the voltage across the lamp?

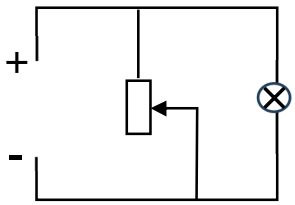
A



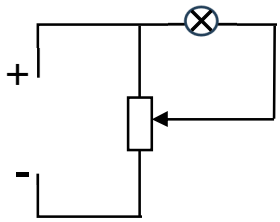
B



C



D

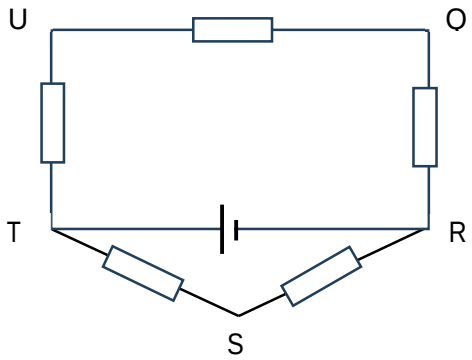


(C)

Options A, B & D allow adjusting the slider to vary the voltage across.

Option C connect directly between the terminals of the cell.

22 Five resistors, each of 50 Ω, are connected in a loop as shown below. A 10.0 V battery of zero internal resistance is connected across TR.



What is the potential difference between points U and R?

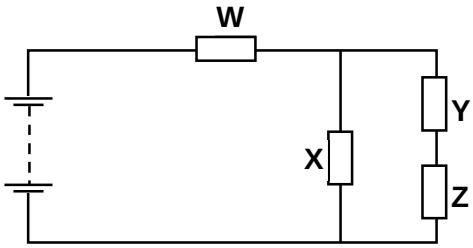
A 10.0 V **B** 8.7 V **C** 6.7 V **D** 3.7 V

(C)

TSR is irrelevant to the calculation.

$$V_{QR} = \frac{R_{QR}}{R_{TU} + R_{QR}} \times 10 = \frac{50 + 50}{50 + 50 + 50} \times 10 = 6.67 \text{ V}$$

23 In the circuit shown below, **W**, **X**, **Y** and **Z** are four identical resistors.



If the power dissipated by resistor **Y** is 3 W, what is the *total* power supplied by the battery?

A 12 W **B** 24 W **C** 32 W **D** 45 W

(D)

$P_Y = P_Z = 3\text{W} \Rightarrow I_{Y/Z} = \sqrt{\frac{P}{R}} = \sqrt{\frac{3}{R}}$

Current in R_X is twice R_Y and R_Z. $I_X = 2\sqrt{\frac{3}{R}}$

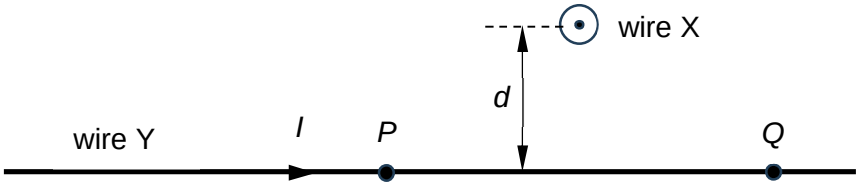
Power in $R_X \Rightarrow P_X = \left(2\sqrt{\frac{3}{R}}\right)^2 R = 12 \text{ W}$

Current in $R_W \Rightarrow I_W = \sqrt{\frac{3}{R}} + 2\sqrt{\frac{3}{R}} = 3\sqrt{\frac{3}{R}}$

Power in $R_W \Rightarrow P_W = \left(3\sqrt{\frac{3}{R}}\right)^2 R = 27 \text{ W}$

Total power = $P_W + P_X + P_Y + P_Z = 273 + 12 + 3 + 3 = 45$ W

24 Two long straight wire X and Y are place perpendicular to each other at a distance *d* apart. A current flows out of the page in wire X. The same current flows from left to right in wire Y.



What are the directions of the forces acting on wire Y at the point P and Q due to the magnetic field produced by wire X?

	force at P	force at Q
A	out of page	into page
B	into page	out of page
C	towards X	away from X
D	towards X	towards X

(B)
Using right-hand grip rule for the wire X, the B-field due to wire X is anti-clockwise on the plane of paper cutting through point P and Q, giving a vertical component downwards at point P, and vertical component pointing upwards at point Q.
Using Fleming's Left Hand rule at point P and Q, the direction of magnetic force can be obtained at points P and Q.

25 When a charged particle is in a region of magnetic field, which of the following is **not** a necessary condition for the particle to experience a magnetic force?

A Particle must be charged.

B Particle must be moving.

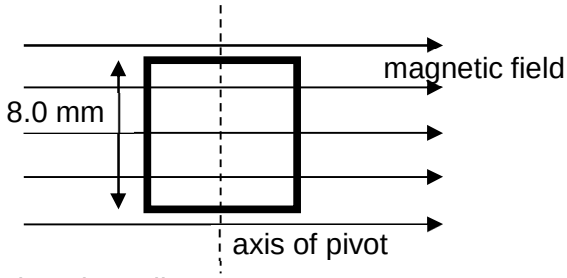
C Particle must be directed at an angle to magnetic flux density.

D Particle must be accelerating.

(D)

Charged particle experiences magnetic force as long as it is in motion, whether it is moving at constant speed or accelerating.

26 A 20-turn square coil of side 8.0 mm is pivoted at the centre and placed in a magnetic field of flux density 0.010 T such that two sides of the coil are parallel to the field and two sides are perpendicular to the field, as shown in the figure. A current of 5.0 mA is passed through the coil.



What is the torque created on the coil?

A 1.6×10^{-9} N m

B 3.2×10^{-8} N m

C 6.4×10^{-8} N m

D 3.2×10^{-5} N m

(C)
Torque = F d = NBIL d = (20)(0.010)(0.005)(0.008)(0.008) = 6.4×10^{-8} N m

27 The deviation of α-particles by thin metal foils through angles that range from 0^o to 180^o can be explained by

A scattering from free electrons

B scattering from bound electrons

C reflection from metal surface

D scattering from small but heavy regions of positive charge.

(D)

Due to repulsion between alpha particles and nucleus.

28 Which statement correctly describes a nucleon?

A a neutron or proton

B a neutron, proton or an electron

C any atomic nucleus

D a radioactive atomic nucleus

(A)

Definition of nucleon

29 The nucleus of uranium ($^{238}_{92}U$) may undergo successive decays, emitting respectively an α-particle, a β-particle and a γ-photon. The resulting nucleus may be represented by

A $^{237}_{92}U$ **B** $^{232}_{91}Pa$ **C** $^{234}_{91}Pa$ **D** $^{234}_{89}Ac$

(C)

Proton no.: 238-4=234

Nucleon no.: 92 – 2 + 1 = 91

30 The table below shows the count rate recorded at a point in a laboratory at various times, with and without a source in position.

time/ days	count rate/ s^{-1}	
	with source	without source
10	60	20
30	30	20
90	20	20

From these readings, what is the half-life of the source?

A 10 days **B** 15 days **C** 20 days **D** 30 days

(A)

In 20 days, C went from 40 s^{-1} to 10 s^{-1}

This implies 2 half lives have passed and thus one half life is 10 days

End of Paper