H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAM
Higher 1

CANDIDATE NAME **SOLUTIONS**

CLASS | TUTOR'S NAME

CENTRE NUMBER S | INDEX NUMBER

PHYSICS 8867/01

Paper 1 Multiple Choice **23 September 2021**

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 **15** 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 terminal velocity v_T of a sphere falling through air of density ρ is given by the following expression

$$v_T = \sqrt{\frac{2mg}{D\rho A}}$$

where m is the mass of the sphere,
g is the acceleration of free fall,
A is its surface area, and
D is the drag coefficient.

Which of the following is a unit of drag coefficient?

A m^{-1} s **B** m s^{-1} **C** kg m^{-1} s **D** dimensionless

Ans: D

2 Which of the following is considered as 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 in measuring the time duration of a 100 m sprint using a stopwatch

C Error due to a stopwatch running too fast

D Zero error of a measuring instrument

Ans: B

3 A student measures two lengths as follows:

T = 20.0 ± 0.1 cm
S = 10.0 ± 0.1 cm.

The student calculates the following:

F_T, the fractional uncertainty in T
F_{TS}, the fractional uncertainty in $T \times S$
F_{T-S}, the fractional uncertainty in $(T - S)$
F_{T+S}, the fractional uncertainty in $(T + S)$.

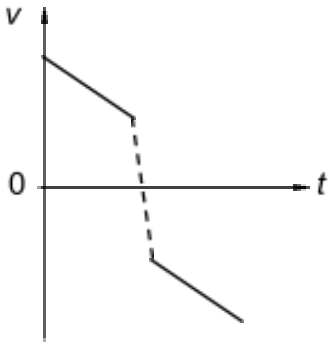
Which of these has the largest magnitude?

A F_T **B** F_{TS} **C** F_{T-S} **D** F_{T+S}

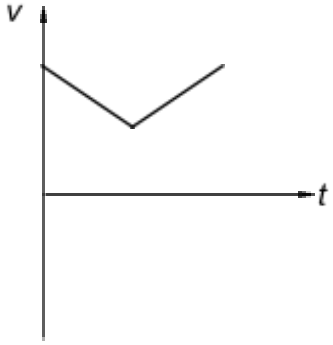
Ans: C

4 A tennis ball is thrown vertically up. It hits the ceiling before it falls down. Assuming the effect of air resistance is negligible, which graph best represents the variation with time *t* of velocity *v* before and after hitting the ceiling?

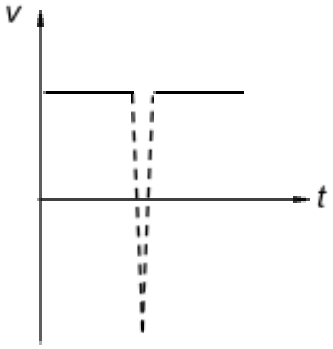
A



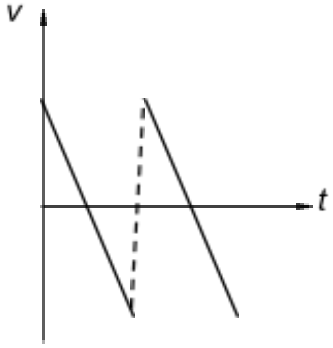
B



C



D



Ans: A
Before hitting and after hitting ceiling, the ball is under free fall, with a constant downward acceleration of 9.81 m s^{-2}, where straight downward diagonal lines are expected. During the collision with the ceiling, the downward acceleration is greater than 9.81 m s^{-2} as the ceiling, in addition to the weight of the ball, exerts a downward foce □ hence a more negative gradient.

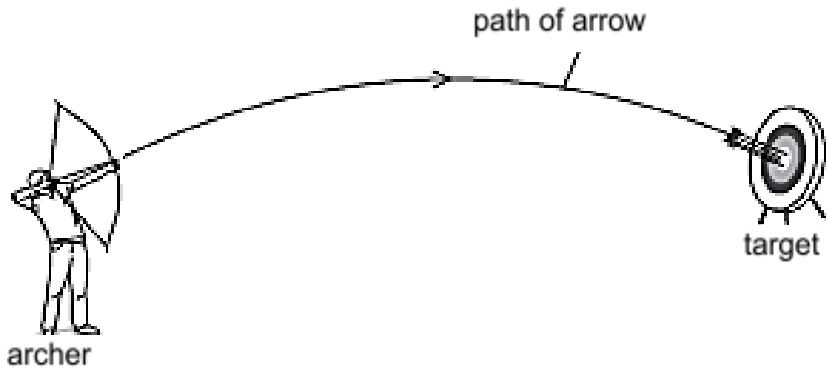
5 An object is projected with velocity 40 m s^{-1} at an angle of 60° to the horizontal. Air resistance is negligible.

What is the speed of the object after 5.0 s?

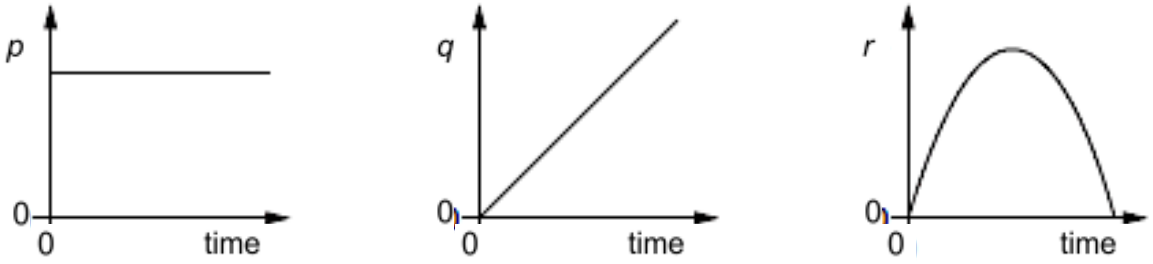
A 14 m s^{-1} **B** 25 m s^{-1} **C** 35 m s^{-1} **D** 45 m s^{-1}

Ans: B
The horizontal velocity is constant at $v_x = u_x = 40 \cos 60° = 20.0$ m s^{-1}.
The initial vertical velocity is $u_x = 40 \sin 60° = 34.6$ m s^{-1}.
After 5.0 s, $v_y = u_y + a_y t = 34.6 + (-9.81)(5.0) = -14.4$ m s^{-1}.
Hence, after 5.0 s, $v = \sqrt{v_x^2 + v_y^2} = 25\ m\ s^{-1}$.

6 An archer shoots an arrow at a target. The diagram shows the path of the arrow.



Air resistance is assumed to be negligible.
The graphs show how three different quantities, *p*, *q* and *r*, relating to the motion of the arrow vary with time.



Which graphs represent the horizontal and vertical components of the displacement of the arrow?

	horizontal component of displacement	vertical component of displacement
A	*q*	*r*
B	*p*	*q*
C	*r*	*p*
D	*r*	*q*

Ans: A
For horizontal displacement, it increases linearly with time since horizontal velocity is constant, hence *q*. For vertical displacement, the arrow ascends before descends. Hence *r*.

7 Which one of the following pair of forces is **not** an example of action and reaction to Newton's third law ?

A The thrust on the rocket and expulsion of hot air due to the burning of fuel.

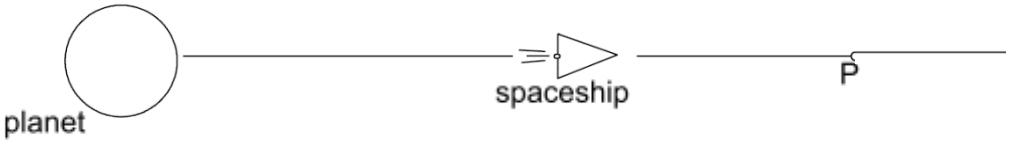
B The gravitational force by Earth on man standing on Earth and the gravitational force on Earth by man.

C The upthrust on a piece of wood in water and the weight of the wood.

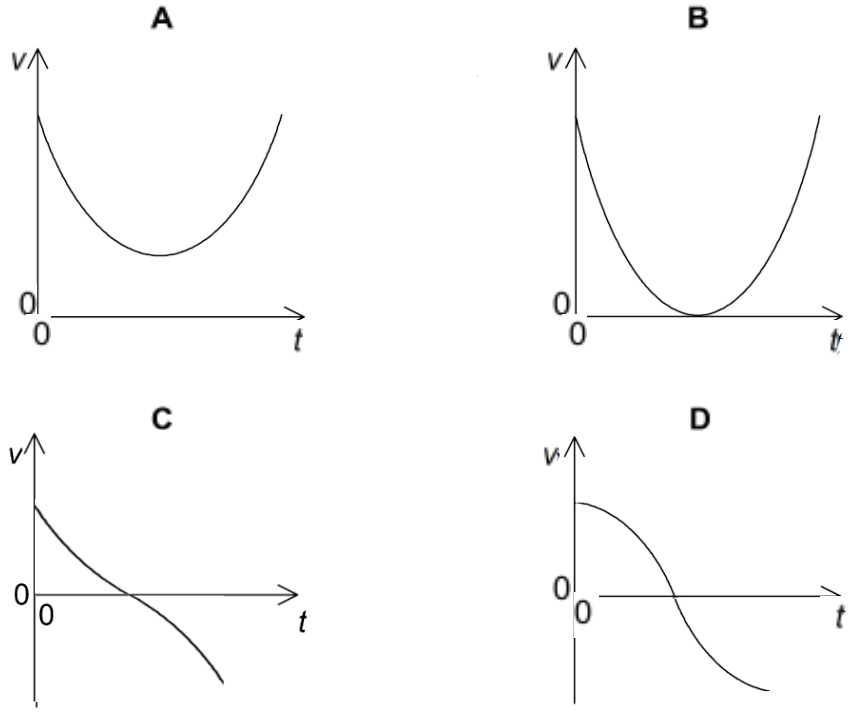
D The magnetic force on a magnet by a long wire carrying current and the magnetic force on the wire by the magnet.

Ans: C

8 A powered spaceship is moving directly away from a planet as shown below.



The spaceship passes point P at t = 0. At point P, the thrusters of the spaceship are switched off but the spaceship remains under the influence of the planet. Which one of the following graphs best represents the subsequent variation with time t of the velocity v of the spaceship?



Ans: C
Gradient is equal to acceleration. As the spaceship moves away from the planet, gravitational force acting on the spaceship, and hence acceleration, must decrease. After the horizontal intercept where v = 0, the spaceship will be travelling toward the planet.

9 A car of mass 1200 kg is accelerated by a resultant force of 3000 N for a time of 5.0 s.

What is the gain in momentum of the car?

A 2.5 kg m s^{-1}

B 6.0×10^2 kg m s^{-1}

C 6.0×10^3 kg m s^{-1}

D 1.5×10^4 kg m s^{-1}

Ans: D

$$\Sigma F = \frac{\Delta p}{t}$$

$$\Delta p = \Sigma F \times t$$

$$= 3000 \times 5.0$$

$$= 1.5 \times 10^4 \text{ kg m s}^1$$

10 A tractor of mass 3500 kg pulls a trailer of mass 1500 kg. The total resistive force acting on tractor and trailer has a constant value of 5000 N. One quarter of this total resistive force acts on the trailer.

When they are moving with an acceleration of 1.0 m s^{-2}, what is the force exerted on the tractor by the trailer?

A 1500 N **B** 2750 N **C** 4750 N **D** 5250 N

Ans: B

Referring to FBD of trailer,

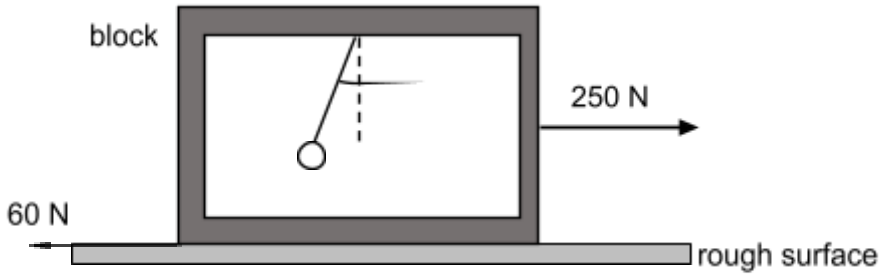
$\Sigma F = ma$

$F_{\text{tractor on trailer}} - 0.25(5000) = 1500(1.0)$

$F_{\text{tractor on trailer}} = 2750$ N

By Newton's third law, $F_{\text{trailer on tractor}} = -F_{\text{tractor on trailer}} = -2750$ N

11 A block with a pendulum bob hanging lies on a rough surface. The total mass of the block and the pendulum bob is 100 kg. A force of 250 N is applied to the block and the pendulum bob makes an angle θ to the vertical axis.



What is the magnitude of θ if a constant frictional force of 60 N is acting on the block?

A 11° **B** 14° **C** 76° **D** 79°

Ans: A

Referring to FBD of whole system,

$\Sigma F = ma$

$250 - 60 = 100a$

$a = 1.9$ m s^{-2}

Referring to FBD of bob,

$\Sigma F_x = m_{bob}a$

$T\sin\theta = m_{bob}$a----- (1)

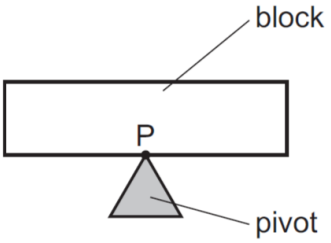
$\Sigma F_y = 0$

$T\cos\theta = m_{bob}g$ ----- (2)

(1)/(2): $\tan\theta = a / g = 1.9 / 9.81$

$\theta = 11°$

12 A thick block of wood balances horizontally on a pivot. The block and the pivot are in contact.



Which statement about the block is always correct?

A In the position shown, all the weight of the block appears to act through point P.

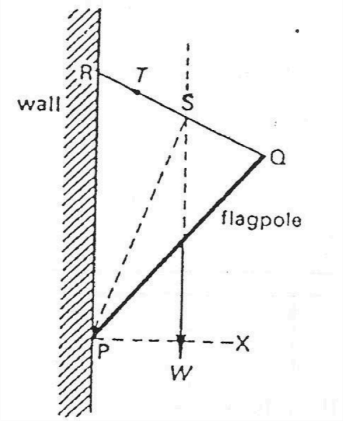
B In the position shown, the centre of gravity of the block is located at point P.

C When the block is given a small displacement, the block will return to its horizontal position.

D When the block is given a small displacement, the moment of the weight of the block about point P is zero.

Ans: A

13 The diagram below shows a heavy flagpole PQ hinged at a vertical wall at end P and held by a wire connected between end Q and a point R on the wall. The weight of the flagpole is *W* and the tension in the wire is *T*.



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

A P to Q **B** P to S **C** P to X **D** S to P

Ans: B

14 The spring used in the suspension mechanism of a vehicle has a spring constant of 100 kN m^{-1}. Four such springs share equally the weight of the vehicle when it is at rest on a level road. If each spring is compressed by 4.0 cm from its natural length when the vehicle is in this situation, what is the mass of the vehicle?

A 400 kg **B** 1600 kg **C** 40 000 kg **D** 160 000 kg

Ans: B

15 The engine of a boat supplies a constant power of 110 kW to propel the boat forward. The boat attains a maximum speed of 21.0 m s^{-1}.

If the magnitude of the resistive force acting on the boat is proportional to the square of the boat's speed, what is the resultant force acting on the boat when it is moving at the instant when its speed is 15.0 m s^{-1}?

A 2.7 kN **B** 3.6 kN **C** 4.7 kN **D** 7.3 kN

Ans: C

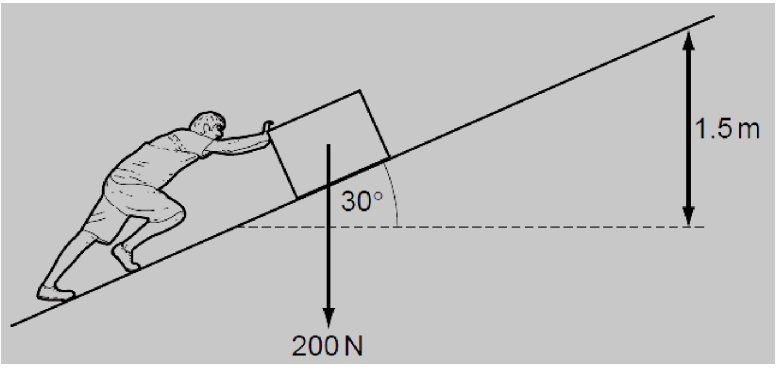
16 A crane is used to raise a weight of 200 N at a constant speed through a vertical height of 8.0 m in 4.0 s.

The efficiency of the crane is 20%. What is the electrical power needed to be supplied to the crane?

A 80 W **B** 400 W **C** 1600 W **D** 2000 W

Ans: D

17 A person pushes a box of weight 200 N so that it moves at a steady speed along a ramp, through a height of 1.5 m. The ramp makes an angle of 30° with the ground. The frictional force on the box is 150 N while the box is moving.

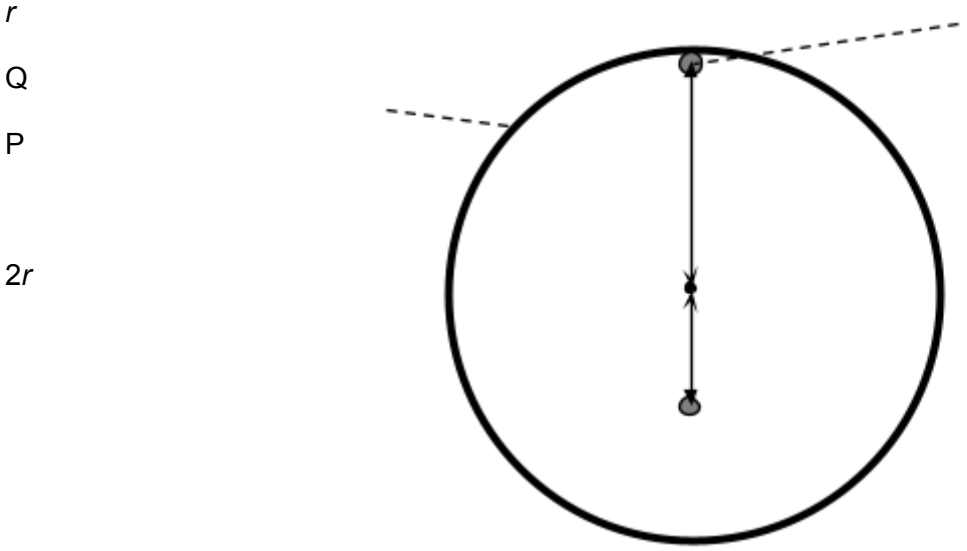


What is the work done by the person?

A 170 J **B** 300 J **C** 450 J **D** 750 J

Ans: D

18 Two discs P and Q of mass m and $2m$ respectively are placed on a rough, horizontal and level turntable as shown in the diagram. P and Q are at a distance of r and $2r$ from the centre of the turntable respectively. The turntable starts rotating from rest with gradually increasing angular velocity ω.



Top View

Given that the maximum frictional force acting on P is half of that on Q, which of the following is correct?

A P will slip first.

B Q will slip first.

C P and Q will slip at the same time.

D Neither P nor Q will slip.

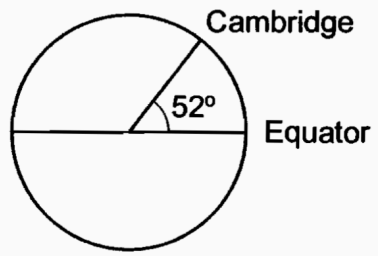
Ans: B
The frictional force provides the centripetal force ⇒ $f = MR\omega^2$.
When P is about to slip, $f_{max\,P} = mr\omega_{max\,P}^2$
$\omega_{max\,P}^2 = f_{max\,P} / mr$ ----- eqn (1)

When Q is about to slip, $f_{max\ Q} = (2m)(2r)\omega^2 = 4mr\omega_{max\ Q}^2$
$\omega_{max\ Q}^2 = f_{max\ Q} / 4mr$ ----- eqn (2)

since $f_{max\ Q} = 2\ f_{max\ P}$, from eqn (2)
$\omega_{max\ Q}^2 = 2f_{max\ P} / 4mr = f_{max\ P} / 2mr$ ----- eqn (3)

Comparing eqn (1) and (3), $\omega_{max\ Q} < \omega_{max\ P}$. Hence Q will slip first.

19 Singapore is on the Equator. Cambridge is at a latitude of 52° north of the equator, as shown in the diagram.



A student at Singapore has a centripetal acceleration a_s because of the Earth's rotation about its axis. The Centripetal acceleration of another student at Cambridge is a_c.

What are the magnitudes of the centripetal accelerations?

(radius of Earth = 6.4×10^6 m; angular velocity of Earth about axis = 7.3×10^{-5} rad s^{-1}.)

	a_s / m s^{-2}	a_c / m s^{-2}
A	3.4×10^{-2}	2.1×10^{-2}
B	3.4×10^{-2}	2.7×10^{-2}
C	3.4×10^{-2}	3.4×10^{-2}
D	4.7×10^{2}	4.7×10^{2}

Ans: A

For Singapore,

$a_s = r_s\omega^2$

$a_s = (6.4\times10^6)(\frac{2\pi}{24\times60\times60})^2 = 3.4\times10^{-2}$ m s^{-2}

For Cambridge,

$a_c = r_c\omega^2$

$a_c = (6.4\times10^6\cos52°)(\frac{2\pi}{24\times60\times60})^2 = 2.1\times10^{-2}$ m s^{-2}

20 Two satellites X and Y are in orbit around the Earth. The orbital radius of satellite X is twice that of satellite Y. Which of the following correctly gives the ratio

$$\frac{\text{orbital period of X}}{\text{orbital period of Y}}?$$

A $2\sqrt{2}$ **B** $\sqrt[3]{4}$ **C** $\frac{1}{2\sqrt{2}}$ **D** $\frac{1}{\sqrt[3]{4}}$

Ans: A

By Kepler's 3rd Law,

$T^2 \propto R^3$

$\frac{T_X}{T_Y} = \left(\frac{R_X}{R_Y}\right)^{\frac{3}{2}} = (2)^{\frac{3}{2}} = 2\sqrt{2}$

21 An ideal cell is connected across a resistor for an unknown period of time.

Which quantities can be used to calculate the energy supplied by the cell?

A The current in the resistor and the resistance of the resistor.

B The current in the resistor and the potential difference across the resistor.

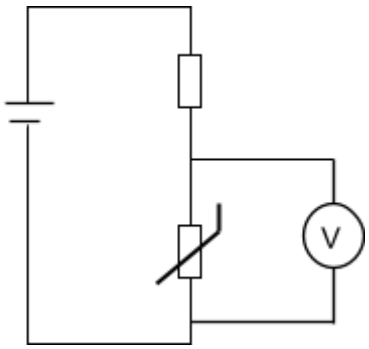
C The total charge passing through the resistor and the resistance of the resistor.

D The total charge passing through the resistor and the potential difference across the resistor.

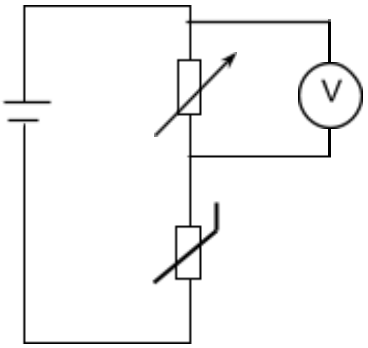
Ans: D
Use formula : V = E /Q

22 Some components are connected to a constant voltage supply with a voltmeter connected in the circuit. The temperature of the thermistor increases and the intensity of light incident on the light dependent resistor decreases, while the other components experience no physical change. In which circuit will the voltmeter reading increase?

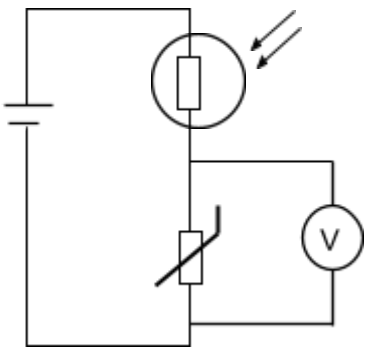
A



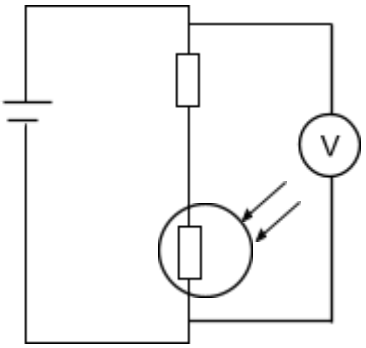
B



C



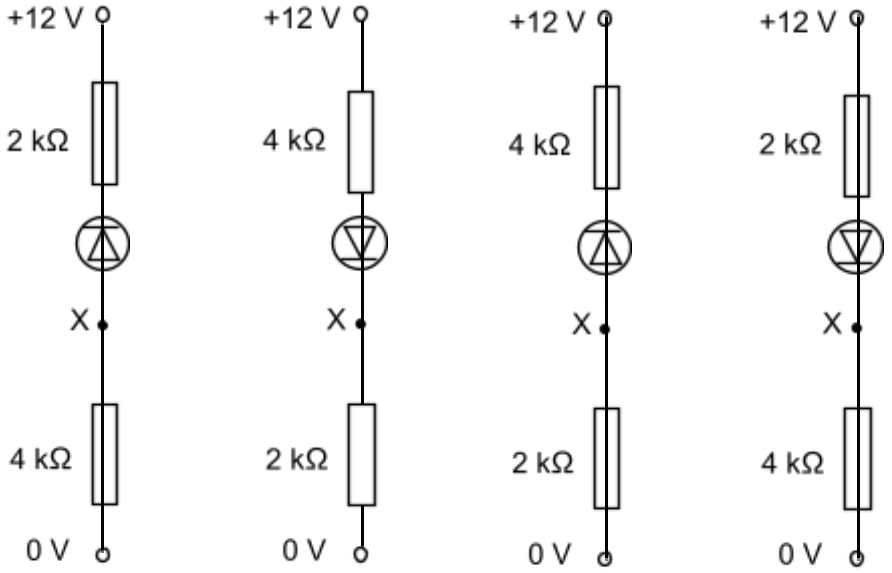
D



Ans : B
Resistance of LDR increases and resistance of thermistor decreases.

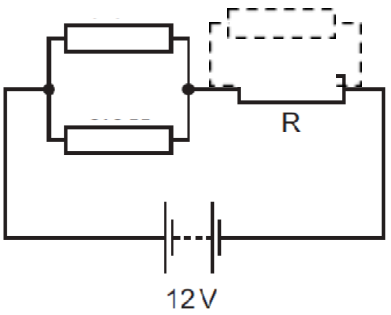
23 The ideal diodes shown here have zero resistance in the forward direction and inifinite resistance in the reverse.
In which arrangement is the potential at X equal to 8 V ?

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



Ans : D
For A and C, no current flow as didode is reversed bias.
For B, V_x = 2/(2+4)12 = 4V.
For D, V_x = 4/(2+4)12 = 8V.

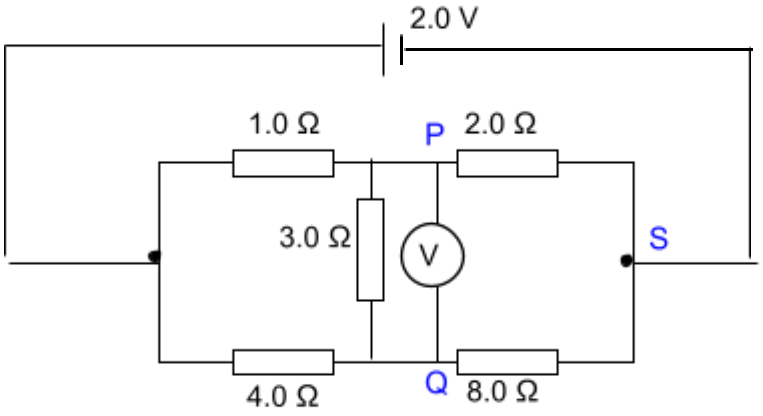
24 A battery of electromotive force (e.m.f) 12 V and negligible internal resistance is connected to three identical resistors as shown in the diagram. The total power dissipated in the circuit is 24 W. Another identical resistor is connected in parallel to resistor R in the circuit. What is the total power dissipated now?



A 26 V **B** 32 V **C** 36 W **D** 48 W

Ans : C
With 3 resistors, total power dissipation is
for the 2 resistors in parallel, $V^2/ R' = 4^2/(R/2) = 32 / R$
for the single resistor in series, $V^2 / R = 8^2 / R = 64 /R$
$32/R + 64/R = 24$, $R = 4\Omega$.
With 4 resistors, $P = 12^2 / 4 = 36$ W.

25 Five resistors are connected in the circuit as shown below.



What is the reading in the voltmeter?

A 0 V **B** 0.45 V **C** 0.5 V **D** 0.67 V

Ans : A
$V_{PS} = 2 /(1+2)\ 2.0 = 2/3V$
$V_{QS} = 8 /(4+8)\ 2.0 = 2/3V$
$V_{PQ} = 0$ V

26 A cell of emf *E* and internal resistance *r* is connected to a variable resistor *R* as shown in Fig. 26.1. Fig. 26.2 shows the variation with ammeter reading *I* of the voltmeter reading *V* as *R* is varied.

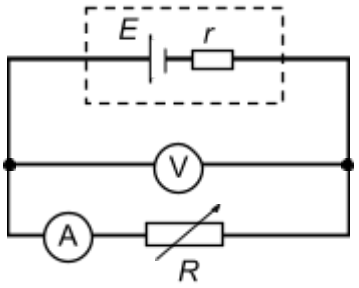


Fig. 26.1

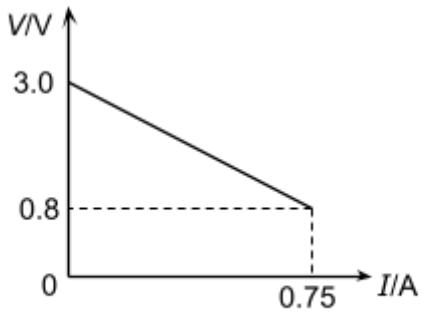


Fig. 26.2

Assuming that both the voltmeter and ammeter are ideal, what is the internal resistance *r*?

A 1.1 Ω **B** 2.9 Ω **C** 4.0 Ω **D** 5.1 Ω

Ans : B

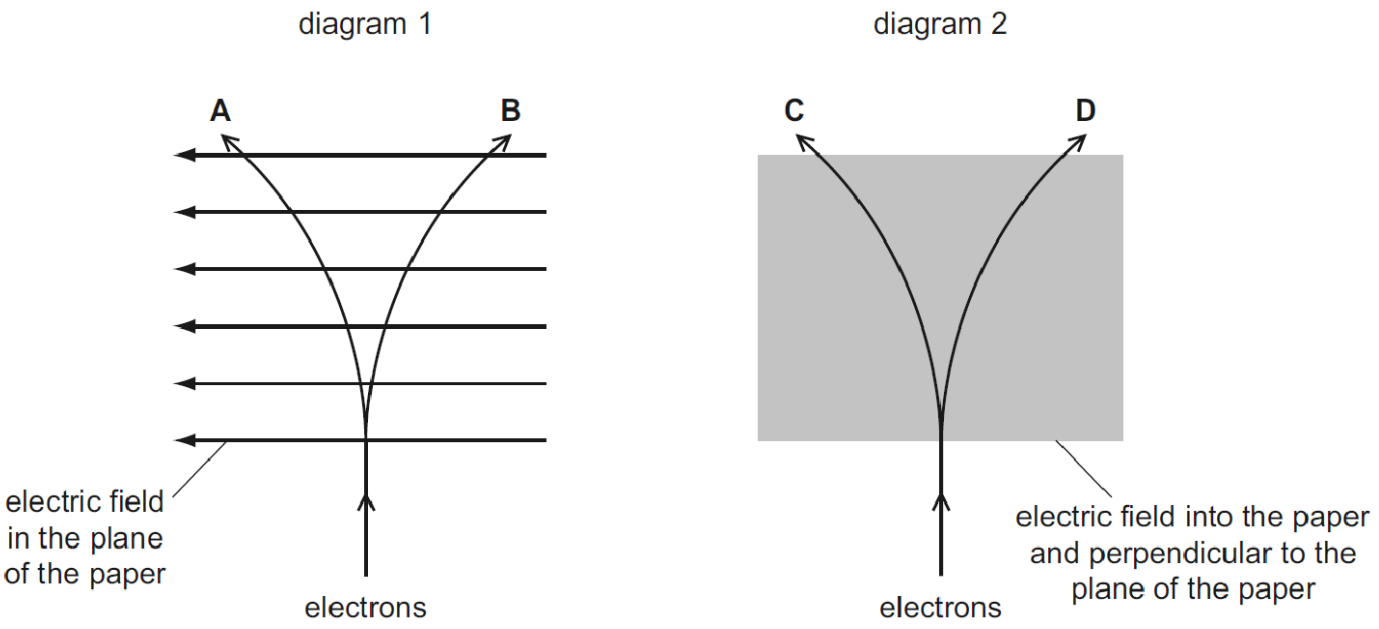
From Fig 24.2, E = 3.0V, and grpah of E - Ir = V is plotted, the r is the gradient of graph in 24.2
Gradient = (3 – 0.8) / 0.75 = 2.9

27 A beam of electrons is directed into an electric field and is deflected by it.

Diagram 1 represents an electric field in the plane of the paper.
Diagram 2 represents an electric field directed perpendicular to the plane of the paper.

The lines **A**, **B**, **C** and **D** represent possible paths of the electron beam. All paths are in the plane of the paper.

Which line best represents the path of the electrons inside the field?



Ans: B
The force acting on electron is always opposite to the E-field.

28 An electron P, having a speed *v*, travels at right-angles to a uniform magnetic field. P then travels in a circular orbit of period *T* and orbital radius *r*.

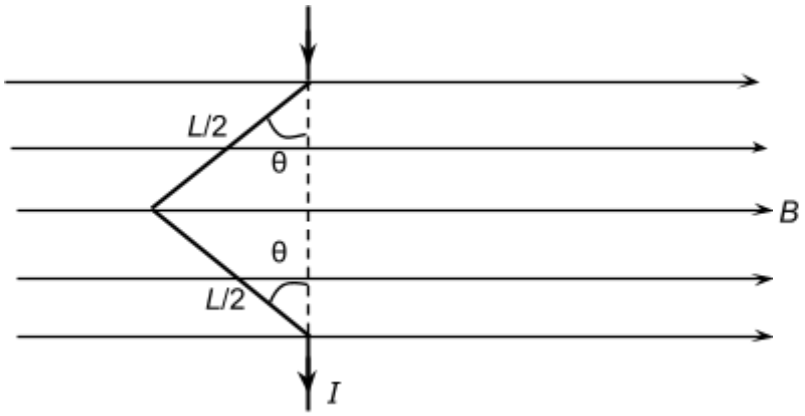
Another electron Q travels at right-angles to the same magnetic field. Q travels in a circular orbit of radius 2*r*. What are the period and speed of Q?

	period	speed
A	2*T*	*v*

B	0.5*T*	*v*
C	*T*	2*v*
D	*T*	0.5*v*

Ans: C
For the first electron, $F = Bqv = mv^2/r$, $r = mv / Bq$
Since, $\omega = v/r = Bq/m$, $T = 2\pi m/Bq$
For the second electron, same m, q, B, r' is 2r, v' = 2v, T is constant.

29 The diagram shows a V-shaped wire in the magnetic field of flux density *B*. The length of the wire in the field is *L* and the first half of the wire is inclined with an angle *θ* normal to the field direction. The current in the wire is *I*.



Which row gives the magnitude and direction of the force acting on the wire?

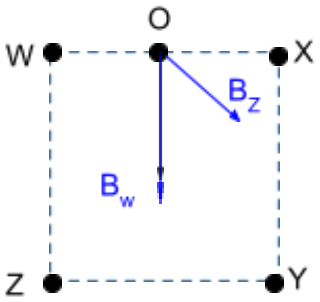
	magnitude	direction
A	*BIL*cos *θ*	into of the page
B	*BIL*cos *θ*	out of the page
C	*BIL*sin *θ*	into the page
D	*BIL*sin *θ*	out of the page

Ans: B

Resolve the wire to be perpendicular to the B-field, F = BI(L/2 cosθ+ L/2 cosθ) = BILcosθ

Using FLHR, direction is out of the page.

30 Four parallel conductors, carrying currents passed vertically through the 4 corners of a sqaure WXYZ. Each of the conductor carries a current of magnitude I.



It is required to produce a resutlant magnetic field at O , which is mid point between W and X, in the direction as shown. What are the directions of the currents at the four corners?

	wires into the plane	wires out of the plane
A	*W and Z*	*X and Y*
B	*X and Z*	*W and Y*
C	*W and Y*	*X and Z*
D	*X and Y*	*W and Z*

Ans: A

B field due to W will in the required direction if I in W is into the plane.

B field due to Z will in the required direction if I in Z is into the plane.

By the same reasoning, then current at X and Y will have to be out of the plane to give the resultant as required.

End of Paper