Class	Index Number	Name

ST. ANDREW'S JUNIOR COLLEGE
JC 2 2024
Preliminary Examination

PHYSICS, Higher 1 **8867/01**

Paper 1 Multiple Choice **12th Sept 2024**
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in HB pencil.
Do not use staplers, paper clips, glue or correction fluid.
Write you name, index number on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** the questions. For each question there are four possible answers **A, B, C, D.**

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. Double entry of choices will be considered as a wrong answer. A mark will not be deducted for a wrong answer.

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

This question paper consists of **18** printed pages including this page.

DATA:

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
unified atomic mass constant	u	=	1.66×10^{-27} kg
The Avogadro constant	N_A	=	6.02×10^{23} mol^{-1}
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
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	=	$u t + \frac{1}{2} a t^2$
	v^2	=	$u^2 + 2 a s$
resistors in series,	R	=	$R_1 + R_2 + ...$
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + ...$

1 What is a reasonable estimate of the cross-sectional area of the wire in a paper clip?

A 1×10^{-3} m^2 **B** 8×10^{-5} m^2 **C** 8×10^{-7} m^2 **D** 1×10^{-9} m^2

2 Which quantity is **not** an SI base quantity?

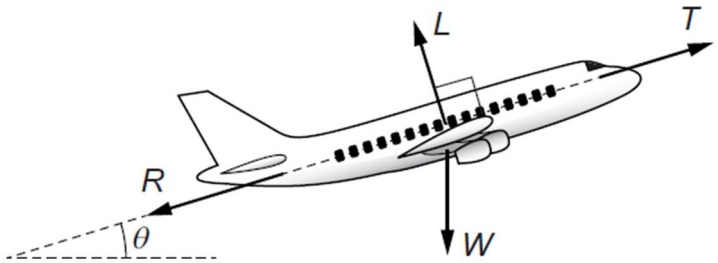
A charge

B mass

C temperature

D time

3 An aeroplane is moving at a constant speed in a straight line at an angle θ to the horizontal. Four forces act on the aeroplane: thrust force *T*, weight *W*, lift force *L* and resistive force *R*.



Which two equations must be correct?

A $L = W \cos \theta$ and $T = R - W \sin \theta$

B $L = W \sin \theta$ and $T = R + W \cos \theta$

C $L = W \cos \theta$ and $T = R + W \sin \theta$

D $L = W \sin \theta$ and $T = R - W \cos \theta$

4 A copper pipe has a true diameter of 42.03 mm.

A builder measures the diameter of the pipe five times using digital calipers. The measurements are shown.

diameter / mm
48.01
47.99
48.01
48.00
47.99

What describes the builder's measurements?

A accurate and precise

B accurate but not precise

C not accurate and not precise

D not accurate but precise

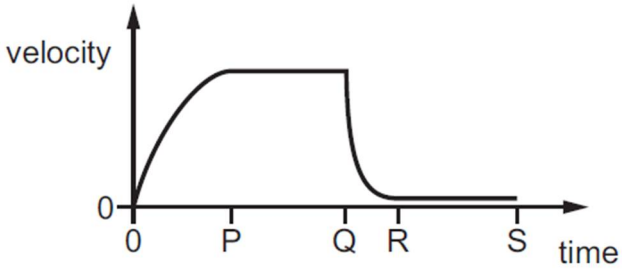
5 The time taken for an object to fall from rest through a certain distance on Mars is T_M. The time taken for the same object to fall from rest through the same distance on Earth is T_E. The acceleration of free fall on Mars is 3.71 m s^{-2}.

Assume that air resistance is negligible on both Earth and Mars.

What is the ratio $\frac{T_M}{T_E}$?

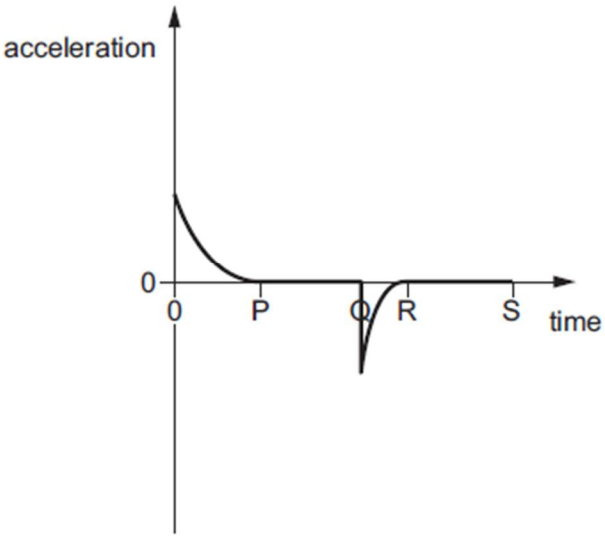
A 0.378 **B** 0.615 **C** 1.63 **D** 2.64

6 A parachutist falls from a stationary balloon at time t = 0. The velocity–time graph for the parachutist from time t = 0 until the time when he is just above the ground is shown.

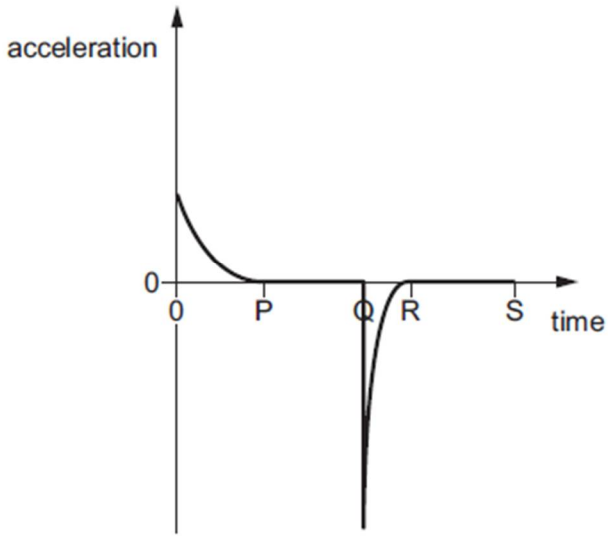


Which graph best shows the variation with time of the acceleration of the parachutist?

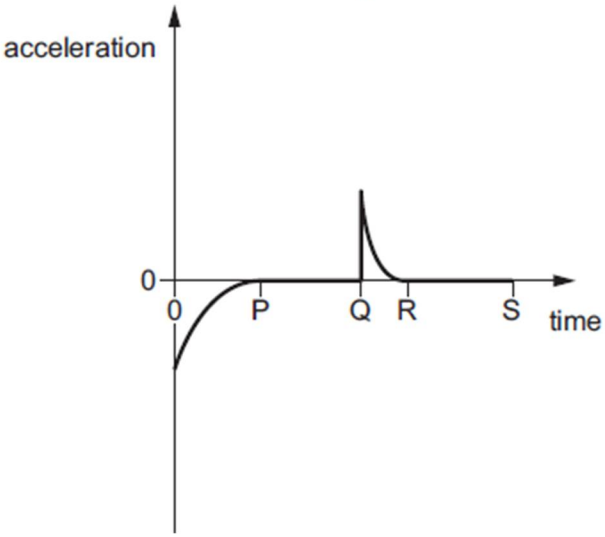
A



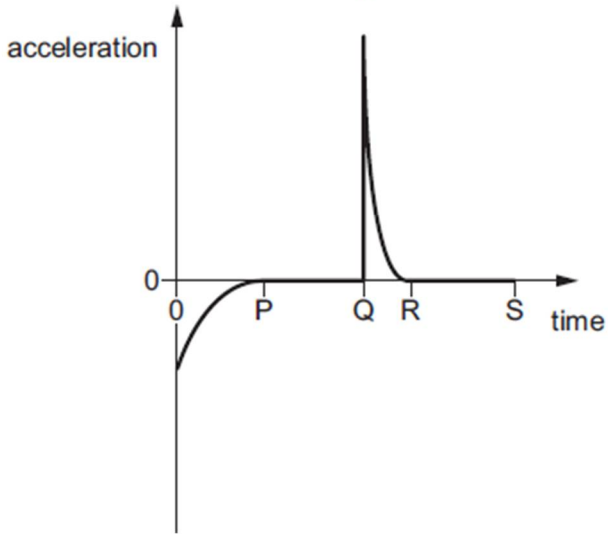
B



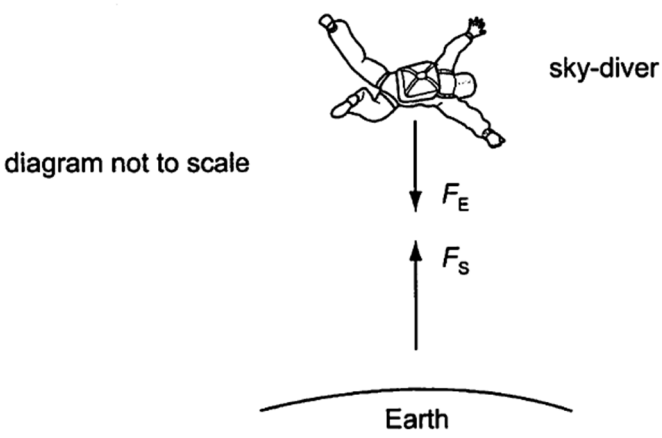
C



D



7 A sky-diver jumps from an aircraft. The Earth exerts a downward force F_E on the sky-diver who also exerts an upward force F_S on the Earth.



Which statement is correct?

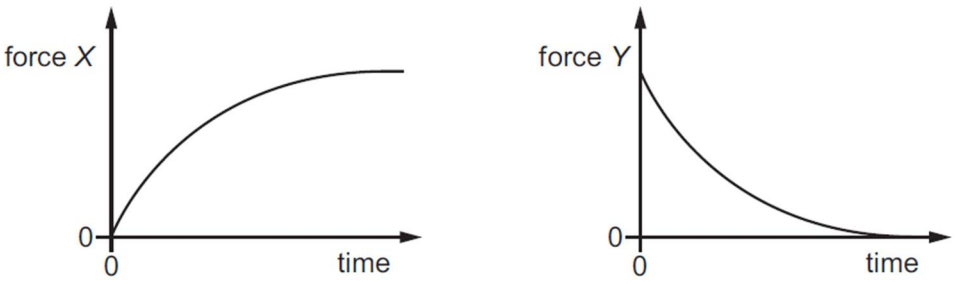
A the magnitude of F_E > the magnitude of F_S

B the magnitude of F_E < the magnitude of F_S

C the magnitude of F_E = the magnitude of F_S and they cancel each other out

D the magnitude of F_E = the magnitude of F_S and they do not cancel each other out

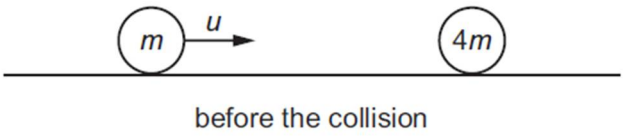
8 A ball falls from rest through air and eventually reaches a constant velocity.
For this fall, forces *X* and *Y* vary with time as shown.



What could be forces *X* and *Y* ?

	force X	force Y
A	air resistance	weight
B	air resistance	resultant force
C	resultant force	weight
D	weight	air resistance

9 An object of mass *m*, moving at speed *u* along a frictionless horizontal surface, collides head-on with a stationary object of mass 4*m*.



before the collision

After the collision, the object of mass *m* rebounds along its initial path with $\frac{1}{4}$ of its kinetic energy before the collision.

What is the speed of the object of mass 4*m* after the collision?

A $\frac{u}{8}$ **B** $\frac{3u}{16}$ **C** $\frac{5u}{16}$ **D** $\frac{3u}{8}$

10 The diagram shows two spheres of masses 2 kg and 3 kg moving at a constant speed along a straight line towards one another.

The speed of the spheres are 4 m s^{-1} and 6 m s^{-1} respectively.

Which statement explains why the spheres cannot come to rest at the same time?

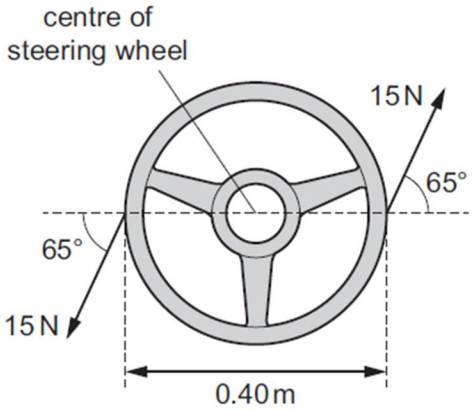
A The impulses during the collision are not equal and opposite.

B The masses of the two spheres are not equal.

C The momenta of the spheres are not equal and opposite.

D The speeds of the spheres are not equal.

11 The driver of a car applies two parallel forces to a steering wheel, as shown.

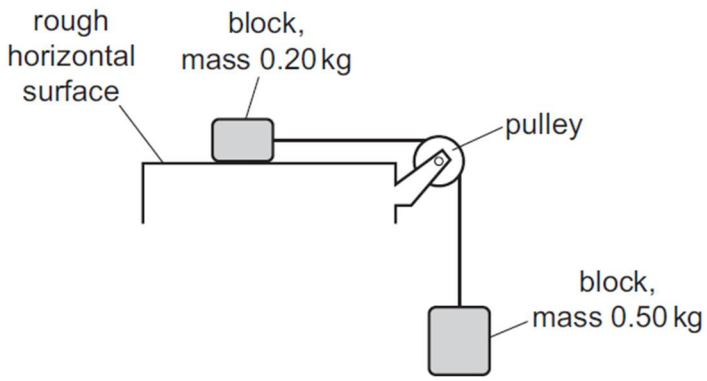


Each force has a magnitude of 15 N and acts in the direction shown. The steering wheel has a diameter of 0.40 m.

What is the torque exerted on the steering wheel?

A 1.3 N m **B** 2.5 N m **C** 2.7 N m **D** 5.4 N m

12 Two blocks, of mass 0.20 kg and 0.50 kg, are connected by a light inextensible string that passes over a frictionless pulley.



The blocks are initially held stationary. The block of mass 0.20 kg rests on a rough horizontal surface.

The block of mass 0.50 kg is suspended in air. Air resistance is negligible.

When the blocks are released, they have an acceleration of magnitude 2.0 m s^{-2}.

What is the magnitude of the frictional force between the block of mass 0.20 kg and the rough surface?

A 3.5 N **B** 3.9 N **C** 4.5 N **D** 6.3 N

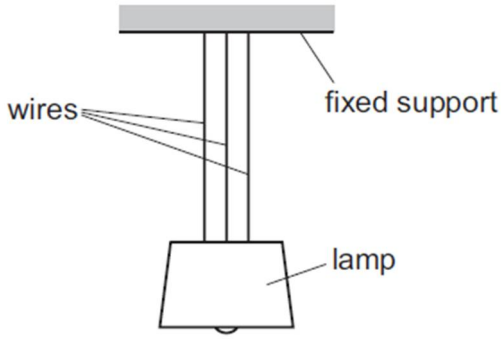
13 A snooker ball has a mass of 200 g. It hits the cushion of a snooker table and rebounds along its original path.

The ball arrives at the cushion with a speed of 14.0 m s^{-1} and then leaves it with a speed of 7.0 m s^{-1}. The ball and the cushion are in contact for a time of 0.60 s.

What is the average force exerted on the ball by the cushion?

A 1.4 N **B** 2.3 N **C** 7.0 N **D** 9.0 N

14 A lamp is suspended in equilibrium from a fixed support by three long identical wires.



The weight of the lamp causes each wire to have an extension of 0.40 cm. The height *h* of the lamp above the floor is measured.

The middle wire suddenly breaks and the lamp falls a small distance as the extensions of the remaining two wires increase. The wires obey Hooke's law. When the lamp is in equilibrium, the height *h* of the lamp above the floor is measured again.

What is the difference between the two values of *h*?

A 0.20 cm **B** 0.27 cm **C** 0.40 cm **D** 0.60 cm

15 An electric car travels at a constant speed of 70 km h^{-1} for 80 km on a straight horizontal road and uses energy *E* from its battery. Assume that the electric motor is 100% efficient and that friction is proportional to the square of the velocity.

How much energy is used from the battery when the car travels at a constant speed of 60 km h^{-1} for 80 km on the straight horizontal road?

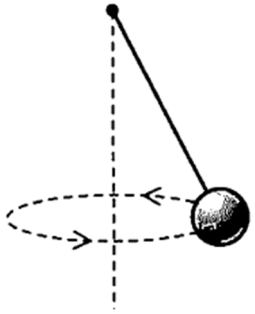
A 0.73 *E* **B** 0.86 *E* **C** 1.2 *E* **D** 1.4 *E*

16 An object is pulled up a frictionless slope by a constant force *F*. When the force has done work *W*, the object has gained gravitational potential energy (g.p.e.) *P* and kinetic energy (k.e.) *K*.

How much g.p.e. and how much k.e. does the object gain when the same force has done work totalling 4W?

	g.p.e.	k.e.
A	2*P*	2*K*
B	2*P*	4*K*
C	4*P*	2*K*
D	4*P*	4*K*

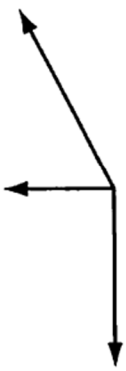
17 A small ball suspended from a light thread moves in a horizontal circle at a constant speed.



A student draws the forces acting on the ball but fails to label them.

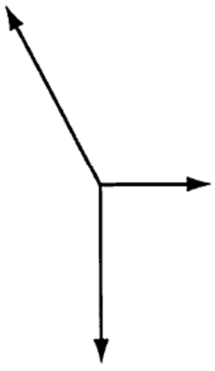
Which diagram shows the correct forces?

A



B

C



D

18 The minute hand of a large clock is 3.0 m long. What is its mean angular speed?

A 1.4×10^{-4} rad s^{-1}

B 5.2×10^{-4} rad s^{-1}

C 1.7×10^{-3} rad s^{-1}

D 3.0×10^{-1} rad s^{-1}

19 A particle travels in a circular path with radius r and centripetal acceleration a.

What is the time taken for 12 complete rotations?

A $24\sqrt{\frac{a}{r}}$

B $24\sqrt{\frac{r}{a}}$

C $\frac{\pi}{6}\sqrt{\frac{r}{a}}$

D $\frac{\pi}{6}\sqrt{\frac{a}{r}}$

20 What is the definition of the potential difference (p.d.) across a component?

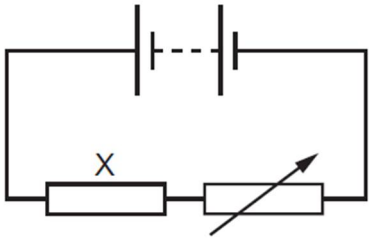
A the charge per unit time passing through the component

B the energy transferred per unit charge

C the force per unit charge

D the resistance per unit current

21 In the circuit shown, a fixed resistor X is connected in series with a battery and a variable resistor.



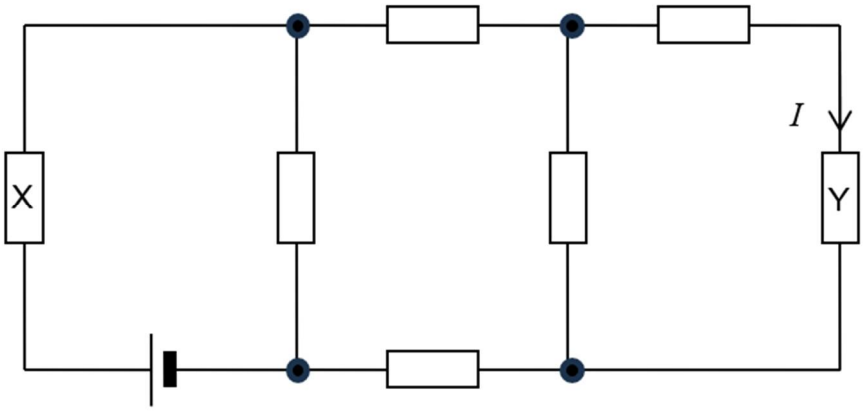
The power dissipated in resistor X is 7.2 W when a current of 3.0 A passes through it.

The variable resistor is adjusted so that the power dissipated in X increases by 50%.

What is the new current in the circuit?

A 2.4 A **B** 3.7 A **C** 4.5 A **D** 14 A

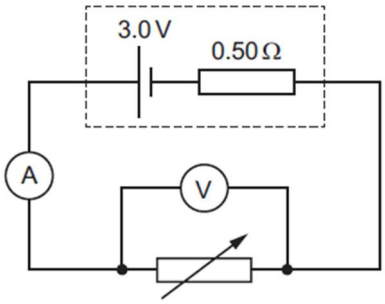
22 A battery of negligible internal resistance is connected to a network of identical resistors as shown.



If the current in resistor Y is I, what is the current in resistor X?

A 19 *I* **B** 11 *I* **C** 7 *I* **D** *I*

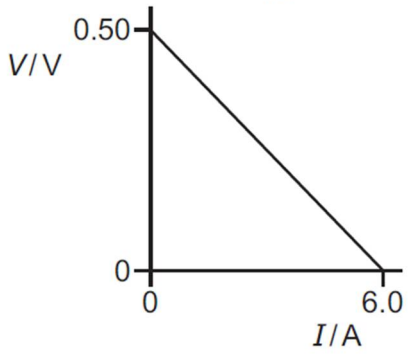
23 A cell of electromotive force (e.m.f.) 3.0 V and internal resistance 0.50 $\wedge$ is connected to a variable resistor, a voltmeter and an ammeter, as shown. The resistance of the variable resistor is varied.



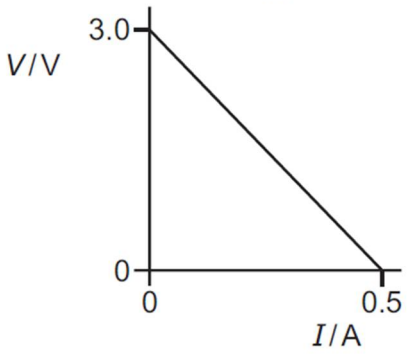
The reading on the ammeter I and the reading on the voltmeter V are recorded.

Which graph shows how V varies with I ?

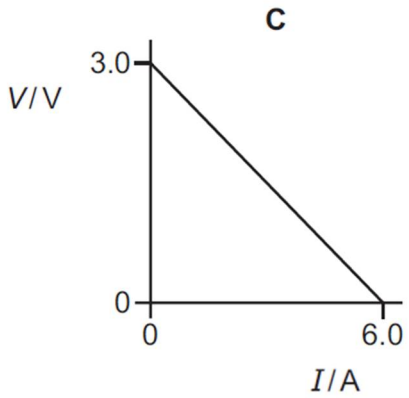
A



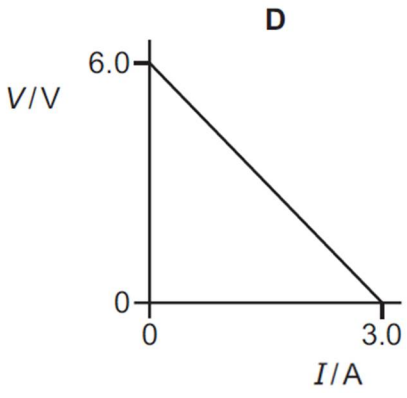
B



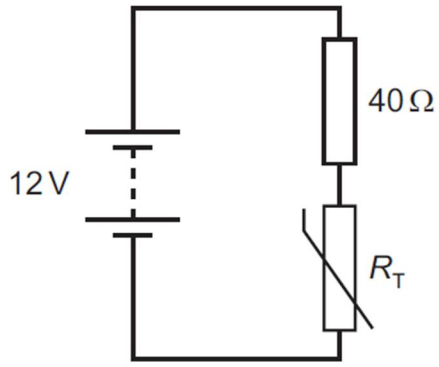
C



D



24 A battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected to a fixed resistor of resistance 40 $\wedge$ and a thermistor of resistance R_T, as shown.

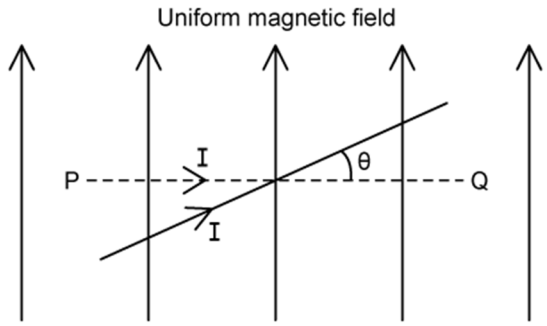


Initially, the temperature of the thermistor is 15°C and the current in the circuit is 0.10 A. The temperature of the thermistor then changes, which causes the current to increase to 0.12 A.

How does the temperature of the thermistor change and what is R_T at the new temperature?

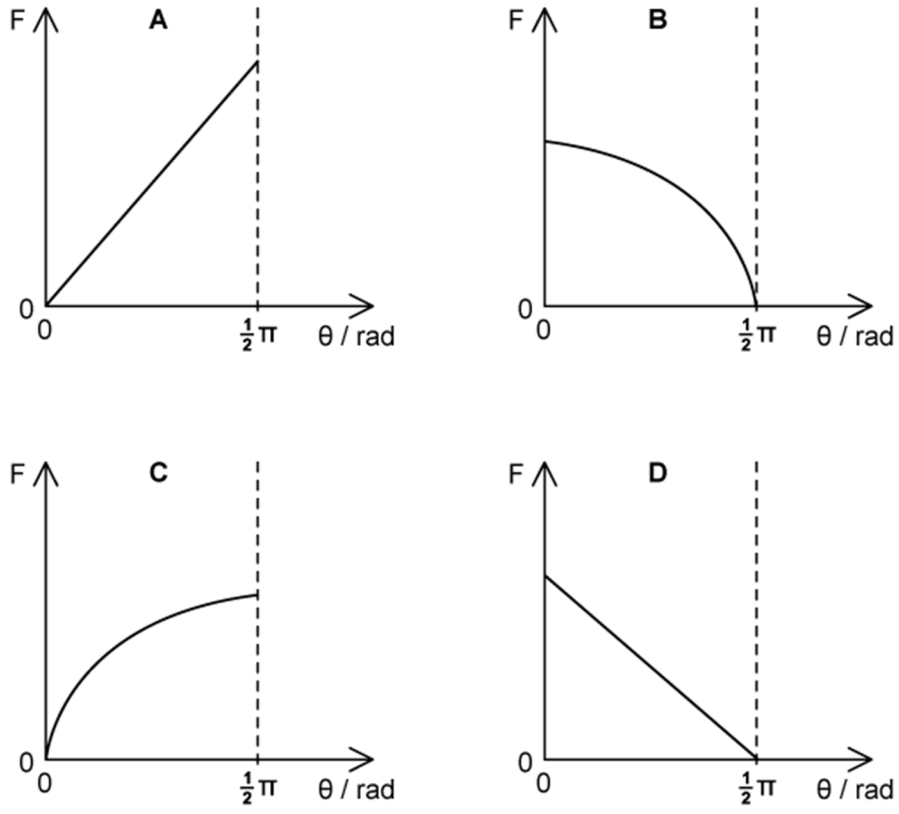
	temperature of thermistor	R_T at new temperature / $\wedge$
A	Increase	60
B	decrease	60
C	Increase	100
D	decrease	100

25 A straight wire PQ carrying a constant current I is placed perpendicular to a uniform magnetic field as represented by the dotted line.

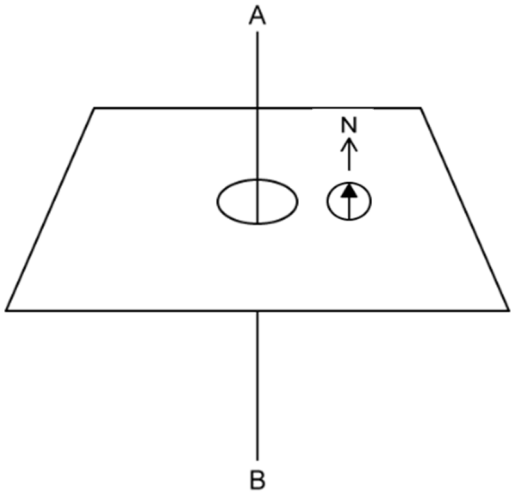


The current-carrying wire is then rotated anti-clockwise through an angle θ about an axis perpendicular to the plane of the magnetic field.

Which of the following graphs shows how the magnitude of the magnetic force F on the wire varies with θ in the range $0 \leq \theta \leq \frac{1}{2}\pi$ radians?

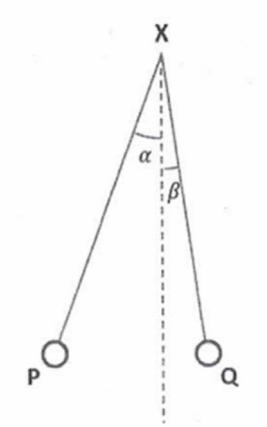


26 A plotting compass is placed next to a vertical wire AB. When there is no current in the wire, the compass points North due to an external magnetic field.



Which diagram shows a possible direction for the compass to point when a current passes from A to B?

27 Two small charged spheres P and Q of small mass are hung by identical nylon threads from a fixed point X. It is found that, in equilibrium, the angle 〈 is greater than angle ®.



Which of the following statements **must** be correct?

A	The mass of Q is less than the mass of P.
B	The mass of P is less than the mass of Q.
C	The charge on P is numerically smaller than that on Q.
D	The charge on Q is numerically smaller than that on P.

28 A nuclear fusion reaction involving deuterium and tritium is described by the nuclear equation below:

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n + \text{energy}$$

How many of such fusion reactions would be required to keep an average household, which uses approximately 2 000 kWh of electrical energy per month, running for a month?

You may use the following data:

- Mass of $^{2}_{1}H$ = 2.014102 u
- Mass of $^{3}_{1}H$ = 3.016049 u
- Mass of $^{4}_{2}He$ = 4.002602 u
- Mass of $^{1}_{0}n$ = 1.008665 u

A 2.6×10^{25}

B 7.6×10^{29}

C 2.6×10^{21}

D 7.6×10^{25}

29 Which of the following statements about the random process of radioactive decay is **incorrect**?

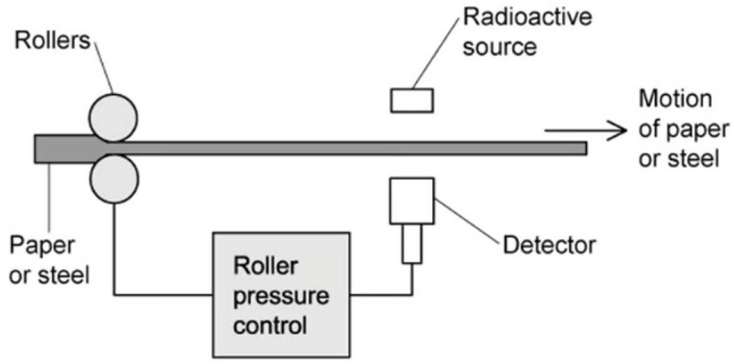
A An estimate of the proportion of nuclei decaying in a given time period can be known.

B There is an equal probability of any nucleus decaying.

C It cannot be known which particular nucleus will decay next.

D It can be known at what time a particular nucleus will decay.

30 The diagram below shows an arrangement used to maintain a constant thickness of sheet of paper or steel as it is being rolled. A radioactive source and detector are used to monitor the thickness.



Alpha, beta or gamma sources could be selected for use in such an arrangement.

Which source would be the most suitable in each case?

	Paper	Steel
A	alpha	beta
B	beta	alpha
C	alpha	gamma
D	beta	gamma

-- END OF PAPER -