VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CLASS		TUTOR NAME	

PHYSICS 9749/01

Paper 1 Multiple Choice **22 September 2025**

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 and tutor name in the spaces on 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 **16** printed pages.

Data

speed of light in free space	$c = 3.00 \times 10^{8}$ m s^{-1}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}
	$(1 / (36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
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
molar gas constant	$R = 8.31$ J K^{-1} mol^{-1}
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ J K^{-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	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on / by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -Gm / r$
temperature	$T / K = T / °C + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
mean translational kinetic energy of an ideal molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$
	$= \pm\omega\sqrt{x_0^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 The e.m.f. induced in a coil by a changing magnetic flux is equal to the rate of change of flux with time. Which is a unit for magnetic flux?

A kg m^2 s^{-2} A^{-1}

B kg m^2 s^{-2} A

C kg m^2 s^2 A^{-1}

D m^2 s^{-2} A^{-1}

2 What is a reasonable estimate for the volume of a wooden metre rule found in a school laboratory?

A 1.5 cm^3 **B** 15 cm^3 **C** 150 cm^3 **D** 1500 cm^3

3 A student carried out an experiment to determine the resistivity ρ of copper using a copper wire. The uncertainties in the measurements are shown.

uncertainty in length l of wire = 0.2%
uncertainty in diameter d of wire = 1.6%

The equation for resistivity ρ is $\rho = \dfrac{\pi d^2 R}{4l}$.

He obtains a resistivity value of $(1.71 \pm 0.07) \times 10^{-8}\,\Omega$ m with its associated uncertainty.

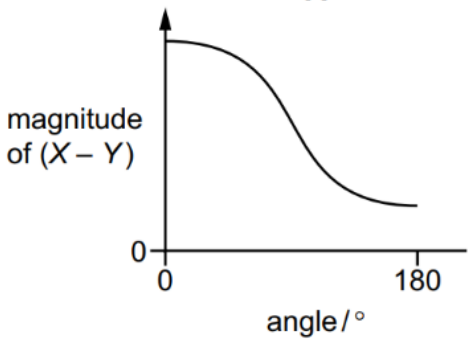
What is the uncertainty in the measurement of resistance R of the wire?

A 0.007% **B** 0.7% **C** 0.9% **D** 7%

4 X and Y are vectors. The magnitude of X is less than the magnitude of Y. The vectors are initially in opposite directions.

As Y is rotated through 180°, how does the magnitude of the vector $(X - Y)$ vary?

A



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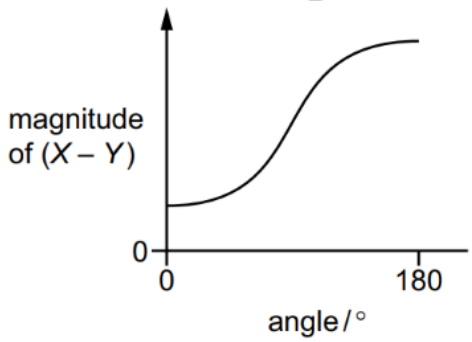

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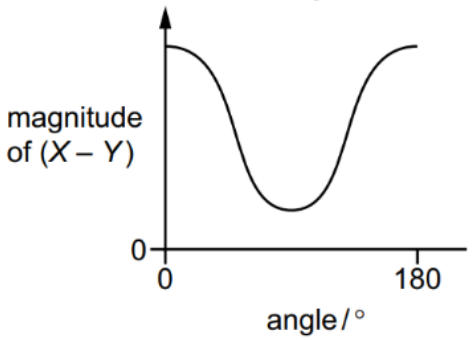
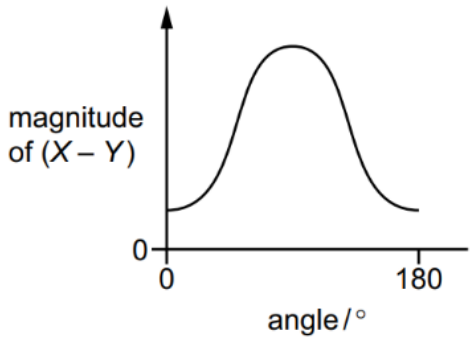
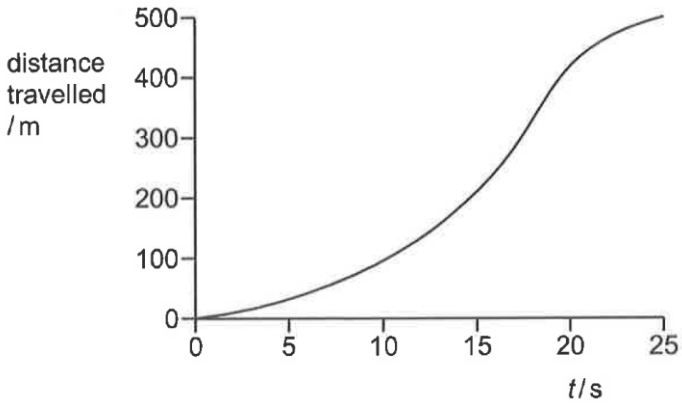


D



5 A car, starting from rest at time $t = 0$, travels along a road. The distance travelled from the starting point is measured over the next 25 seconds.



Which best describes the motion of the car?

A The maximum speed during the first 20 seconds is 10 m s^{-1}.

B At some instant during the first 20 seconds the speed is exactly 20 m s^{-1}.

C The average speed for the first 200 m of the journey is 20 m s^{-1}.

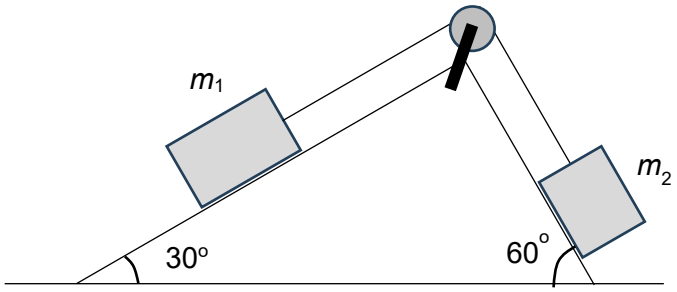
D The average speed between 20 and 25 seconds is greater than that between 15 and 20 seconds.

6 A boy with a ball was in a stationary lift. When the lift starts to accelerate upwards at 1.2 m s^{-2}, the boy released the ball from a height of 1.5 m above the floor of the lift.

What is the time taken by the ball to hit the floor of the lift?

A 0.27 s **B** 0.52 s **C** 0.55 s **D** 0.59 s

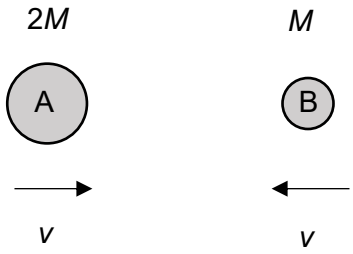
7 Two blocks of masses m_1 = 4.0 kg and m_2 = 1.0 kg are connected by a cord of negligible mass that passes over a frictionless pulley of negligible mass. The blocks slide on frictionless planes inclined at angles $\theta_1 = 30^o$ and $\theta_2 = 60^o$.



What is the tension in the cord?

A 2.3 N **B** 5.8 N **C** 8.0 N **D** 10.7 N

8 Two steel balls A and B of masses 2*M* and 1*M* respectively move towards each other with the same speed *v* and collide elastically.



What are the final velocities of the two balls in terms of *v*? Take the rightward direction as positive.

	final velocity of ball A	final velocity of ball B
A	$\frac{4}{3}v$	$\frac{7}{3}v$
B	$-\frac{1}{3}v$	$\frac{5}{3}v$
C	$\frac{1}{3}v$	$\frac{2}{3}v$
D	$-v$	$2v$

9 A metal block is suspended by a spring balance and is fully submerged in a liquid. When the liquid is replaced with a less dense fluid, the reading on the spring balance

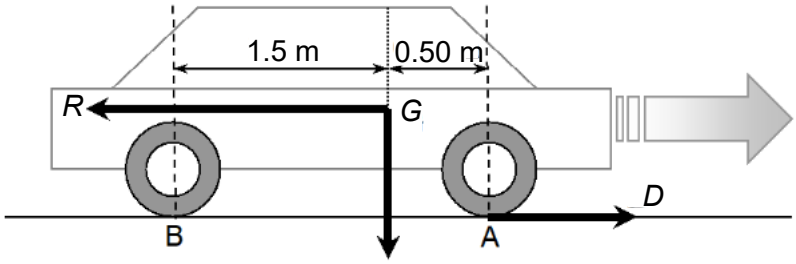
A increases because upthrust decreases.

B increases because the object displaces less fluid.

C remains the same because the volume of the block is unchanged.

D decreases because upthrust increases.

10 The figure below represents the various forces acting on a car moving towards the right. The driving force *D* acts on the front wheels and the total resistive force is represented by the force *R*. The weight *W* of the car is 12000 N and it acts on the centre of mass *G* which is 90 cm above the ground.



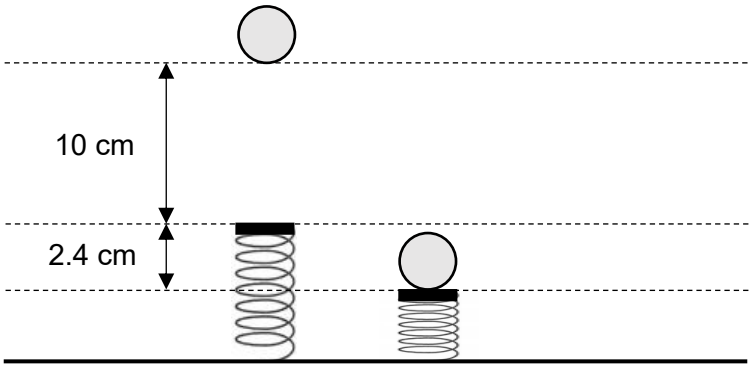
Given that the values of *D* and *R* are both 7000 N, what are the values of the normal reaction forces at A and at B acting on the wheels?

	normal reaction force at A / N	normal reaction force at B / N
A	8100	3900
B	6000	6000
C	6150	5850
D	5850	6150

11 A speed boat has two identical motors. When both motors are working, the speed boat attained a maximum speed of 36.0 m s^{-1}. Given that the drag force on the speed boat is proportional to the square of the speed, what is the maximum speed of the boat when only one motor is working?

A 9.0 m s^{-1} **B** 18.0 m s^{-1} **C** 24.2 m s^{-1} **D** 28.6 m s^{-1}

12 A 20 g ball bearing is released from rest 10 cm above the top of an unstretched spring. It compresses the spring and comes to rest when the spring is compressed by 2.4 cm as shown in the figure below.



What is the spring constant of the spring?

A 2.0 N m $^{-1}$ **B** 8.6 N m $^{-1}$ **C** 68 N m $^{-1}$ **D** 84 N m $^{-1}$

13 A stone of mass m attached to a string is whirled in a vertical circle of radius r. At the top of the circle, the tension in the string is four times the stone's weight. At this point the stone's speed is

A $\sqrt{rg}$ **B** $\sqrt{3rg}$ **C** $\sqrt{4rg}$ **D** $\sqrt{5rg}$

14 Satellites A and B of masses m and $2m$ are placed in geostationary orbits of radii r_A and r_B about the Earth, where the radii are measured from the centre of the Earth to the respective satellites. Which of the following statements is correct?

A The radii r_A and r_B are the same.

B Both satellites have the same centripetal force.

C Both satellites have the same total energy.

D Both satellites have the same gravitational force.

15 The escape speed of an oxygen molecule at the Earth's surface is 1.1×10^4 m s^{-1}. What is the escape speed at $4R$ from the centre of the Earth, where R is the radius of the Earth?

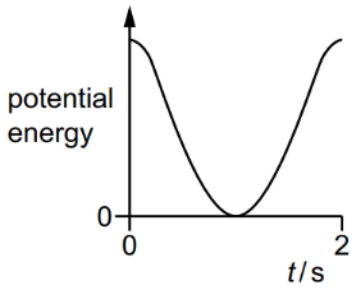
A 5.5×10^3 m s^{-1}

B 6.4×10^3 m s^{-1}

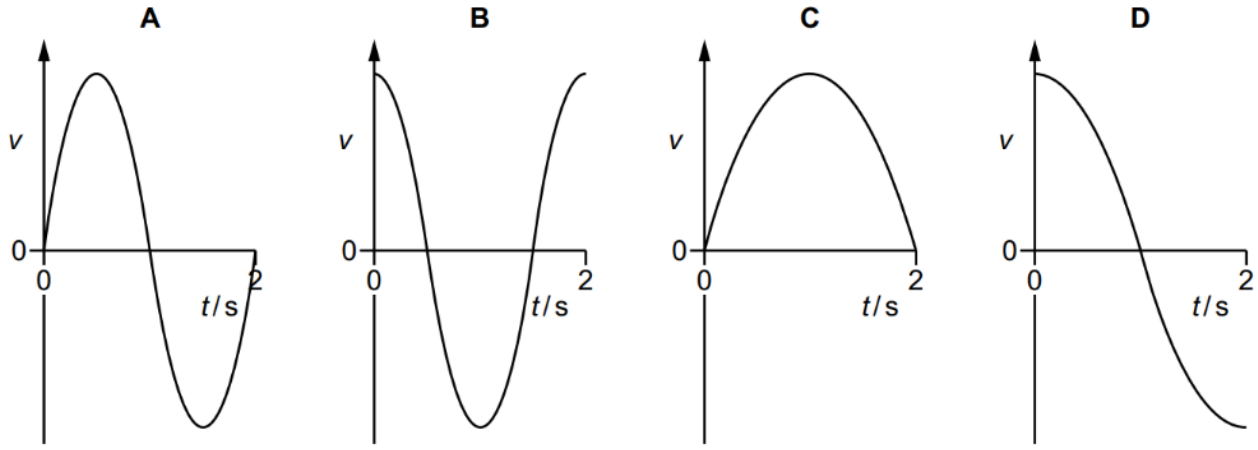
C 1.1×10^4 m s^{-1}

D 1.2×10^4 m s^{-1}

16 A particle oscillates with simple harmonic motion. The graph shows the variation, with time t, of the potential energy of the particle from $t = 0$ to $t = 2$ s.



Which graph could represent the variation, with time t, of the velocity v of the particle from $t = 0$ to $t = 2$ s?



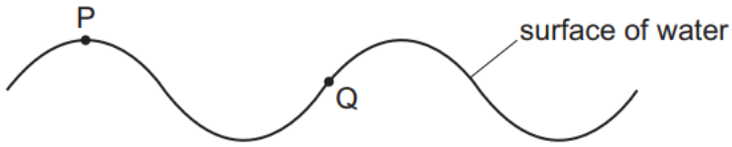
17 Two monoatomic ideal gases X and Y are mixed together in a sealed container. The molar mass of Y is twice that of X. At thermodynamic temperature T, the kinetic energy and root-mean-square speed of an atom of X are given by E and V respectively.

What is the kinetic energy and root-mean-square speed of an atom of Y at temperature T?

	kinetic energy	root-mean-square speed
A	E	$0.71V$
B	E	V
C	E	$1.4V$
D	$2E$	$0.71V$

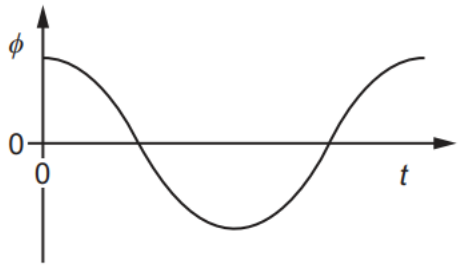
18 In a progressive water wave, two particles P and Q, on the surface of the water, are a fixed horizontal distance apart. P and Q oscillate vertically.

At time $t = 0$, the wave is as shown.

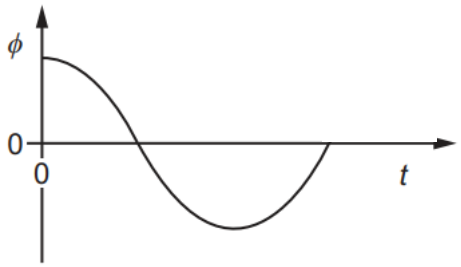


Which graph best represents the variation with time t of the phase difference ϕ between the oscillation of the water particle P and the oscillation of the water particle Q?

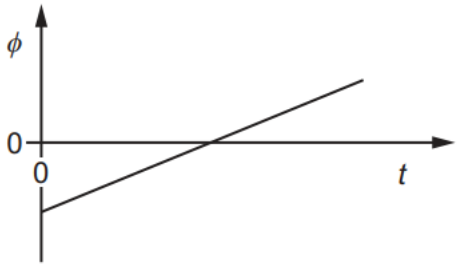
A



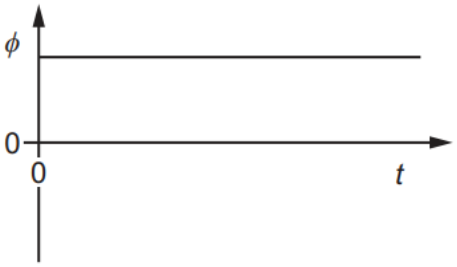
B



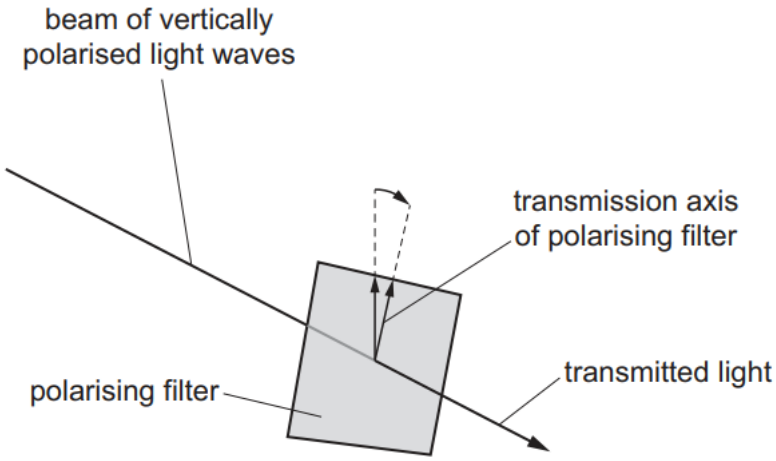
C



D



19 A beam of vertically polarised light is incident normally on a polarising filter. The filter can be rotated so that it is always in a plane perpendicular to the beam. The transmission axis of the filter is initially vertical.



The filter is first rotated clockwise by an angle of 30° so that the transmitted light waves have intensity I_{30}. The filter is then rotated clockwise by a further angle of 30°.

What is the new intensity of the transmitted light waves?

A $0.25I_{30}$ **B** $0.33I_{30}$ **C** $0.75I_{30}$ **D** $0.87I_{30}$

20 Two waves of equal frequency and amplitude are travelling in opposite directions along a stretched string. When they meet, they form a stationary wave with three nodes and two antinodes. The frequency of both waves is doubled and a new stationary wave is formed.

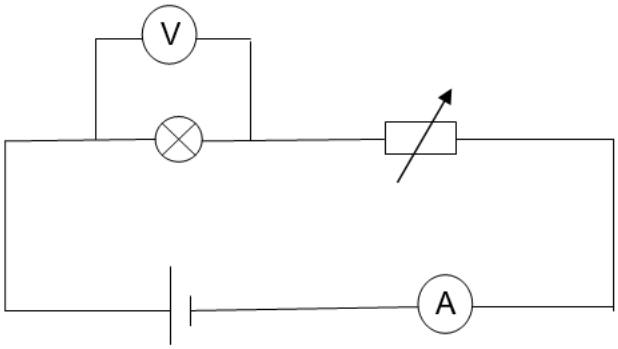
How many antinodes are there in the new stationary wave?

A 1 **B** 3 **C** 4 **D** 5

21 A spherical water droplet with density 1000 kg m^{-3} and diameter 1.20 μm is suspended in a uniform electric field. The electric field strength is 462 N C^{-1} and is directed downwards. How many excess electrons does it have?

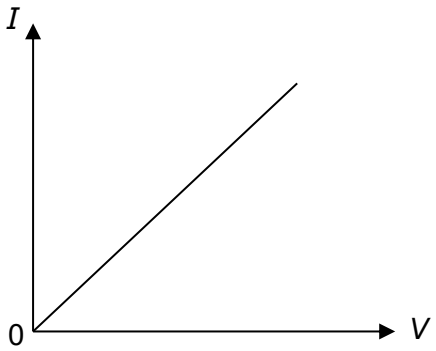
A 1.92×10^{-17} **B** 120 **C** 192 **D** 1.20×10^{11}

22 In the circuit shown below, the current can be varied by means of the rheostat.

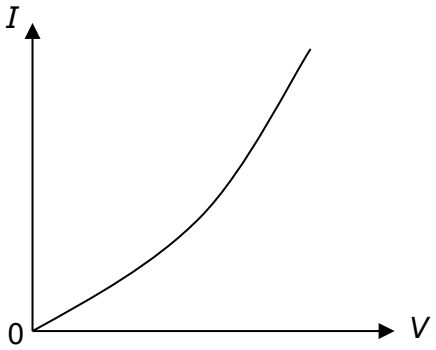


Which one of the following graphs best shows how the ammeter reading I varies with the voltmeter reading V?

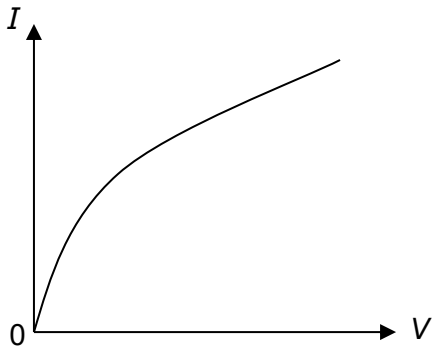
A



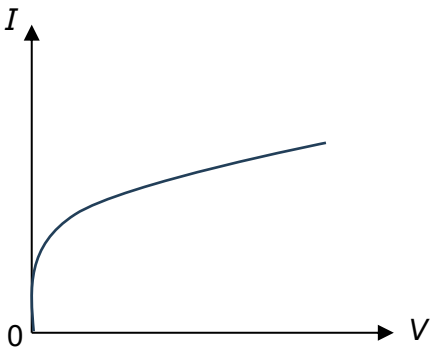
B



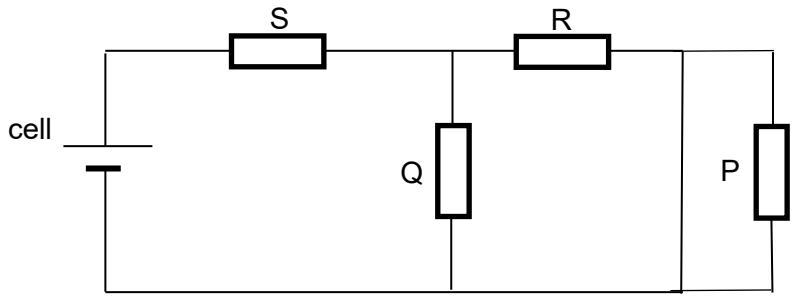
C



D

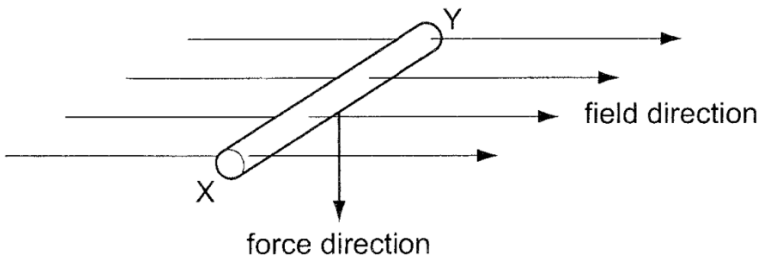


23 A cell is connected across four identical resistors P, Q, R and S. If the source is supplying a total power of 12.0 W, what is the power dissipated as heat in resistor R?



A 2.0 W **B** 3.0 W **C** 4.0 W **D** 5.0 W

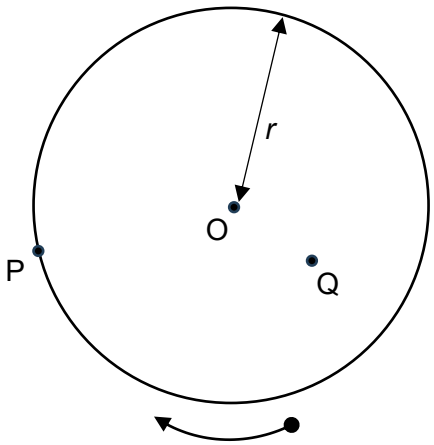
24 A current-carrying conductor is placed at right angles to a uniform magnetic field of flux density 0.50 T. A 10 cm length of conductor lies within the field and experiences a force of 2.4 mN.



What is the direction of electron flow and rate of flow of electrons in the conductor?

	direction of electron flow	rate of flow of electrons / s
A	X to Y	4.8×10^{-2}
B	Y to X	4.8×10^{-2}
C	X to Y	3.0×10^{17}
D	Y to X	3.0×10^{17}

25 An aluminium disc of radius *r* rotates about its centre at a constant speed. It is placed in a uniform magnetic field perpendicular to its surface. A steady electromotive force (e.m.f.) *E* is generated between the centre O and the rim at P.



What is the e.m.f. generated between points Q and P, where Q is a distance $\frac{r}{2}$ from the centre?

A zero **B** $\frac{E}{4}$ **C** $\frac{E}{2}$ **D** $\frac{3E}{4}$

26 An alternating potential difference is connected across a fixed resistor and the frequency *f* of the supply is varied, keeping the r.m.s voltage constant. The mean rate of production of heat in the resistor is

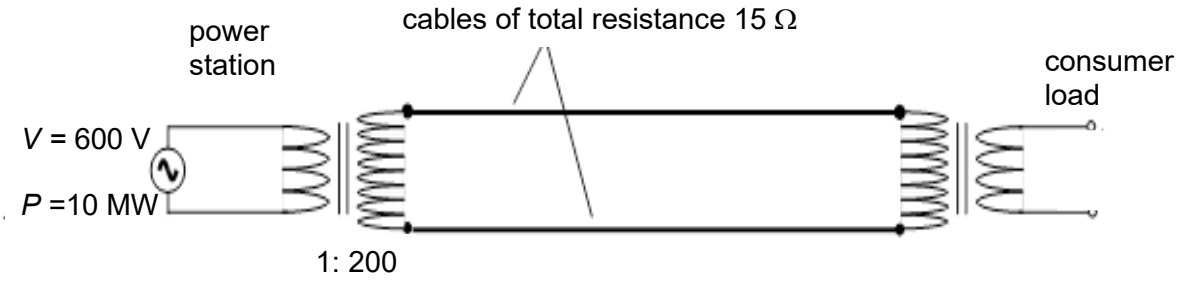
A proportional to *f*

B proportional to $f^{1/2}$

C inversely proportional to *f*

D independent of *f*

27 A 10 MW nuclear power station produces electrical power at 600 V. It uses an ideal step-up transformer with a turns ratio of 1: 200 to increase the voltage before transmitting it over long-distance cables of total resistance 15 Ω. At the consumer load, a second ideal transformer steps down the voltage.



What is the power lost as heat in the cables?

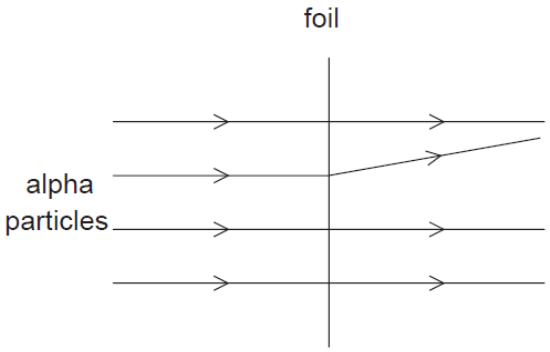
A 50 kW **B** 100 kW **C** 1.0 MW **D** 960 MW

28 What is the wavelength of a particle of mass 1.88×10^{-28} kg when traveling with a speed equal to 10% of the speed of light?

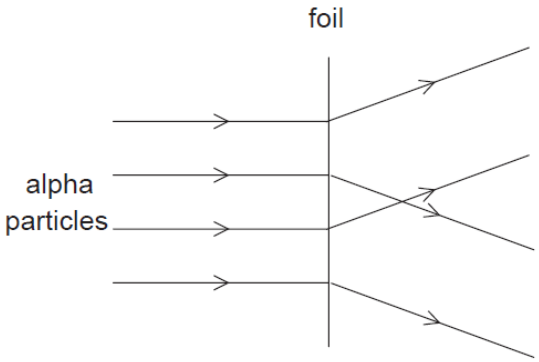
A 7.1×10^{-9} m **B** 4.4×10^{-10} m **C** 1.3×10^{-12} m **D** 1.2×10^{-13} m

29 In the Rutherford alpha particle scattering experiment, alpha particles were directed at a thin gold foil. Which of the following shows how the majority of the alpha particles behave after reaching the foil?

A



B



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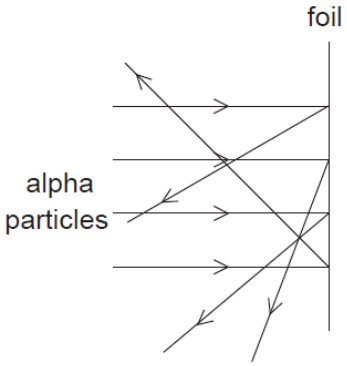
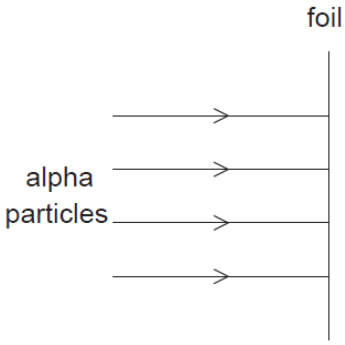
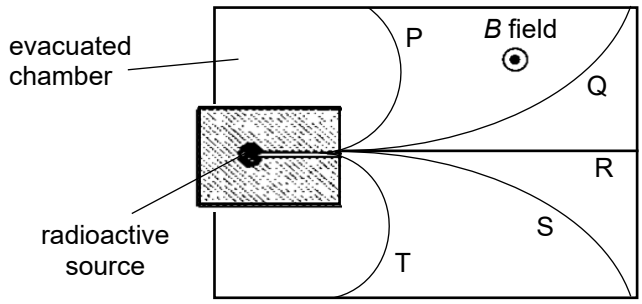


D



30 A source undergoing alpha, beta and gamma decay is placed in an evacuated chamber with magnetic field directed out of the page. Which of the following represents the paths of the radiation particles emitted?



	α-particle	β-particle	γ-ray
A	Q	T	R
B	S	P	R
C	T	R	S
D	S	T	Q