EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY YEAR EXAMINATIONS 2023
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME							
CIVICS GROUP	**2**	**2**	**-**			REGISTRATION NUMBER	

PHYSICS

9749/01

Multiple Choice Questions

22nd September 2023

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
The use of an approved scientific calculator is expected where appropriate.
Answer **all** questions.

There are **thirty** questions in this section.
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.

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.

This document consists of **20** 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}

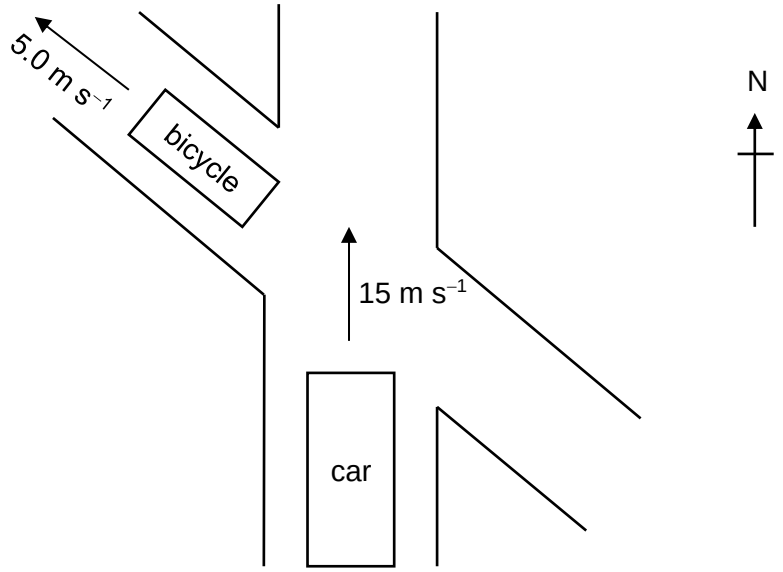
Formulae

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,	$\phi = -\frac{Gm}{r}$
temperature,	$T\ /\ \mathrm{K} = T\ /\ ^\circ\mathrm{C} + 273.15$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas 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.	$v = v_0 \cos \omega t$ $= \pm\ \omega \sqrt{\left(x_0^2 - x^2\right)}$
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	$B = \frac{\mu_0 N I}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 n I$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

Section A – Multiple Choice Questions

1 A car and a bicycle are equal distances from a crossroads. The car is travelling north with a speed of 15 m s^{-1}.

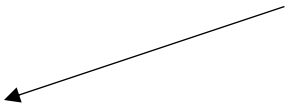
The bicycle is travelling northwest with a speed of 5.0 m s^{-1}.



At this instant, which arrow represents the velocity of the bicycle relative to the car?

A

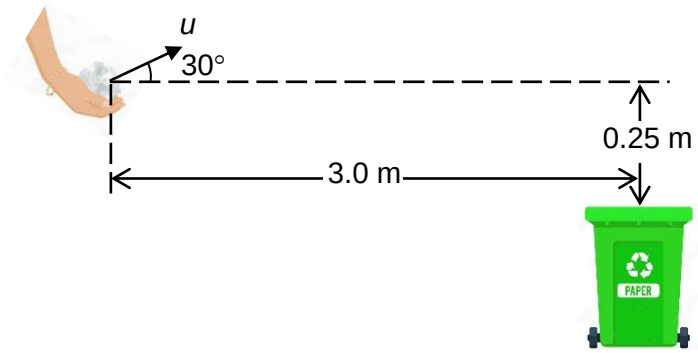
B



C

D

2 A student attempts a long distance shot with a crushed paper ball as shown in the diagram below (not to scale).

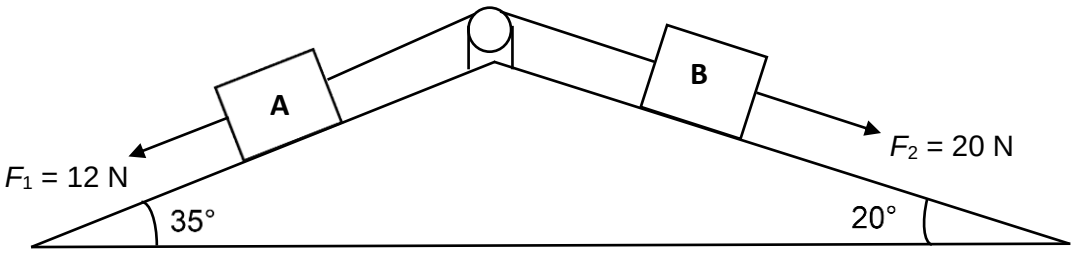


The horizontal distance between the centre of mass of the ball and the centre of the trash bin is 3.0 m, while the vertical distance between them is 0.25 m. The ball is shot at an angle of 30° above the horizontal, with an initial speed u.

Which value should u be, in order for the crushed paper ball to enter the trash bin?

A 5.4 m s^{-1} **B** 6.3 m s^{-1} **C** 30 m s^{-1} **D** 40 m s^{-1}

3 Two blocks, A and B, connected by a massless rope over a smooth pulley, are on a smooth incline plane with angles of inclination as shown in the diagram. The masses of blocks A and B are 2.0 kg and 5.0 kg respectively. The two blocks are acted upon by two external forces, F_1 and F_2, respectively as shown in the diagram with F_1 = 12 N and F_2 = 20 N.



What is the tension in the rope?

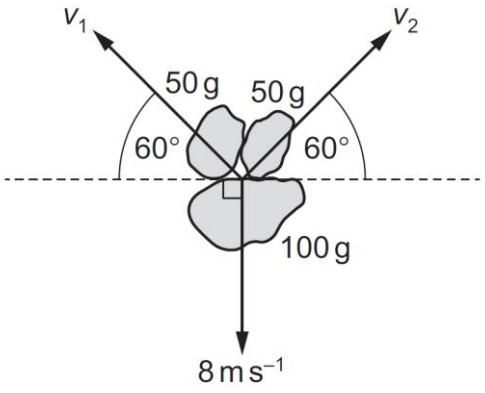
A 21 N

B 27 N

C 39 N

D 42 N

4 A stationary firework explodes into three pieces. The masses and the velocities of the three pieces immediately after the explosion are shown.



What is the speed v_1?

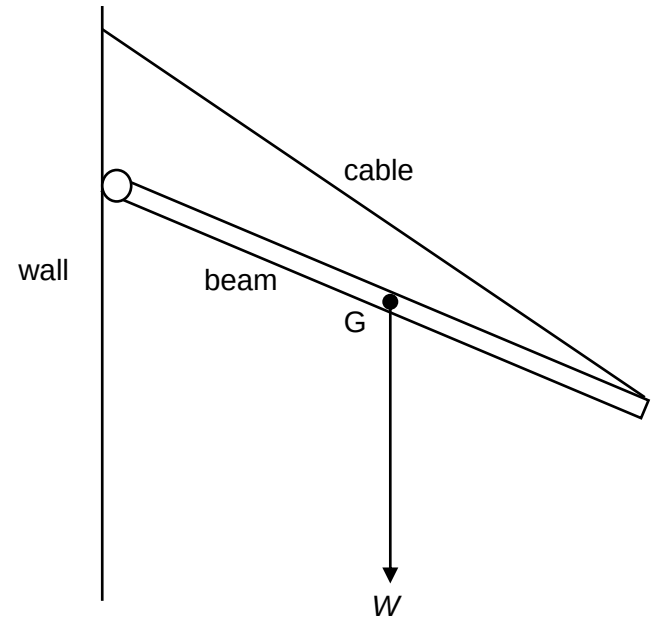
A 4.0 m s^{-1}

B 9.2 m s^{-1}

C 14 m s^{-1}

D 16 m s^{-1}

5 A uniform beam is freely hinged to a wall. It is held by a cable at the other end.



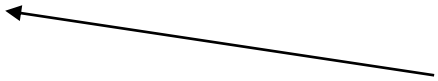
.

Its weight *W* acts through the centre of gravity G.

What is the direction of the force by the hinge on the beam?

A

B



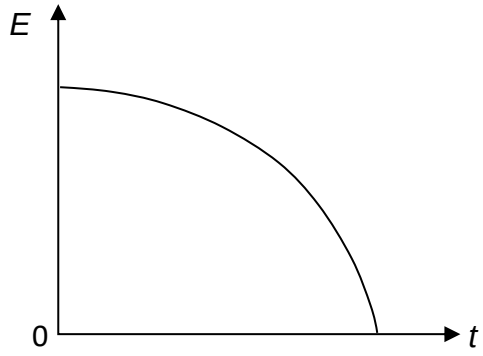
C

D

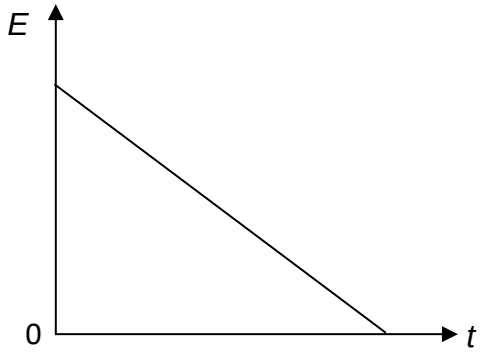
6 An object falls freely from rest. After time *t*, its displacement from origin is *s.*

Which graph(s) shows the correct relationship of how gravitational potential energy *E* of the ball varies?

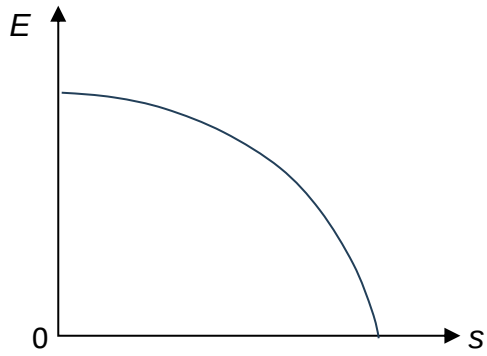
(i)



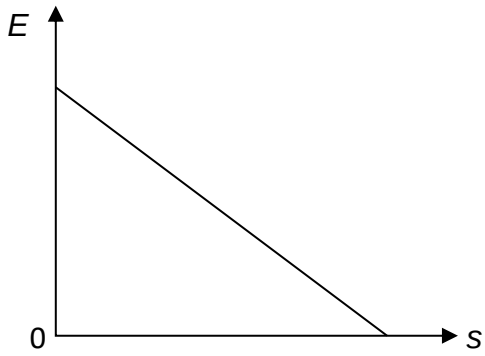
(ii)



(iii)



(iv)



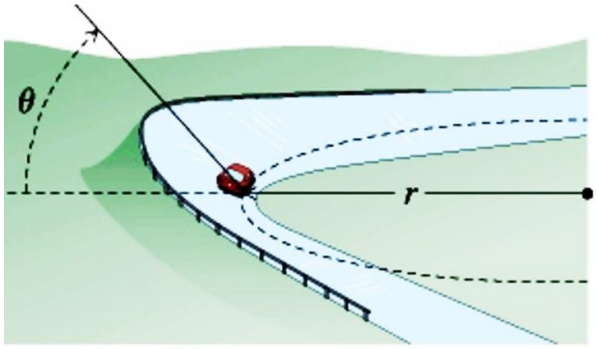
A (i) and (iii) only
B (i) and (iv) only
C (ii) and (iii) only
D (ii) and (iv) only

7 A 1000 kg car travels along a road at with a constant acceleration of 0.50 m s^{-2}. At a speed of 20 m s^{-1}, its power output is 40 kW. The total resistive force on the car is proportional to the square of its speed.

What power will be required to travel at a constant speed of 25 m s^{-1}?

A 1.8 kW **B** 47 kW **C** 59 kW **D** 72 kW

8 A car is driven round an icy road banked at an angle θ of 25° and a radius r of 50 m as shown.



The frictional force between the tyres and the road is negligible.

What is the speed that the car can travel at while maintaining the circular radius?

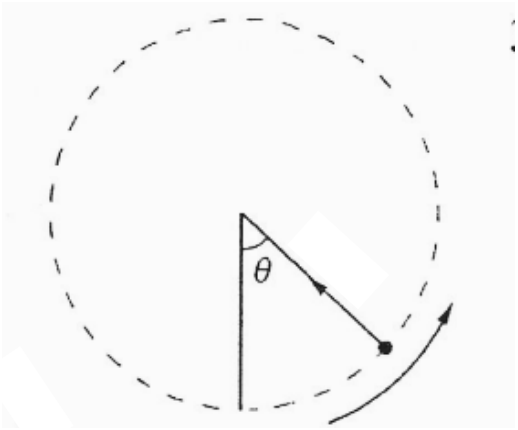
A 2.6 m s^{-1}

B 7.3 m s^{-1}

C 15.1 m s^{-1}

D 21.9 m s^{-1}

9 An object of 3.5 kg is fixed to one end of a light rod which rotates freely in a vertical circle. The length of the rod is 7.7 m.



When θ is 30°, the speed of the object is 25.0 m s^{-1}. Assume that there is no energy loss to the surrounding.

Which of the following describes the force in the rod when the object is at the top of the circular motion?

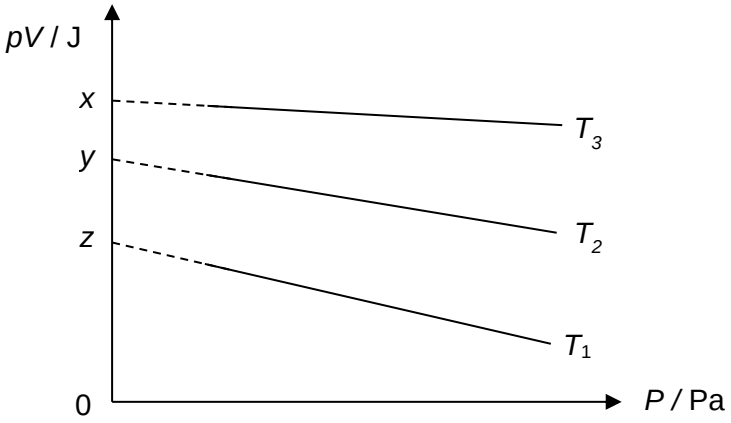
A 94 N in compression

B 94 N in tension

C 121 N in compression

D 121 N in tension

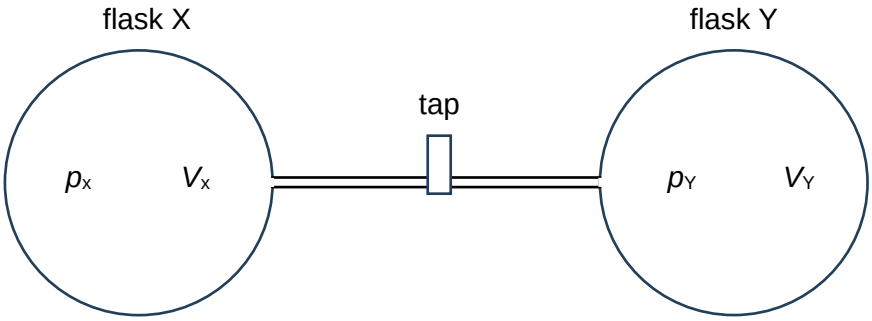
10 The given graph shows the isotherms obtained from a sample of real gas. The temperature T_1 is the ice-point (273.15 K) and T_2 is the boiling point of water at standard pressure.



What is the thermodynamic temperature T_3 in kelvin?

A $273.15\dfrac{(x-y)}{(y-z)}$ **B** $273.15\dfrac{x}{z}$ **C** $273.15+100\dfrac{x}{z}$ **D** $273.15+100\dfrac{(x-y)}{(y-z)}$

11 Some ideal gas is contained in two flasks X and Y. The flasks are connected by a tube of negligible volume that is fitted with a tap, as shown.



With the tap closed, the pressure and volume of the gas in the flask X are p_x and V_x respectively. In flask Y, the gas has pressure p_Y and volume V_Y. The temperature of the gas in both flasks is T.

The tap is opened. After some time, the temperature of the gas returns to T at pressure P and volume V.

Which expression relates the pressures and the volumes before and after opening the tap once the temperature has returned to T?

A $pV=(p_x-p_y)\times(V_x-V_y)$

B $pV=\dfrac{1}{2}(p_x+p_y)\times\dfrac{1}{2}(V_x+V_y)$

C $pV=p_xV_x+p_yV_y$

D $pV=(p_x+p_y)\times(V_x+V_y)$

12 The density of argon at a pressure of 1.00×10^5 Pa and at a temperature of 300 K is 1.60 kg m^{-3}.

There are 4.35×10^{30} molecules of argon in a container.

What is the root mean square speed of argon molecules at this temperature?

A 216 m s^{-1}

B 250 m s^{-1}

C 306 m s^{-1}

D 433 m s^{-1}

13 An experiment was carried out to determine the specific latent heat of fusion of an unknown solid. Two power settings were used.

The power rating of the heater P and the time t to melt 3.0 kg of the solid were recorded in the table below.

P / W	t / min
650	2.0
1200	1.0

What is the specific latent heat of fusion of the solid?

A 22 kJ kg^{-1} **B** 24 kJ kg^{-1} **C** 25 kJ kg^{-1} **D** 26 kJ kg^{-1}

14 The contents of a refrigerator are at a constant temperature, and the surroundings of the refrigerator are at a higher temperature. Because of this, thermal energy flows into the refrigerator from outside, and is removed at the same rate by cooling mechanism.

The first law of thermodynamics may be applied to the contents of the refrigerator. This law is represented by $\Delta U = Q + W$ where ΔU is the increase of internal energy of the contents of the refrigerator, Q is the net heating of the contents and W is the mechanical work done on the contents.

For the refrigerator contents, which of the following quantities ΔU, Q and W is/are zero?

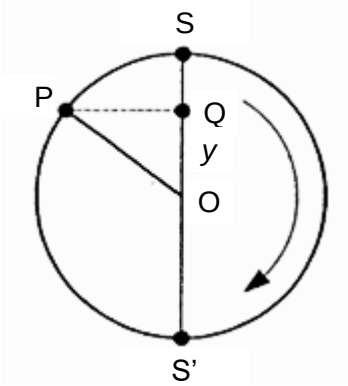
A ΔU only

B Q only

C W only

D each of ΔU, Q and W

15 The given diagram shows a particle rotating clockwise in a horizontal circle of radius r with a constant angular velocity ω. At time t, the particle is at P. At $t = 0$, the particle is at S. The projection of P on the diameter through SS' is represented by Q. With respect to the origin O, the displacement, linear velocity and linear acceleration of Q in the direction OS are y, v and a respectively.



Which set of expressions is correct?

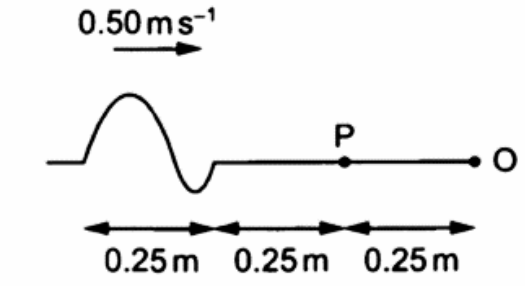
A $y = r\cos\omega t\,;\, v = -r\omega\sin\omega t\,;\, a = r\omega^2\cos\omega t$

B $y = r\cos\omega t\,;\, v = -r\omega\sin\omega t\,;\, a = -r\omega^2\cos\omega t$

C $y = r\cos\omega t\,;\, v = -r\omega\cos\omega t\,;\, a = r\omega^2\sin\omega t$

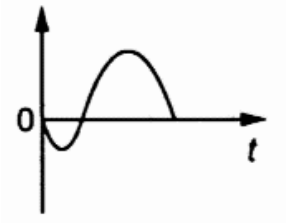
D $y = r\sin\omega t\,;\, v = -r\omega\cos\omega t\,;\, a = r\omega^2\sin\omega t$

16 A wave pulse of length 0.25 m is shown at the time $t = 0$. It moves along a string, fixed at O, at 0.50 m s^{-1}. There is a phase change of π rad upon reflection.

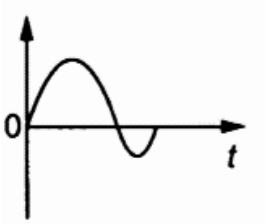


Which graph best represents the displacement of point P with time for the period $t = 1.5$ s to 2.0 s?

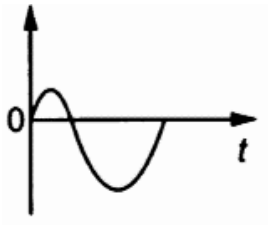
A



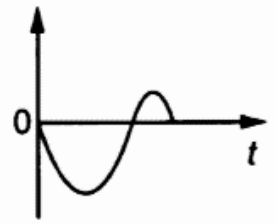
B



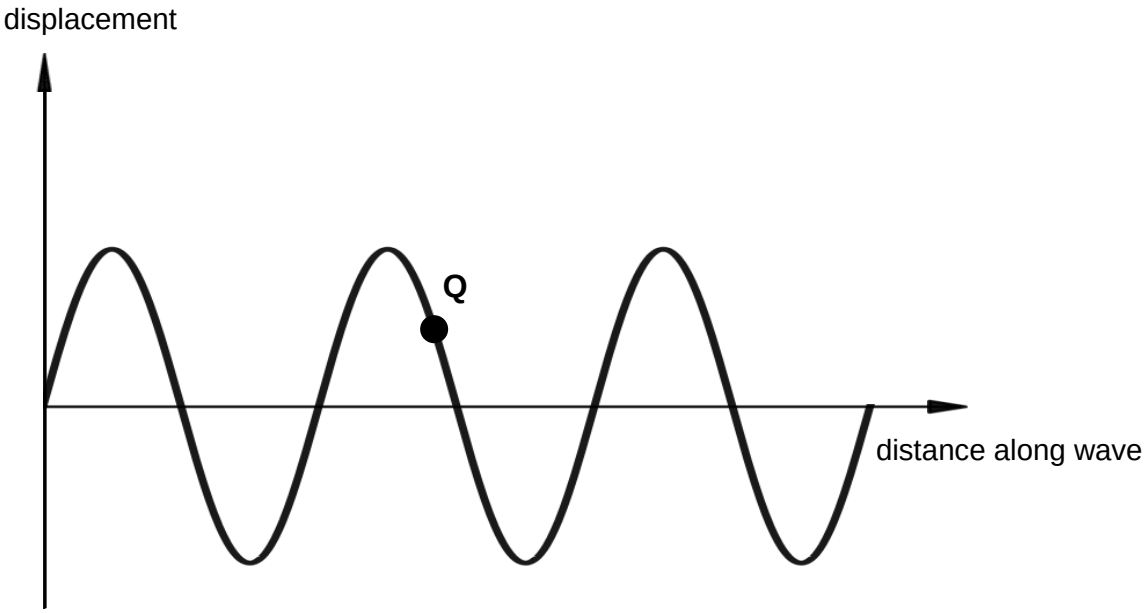
C



D



17 The graph shows the shape at a particular instant of part of a transverse wave. Point Q is displaced upwards but is moving downwards. Point P is $\frac{7}{4}$ of a wavelength away from point Q. The wave moves leftwards and travels from P to Q.



Which of the following statements about the displacement and direction of velocity of P is correct?

A P is displaced upwards and moving upwards.

B P is displaced upwards and moving downwards.

C P is displaced downwards and moving downwards.

D P is displaced downwards and moving upwards.

18 Two coherent sources that are in phase with each other emit waves of wavelength 5.0 m. At a point 135.0 m from one source and 147.5 m from the other, the intensities due to the two sources individually are, respectively, I and $4I$.

What is the resultant intensity at that point?

A I **B** $3I$ **C** $5I$ **D** $9I$

19 The diffraction pattern is formed when a single slit of width 0.60 mm is illuminated with monochromatic light of wavelength 550 nm**.** The width of the central maximum is *w* and the peak intensity is I_o.

The slit width is then doubled.

Given that the angle of diffraction is small, which row correctly shows the new width of the central maximum and the peak intensity?

	width of central maximum	peak intensity
A	½ *w*	$2\,I_o$
B	½ *w*	$4\,I_o$
C	2 *w*	$\frac{1}{2}\,I_o$
D	2 *w*	$\frac{1}{4}\,I_o$

20 Fringes of separation *y* are observed in a plane 1.00 m from a Young's double slit illuminated by yellow light of wavelength 600 nm.

At what distance from the slits would fringes of the same separation *y* be observed when using blue light of wavelength 400 nm?

A 0.33 m

B 0.67 m

C 0.75 m

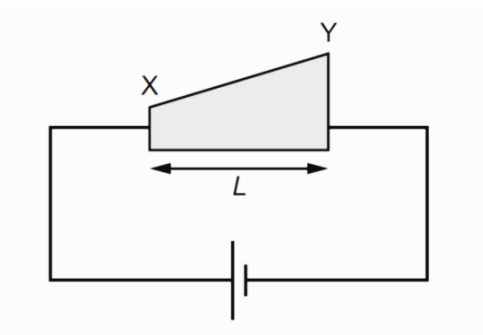
D 1.50 m

21 An oil-drop of mass *m,* carrying a charge *q*, is in the region between two horizontal plates. When the potential difference between the upper and lower plates is *V*, the drop is stationary. The potential difference is then increased to 2*V*.

What is the initial upward acceleration of the oil-drop?

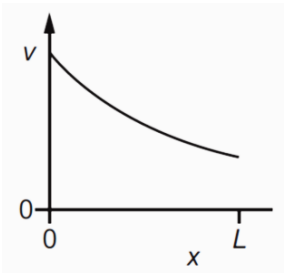
A g **B** $2g$ **C** $\frac{qV}{m}$ **D** $\frac{2qV}{m}$

22 A wedge-shape metal conductor of length *L*, varying width and uniform thickness is connected to a cell, as shown.

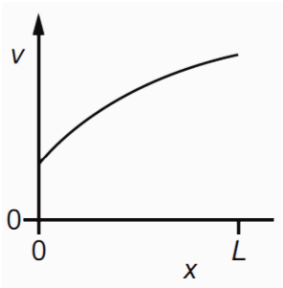


Which graph best shows how the average drift velocity *v* of the electrons in the conductor varies with distance *x* from end X?

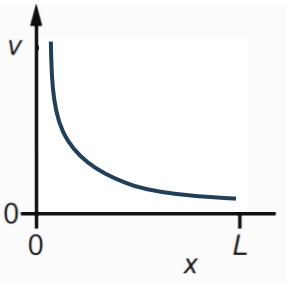
A



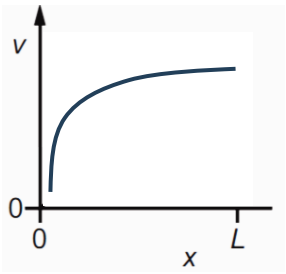
B



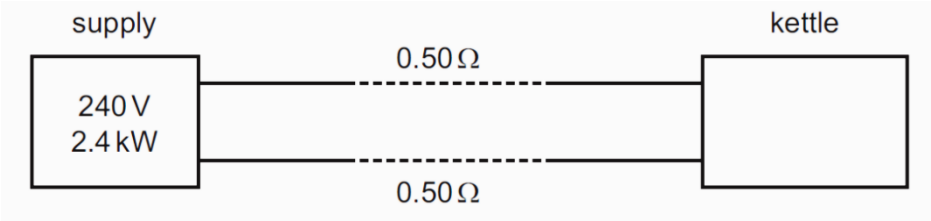
C



D



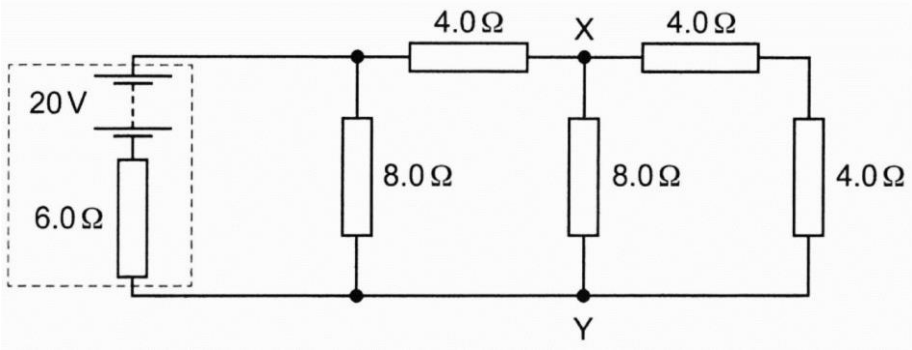
23 The power output of an electrical supply is 2.4 kW at a potential difference (p.d.) of 240 V. The two wires between the supply and a kettle each have a resistance of 0.50 Ω, as shown.



What is the power supplied to the kettle and the p.d. across the kettle?

	power / kW	p.d. / V
A	2.3	230
B	2.3	235
C	2.4	230
D	2.4	235

24 A battery of e.m.f. 20 V and internal resistance 6.0 Ω is connected to a network of resistors.



What is the potential difference between junctions X and Y?

A 2.0 V **B** 4.0 V **C** 6.0 V **D** 8.0 V

25 The force on an electron is 7.3×10^{-16} N when moving at an angle of 23° to a uniform magnetic field of magnetic field strength of 0.084 T.

What is the speed of the electron and what is the shape of the path of the electron?

A 1.4×10^{5} m s^{-1} in a helix

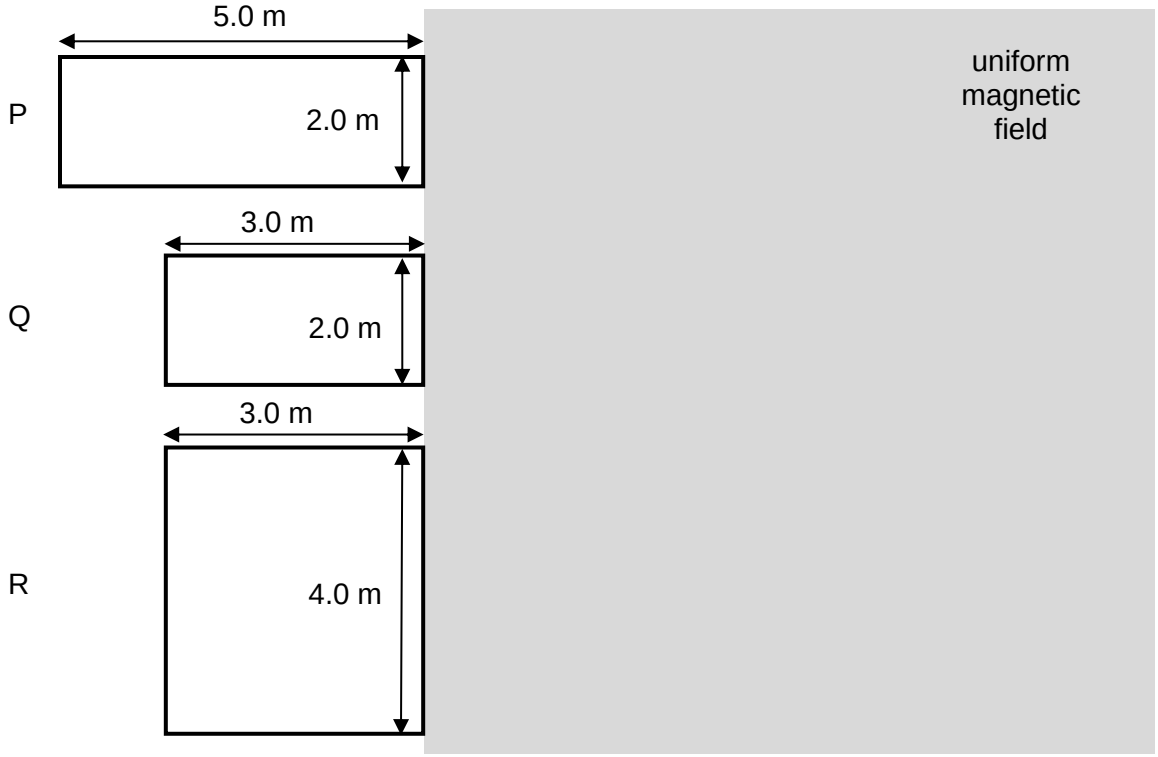
B 1.4×10^{5} m s^{-1} in a spiral

C 2.1×10^{4} m s^{-1} in a helix

D 2.1×10^{4} m s^{-1} in a spiral

26 Three conducting coils P, Q, and R of the same material just enter a region of uniform magnetic field at $t = 0$ with constant velocity of 1.0 m s^{-1}.

Coils P, Q and R have 1, 3 and 1 number of turn(s) respectively.



After 4.0 s, which row shows the coils with the largest magnetic flux, magnetic flux linkage and induced current?

	largest magnetic flux	largest magnetic flux linkage	largest induced current
A	Q	R	P
B	P	Q	R
C	R	Q	P
D	Q	P	Q

27 An alternating potential difference, with peak value V and frequency f, is applied across a light bulb of resistance R. The bulb lights up.

Which of the following changes would result in the maximum increase in the brightness of the bulb?

	V	f	R
A	doubles	doubles	halves
B	halves	doubles	doubles
C	doubles	increases by 4 times	doubles
D	halves	increases by 8 times	halves

28 An electron moves along the x-axis. The speed of the electron is measured with an uncertainty of 0.38c.

What is the smallest uncertainty in position of the electron?

A 10^{-22} m

B 10^{-12} m

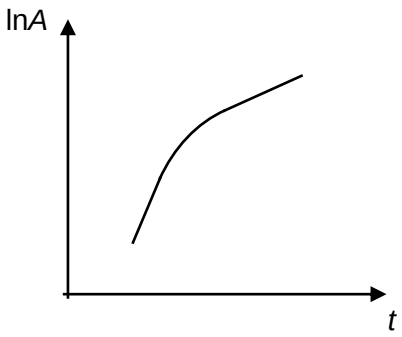
C 10^{8} m

D 10^{10} m

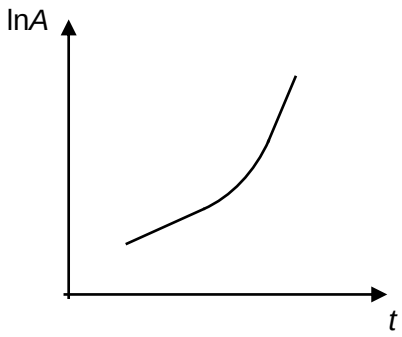
29 Nuclide C has a half-life of 5 years, while nuclide N has a half-life of 90 years. The activity A of a mixture of C and N is measured.

Which graph best represents the variation with time t of the natural logarithm of A?

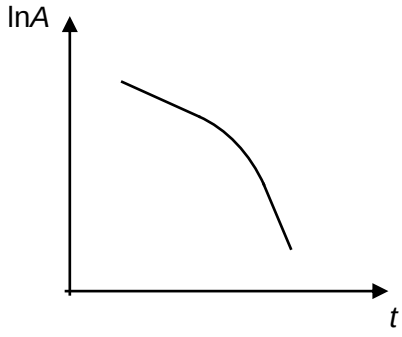
A



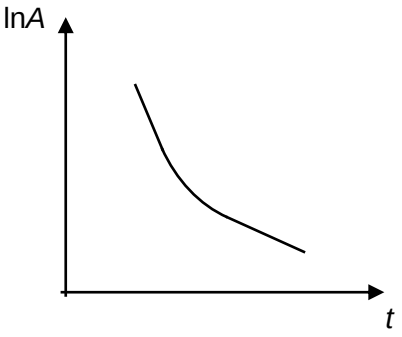
C



B



D



30 What did the Rutherford scattering experiment reveal about the atomic structure?

A Electrons are distributed uniformly throughout the atom.

B The nucleus is charged and contains most of the atom's mass.

C Electrons move in discrete energy levels around the nucleus.

D The atom is composed of protons, neutrons, and electrons.