HWA CHONG INSTITUTION
JC2 Preliminary Examinations
Higher 2

CANDIDATE NAME		**CT GROUP**	**22S**
TUTOR NAME			

PHYSICS **9749/01**

Paper 1 Multiple Choice **20 Sep 2023**

60 minutes

Additional Materials: Optical Mark Sheet

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

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 OMS.

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.

Data

speed of light in free space,
$c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space,
$\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space,
$\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}
$\approx (1/(36\pi)) \times 10^{-9}$ 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 kinetic energy of a molecule of an ideal gas	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_o \sin \omega t$
velocity of particle in s.h.m.	$v = v_o \cos \omega t$ $= \pm \omega \sqrt{(x_o^2 - x^2)}$
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	$V = \frac{Q}{4\pi\varepsilon_o r}$
alternating current / voltage	$x = x_o \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_o N I}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_o n I$
radioactive decay	$x = x_o \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 Which of the following are the correct units of magnetic flux?

	SI unit	SI base units
A	T	kg s^{-2} A^{-1}
B	T	kg m^2 s^{-2} A^{-1}
C	Wb	kg s^{-2} A^{-1}
D	Wb	kg m^2 s^{-2} A^{-1}

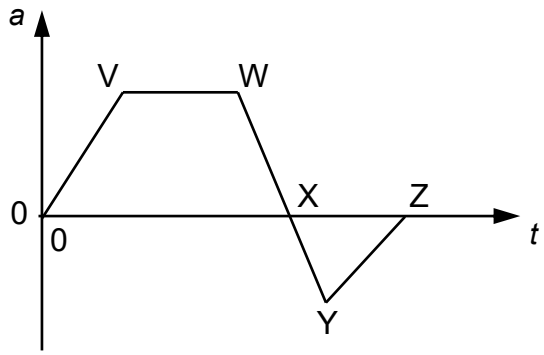
2 A point source is emitting a steady sound wave uniformly in all directions.

A sound intensity meter placed at a distance (2.0 ± 0.1) m away from the source detects an intensity of (0.25 ± 0.05) W m^{-2}.

What is the uncertainty in calculating the power of the source?

A 0.3 W **B** 1 W **C** 3 W **D** 4 W

3 A car starts from rest and moves along a straight road. The graph shows the variation with time *t* of its acceleration *a* during part of its journey.



At which points on the graph does the car have its greatest velocity and greatest displacement?

	greatest velocity	greatest displacement
A	V	W
B	W	Z
C	X	Y
D	X	Z

4 A block is placed on the floor of a lift that moves upwards.
When the lift is slowing down, the magnitude of the force exerted on the block by the floor is always

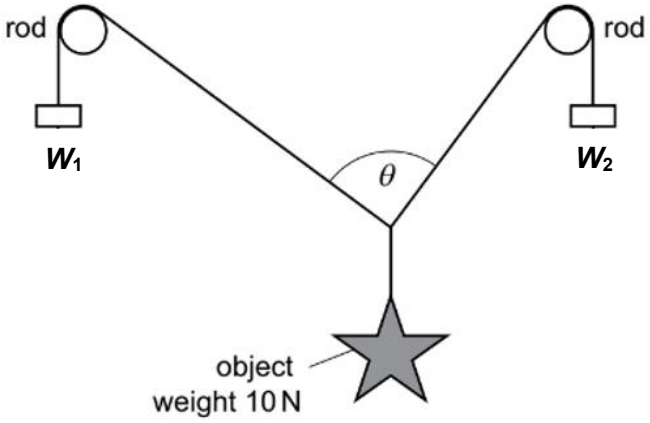
A equal to the magnitude of the weight of the block.

B less than the magnitude of the weight of the block.

C greater than the magnitude of the weight of the block.

D different from the magnitude of the force exerted on the lift floor by the block.

5 An object hangs by means of two cords around two rods, as shown in the diagram below.

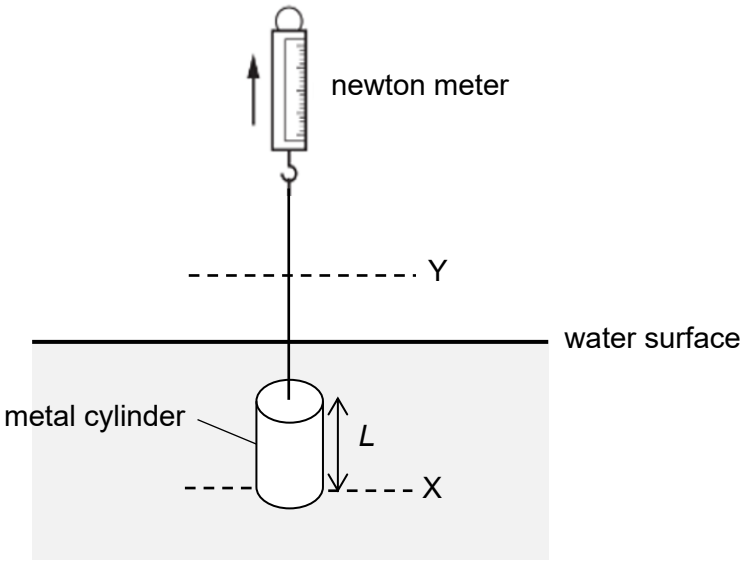


The object is held in equilibrium by the weights W_1 and W_2, such that it is nearer to W_2.
The object weighs 10 N. There is negligible friction between the rods and cords.

Which pair of weights gives an angle θ of 90°?

	W_1 / N	W_2 / N
A	4.0	6.0
B	5.0	5.0
C	6.0	8.0
D	8.0	6.0

6 A metal cylinder, totally immersed in water, is hung from a newton meter.

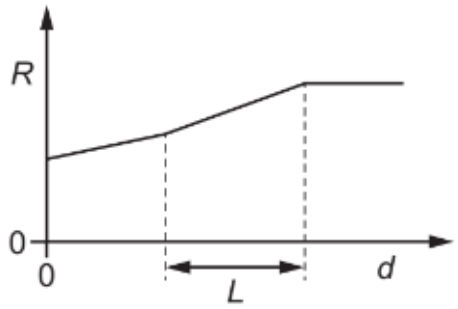


The cylinder, of height *L*, is slowly raised vertically by lifting the newton meter. Drag forces are assumed to be negligible.

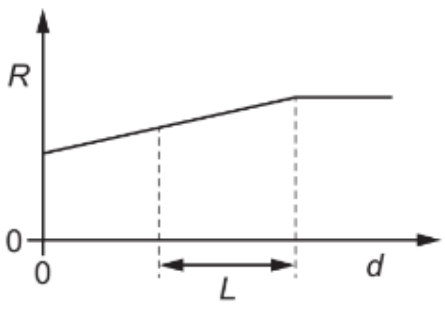
As the base of the cylinder moves from line X in the water to line Y above the surface of the water, the reading *R* on the newton meter is recorded. Assume that the velocity of the cylinder is constant.

Which graph best shows the variation of *R* with the distance *d* of the base of the cylinder from line X?

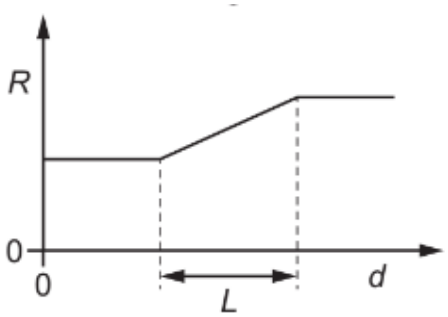
A



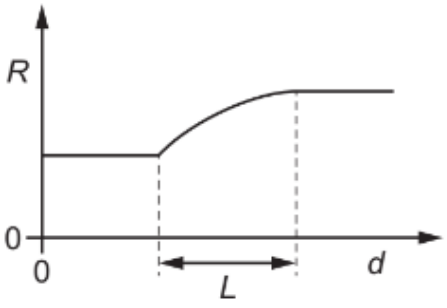
B



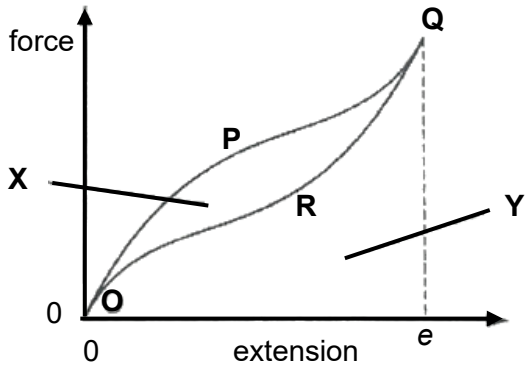
C



D



7 A rubber band is stretched and then relaxed to its original length.
The diagram shows the force-extension graph for this process.



As the force is increased, the curve follows the path OPQ to extension *e*. As the force is reduced, the curve follows the path QRO to return to zero extension.
The area labelled X is between the curves OPQ and QRO.
The area labelled Y is bounded by the curve QRO and the horizontal axis.
Which statement about the process is correct?

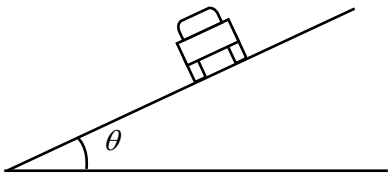
A X is the elastic potential energy stored in the rubber band when it is stretched to *e*.

B (X + Y) is the minimum energy required to stretch the rubber band to *e*.

C (Y – X) is the net work done on the rubber band during the process.

D Y is the energy which heats the rubber band as it is stretched to *e*.

8 A section of highway which has a circular curve, is inclined at an angle θ to the horizontal.
When a car is moving at a particular speed *v*, no frictional force along the road is needed to navigate this bend.



Which of the following correctly describes the directions of the frictional forces on the car along the incline?

	when speed is below *v*	when speed is above *v*
A	upwards along the incline	upwards along the incline
B	upwards along the incline	downwards along the incline
C	downwards along the incline	downwards along the incline
D	downwards along the incline	upwards along the incline

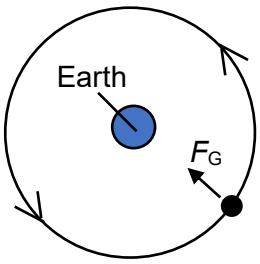
9 A satellite is orbiting the Earth at a constant angular velocity.

The gravitational force on the satellite is F_G.

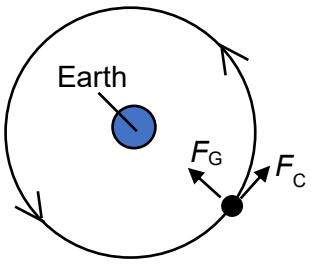
The centripetal force required to maintain the satellite in orbit is F_C.

Which diagram shows the force, or forces, acting on the orbiting satellite?

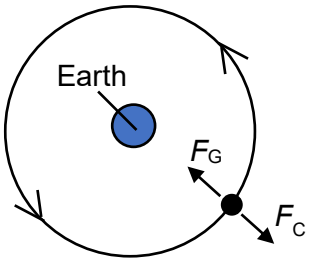
A



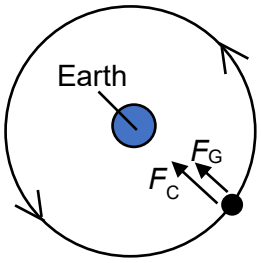
B



C



D



10 Mars has a diameter approximately 0.5 times the diameter of the Earth, and the mass of Mars is about 0.1 times the mass of the Earth.

The gravitational potential at the Earth's surface is -63 MJ kg^{-1}.

What is an approximate value for the gravitational potential at the surface of Mars?

A -13 MJ kg^{-1} **B** -25 MJ kg^{-1} **C** -95 MJ kg^{-1} **D** -320 MJ kg^{-1}

11 Cooling water enters the heat exchanger in the turbine hall of a nuclear power station at 6.0 °C and leaves at 14.0 °C. The rate of heat removal by the water is 6.7 x 10^9 J per minute.

The specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

What is the rate of water flow?

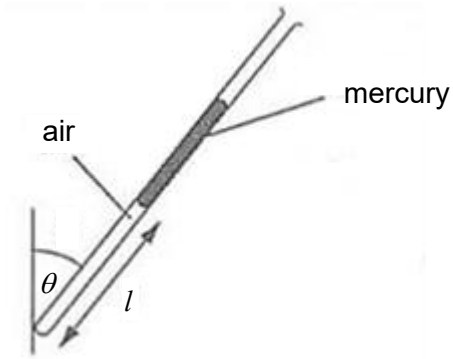
A $\frac{6.7\times10^9\times60}{4200\times8.0}$ kg s^{-1}

B $\frac{6.7\times10^9}{4200\times8.0\times60}$ kg s^{-1}

C $\frac{4200\times8.0}{6.7\times10^9\times60}$ kg s^{-1}

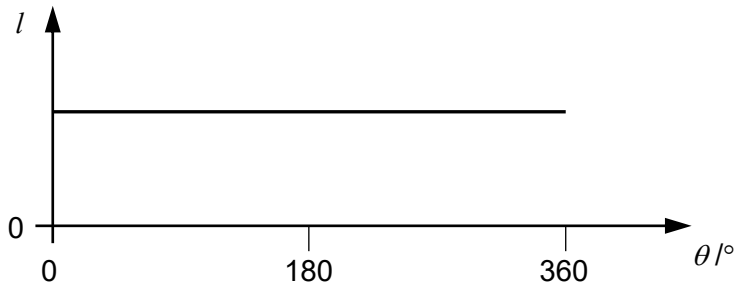
D $\frac{4200\times8.0\times60}{6.7\times10^9}$ kg s^{-1}

12 A narrow tube, closed at one end, contains a column of dry air that is trapped by mercury.

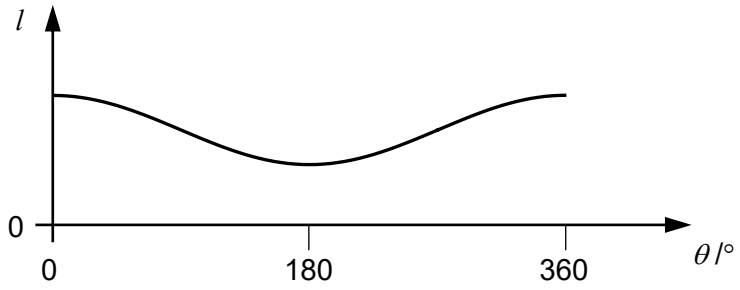


Which diagram best shows the variation of the length l of the air column with the angle θ of the tube to the vertical?

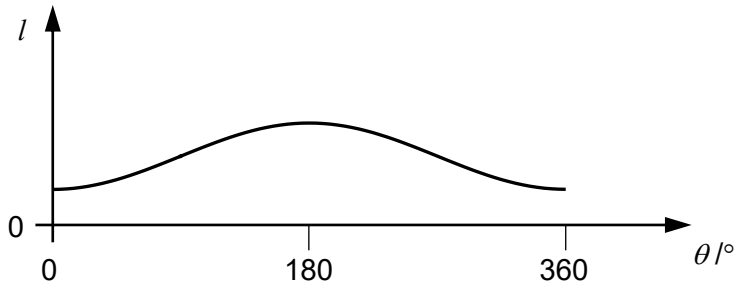
A



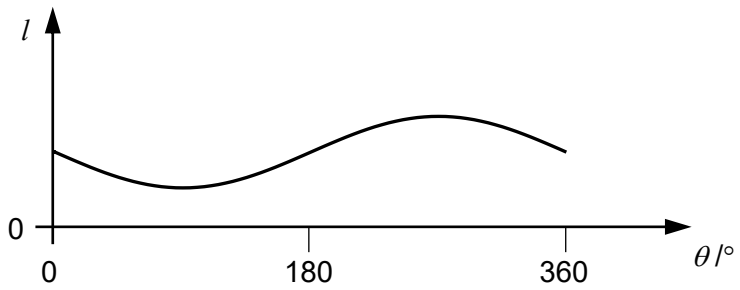
B



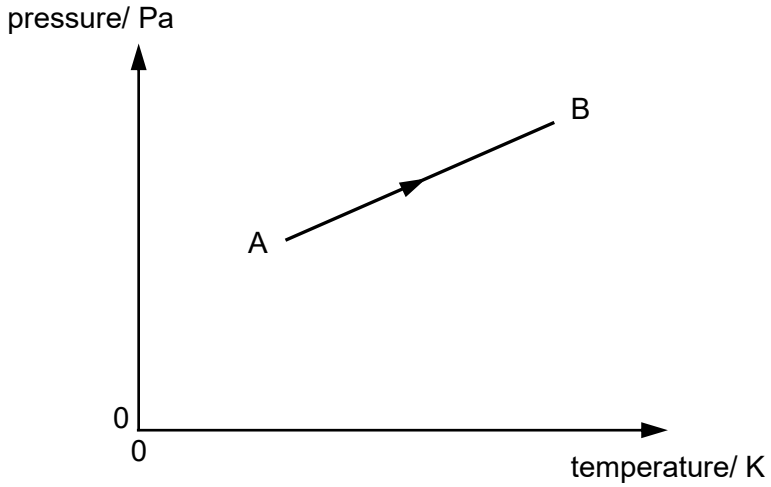
C



D



13 A fixed mass of an ideal gas changes from state A to state B via the process as shown in the pressure – temperature diagram below.



Which of the following statements gives the correct description of the process?

A Positive work is done on the gas and heat is supplied to the gas.

B Positive work is done on the gas and heat is released by the gas.

C Positive work is done by the gas and heat is supplied to the gas.

D Positive work is done by the gas and heat is released by the gas.

14 A simple pendulum is 1.0 m long and oscillates with simple harmonic motion of angular amplitude 0.050 rad and period 2.0 s.

What is the angular speed of the pendulum bob when the angular displacement is 0.030 rad?

A 0.0010 rad s^{-1}

B 0.020 rad s^{-1}

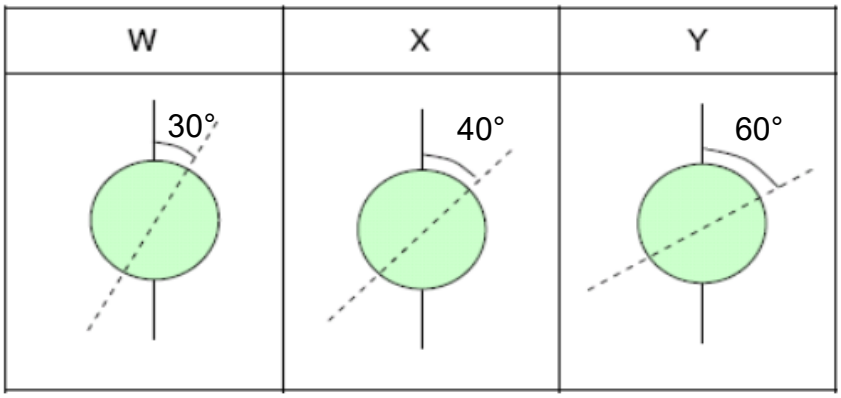
C 0.050 rad s^{-1}

D 0.13 rad s^{-1}

15 The table below shows three polarisers W, X and Y.

A beam of unpolarised light of intensity I_0 is incident normally onto the surface of polariser W, which then passes through polariser X and eventually emerges from polariser Y.

The polarising direction of each polariser is indicated by a dashed line.



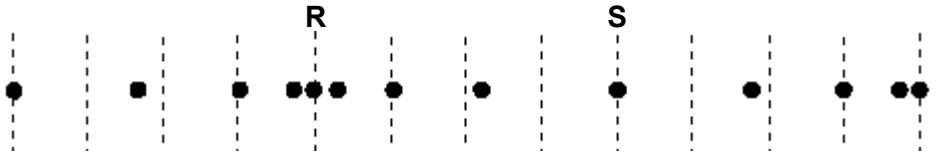
The transmitted intensity of light after the light emerges from polarizer Y is

A 0.32 I_0 **B** 0.43 I_0 **C** 0.64 I_0 **D** 0.86 I_0

16 The figure shows the positions of particles of a medium at a particular instant when a longitudinal wave, travelling from left to right, passes through the medium.

Before the wave arrived, the particles were all spaced equally apart on the vertical dotted lines shown.

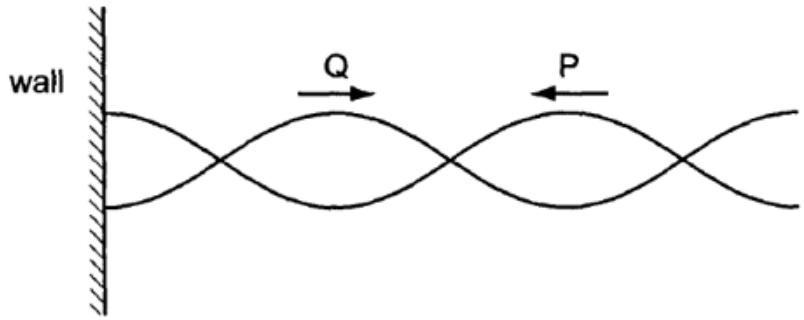
At the instant shown, particles R and S are passing through their original undisturbed positions.



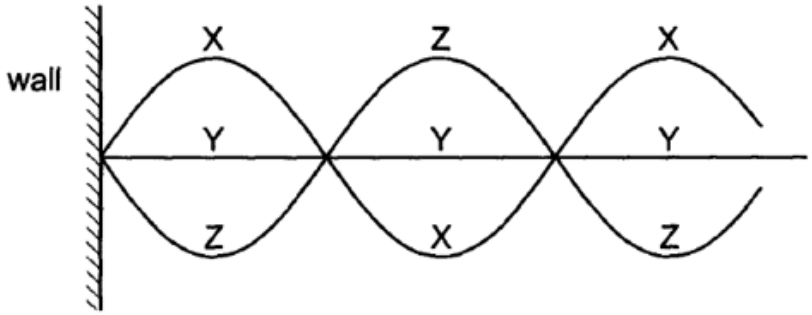
Which of the following describes the direction of the velocities of particles R and S at the instant shown?

	velocity direction for R	velocity direction for S
A	right	right
B	right	left
C	left	left
D	left	right

17 A water wave P is incident on a wall. A reflected wave Q moves away from the wall. The diagram illustrates the position of P and Q at time zero.



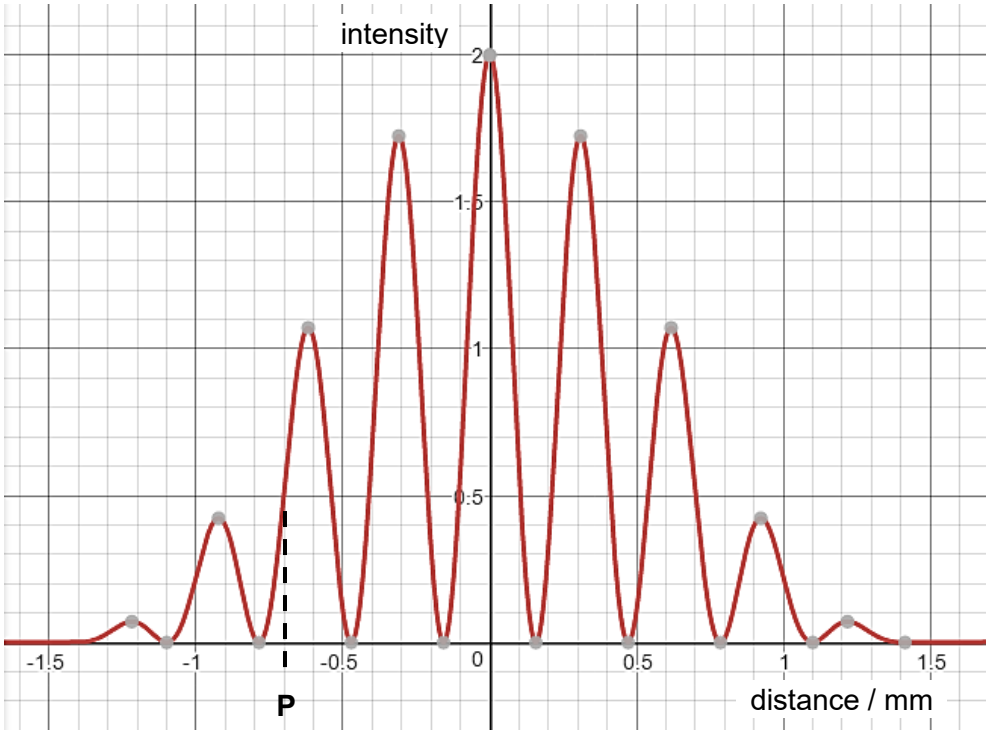
X, Y and Z represent three positions of the resulting stationary wave.



In which order does the stationary wave have these positions, beginning at time zero?

A X Y Z Y
B Y X Y Z
C Y Z Y X
D Z Y X Y

18 Coherent light is incident normally on a double slit. The graph shows the variation of the intensity of light on a screen placed far away from the double slit.



What is the phase angle between the waves from the double slit when the waves meet at point P?

A 0.45 rad **B** 1.43 rad **C** 1.71 rad **D** 4.45 rad

19 In discussing electric fields, the terms ‘electric field strength’, ‘electric potential’ and ‘potential gradient’ are used.

Which statement about these terms is correct?

A Electric field strength at a point is the work done per unit positive charge in bringing a test charge from infinity to the point.

B Electric potential and potential gradient are both scalar quantities.

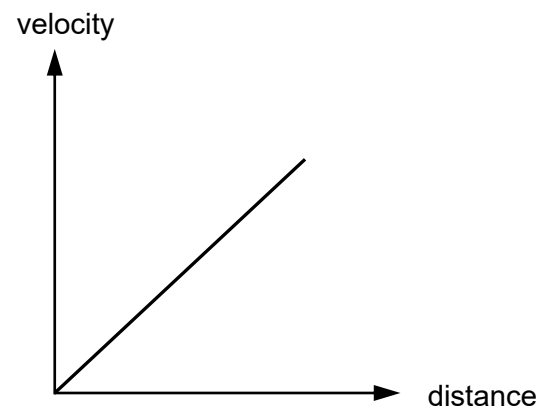
C The potential gradient at a point is numerically equal to the electric field strength at that point.

D A potential gradient of one volt exists between any two points, if one joule of work is done in transporting one coulomb of charge between the points.

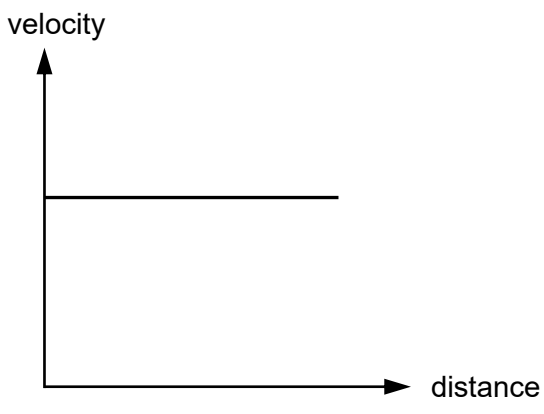
20 An electron is initially at rest in a uniform electric field.

Which graph shows the variation with distance of the velocity of the electron?

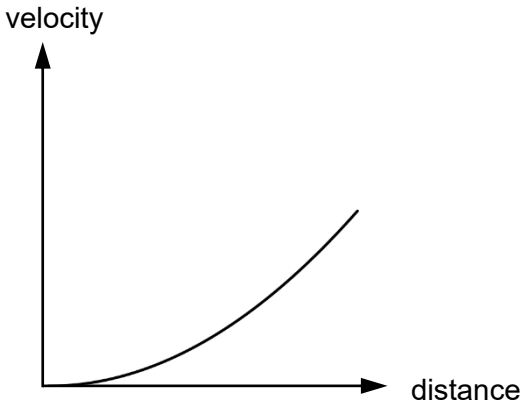
A



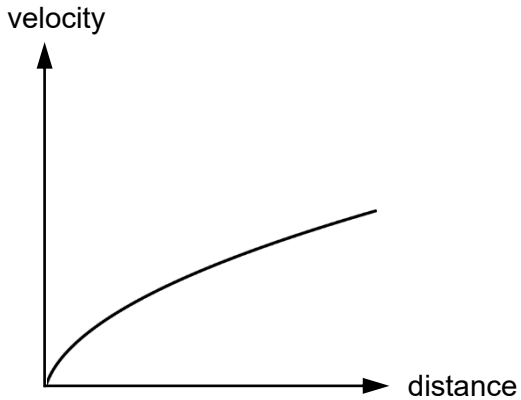
B



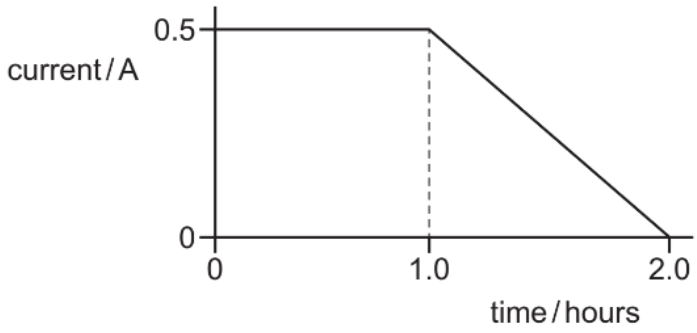
C



D



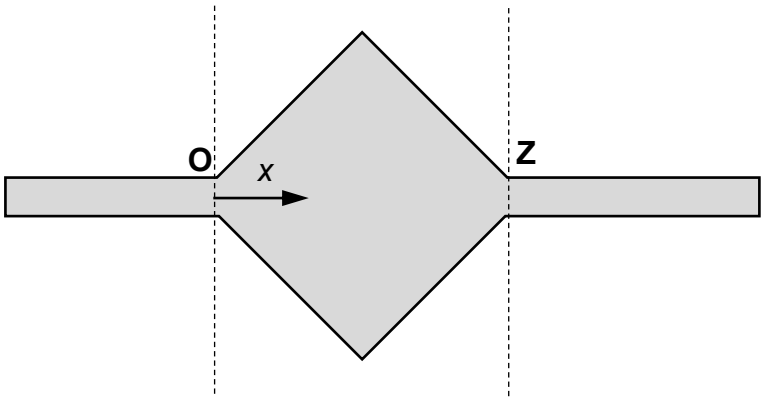
21 A mobile phone battery is charged by connecting it to a constant potential difference of 5.0V. After a time of 1.0 hour, the initial current of 0.50 A slowly decreases to zero, as shown.



What is the best estimate of the energy transferred to the battery during the time of 2.0 hours shown in the graph?

A 2700 J **B** 9000 J **C** 14 000J **D** 18 000J

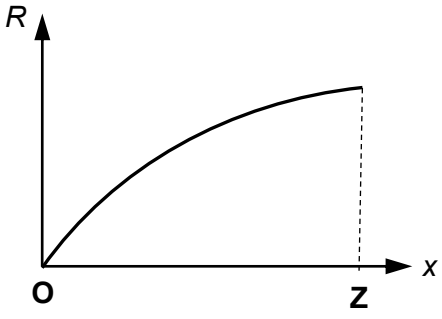
22 A flat conductor which of uniform thickness and resistivity, has the shape shown below.



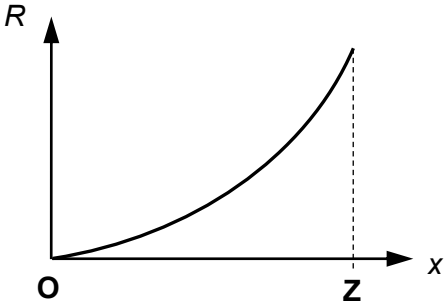
top view

Which of the following graphs best represents the variation of the resistance R with the distance x from O to Z?

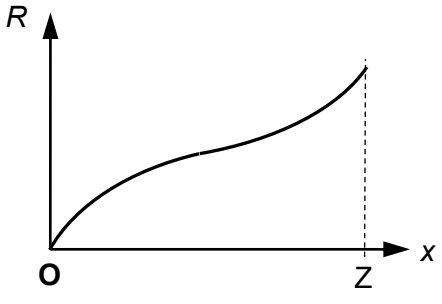
A



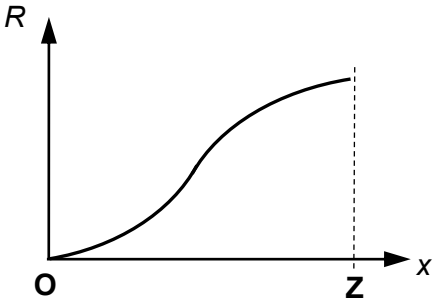
B



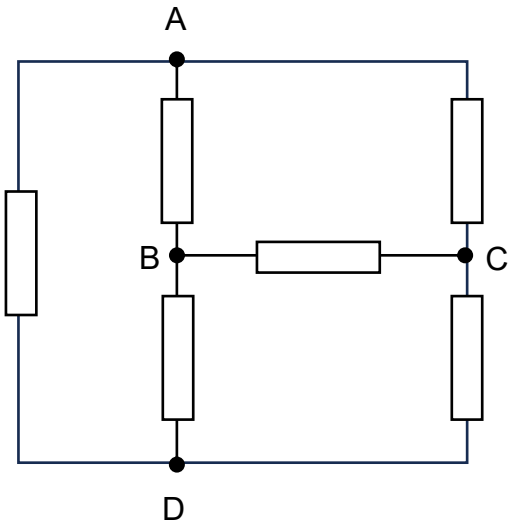
C



D



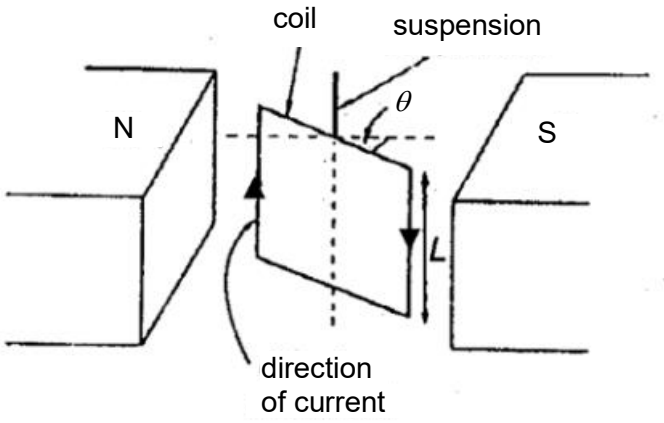
23 Six identical resistors are arranged in a circuit as shown below. Each resistor has a resistance of 6.0 Ω.



What is the effective resistance between points A and D?

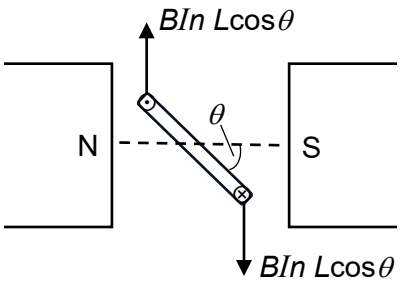
A 1.0 Ω **B** 2.0 Ω **C** 3.0 Ω **D** 6.0 Ω

24 A current I is carried by a square coil of *n* turns and side *L*, suspended vertically as shown in a uniform horizontal magnetic field of flux density *B*.

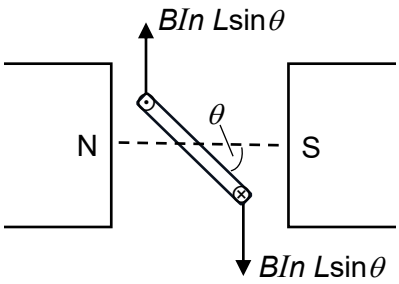


Which one of the plan diagrams correctly shows the magnitude and direction of the forces acting on the vertical sides of the coil?

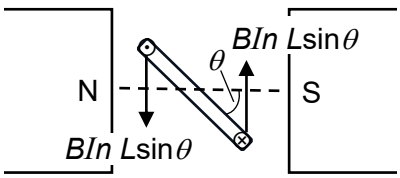
A



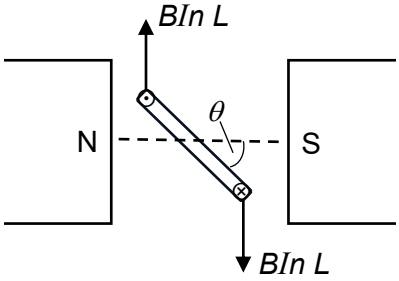
B



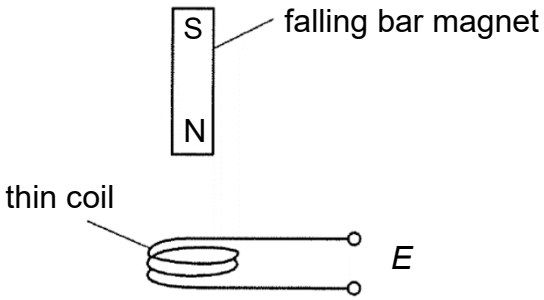
C



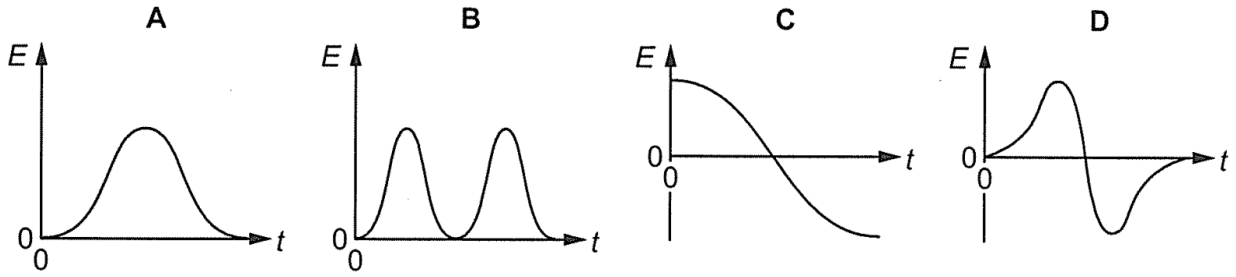
D



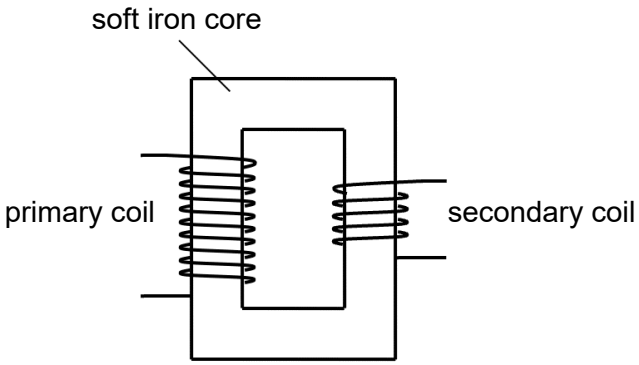
25 In an experiment to record electrical events of short duration, a student drops a bar magnet through a very thin, horizontal coil, as shown.



Which graph best represents how the induced e.m.f. *E* in the coil on the magnet varies with time *t*?



26 The diagram shows a transformer. The primary coil has 100 turns and the secondary coil has 50 turns. The magnetic flux within the primary coil is 0.54 Wb.



What is the average potential difference across the ends of the secondary coil when the flux in the primary coil is reduced to zero in a time of 0.18 s?

A 75 V **B** 150 V **C** 300 V **D** 450 V

27 Fig. (a) and Fig. (b) show two separate types of alternating potential difference with the same peak voltage (V_P) applied across a load resistor R.

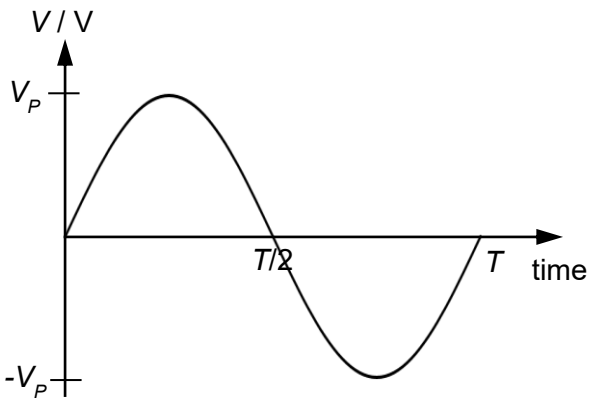


Fig. (a)

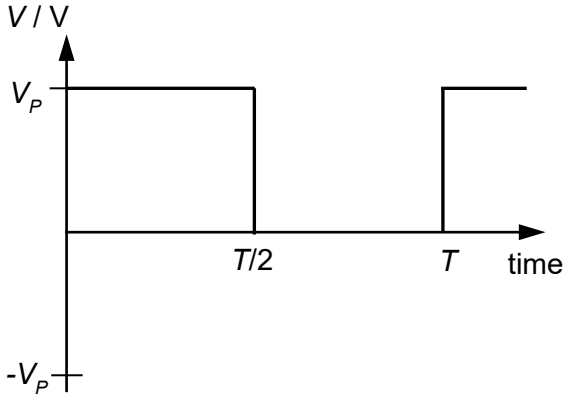


Fig. (b)

What is the ratio of $\frac{\text{root-mean-square potential difference for (a)}}{\text{root-mean-square potential difference for (b)}}$?

A 0.5 **B** 0.7 **C** 1 **D** 1.4

28 When electromagnetic radiation falls on a particular metal surface, photoelectrons may be emitted. The table below gives the maximum kinetic energy of the photoelectrons emitted at a given frequency.

frequency of incident radiation	maximum kinetic energy of photoelectrons
1.0×10^{15} Hz	2.6×10^{-19} J
2.5×10^{15} Hz	E

What is the value of E?

A 1.3×10^{-18} J **B** 9.9×10^{-19} J **C** 7.3×10^{-19} J **D** 6.5×10^{-19} J

29 A uranium-235 nucleus ($^{235}_{92}U$) undergoes fission, producing nuclei of lanthanum-146 ($^{146}_{57}La$) and bromine-87 ($^{87}_{35}Br$). The binding energies per nucleon of these nuclides are shown below.

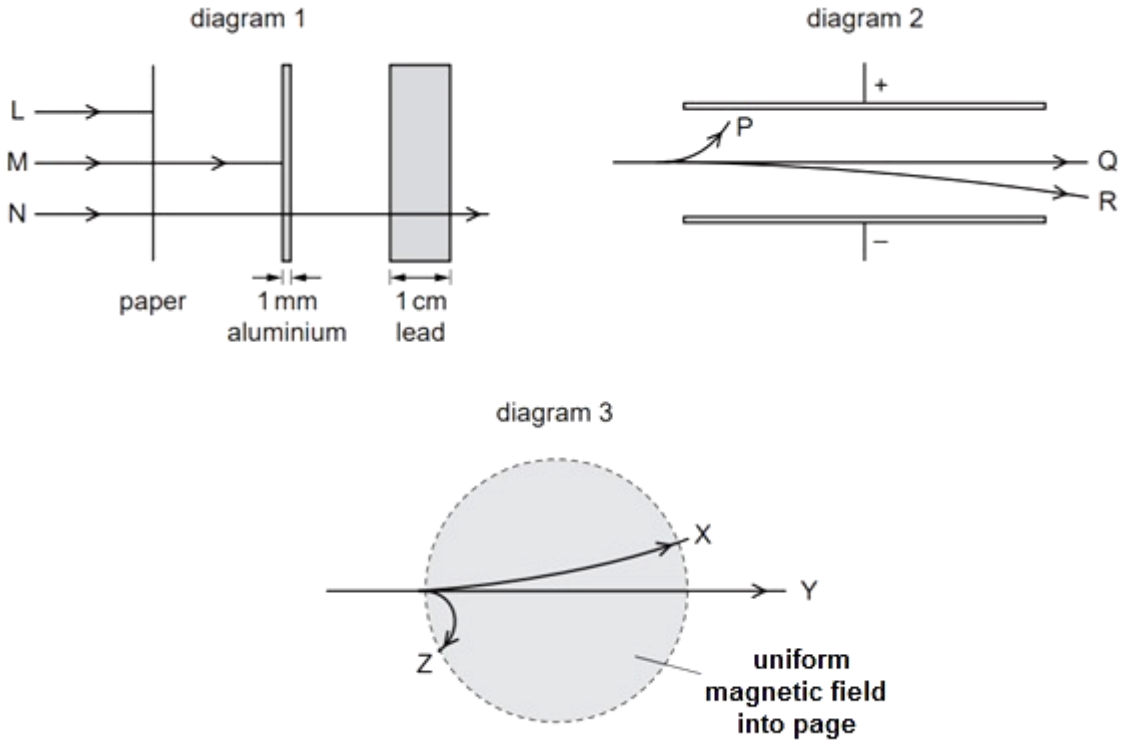
nuclide	binding energy per nucleon / MeV
$^{235}_{92}U$	7.6
$^{146}_{57}La$	8.2
$^{87}_{35}Br$	8.6

What is the energy released from this reaction?

A 9.2 MeV **B** 69.2 MeV **C** 90.2 MeV **D** 159 MeV

30 Alpha, beta and gamma radiations are absorbed to different extents in solids and behave differently in an electric and magnetic field.

The diagrams below illustrate these behaviours.



Which three labels on these diagrams refer to the **same** type of radiation?

A L, P, Z **B** L, R, X **C** M, P, X **D** N, R, X