RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 1
22 SEP 2023

1 HOUR

CANDIDATE NAME									
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	2	J						

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

There are **thirty** questions in this section. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Optical 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 on the Question Paper.

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

Hand in the Optical Answer Sheet.

This document consists of 18 printed pages.

Data

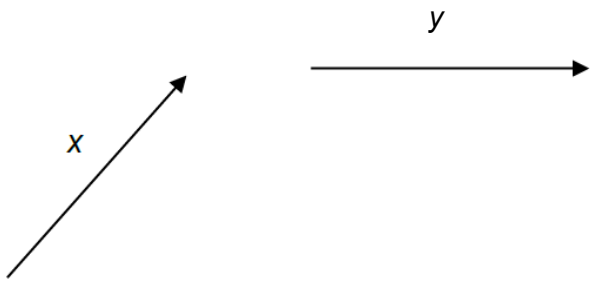
speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_O	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_O	=	8.85×10^{-12} F m^{-1}
			$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-1}
gravitational constant,	G	=	6.67×10^{-11} N m^2 kg^{-2}
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

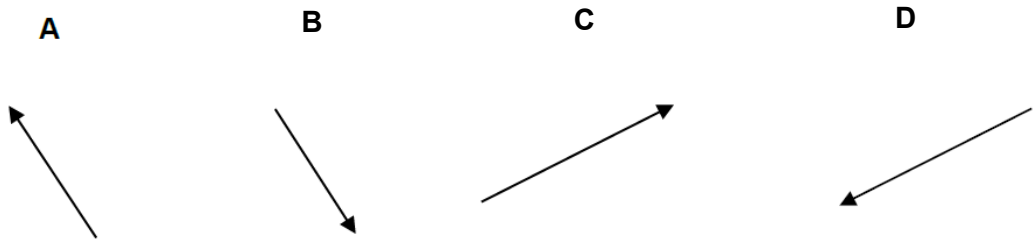
uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -Gm/r$
temperature	T / K = T / °C + 273.15
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
mean translational kinetic energy of an ideal 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.	$v = v_0 \cos \omega t$
	$= \pm\omega\sqrt{x_0^2 - x^2}$
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	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Answer Sheet**.

1 The initial velocity of an object is shown by the vector *x*. The final velocity of the object is shown by the vector *y*.



Which arrow best shows the change in velocity of the object?

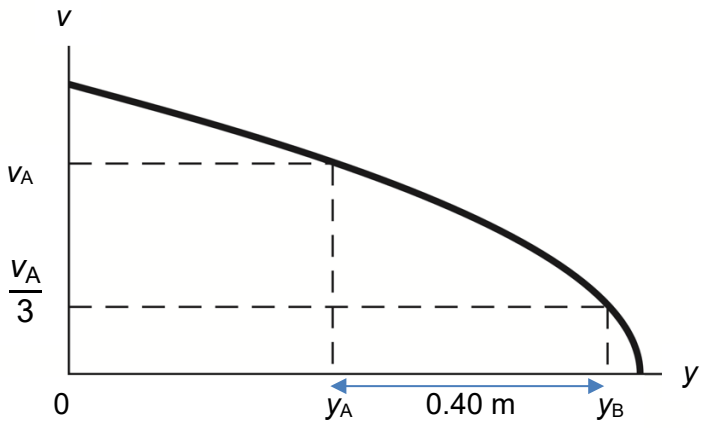


2 The table below shows the estimates of some physical quantities.

Which row is **not** a reasonable estimate?

	quantity	value
A	power consumption of a domestic aircon turned on for 8 hours	20 kW
B	total surface area of an adult human	2 m^2
C	kinetic energy of an Olympic sprint runner	5000 J
D	pressure at the bottom of a public swimming pool	10 kPa

3 The figure shows the variation of speed v with displacement y of a ball tossed directly upwards. The distance between y_A and y_B is 0.40 m. The speed at height y_A is v_A and the speed at y_B is $\frac{v_A}{3}$.



What is speed v_A ?

A 2.6 m s^{-1} **B** 2.7 m s^{-1}

C 3.0 m s^{-1} **D** 8.9 m s^{-1}

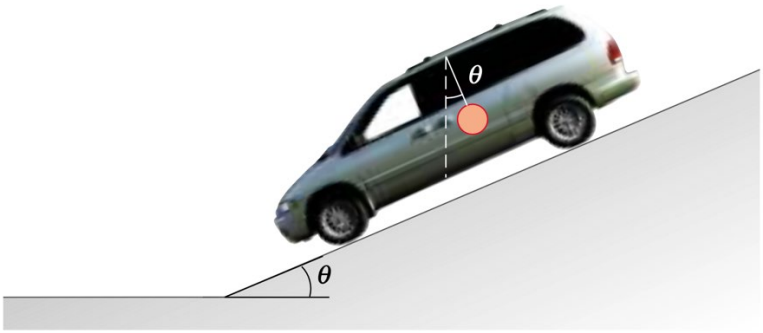
4 A particle X, with kinetic energy E_k, collides with a stationary particle Y. Both particles have the same mass. After colliding, X and Y travel together as a single larger particle.

How much kinetic energy is lost in the collision?

A 0 **B** $\frac{E_k}{4}$

C $\frac{E_k}{2}$ **D** $\frac{3E_k}{4}$

5 The figure shows a car accelerating down a slope, going from rest to 30 m s^{-1} in 6.0 s. The slope is angled at θ above the horizontal.



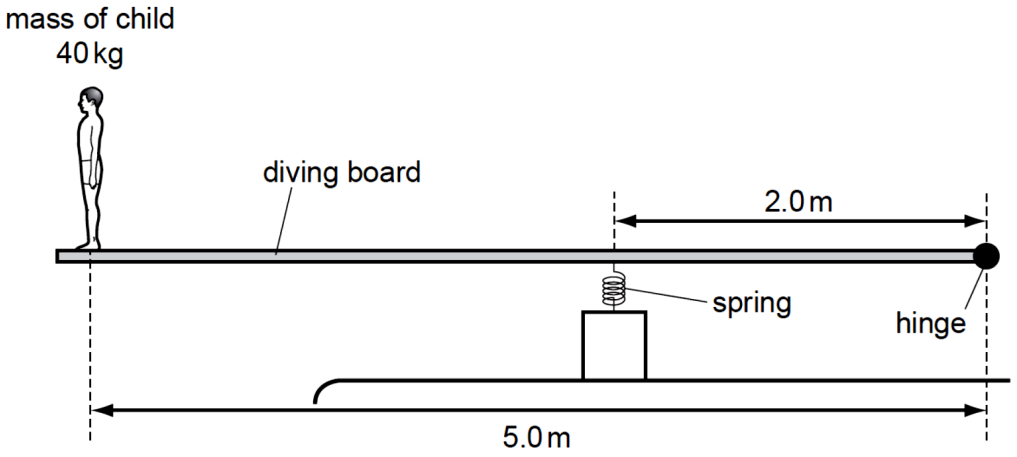
During the acceleration, a ball hangs by a string from the car's ceiling. The acceleration is such that the string remains perpendicular to the ceiling.

What is the angle θ?

A 0 **B** 27°

C 31° **D** 59°

6 A diving board of length 5.0 m is hinged at one end and supported 2.0 m from this end by a spring of spring constant 10 kN m^{-1}. A child of mass 40 kg stands at the far end of the board.



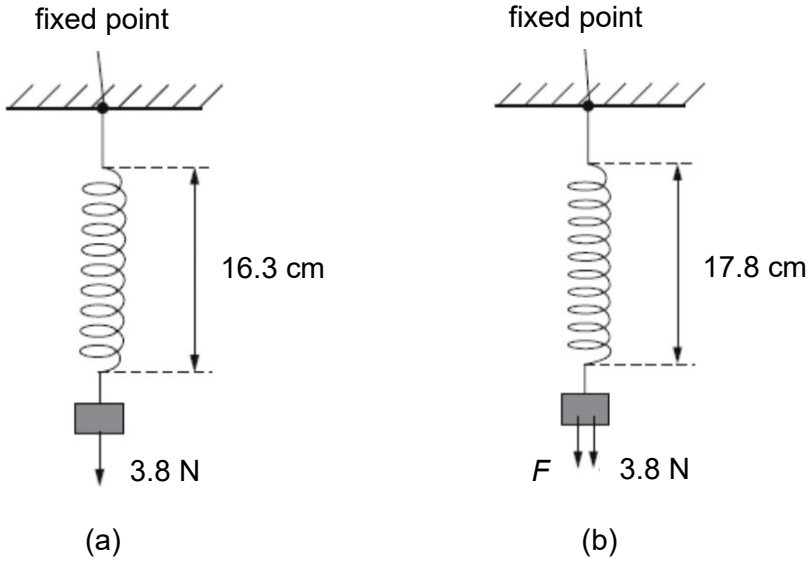
What is the extra compression of the spring caused by the child standing on the end of the board?

A 1.0 cm **B** 1.6 cm

C 9.8 cm **D** 16 cm

7 A mass of weight 3.8 N is suspended on a spring of unstretched length 14.2 cm and spring constant 181 N m^{-1}. The length of the spring is 16.3 cm as shown in (a).

An additional force *F* then extends the spring so that its length becomes 17.8 cm as shown in (b).



What is the work done by *F*?

A 0.057 J **B** 0.020 J

C 0.077 J **D** 0.13 J

8 A car of mass 800 kg is moving at 20 m s^{-1} along a horizontal road. The total resistive force acting on the car is 200 N.

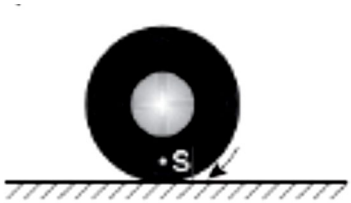
It begins to accelerate at 0.50 m s^{-2}.

What is the total output power developed by the car at its initial acceleration?

A 2.0 kW **B** 4.0 kW

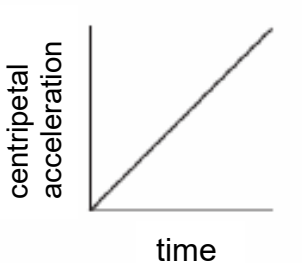
C 8.0 kW **D** 12 kW

9 Point S is a point on a car tyre rotating at a constant rate as shown in the diagram.

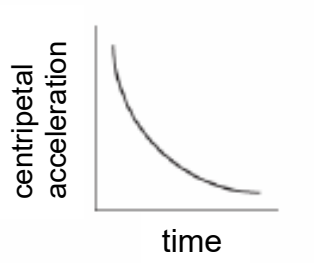


Which graph best represents the magnitude of the centripetal acceleration of point S as a function of time?

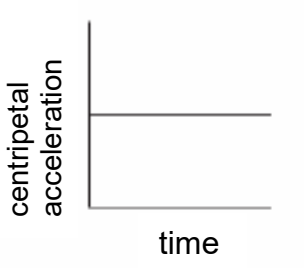
A



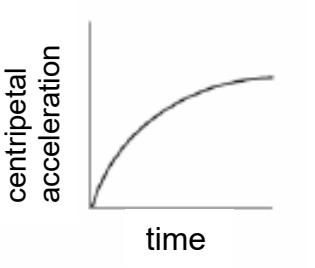
B



C



D



10 A heater in an electric kettle has a power of 2400 W.

When the water in the kettle is boiling at a steady rate, the mass of water evaporated in 120 seconds is 0.106 kg.

What is the rate of loss of thermal energy to the surrounding during the boiling process?

Take latent heat of vaporisation of water to be 2.26×10^6 J kg^{-1}.

A 400 W

B 4400 W

C 48000 W

D 53000 W

11 The number of hydrogen molecules per cm^3 in a container is 6.80×10^{15}. The root-mean-square speed of the molecules is 1.90×10^3 m s^{-1}. The mass of one mole of hydrogen molecule is 2.02 g.

What is the pressure exerted by the gas in the container?

A 0.014 Pa

B 26 Pa

C 27 Pa

D 82 Pa

12 An air bubble of volume 20 cm^3 is at the bottom of a lake 40 m deep where the temperature is 4.0 °C.

The bubble rises to the surface which is at a temperature of 20 °C.

Take the temperature of the bubble's air to be the same as that of the surrounding water.

Take the atmospheric pressure to be 1.0×10^5 Pa and density of water to be 1.2 g cm^{-3}.

What is the volume of the bubble as it reaches the surface?

A 3.7 cm^3

B 100 cm^3

C 120 cm^3

D 570 cm^3

13 Taking the Earth to be a perfect sphere of uniform density rotating about its polar axis, which of the following statements concerning the observed acceleration due to free fall *a* at the surface of the Earth is true?

A The value of *a* at the equator is larger than that at the poles.

B If the rate of rotation of the Earth decreases, the value of *a* at the equator increases.

C If the radius of the Earth increases with its density remaining unchanged, the value of *a* at the poles decreases.

D If the radius of the Earth increases with its density remaining unchanged, the value of *a* at the equator decreases.

14 An astronaut with a mass of 60 kg works on a geostationary satellite that is 3.59×10^7 m from the surface of Earth. The mass and radius of Earth are given as 6.0×10^{24} kg and 6400 km respectively.

What is the gravitational force acting on the astronaut?

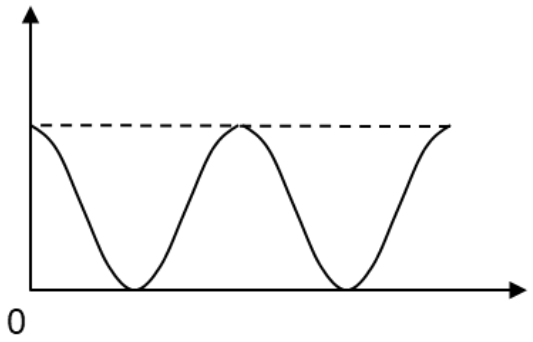
A 13.4 N

B 5.86 N

C 589 N

D 600 N

15 The diagram shows one possible graph for an object undergoing simple harmonic motion.



Which quantities could have been plotted to produce this graph?

A velocity vs time

B potential energy vs time

C acceleration vs displacement

D kinetic energy vs displacement

16 Which of the following statements is *not true* for an oscillating body when light damping is present?

A The presence of light damping changes the period of oscillation.

B The damping force is always in the opposite direction to the velocity of the body.

C The presence of light damping changes the maximum potential energy of the body.

D The damping force is always in the opposite direction to the acceleration of the body.

17 When a beam of unpolarised light is incident normally on a polarising filter, what happens to the intensity of the transmitted light?

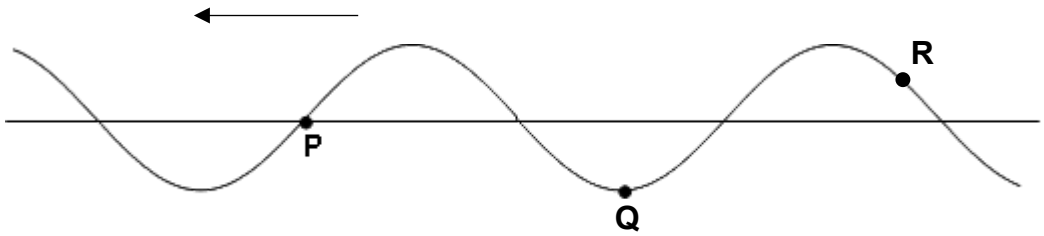
A The intensity is halved.

B The intensity is doubled.

C The intensity remains the same.

D The value of the intensity cannot be determined unless more information is given.

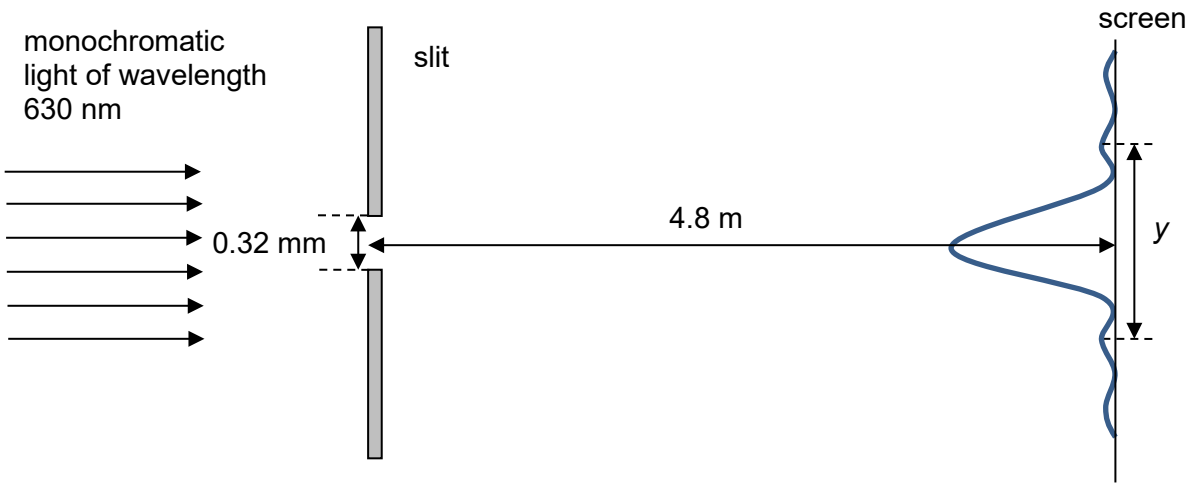
18 The diagram shows a transverse wave on a rope. The wave is travelling from right to left. At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.



Which of the following describes the direction of motion, if any, of the points P, Q and R at this instant?

	P	Q	R
A	downwards	stationary	upwards
B	stationary	downwards	downwards
C	stationary	upwards	upwards
D	upwards	stationary	downwards

19 A laser light of wavelength 630 nm is passed normally through a narrow slit. A screen is placed parallel to the slit 4.8 m away from the slit. An interference pattern is formed on the screen. The width of the slit is 0.32 mm. The distance *y* is the distance between the two first maxima.



What is the value of *y*?

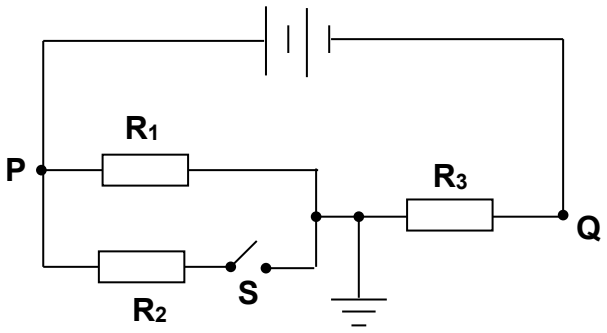
A 4.7 mm

B 9.5 mm

C 19 mm

D 28 mm

20 Resistor R_1, R_2 and R_3 are connected to a battery of constant e.m.f. with negligible internal resistance as shown below. Resistance of R_1 is twice the resistance of R_2. R_2 and R_3 have identical resistance.



What will happen to the electric potential at P and at Q when the switch S is closed?

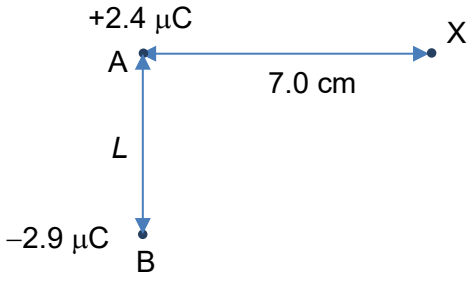
	potential at P	**potential at Q**
A	unchanged	unchanged
B	increases	increases
C	increases	decreases
D	decreases	decreases

21 A beam of beta particles constitutes a current of 10.0 μA. Given that these beta particles travel at a speed of 2.5×10^7 m s^{-1}, what is the average number of beta particles found in one centimetre length of this beam?

A 2.5×10^4 **B** 4.0×10^4

C 2.5×10^6 **D** 4.0×10^6

22 A point charge of +2.4 μC is placed at point A. Point X is 7.0 cm to the right of point A as shown.



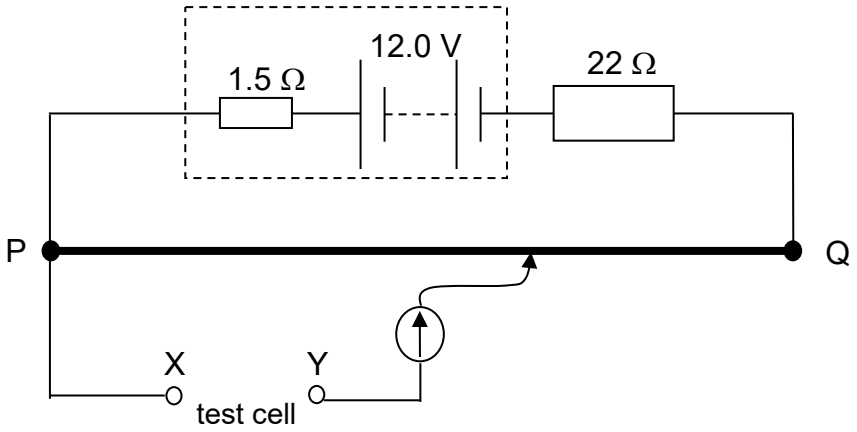
A point charge of −2.9 μC is placed at point B, distance *L* below point A.

What must be the distance *L* for point X to have zero potential?

A 4.7 cm **B** 5.8 cm

C 8.4 cm **D** 11 cm

23 A student attempts to measure the e.m.f. of a test cell using a potentiometer circuit as shown below.



The wire PQ has a resistance of 3.0 Ω and the driver cell has an e.m.f. of 12.0 V and internal resistance of 1.5 Ω. He was unable to obtain an observable balance length on PQ when he connected the circuit. The tutor he consulted told him that the test cell has an e.m.f. of a few millivolts.

What could he do in order to obtain an observable balance length?

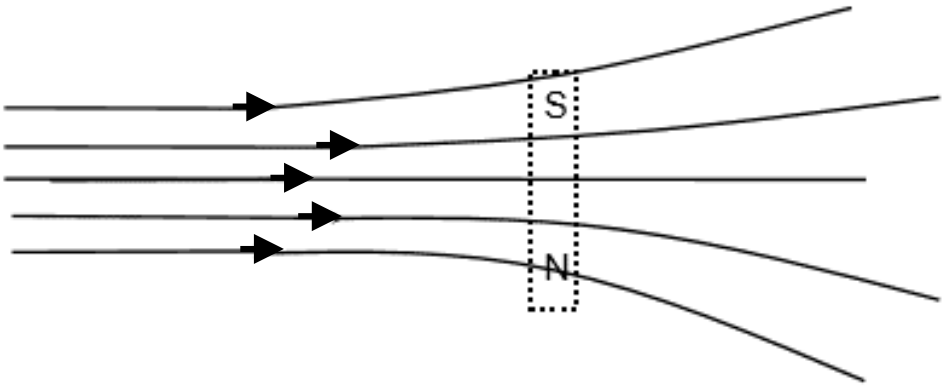
A Use a driver cell of e.m.f. 20 V.

B Reverse the polarity of the test cell at XY.

C Change the wire PQ to a wire of resistance 20 Ω.

D Change the resistance of the connected resistor to 1 kΩ.

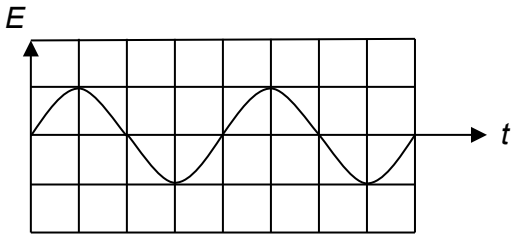
24 A bar magnet is to be placed in a non-uniform magnetic field as shown.



Which row of the table describes the subsequent motion of the magnet?

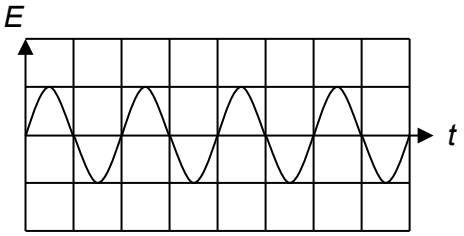
	rotation	movement
A	anticlockwise	to the left
B	anticlockwise	to the right
C	clockwise	to the left
D	clockwise	to the right

25 When a coil is rotated in a magnetic field, the induced e.m.f. E varies with time as shown below.

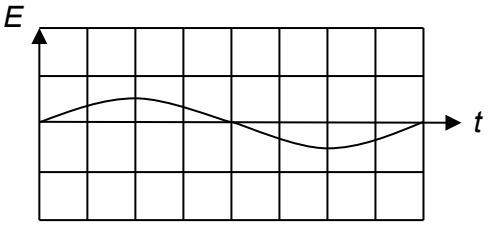


Which of the following graphs, drawn to the same scale, would be obtained if the speed of rotation of the coil is halved?

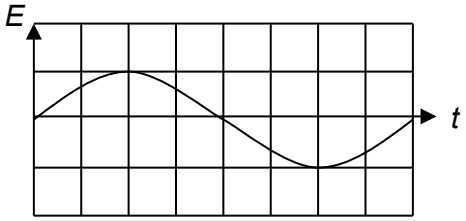
A



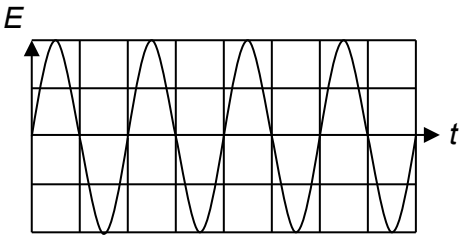
B



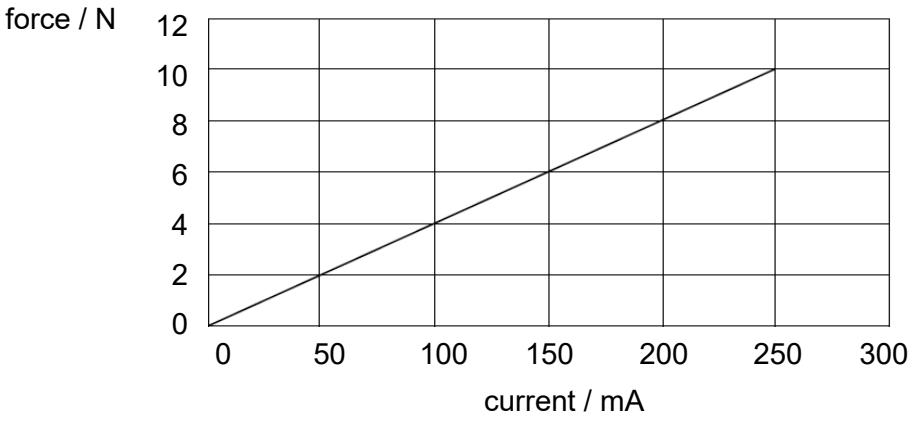
C



D



26 A straight wire which is part of a closed circuit, is positioned at right angles to a uniform magnetic field. The graph below shows the variation of the magnetic force acting on the wire with respect to the current flowing in the wire.



The circuit is subsequently switched off and the same piece of wire is then vibrated at a frequency of 80 Hz and amplitude of 24 mm. The plane of vibration is assumed to always remain perpendicular to the magnetic field.

What is the maximum e.m.f. induced across the wire?

A 0.077 V

B 0.48 V

C 77 V

D 480 V

27 When a steady direct current of value I passes through a heating element of resistance R, the time taken to raise the temperature of water of mass m by 10 K is T.

When a sinusoidal alternating current with a peak current of value I passes through a heating element of resistance $2R$, what is the time taken to raise water of mass m by 10 K?

A $\sqrt{2}\,T$

B T

C $\frac{T}{2}$

D $\frac{T}{4}$

28 Electrical power of 1.0 MW from a substation is to be transmitted at 66 kV r.m.s. via a 5.0 km long cable to a factory.

If the cable resistance is 1.0 Ω km^{-1}, what is the power loss in the transmission cable?

A 1400 W **B** 1100 W

C 460 W **D** 230 W

29 The work function of a certain metal is 4.0×10^{-19} J. It is irradiated with ultra-violet radiation of wavelength 250 nm.

What is the maximum speed of the photoelectron emitted?

A 9.3×10^5 m s^{-1} **B** 9.4×10^5 m s^{-1}

C 1.3×10^6 m s^{-1} **D** 1.6×10^6 m s^{-1}

30 Which of the following samples of radioactive materials has the smallest rate of decay?

	half life / year	amount / 10^{-7} mol
A	0.42	0.02
B	5.3	0.4
C	620	80
D	6200	200

END OF PAPER