H2

TAMPINES JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME							
CIVICS GROUP	1	7				TUTOR NAME	

PHYSICS

9749/01

Paper 1 Multiple Choice

Wednesday, 19 September 2018

Additional Material: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** 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.

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.

Data

speed of light in free space	c =	3.00×10^{8} m s^{-1}
permeability of free space	μ_0 =	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0 =	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} Js
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	=	ρgh
gravitational potential	ϕ	=	$-\frac{GM}{r}$
temperature	T/K	=	T / °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	=	$v_0 \cos\omega t$
		=	$\pm\, \omega\sqrt{(x_0^2 - x^2)}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + ...$
resistors in parallel	$1 / R$	=	$1/R_1 + 1/R_2 + ...$
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	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

1 The relation between the velocity v of waves in the sea with its wavelength λ, the surface tension γ and density ρ of sea water is given by:

$$v = k\sqrt{\frac{\gamma}{\lambda\rho}}$$

where k = constant of proportionality.

If γ = (4.30 $\pm$ 0.05) N m^{-1}, ρ = (1450 $\pm$ 20) kg m^{-3} and the percentage uncertainty in λ is 5 %, what is the percentage uncertainty in the velocity of the waves?

A 2 % **B** 3 % **C** 4 % **D** 8 %

2 A cylindrical tube rolling down a slope of inclination θ moves a distance *L* in time *T*. The equation relating these quantities is

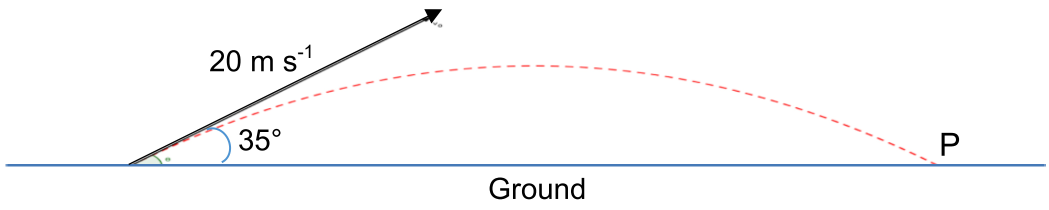
$$L\left(3 + \frac{a^2}{P}\right) = QT^2 \sin\theta$$

where *a* is the internal radius of the tube and *P* and *Q* are constants.

Which of the following gives the correct units for *P* and *Q*?

	units of *P*	units of *Q*
A	m	m s^{-2}
B	m^2	m s^{-2}
C	m^2	m^3 s^{-2}
D	m^2	m^2 s^{-2}

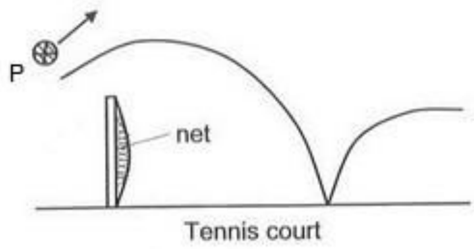
3 A student throws a stone 35° above the horizontal at an initial speed of 20 m s^{-1}. It travels in projectile motion until it hits the ground at P with the same speed.



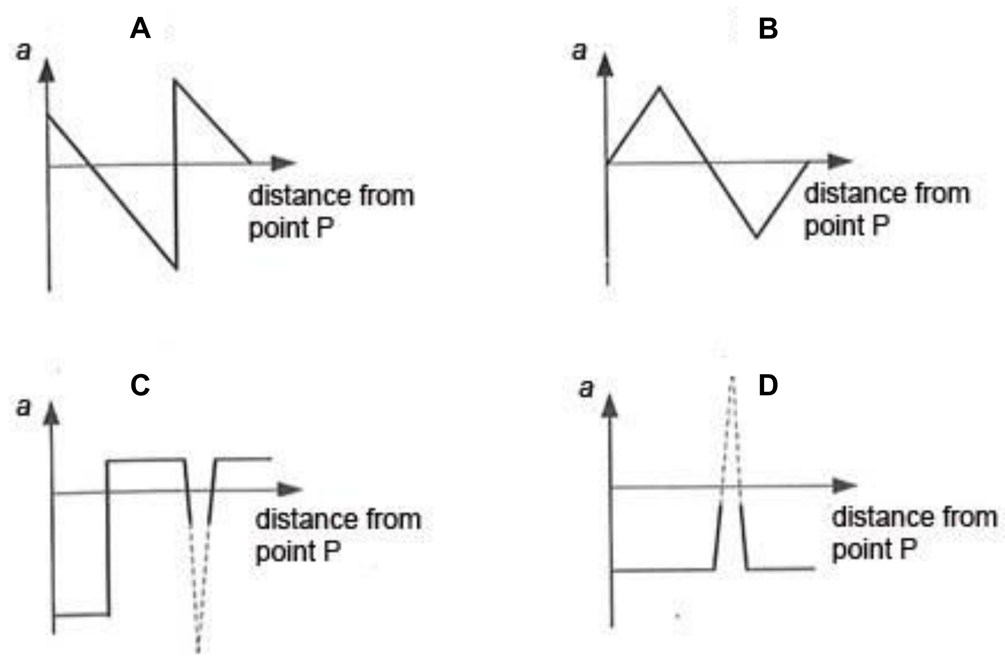
What is the magnitude of the change in velocity of the stone just before hitting the ground at P?

A 0.0 m s^{-1} **B** 20 m s^{-1} **C** 23 m s^{-1} **D** 33 m s^{-1}

4 The diagram below shows the trajectory of a tennis ball crossing the net and bouncing once from the ground.

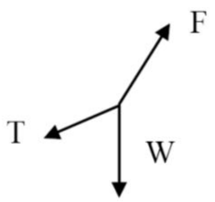


Which of the following graphs represents the variation with the horizontal distance from point P of the acceleration *a* of the ball, taking the upward direction as positive?

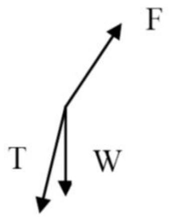


5 A kite is held stationary under the influence of three forces: the tension T in the string, the force F of the wind and the weight W of the kite. Which one of the following force diagrams could be correct?

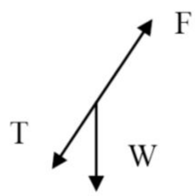
A



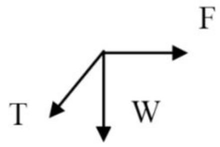
B



C

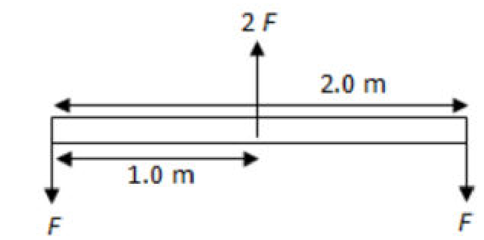


D

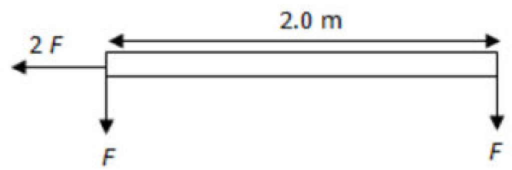


6 In which situation will the forces applied to the rigid object **not** produce a resultant motion?

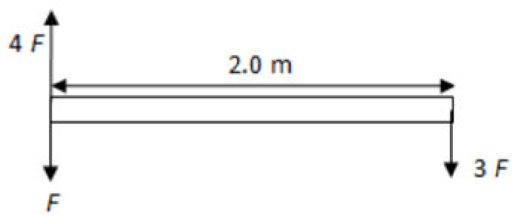
A



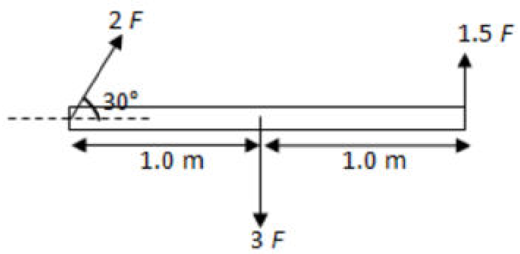
B



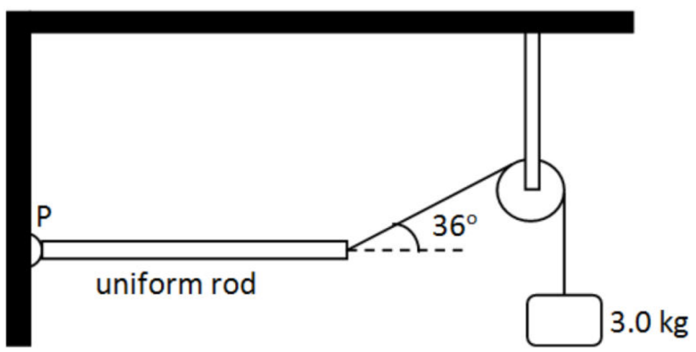
C



D

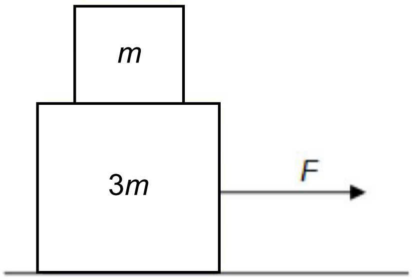


7 The diagram below shows a uniform rod freely pivoted at P. The rod is suspended horizontally, when a string tied to one end of the rod passes over a smooth pulley and is attached to a 3.0 kg mass. Determine the mass of the rod.



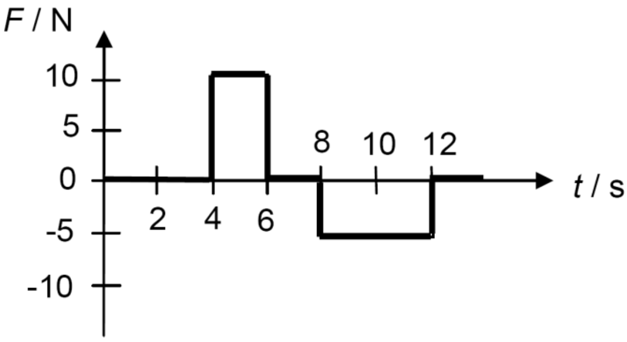
A 4.8 kg **B** 3.5 kg **C** 2.4 kg **D** 1.7 kg

8 A box of mass *m* rests on another box of mass 3*m*. The more massive box slides along a frictionless surface due to a pulling force *F*. Determine the friction between the boxes.

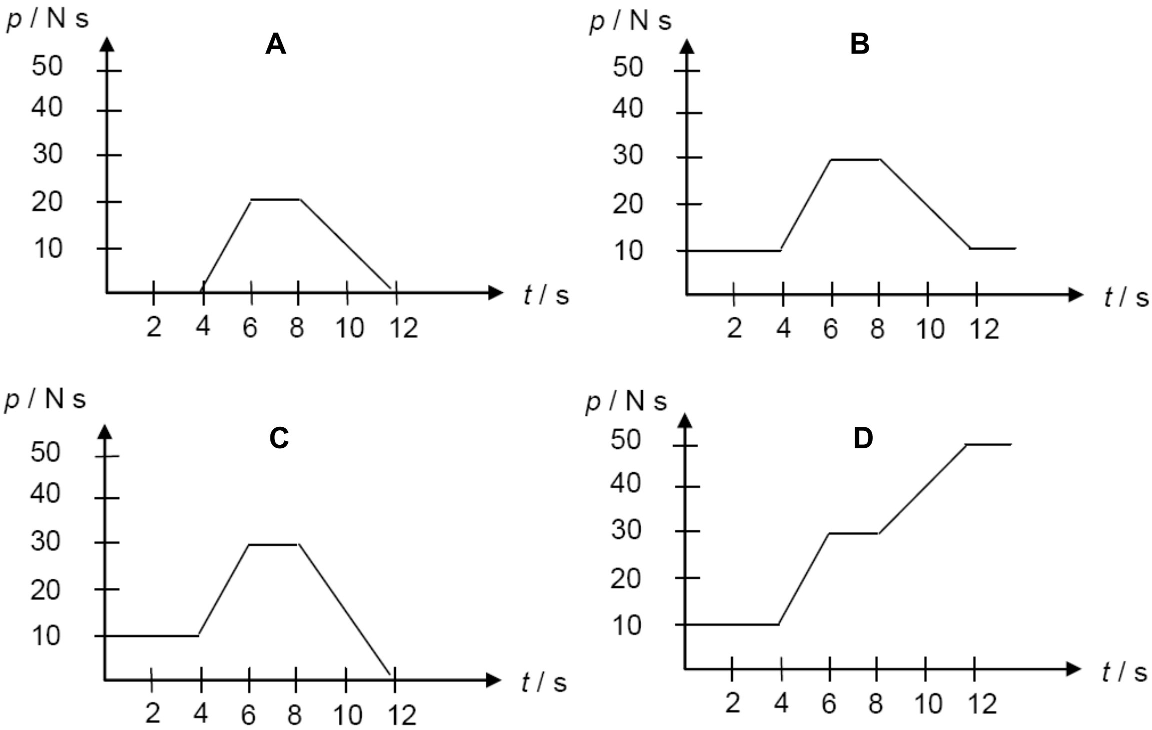


A *F* **B** *F* / 2 **C** *F* / 3 **D** *F* / 4

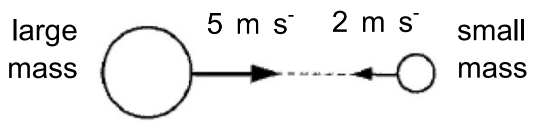
9 An object of mass 2.0 kg is moving at a velocity of 5.0 m s^{-1} at time *t* = 0. The net force *F* on the object varies with time *t* as shown.



Which one of the following graphs best represents how the momentum *p* of the object varies with time *t*?



10 A large mass moving at a velocity of 5 m s^{-1} collides head-on with a small mass moving at a velocity of 2 m s^{-1} in the opposite direction.

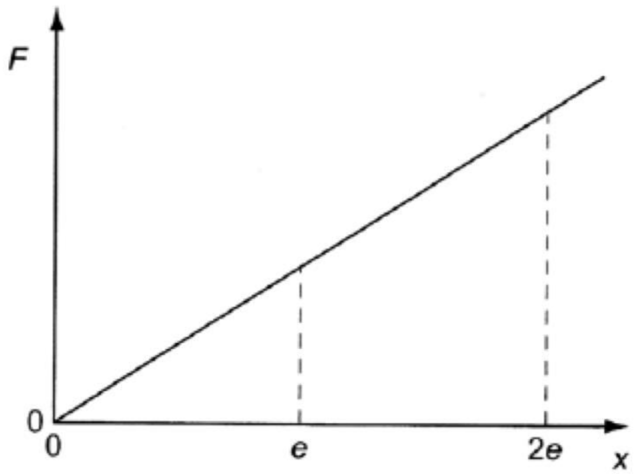


The collision is elastic. After the collision, both masses move to the right. The large mass has a velocity v_1 and the small mass has a velocity v_2.

Which pair of values v_1 and v_2 is possible?

	v_1	v_2
A	2 m s^{-1}	5 m s^{-1}
B	3 m s^{-1}	10 m s^{-1}
C	4 m s^{-1}	4 m s^{-1}
D	5 m s^{-1}	12 m s^{-1}

11 The extension x of a particular spring is related to the stretching force F as shown in the graph.



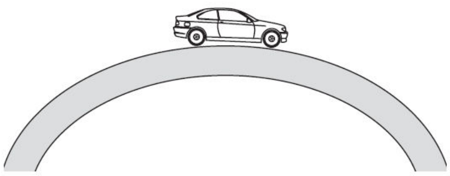
When the extension of the spring is e, the elastic potential energy stored in the spring is E. What is the increase in the elastic potential energy when the extension is increased from e to $2e$?

A E **B** $2E$ **C** $3E$ **D** $4E$

12 An electric motor is required to haul a cage of mass 200 kg up a mine shaft through a vertical height of 800 m in 4.0 minutes. What will be its electrical power required if its overall efficiency is 75%?

A 0.89 kW **B** 4.9 kW **C** 5.2 kW **D** 8.7 kW

13 A car, mass *m*, drives over a circular hump-back bridge of radius *r* with a constant speed *v*.



When it is at the top of the bridge, the force on the car from the bridge is given by

A mg

B $\frac{mv^2}{r} + mg$

C $\frac{mv^2}{r} - mg$

D $mg - \frac{mv^2}{r}$

14 Newton's law of gravitation can be applied to the Earth-Moon system. Which of the following statements is **not** correct?

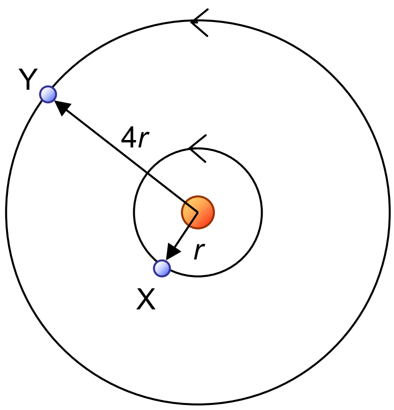
A The value of *G* at the surface of the Moon is the same as that at the surface of the Earth.

B The gravitational force between the Earth and the Moon is proportional to the square of the separation of the Earth and the Moon.

C The gravitational force between the Earth and the Moon is proportional to the mass of the Moon.

D The orbital time of the Moon about the Earth is independent of the mass of the Moon.

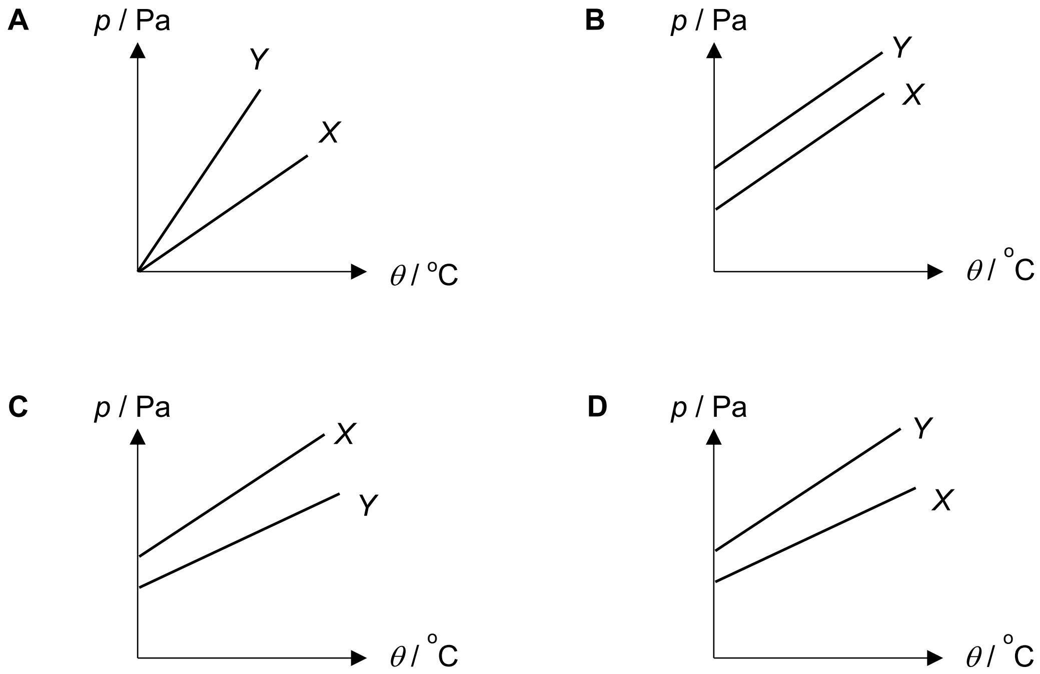
15 Two planets travel around a star in the same direction, in circular orbits. Planet X completes one revolution in time *T*. The radii of the orbits are in the ratio 1 : 4.



How many revolutions does planet Y make in the same time *T*?

A 0.125 **B** 0.25 **C** 0.5 **D** 8

16 Two closed vessels *X* and *Y* contain equal masses of an ideal gas. *X* has a greater volume than *Y*. When the temperature changes, which of the following represents the variation of the pressure *p* (in Pa) of the gas in each vessel with temperature θ (in °C)?



17 A body performs simple harmonic motion with a period of 0.063 s. The maximum speed of the body is 3.0 m s^{-1}. What are the values of the amplitude x_0 and the angular frequency ω?

	x_0 / m	ω / rad s^{-1}
A	0.030	100
B	0.19	16
C	5.3	16
D	33	100

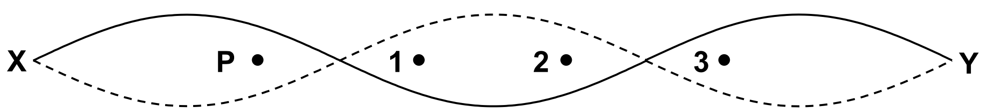
18 A point source of sound emits energy equally in all directions at a constant rate and a person 8.0 m from the source listens. After a while, the intensity of the source is tripled. If the person wishes the sound to seem as loud as before, how far should he be standing now?

A 4.9 m **B** 11.5 m **C** 13.9 m **D** 24.0 m

19 When light of wavelength 570 nm is incident normally on a plane diffraction grating, the angle between second-order diffraction images is 69.6°. What is the number of lines per millimetre of the grating?

A 500 **B** 1000 **C** 2000 **D** 500 000

20 A standing wave is set up on a stretched string **XY** as shown.

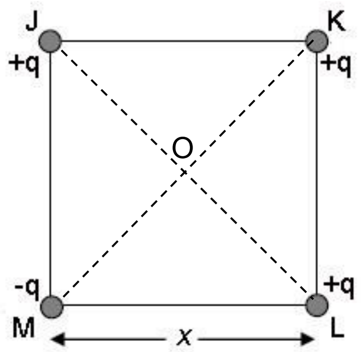


At which point(s) will the oscillation be in phase with that at **P**?

A 1 and 2 only **B** 1 only **C** 2 only **D** 3 only

21 Four point charges, each of magnitude *q*, lie at the four corners J, K, L, M of a square.

The signs of the charges are shown in the diagram. The side of the square is of length *x*.



What is the electric field strength at the centre O of the square?

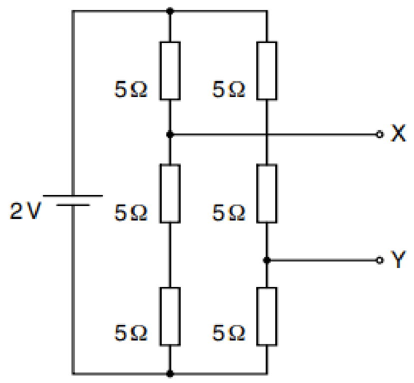
A $\dfrac{q}{\pi\varepsilon_0 x^2}$ towards K

B $\dfrac{q}{\pi\varepsilon_0 x^2}$ towards M

C $\dfrac{q}{2\pi\varepsilon_0 x^2}$ towards K

D $\dfrac{q}{2\pi\varepsilon_0 x^2}$ towards M

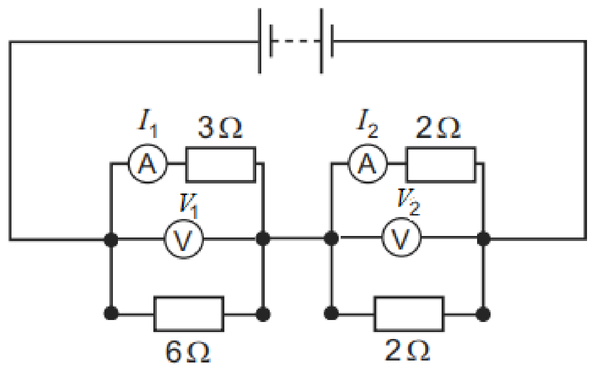
22 Six resistors, each of resistance 5 Ω, are connected to a 2 V cell with negligible internal resistance.



What is the potential difference between terminals X and Y?

A $\frac{2}{3}$ V **B** $\frac{8}{9}$ V **C** $\frac{4}{3}$ V **D** 2 V

23 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance.



The readings on the meters are I_1, I_2, V_1 and V_2, as labelled. Which is correct?

A $I_1 > I_2$ and $V_1 > V_2$

B $I_1 > I_2$ and $V_1 < V_2$

C $I_1 < I_2$ and $V_1 > V_2$

D $I_1 < I_2$ and $V_1 < V_2$

24 Fig. A shows a vertical plane square coil of 50 turns, carrying a current of 3.0 A. The length of each side of the coil is 4.0 cm. Fig. B shows a view of this coil from above within a horizontal magnetic field of flux density 0.20 T.

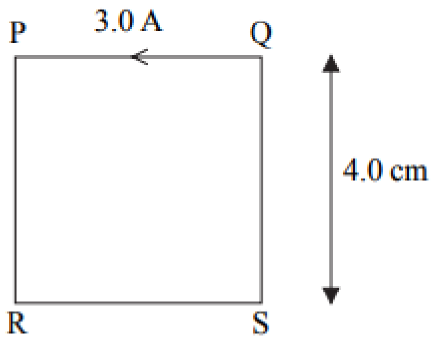


Fig. A

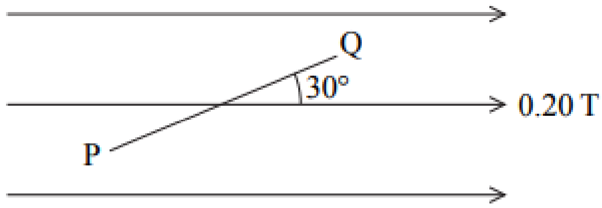


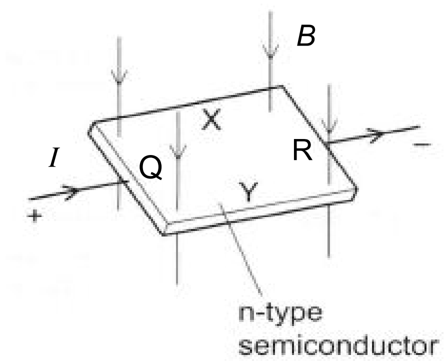
Fig. B

What is the magnitude of the resultant moment on the square coil?

A 0 N m **B** 0.024 N m **C** 0.042 N m **D** 0.048 N m

25 In n-type semiconductors, the majority of mobile charge carriers are conduction electrons.

A thin slab of n-type semiconductor is connected at its ends to a battery causing a current I through it as shown.



A uniform magnetic field B is applied vertically downwards over the surface of the slab causing an electric field to be induced in the slab.

Which of the options give the correct direction of the induced electric field?

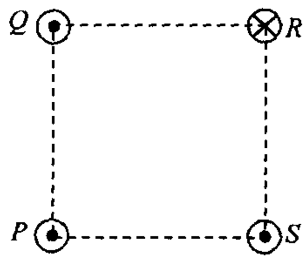
A from Q to R

B from R to Q

C from X to Y

D from Y to X

26 Four long straight current-carrying wires perpendicular to the plane of the paper are arranged at the corners of a square PQRS as shown. The same current I flows along the wires at P, Q and S. The current flows along the wire at R in the opposite direction.

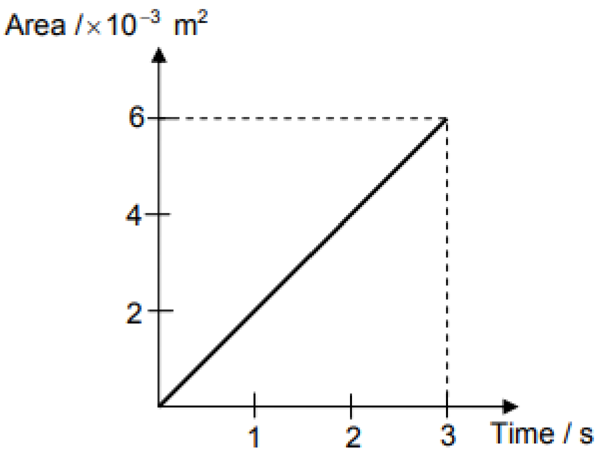


If the wire at P experiences no net force, what is the amount of current flowing along the wire at R?

A $\frac{I}{\sqrt{2}}$ **B** $\frac{I}{2}$ **C** $\sqrt{2}\,I$ **D** $2\,I$

27 A single circular loop of wire moves in a uniform magnetic field of flux density 1.2 T.

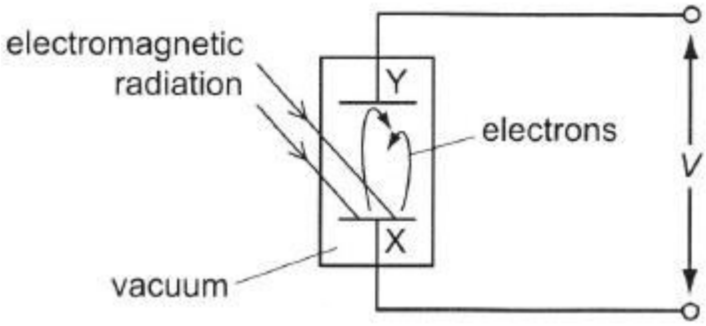
The graph shows how the area of the loop perpendicular to the magnetic field varies with time.



What is the e.m.f. induced?

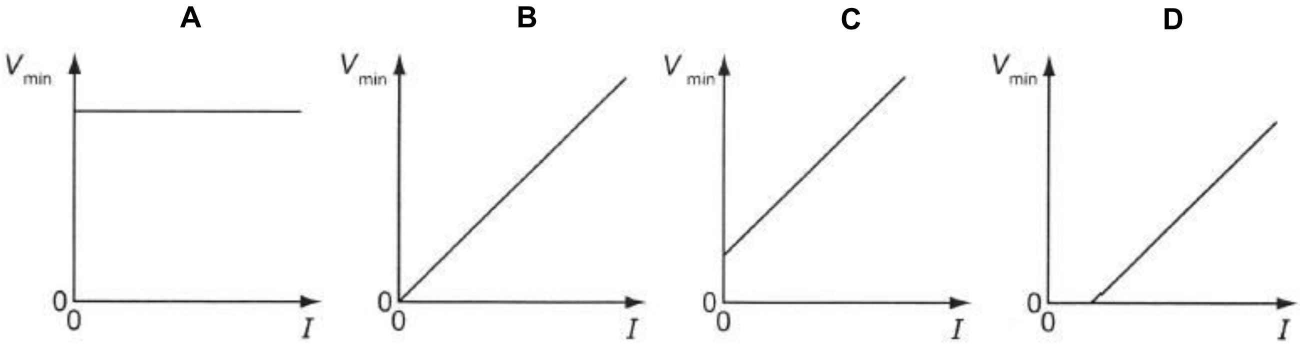
A 1.2×10^{-3} V **B** 2.4×10^{-3} V **C** 3.6×10^{-3} V **D** 7.2×10^{-3} V

28 Electromagnetic radiation of frequency f and intensity I is directed onto a metal electrode X causing photoelectrons to be emitted. Some of these electrons reach electrode Y causing a current in the circuit.



A reverse voltage V_{min} is applied so that the electrons are just prevented from reaching Y.

Which graph represents the variation of V_{min} with intensity I when f is constant?



29 Three different radioactive nuclides P, Q and R each decay by three different successive emissions.

P emits α α β

Q emits α β β

R emits β β β

Which nuclide produces a final nucleus that has the same proton number as its starting nucleus and which the same nucleon number as its starting nucleus?

	same proton number	same nucleon number
A	P	Q
B	P	R
C	Q	P
D	Q	R

30 Nuclei of atoms can exist in excited states. When an excited nucleus returns to its state of lowest energy (the ground state), a γ-ray photon may be emitted.

The mass of a nucleus in its ground state is 59.9308 u. The energy of the photon emitted when this nucleus returns from an excited state to the ground state is 2.13×10^{-13} J.

What is the mass of the nucleus in the excited state?

A 59.9280 u **B** 59.9294 u **C** 59.9322 u **D** 59.9337 u

End of Paper

TPJC JC2 Prelim H2 Physics Paper 1 (Answers)

Answer Key:

1 C	**2** B	**3** C	**4** D	**5** A	**6** A	**7** B	**8** D	**9** B	**10** B
11 C	**12** D	**13** D	**14** B	**15** A	**16** D	**17** A	**18** C	**19** A	**20** D
21 B	**22** A	**23** A	**24** C	**25** D	**26** D	**27** B	**28** A	**29** D	**30** C

1 The relation between the velocity v of waves in the sea with its wavelength λ, the surface tension γ and density ρ of sea water is given by:

$$v = k\sqrt{\frac{\gamma}{\lambda\rho}}$$

where k = constant of proportionality.

If γ = (4.30 $\pm$ 0.05) N m^{-1}, ρ = (1450 $\pm$ 20) kg m^{-3} and the percentage uncertainty in λ is 5 %, what is the percentage uncertainty in the velocity of the waves?

A 2 % **B** 3 % **C** 4 % **D** 8 %

$$\frac{\Delta v}{v} \times 100\% = \frac{1}{2}\left(\frac{0.05}{4.30} + \frac{20}{1450} + 0.05\right) \times 100\% = 3.8\% \approx 4\%$$

2 A cylindrical tube rolling down a slope of inclination θ moves a distance *L* in time *T*. The equation relating these quantities is

$$L\left(3 + \frac{a^2}{P}\right) = QT^2 \sin\theta$$

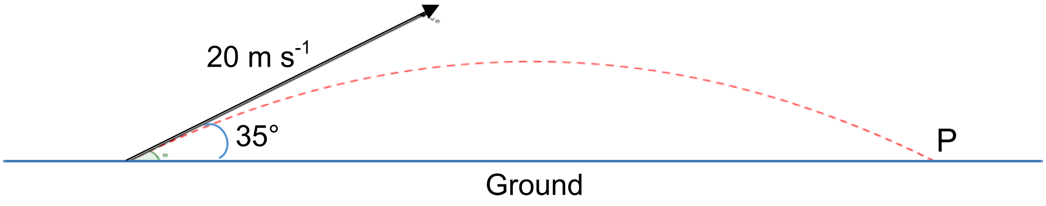
where *a* is the internal radius of the tube and *P* and *Q* are constants.

Which of the following gives the correct units for *P* and *Q*?

	units of *P*	units of *Q*
A	m	$m\,s^{-2}$
B	m^2	$m\,s^{-2}$
C	m^2	$m^3 s^{-2}$
D	m^2	$m^2 s^{-2}$

$\frac{a^2}{P}$ has no units so P has units of m^2. QT^2 has units of m so Q has units of m s^{-2}

3 A student throws a stone 35° above the horizontal at an initial speed of 20 m s^{-1}. It travels in projectile motion until it hits the ground at P with the same speed.

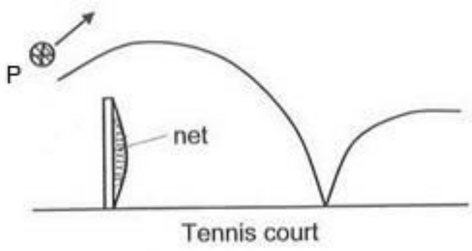


What is the magnitude of the change in velocity of the stone just before hitting the ground at P?

A 0.0 m s^{-1} **B** 20 m s^{-1} **C** 23 m s^{-1} **D** 33 m s^{-1}

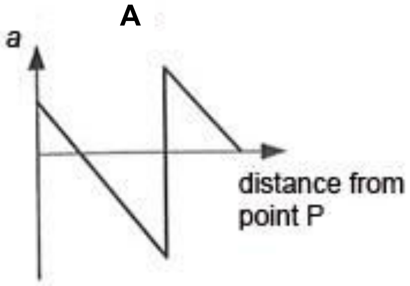
Initial vertical velocity = 20sin35° = 11.47 m s^{-1}.
Final vertical velocity = -11.47 m s^{-1}
So the change in velocity is 23 m s^{-1}.
(Horizontal velocity does not change).

4 The diagram below shows the trajectory of a tennis ball crossing the net and bouncing once from the ground.

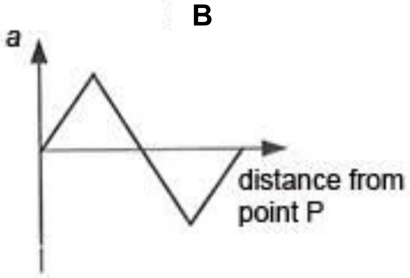


Which of the following graphs represents the variation with the horizontal distance from point P of the acceleration *a* of the ball, taking the upward direction as positive?

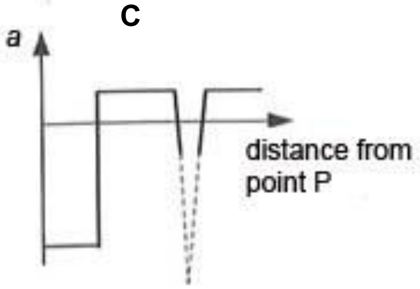
A



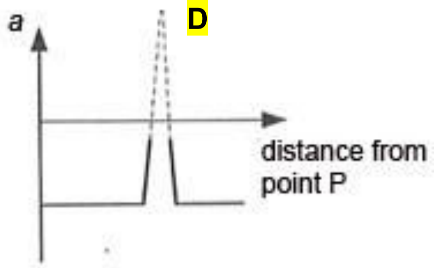
B



C

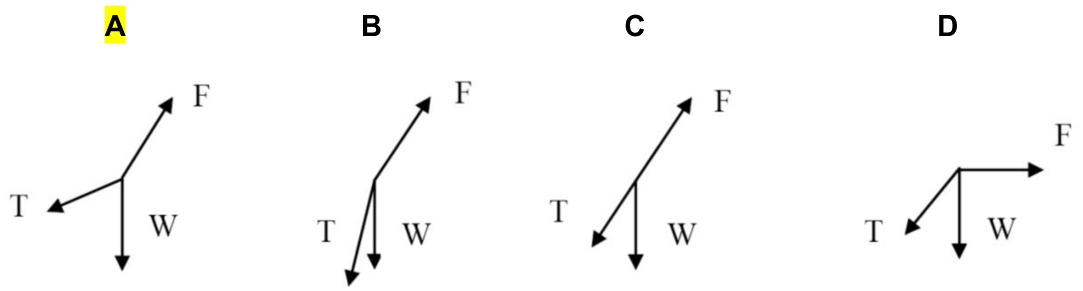


D

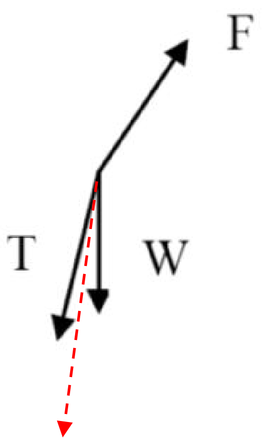


Acceleration is everywhere downwards 9.81 m s^{-2} except when the ball hits the floor when the acceleration is upwards and positive.

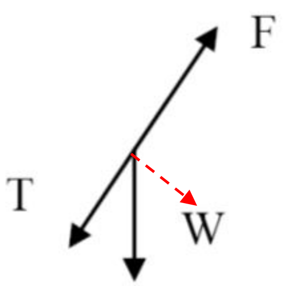
5 A kite is held stationary under the influence of three forces: the tension *T* in the string, the force *F* of the wind and the weight *W* of the kite. Which one of the following force diagrams could be correct?



For option B, the lengths are incorrect and the vectors do not form a closed triangle.
The resultant (dashed line) of W and T is not in the opposite direction as F. So the resultant of W and T does not balance out with F.



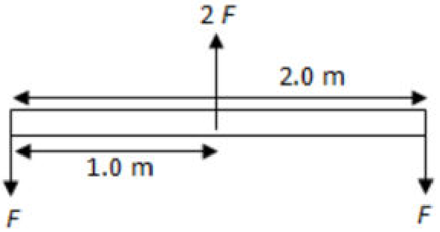
For option C, the component of W (dashed line) which is perpendicular to T is unbalanced.



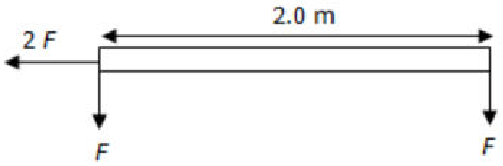
For option D, W and the downward component of T are unbalanced as there is no force with an upward component.

6 In which situation will the forces applied to the rigid object **not** produce a resultant motion?

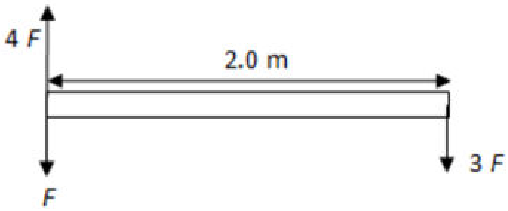
A



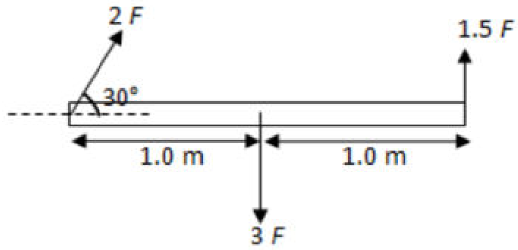
B



C



D



For answer A, the resultant force is zero.

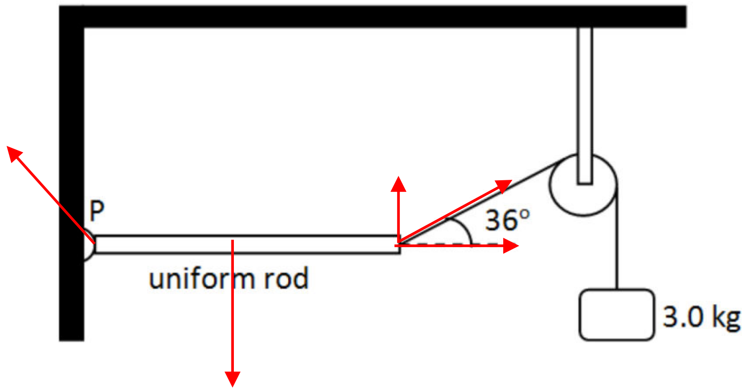
taking moments about centre of object,

total anticlockwise moment = F (1.0) = F

total clockwise moment = F (1.0) = F

hence the resultant moment is zero.

7 The diagram below shows a uniform rod freely pivoted at P. The rod is suspended horizontally, when a string tied to one end of the rod passes over a smooth pulley and is attached to a 3.0 kg mass. Determine the mass of the rod.

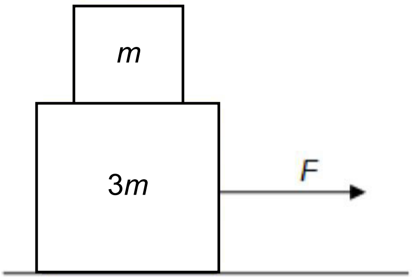


A 4.8 kg **B** 3.5 kg **C** 2.4 kg **D** 1.7 kg

Taking moments about P, $3.0 \times 9.81 \times \sin 36^o \times L = m \times 9.81 \times \frac{1}{2}L$

So m = 3.5 kg

8 A box of mass *m* rests on another box of mass 3*m*. The more massive box slides along a frictionless surface due to a pulling force *F*. Determine the friction between the boxes.



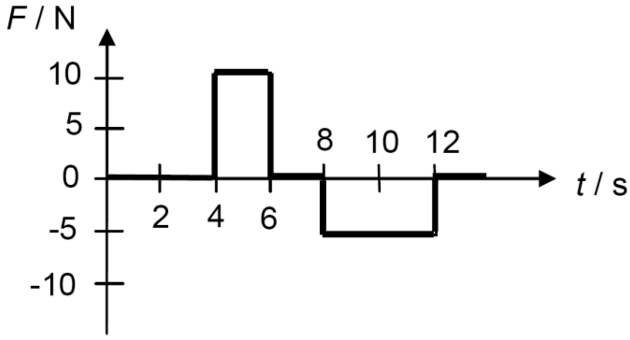
A *F* **B** *F* / 2 **C** *F* / 3 **D** *F* / 4

Acceleration of each of the masses = $\frac{F}{4m}$

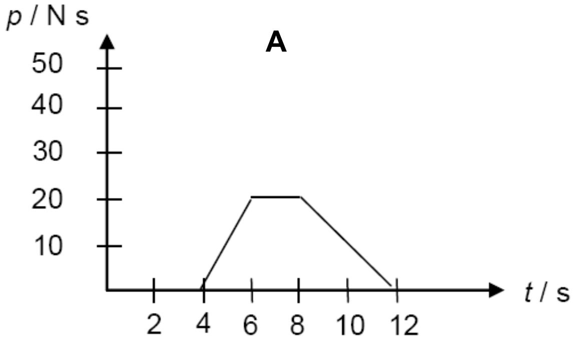
Resultant force on small mass = $m \times a$ = $\frac{F}{4}$

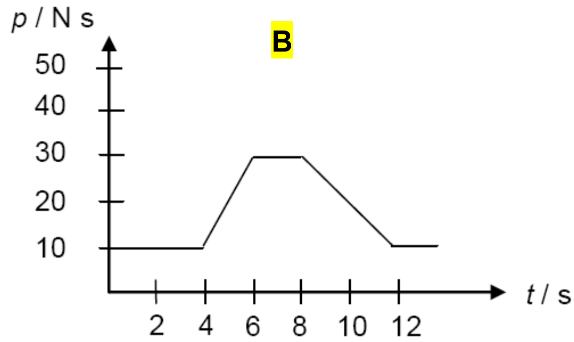
Since friction is the only force that is accelerating the small mass forward, the friction = $\frac{F}{4}$

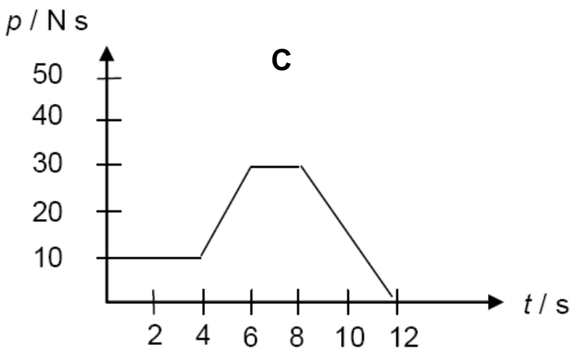
9 An object of mass 2.0 kg is moving at a velocity of 5.0 m s^{-1} at time t = 0. The net force F on the object varies with time t as shown.

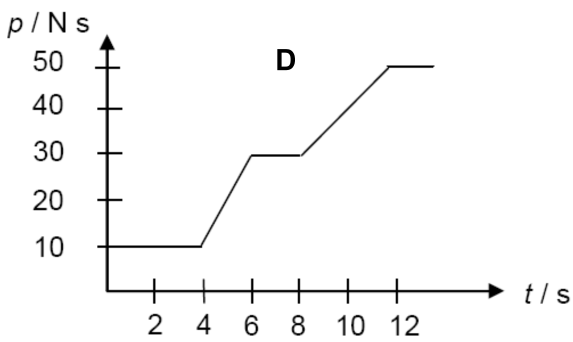


Which one of the following graphs best represents how the momentum p of the object varies with time t?





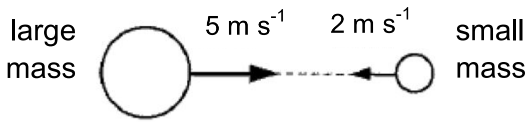




Initial momentum of object = (2.0)(5.0) = 10 kg m s^{-1}

The area under the force- time graph shows the change in momentum.
Hence
from t = 0 to 4 s, there is no change in momentum.
from t = 4 to 6 s, there is a positive change in momentum of 20 Ns.
from t = 6 to 8 s, there is no change in momentum.
from t = 8 to 12 s, there is a negative change in momentum of 20 Ns.

10 A large mass moving at a velocity of 5 m s^{-1} collides head-on with a small mass moving at a velocity of 2 m s^{-1} in the opposite direction.



The collision is elastic. After the collision, both masses move to the right. The large mass has a velocity v_1 and the small mass has a velocity v_2.

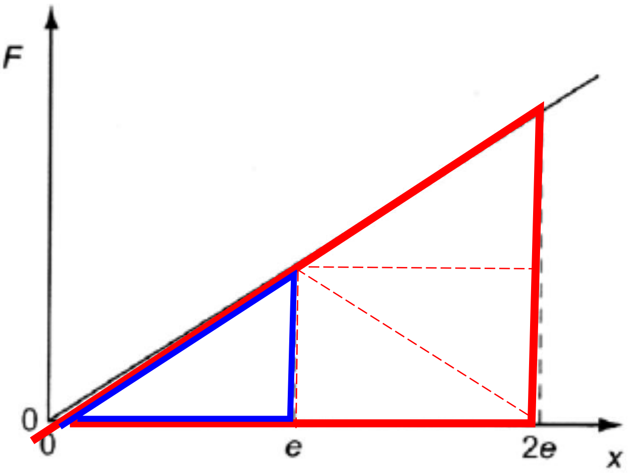
Which pair of values v_1 and v_2 is possible?

	v_1	v_2
A	2 m s^{-1}	5 m s^{-1}
B	3 m s^{-1}	10 m s^{-1}
C	4 m s^{-1}	4 m s^{-1}
D	5 m s^{-1}	12 m s^{-1}

RSA = RSS and the sum of KE must not be higher than before.

"A" is out because the RSA is 7 m s^{-1} but the RSS is 3 m s^{-1}.
"C" is out because the RSA is 7 m s^{-1} but the RSS is 0 m s^{-1}.
"D" is out because the large mass retains speed while the small mass increases speed. Hence KE is not conserved.

11 The extension x of a particular spring is related to the stretching force F as shown in the graph.



When the extension of the spring is e, the elastic potential energy stored in the spring is E. What is the increase in the elastic potential energy when the extension is increased from e to $2e$?

A E **B** $2E$ **C** $3E$ **D** $4E$

The area can be found using a graphical method given that elastic potential energy E = area under F-x graph

When extension is e,

E = area under F-x graph (small blue triangle)

When extension is 2e,

E_{new} = area under F-x graph (large red triangle which is 4 times the area of the blue triangle))

E_{new} = 4 E

Therefore increase in elastic potential energy = 4 E – E = 3 E

12 An electric motor is required to haul a cage of mass 200 kg up a mine shaft through a vertical height of 800 m in 4.0 minutes. What will be its electrical power required if its overall efficiency is 75%?

A 0.89 kW **B** 4.9 kW **C** 5.2 kW **D** 8.7 kW

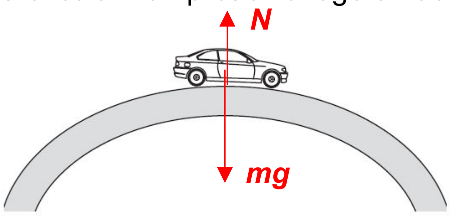
Useful power output

$$= \frac{work\ done\ on\ cage\ by\ motor}{time} = \frac{Force\ on\ cage\ by\ motor\ x\ distance\ moved}{4 \times 60} = \frac{200 \times 9.81 \times 800}{4 \times 60} = 6540\ W$$

efficiency = useful power / input power

Hence input power = $\frac{6540}{0.75} = 8720\ W$

13 A car, mass *m*, drives over a circular hump-back bridge of radius *r* with a constant speed *v*.



When it is at the top of the bridge, the force on the car from the bridge is given by

A mg

B $\frac{mv^2}{r} + mg$

C $\frac{mv^2}{r} - mg$

D $mg - \frac{mv^2}{r}$

$$F_{net} = mg - N = \frac{mv^2}{r}$$

$$\text{force on car by bridge}, N = mg - \frac{mv^2}{r}$$

14 Newton's law of gravitation can be applied to the Earth-Moon system. Which of the following statements is **not** correct?

A The value of *G* at the surface of the Moon is the same as that at the surface of the Earth.

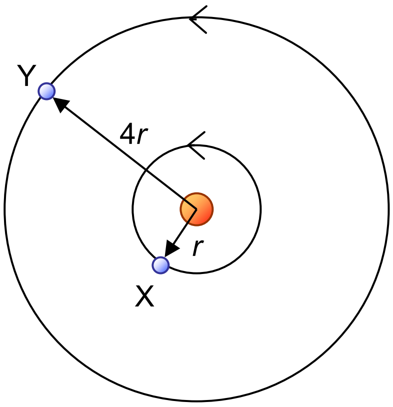
B The gravitational force between the Earth and the Moon is proportional to the square of the separation of the Earth and the Moon.

C The gravitational force between the Earth and the Moon is proportional to the mass of the Moon.

D The orbital time of the Moon about the Earth is independent of the mass of the Moon.

B should read "inversely proportional to the square of the separation" to be correct.

15 Two planets travel around a star in the same direction, in circular orbits. Planet X completes one revolution in time *T*. The radii of the orbits are in the ratio 1 : 4.



How many revolutions does planet Y make in the same time *T*?

A 0.125 **B** 0.25 **C** 0.5 **D** 8

$GMm / r^2 = m\, r\, \omega^2$

$GM / r^3 = \omega^2$

$GM / r^3 = (2\pi / T)^2$

$T^2 = (4\pi^2 / GM)\, r^3$

$T^2 \propto R^3$

$T_X^2 / r_X^3 = T_Y^2 / r_Y^3$

$T^2 / r_X^3 = T_Y^2 / (4\, r_X)^3$

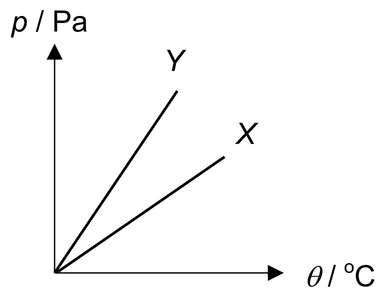
$T_Y = 8\, T$

So planet Y's orbital period is 8 times that of X. Planet Y completes only $\frac{1}{8}$ of an orbit for every 1 orbit of Planet X.

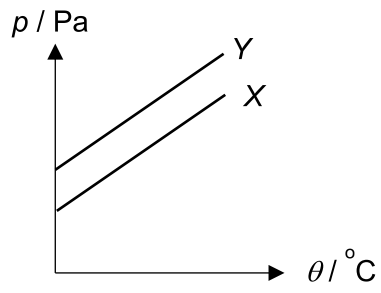
Hence in time T, planet Y only completes 0.125 of a revolution.

16 Two closed vessels *X* and *Y* contain equal masses of an ideal gas. *X* has a greater volume than *Y*. When the temperature changes, which of the following represents the variation of the pressure *p* (in Pa) of the gas in each vessel with temperature θ (in °C)?

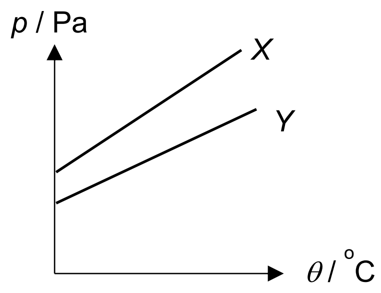
A



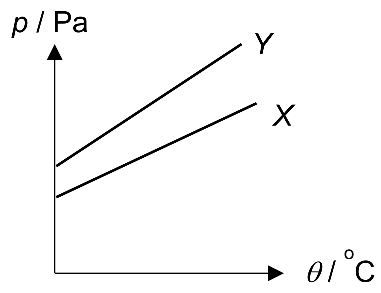
B



C



D



$P = \frac{nR}{V}$T Since volume of X is larger than Y, the gradient of X is less than for Y,

Since P = 0 at T = 0 K (- 273.15 °C), the x-intercept must be a negative value. Hence answer D is correct.

17 A body performs simple harmonic motion with a period of 0.063 s. The maximum speed of the body is 3.0 m s^{-1}. What are the values of the amplitude x_0 and the angular frequency ω?

	x_0 / m	ω / rad s^{-1}
A	0.030	100
B	0.19	16
C	5.3	16
D	33	100

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.063} = 100$$

$$v_0 = \omega x_0, \text{ so } x_0 = \frac{v_0}{\omega} = 0.030$$

18 A point source of sound emits energy equally in all directions at a constant rate and a person 8.0 m from the source listens. After a while, the intensity of the source is tripled. If the person wishes the sound to seem as loud as before, how far should he be standing now?

A 4.9 m **B** 11.5 m **C** 13.9 m **D** 24.0 m

$$\text{Intensity } I = \frac{Power}{Area} = \frac{P}{4\pi d^2}$$

Since the loudness (intensity) at a point is to be constant, $P \propto d^2$

Intensity of the source being tripled implies power of source P is tripled.

$P_1 / d_1^2 = P_2 / d_2^2$

$P_1 / 8^2 = 3 P_1 / d_2^2$

$d_2 = 13.9$ m

19 When light of wavelength 570 nm is incident normally on a plane diffraction grating, the angle between second-order diffraction images is 69.6°. What is the number of lines per millimetre of the grating?

A 500 **B** 1000 **C** 2000 **D** 500 000

$$d \sin\theta = n\lambda$$

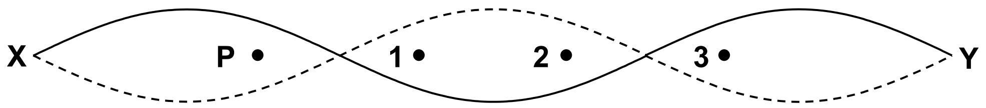
When $n = 2$, $\theta = 69.6^o \div 2 = 34.8^o$

$d \sin 34.8 = 2\,(570 \times 10^{-9})$

$d = 2 \times 10^{-6} m$

$$\frac{1 \times 10^{-3}}{d} = 500$$

20 A standing wave is set up on a stretched string **XY** as shown.



At which point(s) will the oscillation be in phase with that at **P**?

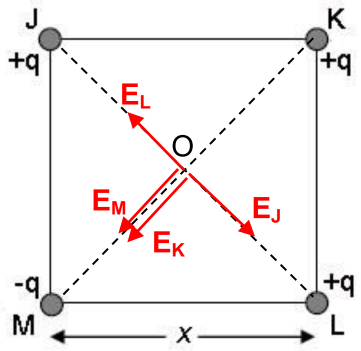
A 1 and 2 only **B** 1 only **C** 2 only **D** 3 only

For stationary ware, the particles in adjacent "segments" are oscillating in antiphase.
hence particles 1 and 2 are in antiphase with P.

On the other hand, the particles in alternate "segments" are oscillating in phase.
hence particle 3 is in phase with P.

21 Four point charges, each of magnitude *q*, lie at the four corners J, K, L, M of a square.

The signs of the charges are shown in the diagram. The side of the square is of length *x*.



What is the electric field strength at the centre O of the square?

A $\dfrac{q}{\pi\varepsilon_0 x^2}$ towards K

B $\dfrac{q}{\pi\varepsilon_0 x^2}$ towards M

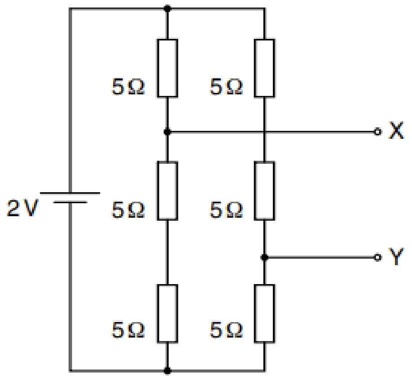
C $\dfrac{q}{2\pi\varepsilon_0 x^2}$ towards K

D $\dfrac{q}{2\pi\varepsilon_0 x^2}$ towards M

The electric fields of J and L cancel at the centre of the square, only need to consider K and M.

Vector sum of field strengths due to K and M at O = $2 \times \frac{1}{4\pi\epsilon_0}\frac{q}{(0.5\times\sqrt{2}\times x)^2}$

22 Six resistors, each of resistance 5 Ω, are connected to a 2 V cell with negligible internal resistance.

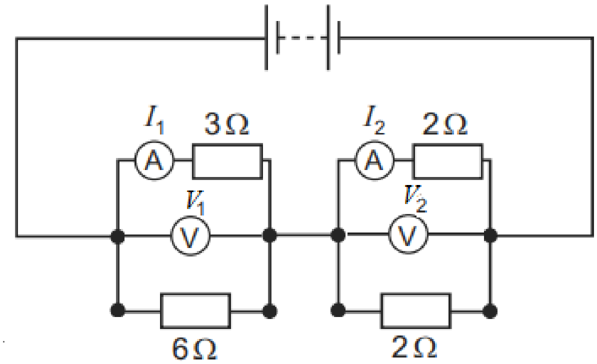


What is the potential difference between terminals X and Y?

A $\frac{2}{3}$ V **B** $\frac{8}{9}$ V **C** $\frac{4}{3}$ V **D** 2 V

Potential at X = (10/15) (2) = 4/3
Potential at Y = (5/15) (2) = 2/3
Potential difference between XY = 2/3 V

23 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance.



The readings on the meters are I_1, I_2, V_1 and V_2, as labelled. Which is correct?

A $I_1 > I_2$ and $V_1 > V_2$

B $I_1 > I_2$ and $V_1 < V_2$

C $I_1 < I_2$ and $V_1 > V_2$

D $I_1 < I_2$ and $V_1 < V_2$

since 3 Ω is lower than 6 Ω, hence more than half of the total circuit current flows through 3 Ω.

since 2 Ω is equal to 2 Ω, hence exactly half of the total circuit current flows through 2 Ω.

therefore $I_1 > I_2$

effective resistance of 3 Ω and 6 Ω = $(1 / 3 + 1 / 6)^{-1}$ = 2 Ω

effective resistance of 2 Ω and 2 Ω = $(1 / 2 + 1 / 2)^{-1}$ = 1 Ω

using potential divider formula,

since effective resistance of 3 Ω and 6 Ω is larger than effective resistance of 2 Ω and 2 Ω, therefore more than half of the battery's e.m.f. goes to 3 Ω and 6 Ω.

therefore $V_1 > V_2$

24 Fig. A shows a vertical plane square coil of 50 turns, carrying a current of 3.0 A. The length of each side of the coil is 4.0 cm. Fig. B shows a view of this coil from above within a horizontal magnetic field of flux density 0.20 T.

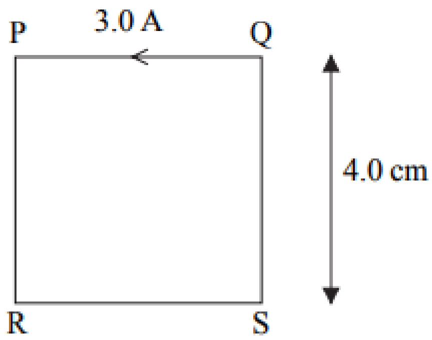


Fig. A

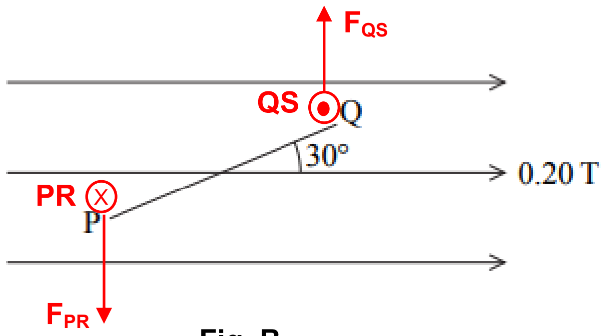


Fig. B

What is the magnitude of the resultant moment on the square coil?

A 0 N m **B** 0.024 N m **C** 0.042 N m **D** 0.048 N m

Taking moments about the centre of PQ,

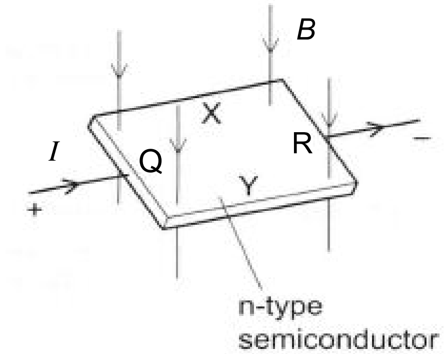
moment by F_{QS} = N BIL sin θ (0.5 L_{PQ} cos 30°)
= (50) (0.20) (3.0) (0.040) sin 90° (0.5 (0.040) cos 30°)
= 0.021 N m (anticlockwise)

moment by F_{PR} = N BIL sin θ (0.5 L_{PQ} cos 30°)
= (50) (0.20) (3.0) (0.040) sin 90° (0.5 (0.040) cos 30°)
= 0.021 N m (anticlockwise)

resultant moment = 0.021 + 0.021 = 0.042 N m

25 In n-type semiconductors, the majority of mobile charge carriers are conduction electrons.

A thin slab of n-type semiconductor is connected at its ends to a battery causing a current I through it as shown.



A uniform magnetic field B is applied vertically downwards over the surface of the slab causing an electric field to be induced in the slab.

Which of the options give the correct direction of the induced electric field?

A from Q to R

B from R to Q

C from X to Y

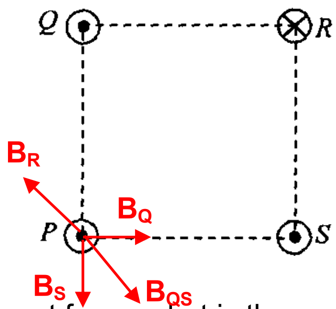
D from Y to X

Using fleming's left hand rule, there will be a magnetic force on the electrons in the direction from Y to X.

Electrons gather at side X and side Y becomes short of electrons. So side Y is positively charged and side Y is negatively charged.

Hence the electric field is directed from Y to X.

26 Four long straight current-carrying wires perpendicular to the plane of the paper are arranged at the corners of a square PQRS as shown. The same current I flows along the wires at P, Q and S. The current flows along the wire at R in the opposite direction.



If the wire at P experiences no net force, what is the amount of current flowing along the wire at R?

A $\frac{I}{\sqrt{2}}$ **B** $\frac{I}{2}$ **C** $\sqrt{2}\,I$ **D** $2\,I$

$B_Q = u_0 I / (2 \pi d)$

$B_S = u_0 I / (2 \pi d)$

$B_{QS} = \sqrt{(\frac{u_0 I}{2\pi d})^2 + (\frac{u_0 I}{2\pi d})^2} = \sqrt{2(\frac{u_0 I}{2\pi d})^2} = \sqrt{2}(\frac{u_0 I}{2\pi d})$

In order for no net force at P, the magnetic field B_R at P due to R must be equal and opposite to B_{QS} .

$B_R = \sqrt{2}(\frac{u_0 I}{2\pi d})$

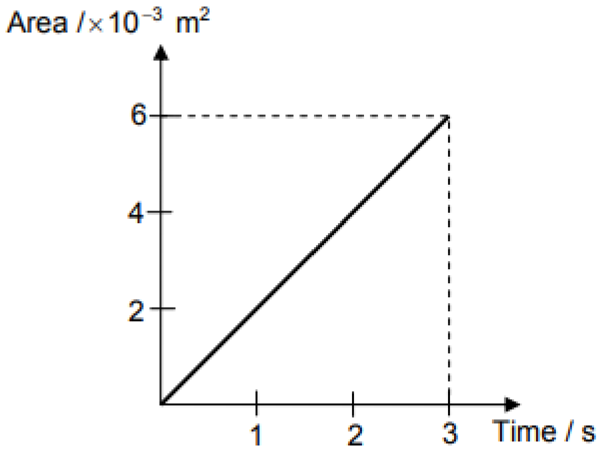
$\frac{u_0 I_R}{2\pi(\sqrt{2}d)} = \sqrt{2}(\frac{u_0 I}{2\pi d})$

$\frac{u_0 I_R}{2\pi(d)} = 2(\frac{u_0 I}{2\pi d})$

$I_R = 2I$

27 A single circular loop of wire moves in a uniform magnetic field of flux density 1.2 T.

The graph shows how the area of the loop perpendicular to the magnetic field varies with time.



What is the e.m.f. induced?

A 1.2×10^{-3} V **B** 2.4×10^{-3} V **C** 3.6×10^{-3} V **D** 7.2×10^{-3} V

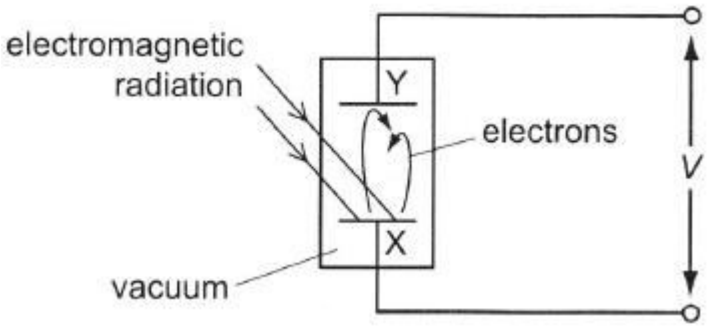
$\varepsilon = - \Delta(\text{flux linkage}) / \Delta t$

$\varepsilon = - N B \Delta A / \Delta t$

$\varepsilon = - (1) (1.2) (6 \times 10^{-3} - 0) / (3 - 0)$

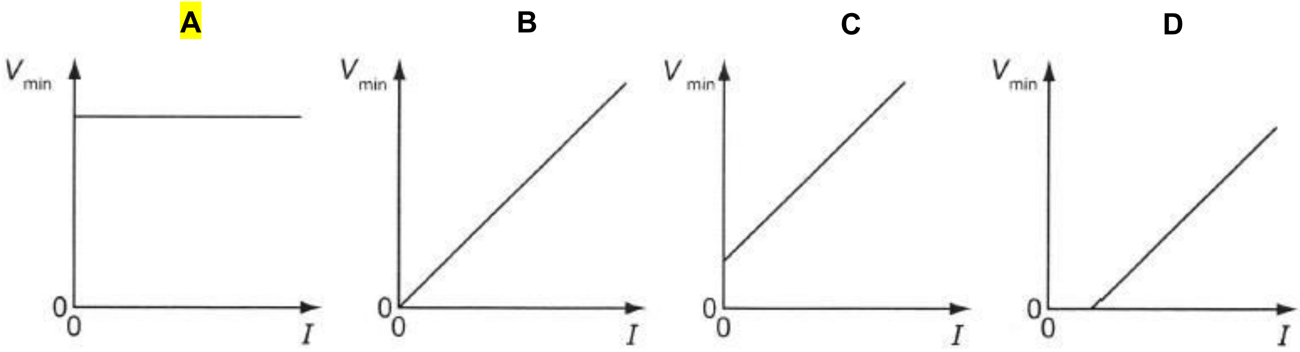
$\varepsilon = - 0.0024$ V

28 Electromagnetic radiation of frequency *f* and intensity *I* is directed onto a metal electrode X causing photoelectrons to be emitted. Some of these electrons reach electrode Y causing a current in the circuit.



A reverse voltage V_{min} is applied so that the electrons are just prevented from reaching Y.

Which graph represents the variation of V_{min} with intensity I when f is constant?



h f = work function + e V_{min}
since f is constant, V_{min} will not change

29 Three different radioactive nuclides P, Q and R each decay by three different successive emissions.

P emits α α β

Q emits α β β

R emits β β β

Which nuclide produces a final nucleus that has the same proton number as its starting nucleus and which the same nucleon number as its starting nucleus?

	same proton number	same nucleon number
A	P	Q
B	P	R
C	Q	P
D	Q	R

30 Nuclei of atoms can exist in excited states. When an excited nucleus returns to its state of lowest energy (the ground state), a γ-ray photon may be emitted.

The mass of a nucleus in its ground state is 59.9308 u. The energy of the photon emitted when this nucleus returns from an excited state to the ground state is 2.13 x 10^{-13} J.

What is the mass of the nucleus in the excited state?

A 59.9280 u **B** 59.9294 u **C** 59.9322 u **D** 59.9337 u

mass equivalent of the photon energy = $\frac{2.13\times10^{-13}}{c^2} = 2.36666\times10^{-30}kg = 1.42570\times10^{-3}u$

So excited nucleus mass = $59.9308u + 1.42570\times10^{-3}u = 59.9322u$

End of Paper

H2

TAMPINES JUNIOR COLLEGE
JC2 PRELIMINARY ASSESSMENT

CANDIDATE NAME	
CIVICS GROUP	1 7
TUTOR NAME	

PHYSICS
Paper 2 Structured Questions

9749/02

Wednesday, 29 August 2018

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs.
Do not use paper clips, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Section A		
1	10	
2	10	
3	10	
4	8	
5	10	
6	12	
7	20	
s.f		
Total / 80		

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	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} Js
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	=	ρgh
gravitational potential	ϕ	=	$-\frac{GM}{r}$
temperature	T/K	=	T / °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	=	$v_0 \cos\omega t$
		=	$\pm\, \omega\sqrt{(x_0^2 - x^2)}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + ...$
resistors in parallel	$1 / R$	=	$1/R_1 + 1/R_2 + ...$
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	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

Answer **all** the questions in the spaces provided.

1 **(a)** A body is released in a fluid. With the aid of a free body diagram, explain how the body falling through a fluid can reach terminal velocity.

....

....

....

.... [5]

(b) A uniform rigid rod of weight 400 N is attached to a vertical beam by a hinge as shown in Fig. 1.1. The other end of the rod is fastened to a support cable. The structure is used to support a load of weight 2000 N.

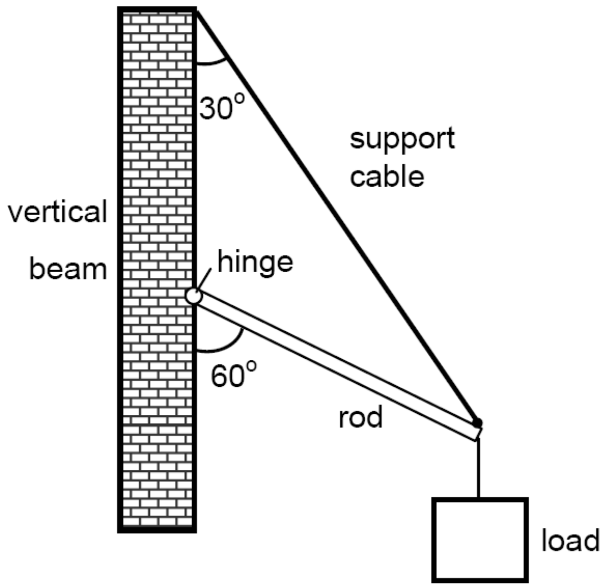


Fig. 1.1

(i) State two conditions needed for the rod to be in a state of equilibrium.

....

.... [2]

(ii) Determine the magnitude of the tension in the support cable.

tension = …………………… N [3]

2 **(a)** A uniform wire AB of length 100 cm is connected between the terminals of a cell of e.m.f. 1.5 V and negligible internal resistance, as shown in Fig. 2.1.

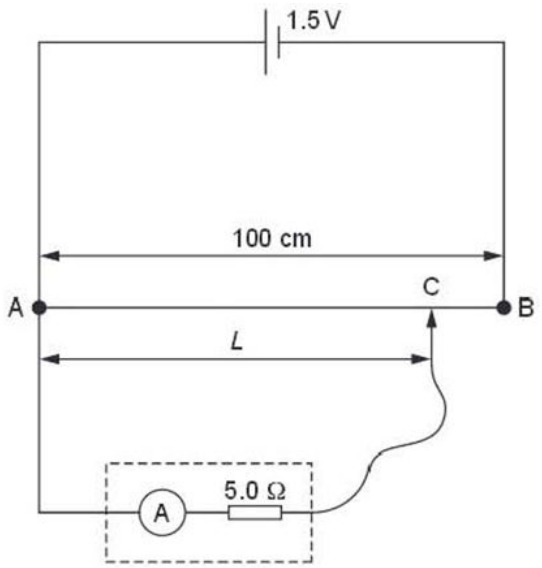


Fig. 2.1

An ammeter of internal resistance 5.0 Ω is connected to end A of the wire and to a contact C that can be moved along the wire.

Determine the reading on the ammeter for the contact C placed

(i) at A,

reading = ………………… A [1]

(ii) at B.

reading = ………………… A [1]

(b) Using the circuit in Fig. 2.1, the ammeter reading I is recorded for different distances L of the contact C from end A of the wire. Some data points are shown on Fig. 2.2.

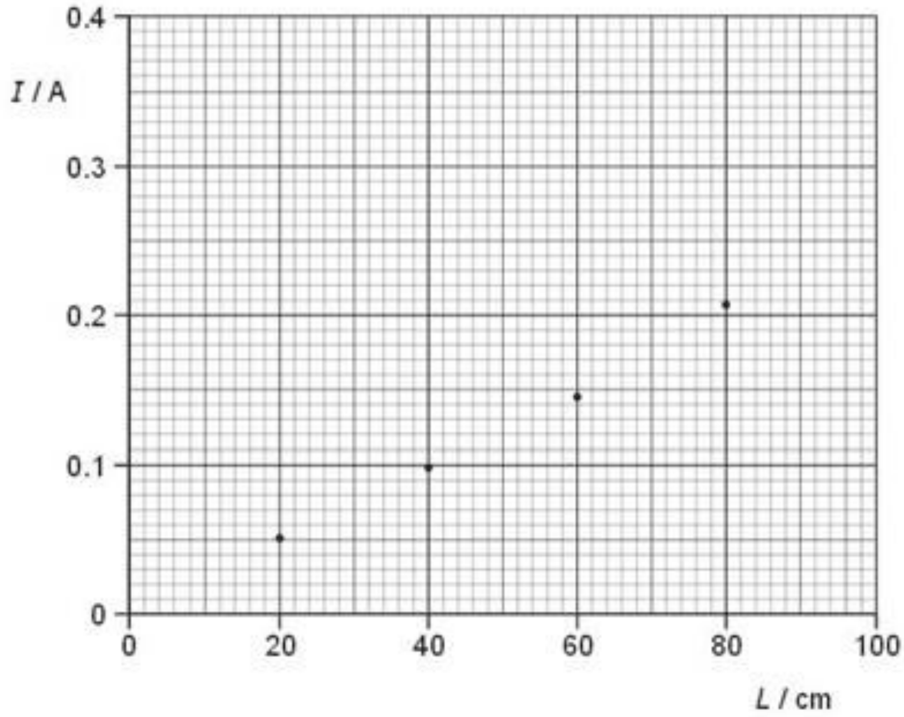


Fig 2.2

(i) Use your answers in **(a)** to plot data points on Fig. 2.2 corresponding to the contact C placed at end A and at end B of the wire. [2]

(ii) Draw a line of best fit for all of the data points and hence determine the ammeter reading for contact C placed at the midpoint of the wire.

reading = ………………… A [2]

(iii) Use your answer in **(ii)** to calculate the potential difference between A and the contact C for the contact placed at the midpoint of AB.

potential difference = …………………. V [2]

(c) Explain why, although the contact C is at the midpoint of wire AB, the answer in **(b)(iii)** is **not** numerically equal to half of the e.m.f. of the cell.

....

....

.... [2]

3 **(a)** State what is meant by *simple harmonic motion*.

....

.... [2]

(b) A spring hangs vertically from a fixed point. A copper plate is attached to the free end of the spring as illustrated in Fig. 3.1.

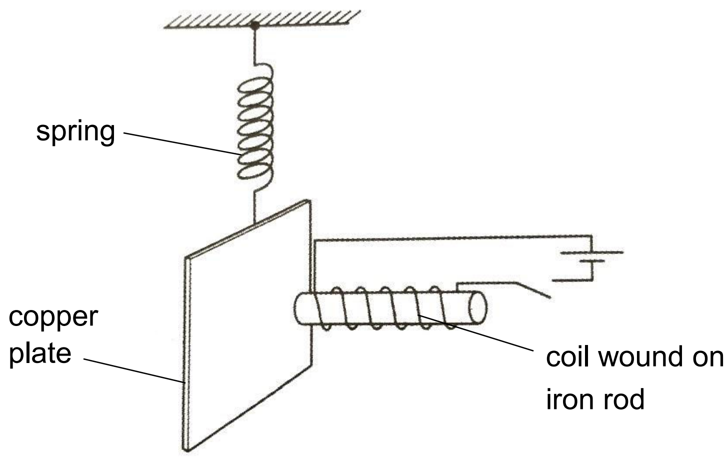


Fig 3.1

One end of a coil of wire, wound on an iron rod, is placed near to the copper plate.

The copper plate is displaced vertically and then released. The variation with time *t* of the vertical displacement *y* of the plate is shown in Fig. 3.2.

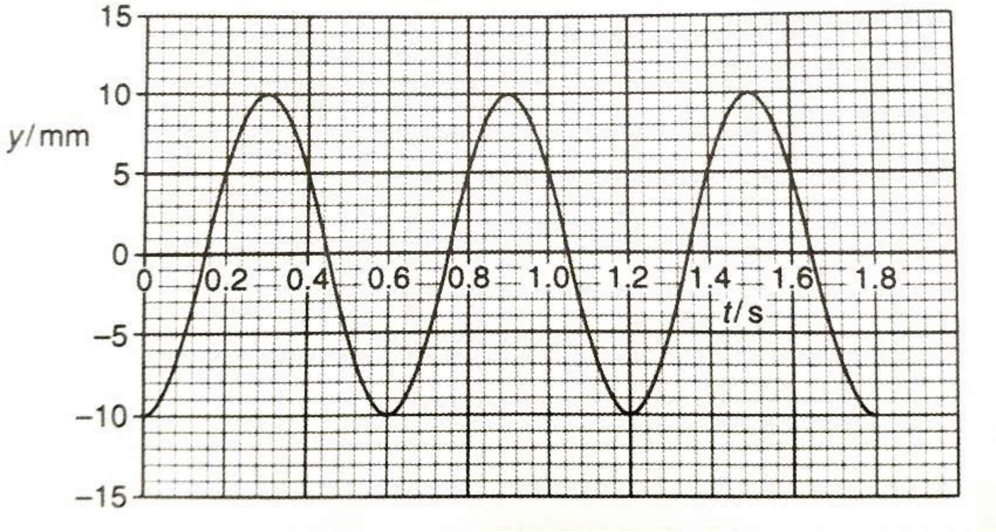


Fig 3.2

The copper plate undergoes simple harmonic motion. The mass m of the oscillating copper plate is 320 g.

(i) Determine the frequency f of the copper plate.

frequency = …………………… Hz [1]

(ii) Determine the maximum acceleration of the copper plate.

maximum acceleration = …………………… m s^{-2} [2]

(iii) Using your answer from **(ii)**, determine the maximum force exerted by the spring on the copper plate.

maximum force = …………………… N [2]

(c) When the switch is closed, the oscillation of the copper plate is lightly damped.

(i) On Fig 3.2, sketch the variation with time *t* of the vertical displacement *y* of the plate when the switch is closed. [2]

(ii) State the energy transformations that occur in the copper plate when the switch is closed.

....

.... [1]

4 **(a)** With reference to the vibrations of the particles on a wave and its direction of energy transfer, distinguish between transverse waves and longitudinal waves.

....

....

....

.... [2]

(b) Fig. 4.1 shows the equilibrium positions of the particles in a medium when they are undisturbed as compared to their displaced positions in the presence of a progressive sinusoidal wave. Displacement to the right is taken as positive.

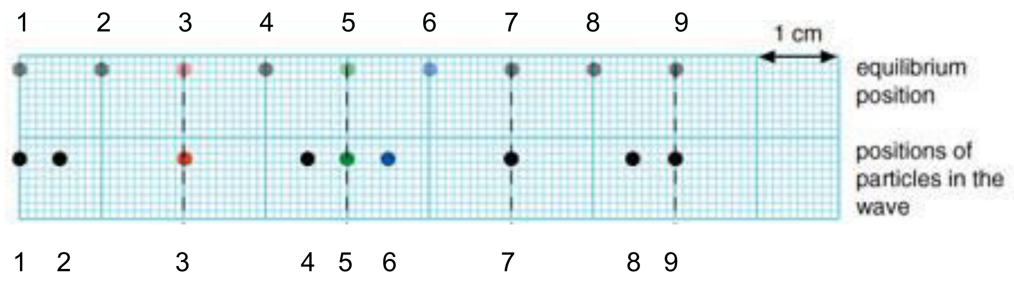


Fig. 4.1

(i) Deduce the displacement of particle 2 when the wave passes through it at the instant shown in Fig. 4.1.

displacement = ………………………… cm [1]

(ii) Draw, using the axes provided below, the displacement-position graph representing all the particles disturbed by the wave as shown in Fig. 4.1. Indicate on your graph all centers of rarefaction R and compression C.

[3]

(iii) Hence deduce the amplitude of the progressive wave.

amplitude = ………………………….. cm [1]

(iv) State the phase difference between particles 5 and 7.

phase difference = ………………………….. rad [1]

5 **(a)** A thermometer and an electrical heater are inserted into holes in an aluminium block of mass 960 g, as shown in Fig. 5.1.

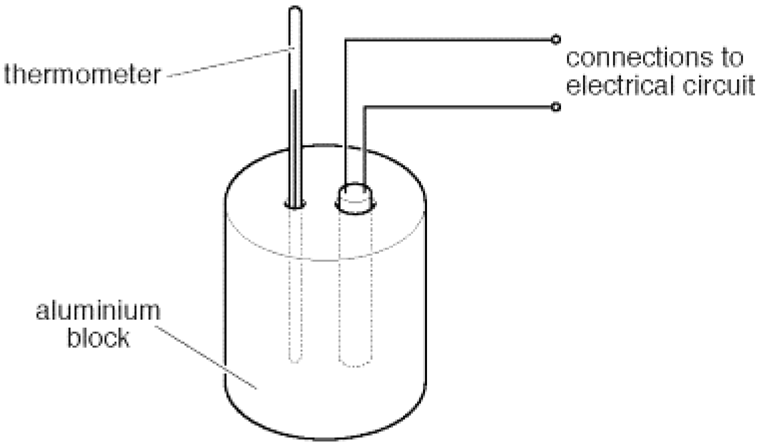


Fig. 5.1

The power rating of the heater is 54 W. The heater is switched on and readings of the temperature of the block are taken at regular time intervals. The variation with time t of the temperature θ of the block is shown in Fig. 5.2.

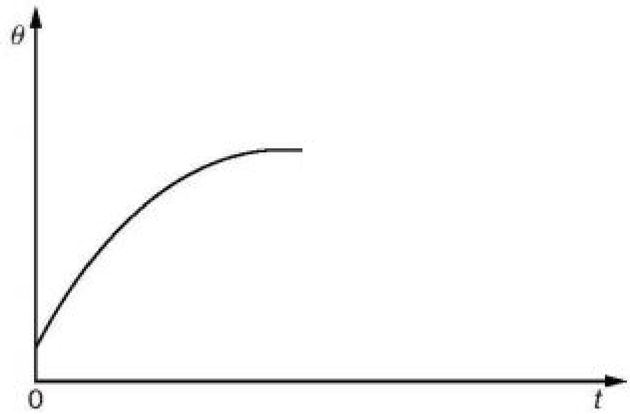


Fig. 5.2

(i) Suggest why the rate of rise of temperature of the block decreases to zero.

....

....

.... [2]

(ii) When the block reaches a constant temperature, the heater is switched off and then further temperature readings are taken. The maximum rate of fall of temperature is found to be around 3.7 °C per minute.

Estimate the heat capacity of the aluminium block.

heat capacity = …………………………….J K^{-1} [2]

(b) Fig. 5.3 shows an insulated cylinder fitted with a perfectly fitting piston and a heater.

There is negligible friction between the cylinder and the piston. The cylinder contains a fixed mass of an ideal gas.

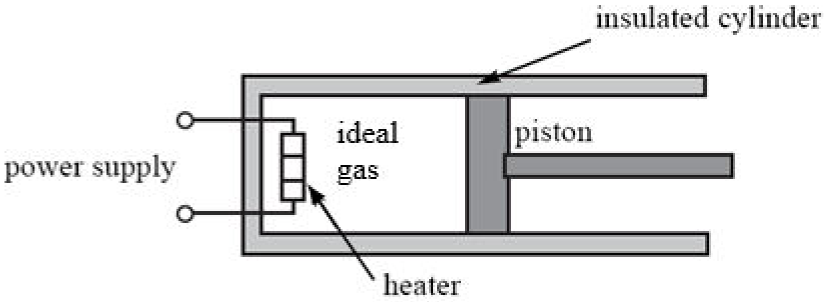


Fig. 5.3

The following two experiments are performed.

Experiment 1 The heater provides 150 J of energy with the piston fixed in position. The temperature rise of the gas is found to be 29 K.

Experiment 2 The heater supplies 150 J of energy with the piston free to move so that the gas expands at constant pressure. The temperature rise of the gas is now 18 K.

(i) Explain why the temperature rise is different in the two experiments.

....

....

.... [2]

(ii) Fill up the table below to show the values of each of the quantities for experiments 1 and 2. Present your workings using the space provided below.

	thermal energy supplied to gas / J	**work done on gas / J**	**increase in internal energy of gas / J**
Experiment 1			
Experiment 2			

[4]

6 (a) Fig. 6.1 shows some energy levels for the hydrogen atom (not to scale).

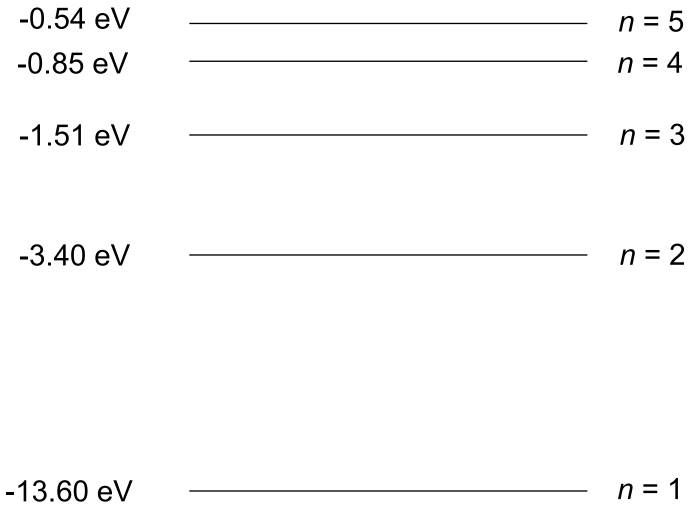


Fig 6.1

(i) State the number of emission lines that could be produced from the energy levels shown in Fig 6.1.

number of emission lines = ……………………… [1]

Visible light wavelengths range approximately from 400 nm to 750 nm.

(ii) Show that the emission spectrum when electrons make transitions to the n = 1 state does not fall within the visible region of the electromagnetic spectrum.

[3]

(iii) Hence or otherwise, determine the number of *visible* emission lines for the energy levels shown in Fig. 6.1. Show all workings clearly.

number of visible emission lines = ……………………… [4]

(b) The atomic energy levels for a multi-electron atom can be approximated using the formula:

$$E_n = -\frac{(13.60)(Z-1)^2}{n^2}$$

where Z is the atomic number of the atom, n is the quantum number of the shell, and E_n is the energy of the shell in eV.

(i) Using the formula provided in **(b)**, determine the energy of the photon released when an electron transitions from n = 2 to n = 1 in a tungsten atom (atomic number 74).

energy of photon released = ……………………… eV [3]

(ii) Hence state the type of electromagnetic radiation emitted when an electron transitions from n = 2 to n = 1 in a tungsten atom.

.... [1]

7 Read the following passage and then answer the questions which follow it.

Lithium solid-state batteries

Solid-state battery is a battery technology that uses both solid electrodes and solid electrolytes, instead of the liquid electrolytes found ordinary battery systems.

Fig. 7.1 shows an example of a lithium solid-state cell. A solid plastic film separates a lithium metal anode (positive electrode) from a composite cathode (negative electrode) which is in contact with aluminium foil.

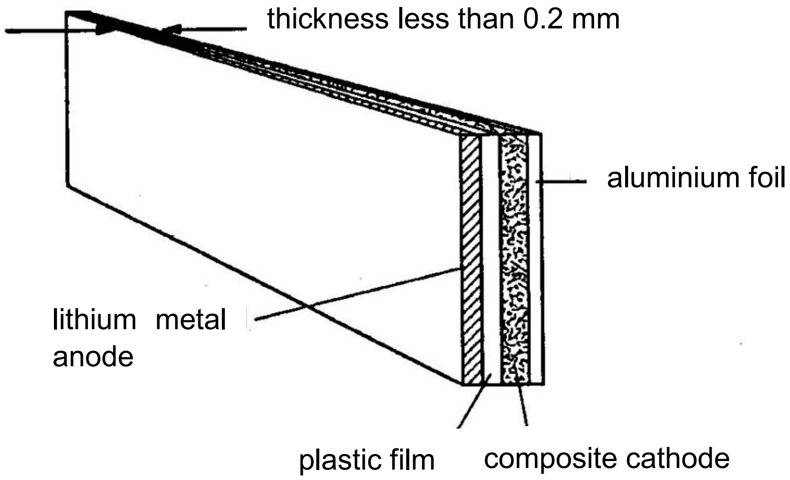


Fig. 7.1

The resultant cell can be constructed so that it has a large electrode area but is less than 0.2 mm thick. It is many ways similar to a sheet of paper and can be cut and formed into almost any shape. Lithium solid-state cells such as this are rechargeable and can be incorporated into the cases of equipment or into such items as credit cards.

The initial e.m.f. of the cell at full charge is 3.4 V but it rapidly falls to about 2.8 V on load and thereafter falls as shown in Fig. 7.2. The cell needs to be recharged when the e.m.f. reaches 2.0 V. In practice, its average e.m.f. is 2.5 V.

The current density, energy density and charge capacity all have to be considered for a particular application.

The recommended maximum value of discharge current density is 0.15 milliamperes per square centimetre of electrode area, the charge capacity is 3.6 coulombs per square centimetre of electrode area, and the energy density is 120 watt-hours per kilogram of cell mass.

Charging one of these cells should be carried out with a constant applied voltage of 3.4 V and with a current density limited to 2.5 mA cm^{-2}. A typical charging current against time graph is shown in Fig. 7.3 for a cell of electrode area 50 cm^{2}.

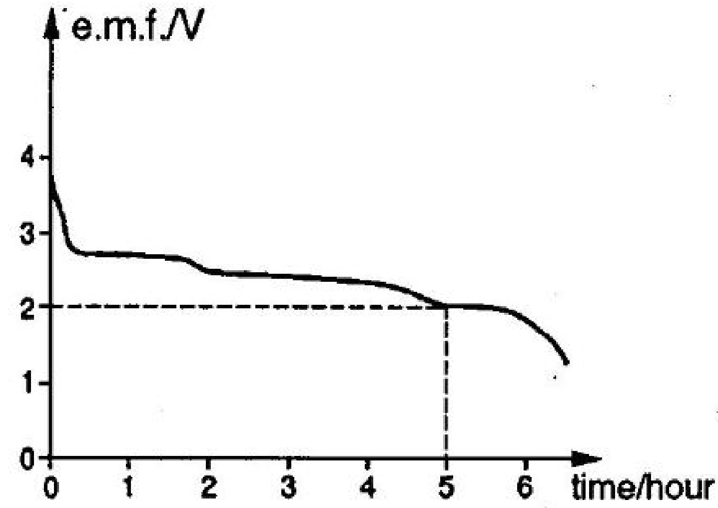


Fig. 7.2

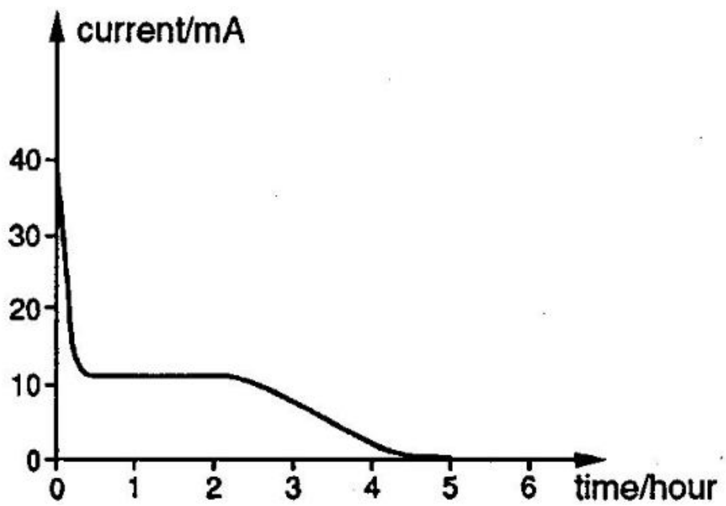


Fig. 7.3

For safety it is vital that

- cells should not be short circuited. (A fuse should be incorporated in any circuit with a cell of charge-storage capacity greater than 3600 coulombs.)
- cells should not be used in environments with a temperature above 140 ^{o}C.
- water or water vapour is kept away from lithium cells.

(a) Suggest one possible use of a lithium solid-state cell.

.... [1]

(b) Deduce from the units, and then write down, the meaning of the terms *current density* and *energy density*.

....

.... [2]

(c) Answer the following questions for a cell of electrode area 50 cm^2.

(i) Calculate the charge-storage capacity of this cell.

charge-storage capacity = …………………… C [1]

(ii) Calculate the recommended maximum value of the discharge current.

maximum current = …………………… mA [1]

(iii) Determine how long this cell can supply the maximum current calculated in **(ii)**.

length of time = …………………… s [2]

(iv) Calculate the energy it supplies in this time, assuming that the e.m.f. has a constant value of 2.5 V.

energy supplied = …………………… J [2]

(d) Fig. 7.3 shows the charging graph for a cell of the same electrode area as in **(c)**.

(i) Describe briefly the variation with time of the charging current.

....

.... [1]

(ii) State what is represented by the area under the graph.

....

.... [1]

(iii) From the graph, estimate the average charging current over the 5-hour charging time.

average charging current = …………………… mA [1]

(iv) Calculate the energy used in charging the cell.

energy used = …………………… J [2]

(e) Using your answers to **(c)(iv)** and **(d)(iv)**, deduce the electrical efficiency of the charge/discharge cycle.

efficiency = …………………… % [2]

(f) Suggest reasons for **two** of the safety considerations.

....

....

....

.... [2]

(g) Draw a diagram, using circuit symbols, to illustrate how you would connect a battery of cells which could produce a current of up to 300 mA at a voltage of approximately 10 V. In your answer, specify the electrode area of the individual cells.

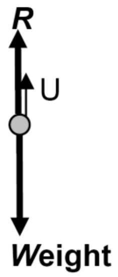
[2]

End of Paper

TPJC JC2 Prelim H2 Physics Paper 2 (Mark Scheme)

1 **(a)**

Free body diagram:



[maximum 2 marks]
minus 1 mark for each missing force or force with wrong direction.
minus 1 mark if forces are not correctly labelled.

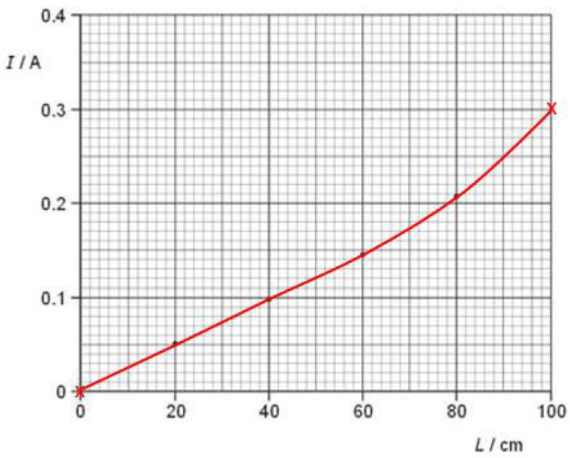
Explanation:
As speed of body increases, fluid resistance *R* increases. [B1]
As *R* increases, net acceleration decreases / speed increases at a decreasing rate. [B1]
when *R* + upthrust *U* becomes equal to weight *W*, no net force [B1]
so the body reaches terminal velocity.

(b) **(i)**
No resultant force acts on the rod in any direction (ensures translation equilibrium) [B1]
No resultant moment (or torque) about any axis (ensures rotational equilibrium) [B1]

(ii)
By Principle of Moments, [C1]
$(400 \sin 60^{o})(0.5L) + (2000 \sin 60^{o})(L) = (T \sin 30^{o})(L)$ [M1]
T = 3810 N [A1]

2 **(a)** **(i)** zero **[A1]**
(ii) 1.5/5.0 = 0.30 A **[A1]**

(b) **(i)** Correct plots to within ± 1mm **[B2]**
(ii) Reasonable line / curve through points **[B1]**
giving current 0.120 A (allow ± 0.005 A), read to half small square precision **[A1]**



(iii) $V = IR$ **[C1]**

$V = 0.12 \times 5.0$

$= 0.60$ V **[A1]**

(c) Resistance between A and C not equal to resistance between C and B **[B1]**
Current in wire AC × *R* is not equal to current in wire BC × *R* **[B1]**
Or current in AC not the same as current in BC

3 **(a)** Simple harmonic motion is the motion of a body whose acceleration is proportional to the displacement from the equilibrium point [B1] and is always directed towards that point [B1].

(b)

(i)

$f = \frac{1}{T} = \frac{1}{0.60} = 1.67\ Hz\ or\ 1.7\ Hz$ **[A1 to 2 or 3 s.f.]**

(ii)

$a_0 = \omega^2 x_0 = (2\pi \times 1.67)^2 \times 10 \times 10^{-3}$ **[C1]**

$= 1.10\ m\ s^{-2}$ **[A1]**

(iii)

$F_0 - W = ma_0$

$F_0 = ma_0 + mg = 0.320 \times (9.81 + 1.10)$ **[M1]**

$= 3.49\ N$ **[A1]**

(c) **(i)**

Negative cosine curve with same period as undamped (or slightly longer period) amplitude decreases gradually with time

(ii)

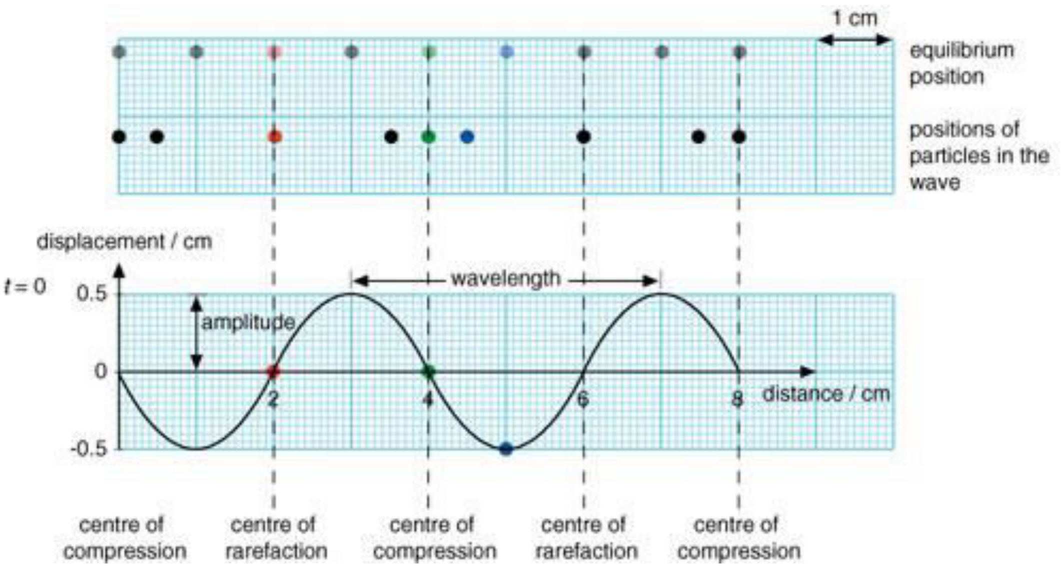
kinetic energy of the plate -> electrical energy -> thermal energy / heat energy

4 (a) Transverse wave: the directions of vibrations of the particles are perpendicular to the direction of energy transfer [B1]

Longitudinal wave: the direction of vibration of the particle is along the direction of energy transfer [B1]

(b) (i) Displacement = - 0.5 cm

(ii)



(iii) amplitude = 0.5 cm

(iv) phase difference = 3.14 rad

5 **(a)** **(i)** Rate of thermal energy losses (to the surroundings) increase as temperature rises, resulting in less of the power input being used to increase the temperature [B1]

Rate of rise in temperature becomes zero when the rate of thermal energy loss increase to be equal to the power input [B1]

(ii) Maximum rate of thermal energy loss = power input

C (dθ / dt) = 54

C (3.7 / 60) = 54 [M1]

C = 876 or 880 J K^{-1} [A1]

(b) **(i)** For experiment 1, no work is done by gas, hence all the thermal energy supplied is used to increase the internal energy while for experiment 2, some of the thermal energy supplied is used by the gas to do work in expanding, resulting in less increase in internal energy [B1]

Hence experiment 2 has a smaller increase in internal energy than experiment 1, resulting in smaller temperature rise [B1]

(ii)

	thermal energy supplied to gas/J	work done on gas /J	increase in internal energy of gas/J
Experiment 1	+150	0 [1 mark]	+150 [1 mark]
Experiment 2	+150	-57 [1 with working]	+ 93 [1 mark]

- 1 mark for work done on gas in experiment 1
- 1 mark for increase in internal energy for experiment 1
- 1 mark for calculating increase in internal energy for experiment 2, with working

$\Delta U_2 = \Delta U_1 (\Delta T_2 / \Delta T_1) = 150 (18 / 29) = 93$ J

- 1 mark for calculating work done on gas in experiment 2, with working

W = Δ U – Q = 93 – 150 = - 57 J

6 **(a)** **(i)** number of emission lines = …………10……………

(ii) Choose transition from n = 2 to n = 1 as that gives the **minimum** energy change.

Energy change = $-13.6 - (-3.4) = -10.2\ eV$

Energy change in Joules = $10.2 \times 1.6 \times 10^{-19} = 1.632 \times 10^{-18}\ J$ [C1]

Wavelength for transition = $\frac{hc}{\Delta E} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{1.632\times10^{-18}} = 122 \times 10^{-9} m$ [B1]

Conclusion: "The wavelength for the lowest energy transition / smallest energy gap is 122 nm which is shorter than all visible wavelengths. Hence any transition from n = 3 or higher to n = 1 will also be shorter than visible wavelengths / all transitions to n = 1 will not be in visible wavelengths". [A1]

(iii) Energy of 400 nm wavelength radiation in eV = 3.11 eV
Energy of 750 nm wavelength radiation in eV = 1.66 eV
[C1 for any calculation of the range of visible spectrum in J or eV]

Calculating energy change for transitions
Maximum energy gap n = 5 to n = 2 is = $-3.40 - (-.54) = 2.86\ eV$
Minimum energy gap n = 3 to n = 2 is = $-3.40 - (-1.51) = 1.89\ eV$
"Hence all 3 transitions to n = 2 lie within visible spectrum"
[B1 for any calculation that shows that 3 transitions to n=2 are in the visible spectrum (working must be shown)]

from n = 5 to n = 3 is = $-1.51 - (-0.54) = 0.97\ eV$
"Since the maximum energy for transitions to n=3 lie in the infrared or longer wavelength, none of the emissions to n=3 or n=4 are visible. "
[B1 for correct calculation that shows transitions to n = 3 and n = 4 do not produce visible radiation (working must be shown)]

Answer: 3 visible emission lines **[A1 – with supporting working above. Unsupported answers which are derived from guesswork or with no working will not get this mark.]**

(b) **(i)** $E_1 = -\frac{13.60\times(74-1)^2}{1^2} = -7.25 \times 10^4\ eV$ **[C1]**
$E_2 = -\frac{13.60\times(74-1)^2}{2^2} = -1.81 \times 10^4\ eV$ **[C1]**
Energy change = $-7.25 \times 10^4 - (-1.81 \times 10^4) = -5.43 \times 10^4\ eV$
Energy of the emitted photon is 54.3 keV **[A1]**

(ii) X-ray. [A1]

7 **(a)** Expected answers: battery / power source for pacemakers, RFID, and wearable devices.
(0 mark if devices are quoted with no reference to the cell being used as a power source.)

(b) Current density is current per unit area. [B1]
Energy density is energy per unit mass. [B1]
(Answers in terms of units not accepted)

(c) **(i)** Given charge capacity is 3.6 C cm^{-2},
Charge storage capacity = 3.6 x 50
= 180 C [A1]

(ii) Given recommended max. discharge current density is 0.15 mA cm^{-2},
recommended max. discharge current = 0.15 x 50
= 7.5 mA [A1]

(iii) $Q = It$
$180 = (7.5 \times 10^{-3})t$ [C1]
t = 24 000 s [A1]

(iv) $E = QV$
= (180)(2.5) [C1]
= 450 J [A1]

(d) (i) The charging current decreases rapidly for a short duration, then stays constant for a while before decreasing gradually to zero. [A1]

(ii) The area represents the total charge supplied to the cell. [A1 – reference must be made to the cell]

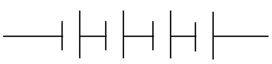
(iii) 9 mA. (Acceptable range: 8 – 10 mA) [A1]

(iv) $E = QV$
$= (9 \times 10^{-3})(5 \times 60 \times 60)(3.4)$ [C1]
= 551 J [A1]

(e) Efficiency = (discharged energy / energy used to charge cell) x 100%
= (450 / 551) x 100%
= 81.7%
(Do not accept answer > 100%)

(f) Possible answers:
(1) Short circuited results in large currents which cause overheating, cell may catch fire; result in burn hazard.
(2) Above 140 °C, cells may overheat and catch fire; result in burn hazard Or plastic film may melt.
(3) Water or water vapour within lithium cells may result in electric shocks Or lithium reacts violently with water.

(g) 4 cells arranged in series [B1] as each cell has average e.m.f. of 2.5 V.



Each cell having an electrode area of 2000 cm^2 [B1] based on recommended max current density of 0.15 mA per cm^2.

H2

TAMPINES JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME

CIVICS GROUP | 1 | 7 | | | |

TUTOR NAME

PHYSICS
Paper 3 Longer Structured Questions

9749/03

Friday, 14 September 2018

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **one** question.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
Section A		
1	10	
2	10	
3	11	
4	9	
5	10	
6	10	
Section B		
7	20	
8	20	
s.f		
Total / 80		

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
permeability of free space	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_0	=	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} Js
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	=	ρgh
gravitational potential	ϕ	=	$-\frac{GM}{r}$
temperature	T/K	=	T / °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	=	$v_0 \cos\omega t$
		=	$\pm\,\omega\sqrt{(x_0^2 - x^2)}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + ...$
resistors in parallel	$1 / R$	=	$1/R_1 + 1/R_2 + ...$
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	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

Section A

Answer **all** the questions in this section.

1 An object of mass 1.5 kg is released from a stationary hot air balloon. Fig. 1.1 shows how the velocity of the object varies with time.

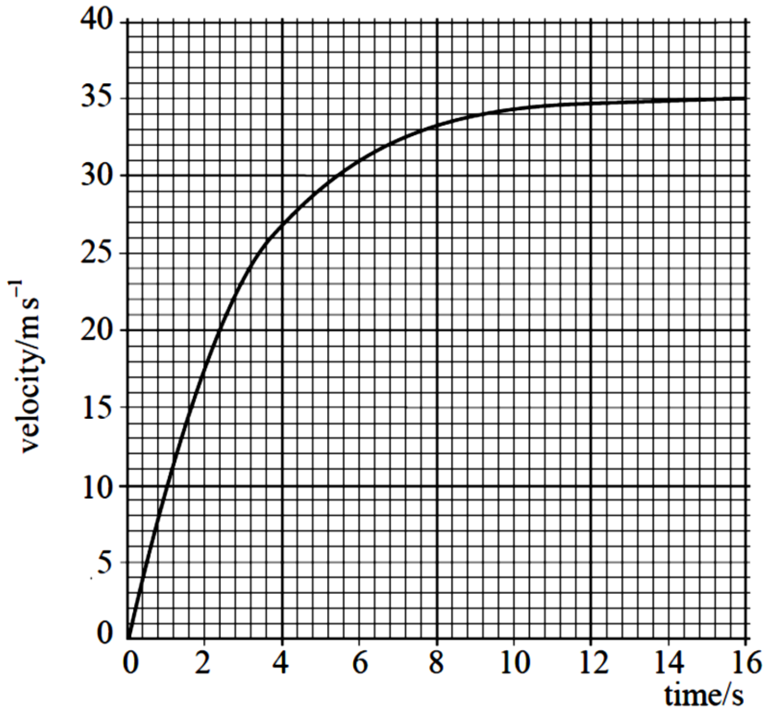


Fig. 1.1

(a) Describe how the acceleration of the falling object changes over the first 16 s.

....

....

.... [2]

(b) Explain how the forces acting on the falling object cause the changes in acceleration described in **(a)**.

....

....

.... [2]

(c) Use Fig. 1.1 to determine the acceleration of the object 5.0 s after it was released.

acceleration = …………………… m s^{-2} [2]

(d) Estimate the distance fallen in the first 16 s.

distance = …………………… m [2]

(e) Sketch the graph of distance against time using the axes provided below.

[2]

2 **(a)** A horizontal force of 54 N is applied to push two touching blocks of mass 6.0 kg and 2.0 kg along a flat surface. The frictional force between the blocks and the surface is 6.0 N.

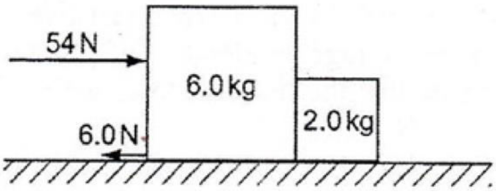


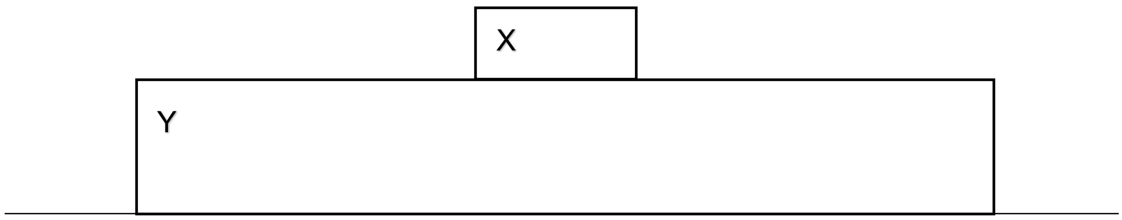
Fig. 2.1

Calculate the magnitude of the resultant force on the 6.0 kg mass.

resultant force = …………………… N [3]

(b) A metal block X of mass 0.015 kg is dropped from rest from a certain height until it hits a table Y.

(i) Using the diagram below, for the instant of impact between the metal block X and table Y, draw and label all forces acting on X and Y. Make it clear which forces are equal in magnitude and opposite in direction.



[3]

(ii) Just before hitting the table-top, the metal block has a speed of 3.92 m s^{-1}.

Upon impact with the table-top, the metal block remains in contact with the table-top for a duration of 1.5 ms before it bounces vertically off the table-top with a 20% reduction in speed.

1. Calculate the change in momentum of the metal block after its collision with the table-top.

change in momentum = …………………… N s [2]

2. Hence determine the average force exerted by the metal block on the table-top.

average force = …………………… N [2]

3 Fig. 3.1 shows the variation with distance x of the gravitational potential ϕ between the surface of the Earth and the surface of the Moon. At point P, the gravitational potential is a maximum.

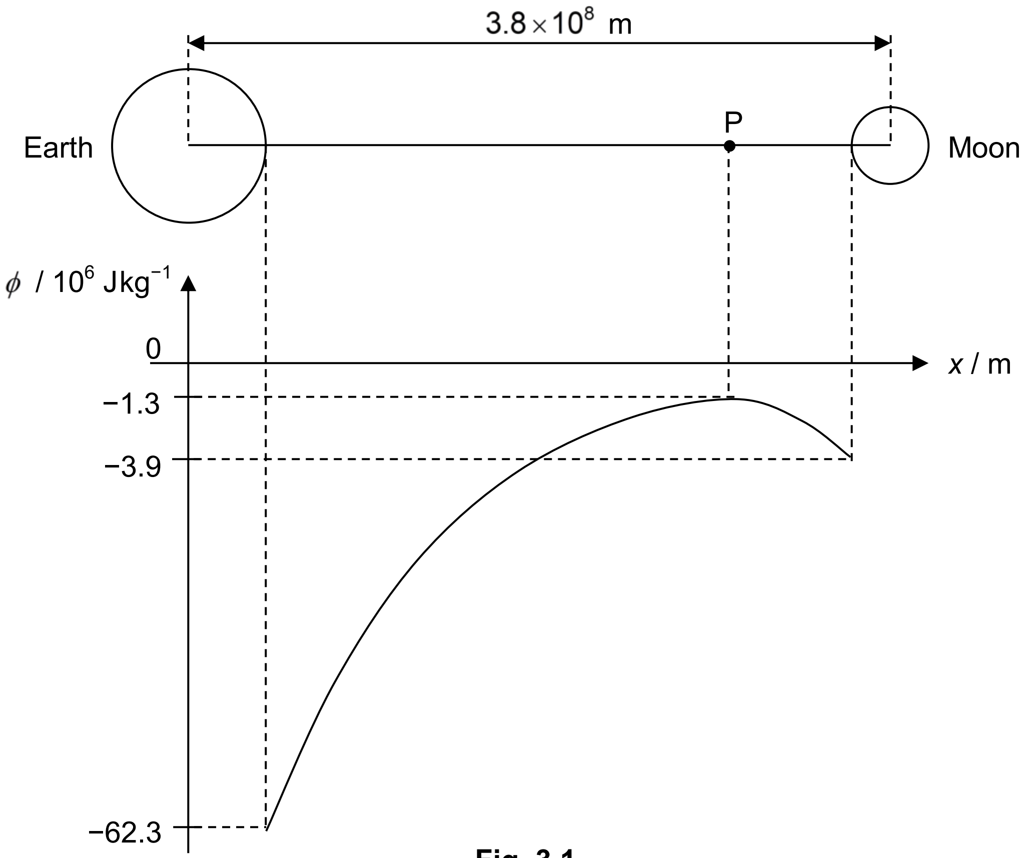


Fig. 3.1

The centres of both masses are separated by a distance of 3.8×10^{8} m. The masses of the Earth and the Moon are 6.0×10^{24} kg and 7.4×10^{22} kg respectively.

(a) Define *gravitational potential* at a point and explain why the values of the potential shown in Fig. 3.1 are negative.

....

....

....

....

....

....

.... [3]

(b) **(i)** State how the resultant gravitational field strength at any point between the Earth and the Moon can be deduced from the graph in Fig. 3.1.

....

.... [1]

(ii) Determine the distance from the centre of the Earth where the resultant gravitational field strength is zero.

distance = ... m [2]

(iii) On Fig. 3.2, sketch a graph to show the variation of the resultant gravitational field strength with distance x between the surface of the Earth and the surface of the Moon. Numerical values are not required.

Fig. 3.2

[2]

(c) A spacecraft is to be launched from the surface of the Earth to reach the surface of the Moon. Determine the minimum speed required to project the spacecraft from the surface of the Earth. Explain your answers clearly.

minimum speed = ... m s^{-1} [3]

4 **(a)** State what is meant by an electric field.

....

.... [1]

(b) Fig. 4.1 shows a small charged particle at a point A in a uniform electric field. The particle experiences an electric force F of 5.0×10^{-7} N. The grid lines are at intervals of 1.0 cm.

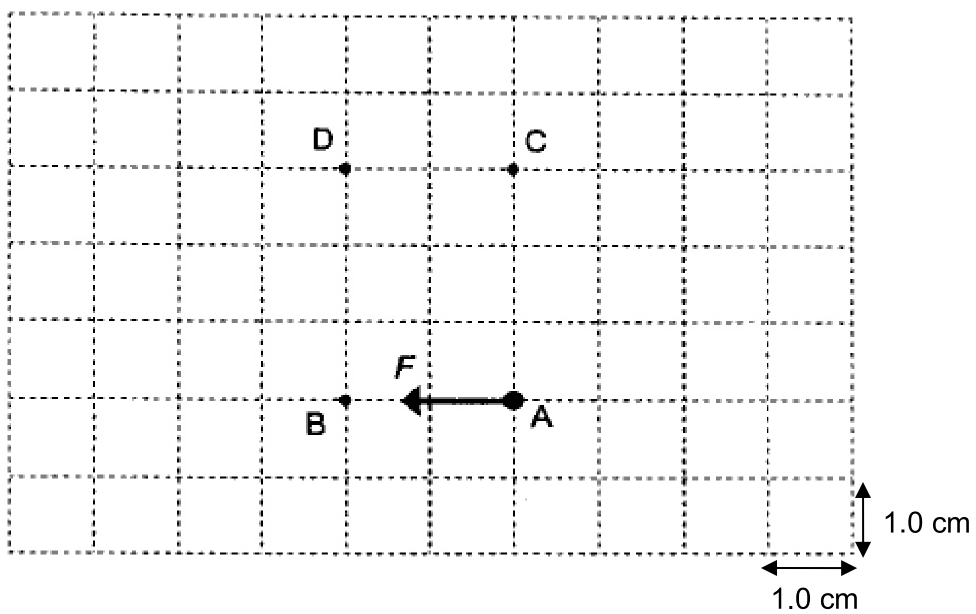


Fig. 4.1

Determine the work done by the electric force if the particle is moved

(i) from A to B,

W_{AB} = ……………………… J [1]

(ii) from A to D.

W_{AD} = ……………………… J [1]

(c) If the particle carries a charge of -2.5×10^{-11} C and point A is at a potential of +200 V, calculate the potential at point B due to the uniform field.

potential at B = ... V [2]

(d) The uniform electric field is produced by a pair of flat metal plates, one of which is earthed and the other is at a potential of +1000 V.

Sketch on Fig. 4.1

(i) the positions of the two plates. [2]

(ii) at least four equipotential lines in the region between the two plates. Label the value of the potential of each line that is drawn. [2]

5 A *cyclotron* is a device that accelerates charged particles to high energies.

The cyclotron uses a magnetic field to keep charged particles moving in circles. The charged particles move within two D-shaped hollow metal conductors called *dees*, which are separated by a very narrow gap.

An alternating square-wave potential difference is applied between the dees, resulting in a region of electric field at the gap. Each time the charged particles pass into the gap between the dees, they are accelerated by the potential difference across the gap. This increase their speed and also increases the radius of curvature of their path.

After many revolutions, the charged particles acquire high kinetic energies and exit the outer edge of the cyclotron.

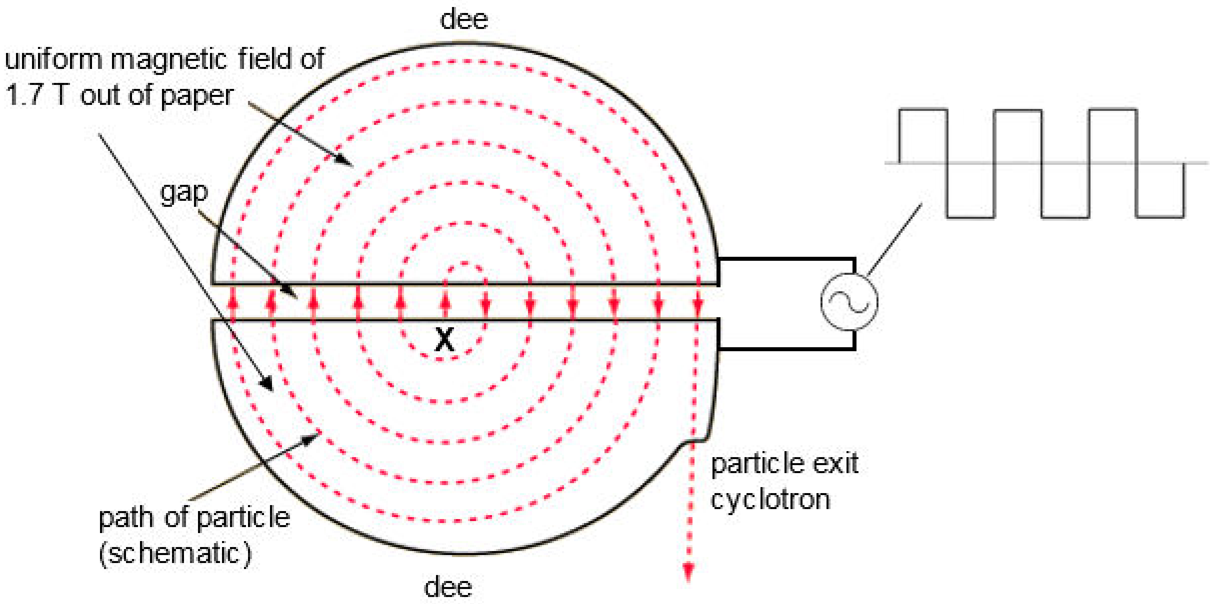


Fig. 5.1

A particle, enters the centre **X** of the cyclotron, as shown in Fig. 5.1, at a *low speed*, and travels in circular paths under the influence of a uniform magnetic field of flux density 1.7 T, which is acting perpendicularly out the page.

(a) The particle is either an electron or a proton. With reference to Fig 5.1, state what the particle is supposed to be.

.... [1]

(b) **(i)** The frequency of the alternating potential difference applied between the dees has to be set accurately to be equal to the frequency of revolutions of the charged particle.

Explain what will happen if the frequency is not set accurately.

....

.... [1]

(ii) Show that the frequency needed for the alternating potential difference is 2.6×10^7 Hz.

[3]

(c) Just before exiting the cyclotron, the particle was traveling in a path of radius 0.25 m and had just completed 100 revolutions.

Determine

(i) the kinetic energy of the particle just before it exits the cyclotron.

kinetic energy = …………………… J [3]

(ii) the amplitude of the alternating potential difference applied across the dees.

amplitude = …………………… V [2]

6 **(a)** State what is meant by a *photon*.

....

…………………………………………………………………………………………… [1]

(b) An X-ray photon of wavelength 965.0 x 10^{-12} m collides elastically with a stationary electron, as shown in Fig 6.1.

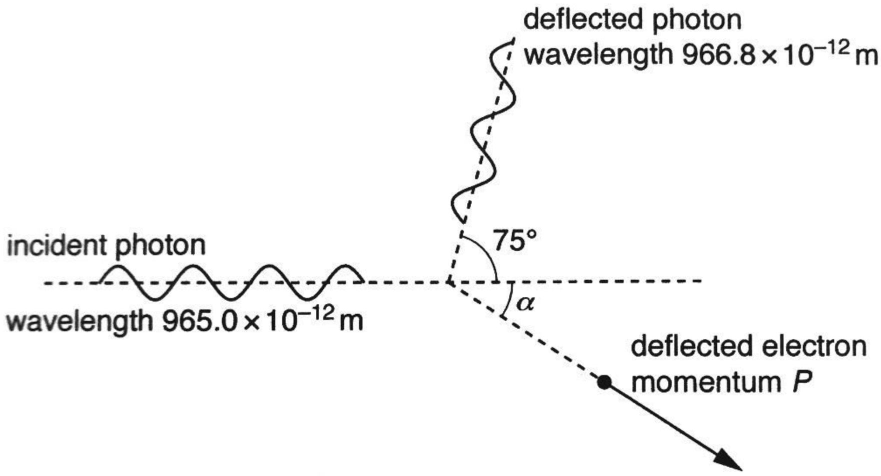


Fig. 6.1

The photon is deflected through an angle of 75° and its wavelength changes to 966.8 x 10^{-12} m after the collision. The electron is deflected through an angle α.

(i) Calculate the change in the energy of the photon as it is deflected.

energy change = …………………… J [2]

(ii) Use conservation of energy to show that the momentum P of the deflected electron is 8.36×10^{-25} N s.

[2]

(c) Momentum is a vector quantity. By taking components of momentum perpendicular to the direction of the incident photon, calculate the angle α of deflection of the electron as shown in Fig 6.1.

Explain your working.

angle α = …………………… ° [5]

Section B

Answer any **one** question from this section.

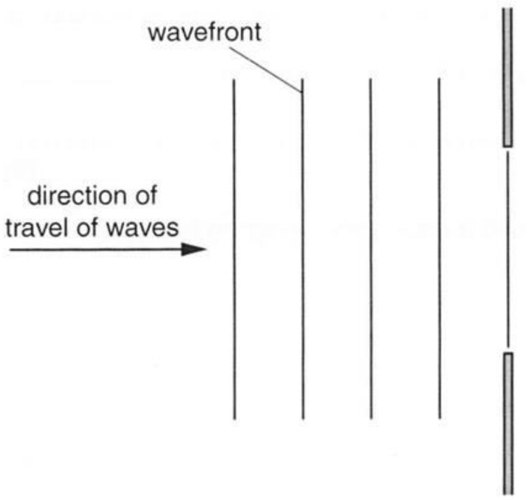
7 **(a)** **(i)** Explain what is meant by the diffraction of a wave.

....

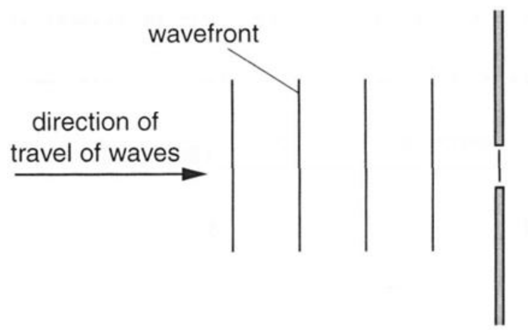
.... [1]

(ii) A ripple tank is used to show the diffraction and interference of waves. On Fig. 7.1, plane wave-fronts are shown in two cases, approaching a single slit. Draw four wave-fronts to show the waves after they have passed through the slit in each case.

[3]



Wide slit



Narrow slit

Fig. 7.1

(iii) In a separate experiment using *double-slit arrangement*, two source interference of water waves were not observed when the slit widths are wide.

However, narrowing the slits while maintaining the same slit-to-slit separation produced obvious interference patterns.

Suggest why.

....

....

....

....

....

....

.... [3]

(b) (i) By reference to waves, state what is meant by *coherent sources.*

....

....

....

.... [2]

(ii) Two sources **S_1** and **S_2** operate in phase to produce circular waves as shown in Fig. 7.2. (Note that the circles represent crests.)

Along the line **XY**, there is a series of alternate maxima and minima.

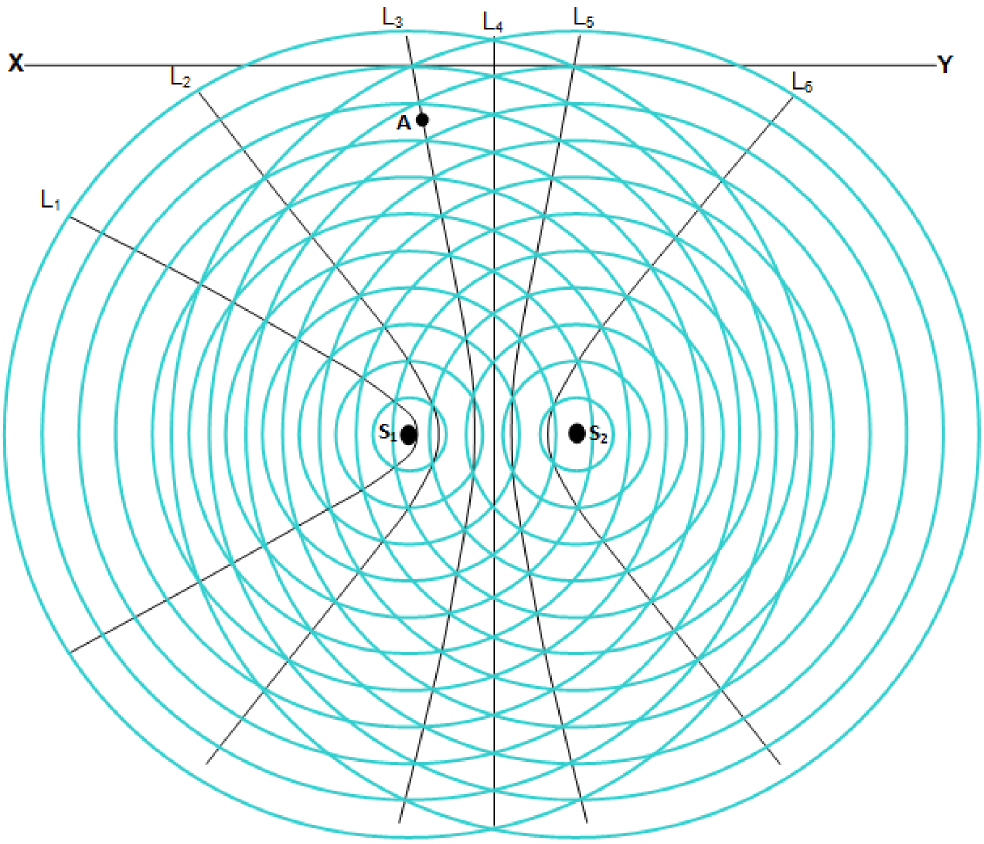


Fig. 7.2

1. Explain what lines L_1 to L_6 represent and whether point **A**, as indicated in Fig. 7.2, is a point of constructive or destructive interference.

....

.... [2]

2. State the relationship between the magnitude of the path difference $S_1A - S_2A$ and the wavelength.

.... [1]

3. Draw, on Fig. 7.2, a line to show one direction along which the waves have minimum amplitude. Label this line as Z. [1]

4. If the separation of the sources is increased, state what would happen to the spacing between maxima.

.... [1]

(c) Monochromatic light is passed through a rectangular slit of width *b* of 0.20 mm. The light is observed on a screen placed 0.75 m from the slit, as shown in Fig. 7.3.

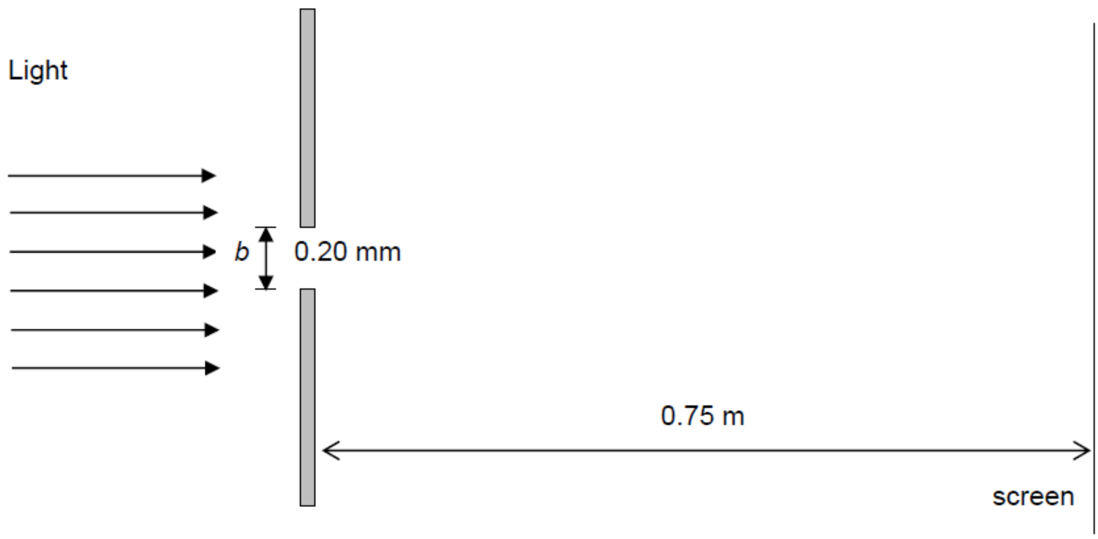


Fig. 7.3

Light passing through the slit is diffracted through an angle θ.
The variation of the intensity I of the light with the angle θ of diffraction is shown in Fig. 7.4. The maximum value of intensity is I_0.

The angular separations between successive minima are the same.

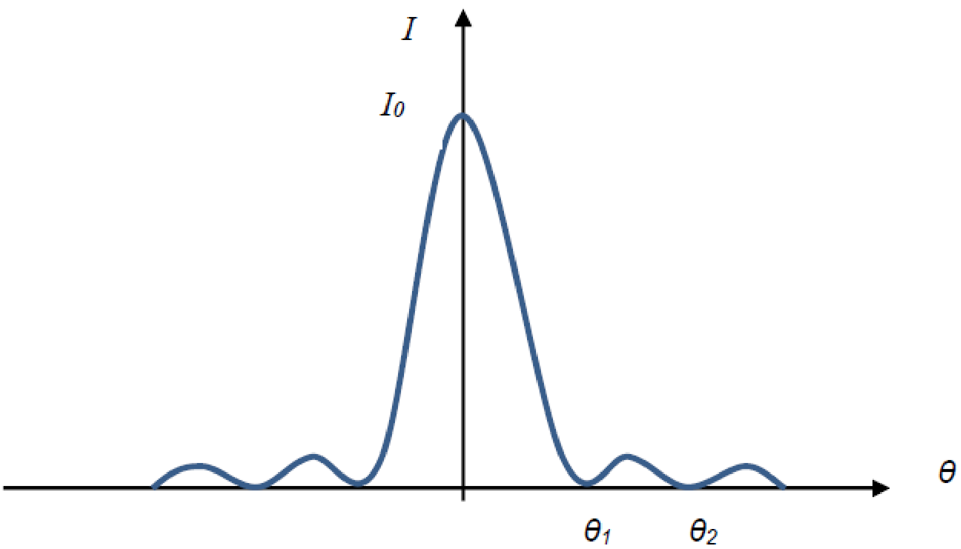


Fig. 7.4

(i) The value of θ_1, the angle of diffraction corresponding to the first order minima, is 0.169°. Determine the wavelength of the monochromatic light.

wavelength = …………………… nm [2]

(ii) Calculate the width of the central fringe, as observed on the screen.

width = …………………… mm [2]

(iii) Sketch, on the axes of Fig. 7.4, how the intensity *I* varies with angle θ if the slit width is halved.

[2]

8 **(a)** Explain what is meant by

(i) an isotope.

....

.... [1]

(ii) radioactive decay.

....

....

.... [2]

(iii) half-life of a radioactive substance.

....

....

.... [2]

(b) The number of atoms present in a radioactive source when the source was first acquired in 1990 was 2.5×10^{14}.

In 2018, the number of atoms that remains is 1.3×10^{14}. Determine the number of atoms that will remain in 2032.

number of atoms = ... [4]

(c) Strontium-90 $\left({}^{90}_{38}\text{Sr}\right)$ undergoes β-decay to form yttrium (Y).

Yttrium is itself radioactive and decays by the emission of a β-particle. The yttrium decays to form zirconium (Zr) which is stable.

Complete the nuclear equations below for the decay of strontium-90 to form zirconium.

$$ {}^{90}_{38}\text{Sr} \rightarrow \quad \text{Y} \quad + $$

$$ \text{Y} \rightarrow \quad \text{Zr} \quad + $$

[2]

(d) Plutonium-239 decays by α-emission to form the isotope uranium-235. In this nuclear reaction, 5.26 MeV of energy is released. The energy of the emitted α-particle is 5.15 MeV.

Suggest and explain why these two values are different.

....

....

.... [2]

(e) Fig. 8.2 lists various nuclides and their respective mass and binding energy per nucleon.

Particle/ Nuclide	**Name**	**Mass / u**	**Binding energy per nucleon / MeV**
${}^{1}_{1}\text{H}$	Proton	1.00728	0
${}^{1}_{0}\text{n}$	Neutron	1.00866	0
${}^{4}_{2}\text{He}$	Helium	-	7.07470
${}^{14}_{7}\text{N}$	Nitrogen	-	7.47724
${}^{17}_{8}\text{O}$	Oxygen	-	7.75224

Fig. 8.2

(i) Explain why the binding energy of a proton or neutron is zero.

....

.... [1]

(ii) Using the values from Fig. 8.2, determine the mass of helium nucleus, expressing your answer to an appropriate number of significant figures.

mass = ... u [3]

(iii) In a particular nuclear reaction, a slow moving alpha particle bombards a stationary nitrogen nucleus $^{14}_{7}N$, transmuting it to an oxygen nucleus $^{17}_{8}O$ and a proton.

The nuclear reaction is shown below.

$$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$$

Making use of values from Fig. 8.2, determine quantitatively whether the reaction can be spontaneous. Explain your workings.

[3]

End of Paper

TPJC JC2 Prelim H2 Physics Paper 3 (Mark Scheme)

1 **(a)** The gradient of the graph gives acceleration. Acceleration is largest initially [either 1] / it is constant for the first 0.1.2 s [or 1] and decreases to zero (or nearly zero) at 16 s. [1]

(b) As air resistance (viscous force) increases with speed [B1], weight and air resistance acting in opposite direction on the falling object causes resultant force or acceleration to decrease until zero. [B1]

(c) Tangent drawn at 5.0 s, acceleration = 2.1 m s^{-2} (±0.2) M1 A1

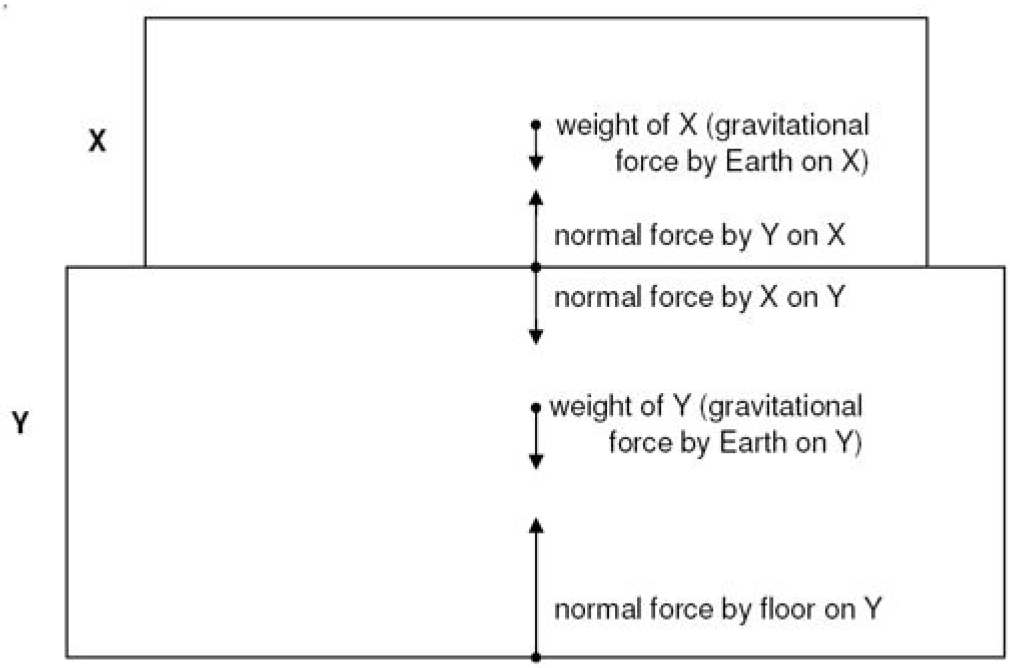
(d) Distance fallen
= Area under graph (correct method either counting squares or trap rule
= 460 m (accept 420-480 m) M1 A1

(e) Value of d increases at an increasing rate (with no noticable straight lines) [B1]
Gradient of d = 0 at t = 0 [B1]

2 **(a)** $F_{net} = m\,a$
$54 - 6.0 = (6.0 + 2.0)\,a$ [C1]
$a = 6.0$ m s^{-2}

$F_{net} = m\,a$
$F_{net} = (6.0)\,(6.0)$ [C1]
$F_{net} = 36$ N [A1]

(b) **(i)**



Forces drawn clearly with correct directions and labels [B2 for 5 forces, B1 for 4 forces, B0 for anything less.]
Action reaction pair: normal by Y on X and normal by X on Y drawn approximately to the same length [B1]

(ii) **1.** Change in momentum Δp
$= m\,\Delta v$
$= 0.015\,[\,(0.8 \times 3.92) - (-3.92)\,]$ [C1]
$= 0.106$ N s [A1]

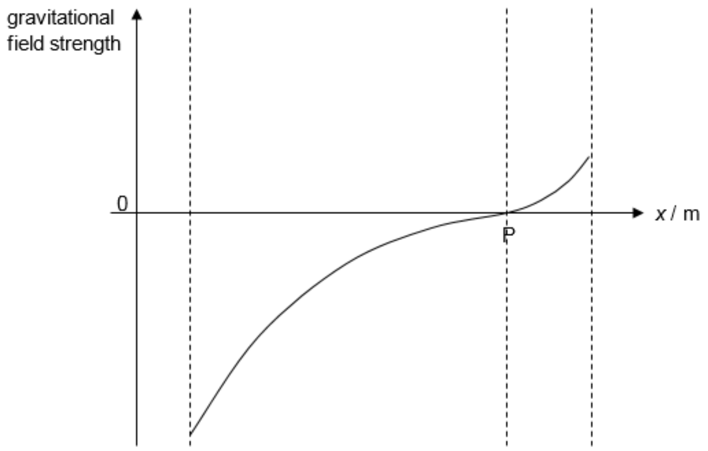
2. Change in momentum = (average force) x time
$0.106 = (\text{average force}) \times (1.5 \times 10^{-3})$ [C1 allow ecf from part 1]
average force = 70.7 N [A1]

3 **(a)** Gravitational potential at a point is the work done per unit mass by an external agent in bringing a small test mass from infinity to that point (at constant speed). [B1]
The potential at any point is negative as potential at infinity is taken to be zero [B1] and gravitational force is an attractive force. [B1]

(b) **(i)** The resultant gravitational field strength can be obtained by determining the negative of the gradient at any point from the graph. [B1]

(ii) At P,
$g_{Earth} = g_{Moon}$
$GM_{Earth} / r^2 = GM_{Moon} / (3.8 \times 10^8 - r)^2$ [C1]
(substitution)
$r = 3.42 \times 10^8$ m [A1]

(iii)



Correct shape [B1]

Correct details [B1]
- presence of zero field strength point closer to moon
- the field strength at surface of Moon smaller magnitude than that at surface of Earth
- the graph does not intersect at vertical axis (as x is taken from centre of Earth based on Fig 3.1)

(c)

The spacecraft will be provided with just enough energy for it to reach slightly beyond point P. Beyond point P, the spacecraft will be pulled towards Moon due to the resultant gravitational field pointing towards the Moon. [B1] for clear explanation

For spacecraft to just reach point P,

loss in k.e. = gain in g.p.e.

$$\frac{1}{2}mv_E^{\ 2} - \frac{1}{2}mv_P^{\ 2} = m\phi_P - m\phi_E$$

Since $v_P > 0$,

$$\frac{1}{2}v_E^{\ 2} > \left[-1.3 - (-62.3)\right] \times 10^6$$ [M1] for substitution

$v_E > 1.1 \times 10^4$ m s^{-1} [A1] for answer

4 **(a)** Electric field is a region of space within which a charge experiences an electric force. [B1]

(b) **(i)** W_{AB} = 5.0 x 10^{-7} x 2.0 x 10^{-2} = 1.0 x 10^{-8} J [A1]

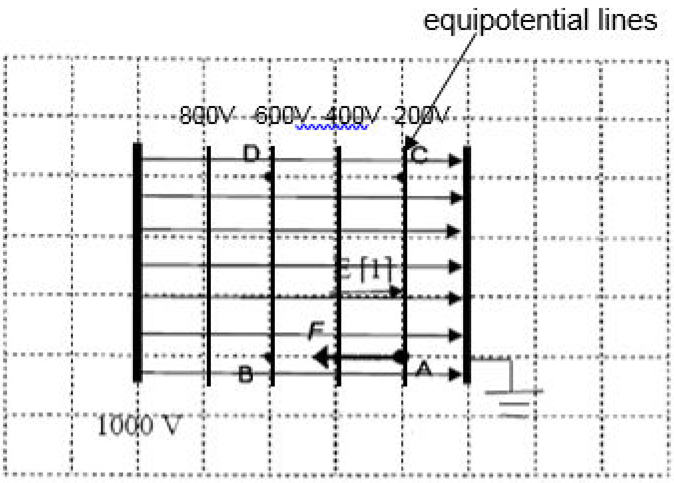
(ii) W_{AD} = 1.0 x 10^{-8} J [A1]

(c) $V_{AB} = W_{AB} / Q$
= 1.00 x 10^{-8} / 2.50 x 10^{-11}
= 400 V [M1]

$V_{AB} = V_B - V_A$
400 = V_B – 200
V_B = 600 V [A1]

(d) **(i)** Correct position of earthed plate [B1] and the 1000 V plate [B1], based on the given V_A = +200 V, and the calculated V_B in part c).

(ii) Correct sketch of 4 equipotential lines [B1], between the two drawn plates in part di).
Correct labelling of lines at 800 V, 600 V, 400 V and 200 V [B1]



5 **(a)** Proton. [B1]

(since by Fleming's left hand rule, the current is in the same direction as the velocity of particle)

(b) **(i)** If not set accurately, the charged particle will experience decelerations at times when crossing the gap [A1]. Hence it cannot achieve high speed.

(ii) $Bqv = mr\omega^2$ [B1]

$Bq\,(r\omega) = mr\omega^2$

$\omega = Bq / m$

$f = Bq / 2\pi m$ [B1]

$= 1.7\,(1.6 \times 10^{-19}) / 2\pi\,(1.67 \times 10^{-27})$ [M1 – no ecf for using mass of electron]

$= 2.6 \times 10^{7}$ Hz [A0]

(c) **(i)** (Allow ecf from (a))

$Bqv = mv^2/r \Rightarrow v = Bqr / m$ [B1]

$KE = \frac{1}{2} m v^2 = B^2q^2r^2 / 2m$

$= (1.7)^2\,(1.6 \times 10^{-19})^2(0.25)^2 / 2\,(1.67 \times 10^{-27})$ [M1]

$= 1.4 \times 10^{-12}$ J [A1]

(ii) (allow ecf from (i))

With 100 revolutions, the proton had undergone 200 times of acceleration by the electric field across the gap

Hence

$200\ q\ V_0$ = Gain in KE

$200\ (1.6 \times 10^{-19})\ V_0 = 1.392 \times 10^{-12}$ [M1]

$V_o = 4.35 \times 10^4$ V [A1]

6 (a) A photon is a quantum of electromagnetic radiation. [B1]

(b) (i) Change in energy
$= hc / (966.8 \times 10^{-12}) - hc / (965.0 \times 10^{-12})$ [C1]
$= -3.84 \times 10^{-19}$ J [A1]
(Ignore sign)

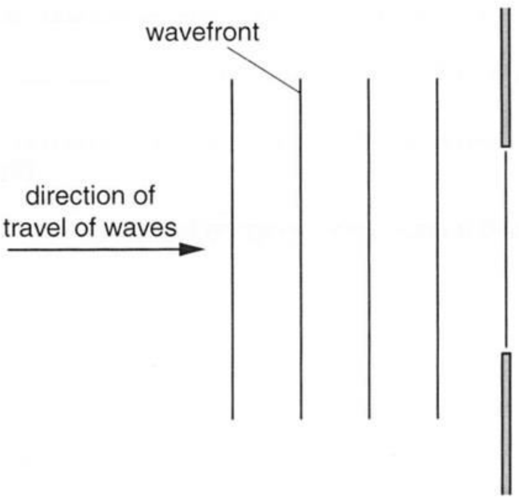
(ii) By conservation of energy,
Initial energy of photon = final energy of photon + energy of electron [B1]
$hc / (965.0 \times 10^{-12}) = hc / (966.8 \times 10^{-12}) + p^2 / (2 \times 9.11 \times 10^{-31})$ [M1]
$p = 8.36 \times 10^{-25}$ Ns [A0]

(c) By conservation of momentum, [B1]
total initial perpendicular component = total final perpendicular component [B1]
Taking upwards as positive,
$0 = p_{photon} \sin 75^o - p_{electron} \sin \alpha^o$ [M1]
$p_{electron} \sin \alpha^o = p_{photon} \sin 75^o$
$(8.36 \times 10^{-25}) \sin \alpha^o = [h / (966.8 \times 10^{-12})] \sin 75^o$ [M1]

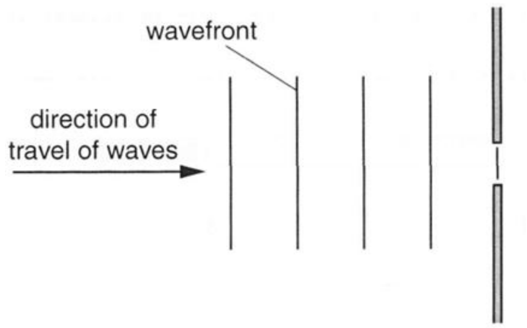
$\alpha = 52.4^o$ [A1]

7 **(a)** **(i)** Spreading of a wave **after** it passes through openings and around obstacles. [B1]

(ii)



Wide slit



Narrow slit

For both,
same wavelength in and out [1]
Individually,
Circular pattern for narrow gap [1],
straight with curve at edges for wide gap [1]

Marker's Comment:

- The wide slit cannot cause larger angle of spreading than the narrow slit.

(iii) When slits are wide, there is little spreading (diffraction) of water waves and hence waves from the 2 sources do not overlap sufficiently. [B1]

When slits are narrow, there is significant spreading for waves from the 2 sources to overlap and [M1]

produce positions of constructive and destructive interference, forming observable two source interference [A1].

(b) **(i)** Coherent sources are sources that emit waves with constant phase difference. [B1]

This means that the waves have the same frequency/wavelength/speed (any 2). [B1]

(ii) **1.** They are lines joining points of **constructive interference/maxima** [B1]. Point A lies on the line of constructive interference, hence **constructive** [B1].

2. $\mathbf{S_1A - S_2A = n\lambda}$ where n = 1

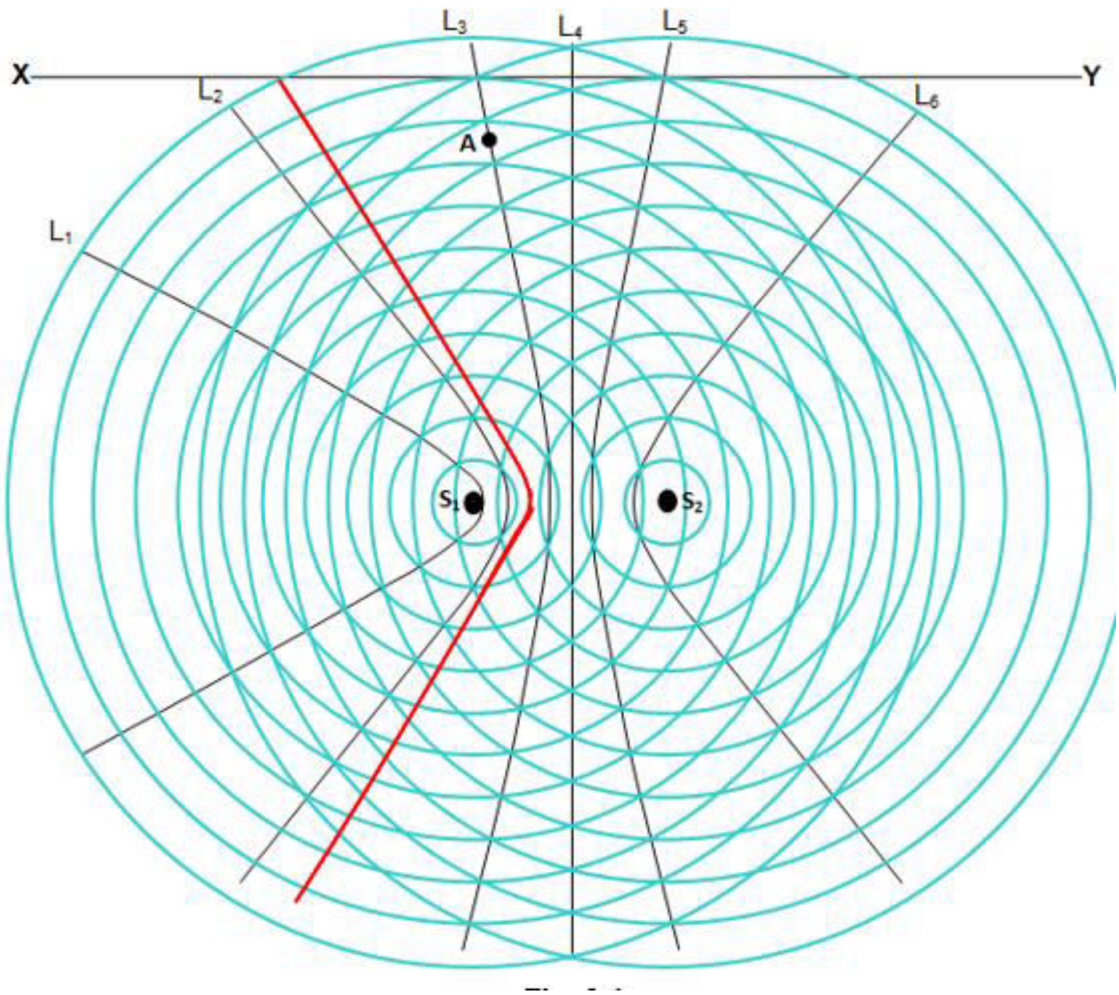
Path difference $\mathbf{S_1A - S_2A}$ is equal to the wavelength. [A1]

Mark is also given for "an integer number of wavelengths"

3. See red line in Fig. 7.2 below. Line cannot cross constructive interference line.

4. Spacing decreases (similar to double slit formula) [A1]

Ans:



(c) (i) $\sin\theta = \lambda / b$

$\sin 0.169^{\circ} = \lambda / (0.20 \times 10^{-3})$ [C1]

$\lambda = 590$ nm [A1]

(ii) width = $2 \times \tan 0.169^{\circ} \times 0.75$ [C1]

$= 4.42 \times 10^{-3}$ m

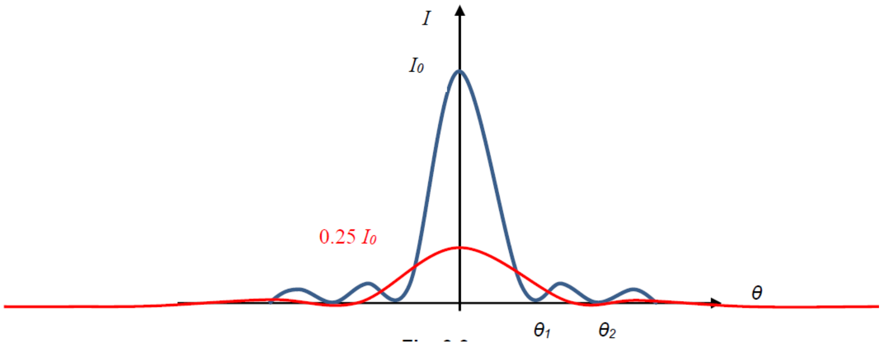
= 4.42 mm [A1]

(iii) Curve drawn should be reasonably smooth with:

[B1] Smaller maximum intensity. (Actual max intensity is $0.25\ I_0$)

[B1] First order minimum occurs at 0.338°. (Wider central fringe than before)

(Can be calculated using $\sin\theta = \lambda / b$)



8 (a) (i) Isotopes are atoms with the same number of protons (same element) but with different number of neutrons. [B1]

(ii) Radioactive decay is the spontaneous and random disintegration of unstable atomic nuclei into more stable nuclei [B1] by the emission of particles or radiation [B1].

(iii) Half-life is the average [B1] time taken for the activity of the radioactive substance to decrease to half of its original value. [B1]

(OR number of radioactive nuclei to decrease to half)

(b) $N = N_0 e^{(-\lambda t)}$

$1.3 \times 10^{14} = 2.5 \times 10^{14}\ e^{(-\lambda)(2018 - 1990)}$ [C1]

$\lambda = 0.0234\ \text{yr}^{-1}$ [C1]

$N = N_0 e^{(-\lambda t)}$

$N = 1.3 \times 10^{14}\ e^{(-0.0234)(2032 - 2018)}$ [M1] or $N = 2.5 \times 10^{14}\ e^{(-0.0234)(2032 - 1990)}$

$N = 9.37 \times 10^{13}$ [A1]

(c) ${}^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}e$ [M1]

${}^{90}_{39}Y \rightarrow {}^{90}_{40}Zr + {}^{0}_{-1}e$ [A1]

(d) Some the energy released provides the kinetic energy of the uranium-235 nucleus [B1] which has to move in the opposite direction to the α-particle due to conservation of linear momentum [B1].

(i) A proton or neutron is a nucleon that is not bound to any nucleus. [A1]

(ii) BE = (mass defect) c^2

(BE in MeV) x 10^6 x e = $(2m_p + 2m_n - m_{helium})$ x u x c^2 [C1]

4 x 7.07470 x 10^6 x e = [2 (1.00728 + 1.00866) – m_{helium})] x u x c^2 [M1]

m_{helium} = 4.00157 u (*leave answer to 6 s.f.)* [A1]

(iii) Total B.E of reactants = (28.2988 + 104.681) MeV

Total B.E of products = (131.788) MeV [B1 for correct BEs calculated]

Since total B.E of reactants is greater than total B.E of products, this implies energy needs to be absorbed for reaction to happen [M1]

or Comparison of total mass. i.e. Mass of products > Mass of reactants

This cannot be spontaneous. [A1]

H2

TAMPINES JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION

CANDIDATE NAME	

CIVICS GROUP	1	7				TUTOR NAME	

PHYSICS

9749/04

Paper 4 Practical

Thursday, 16 August 2018

2 hours 30 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs or rough working.

Do not use paper clips, glue or correction fluid.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory, where appropriate, in the boxes provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use		
1	13	
2	10	
3	20	
4	12	
Total	**55**	

1 This experiment compares the diameters of objects seen through air with their apparent diameters seen through water and glass.

(a) The external diameter d_1 of the measuring cylinder is shown in Fig. 1.1.

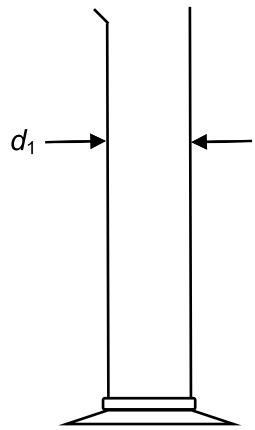


Fig. 1.1

Measure and record d_1 using the rule, the vernier caliper and the micrometer screw gauge.

rule: d_1 = ... [1]

vernier caliper: d_1 = ... [1]

micrometer screw gauge: d_1 = ... [1]

(b) **(i)** Stand the measuring cylinder upside down in the **centre** of the beaker of water as shown in Fig. 1.2.

Look through the glass and water at the measuring cylinder.

The external diameter d_2 of the measuring cylinder **as seen through the water and glass** is shown in Fig. 1.2.

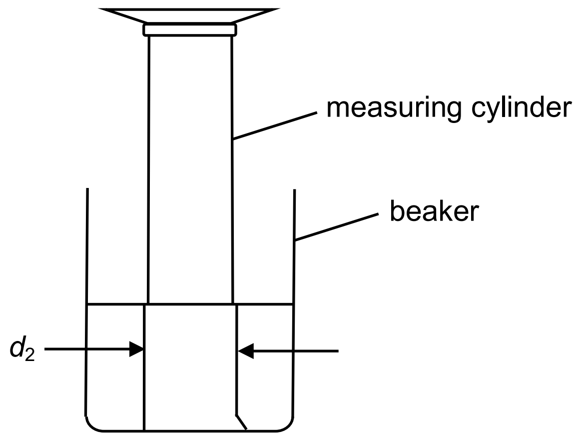


Fig. 1.2

(ii) Measure and record d_2 using only one of the measuring instruments.

d_2 = ... [1]

(iii) Remove the measuring cylinder from the beaker and place it aside.

(iv) State which measuring instrument you used to measure d_2.

....

(c) **(i)** Use one of the measuring instruments to measure and record the external diameter d_1 of the boiling tube.

d_1 = ...

(ii) Repeat **(b)** for the boiling tube.

d_2 = ... [1]

measuring instrument used: ....

(iii) Determine the percentage uncertainty in your value of d_2.

percentage uncertainty in d_2 = ... [1]

(iv) Explain why the other two measuring instruments were not used to measure d_2.

....

....

....

....

....

.... [2]

(d) It is suggested that d_1 and d_2 are related by the expression $\boldsymbol{d_2 = k\, d_1}$ where k is a constant.

(i) Use your values from **(a)**, **(b)(ii)**, **(c)(i)** and **(c)(ii)** to determine two values of k.

first value of k = ……………………………….

second value of k = …………………………… [1]

(ii) Do the results of your experiment support the suggested relationship?
Justify your answer by referring to your value in **(c)(iii)**.

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(iii) Justify the number of significant figures that you have given for your values of k.

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(e) **(i)** Suggest one significant source of error.

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(ii) Suggest an improvement to the experiment to address that source of error identified in **(e)(i)**. You may suggest the use of other apparatus or a different procedure.

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………… [1]

[Total: 13 marks]

2 This investigation considers the amount of charge flowing through a resistor.

(a) (i) Set up the circuit shown in Fig. 2.1, taking care to connect component Y the right way round.

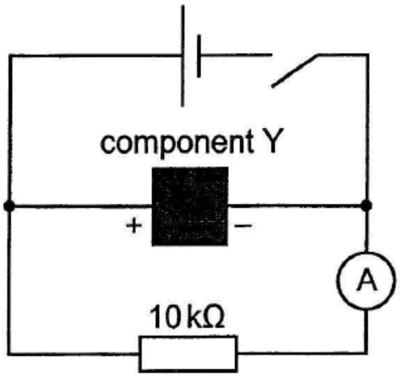


Fig. 2.1

(ii) Close the switch and wait about 10 s. Record the reading I on the ammeter.

I = ... [1]

(b) When the switch is opened, the current in the resistor gradually decreases to zero.

(i) Open the switch and start the stopwatch.

(ii) Record at least five more readings of I and time elapsed t up to a value of t = 50 s. You may need several attempts before you have a satisfactory set of results.

Record all measurements in a single table. Include the measurement obtained in **(a)(ii)**.

[3]

(iii) State two problems that arose in taking the readings.

1. ....

....

2. ....

.... [2]

(c) Plot your values from **(b)(ii)** on Fig. 2.2. The graph obtained should be a curve.

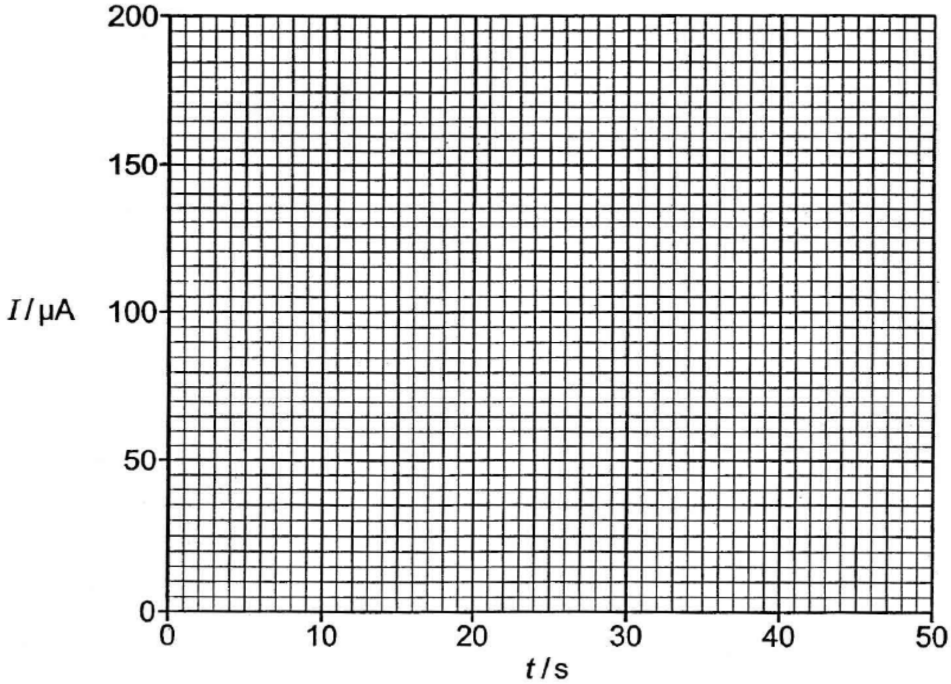


Fig. 2.2

[2]

(d) The area under the graph represents the charge *Q* that has flowed through the resistor during the 50 s. Hence, estimate this charge.

Q = ... [2]

[Total: 10 marks]

3 This investigation considers an oscillating system which consists of a load supported by a spring.

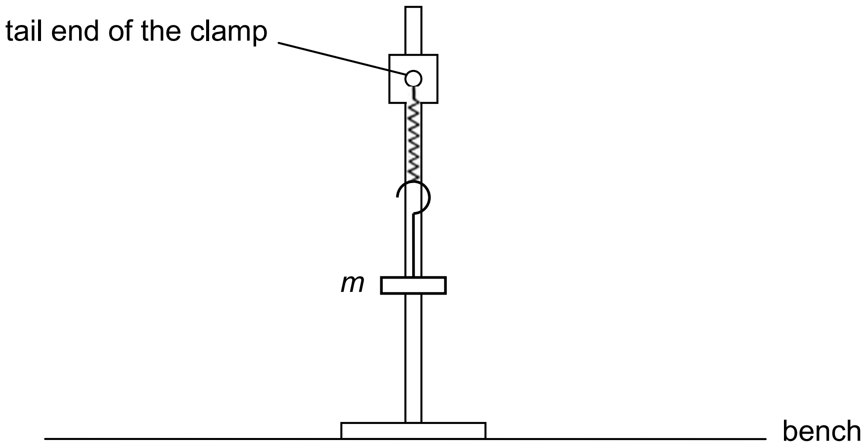


Fig. 3.1

(a) Set up the apparatus as shown in Fig 3.1.

(b) Displace a load *m* of 100 g vertically and set the system into oscillation.

Determine T_v, the period of the vertical oscillations of the load.

T_v = ...

(c) Displace the load *m* of 100 g horizontally sideways and set the system into oscillation.

Determine the period T_h of the horizontal oscillations of the load.

T_h = ... [1]

(d) Repeat the measurements of T_v and T_h for various values of load *m,* 100 g ≤ *m* ≤ 350 g.

Record all measurements in a single table. Include the measurements obtained in **(b)** and **(c)**.

[7]

(e) In this experiment, it is thought that T_v, T_h and *m* are related by an expression of the form

$$\left(\frac{T_h}{T_v}\right)^2 = A\left(\frac{1}{m}\right) + B$$

where *A* and *B* are constants.

Plot a suitable graph to find the values for *A* and *B* with appropriate unit(s), if any.

A = ...

B = ... [4]

[3]

(f) Comment on any anomalous data or results that you may have obtained.

....

.... [1]

(g) Using the expression and the values of *A* and *B* in **(e)**, calculate mass *m* for which T_v is twice of T_h.

m = ... [1]

(h) Based on the calculated *m* in **(g)**, comment on whether it is possible to conduct the experiment.

....

....

.... [1]

(i) State one **significant** source of error.

....

....

.... [1]

(j) Suggest one improvement that could be made to the experiment to address the error identified in **(i)**. You may suggest the use of other apparatus or different procedures.

....

....

.... [1]

[Total: 20 marks]

4 The reflection of sound by a foam attached to a wall as shown in Fig. 4.1 varies with the density of the foam.

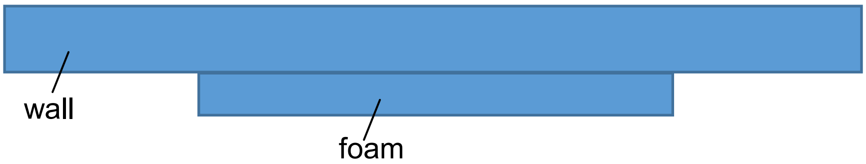


Fig 4.1

It is suggested that the intensity of reflected sound I varies with the density ρ of the foam as given below,

$$I = I_o e^{-k\rho}$$

where I_o is the intensity of the incident sound, and k is a constant.

Design an experiment to test the relationship and determine the value of k.

You are provided with foam of different, known densities. You may also use any other equipment usually found in a Physics laboratory.

You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) the measurements to be taken,

(c) the control of variables,

(d) the analysis of the data,

(e) the safety precautions to be taken.

Diagram

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

[12]

[Total: 12 marks]

TPJC JC2 Prelim H2 Physics Paper 4 (Mark Scheme)

1 (a) Values of d_1 to the nearest: (rule) 0.1 cm, (vernier) 0.01 cm, (micrometer) 0.01 mm. [1, 1, 1]

Or equivalent e.g. (rule) nearest 1 mm or 0.001 m

e.g. rule = 2.8 cm, vernier = 2.59 cm, micrometer = 25.27 mm

(b)(ii) Value of d_2 to the nearest: (rule) 0.1 cm, (vernier) 0.01 cm, (micrometer) 0.01 mm. [1]

Or equivalent e.g. (rule) nearest 1 mm or 0.001 m

$d_2 > d_1$

e.g. d_2 = 3.6 cm

(c)(ii) Value of d_2 to the nearest: (rule) 0.1 cm, (vernier) 0.01 cm, (micrometer) 0.01 mm. [1]

Or equivalent e.g. (rule) nearest 1 mm or 0.001 m

$d_2 > d_1$

e.g. d_2 = 3.1 cm

(c)(iii) $\Delta d_2 \geq 0.2$ cm, correct method shown to find the percentage uncertainty, answer calculated correctly in 1 or 2 s.f. [1]

e.g. $\Delta d/d$ = 0.2/3.1 x 100% = 6%

(c)(iv) The experimental measurements involve high uncertainties. [M1]

The use of more precise measuring instruments (vernier caliper and micrometer screw gauge) is not required. [A1]

(d)(i) Two values of k calculated correctly. [1]

e.g. k_1 = 3.6/2.8 = 1.29, k_2 = 3.1/2.5 = 1.24

(d)(ii) Sensible comment relating to the calculated values of k, testing against (c)(iii). [1]

e.g. % difference = (1.29 – 1.24)/1.24 = 4% which is within the percentage uncertainty, so the results support the suggested relationship.

(d)(iii) Justification of s.f. in *k* linked to d_1 <u>AND</u> d_2. [1]

e.g. *k* is in 2 s.f. because it follows the least s.f. d_1 and d_2.

(e)(i) Possible significant source of error: [1]

Diameters of the cylinder and test tube are relatively small for an experiment involving high uncertainty in measurement.

Difficult to see the edge of the transparent cylinder and test tube in water.

(e)(ii) Possible corresponding improvement: [1]

Use cylinder and test tube with larger diameters

Use coloured cylinder or test tube / Use coloured tape on the surfaces of cylinder and test tube.

2 (a)(ii) To the nearest 0.1 μA <u>only</u>; Allow 100.0 μA ≤ I ≤ 170.0 μA. [1]

(b)(ii) Tabulated at least 6 sets of data for 0 s ≤ t ≤ 50 s, showing correct trend. [1]

Column headings contain quantity and correct unit: t/s and I/μA. [1]

All values of t and I must be given to the same number of decimal places. [1]

(b)(iii) Decay is too quick. [1]

Difficult to read two instruments simultaneously. [1]

(c) Plotting of points: [1]

- All observations in the table must be accurately plotted.
- Diameter of points must be ⩽ half a small square (no "blobs").
- Work to an accuracy of half a small square.

Curve of best fit: [1]

- Judge by balance of all points on the grid about the candidate's curve, allowing one anomalous point.
- Curve must not be kinked or thicker than half a small square.
- No straight line allowed.

(d) Estimate area under graph using square-count or trapezium rule (minimum 2 trapeziums). Working with substitutions clearly shown. [1]

Correct calculation of Q (2 or 3 s.f.), with correct unit. [1]

Allow 1500 μC ≤ Q ≤ 3500 μC).

3 (c) Value of total oscillation time t measured to the nearest 0.1 s or 0.01 s with correct unit; Period calculated correctly with $T_h > T_v$. [1]

(d) Recorded 6 sets of raw data for 100 g ≤ m ≤ 350 g. (five sets 1 mark **[2]**

Labelled each column heading with an appropriate quantity and unit. e.g. t_1 / s [1]

Recorded m to nearest 10 g, and t to the nearest 0.1 s or 0.01 s consistently. [1]

Repeated timings for each value of m with total oscillation time t > 10s. [1]

All values of $\left(\frac{1}{m}\right)$, T_h, T_v and $\left(\frac{T_h}{T_v}\right)^2$ calculated correctly. $T_h > T_v$ [1]

Calculated $\left(\frac{1}{m}\right)$, T_h, T_v and $\left(\frac{T_h}{T_v}\right)^2$ follow least s.f of raw data. (note that $\left(\frac{1}{m}\right)$ should be **consistently** rounded off to either 2 s.f. or 3 s.f.). Average t and T follows d.p. of t and T respectively [1]

<u>Sample table</u>

m/g	(1/m)/g^{-1}	Time for **30** verti oscillations		T_v/s	Time for **10** horiz oscillations		T_h/s	$\left(\frac{T_h}{T_v}\right)^2$
		t_1/s	t_2/s		t_1/s	t_2/s		
100	0.0100	14.4	14.8	0.487	10.3	10.5	1.04	4.57
150	0.00667	17.8	18.3	0.602	10.8	10.6	1.07	3.16
200	0.00500	20.2	20.7	0.682	11.3	10.8	1.11	2.63
250	0.00400	23.1	23.4	0.775	11.3	11.3	1.13	2.13
300	0.00333	25.8	25.4	0.847	11.7	11.8	1.18	1.93
350	0.00286	27.3	27.4	0.912	12.3	12.2	1.23	1.81

(e) Graph

Axes and scales: [1]

- Axes must be labelled with the quantity that is being plotted.
- Sensible scales must be used, no awkward scales (e.g. 3:10).
- Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions
- Scale markings should be no more than three large squares apart.

Plotting of points: [1]

- All observations in the table must be accurately plotted.
- Diameter of points must be ⩽ half a small square (no “blobs”).
- Work to an accuracy of half a small square.

Line of best fit: [1]

- Judge by balance of all points on the grid about the candidate’s line (at least 5 points).
- There must be an even distribution of points either side of the line along the full length.
- Allow one anomalous point only if clearly indicated (i.e. circled or labelled) by the candidate.
- Line must not be kinked or thicker than half a small square.

(e) Linearising equation and deriving expressions for gradient and *y*-intercept. [1]

Gradient: [1]

- The hypotenuse of the triangle must be at least half the length of the drawn line.
- Both read-offs must be accurate to half a small square in both the x and y directions.
- Gradient calculated correctly using the gradient coordinates (Δy / Δx).

y-intercept: [1]

Either:

- y-intercept calculated correctly using correct read-off from a point on the line and substituted into y = mx + c.

Or:

- Correct read-off of the intercept directly from the graph.
- Read-off must be accurate to half a small square in both x and y directions.

Values of *A* and *B* determined correctly with appropriate s.f. (2 or 3 s.f.) and unit. [1]

e.g. *A* = 390 g (3 s.f.) ; *B* = 0.635 *(no units)* (3 s.f.)

(f) Made comments on any anomalous results: [1]

- There are no anomalous points because all points lie comparably close to the line of best fit.

Or

- There is an anomaly at 1/m = ______ g^{-1} because this point is significantly far from the line of best fit as compared to the other points.

(g) Negative mass *m* correctly calculated with units for which T_v, is twice of T_h. [1]

e.g. Substitue $\left(\frac{T_h}{T_v}\right)$ = ½ into equation,

$(0.5)^2 = 390\,(1/m) + 0.635 \Rightarrow m$ is a negative value.

(h) Appropriate comment on whether it is possible to conduct the experiment. [1]

e.g. It is not possible for mass to be negative. (or It is not possible to measure negative mass.) Hence, not possible to conduct experiment.

(i) Possible significant source of error: [1]

Shifting of pivot point (i.e. between spring & tail end of clamp) during oscillations.

Difficult to judge the start and end of the oscillation.

(j) Possible improvement: [1]

Introduce a groove (on tail end of clamp) to hang spring to minimise shifting.

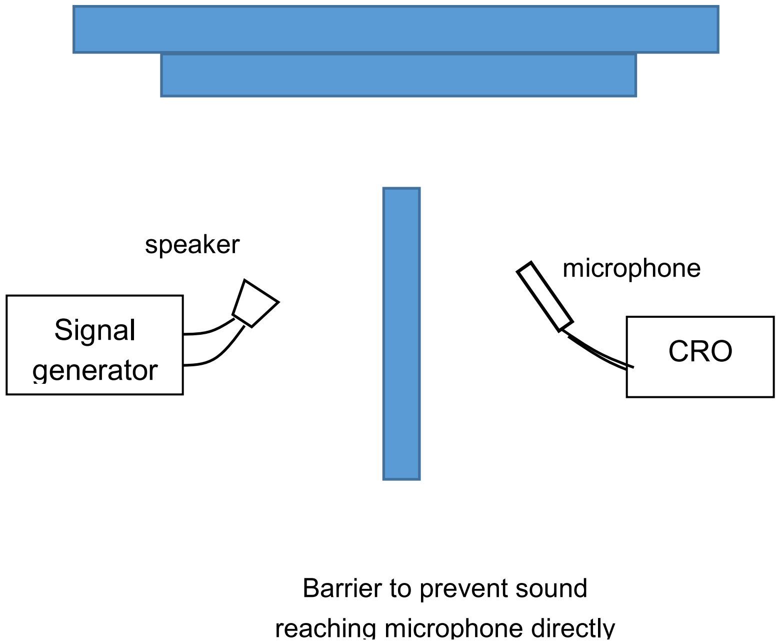
Use a set square as a fiducial marker to determine the start and end of the oscillation.

4 [Total: 12 marks]

Diagram: [2]

D1 Labelled diagram showing speaker connected to signal generator

D2 Microphone detector connected to oscilloscope OR sound intensity probe or sound intensity meter to measure intensity of reflected sound OR sound detector/sensor connected to CRO



Procedure [4]

P1 Determine **reflected intensity *I*** and Repeat experiment using foam of different densities to vary ρ.

P2 Plot a graph of **ln *I* against ρ**.

P3 Relationship is valid if a straight line is obtained

P4 k is the **negative** of the gradient of the line

Control of variables & accuracy enhancement

Relevant points might include:

Max 2 marks

Factors that are kept constant:

- Position of speaker /distance between speaker and foam and amplitude of signal from signal generator OR position of detector or microphone
- Frequency of sound from signal generator
- Thickness of foam
- Area of foam for reflecting sound is kept constant

Max 3 marks

- By using the **amplitude *A*** of the signal on CRO display to deduce Intensity I
- Barrier to prevent sound going directly to detector
- Position of detector is adjusted to detect the loudest reflected sound
- Use the same setup without the foam and wall to take measurement of intensity of sound that reaches detector directly from speaker (due to diffraction and transmission through barrier). Subtract this intensity from all measured intensities.
- Perform experiment in sound-proof room
- Intensity is proportional to the square of amplitude obtained from CRO
- Use high amplitude for the incident sound so that reflected sound has a higher amplitude to reduce fractional uncertainty
- Take preliminary values of Intensity/amplitude using foam of lowest and highest density such that measurable readings can be obtained.

Safety considerations [1 max]

- Wear ear plugs to prevent damage to hearing