



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--



PHYSICS

9702/21

Paper 2 AS Structured Questions

October/November 2013

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

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

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

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

At the end of the examination, fasten all your work securely together.

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

For Examiner's Use

1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **14** printed pages and **2** blank pages.



Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For
Examiner's
Use

- 1 (a) State two SI base units other than the kilogram, metre and second.

1.

2.

[2]

- (b) A metal wire has original length l_0 . It is then suspended and hangs vertically as shown in Fig. 1.1.

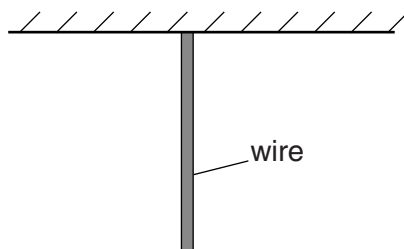


Fig. 1.1

The weight of the wire causes it to stretch. The elastic potential energy stored in the wire is E .

- (i) Show that the SI base units of E are $\text{kg m}^2 \text{s}^{-2}$.

[2]

- (ii) The elastic potential energy E is given by

$$E = C\rho^2 g^2 A l_0^3$$

where ρ is the density of the metal,
 g is the acceleration of free fall,
 A is the cross-sectional area of the wire
and C is a constant.

Determine the SI base units of C .

SI base units of C [3]

For
Examiner's
Use

BLANK PAGE

- 2 A source of radio waves sends a pulse towards a reflector. The pulse returns from the reflector and is detected at the same point as the source. The emitted and reflected pulses are recorded on a cathode-ray oscilloscope (c.r.o.) as shown in Fig. 2.1.

For
Examiner's
Use

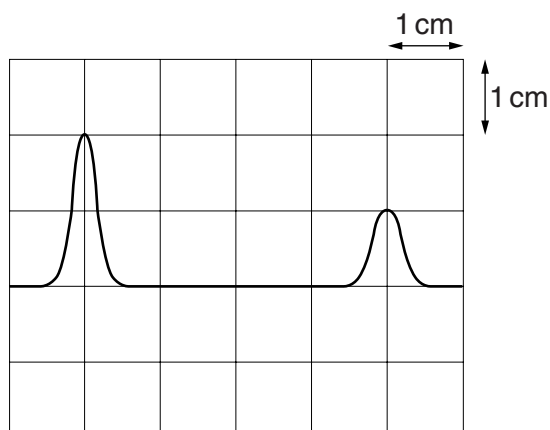


Fig. 2.1

The time-base setting is $0.20 \mu\text{s cm}^{-1}$.

- (a) Using Fig. 2.1, determine the distance between the source and the reflector.

distance = ... m [4]

- (b) Determine the time-base setting required to produce the same separation of pulses on the c.r.o. when sound waves are used instead of radio waves.
The speed of sound is 300 m s^{-1} .

.....

 [3]

- 3 (a) State what is meant by *work done*.

For
Examiner's
Use

.....
..... [1]

- (b) A trolley of mass 400 g is moving at a constant velocity of 2.5 m s^{-1} to the right as shown in Fig. 3.1.



Fig. 3.1

Show that the kinetic energy of the trolley is 1.3 J.

[2]

- (c) The trolley in (b) moves to point P as shown in Fig. 3.2.

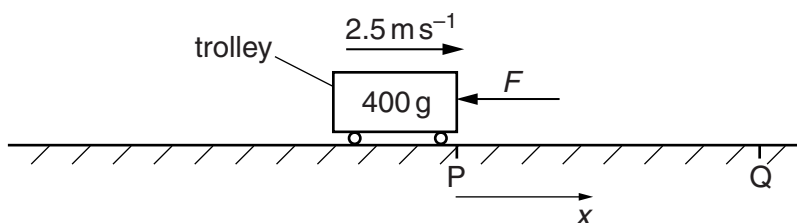


Fig. 3.2

At point P the speed of the trolley is 2.5 m s^{-1} .

A variable force F acts to the left on the trolley as it moves between points P and Q.

The variation of F with displacement x from P is shown in Fig. 3.3.

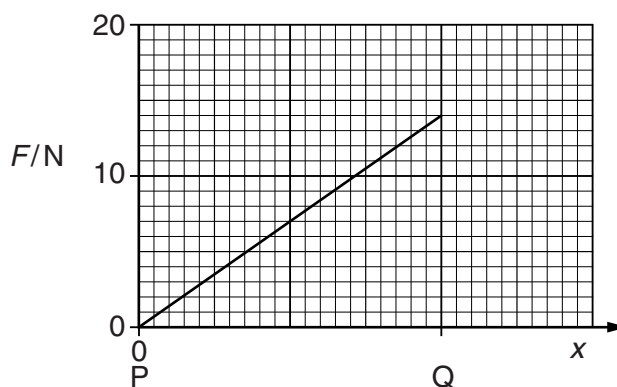


Fig. 3.3

The trolley comes to rest at point Q.

- (i) Calculate the distance PQ.

For
Examiner's
Use

distance PQ = ... m [3]

- (ii) On Fig. 3.4, sketch the variation with x of velocity v for the trolley moving between P and Q.

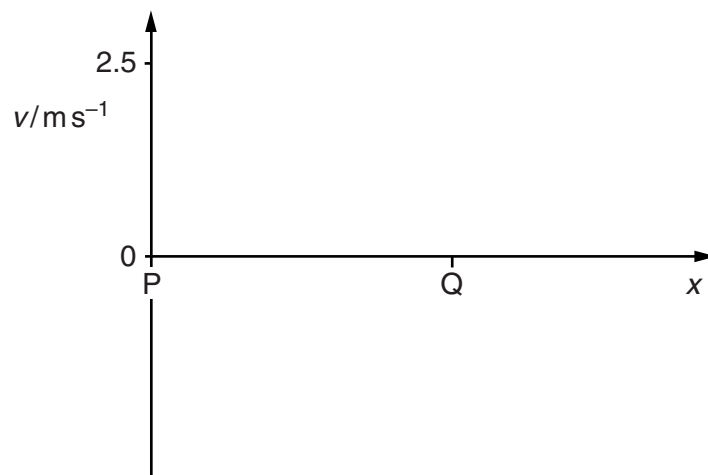


Fig. 3.4

[2]

- 4 (a) Define the *torque* of a couple.

.....
 [2]

- (b) A wheel is supported by a pin P at its centre of gravity, as shown in Fig. 4.1.

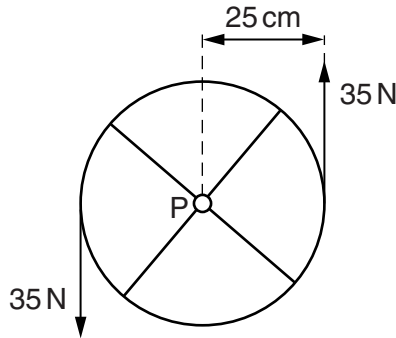


Fig. 4.1

The plane of the wheel is vertical. The wheel has radius 25 cm.
 Two parallel forces each of 35 N act on the edge of the wheel in the vertical directions shown in Fig. 4.1. Friction between the pin and the wheel is negligible.

- (i) List two other forces that act on the wheel. State the direction of these forces and where they act.

1.

2.

[2]

- (ii) Calculate the torque of the couple acting on the wheel.

torque = ... Nm [2]

- (iii) The resultant force on the wheel is zero. Explain, by reference to the four forces acting on the wheel, how it is possible that the resultant force is zero.

.....

..... [1]

- (iv) State and explain whether the wheel is in equilibrium.

..... [1]

- 5 A long rope is held under tension between two points A and B. Point A is made to vibrate vertically and a wave is sent down the rope towards B as shown in Fig. 5.1.

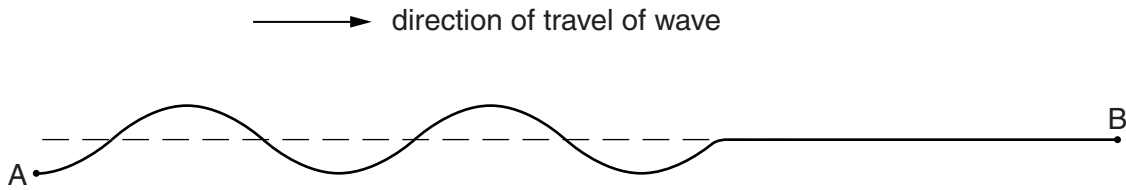


Fig. 5.1 (not to scale)

The time for one oscillation of point A on the rope is 0.20 s. The point A moves a distance of 80 mm during one oscillation. The wave on the rope has a wavelength of 1.5 m.

- (a) (i) Explain the term *displacement* for the wave on the rope.

.....
 [1]

- (ii) Calculate, for the wave on the rope,

1. the amplitude,

amplitude = ... mm [1]

2. the speed.

speed = ... ms^{-1} [3]

- (b) On Fig. 5.1, draw the wave pattern on the rope at a time 0.050 s later than that shown. [2]

- (c) State and explain whether the waves on the rope are

- (i) progressive or stationary,

.....
 [1]

- (ii) longitudinal or transverse.

.....
 [1]

- 6 (a) Define *potential difference* (p.d.).

..... [1]

- (b) A power supply of e.m.f. 240 V and zero internal resistance is connected to a heater as shown in Fig. 6.1.



Fig. 6.1

The wires used to connect the heater to the power supply each have length 75 m. The wires have a cross-sectional area 2.5 mm^2 and resistivity $18 \text{ n}\Omega \text{ m}$. The heater has a constant resistance of 38Ω .

- (i) Show that the resistance of each wire is 0.54Ω .

[3]

- (ii) Calculate the current in the wires.

current = ... A [3]

- (iii) Calculate the power loss in the wires.

power = ... W [3]

- (c) The wires to the heater are replaced by wires of the same length and material but having a cross-sectional area of 0.50 mm^2 . Without further calculation, state and explain the effect on the power loss in the wires.

For
Examiner's
Use

.....

.....

.....[2]

- 7 (a) An electric field is set up between two parallel metal plates in a vacuum. The deflection of α -particles as they pass between the plates is shown in Fig. 7.1.

For
Examiner's
Use

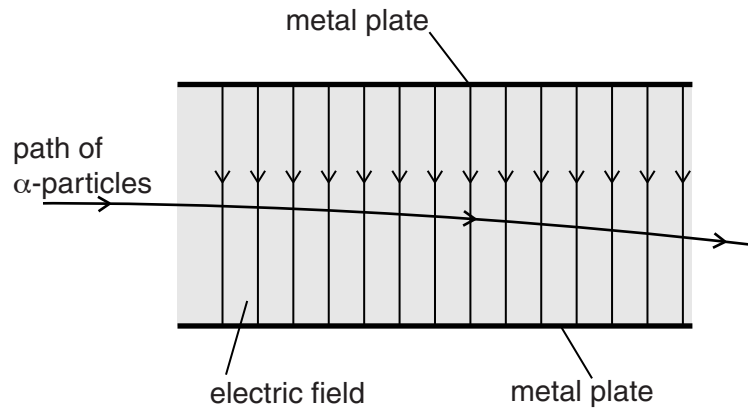


Fig. 7.1

The electric field strength between the plates is reduced. The α -particles are replaced by β -particles. The deflection of β -particles is shown in Fig. 7.2.

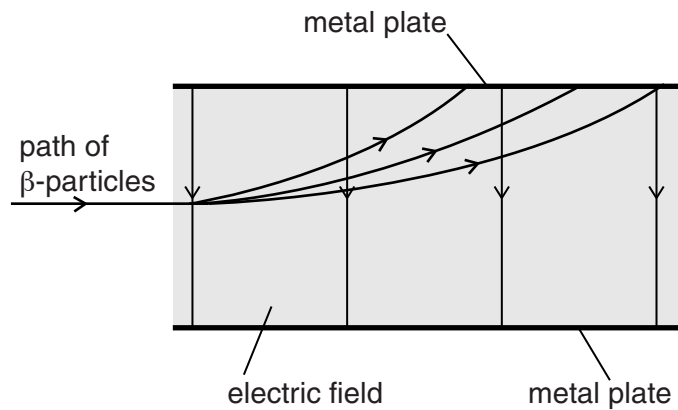


Fig. 7.2

- (i) State one similarity of the electric fields shown in Fig. 7.1 and Fig. 7.2.

.....
[1]

- (ii) The electric field strength in Fig. 7.2 is less than that in Fig. 7.1. State two methods of reducing this electric field strength.

1.
 2.
 [2]

- (iii) By reference to the properties of α -particles and β -particles, suggest three reasons for the differences in the deflections shown in Fig. 7.1 and Fig. 7.2.

1.

.....

2.

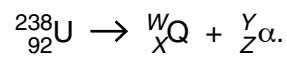
.....

3.

.....

[3]

- (b) A source of α -particles is uranium-238. The nuclear reaction for the emission of α -particles is represented by



State the values of W

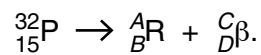
X

Y

Z

[2]

- (c) A source of β -particles is phosphorus-32. The nuclear reaction for the emission of β -particles is represented by



State the values of A

B

C

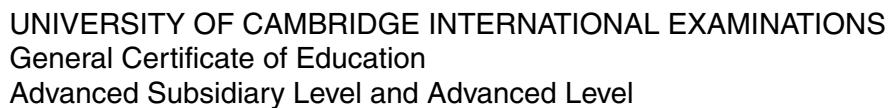
D

[1]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9702/22

October/November 2013

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **14** printed pages and **2** blank pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For
Examiner's
Use

- 1 (a) State two SI base units other than the kilogram, metre and second.

1.

2.

[2]

- (b) A metal wire has original length l_0 . It is then suspended and hangs vertically as shown in Fig. 1.1.

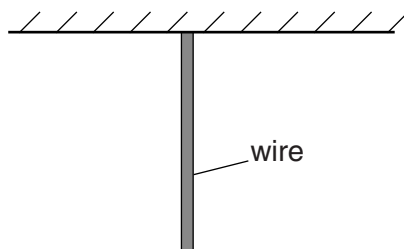


Fig. 1.1

The weight of the wire causes it to stretch. The elastic potential energy stored in the wire is E .

- (i) Show that the SI base units of E are $\text{kg m}^2 \text{s}^{-2}$.

[2]

- (ii) The elastic potential energy E is given by

$$E = C\rho^2 g^2 A l_0^3$$

where ρ is the density of the metal,
 g is the acceleration of free fall,
 A is the cross-sectional area of the wire
and C is a constant.

Determine the SI base units of C .

SI base units of C [3]

For
Examiner's
Use

BLANK PAGE

- 2 A source of radio waves sends a pulse towards a reflector. The pulse returns from the reflector and is detected at the same point as the source. The emitted and reflected pulses are recorded on a cathode-ray oscilloscope (c.r.o.) as shown in Fig. 2.1.

For
Examiner's
Use

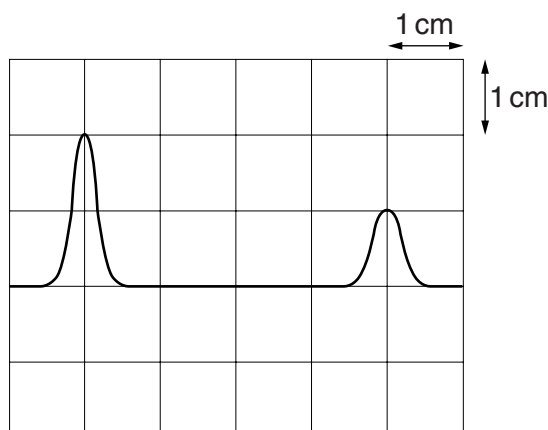


Fig. 2.1

The time-base setting is $0.20 \mu\text{s cm}^{-1}$.

- (a) Using Fig. 2.1, determine the distance between the source and the reflector.

distance = ... m [4]

- (b) Determine the time-base setting required to produce the same separation of pulses on the c.r.o. when sound waves are used instead of radio waves.
The speed of sound is 300 m s^{-1} .

.....

 [3]

- 3 (a) State what is meant by *work done*.

For
Examiner's
Use

.....
..... [1]

- (b) A trolley of mass 400 g is moving at a constant velocity of 2.5 m s^{-1} to the right as shown in Fig. 3.1.



Fig. 3.1

Show that the kinetic energy of the trolley is 1.3 J.

[2]

- (c) The trolley in (b) moves to point P as shown in Fig. 3.2.

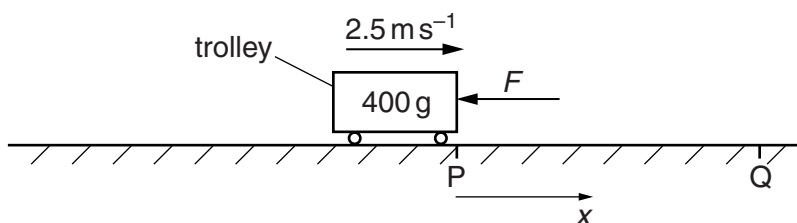


Fig. 3.2

At point P the speed of the trolley is 2.5 m s^{-1} .

A variable force F acts to the left on the trolley as it moves between points P and Q.

The variation of F with displacement x from P is shown in Fig. 3.3.

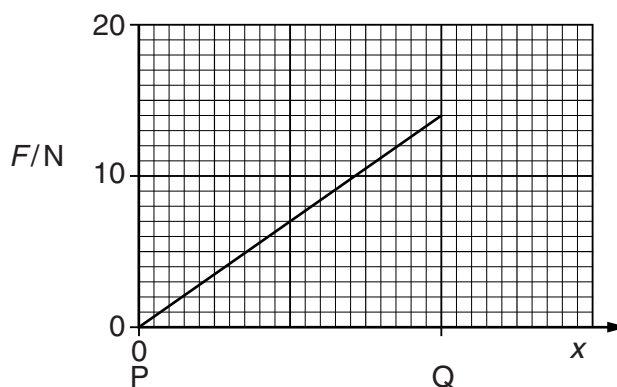


Fig. 3.3

The trolley comes to rest at point Q.

- (i) Calculate the distance PQ.

For
Examiner's
Use

distance PQ = ... m [3]

- (ii) On Fig. 3.4, sketch the variation with x of velocity v for the trolley moving between P and Q.

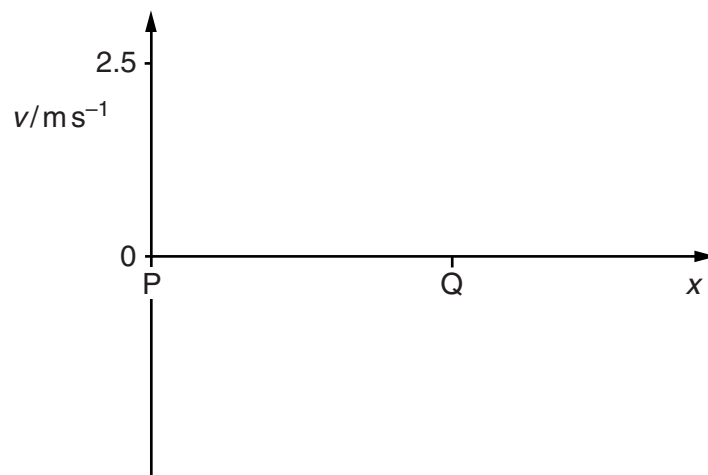


Fig. 3.4

[2]

- 4 (a) Define the *torque* of a couple.

.....
 [2]

- (b) A wheel is supported by a pin P at its centre of gravity, as shown in Fig. 4.1.

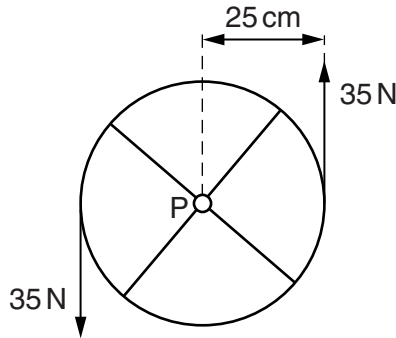


Fig. 4.1

The plane of the wheel is vertical. The wheel has radius 25 cm.
 Two parallel forces each of 35 N act on the edge of the wheel in the vertical directions shown in Fig. 4.1. Friction between the pin and the wheel is negligible.

- (i) List two other forces that act on the wheel. State the direction of these forces and where they act.

1.

2.

[2]

- (ii) Calculate the torque of the couple acting on the wheel.

torque = ... Nm [2]

- (iii) The resultant force on the wheel is zero. Explain, by reference to the four forces acting on the wheel, how it is possible that the resultant force is zero.

.....

..... [1]

- (iv) State and explain whether the wheel is in equilibrium.

..... [1]

- 5 A long rope is held under tension between two points A and B. Point A is made to vibrate vertically and a wave is sent down the rope towards B as shown in Fig. 5.1.

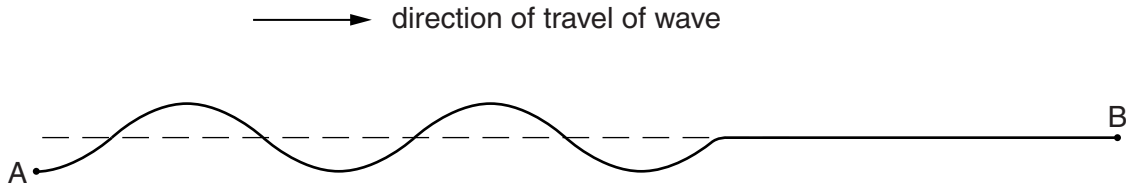


Fig. 5.1 (not to scale)

The time for one oscillation of point A on the rope is 0.20 s. The point A moves a distance of 80 mm during one oscillation. The wave on the rope has a wavelength of 1.5 m.

- (a) (i) Explain the term *displacement* for the wave on the rope.

.....
 [1]

- (ii) Calculate, for the wave on the rope,

1. the amplitude,

amplitude = ... mm [1]

2. the speed.

speed = ... ms^{-1} [3]

- (b) On Fig. 5.1, draw the wave pattern on the rope at a time 0.050 s later than that shown. [2]

- (c) State and explain whether the waves on the rope are

- (i) progressive or stationary,

.....
 [1]

- (ii) longitudinal or transverse.

.....
 [1]

- 6 (a) Define *potential difference* (p.d.).

..... [1]

- (b) A power supply of e.m.f. 240 V and zero internal resistance is connected to a heater as shown in Fig. 6.1.

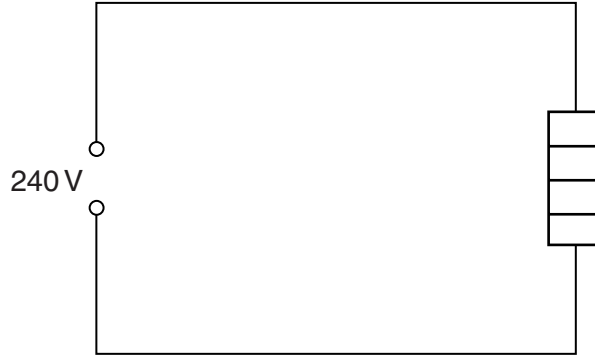


Fig. 6.1

The wires used to connect the heater to the power supply each have length 75 m. The wires have a cross-sectional area 2.5 mm^2 and resistivity $18 \text{ n}\Omega \text{ m}$. The heater has a constant resistance of 38Ω .

- (i) Show that the resistance of each wire is 0.54Ω .

[3]

- (ii) Calculate the current in the wires.

current = ... A [3]

- (iii) Calculate the power loss in the wires.

power = ... W [3]

- (c) The wires to the heater are replaced by wires of the same length and material but having a cross-sectional area of 0.50 mm^2 . Without further calculation, state and explain the effect on the power loss in the wires.

*For
Examiner's
Use*

.....

.....

.....[2]

- 7 (a) An electric field is set up between two parallel metal plates in a vacuum. The deflection of α -particles as they pass between the plates is shown in Fig. 7.1.

For
Examiner's
Use

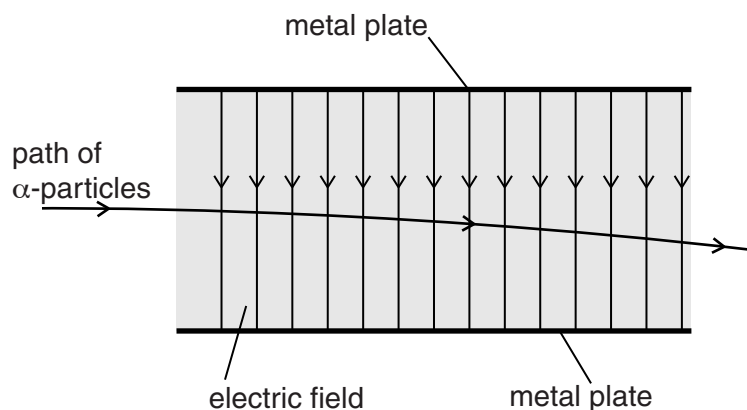


Fig. 7.1

The electric field strength between the plates is reduced. The α -particles are replaced by β -particles. The deflection of β -particles is shown in Fig. 7.2.

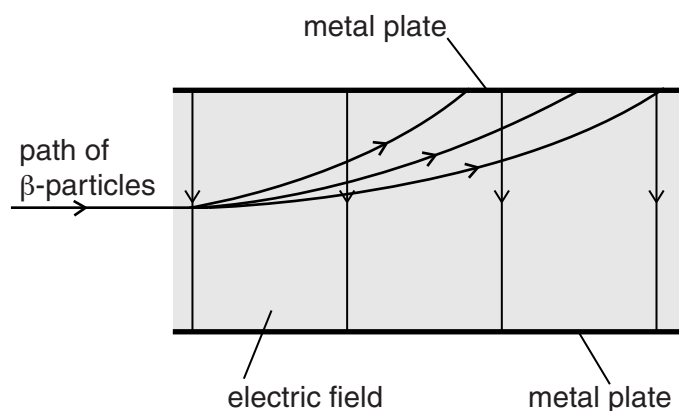


Fig. 7.2

- (i) State one similarity of the electric fields shown in Fig. 7.1 and Fig. 7.2.

.....
[1]

- (ii) The electric field strength in Fig. 7.2 is less than that in Fig. 7.1. State two methods of reducing this electric field strength.

1.
 2.

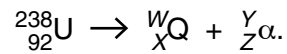
[2]

- (iii) By reference to the properties of α -particles and β -particles, suggest three reasons for the differences in the deflections shown in Fig. 7.1 and Fig. 7.2.

1.
.....
2.
.....
3.
.....

[3]

- (b) A source of α -particles is uranium-238. The nuclear reaction for the emission of α -particles is represented by



State the values of W

X

Y

Z

[2]

- (c) A source of β -particles is phosphorus-32. The nuclear reaction for the emission of β -particles is represented by



State the values of A

B

C

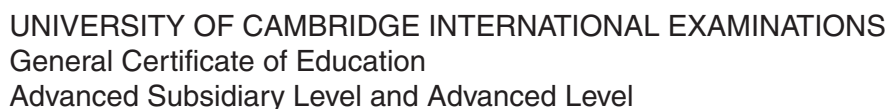
D

[1]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9702/23

October/November 2013

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **15** printed pages and **1** blank page.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

work done on/by a gas,

$$W = p\Delta V$$

gravitational potential,

$$\phi = -\frac{Gm}{r}$$

hydrostatic pressure,

$$p = \rho gh$$

pressure of an ideal gas,

$$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$$

simple harmonic motion,

$$a = -\omega^2 x$$

velocity of particle in s.h.m.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{(x_0^2 - x^2)}$$

electric potential,

$$V = \frac{Q}{4\pi\epsilon_0 r}$$

capacitors in series,

$$1/C = 1/C_1 + 1/C_2 + \dots$$

capacitors in parallel,

$$C = C_1 + C_2 + \dots$$

energy of charged capacitor,

$$W = \frac{1}{2} QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

alternating current/voltage,

$$x = x_0 \sin \omega t$$

radioactive decay,

$$x = x_0 \exp(-\lambda t)$$

decay constant,

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

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

For
Examiner's
Use

- 1 A cylindrical disc is shown in Fig. 1.1.

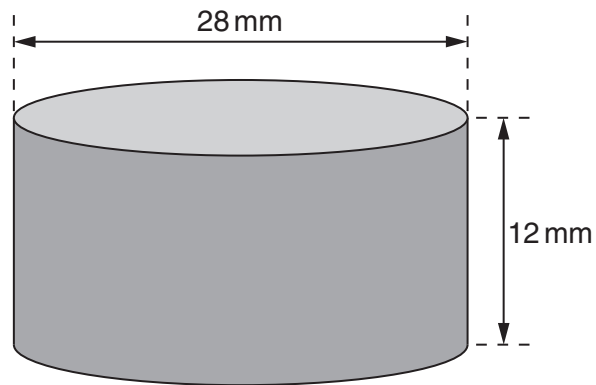


Fig. 1.1

The disc has diameter 28 mm and thickness 12 mm.
The material of the disc has density $6.8 \times 10^3 \text{ kg m}^{-3}$.

Calculate, to two significant figures, the weight of the disc.

weight = ... N [4]

- 2 The time T for a satellite to orbit the Earth is given by

$$T = \sqrt{\left(\frac{KR^3}{M}\right)}$$

where R is the distance of the satellite from the centre of the Earth,
 M is the mass of the Earth,
 and K is a constant.

- (a) Determine the SI base units of K .

SI base units of K [2]

- (b) Data for a particular satellite are given in Fig. 2.1.

quantity	measurement	uncertainty
T	$8.64 \times 10^4 \text{ s}$	$\pm 0.5\%$
R	$4.23 \times 10^7 \text{ m}$	$\pm 1\%$
M	$6.0 \times 10^{24} \text{ kg}$	$\pm 2\%$

Fig. 2.1

Calculate K and its actual uncertainty in SI units.

$K = \dots \pm \dots$ SI units [4]

3 (a) Define

(i) *velocity*,

.....
[1]

(ii) *acceleration*.

.....
[1]

- (b) A car of mass 1500 kg travels along a straight horizontal road.
 The variation with time t of the displacement x of the car is shown in Fig. 3.1.

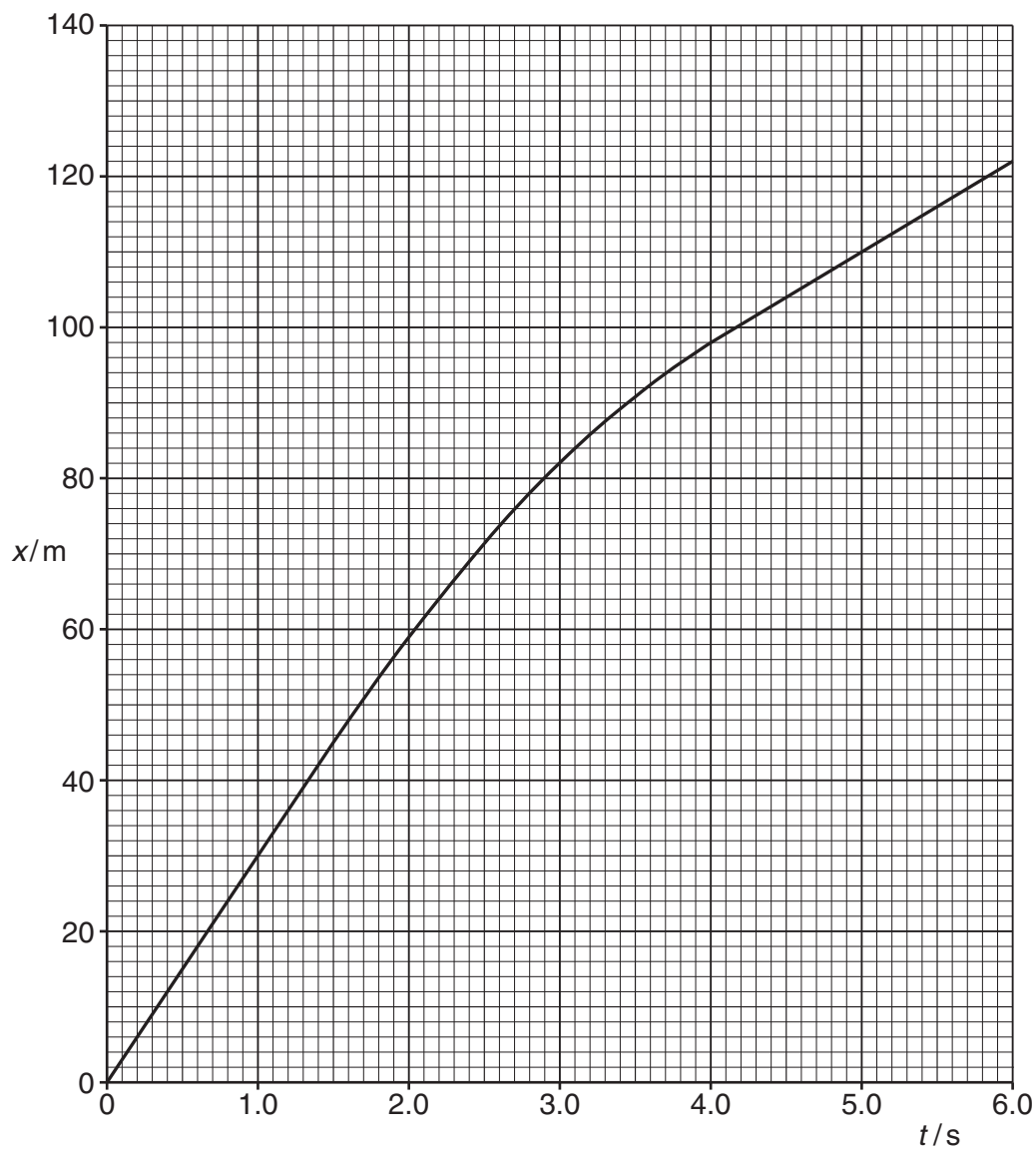


Fig. 3.1

- (i) Use Fig. 3.1 to describe qualitatively the velocity of the car during the first six seconds of the motion shown.
Give reasons for your answers.

.....

.....

.....

.....

.....[3]

- (ii) Calculate the average velocity during the time interval $t = 0$ to $t = 1.5$ s.

average velocity = ... ms^{-1} [1]

- (iii) Show that the average acceleration between $t = 1.5$ s and $t = 4.0$ s is -7.2 ms^{-2} .

[2]

- (iv) Calculate the average force acting on the car between $t = 1.5$ s and $t = 4.0$ s.

force = ... N [2]

- 4 (a) Distinguish between gravitational potential energy and elastic potential energy.

.....

 [2]

- (b) A ball of mass 65g is thrown vertically upwards from ground level with a speed of 16 m s^{-1} . Air resistance is negligible.

- (i) Calculate, for the ball,

1. the initial kinetic energy,

kinetic energy = ... J [2]

2. the maximum height reached.

maximum height = ... m [2]

- (ii) The ball takes time t to reach maximum height. For time $\frac{t}{2}$ after the ball has been thrown, calculate the ratio

$$\frac{\text{potential energy of ball}}{\text{kinetic energy of ball}}.$$

ratio = ... [3]

- (iii) State and explain the effect of air resistance on the time taken for the ball to reach maximum height.

.....

 [1]

5 (a) (i) Define, for a wave,

1. wavelength λ ,

.....
.....[1]

2. frequency f .

.....
.....[1]

(ii) Use your definitions to deduce the relationship between λ , f and the speed v of the wave.

[1]

- (b) Plane waves on the surface of water are represented by Fig. 5.1 at one particular instant of time.

For
Examiner's
Use

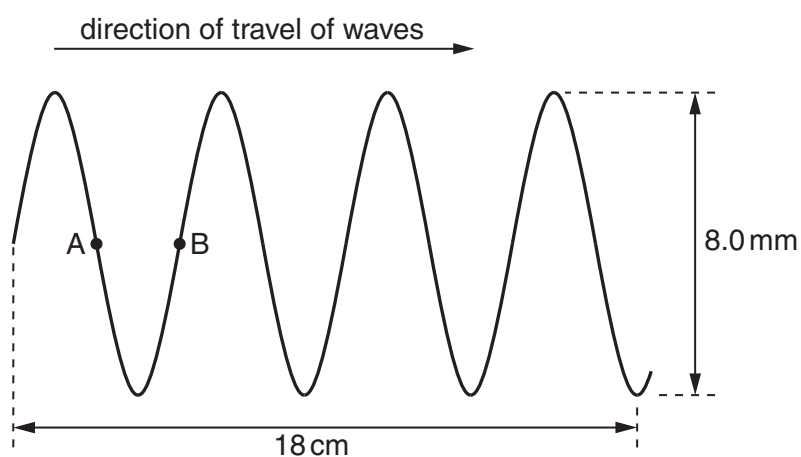


Fig. 5.1 (not to scale)

The waves have frequency 2.5 Hz.

Determine, for the waves,

- (i) the amplitude,

amplitude = ... mm [1]

- (ii) the speed,

speed = ... ms^{-1} [2]

- (iii) the phase difference between points A and B.

phase difference = ... unit [1]

- (c) The wave in (b) was produced in a ripple tank. Describe briefly, with the aid of a sketch diagram, how the wave may be observed.

*For
Examiner's
Use*

.....

.....

.....

[2]

- 6 A battery connected in series with a resistor R of resistance $5.0\ \Omega$ is shown in Fig. 6.1.

For
Examiner's
Use

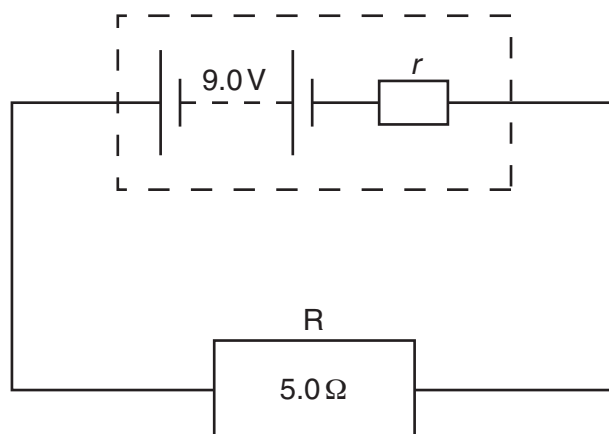


Fig. 6.1

The electromotive force (e.m.f.) of the battery is 9.0V and the internal resistance is r .
The potential difference (p.d.) across the battery terminals is 6.9V .

- (a) Use energy considerations to explain why the p.d. across the battery is not equal to the e.m.f. of the battery.

.....

 [2]

- (b) Calculate

- (i) the current in the circuit,

current = ... A [2]

- (ii) the internal resistance r .

$r = \dots\dots\dots \Omega$ [2]

(c) Calculate, for the battery in the circuit,

(i) the total power produced,

power = ... W [2]

(ii) the efficiency.

efficiency = ... [2]

For
Examiner's
Use

- 7 (a) Two horizontal metal plates are connected to a power supply, as shown in Fig. 7.1.

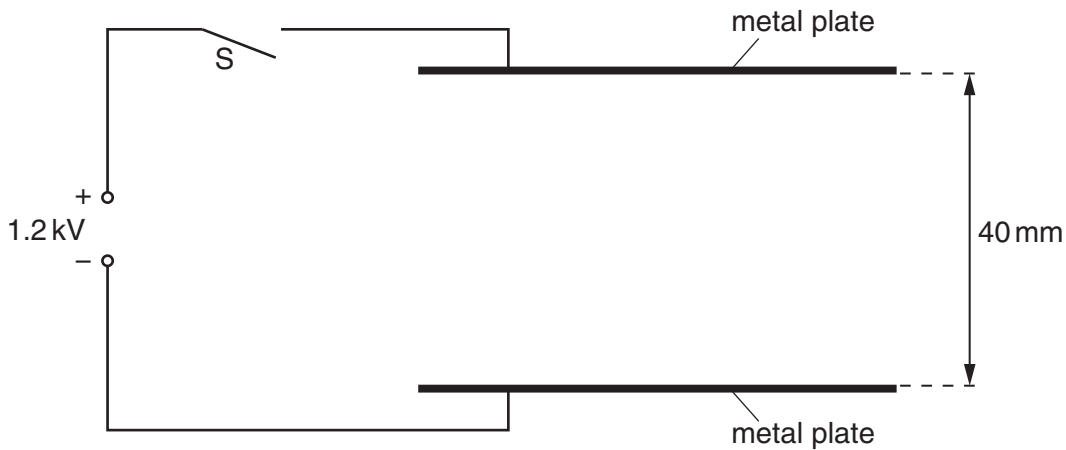


Fig. 7.1

The separation of the plates is 40 mm.

The switch S is then closed so that a potential difference of 1.2 kV is applied across the plates.

- (i) On Fig. 7.1, draw six field lines to represent the electric field between the metal plates. [2]
- (ii) Calculate the electric field strength E between the plates.

$$E = \dots\dots\dots \text{ V m}^{-1} \text{ [2]}$$

- (b) The switch S is opened and the plates lose their charge. Two very small metal spheres A and B joined by an insulating rod are placed between the metal plates as shown in Fig. 7.2.

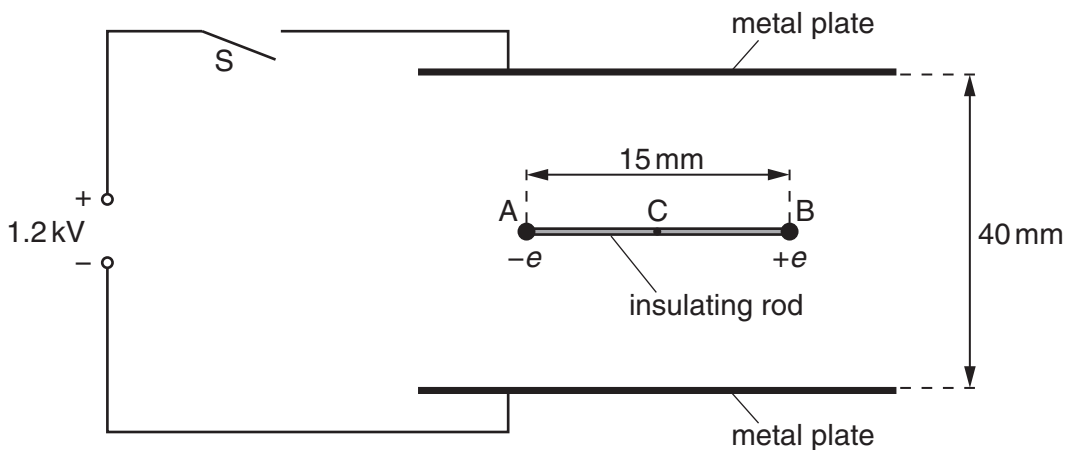


Fig. 7.2

Sphere A has charge $-e$ and sphere B has charge $+e$, where e is the charge of a proton. The length AB is 15 mm. The rod is supported at its centre C so that the rod is horizontal and in equilibrium.

The switch S is then closed so that the potential difference of 1.2 kV is applied across the plates.

- (i) There is a force acting on A due to the electric field between the plates. Show that this force is $4.8 \times 10^{-15} \text{ N}$.

[2]

- (ii) The insulating rod joining A and B is fixed in the position shown in Fig. 7.2. Calculate the torque of the couple acting on the rod.

torque = ... unit [3]

- (iii) The insulating rod is now released so that it is free to rotate about C. State and explain the position of the rod when it comes to rest.

.....

 [2]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.