

Please write clearly in block capitals.

Centre number

--	--	--	--	--

Candidate number

--	--	--	--

Surname

StemUp Model Solution

Forename(s)

Candidate signature

A-level PHYSICS

Paper 2

Friday 8 June 2018

Morning

Time allowed: 2 hours

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- a Data and Formulae Booklet.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do **all** rough work in this book. Cross through any work you do not want to be marked.
- Show **all** your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 85.
- You are expected to use a scientific calculator where appropriate.
- A Data and Formulae Booklet is provided as a loose insert.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8–32	
TOTAL	



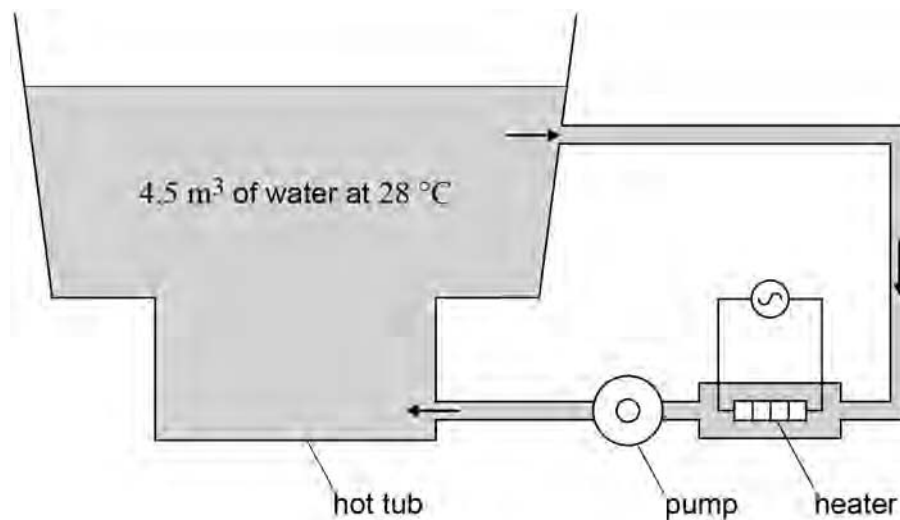
J U N 1 8 7 4 0 8 2 0 1

Section AAnswer **all** questions in this section.**0 1 . 1**

Explain what is meant by specific latent heat of fusion.

[2 marks]

Specific latent heat of fusion is the energy required to change 1 kg (unit mass) of a substance from the solid state to the liquid state (to melt it), without any change in temperature (at its melting point).

0 1 . 2**Figure 1** shows how the temperature of the water is maintained in a hot tub.**Figure 1**

The hot tub system has a volume of 4.5 m^3 and is filled with water at a temperature of 28°C

The heater transfers thermal energy to the water at a rate of 2.7 kW while a pump circulates the water.

Assume that no heat is transferred to the surroundings.



Calculate the rise in water temperature that the heater could produce in 1.0 hour.

density of water = 1000 kg m^{-3}

specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$

[3 marks]

Energy supplied in 1.0 hour: $Q = Pt = 2700 \times (60 \times 60) = 9.72 \times 10^6 \text{ J}$

Mass of water: $m = \rho V = 1000 \times 4.5 = 4500 \text{ kg}$

$Q = mc\Delta\theta$ so $\Delta\theta = Q / mc$

$\Delta\theta = 2700 \times (60 \times 60) / (4500 \times 4200)$

$\Delta\theta = 0.514 \text{ K}$

temperature rise = 0.51 K

0 1 . 3

The pump can circulate the water at different speeds.

When working at higher speeds the rise in temperature is greater.

Explain why.

Again assume that no heat is transferred to the surroundings.

[2 marks]

*At higher speeds the pump does more work on the water (per second),
against friction / viscous forces.*

*This work adds to the internal energy of the water as well as the heat
from the heater ($\Delta U = Q + W$), so the molecules gain more random
kinetic energy and the temperature rises more.*

7

Turn over for the next question

Turn over ►



0 2 1

Define the electric field strength at a point in an electric field.

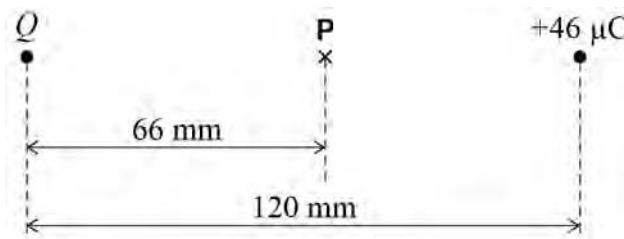
[2 marks]

The electric field strength at a point is the force per unit charge acting on a small positive (test) charge placed at that point ($E = F / Q$).

0 2 2

Figure 2 shows a point charge of $+46 \mu\text{C}$ placed 120 mm from a point charge Q .

Figure 2



Position **P** is on the line joining the charges at a distance 66 mm from charge Q .
The resultant electric field strength at position **P** is zero.

Calculate the charge Q .

[3 marks]

At P the field strength due to Q equals the field strength due to the $+46 \mu\text{C}$ charge (they act in opposite directions):

$$Q / (4\pi\epsilon_0 \times 0.066^2) = 46 \times 10^{-6} / (4\pi\epsilon_0 \times 0.054^2)$$

$$Q = 46 \times 10^{-6} \times (0.066 / 0.054)^2$$

$$Q = +6.87 \times 10^{-5} \text{ C}$$

$$Q = \underline{+6.9 \times 10^{-5}} \text{ C}$$



0	2	.	3
---	---	---	---

Explain, without calculation, whether net work must be done in moving a proton from infinity to position **P** in **Figure 2**.

[2 marks]

Yes, net work must be done on the proton. Both charges are positive, so the potential at P is positive (the sum of two positive potentials), while the potential at infinity is zero.

The proton is positive, so work must be done on it against the repulsive forces from both charges (like charges repel), increasing its electric potential energy.

Question 2 continues on the next page

Turn over ►

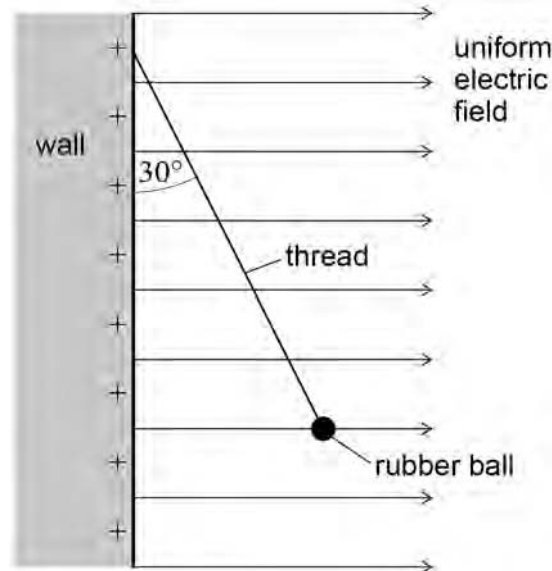


0 2 . 4

A small rubber ball coated with a conducting paint carries a positive charge. The ball is suspended in equilibrium from a vertical wall by an uncharged non-conducting thread of negligible mass. The wall is positively charged and produces a horizontal uniform electric field perpendicular to the wall along the whole of its length.

Figure 3 shows that the thread makes an angle of 30° to the wall.

Figure 3



The thread breaks.

Explain the motion of the ball.

[2 marks]

When the thread breaks, two constant forces act on the ball: its weight vertically downwards and a horizontal electric force away from the wall (repulsion from the positive wall).

The resultant force is constant, so the ball moves from rest with a constant acceleration in a straight line at 30° to the vertical, away from the wall (along the line of the thread).



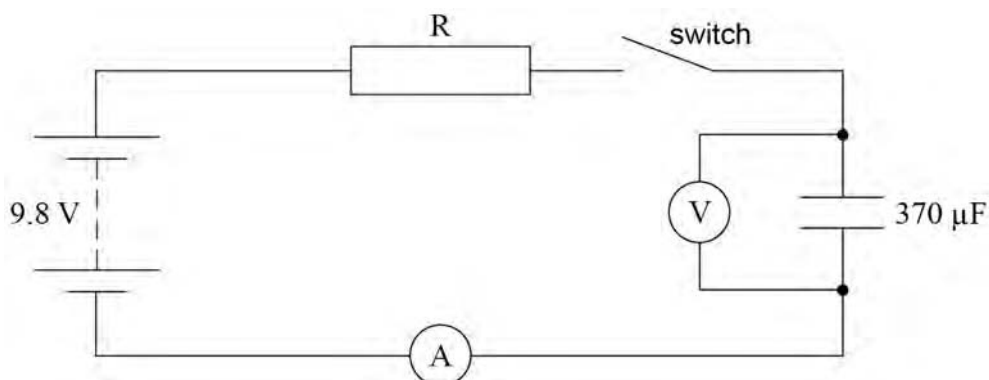
0 3 . 1 State what is meant by a capacitance of $370 \mu\text{F}$

[2 marks]

The capacitor stores $370 \mu\text{C}$ of charge for every 1 volt of potential difference across its plates (the ratio of charge to pd is $370 \times 10^{-6} \text{ C V}^{-1}$).

0 3 . 2 The charging of a $370 \mu\text{F}$ capacitor is investigated using the circuit shown in **Figure 4**. Both meters in the circuit are ideal.

Figure 4



The power supply of emf 9.8 V has a negligible internal resistance. The capacitor is initially uncharged. When the switch is closed at time $t = 0$ charge begins to flow through resistor R . The time constant of the charging circuit is 1.0 s

Calculate the resistance of R .

[1 mark]

Time constant = RC so $R = 1.0 / (370 \times 10^{-6})$

$R = 2.70 \times 10^3 \Omega$

resistance of $R = \underline{2.7 \times 10^3} \Omega$

Question 3 continues on the next page

Turn over ►



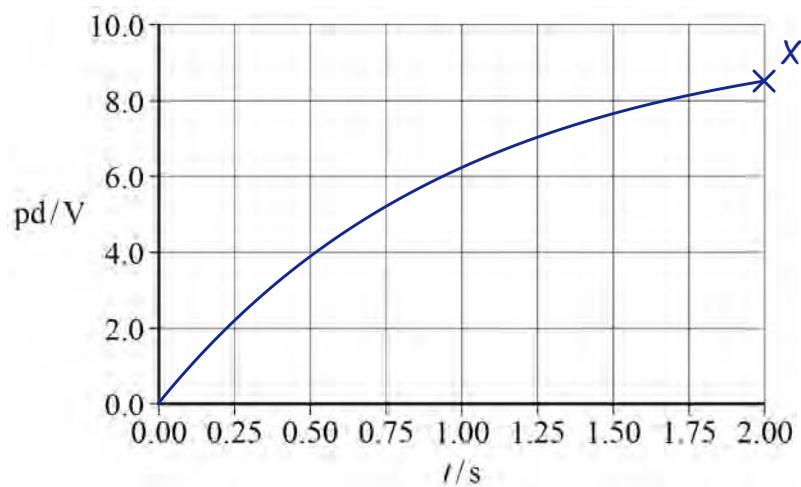
0 3 . 3

Identify, with the symbol X on **Figure 5**, the potential difference (pd) across the capacitor when the switch has been closed for 2.0 s
Sketch the graph that shows how the pd varies from $t = 0$ to $t = 2.0$ s

[2 marks]

$$V = V_0(1 - e^{-t/RC}) = 9.8 \times (1 - e^{-2.0/1.0}) = 8.5 \text{ V}$$

Figure 5



0 3 . 4

Calculate the time taken for the charging current to fall to half its initial value.

[1 mark]

Current halves in one half-life: $T_{1/2} = 0.69RC$

$$T_{1/2} = 0.69 \times 1.0 = 0.69 \text{ s}$$

time = 0.69 s



0 3 . 5

Calculate the time taken for the charge on the capacitor to reach 3.0 mC

[3 marks]

$$Q = Q_0(1 - e^{-t/RC})$$

$$Q_0 = CV_0 = 370 \times 10^{-6} \times 9.8 = 3.63 \times 10^{-3} \text{ C}$$

$$3.0 \times 10^{-3} = 370 \times 10^{-6} \times 9.8 \times (1 - e^{-t/1.0})$$

$$0.827 = 1 - e^{-t} \quad \text{so} \quad e^{-t} = 0.173, \quad e^t = 5.79$$

$$t = \ln 5.79 = 1.76 \text{ s}$$

time = 1.8 s

9

Turn over for the next question**Turn over ►**

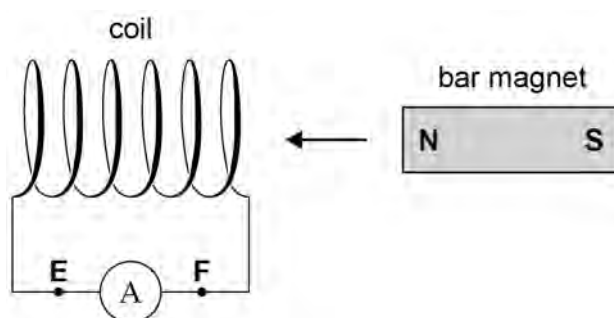
0 4 . 1 State Lenz's law.

[1 mark]

The direction of the induced emf is such that it tends to oppose the change (in magnetic flux linkage) that is producing it.

0 4 . 2 Lenz's law can be demonstrated using a bar magnet and a coil of wire connected to a sensitive ammeter as shown in **Figure 6**.

Figure 6



The bar magnet is moved towards the coil and is then brought to a halt.

State how the reading on the ammeter changes during this process.

[1 mark]

The ammeter shows a current (a deflection) while the magnet is moving towards the coil, and the reading then falls to zero when the magnet stops moving.

0 4 . 3 During the demonstration an induced current is detected by the ammeter. The induced current is in the direction **E** to **F**.

Explain how this demonstrates Lenz's law.

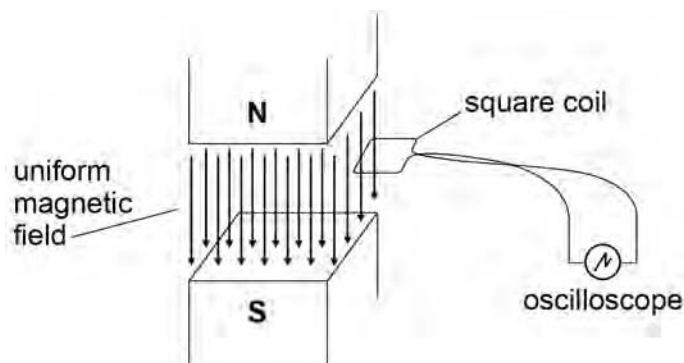
[2 marks]

A current from E to F means the induced current makes the right-hand end of the coil (nearest the magnet) a north pole.

The two north poles repel each other, so the induced current opposes the motion of the magnet towards the coil, i.e. it opposes the change producing it, as Lenz's law states.

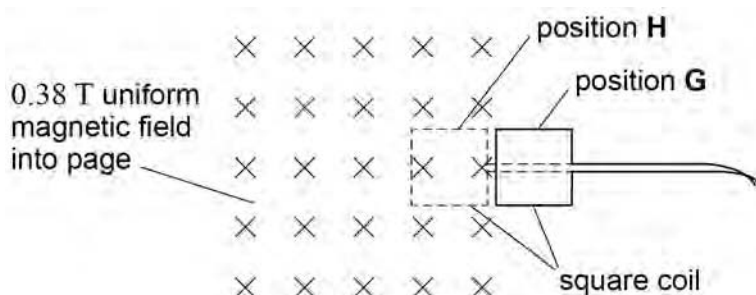


0 4 . 4

Figure 7 shows an arrangement for investigating induced emf.**Figure 7**

As shown, the uniform vertical magnetic field is confined to the gap between the poles of the magnet. The plane of the square coil is horizontal and is made of conducting wire. The coil consists of a single turn and is attached by flexible wire to an oscilloscope.

The oscilloscope gives a reading of 2.9×10^{-4} V when the coil is moved at uniform speed from position **G** outside the field to position **H** inside the field, as shown in **Figure 8**.

Figure 8

Length of side of square coil = 32 mm

Magnetic flux density of uniform magnetic field = 0.38 T

Calculate the time taken to move the coil from position **G** to position **H**.

[2 marks]

$$\epsilon = \Delta\Phi / \Delta t = BA / t \quad \text{so} \quad t = BA / \epsilon$$

$$t = 0.38 \times 0.032^2 / 2.9 \times 10^{-4} = 3.89 \times 10^{-4} / 2.9 \times 10^{-4}$$

$$t = 1.34 \text{ s}$$

time = 1.34 s

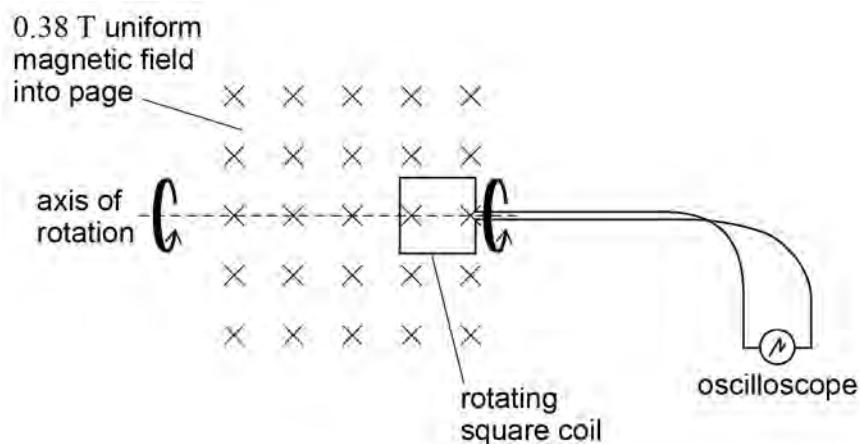
Question 4 continues on the next page

Turn over ►



0 4 . 5

The square coil is rotated through 360° at a constant angular speed about the horizontal axis shown in **Figure 9**.

Figure 9

Calculate the angular speed of the coil when the maximum reading on the oscilloscope is 5.1 mV

[2 marks]

$$\epsilon_{\max} = BAN\omega \text{ so } \omega = \epsilon_{\max} / BAN = 5.1 \times 10^{-3} / (0.38 \times 0.032^2 \times 1)$$

$$\omega = 5.1 \times 10^{-3} / 3.89 \times 10^{-4} = 13.1 \text{ rad s}^{-1}$$

angular speed = 13.1 rad s⁻¹

8



0	5	.	1
---	---	---	---

Suggest, with a reason, which type of radiation is likely to be the most appropriate for the sterilisation of metallic surgical instruments.

[1 mark]

Gamma radiation, because it is the most penetrating, so it can pass through the packaging and reach all sides of the instruments (they can be sterilised already sealed).

0	5	.	2
---	---	---	---

Explain why the public need not worry that irradiated surgical instruments become radioactive once sterilised.

[1 mark]

The radiation only affects (ionises) the outer electrons of the atoms; it does not affect the nucleus, so the instruments cannot become radioactive.

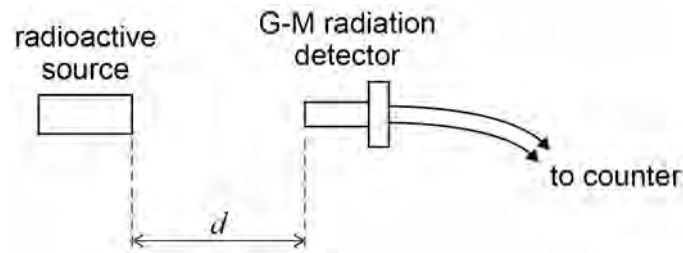
Question 5 continues on the next page

Turn over ►



0 5 . 3

A student detects the counts from a radioactive source using a G-M radiation detector as shown in **Figure 10**.

Figure 10

The student measures the count rate for three different distances d . **Table 1** shows the count rate, in counts per minute, corrected for background for each of these distances.

Table 1

d/m	Corrected count rate / counts per minute	d^2 / m^2	$\text{count rate} \times d^2$ / $\text{counts min}^{-1} \text{m}^2$	
0.20	9013	0.040	361	
0.50	1395	0.25	349	
1.00	242	1.00	242	

Explain, with the aid of suitable calculations, why the data in **Table 1** are **not** consistent with an inverse-square law. You may use the blank columns for your working.

[2 marks]

If the inverse-square law ($I = k / d^2$) applied, count rate $\times d^2$ would be constant.

But count rate $\times d^2$ falls from 361 to 349 to 242, so it is not constant and the data do not follow an inverse-square law.



0 5 . 4

State **two** possible reasons why the results do **not** follow the expected inverse-square law.

[2 marks]

Reason 1 *The source is not a point source, so d is not the real distance between the source and the detector (the source is inside its holder).*

Reason 2 *The G-M tube has a dead time, so at the higher count rates (small d) some counts are missed.*

6

Turn over for the next question

Turn over ►

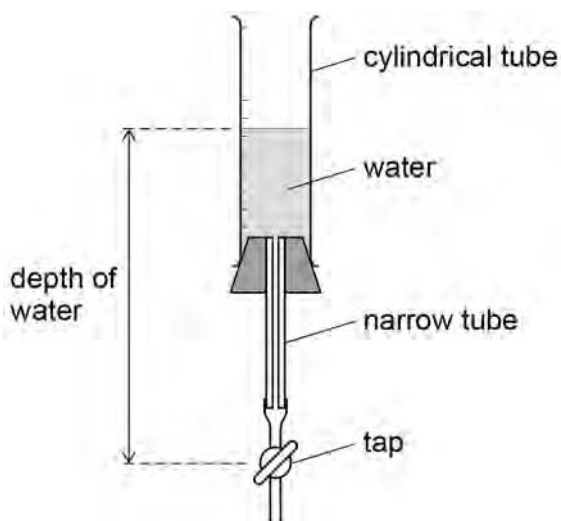


0 6

Figure 11 shows how radioactive decay of one nuclide can be modelled by draining water through a tap from a cylindrical tube.

Do not write
outside the
box

Figure 11

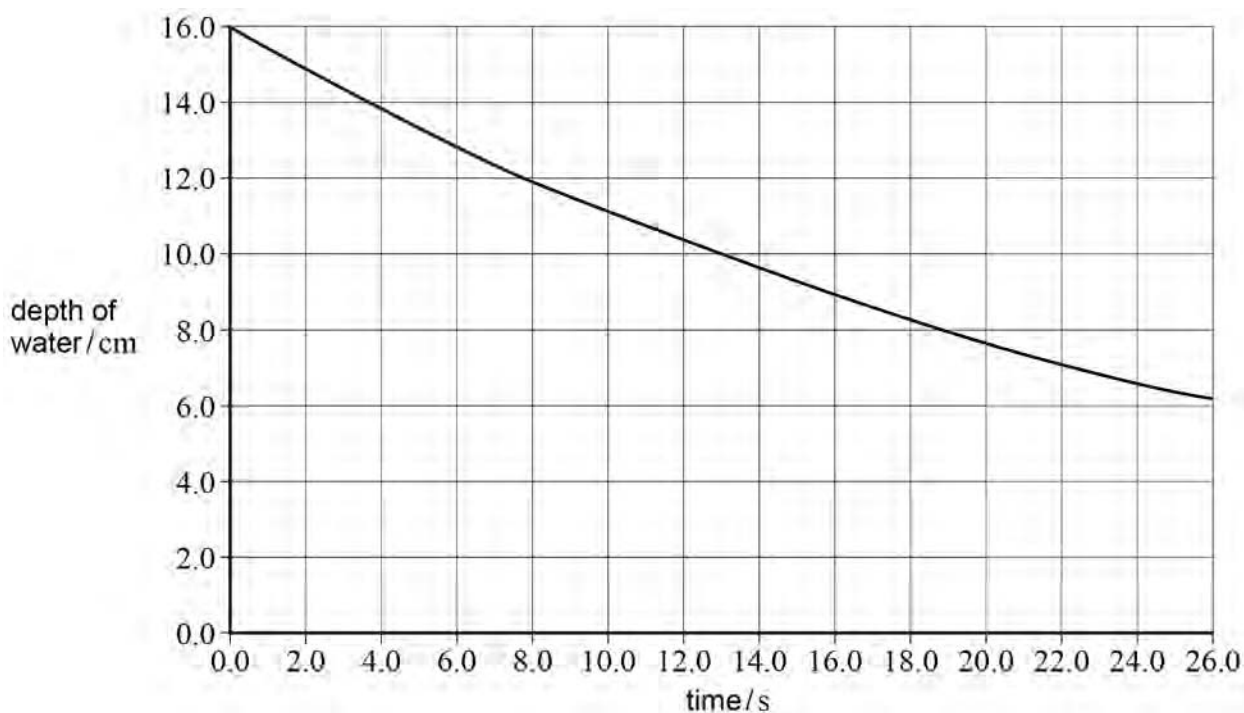


The water flow-rate is proportional to the pressure of the water. The pressure of the water is proportional to the depth of the water. Therefore the rate at which the depth decreases is proportional to the depth of the water.

Before the tap is opened the depth is 16.0 cm

The tap is opened and the depth is measured at regular intervals. These data are plotted on the graph in **Figure 12**.

Figure 12



0 6 . 1

Determine the predicted depth of water when the time is 57 s

[1 mark]

*Depth halves every 19 s (16.0 cm to 8.0 cm in 19 s)**57 s = 3 × 19 s: 16 → 8 → 4 → 2 cm*depth = 2.0 cm

0 6 . 2

Suggest how the apparatus in **Figure 11** may be changed to represent a radioactive sample of the same nuclide with a greater number of nuclei.

[1 mark]

Use more water: start with a greater depth of water in the same cylindrical tube (the half-life stays the same).

0 6 . 3

Suggest how the apparatus in **Figure 11** may be changed to represent a radioactive sample of a nuclide with a smaller decay constant.

[1 mark]

Close the tap more (partly), so the water flows out more slowly and the depth decreases more slowly (a longer half-life).

0 6 . 4

The age of the Moon has been estimated from rock samples containing rubidium (Rb) and strontium (Sr), brought back from Moon landings.

 $^{87}_{37}\text{Rb}$ decays to $^{87}_{38}\text{Sr}$ with a radioactive decay constant of $1.42 \times 10^{-11} \text{ year}^{-1}$ Calculate, in years, the half-life of $^{87}_{37}\text{Rb}$.

[1 mark]

$$T_{1/2} = \ln 2 / \lambda = 0.693 / 1.42 \times 10^{-11}$$

$$T_{1/2} = 4.88 \times 10^{10} \text{ years}$$

half-life = 4.88×10^{10} years

Question 6 continues on the next page

Turn over ►



0 6 . 5

A sample of Moon rock contains 1.23 mg of $^{87}_{37}\text{Rb}$.

Calculate the mass, in g, of $^{87}_{37}\text{Rb}$ that the rock sample contained when it was formed 4.47×10^9 years ago.

Give your answer to an appropriate number of significant figures.

[3 marks]

$$\text{Mass} \propto \text{number of nuclei, so } m = m_0 e^{-\lambda t} \text{ and } m_0 = m e^{\lambda t}$$

$$\lambda t = 1.42 \times 10^{-11} \times 4.47 \times 10^9 = 0.0635$$

$$m_0 = 1.23 \times 10^{-3} \times e^{0.0635}$$

$$m_0 = 1.31 \times 10^{-3} \text{ g (3 s.f.)}$$

$$\text{mass} = \underline{1.31 \times 10^{-3}} \text{ g}$$

0 6 . 6

Calculate the activity of a sample of $^{87}_{37}\text{Rb}$ of mass 1.23 mg

Give an appropriate unit for your answer.

[3 marks]

$$N = \text{mass} / 87u = 1.23 \times 10^{-6} / (87 \times 1.661 \times 10^{-27}) = 8.51 \times 10^{18}$$

$$\lambda = 1.42 \times 10^{-11} / (365 \times 24 \times 60 \times 60) = 4.50 \times 10^{-19} \text{ s}^{-1}$$

$$A = \lambda N = 4.50 \times 10^{-19} \times 8.51 \times 10^{18}$$

$$A = 3.83 \text{ Bq}$$

$$\text{activity} = \underline{3.8} \text{ unit } \underline{\text{Bq}}$$

10

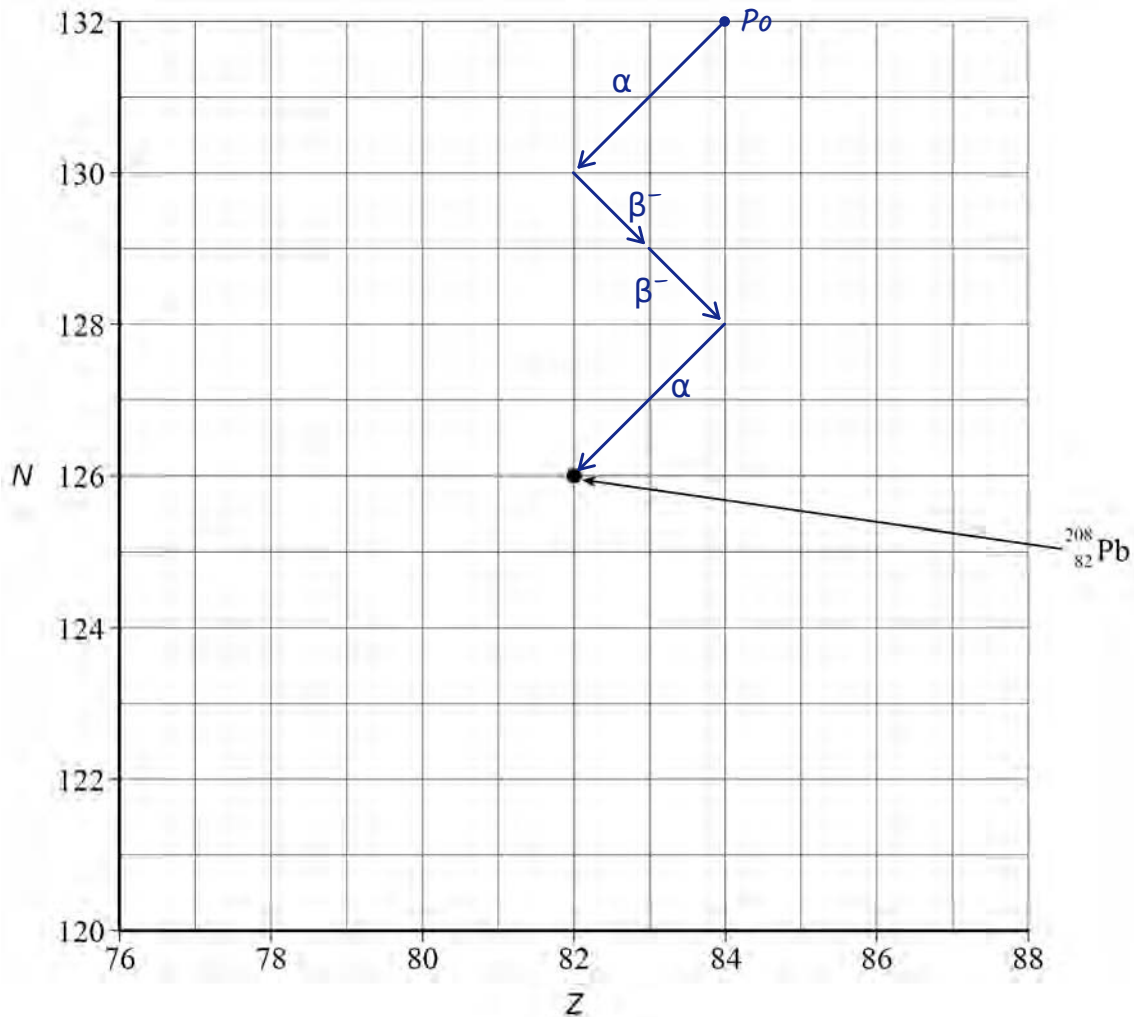


0 7

A nucleus of polonium Po may decay to the stable isotope of lead $^{208}_{82}\text{Pb}$ through a chain of emissions following the sequence $\alpha \beta^- \beta^- \alpha$.

Figure 13 shows the position of the isotope $^{208}_{82}\text{Pb}$ on a grid of neutron number N against proton number Z .

Figure 13



0 7 . 1

Draw **four** arrows on **Figure 13** to show the sequence of changes to N and Z that occur as the polonium nucleus is transformed into $^{208}_{82}\text{Pb}$.

[2 marks]

Question 7 continues on the next page

Turn over ►



0 7 . 2

A nucleus of the stable isotope $^{208}_{82}\text{Pb}$ has more neutrons than protons.

Explain why there is this imbalance between proton and neutron numbers by referring to the forces that operate within the nucleus. Your explanation should include the range of the forces and which particles are affected by the forces.

[4 marks]

The strong nuclear force acts between all nucleons (protons and neutrons). It is attractive up to a range of about 3 fm, so it is very short range and each nucleon only attracts its nearest neighbours.

Below about 0.5 fm the strong nuclear force is repulsive, which stops the nucleus collapsing.

The electrostatic (electromagnetic) force is repulsive and acts only between protons. It has an infinite (long) range, so each proton repels every other proton across the whole nucleus, and the total repulsion increases greatly as the proton number increases.

So a large nucleus such as lead needs extra neutrons: they add to the strong nuclear attraction holding the nucleus together without adding any electrostatic repulsion. Having fewer protons than neutrons reduces the repulsion, so the nucleus is stable.

0 7 . 3

Many, but not all, isotopes of lead are stable. For example, $^{205}_{82}\text{Pb}$ decays by electron capture to become an isotope of thallium, Tl.

Write the equation to represent this decay, including the isotope of thallium produced.

[1 mark]



0 7 . 4

The thallium nucleus is formed in an excited state. Electromagnetic radiation is emitted from the thallium atom following its formation.

Explain the origin and location of **two** sources of this radiation.

[2 marks]

Source 1 *An electron in an outer shell of the thallium atom falls to fill the vacancy left in an inner shell by the captured electron, releasing its energy as an electromagnetic photon (X-ray). This originates in the electron shells of the atom.*

Source 2 *The thallium nucleus is formed in an excited state, so the excited nucleus de-excites to its ground state by emitting a gamma ray photon. This originates in the nucleus.*

0 7 . 5

Other nuclides also emit electromagnetic radiation.

Explain why the metastable form of the isotope of technetium $^{99}_{43}\text{Tc}$ is a radioactive source suitable for use in medical diagnosis.

[2 marks]

Technetium-99m emits only gamma rays, which can penetrate out of (escape from) the body to be detected, and are weakly ionising so they cause less damage to the body than other radiations.

Its half-life (about 6 hours) is long enough to complete the diagnosis but short enough that it does not remain in the body for too long. It can also be prepared at the hospital.

11

END OF SECTION A

Turn over ►



Section B

Each of Questions 08 to 32 is followed by four responses, A, B, C and D.

For each question select the best response.

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

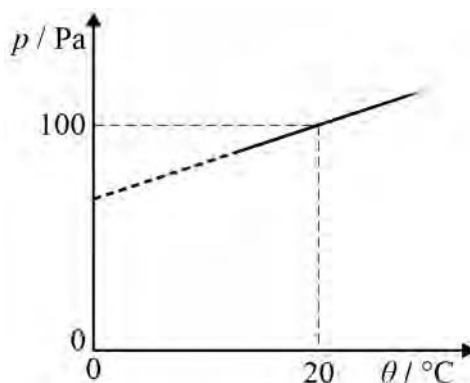
You may do your working in the blank space around each question but this will not be marked.
Do **not** use additional sheets for this working.

0 8

The graph shows the variation of pressure p with temperature θ for a fixed mass of an ideal gas at constant volume.

What is the gradient of the graph?

[1 mark]



A 0.341



B 0.395



C 2.93



D 5.00



0 9

Two flasks **X** and **Y** are filled with an ideal gas and are connected by a tube of negligible volume compared to that of the flasks. The volume of **X** is twice the volume of **Y**. **X** is held at a temperature of 150 K and **Y** is held at a temperature of 300 K

What is the ratio $\frac{\text{mass of gas in X}}{\text{mass of gas in Y}}$?

[1 mark]**A** 0.125☐**B** 0.25☐**C** 4☒**D** 8☐**1 0**

The average mass of an air molecule is 4.8×10^{-26} kg

What is the mean square speed of an air molecule at 750 K?

[1 mark]**A** $3.3 \times 10^5 \text{ m}^2 \text{ s}^{-2}$ ☐**B** $4.3 \times 10^5 \text{ m}^2 \text{ s}^{-2}$ ☐**C** $6.5 \times 10^5 \text{ m}^2 \text{ s}^{-2}$ ☒**D** $8.7 \times 10^5 \text{ m}^2 \text{ s}^{-2}$ ☐**1 1**

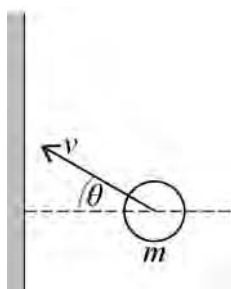
A transparent illuminated box contains small smoke particles and air. The smoke particles are observed to move randomly when viewed through a microscope.

What is the cause of this observation of Brownian motion?

[1 mark]**A** Smoke particles gaining kinetic energy by the absorption of light☐**B** Collisions between smoke particles and air molecules☒**C** Smoke particles moving in convection currents caused by the air being heated by the light☐**D** The smoke particles moving randomly due to their temperature☐**Turn over ►**

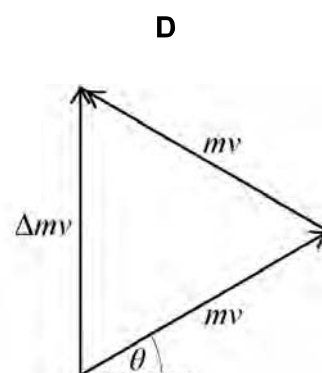
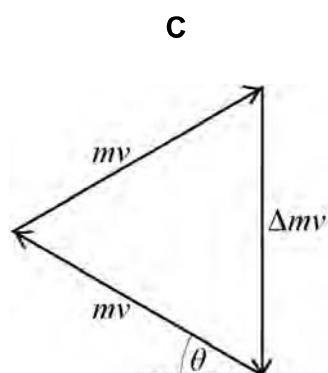
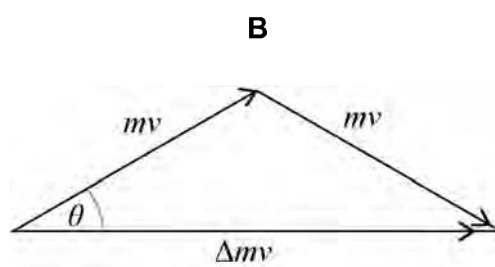
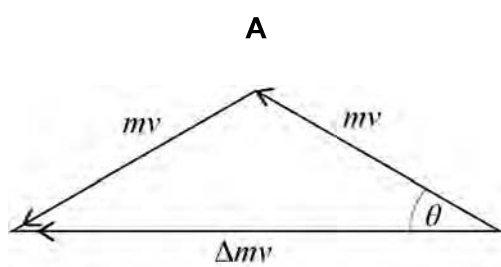
1 2

The diagram shows a gas particle about to collide elastically with a wall.



Which diagram shows the correct change in momentum Δmv that occurs during the collision?

[1 mark]

A ☐B ☒C ☐D ☐

1 3 The distance between the Sun and the Earth is $1.5 \times 10^{11} \text{ m}$

What is the gravitational force exerted on the Sun by the Earth?

[1 mark]

A $3.5 \times 10^{22} \text{ N}$

☒

B $1.7 \times 10^{26} \text{ N}$

☐

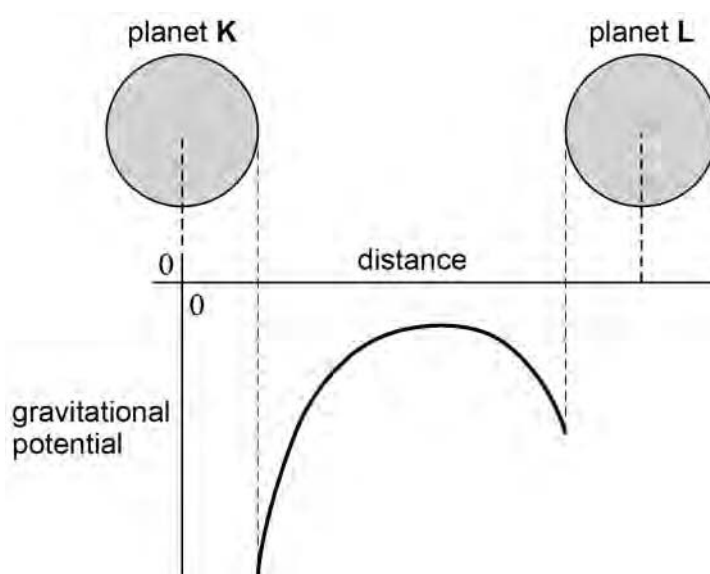
C $5.3 \times 10^{33} \text{ N}$

☐

D $8.9 \times 10^{50} \text{ N}$

☐

1 4 The graph shows how the gravitational potential varies with distance between two planets, **K** and **L**, that have the same radius.



Which statement is correct?

[1 mark]

A The mass of **L** is greater than the mass of **K**.

☐

B The gravitational field strength at the surface of **L** is greater than that at the surface of **K**.

☐

C The escape velocity from planet **L** is greater than that from planet **K**.

☐

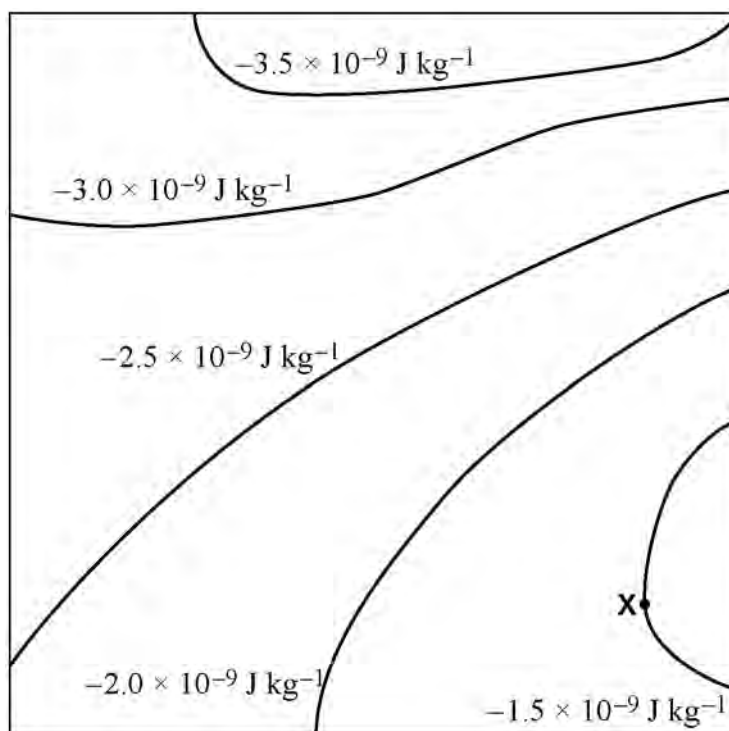
D More work must be done to move a mass of 1 kg from the surface of **K** to a distant point, than 1 kg from the surface of **L**.

☒

Turn over ►



- 1 5** The diagram shows equipotential lines near a group of asteroids.



Which arrow shows the direction of the gravitational field at X?

[1 mark]

- A $\uparrow$
 B $\downarrow$
 C $\leftarrow$
 D $\rightarrow$

☐
☐
☒
☐


1 6

Planet **N** has a gravitational potential $-V$ at its surface. Planet **M** has double the density and double the radius of planet **N**. Both planets are spherical and have uniform density.

What is the gravitational potential at the surface of planet **M**?

[1 mark]**A** $-16V$ ☐**B** $-8V$ ☒**C** $-4V$ ☐**D** $-0.2V$ ☐**1 7**

A spacecraft of mass 1.0×10^6 kg is in orbit around the Sun at a radius of 1.1×10^{11} m. The spacecraft moves into a new orbit of radius 2.5×10^{11} m around the Sun.

What is the total change in gravitational potential energy of the spacecraft?

[1 mark]**A** -6.76×10^{14} J☐**B** -3.38×10^{14} J☐**C** 3.38×10^{14} J☐**D** 6.76×10^{14} J☒

Turn over for the next question

Turn over ►

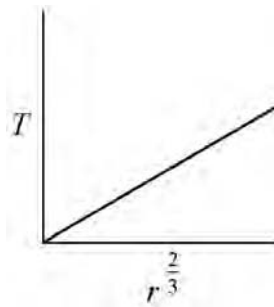


1 8

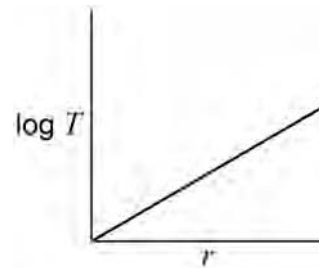
Which graph shows the relationship between the time period T and the orbital radius r of a planet in orbit around the Sun?

[1 mark]

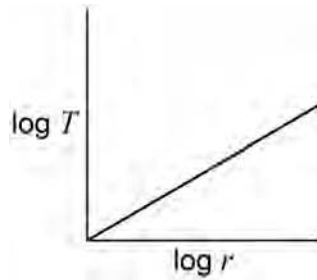
A



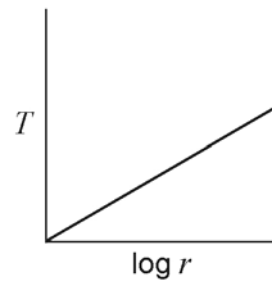
B



C



D

A ☐B ☐C ☒D ☐

1 9

The Earth can be assumed to be a uniform sphere of radius R .

What is the mean density of the Earth?

[1 mark]

A $\frac{3g}{4\pi RG}$



B $\frac{3RG}{4\pi g}$



C $\frac{3G}{4\pi Rg}$



D $\frac{3Rg}{4\pi G}$



Turn over for the next question

Turn over ►

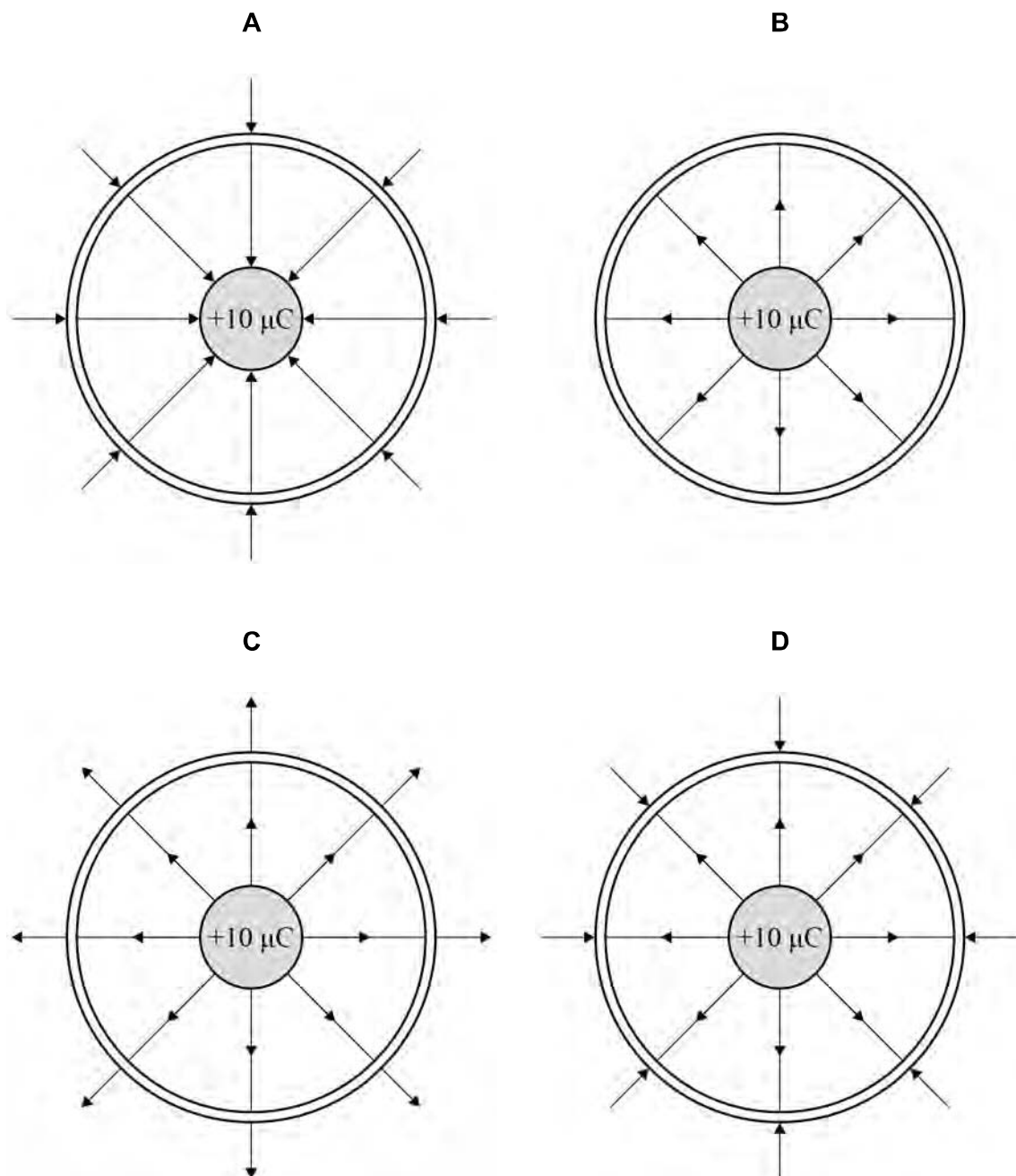


2 0

A conducting sphere holding a charge of $+10\ \mu\text{C}$ is placed centrally inside a second uncharged conducting sphere.

Which diagram shows the electric field lines for the system?

[1 mark]



- A ☐
- B ☐
- C ☒
- D ☐



2 1

A charged spherical conductor has a radius r . An electric field of strength E exists at the surface due to the charge.

What is the potential of the spherical conductor?

[1 mark]

A $r^2 E$

☐

B $r E^2$

☐

C $\frac{E}{r}$

☐

D $r E$

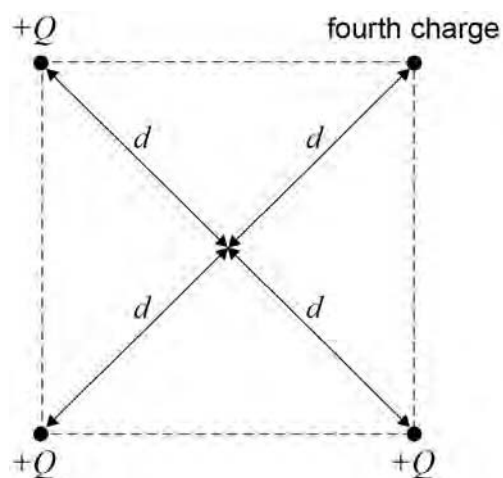
☒

Turn over for the next question

Turn over ►



- 2 2** Four positive charges are fixed at the corners of a square as shown.



The total potential at the centre of the square, a distance d from each charge, is $\frac{5Q}{4\pi\epsilon_0 d}$.
Three of the charges have a charge of $+Q$.

What is the magnitude of the fourth charge?

[1 mark]

A $-\frac{7Q}{4}$

☐

B Q

☐

C $\sqrt{2}Q$

☐

D $2Q$

☒


2 3

An air-filled parallel-plate capacitor is charged from a source of emf. The electric field has a strength E between the plates. The capacitor is disconnected from the source of emf and the separation between the isolated plates is doubled.

What is the final electric field between the plates?

[1 mark]**A** $2E$ **B** E **C** $\frac{E}{2}$ **D** $\frac{E}{4}$ **2 4**

A parallel-plate capacitor has square plates of length l separated by distance d and is filled with a dielectric.

A second capacitor has square plates of length $2l$ separated by distance $2d$ and has air as its dielectric.

Both capacitors have the same capacitance.

What is the relative permittivity of the dielectric in the first capacitor?

[1 mark]**A** $\frac{1}{2}$ **B** 1**C** 2**D** 8

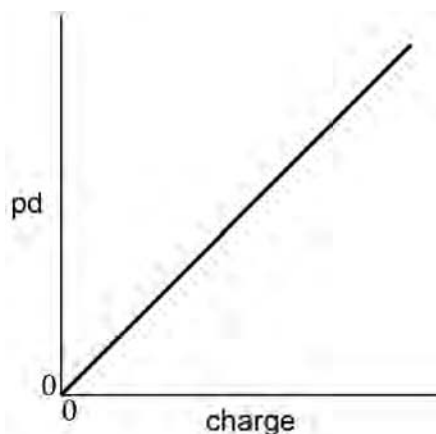
Turn over for the next question

Turn over ►



2 5

The graph shows the variation of potential difference (pd) with charge for a capacitor while it is charging.



Which statement can be deduced from the graph?

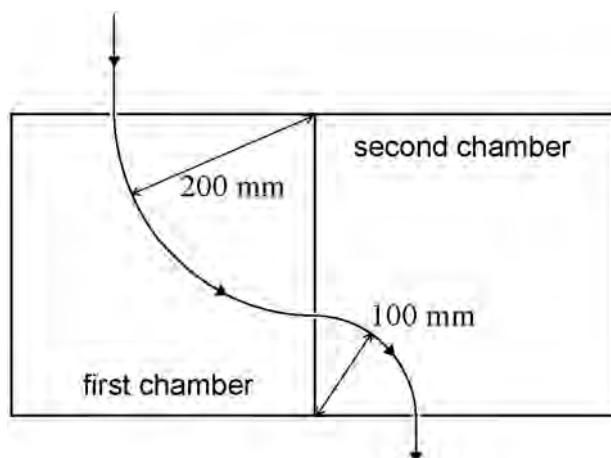
[1 mark]

- A** The charging current is constant. ☐
- B** The energy stored in the capacitor increases uniformly with time. ☐
- C** The capacitance of the capacitor is constant. ☒
- D** The power supply used to charge the capacitor had a constant terminal pd. ☐



2 6

Different magnetic fields are present in the two chambers shown. A particle enters the first chamber at a velocity of 80 m s^{-1} and is deflected into a circular path of radius 200 mm . In the second chamber it follows a circular path of radius 100 mm .



The particle leaves the second chamber at a speed of

[1 mark]

- A** 20 m s^{-1}
B 40 m s^{-1}
C 80 m s^{-1}
D 160 m s^{-1}

☐
☐
☒
☐

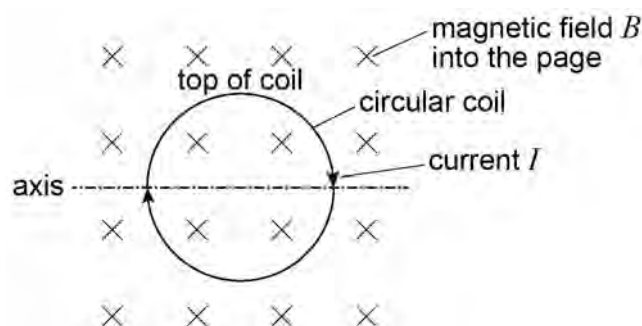
Turn over for the next question

Turn over ►



2 7

The diagram shows a clockwise current I in a circular coil placed in a uniform magnetic field B with the plane of the coil perpendicular to the magnetic field.



What is the effect on the coil of the interaction between the current and the magnetic field? [1 mark]

A It rotates about the axis with the top moving out of the page.

☐

B It rotates about the axis with the top moving into the page.

☐

C It causes an increase in the diameter of the coil.

☒

D It causes a decrease in the diameter of the coil.

☐
2 8

A transformer has an efficiency of 80%

It has 7000 turns on its primary coil and 175 turns on its secondary coil. When the primary of the transformer is connected to a 240 V ac supply, the secondary current is 8.0 A

What are the primary current and secondary voltage?

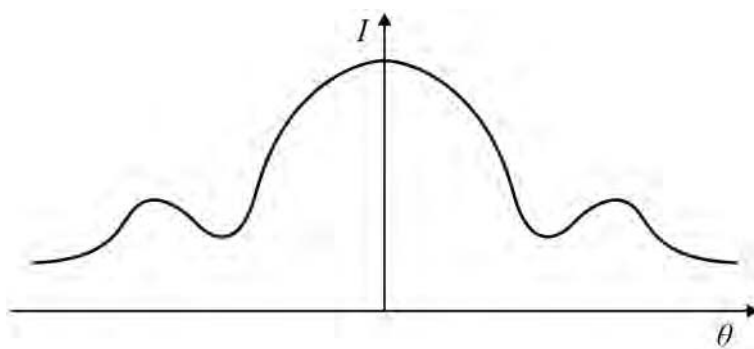
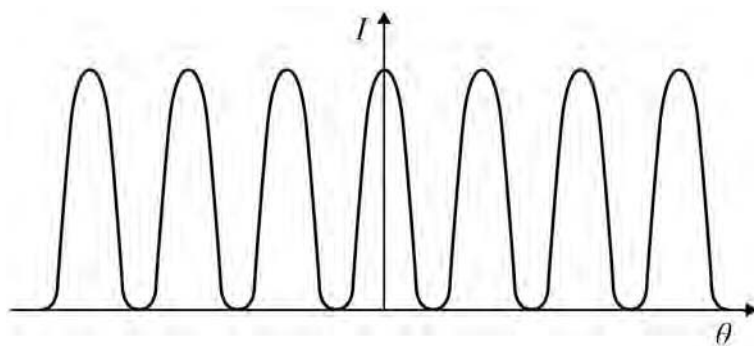
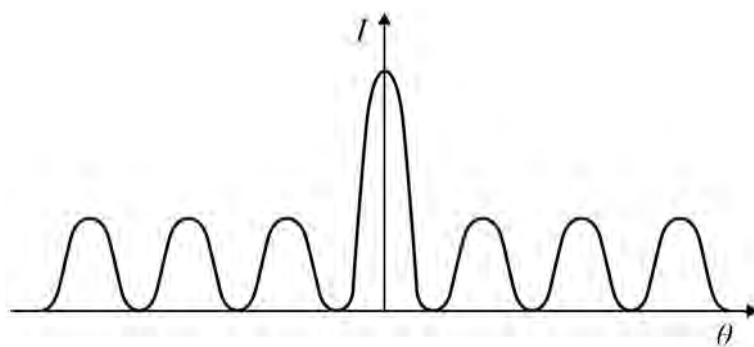
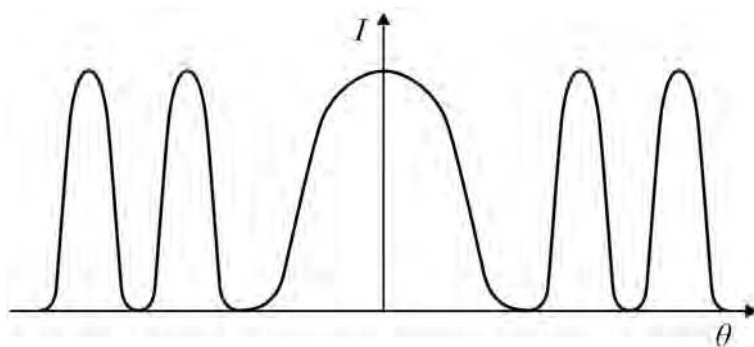
[1 mark]

	Primary current / mA	Secondary voltage / V	
A	250	6.0	☒
B	160	6.0	☐
C	250	9600	☐
D	160	9600	☐



2 9

Which graph shows how intensity I varies with angle θ when electrons are diffracted by a nucleus?

[1 mark]**A****B****C****D****Turn over ►**

- 3 0** The radius of a uranium $^{238}_{92}\text{U}$ nucleus is $7.75 \times 10^{-15} \text{ m}$
What is the radius of a $^{12}_6\text{C}$ nucleus?

[1 mark]

A $1.10 \times 10^{-18} \text{ m}$

☐

B $3.91 \times 10^{-16} \text{ m}$

☐

C $2.86 \times 10^{-15} \text{ m}$

☒

D $3.12 \times 10^{-15} \text{ m}$

☐

- 3 1** During a single fission event of uranium-235 in a nuclear reactor the total mass lost is 0.23 u. The reactor is 25% efficient.

How many events per second are required to generate 900 MW of power?

[1 mark]

A 1.1×10^{14}

☐

B 6.6×10^{18}

☐

C 1.1×10^{20}

☒

D 4.4×10^{20}

☐

- 3 2** Which of the following substances can be used as a moderator in a nuclear reactor?

[1 mark]

A Boron

☐

B Concrete

☐

C Uranium-238

☐

D Water

☒

25

END OF QUESTIONS



There are no questions printed on this page

*Do not write
outside the
box*

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**



There are no questions printed on this page

*Do not write
outside the
box*

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

Copyright information

For confidentiality purposes, from the November 2015 examination series, acknowledgements of third party copyright material will be published in a separate booklet rather than including them on the examination paper or support materials. This booklet is published after each examination series and is available for free download from www.aqa.org.uk after the live examination series.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team, AQA, Stag Hill House, Guildford, GU2 7XJ.

Copyright © 2018 AQA and its licensors. All rights reserved.

