OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL A-LEVEL

PHYSICS

Unit 3 Fields and their consequences

Monday 18 May 2026 08:00 UK Time Time allowed: 2 hours

Materials

For this paper you must have:

- a Data and Formulae Booklet as a loose insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate
- a protractor.

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.
- All working must be shown.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8–22	
TOTAL	

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Section A

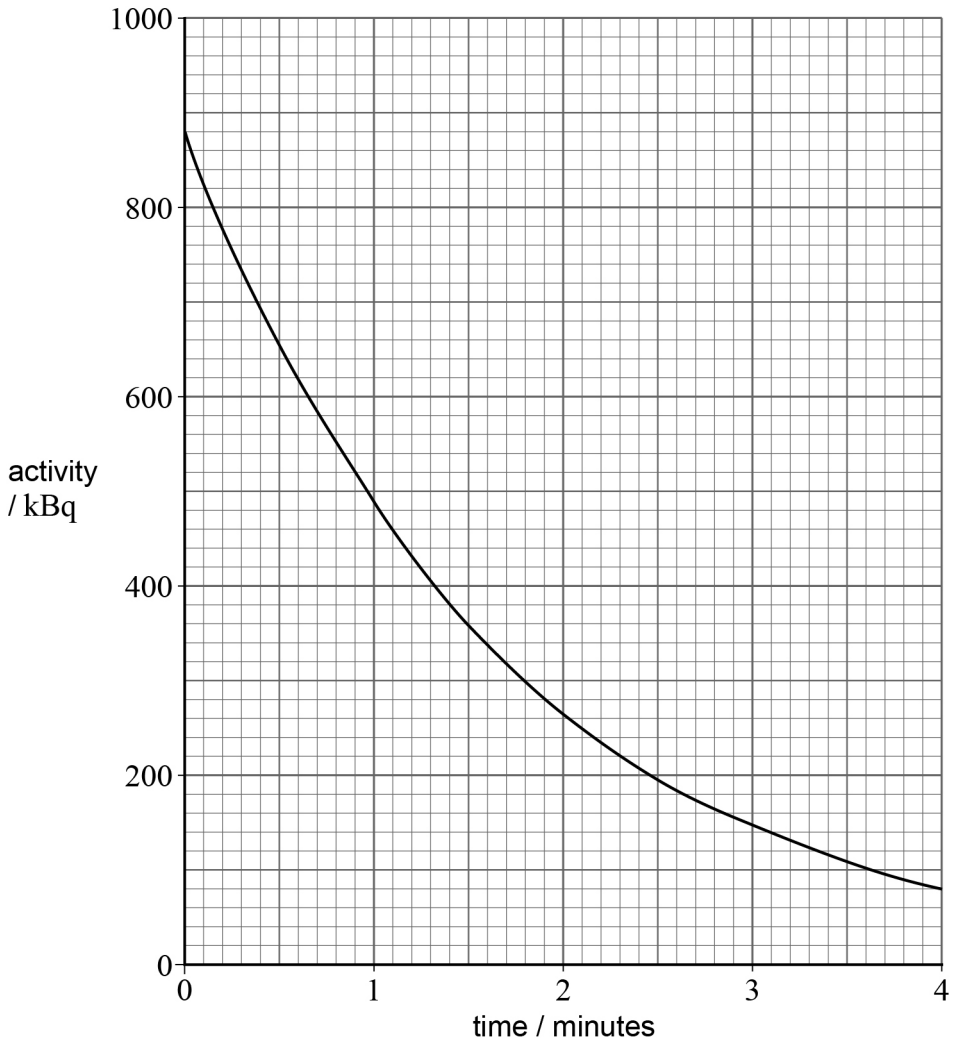
Answer **all** questions in this section.

0 1 . 1 Describe **one** safety procedure when working with a radioactive source in a school laboratory.

[1 mark]

Figure 1 shows the variation of the activity of a radioactive source with time.

Figure 1



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0 1 . 2 State what is meant by the decay constant of a radioactive source.

[1 mark]

0 1 . 3 Use **Figure 1** to determine, in s^{-1}, an accurate value for the decay constant of the radioactive source.

[4 marks]

decay constant = _____ s^{-1}

0 1 . 4 Carbon-11 is a radioactive nuclide that decays to boron-11. Boron-11 is stable. Carbon-11 has a decay constant of $5.7 \times 10^{-4}\ s^{-1}$.

A radioactive sample initially contains 5.0×10^{6} carbon-11 nuclei and no boron-11 nuclei.

Calculate the time taken for the sample to contain 4.0×10^{6} nuclei of boron-11.

[2 marks]

time = _____ s

8

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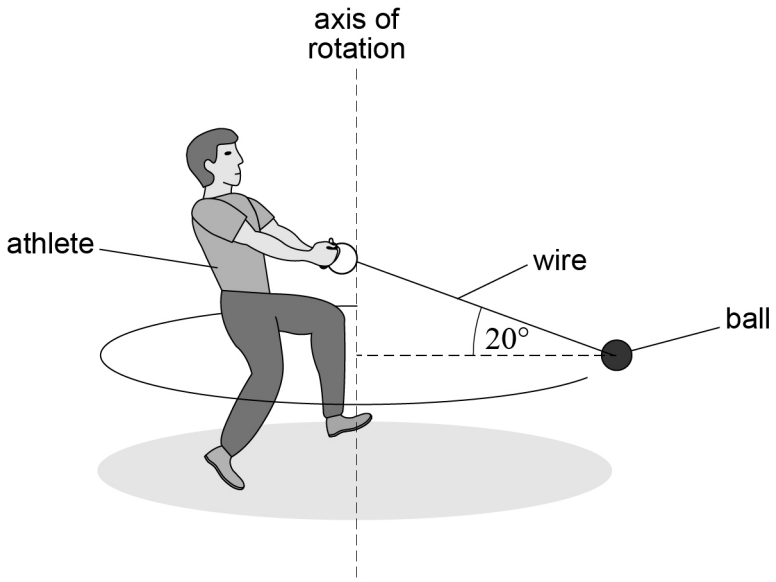
0 2 In the sport of hammer throwing, the hammer consists of a heavy ball attached to a wire. At the other end of the wire is a handle. During a hammer throw an athlete rotates, causing the ball to travel at a constant speed in a horizontal circle.

Figure 2 shows the position of the ball at one instant.
The wire is at an angle of $20°$ to the horizontal.

Figure 2



0 2 . 1 Draw an arrow on **Figure 2** to indicate the resultant force acting on the ball at this instant.
Label your arrow **F**.

[1 mark]

0 2 . 2 Explain why the wire must be at an angle below the horizontal when the ball moves in a horizontal circle.

[1 mark]

Do not write outside the box

0 2 . 3 In **Figure 2**, the ball is moving at an angular speed of $4.5\ \text{rad s}^{-1}$.

Determine the radius of the ball's path.

[3 marks]

radius = _____ m

0 2 . 4 The athlete now increases the tension in the wire so that the ball moves in a different horizontal circle.
The axis of rotation of the ball remains at the end of the wire. The length of the wire does not change.

State and explain what happens to:
- the angle that the wire makes with the horizontal
- the linear speed of the ball.

[4 marks]

9

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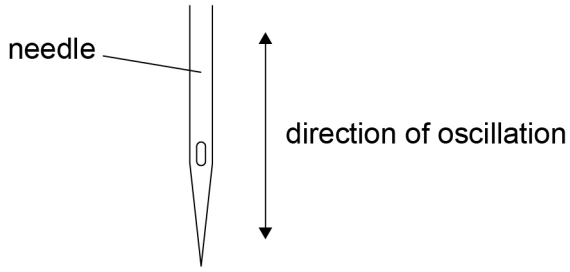
0 3 **Figure 3** shows a needle that is used in a sewing machine.

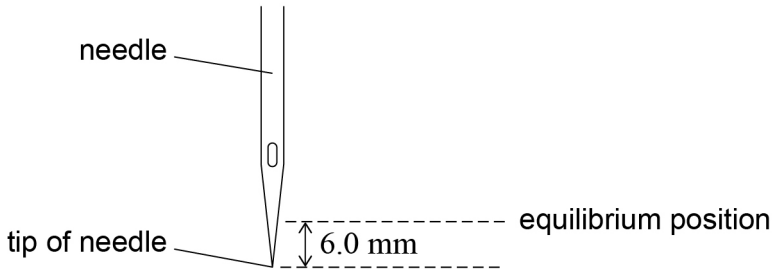
Figure 3



The needle oscillates vertically with simple harmonic motion. It has an amplitude of $13\ \text{mm}$ and an angular frequency ω of $22\ \text{rad s}^{-1}$.

Figure 4 shows the needle at an instant when it is moving downwards.
The tip of the needle is at a distance of $6.0\ \text{mm}$ below its equilibrium position.

Figure 4



0 3 . 1 Calculate the speed of the tip of the needle at the instant shown in **Figure 4**.

[2 marks]

speed = _____ m s^{-1}

Do not write outside the box

0 3 . 2 The mass of the needle is 2.8×10^{-4} kg.

Calculate the magnitude of the resultant force acting on the needle in **Figure 4**.

[2 marks]

resultant force = _____ N

0 3 . 3 State and explain the direction of the resultant force acting on the needle in **Figure 4**.

[1 mark]

_____

_____

_____

0 3 . 4 Calculate the minimum time taken for the tip of the needle to return to the position shown in **Figure 4**.

[3 marks]

minimum time = _____ s

Question 3 continues on the next page

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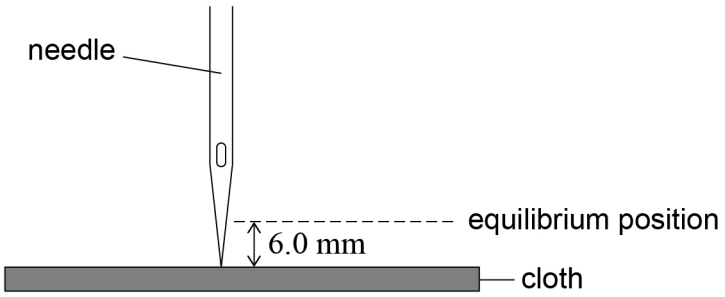
0 3 . 5 **Figure 5** shows a cloth placed $6.0\ \text{mm}$ beneath the equilibrium position. The needle oscillates vertically and the tip of the needle passes through the cloth.

Figure 5



Suggest whether the motion of the needle is still simple harmonic motion.

[2 marks]

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 4 A satellite is in a circular orbit around a planet of mass 1.9×10^{27} kg.
The orbit has a radius of 4.5×10^{8} m.

0 4 . 1 The kinetic energy of the satellite is 2.2×10^{11} J.

Show that the mass of the satellite is approximately 2000 kg.

[3 marks]

The satellite moves to a new circular orbit of radius 4.0×10^{8} m.

0 4 . 2 Calculate the change in the gravitational potential energy of the satellite.

[4 marks]

change in gravitational potential energy = _____ J

Do not write outside the box

0 4 . 3 State and explain how this change of orbital radius affects the total energy of the satellite.

[2 marks]

9

Turn over for the next question

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0 5 The Earth produces an electric field above its surface.

0 5 . 1 The electric field strength is $110\ \text{V m}^{-1}$ just above the surface of the Earth.

Calculate the magnitude of the charge on the Earth.
Assume that the Earth behaves as a charged sphere.

[2 marks]

charge = _____ C

Spiders use the electric field of the Earth to move through the air on charged strings of web. A spider can move through a vertical distance of a few metres in this way.

0 5 . 2 Explain why the electric field of the Earth can be assumed to be uniform throughout the spider's movement.

[1 mark]

_____

_____

_____

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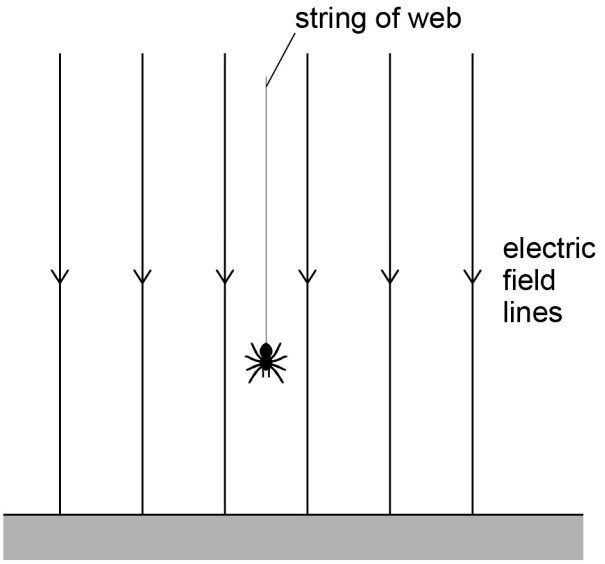
Figure 6 shows a spider firmly attached to a vertical string of web. An upwards force is exerted on the string of web by the electric field.

Figure 6



0 5 . 3 Explain whether the charge on the string of web is positive or negative.

[1 mark]

0 5 . 4 The magnitude of the charge on the string of web is 2.5×10^{-7} C.
Assume that the string of web acts like a point charge.
The total mass of the spider and string of web is 1.5 mg.

Calculate the acceleration of the spider.
Ignore any forces due to the air.

[3 marks]

acceleration = _____ m s^{-2}

7

Turn over ►

Do not write outside the box

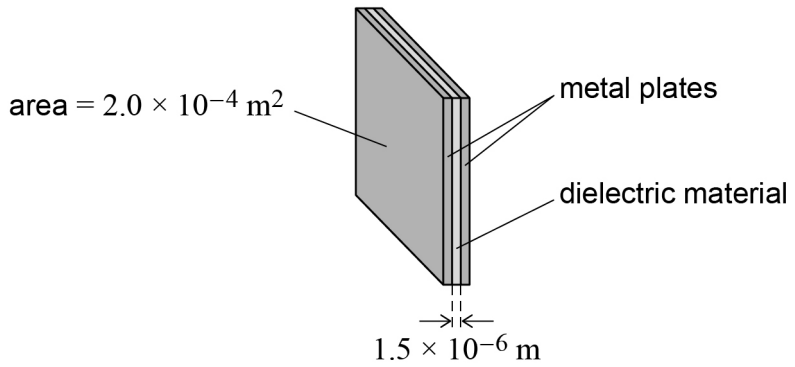
0 6 . 1 Explain how the addition of a dielectric material increases the capacitance of a capacitor.

[2 marks]

Figure 7 shows a capacitor with parallel metal plates separated by a dielectric material.

The plates have a separation of 1.5×10^{-6} m and each plate has an area of 2.0×10^{-4} m^2.

Figure 7



0 6 . 2 The capacitor stores a charge of 1.9×10^{-8} C when there is a potential difference of 5.0 V across its plates.

Calculate the relative permittivity of the dielectric material.

[2 marks]

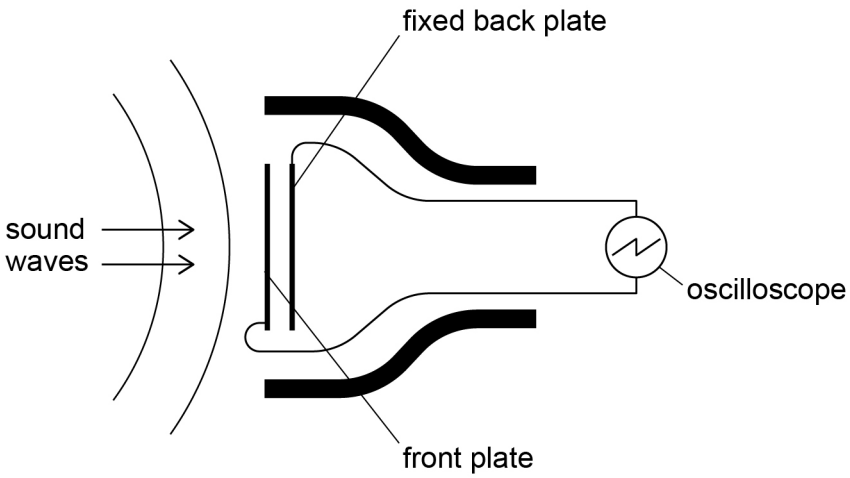
relative permittivity = _____

Do not write outside the box

Figure 8 shows a design for a microphone that uses the capacitor in **Figure 7**.

The microphone is connected to an oscilloscope.

Figure 8



The capacitor has a front plate which can move and a fixed back plate.
Sound waves cause the front plate to oscillate so that the separation of the plates changes.

The potential difference across the capacitor varies as the front plate oscillates.
The charge on the capacitor stays constant.
The relative permittivity of the dielectric material does not change.

0 6 . 3 Explain how the potential difference across the plates changes as the sound waves cause the separation of the plates to decrease.

[2 marks]

Question 6 continues on the next page

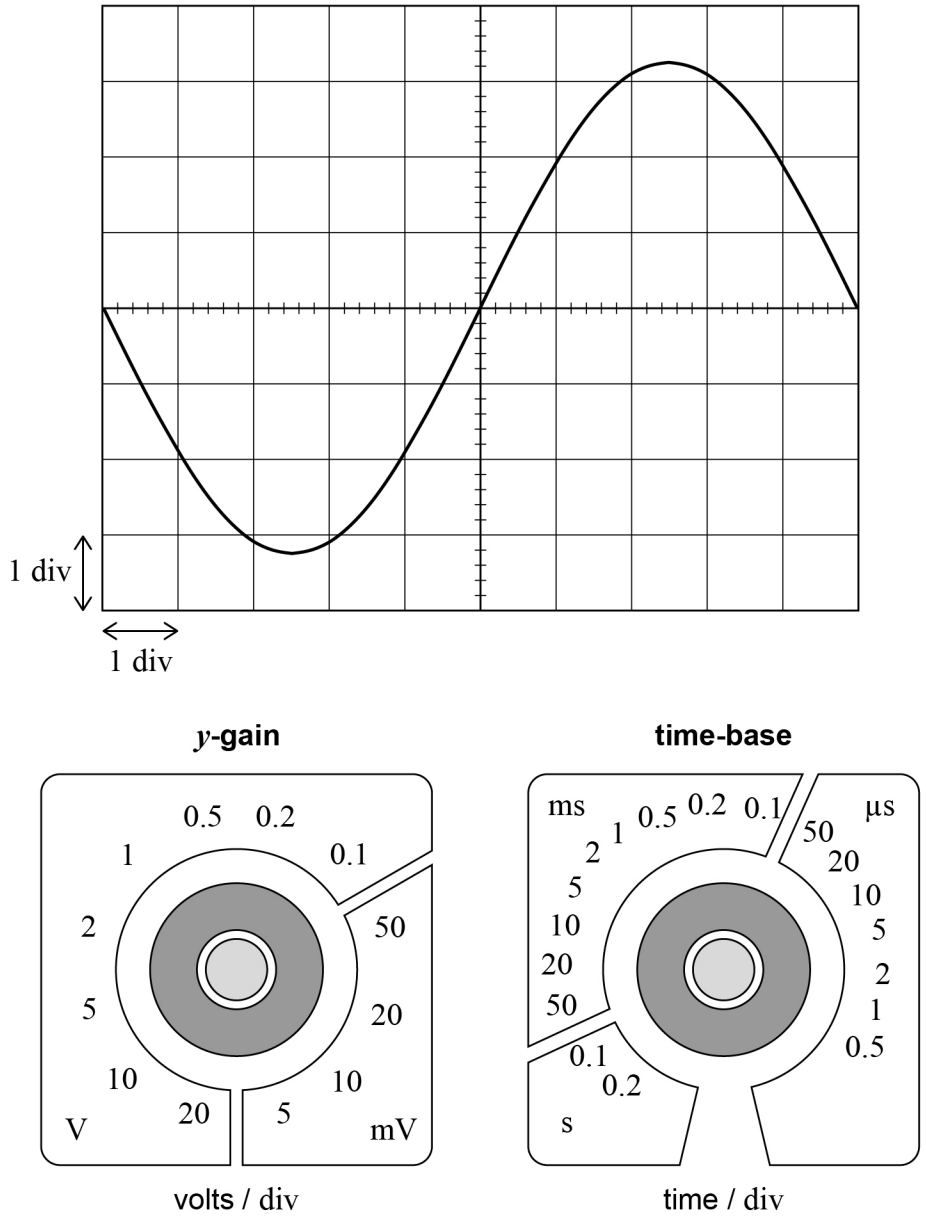
Do not write outside the box

0 6 . 4 The sound waves cause the front plate to oscillate with simple harmonic motion. The frequency of the oscillation is 100 Hz.

The capacitance of the capacitor varies between 2.9 nF and 5.8 nF.
The charge on the capacitor is 1.9×10^{-8} C.

Figure 9 shows the oscilloscope screen and the controls of the oscilloscope.
The settings on the dial are not shown.

Figure 9



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Determine the y-gain and time-base settings of the oscilloscope.
Give the units for your answers.

[5 marks]

y-gain = _____ unit = _____

time-base = _____ unit = _____

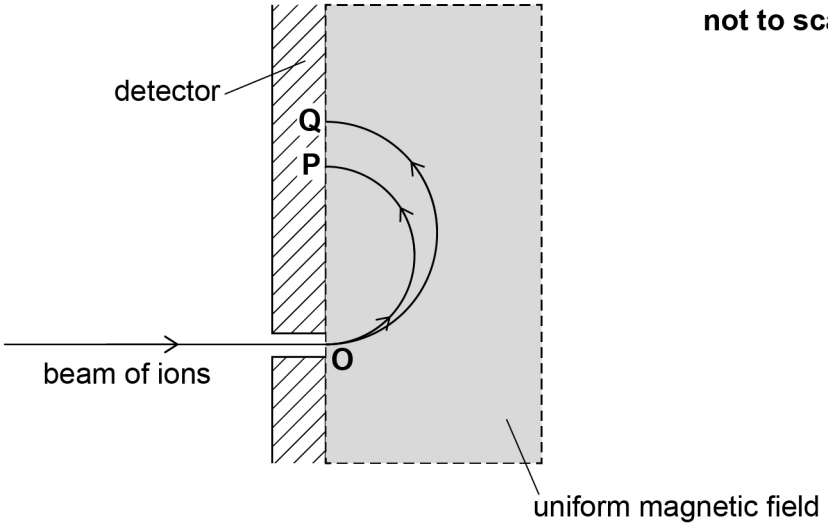
11

Turn over for the next question

Do not write outside the box

0 7 A beam of lithium ions contains two different isotopes of lithium. **Figure 10** shows the paths of the ions. The ions enter a magnetic field at point **O** and strike a detector at points **P** and **Q**.

Figure 10



0 7 . 1 Explain why the ions move in a circular path inside the magnetic field.

[1 mark]

0 7 . 2 The ions are positively charged.

State and explain the direction of the magnetic field in **Figure 10**.

[2 marks]

Do not write outside the box

The ions all have the same charge and enter the magnetic field with the same velocity.

0 7 . 3 Compare, using **Figure 10**, the mass of an ion at **P** with the mass of an ion at **Q**. Explain your answer.

[2 marks]

Question 7 continues on the next page

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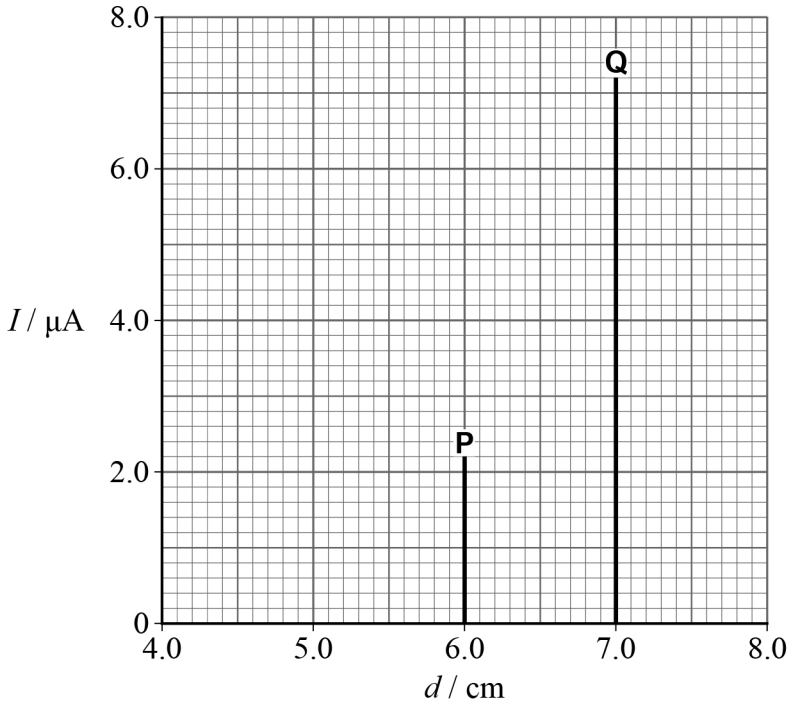
0 7 . 4 The detector measures the current at different distances d from **O**.

Figure 11 shows the variation of current with d.

Figure 11



The ions striking the detector at **Q** have a molar mass of 7.02 g.
Each ion has a charge of +1e.
The ions have a speed of 2.5×10^5 m s^{-1}.

Calculate the magnetic flux density of the magnetic field.

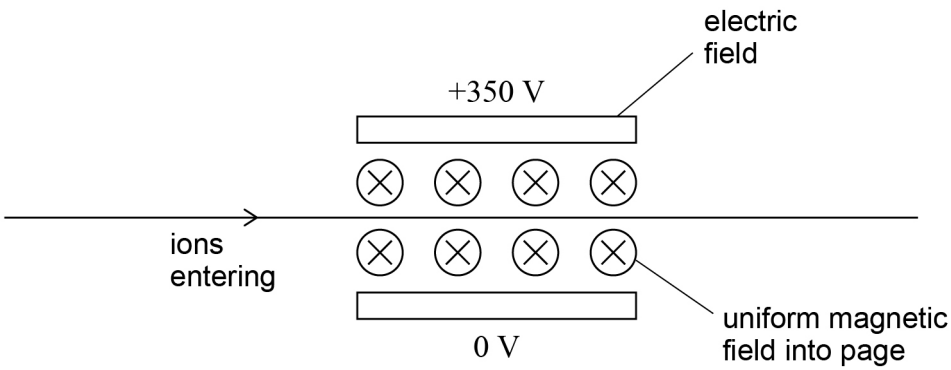
[3 marks]

magnetic flux density = _____ T

Do not write outside the box

Figure 12 shows the ions entering a region where an electric field and a magnetic field act on the ions. This is a different magnetic field to the one in **Figure 10**.

Figure 12



The electric field in **Figure 12** is produced by a potential difference of 350 V across two parallel plates with a separation of 1.8 cm.

0 7 . 5 An ion with a charge of +1e passes between the plates.

Calculate the force on the ion due to the electric field.

[2 marks]

force = _____ N

0 7 . 6 Explain why the ions are **not** deflected as they travel through the region.

[1 mark]

_____

_____

_____

11

END OF SECTION A

Do not write outside the box

Section B

Each of the questions in this section 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 question, 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 pages for this working.

0 8 A planet of mass M has gravitational field strength g and gravitational potential V.

Which expression is equivalent to g?

[1 mark]

A $-V$

B $\frac{V}{GM}$

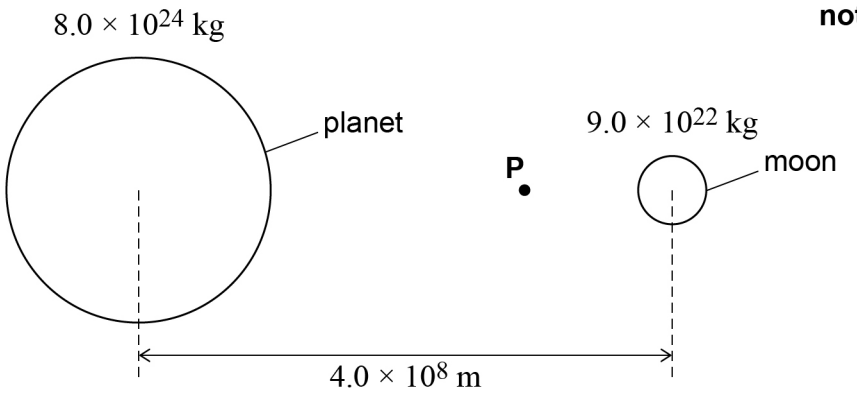
C $\frac{V^2}{GM}$

D $\frac{V^2}{G^2M^2}$

Do not write outside the box

0 9 The distance between the centre of a planet and the centre of its moon is 4.0×10^8 m.

mass of planet = 8.0×10^{24} kg
mass of moon = 9.0×10^{22} kg



At point **P** the gravitational field strength is zero.

What is the distance of **P** from the centre of the planet?

[1 mark]

A 4.45×10^6 m ⬭

B 3.84×10^7 m ⬭

C 3.62×10^8 m ⬭

D 3.96×10^8 m ⬭

Turn over for the next question

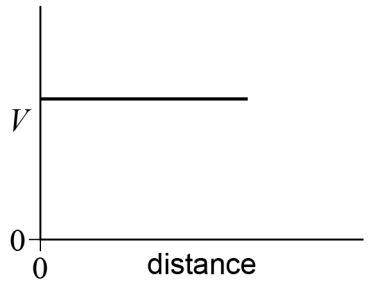
Do not write outside the box

1 0 A uniform electric field is produced between two parallel plates.
A probe **P** is inserted between the plates. The potential difference V is measured between **P** and the negative plate.

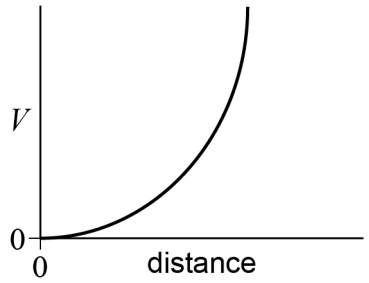
Which graph shows how V varies with the distance of **P** from the negative plate?

[1 mark]

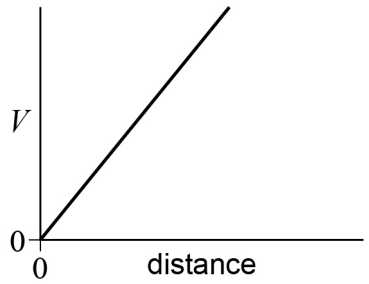
A



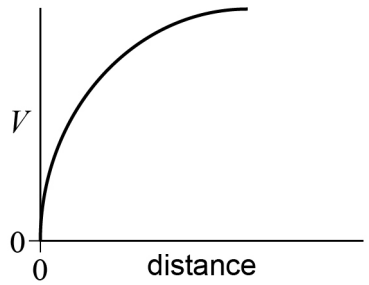
B



C



D



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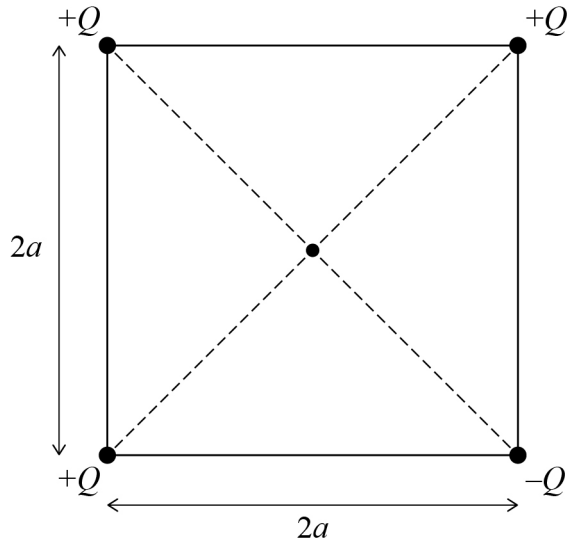
1 1 The diagram shows four point charges at the corners of a square of side $2a$.



What is the electric potential at the centre of the square?

[1 mark]

A $\frac{Q}{2\sqrt{2}\pi\varepsilon_0 a}$ ⬭

B $\frac{Q}{\sqrt{2}\pi\varepsilon_0 a}$ ⬭

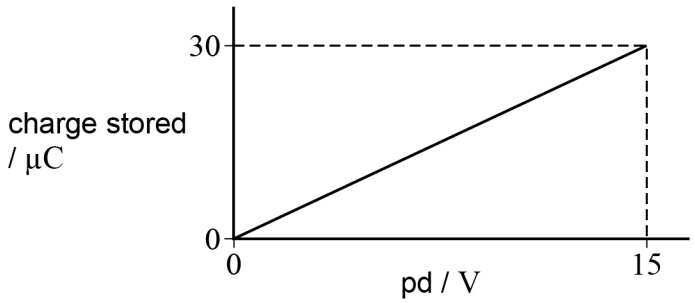
C $\frac{Q}{2\pi\varepsilon_0 a}$ ⬭

D $\frac{Q}{4\pi\varepsilon_0 a}$ ⬭

Turn over for the next question

Do not write outside the box

1 2 The graph shows the variation of charge stored on a capacitor with the potential difference (pd) across it.



The pd across the capacitor increases from $5.0\ \text{V}$ to $10.0\ \text{V}$.

What is the increase in the energy stored in the capacitor?

[1 mark]

A $2.5 \times 10^{-5}\ \text{J}$ ⬭

B $7.5 \times 10^{-5}\ \text{J}$ ⬭

C $1.0 \times 10^{-4}\ \text{J}$ ⬭

D $2.0 \times 10^{-4}\ \text{J}$ ⬭

1 3 A capacitor of capacitance $10 \times 10^{-6}\ \text{F}$ is discharged through a resistor of resistance $1.0 \times 10^{6}\ \Omega$.
The initial charge on the capacitor is $2.0 \times 10^{-3}\ \text{C}$.

What is the charge on the capacitor after $40\ \text{s}$?

[1 mark]

A $37\ \mu\text{C}$ ⬭

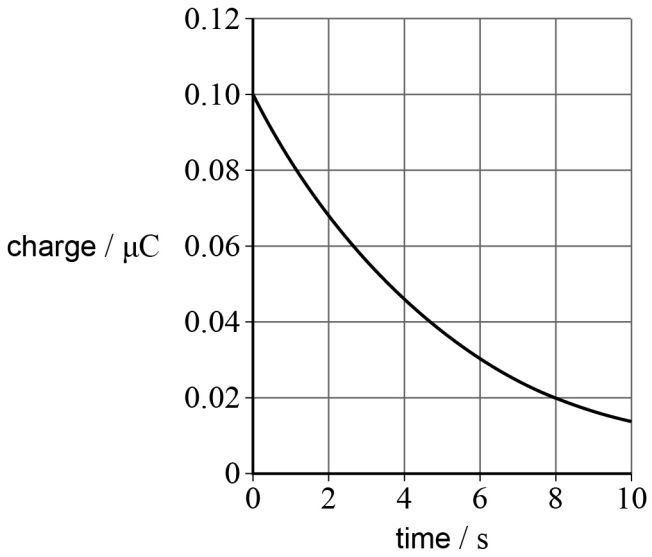
B $125\ \mu\text{C}$ ⬭

C $270\ \mu\text{C}$ ⬭

D $500\ \mu\text{C}$ ⬭

Do not write outside the box

1 4 A capacitor is discharged through a resistor. The graph shows the variation of charge on the capacitor with time.



What is the time constant for the discharge circuit?

[1 mark]

A 3.0 s ⬭

B 4.0 s ⬭

C 5.0 s ⬭

D 8.0 s ⬭

Turn over for the next question

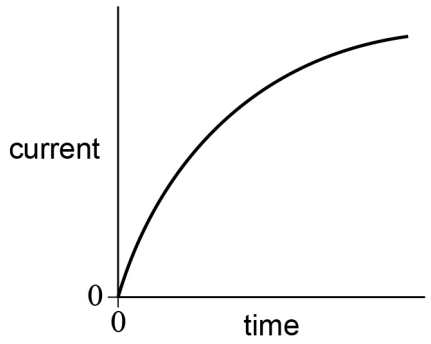
Do not write outside the box

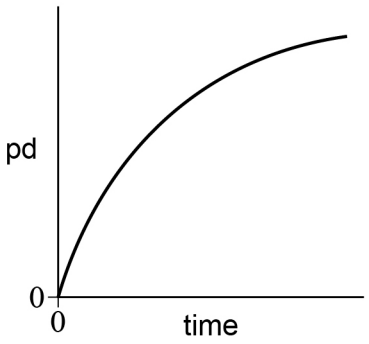
1 5 A capacitor is initially uncharged. The capacitor is charged through a fixed resistor from a cell of constant emf.

Which pair of graphs shows the variation of current with time and the variation of potential difference (pd) with time?

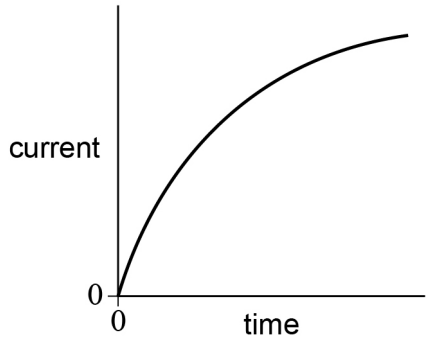
[1 mark]

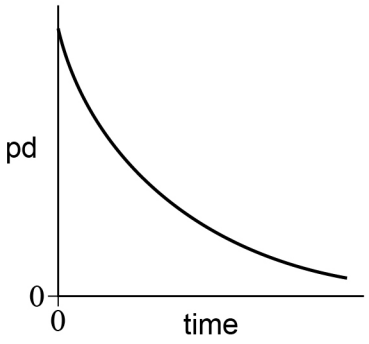
A





B





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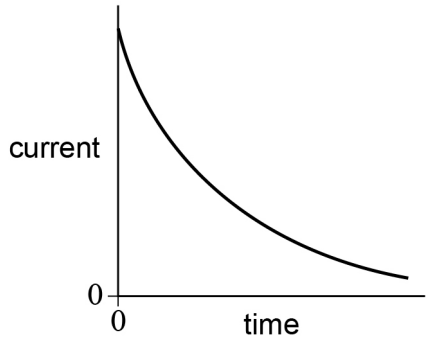
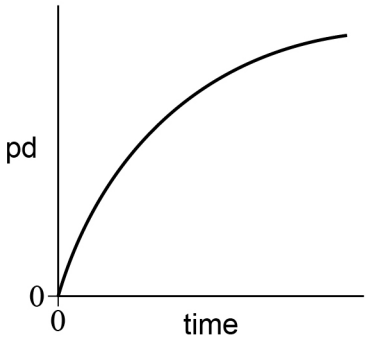
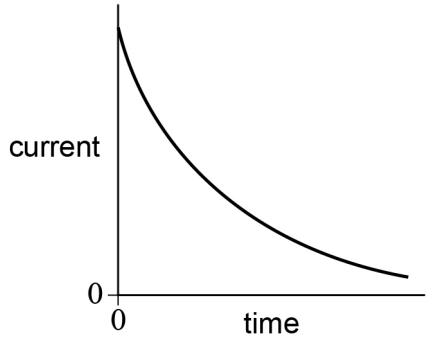
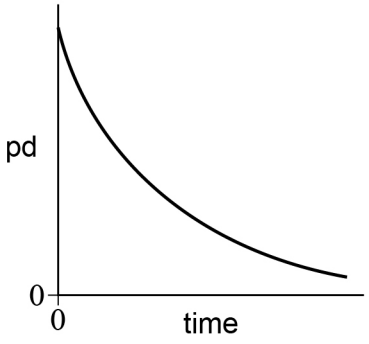




D





Do not write outside the box

1 6 A radioactive nuclide has a half-life of two hours. A specific nucleus of the nuclide does not decay between a time $t = 0$ and $t = 2$ hours.

The probability that this nucleus decays between $t = 2$ hours and $t = 4$ hours is:

[1 mark]

A equal to 100%. ⬭

B greater than 50%. ⬭

C equal to 50%. ⬭

D less than 50%. ⬭

Turn over for the next question

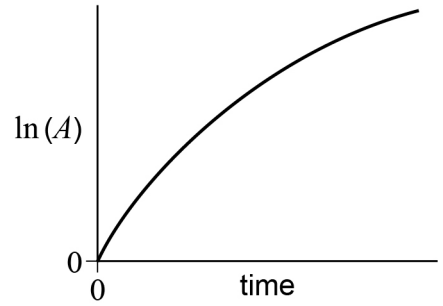
Do not write outside the box

1 7 A radioactive sample has an activity A.

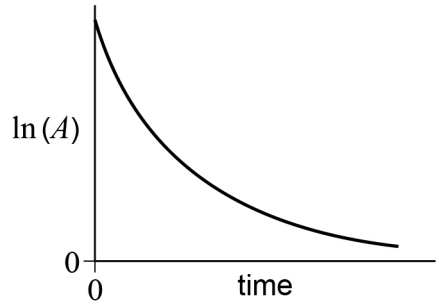
Which graph shows the variation of $\ln(A)$ with time for the sample?

[1 mark]

A



B



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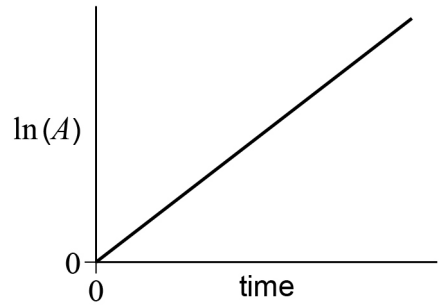
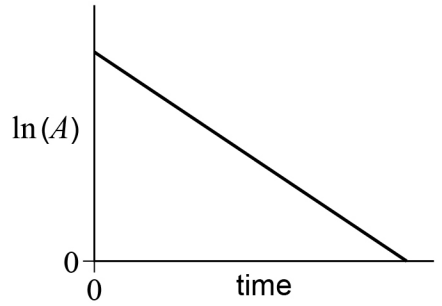


D



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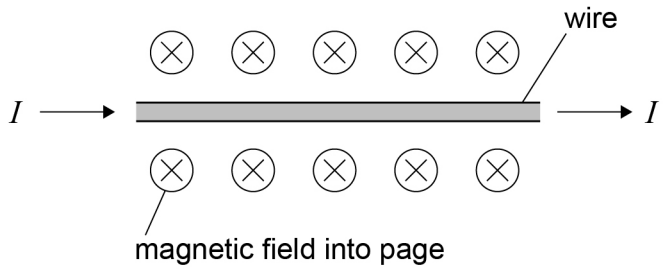
1 8 A straight wire of length L carries a current I.
There is a horizontal uniform magnetic field of flux density B perpendicular to the wire.

The wire experiences a force due to the magnetic field. The force is equal in magnitude and opposite in direction to the weight of the wire.



The mass per unit length of the wire is μ.

What is B?

[1 mark]

A $\mu g L I$ ⬭

B $\frac{\mu g}{I}$ ⬭

C $\frac{\mu g}{I L}$ ⬭

D $\mu g I$ ⬭

1 9 The rms current in a bulb is 0.25 A. The resistance of the bulb is $960\ \Omega$.

What is the peak power of the bulb?

[1 mark]

A 30 W ⬭

B 60 W ⬭

C 85 W ⬭

D 120 W ⬭

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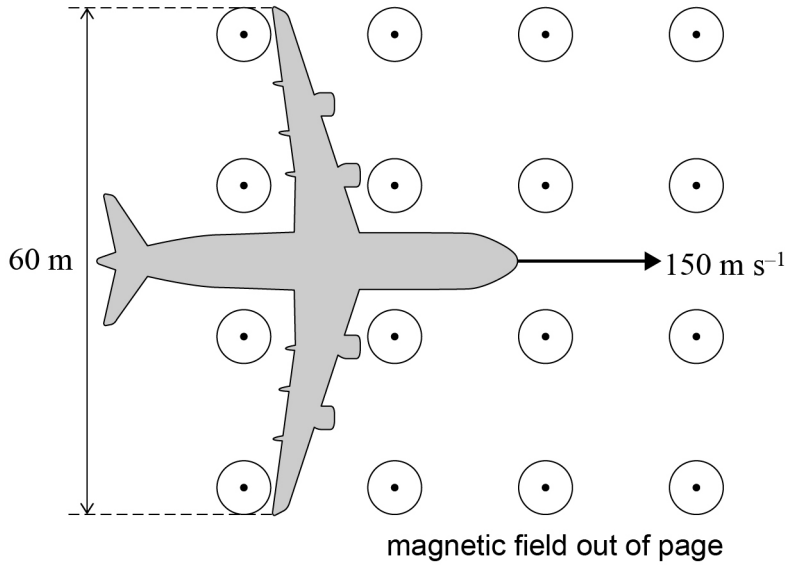
2 0 An aircraft with a wingspan of $60\ \text{m}$ flies horizontally at a speed of $150\ \text{m s}^{-1}$.

The vertical component of the Earth's magnetic field is $1.0 \times 10^{-5}\ \text{T}$.



What is the magnetic flux cut by the wings in a time of $10\ \text{s}$?

[1 mark]

A $9.0 \times 10^{-1}\ \text{Wb}$ ⬭

B $9.0 \times 10^{-2}\ \text{Wb}$ ⬭

C $1.0 \times 10^{-4}\ \text{Wb}$ ⬭

D $1.0 \times 10^{-5}\ \text{Wb}$ ⬭

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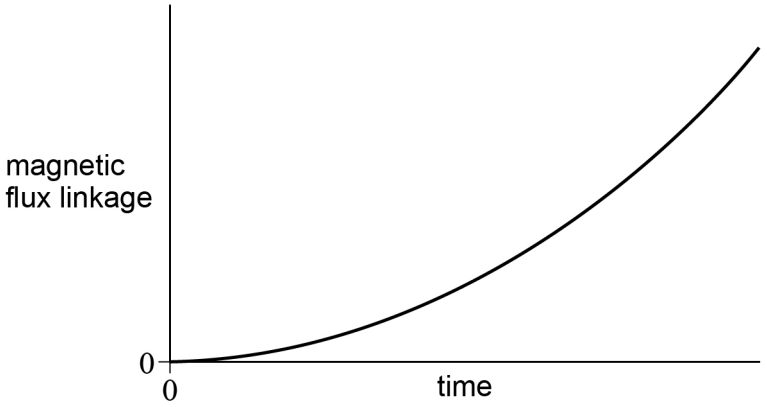
2 1 The graph shows the variation of the magnetic flux linkage in a coil with time.



For the time shown in the graph, the magnitude of the emf is:

[1 mark]

A zero. ⬭

B increasing. ⬭

C decreasing. ⬭

D constant. ⬭

2 2 A 230 V ac supply is connected across the primary coil of a transformer.
The transformer supplies a current of 3.0 A at a voltage of 12.0 V.
The efficiency of the transformer is 90%.

What is the current in the primary coil?

[1 mark]

A 0.14 A ⬭

B 0.16 A ⬭

C 0.17 A ⬭

D 5.80 A ⬭

15

END OF QUESTIONS

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