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

Tuesday 13 January 2026 07:00 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	
9–23	
TOTAL	

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Section A

Answer **all** questions in this section.

0 1 Fluorine-18 $\left({}^{18}_{9}\mathrm{F}\right)$ is a radioactive nuclide that is used in medical scans.

Fluorine-18 decays only by β^+ decay. A stable nuclide X is produced by this decay.

0 1 . 1 Complete the equation below for this decay.

[1 mark]

$$^{18}_{9}\mathrm{F} \rightarrow {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{X} + {}^{\ldots\ldots}_{\ldots\ldots}\beta^+ + {}^{\ldots\ldots}_{\ldots\ldots}\ldots\ldots$$

Fluorine-18 has a decay constant of $1.1 \times 10^{-4}\ \mathrm{s}^{-1}$.

The initial mass of fluorine-18 used in a scan is $5.7 \times 10^{-14}\ \mathrm{kg}$.

0 1 . 2 Calculate the initial activity of the fluorine-18 used in this scan.

Give an appropriate unit for your answer.

molar mass of fluorine-18 = 18 g

[3 marks]

activity = _____ unit = _____

Do not write outside the box

0 1 . 3 Calculate the mass of fluorine-18 that decays during the first 5.0 hours of the scan.

[3 marks]

mass = _____ kg

0 1 . 4 Gamma radiation is detected during this scan.

Suggest why the amount of gamma radiation detected is greater than the amount due to background radiation.

[1 mark]

_____

_____

_____

8

Turn over for the next question

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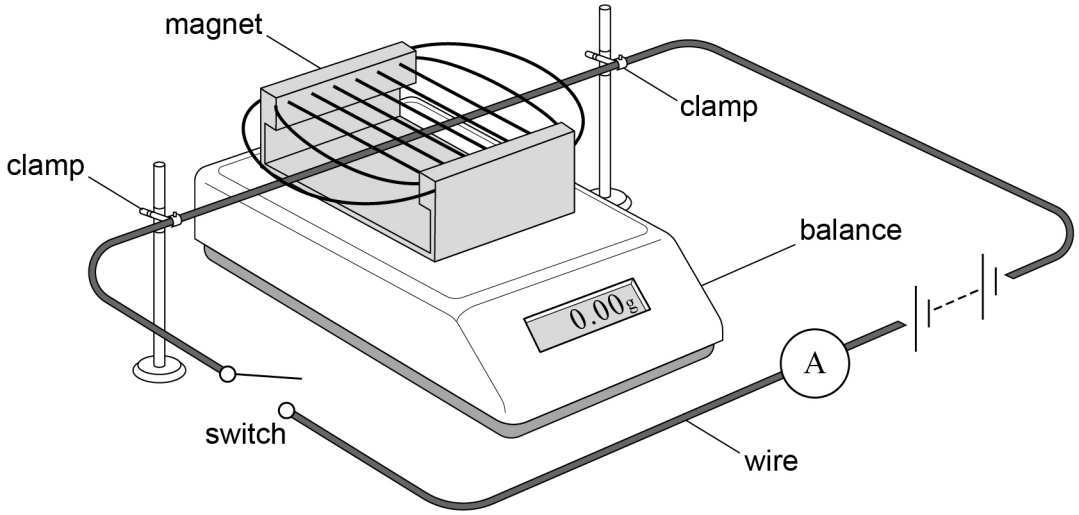
0 2 . 1 State what is meant by a magnetic flux density of $1\ \mathrm{T}$.

[2 marks]

A student does an experiment to measure B, the magnetic flux density between the poles of a magnet.
Figure 1 shows the apparatus. Field lines for the magnetic field are shown, but without their direction.

Figure 1



A magnet is placed on top of a balance.
A horizontal metal wire is clamped between the poles of the magnet.
The wire is perpendicular to the magnetic field.
The wire is connected to a switch, an ammeter and a battery.

The switch is open and the balance is set to zero.

Do not write outside the box

The switch is now closed and the wire remains stationary.
The ammeter reads $2.0\ \text{A}$ and the balance reads $+0.45\ \text{g}$.

0 2 . 2 Draw an arrow on one of the magnetic field lines in **Figure 1** to show the direction of the magnetic field between the poles.

Go on to explain your answer.
You should refer to appropriate physical laws.

[3 marks]

0 2 . 3 The length of the wire between the poles of the magnet is $5.0\ \text{cm}$.

Calculate B.

[2 marks]

$B =$ _____ T

Question 2 continues on the next page

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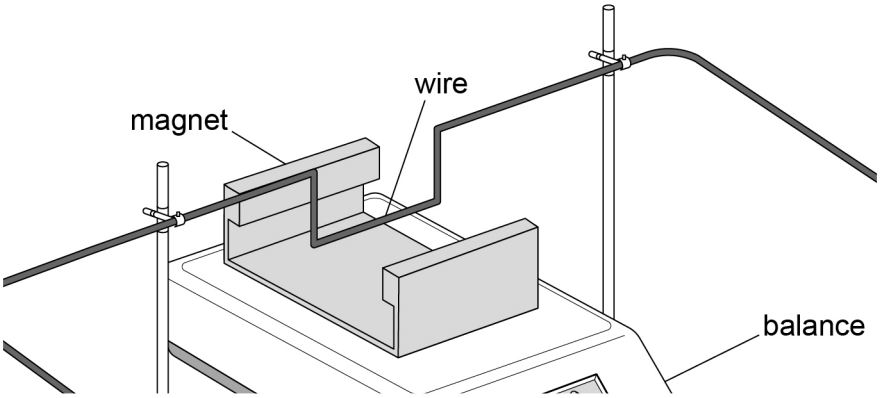
0 2 . 4 Another student suggests the use of a different shaped wire, as shown in **Figure 2**.

Figure 2



The length of the horizontal section of the wire between the poles of the magnet shown in **Figure 2** is $5.0\ \text{cm}$.

Explain why the use of this wire gives a more accurate value for B than the arrangement shown in **Figure 1**.

[2 marks]

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 . 1 **Figure 3** shows an isolated proton **P**.

Draw on **Figure 3** the electric field due to **P**.

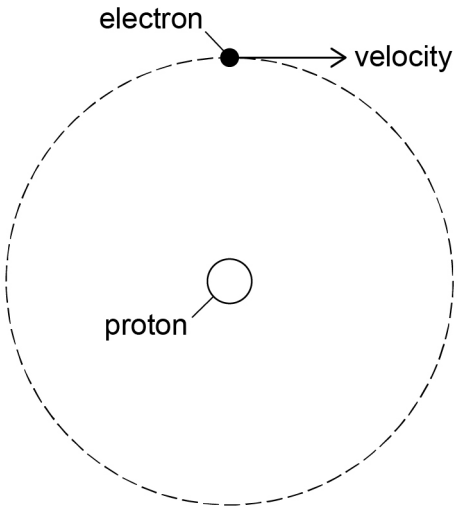
[1 mark]

Figure 3

not to scale

In an early model of a hydrogen atom, the electron orbits the proton in a circular path, as shown in **Figure 4**.

Figure 4



not to scale

In this model, the only force acting on the electron is the electrostatic force exerted by the proton.

The distance between the centre of the electron and the centre of the proton is 5.29×10^{-11} m.

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0 3 . 2 Determine the ratio $\frac{\text{electrostatic force}}{\text{gravitational force}}$ for the forces between the proton and the electron in **Figure 4**.

[3 marks]

$$\frac{\text{electrostatic force}}{\text{gravitational force}} = \_\_\_\_\_$$

0 3 . 3 Show that the kinetic energy of the electron is approximately 2×10^{-18} J.

[3 marks]

Question 3 continues on the next page

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0 3 . 4 Calculate the energy required to completely separate the orbiting electron from the proton.

Assume that the electron has only kinetic energy and electric potential energy.

[3 marks]

energy = _____ J

10

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0 4 An old design for a camera flash contains a capacitor and a filament lamp.
The capacitor supplies energy to the lamp for a short time to make the lamp flash.

The capacitor has a capacitance of $185\ \mu F$.
The maximum charge stored by the capacitor is $3.7 \times 10^{-2}\ C$.

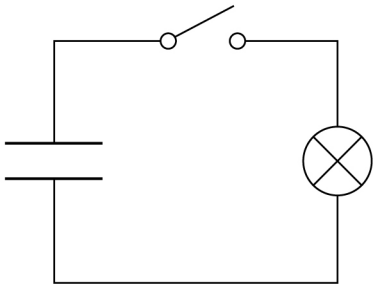
0 4 . 1 Calculate the maximum energy stored by the capacitor.

[1 mark]

maximum energy stored = _____ J

0 4 . 2 **Figure 5** shows the charged capacitor in a circuit with the lamp and a switch.
At time $t = 0$, the switch is closed and the resistance of the lamp is $27\ \Omega$.

Figure 5



Calculate the initial current in the lamp when the switch closes.

[2 marks]

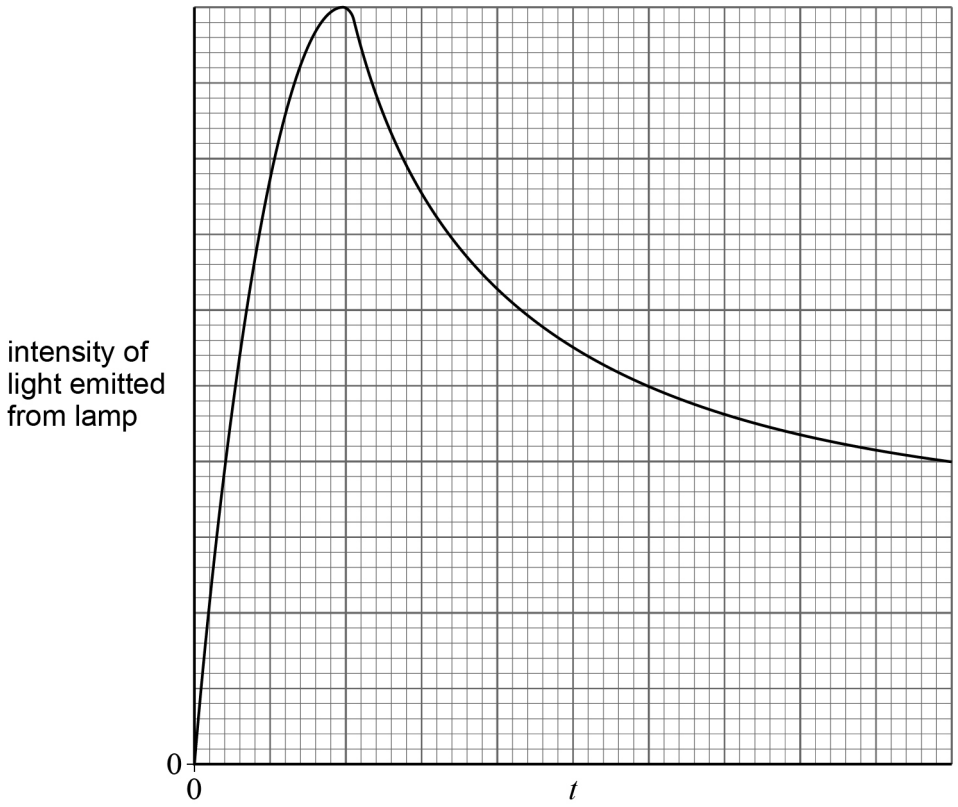
initial current = _____ A

Question 4 continues on the next page

The filament in the lamp is made from metal.
The intensity of the light emitted by the lamp increases with the temperature of the filament.

Figure 6 shows how the intensity of the light varies with t during one flash.

Figure 6



0 4 . 3 Explain the variation of the intensity of the light emitted with t in **Figure 6**.

[4 marks]

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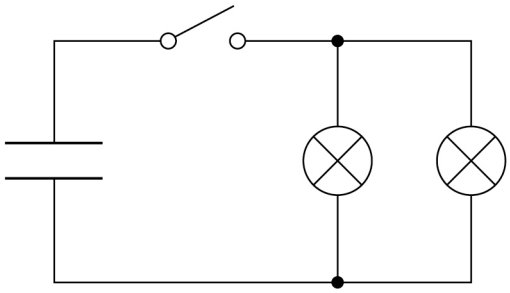
0 4 . 4 The intensity of the light emitted by the lamp reaches a maximum value shortly after the switch is closed.

Determine whether the intensity of the light emitted by the lamp decreases exponentially with time after it reaches this maximum value.

[2 marks]

0 4 . 5 The capacitor is fully charged.
A second identical lamp is added in parallel with the first lamp as shown in **Figure 7**.

Figure 7



A student suggests that the addition of the second lamp will increase the duration of one flash.

Explain whether the student is correct.

[1 mark]

10

Turn over ►

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ANSWER IN THE SPACES PROVIDED

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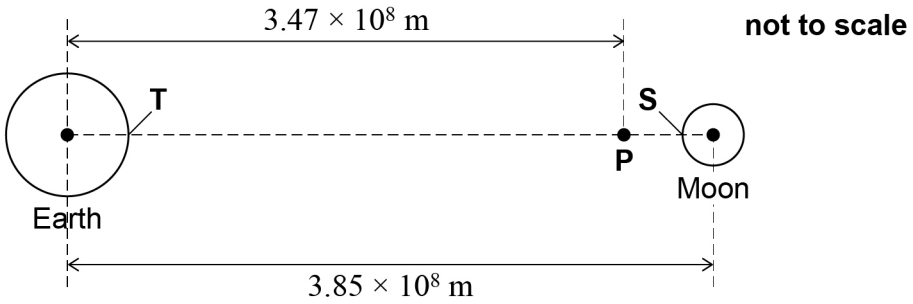
0 5 **Figure 8** shows the Earth, the Moon and points **P**, **S** and **T**.
P is the point where the resultant gravitational field strength is zero.
S is the point on the surface of the Moon closest to the Earth.
T is the point on the surface of the Earth closest to the Moon.

P is a distance of 3.47×10^8 m from the centre of the Earth.

Figure 8



The distance between the centre of the Earth and the centre of the Moon, as shown in **Figure 8**, is 3.85×10^8 m.

0 5 . 1 Explain why the resultant gravitational field strength is zero at **P**.

[1 mark]

0 5 . 2 Determine the mass of the Moon.

[2 marks]

mass of Moon = _____ kg

Question 5 continues on the next page

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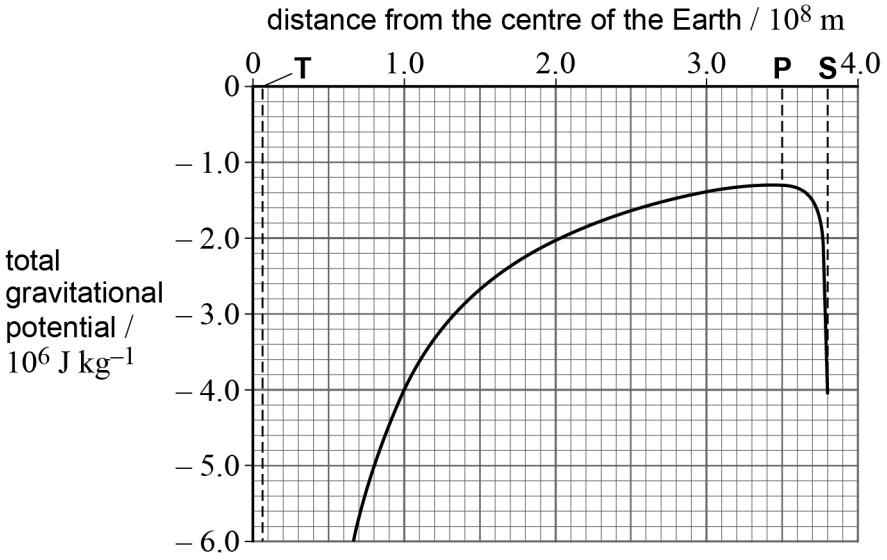
Figure 9 shows the variation of the total gravitational potential with distance from the centre of the Earth towards the centre of the Moon.
P, **S** and **T** are shown on **Figure 9**.

Figure 9



0 5 . 3 Explain why the total gravitational potential at **P** is **not** zero.

[1 mark]

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0 5 . 4 Use **Figure 9** to calculate the resultant gravitational field strength at a distance of 2.0×10^8 m from the centre of the Earth.

[3 marks]

resultant gravitational field strength = _____ $\mathrm{N\,kg^{-1}}$

0 5 . 5 The total gravitational potential at **T** is -6.26×10^7 J kg^{-1}.

Determine the minimum energy required to move an object of mass 950 kg from the surface of the Earth to the surface of the Moon.
Ignore any effects due to the Earth's atmosphere.

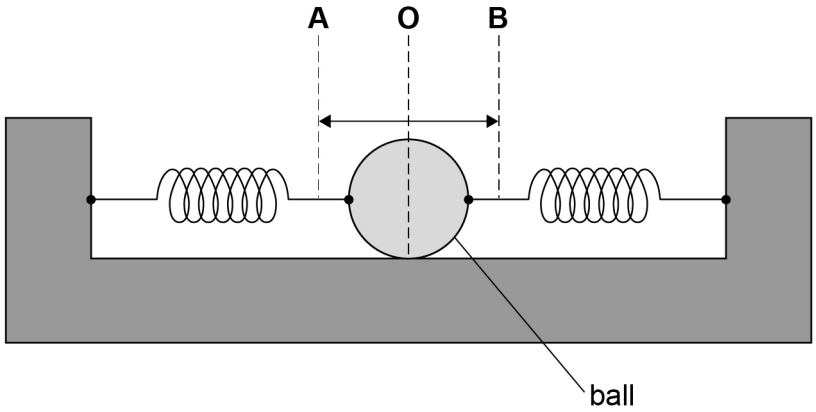
[2 marks]

energy required = _____ J

9

0 6 This question is about the simple harmonic motion of a mass–spring system.
Figure 10 shows a ball held in position by springs.
The equilibrium position of the ball is at **O**.

Figure 10



The centre of the ball is displaced to **B**, a distance of $3.6\ \text{cm}$ to the right of **O**.
The ball is released at time $t = 0$ and then oscillates horizontally between **A** and **B**.
The frequency of the oscillation is $1.7\ \text{Hz}$.

0 6 . 1 Calculate the minimum time taken for the centre of the ball to travel from **B** to **O**.
[1 mark]

minimum time = _____ s

Do not write outside the box

0 6 . 2 Calculate the minimum time taken for the centre of the ball to travel from **B** to a point $1.8\ \text{cm}$ to the left of **O**.

[2 marks]

minimum time = _____ s

0 6 . 3 The maximum kinetic energy of the ball is $3.8\ \text{mJ}$.

Calculate the mass of the ball.

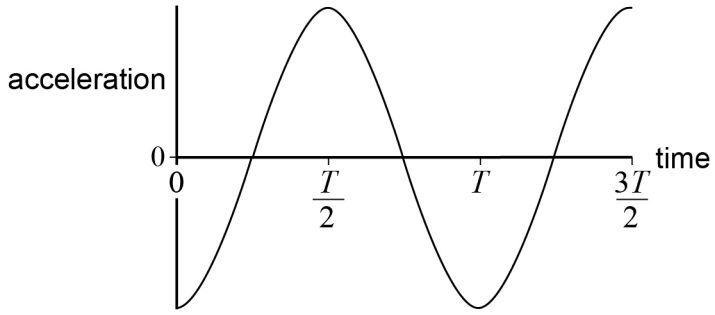
[2 marks]

mass = _____ kg

Question 6 continues on the next page

0 6 . 4 **Figure 11** shows the variation of acceleration with time for the ball.
T is the period of the oscillation.

Figure 11

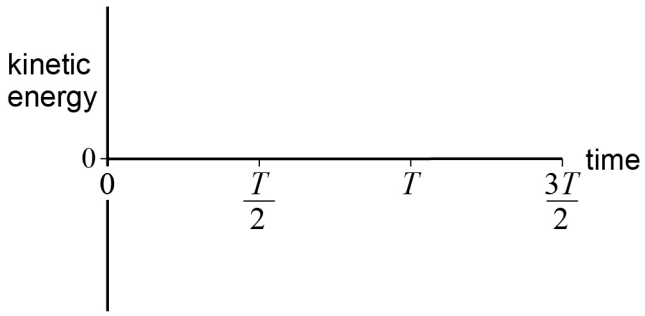


Sketch, on **Figure 12**, the variation of the kinetic energy of the ball with time, for the time shown in **Figure 11**.

Do not include numerical values on the axes.

[2 marks]

Figure 12



7

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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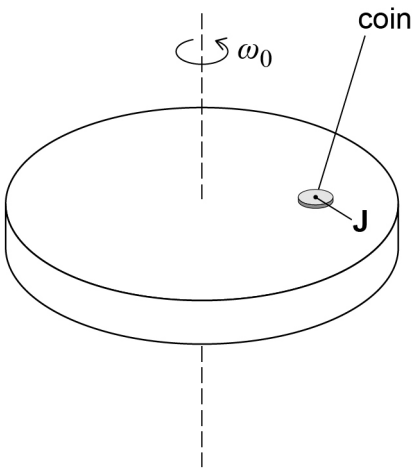
0 7 **Figure 13** shows a coin on a plate. The centre of mass of the coin is at point **J**.

The plate rotates about its centre in a horizontal plane. The plate initially has a constant angular speed ω_0. The coin does not slip.

Figure 13



0 7 . 1 Draw an arrow on **Figure 13** to show the direction of the frictional force acting on the coin.

[1 mark]

The friction acting on the coin increases with angular speed up to a maximum value. The maximum friction is 85% of the weight of the coin at all points on the plate.

0 7 . 2 The angular speed of the plate is gradually increased. Initially, the centre of mass of the coin remains at **J**. At this time it is moving in a circle of circumference $0.94\ \text{m}$.

When the plate reaches an angular speed ω_1 the coin begins to slide.
At ω_1 the friction has reached its maximum value.

Calculate ω_1.

[3 marks]

$\omega_1 =$ _____ rad s^{-1}

Do not write outside the box

0 7 . 3 The plate is brought to rest and the coin is now placed so that its centre of mass is closer to the centre of the plate.

The angular speed of the plate is gradually increased. The coin begins to slide when the plate reaches an angular speed ω_2.

Compare ω_2 with ω_1.
Explain your answer.

[2 marks]

6

Turn over for the next question

0 8 This question is about electromagnetic induction.

Figure 14 shows an electromagnet connected to an ac power supply.
Coil **X** is placed in the magnetic field of the electromagnet.
The plane of **X** is perpendicular to the magnetic flux density B of the electromagnet.

Figure 14

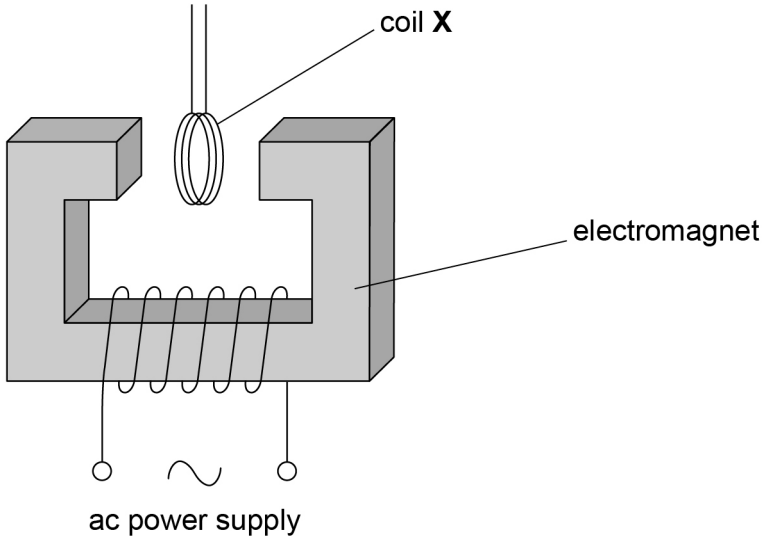
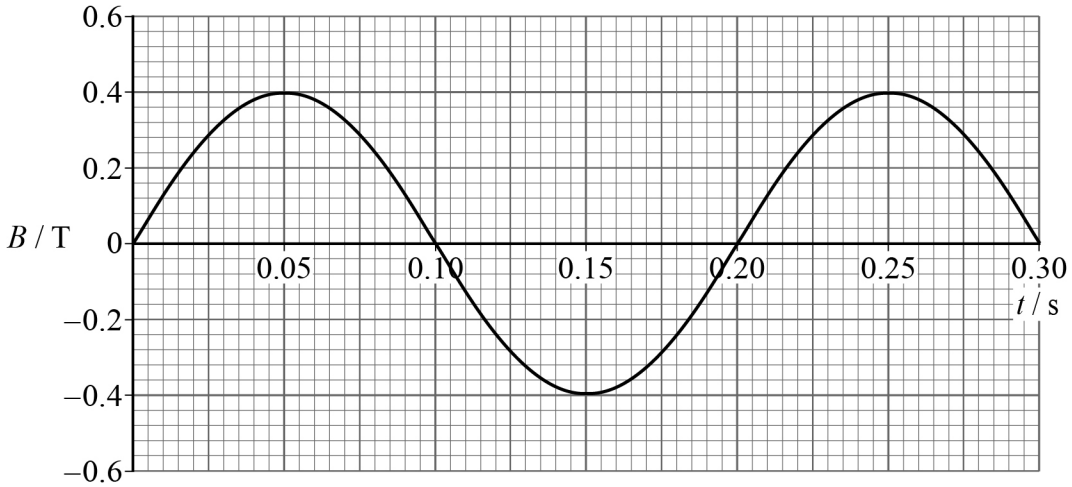


Figure 15 shows the variation of B with time t.

Figure 15



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0 8 . 1 **X** has 800 turns and an area of 1.5×10^{-4} m^2.

Determine:
- the magnitude of the mean emf ε_1 between $t = 0$ and $t = 0.10$ s
- the magnitude of the mean emf ε_2 between $t = 0.05$ s and $t = 0.15$ s.

[3 marks]

$\varepsilon_1 =$ _____ V

$\varepsilon_2 =$ _____ V

0 8 . 2 The ac power supply is adjusted so that B has:

- a decreased peak value
- an increased period.

State and explain any changes in the frequency and amplitude of the emf induced in **X**.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

6

END OF SECTION A

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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 9 A spinning platform makes 16 revolutions in 3.0 minutes.

What is the mean angular speed of the platform?

[1 mark]

A $0.090\ \text{rad s}^{-1}$ ⬭

B $0.28\ \text{rad s}^{-1}$ ⬭

C $0.56\ \text{rad s}^{-1}$ ⬭

D $33.5\ \text{rad s}^{-1}$ ⬭

1 0 A satellite travels at a constant speed in a circular orbit around the Earth.

Which statement is correct?

[1 mark]

A The momentum of the satellite is constant. ⬭

B The satellite accelerates towards the centre of the Earth. ⬭

C The gravitational force on the satellite is negligible. ⬭

D The satellite does not exert any force on the Earth. ⬭

Do not write outside the box

1 1 A particle undergoes simple harmonic motion.

What is the phase difference between the particle's displacement and its acceleration?

[1 mark]

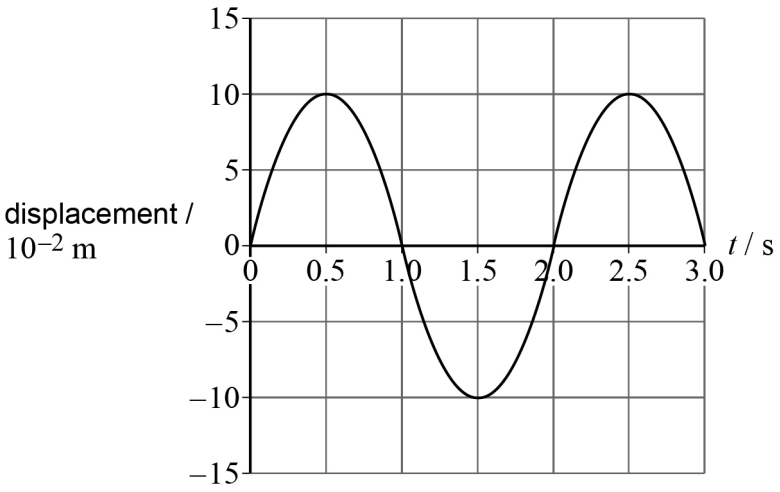
A 0 ⬭

B $\frac{\pi}{4}$ rad ⬭

C $\frac{\pi}{2}$ rad ⬭

D π rad ⬭

1 2 An object of mass 0.45 kg undergoes simple harmonic motion.
The graph shows the variation of the object's displacement with time t.



What is the potential energy of the object when $t = 1.5$ s?

[1 mark]

A 0 ⬭

B 1.1×10^{-2} J ⬭

C 2.2×10^{-2} J ⬭

D 8.9×10^{-2} J ⬭

Do not write outside the box

1 3 Two satellites **X** and **Y** are in circular orbits around the Earth.

X and **Y** have the same mass.
The orbital radius of **X** is less than the orbital radius of **Y**.

X has an orbital period T_X and a total energy E_X.
Y has an orbital period T_Y and a total energy E_Y.

Which row is correct?

[1 mark]

	Orbital period	Total energy	
A	$T_X < T_Y$	$E_X < E_Y$	⬭
B	$T_X < T_Y$	$E_Y < E_X$	⬭
C	$T_Y < T_X$	$E_X < E_Y$	⬭
D	$T_Y < T_X$	$E_Y < E_X$	⬭

1 4 A capacitor is discharged through a resistor and loses 50% of its charge in a time of $10\ \text{s}$.

What is the time constant of the circuit?

[1 mark]

A $5\ \text{s}$ ⬭

B $7\ \text{s}$ ⬭

C $10\ \text{s}$ ⬭

D $14\ \text{s}$ ⬭

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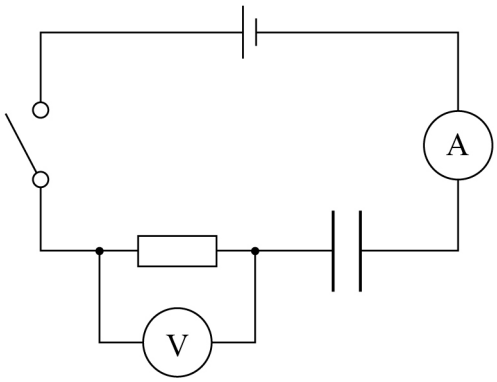
1 5 The circuit shown is used to charge an uncharged capacitor.

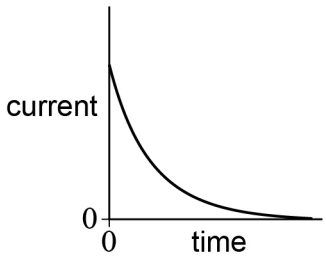


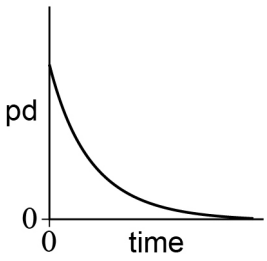
The switch is closed at a time equal to zero.

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

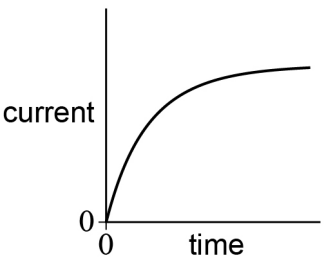
[1 mark]

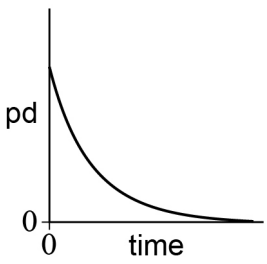
A



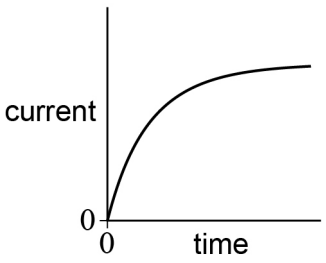


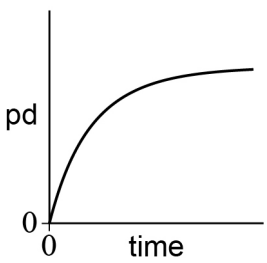
B



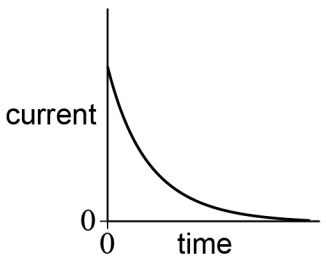


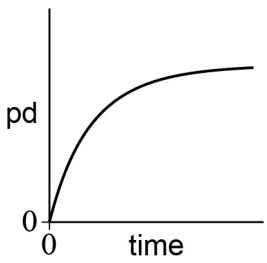
C





D





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1 6 An uncharged capacitor of capacitance C is fully charged by a cell of emf ε and negligible internal resistance, through a resistor of resistance R.

What is the total energy dissipated by the resistor?

[1 mark]

A $\frac{1}{2} C \varepsilon^2$ ⬭

B $C \varepsilon^2$ ⬭

C $\frac{\varepsilon^2}{R}$ ⬭

D $\frac{1}{2} \frac{\varepsilon^2}{R}$ ⬭

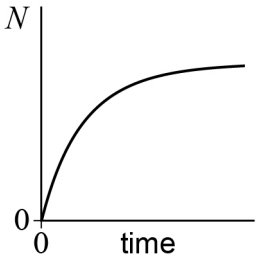
1 7 Cobalt-60 is a radioactive isotope that decays into a stable isotope of nickel.
A sample of cobalt-60 is placed into a sealed container that initially contains no nickel.

N is the number of nickel atoms in the container at any time.

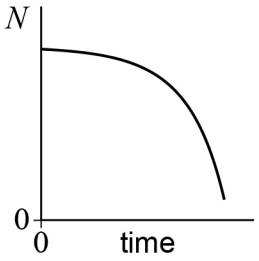
Which graph shows the variation of N with time?

[1 mark]

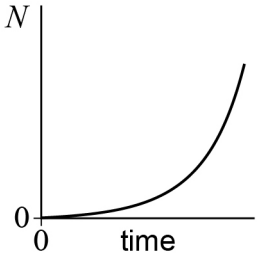
A



B



C



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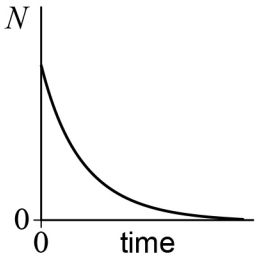

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1 8 A particle of mass m, charge Q and velocity v is moving in a circle in a magnetic field. The magnetic flux density B is perpendicular to v.

What is the time taken for the particle to travel once around the circle?

[1 mark]

A $\frac{BQ}{2\pi m}$ ⬭

B $\frac{2\pi m}{BQ}$ ⬭

C $\frac{BQv}{2\pi m}$ ⬭

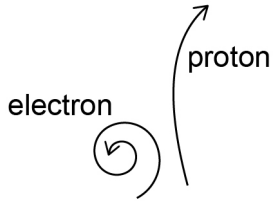
D $\frac{2\pi m}{BQv}$ ⬭

1 9 A proton and an electron travelling at the same speed enter a gas.
A magnetic field is directed into the page.
The velocities of the proton and the electron are both perpendicular to the magnetic field.

Which diagram shows the motion of the particles?

[1 mark]

A



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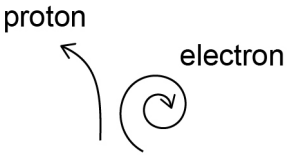
B



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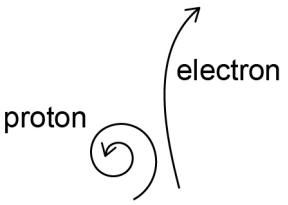

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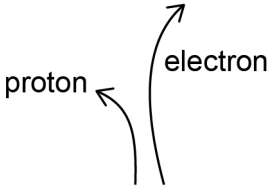

⬭

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2 0 What is the most important reason for transmitting electrical power at high voltage?

[1 mark]

A to increase the current in the cables ⬭

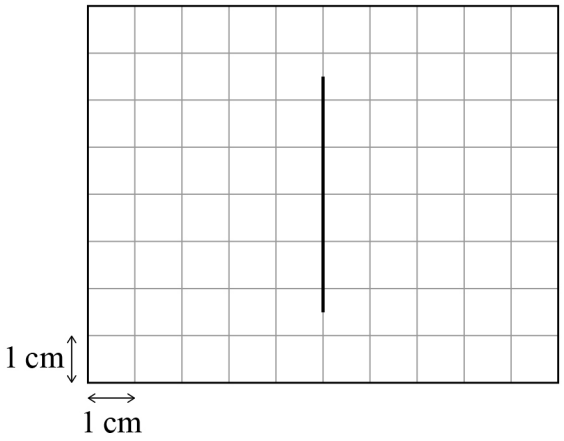
B to provide high voltage for industrial users ⬭

C to increase the resistance of the cables ⬭

D to reduce the power wasted in transmission ⬭

2 1 A power supply is connected to an oscilloscope. The time-base on the oscilloscope is switched off. The voltage sensitivity is $10\ \text{V cm}^{-1}$.

The oscilloscope screen is shown.



The power supply is providing:

[1 mark]

A ac with an rms voltage of $50\ \text{V}$. ⬭

B ac with a peak voltage of $50\ \text{V}$. ⬭

C ac with a peak-to-peak voltage of $50\ \text{V}$. ⬭

D dc with a voltage of $50\ \text{V}$. ⬭

Turn over for the next question

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2 2 A transformer with 100% efficiency has eight times more turns in the primary coil than it has in the secondary coil.

When in use:
- the mean input power is 10 kW
- the rms current in the secondary coil is 25 A.

What is the rms voltage across the primary coil?

[1 mark]

A 50 V ⬭

B 400 V ⬭

C 3200 V ⬭

D 31 300 V ⬭

2 3 A resistor dissipates a mean power of 48 W and has an rms voltage of 12 V ac across it.

What is the peak current in the resistor?

[1 mark]

A 1.4 A ⬭

B 2.8 A ⬭

C 4.0 A ⬭

D 5.7 A ⬭

15

END OF QUESTIONS

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