A

AQA

Surname ______________________

Forename(s) ______________________

Centre Number ______________________

Candidate Number ______________________

Candidate Signature ______________________

I declare this is my own work.

A-level

PHYSICS

Paper 3

Section B Turning points in physics

7408/3BD

Thursday 15 June 2023 Morning

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

Time allowed: The total time for both sections of this paper is 2 hours. You are advised to spend approximately 50 minutes on this section.

MATERIALS

For this paper you must have:

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

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **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.**
- **Show all your working.**

INFORMATION

- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 35.**
- **You are expected to use a scientific calculator where appropriate.**
- **A Data and Formulae Booklet is provided as a loose insert.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

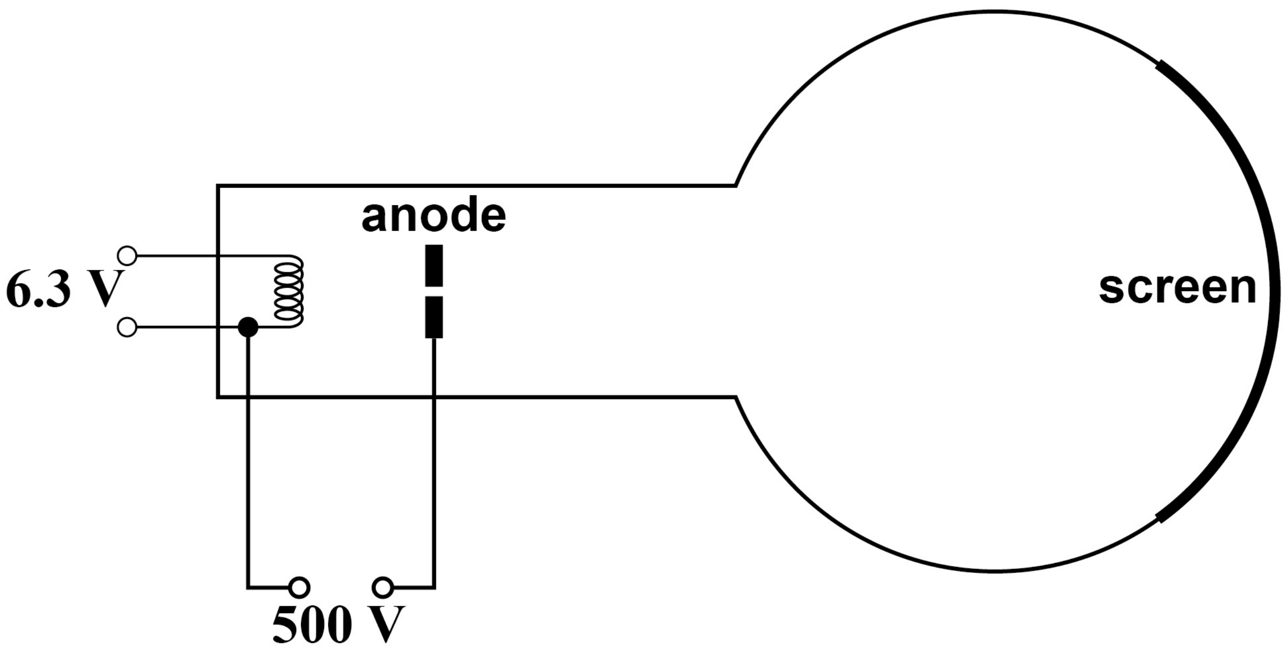
SECTION B

Answer ALL questions in this section.

0 1

In FIGURE 1, a beam of electrons travels through the aperture in the anode and hits the screen.

FIGURE 1



01.1

Explain how the electrons that form the beam are emitted. [1 mark]

01.2

Show that the maximum speed of the electrons in the beam is about $1.3 \times 10^{7}\ \mathrm{m\ s^{-1}}$. [1 mark]

[Turn over]

0 1 . 3

A student suggests that the apparatus can be used to demonstrate the wave properties of electrons in the beam, provided that the aperture in the anode has a suitable diameter.

Discuss whether the student is correct.
Support your answer with a calculation. [3 marks]

[Turn over]

0 1 . 4

In 1897, JJ Thomson determined a value for the specific charge of an unknown particle.

The unknown particle is now known to be the electron.

Describe ONE method to determine the specific charge of the electron.

Your answer should include:

- **a description of the apparatus used and the measurements made**
- **a description of how the specific charge can be determined using these measurements**
- **an explanation of the conclusion made by Thomson from the value that he determined.**

[6 marks]

9

[Turn over]

[Turn over]

11

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[Turn over]

0 2

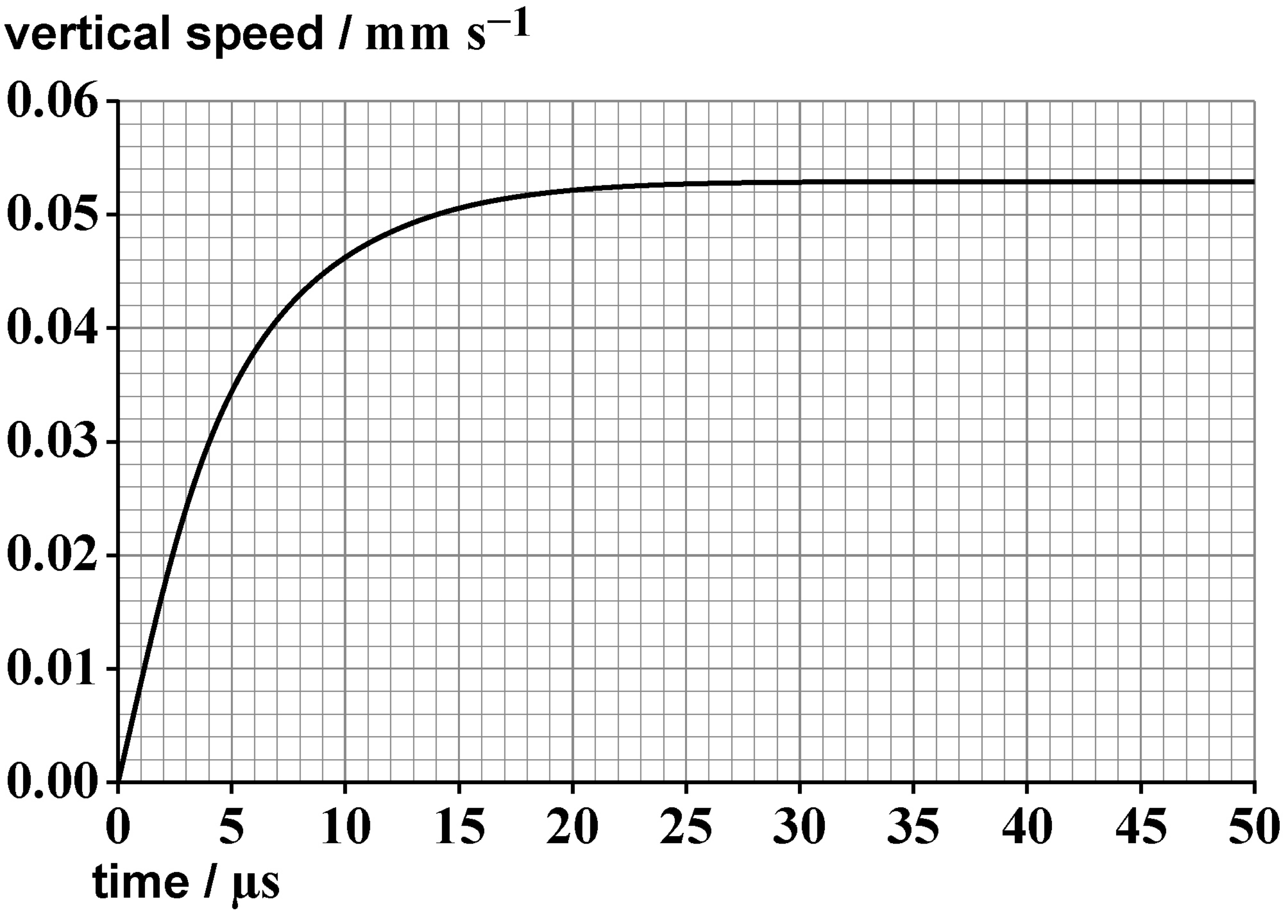
In an experiment to determine the electronic charge, a charged oil drop falls from rest between two uncharged plates.

The oil drop has a weight of 1.2×10^{-14} N and a radius of 6.8×10^{-7} m.

Ignore the buoyancy force of the air on the oil drop.

FIGURE 2 shows the variation of the vertical speed of the oil drop with time.

FIGURE 2



0 2 . 1

Calculate the viscosity of the air between the plates.
[3 marks]

viscosity = ______________________________ $\mathrm{N\ s\ m^{-2}}$

[Turn over]

0 2 . 2

During the experiment, an electric field is produced between the plates and is adjusted until the oil drop is stationary.
The electric field strength is $18.8\ \mathrm{kV\ m^{-1}}$.

Discuss whether the outcome of the experiment is consistent with the accepted value for electronic charge. [3 marks]

6

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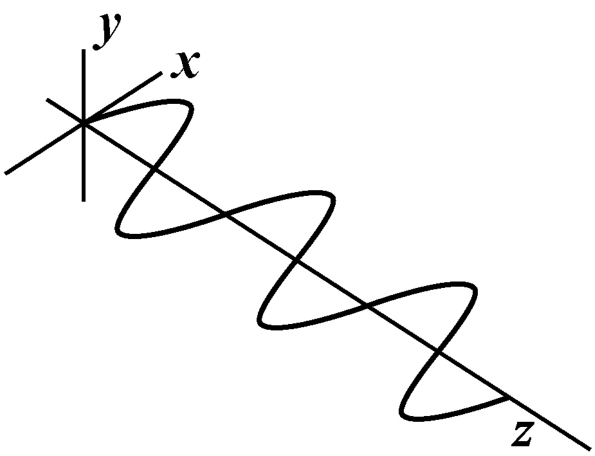
[Turn over]

0 | 3

An electromagnetic wave is propagating through space.

FIGURE 3 shows the variation of the magnetic flux density of the wave with distance.
The magnetic field is in the xz plane.
The y-axis is at right-angles to the xz plane.

FIGURE 3



0 3 . 1

Draw and label on FIGURE 3:

- **the corresponding electric field**
- **the direction of propagation of the wave.**

[1 mark]

0 3 . 2

Which scientist proposed the electromagnetic wave model of light? [1 mark]

Tick (✓) ONE box.

- [ ] **Hertz**
- [ ] **Huygens**
- [ ] **Maxwell**
- [ ] **Young**

[Turn over]

0 3 . 3

Another theory of the nature of light was proposed by Isaac Newton.

Describe how Newton's theory was used to explain the refraction of light as it moves from air into glass.
[3 marks]

[Turn over]

0 3 . 4

Describe a demonstration using visible light that can be performed in a school laboratory to show that Newton's theory is not correct. [3 marks]

[Turn over]

8

0 4

Einstein developed his theory of special relativity from two postulates. One postulate states that physical laws have the same form in all inertial frames.

0 4 . 1

State the other postulate and explain how it is consistent with the equation:

$$c = \sqrt{\frac{1}{\mu_0 \varepsilon_0}}$$

[2 marks]

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[Turn over]

A proton leaves a particle accelerator at point X and moves at a constant speed towards a target at point Y.

The speed of the proton is 2.5×10^8 m s^{-1} in the frame of reference of the target.

The distance XY in the frame of reference of the proton is 38 m.

0 4 . 2

Calculate the distance XY in the frame of reference of the target. [2 marks]

distance XY in the frame of reference of the target =

______________________________ **m**

[Turn over]

0 4 . 3

Show that the kinetic energy E_k of the proton is about 1.2×10^{-10} J. [3 marks]

0 4 . 4

On the opposite page, sketch on FIGURE 4 the variation of E_k with speed v for a proton.

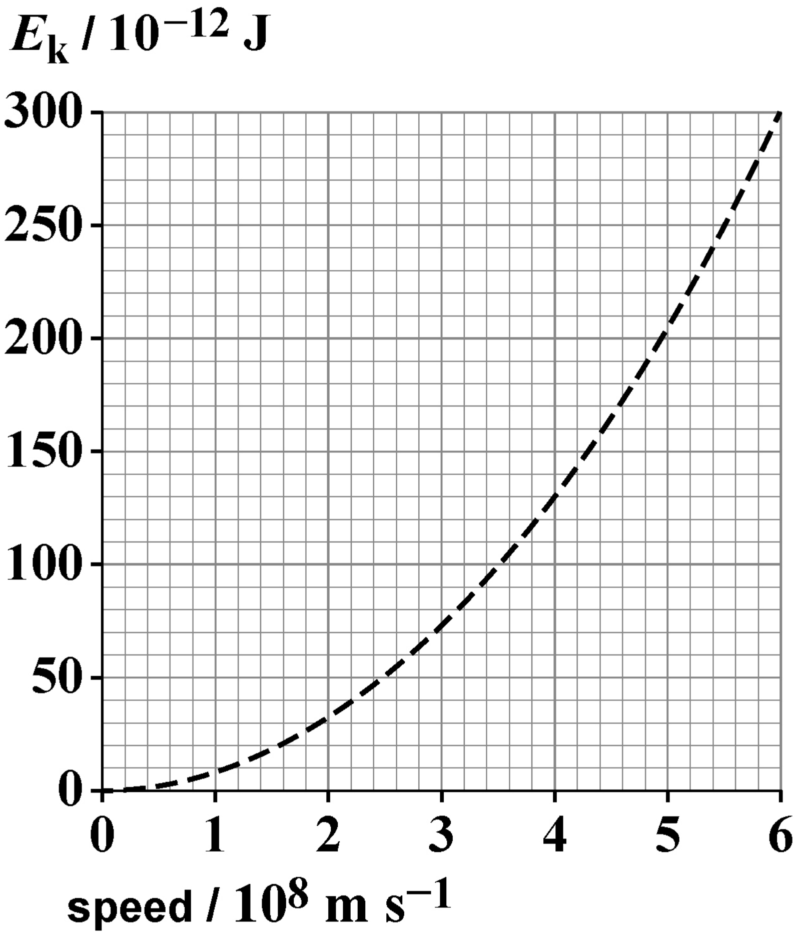
To help you, the dashed line represents

$$E_k = \frac{1}{2} m_0 v^2$$

where m_0 is equal to the mass of a proton at rest.

[3 marks]

FIGURE 4



END OF QUESTIONS

10

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
2	
3	
4	
TOTAL	