



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

A-level PHYSICS

Paper 3

Section B Turning points in physics

Monday 17 June 2024

Morning

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.
- 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.
- 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.

For Examiner's Use

Question	Mark
1	
2	
3	
4	
TOTAL	



J U N 2 4 7 4 0 8 3 B D 0 1

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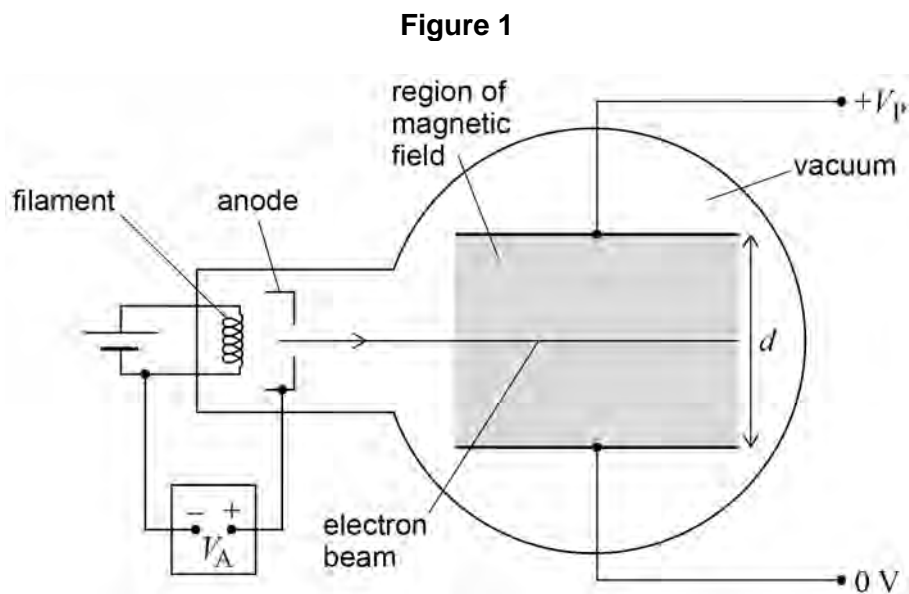
Section B

Answer **all** questions in this section.

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0 1 . 1

Figure 1 shows apparatus used in an experiment to measure the specific charge of the electron.



Electrons are accelerated by the potential difference V_A .

The electrons then enter the region between two parallel metal plates, shown shaded in **Figure 1**. The parallel metal plates are separated by a distance d with a potential difference V_P across them. In the same region there is a uniform magnetic field of flux density B into the plane of the diagram.

Explain why the electron beam is undeflected in the shaded region shown in **Figure 1**.
[2 marks]



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0 1 . 2 Determine, using the following data, a value for the specific charge of the electron.

$$B = 1.59 \text{ mT}$$

$$V_p = 1.51 \text{ kV}$$

$$d = 5.0 \text{ cm}$$

$$V_A = 1.00 \text{ kV}$$

[4 marks]

specific charge = _____ C kg^{-1}

6

Turn over for the next question

Turn over ►



0	2	.	2
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On one occasion, the radius of a droplet was determined to be 1.20×10^{-6} m.
When the droplet was stationary, the voltmeter reading was 467 V.

Show that the charge on the droplet was approximately 8×10^{-19} C.

density of oil = 880 kg m^{-3}

[3 marks]

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0	3
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Hertz did an experiment to determine the speed of radio waves.

Describe this experiment.

In your answer you should:

- include a labelled diagram
- state the measurements that were taken
- describe how the data were used to determine the speed of radio waves.

[5 marks]

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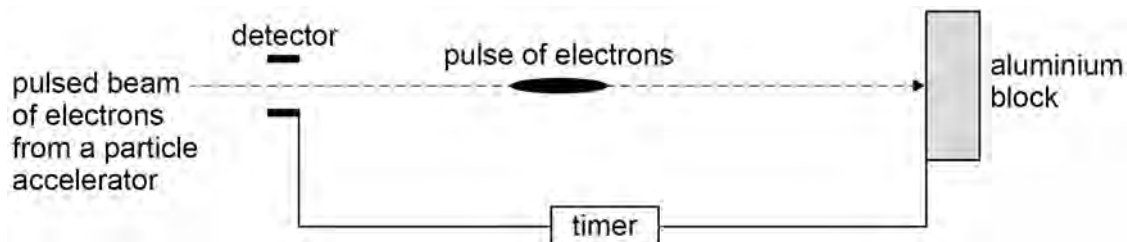


0 4

Figure 3 shows a modern version of Bertozzi's experiment to measure the kinetic energy of high-speed electrons. A timer is used to measure the time taken for a pulse of electrons to travel from the detector to the aluminium block.

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Figure 3



0 4 . 1

A potential difference (pd) of 1.30 MV is used to accelerate the electrons.

Show that each electron gains approximately 2×10^{-13} J of kinetic energy.

[1 mark]

0 4 . 2

These electrons cause the temperature of the aluminium block to increase by 68.0 K. The number of electrons that cause this increase in temperature is 4.50×10^{17}

Deduce whether this increase in temperature is consistent with an accelerating pd of 1.30 MV.

specific heat capacity of aluminium = $903 \text{ J kg}^{-1} \text{ K}^{-1}$

mass of aluminium block = 1.50 kg

[2 marks]



0	4	.	3
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The speed of the electrons between the detector and the block is $2.88 \times 10^8 \text{ m s}^{-1}$.

Student **A** suggests that the non-relativistic equation for kinetic energy could be used.
Student **B** suggests that the relativistic equation for kinetic energy is required in this situation.

Evaluate the suggestions of student **A** and student **B**.
Support your answer with calculations.

[4 marks]

Question 4 continues on the next page

Turn over ►



0 4 . 4 The timer in **Figure 3** records a time of 29.8 ns.

What is the proper time interval for an electron travelling from the detector to the aluminium block?

Tick (✓) **one** box.

[1 mark]

< 29.8 ns

29.8 ns

> 29.8 ns

0 4 . 5 The electrons in **Figure 3** were accelerated from rest in 13 stages.

In each stage the electrons were accelerated by a pd of 100 kV.

As a result, an electron increases its speed and kinetic energy during each stage.

Compare, for an electron,

- its increase in speed for the first stage with that for the last stage
- its increase in kinetic energy for the first stage with that for the last stage.

Justify your answer.

No further calculations are required.

[4 marks]

END OF QUESTIONS



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ANSWER IN THE SPACES PROVIDED**



