

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

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.

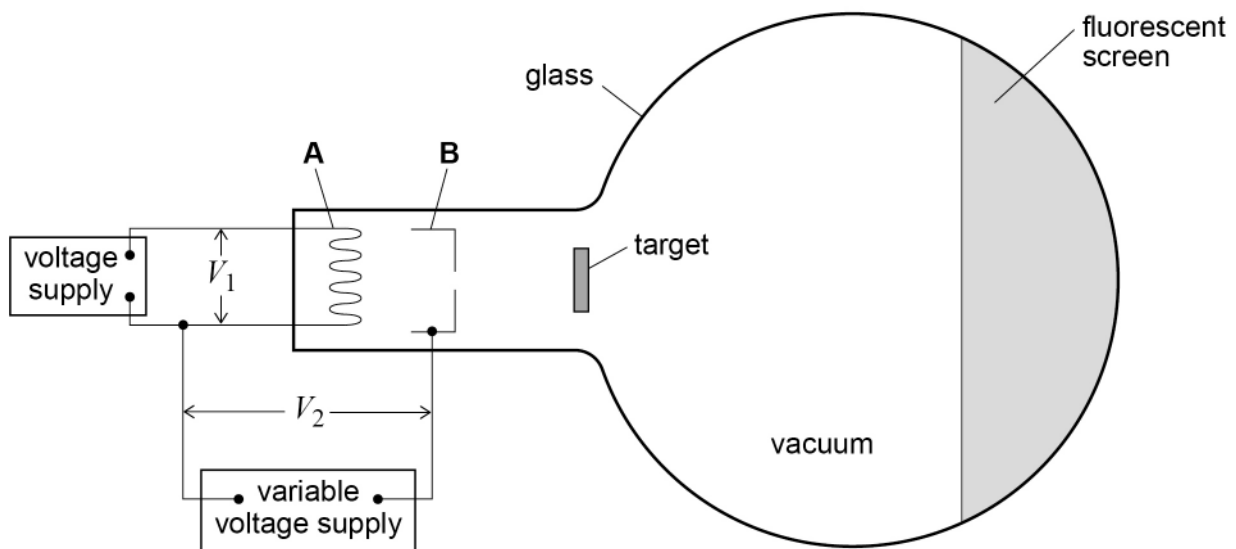
Information

- 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.

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.

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



Section BAnswer **all** questions in this section.**0 1****Figure 1** shows the apparatus used in an experiment to investigate electron diffraction and the de Broglie hypothesis.**Figure 1****0 1 . 1**Explain how high-speed electrons are produced in the apparatus in **Figure 1**.

In your answer you should:

- name parts **A** and **B**
- discuss the purposes of potential differences V_1 and V_2 .

[4 marks]



0	1	.	2
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In the experiment, electrons are incident on a target made of a crystalline material. The electron wavelengths need to be about 50% the size of an atom to produce a diffraction pattern on the screen.

Suggest a suitable value for V_2 .

Support your answer with a calculation.

[4 marks]

$V_2 =$ _____ V

Question 1 continues on the next page

Turn over ►



Figure 2 shows a typical diffraction pattern produced on the screen by the electrons.

[4 marks]

[illegible]

0 1 . 4

STM and TEM are abbreviations for two types of electron microscope.

Which row links the type of microscope to a relevant property of moving electrons?
Tick (✓) **one** box.

[1 mark]

STM	TEM
Moving electrons can cross a potential barrier.	Moving electrons can be deflected by a magnetic field.
Moving electrons can be deflected by a magnetic field.	Moving electrons can be deflected by a magnetic field.
Moving electrons can be deflected by a magnetic field.	Moving electrons can cross a potential barrier.
Moving electrons can cross a potential barrier.	Moving electrons can cross a potential barrier.

☐☐☐☐

13

Turn over for the next question

Turn over ►



0 2

In 1864, James Clerk Maxwell published a theory that included an equation for the speed of electromagnetic waves in a vacuum.

0 2 . 1

Show that Maxwell's theory agrees with the accepted value for the speed of light in a vacuum.

Use information from the Data and Formulae Booklet in your answer.

[2 marks]

Between 1886 and 1889, Heinrich Hertz completed a series of experiments in an attempt to verify Maxwell's theory. **Figure 3** shows a simplified arrangement similar to the one used by Hertz in one of his experiments.

Figure 3



T is a radio wave transmitter with an aerial consisting of two vertical metal rods.
D is a detector that uses a conducting loop aerial.



T is switched on so that an oscillating current is produced in the metal rods. An emf is detected in the conducting loop aerial.

[4 marks]

[illegible]

Question 2 continues on the next page

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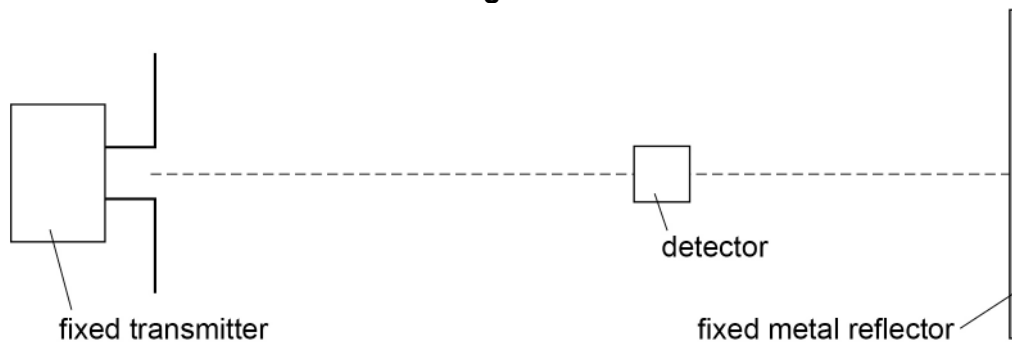


0 2 . 3

In a different experiment Hertz used stationary waves to determine the speed of radio waves.

Figure 4 shows an experimental arrangement similar to the arrangement Hertz used.

Figure 4



Stationary waves are produced between the fixed transmitter and the fixed metal reflector.

In one experiment the distance between the transmitter and reflector is about 12 m and the transmitter frequency is 75 MHz.

Deduce whether this arrangement can be used to measure the speed of electromagnetic waves suggested by Maxwell's equation.

[4 marks]



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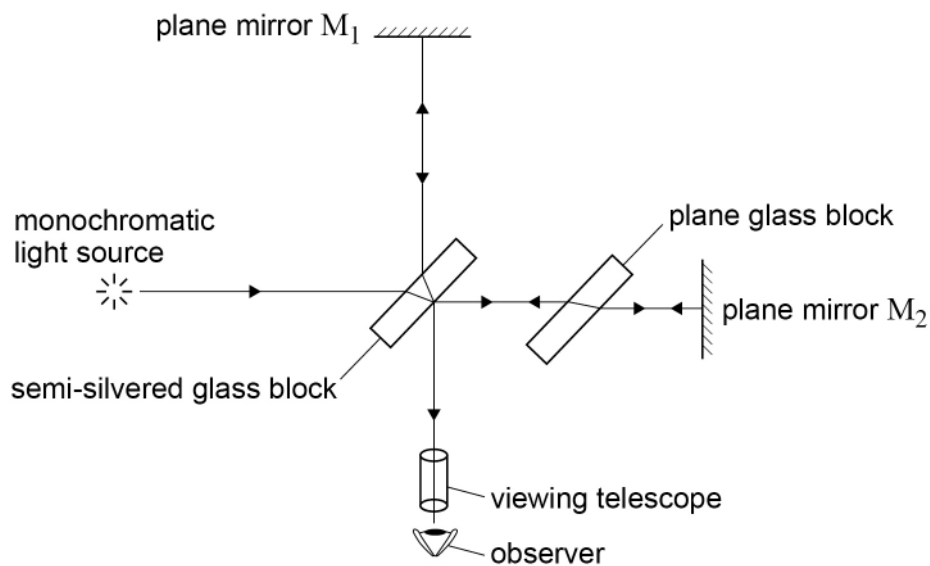
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0	3
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Figure 5 shows the features of a Michelson-Morley interferometer.

Figure 5



Explain how, using this arrangement, Michelson and Morley attempted to detect the absolute motion of the Earth.

In your answer you should:

- outline the experimental procedure
- explain the expected result of the experiment
- describe the actual result and explain the significance of this result.

[6 marks]

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[illegible]

6

0 4 . 1

State what is meant by an inertial frame of reference.

[1 mark]

0 4 . 2

A pair of detectors is set up to measure the intensity of a parallel beam of unstable particles.

In the reference frame of the laboratory, the detectors are separated by a distance of 45 m. The speed of the particles in the beam is $0.97c$.

The intensity of the beam at the second detector is 12.5% of the intensity at the first detector.

Calculate the half-life of the particles in the reference frame in which they are at rest.

[4 marks]

half-life = _____ s

0 4 . 3

In calculations involving time dilation, it is important to identify proper time.

Identify the proper time in the calculation in Question 04.2.

[1 mark]

END OF QUESTIONS



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Question number	Additional page, if required. Write the question numbers in the left-hand margin.
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