

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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



General Certificate of Education  
Advanced Level Examination  
June 2012

## Physics A

## PHYA5/2D

### Unit 5D Turning Points in Physics Section B

Monday 18 June 2012 9.00 am to 10.45 am

**For this paper you must have:**

- a calculator
- a ruler
- a Data and Formulae Booklet (enclosed).

**Time allowed**

- The total time for both sections of this paper is 1 hour 45 minutes.  
You are advised to spend approximately 50 minutes on this section.

**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.
- 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 section is 35.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.



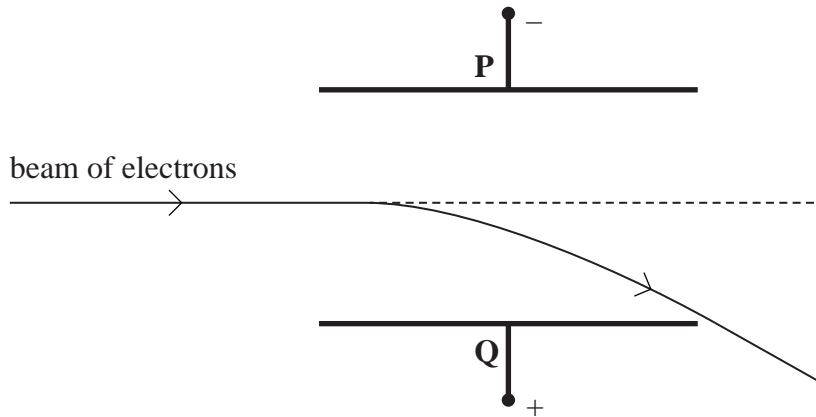
J U N 1 2 P H Y A 5 2 D 0 1

**Section B**

The maximum mark for this section is 35 marks. You are advised to spend approximately 50 minutes on this section.

- 1 A narrow beam of electrons is directed into the region between two parallel plates, **P** and **Q**. When a constant potential difference is applied between the two plates, the beam curves downwards towards plate **Q** as shown in **Figure 1**.

**Figure 1**



- 1 (a) Explain why the beam curves downwards at an increasing angle to its initial direction.

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(3 marks)

- 1 (b) A uniform magnetic field is then applied at right angles to both the beam and the electric field between the plates **P** and **Q**. As a result, the downward deflection of the beam is increased.

- 1 (b) (i) The arrangement is to be used to determine the speed of the electrons in the beam. Describe what adjustments to the flux density  $B$  of the magnetic field should be made to reduce the deflection of the beam to zero.

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(1 mark)



1 (b) (ii) Explain why the electrons pass undeflected through the fields when their speed  $v$  is given by

$$v = \frac{V}{Bd}$$

where  $V$  is the potential difference between plates **P** and **Q** and  $d$  is the perpendicular distance between the plates.

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(2 marks)

1 (c) The beam of electrons was produced by thermionic emission from a heated filament. When the potential difference between the anode and the filament was 4200 V, the speed of the electrons in the beam was  $3.9 \times 10^7 \text{ m s}^{-1}$ .

Use this information to determine the specific charge of the electron.

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answer = .....  $\text{C kg}^{-1}$   
(3 marks)

9

Turn over ►



**2 (a)** Describe, in terms of electric and magnetic fields, a plane polarised electromagnetic wave travelling in a vacuum. You may wish to draw a labelled diagram.

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(3 marks)

**2 (b)** In his theory of electromagnetic waves, Maxwell predicted that the speed of all electromagnetic waves travelling through free space is given by

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

where  $\mu_0$  is the permeability of free space and  $\epsilon_0$  is the permittivity of free space.

Explain why this prediction led to the conclusion that light waves are electromagnetic waves.

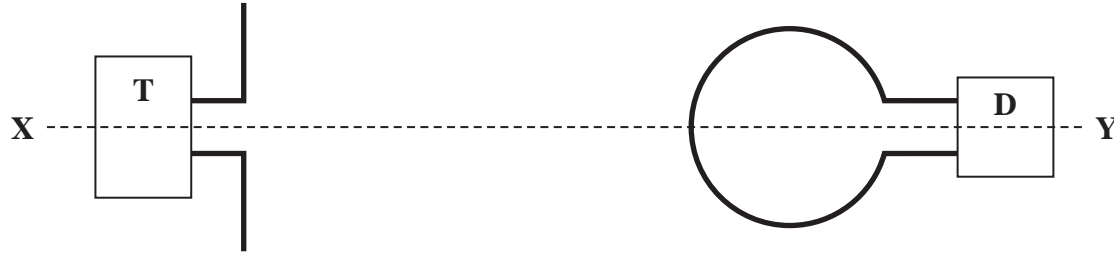
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(2 marks)



- 2 (c) Hertz discovered how to produce and detect radio waves. **Figure 2** shows a transmitter of radio waves, **T**, and a detector **D**. The detector loop and the transmitter aerial are in the same vertical plane.

**Figure 2**



- 2 (c) (i) Explain why an alternating emf is induced in the loop when it is in this position.

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(3 marks)

- 2 (c) (ii) Explain why an alternating emf **cannot** be detected if the detector loop is turned through  $90^\circ$  about the axis **XY**.

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(1 mark)

9
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Turn over ►





**3 (b)** An electron is travelling at a speed of  $0.890c$  where  $c$  is the speed of light in free space.

**3 (b) (i)** Show that the electron has a de Broglie wavelength of  $1.24 \times 10^{-12}$  m.

(2 marks)

**3 (b) (ii)** Calculate the energy of a photon of wavelength  $1.24 \times 10^{-12}$  m.

answer = ..... J  
(1 mark)

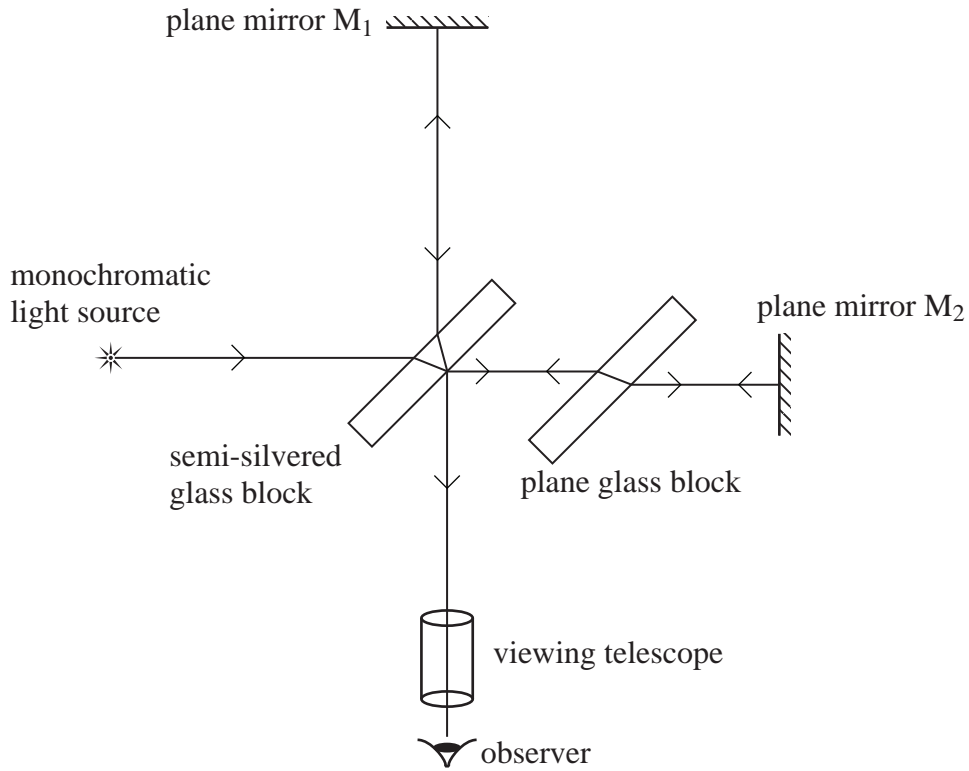
**3 (b) (iii)** Calculate the kinetic energy of an electron with a de Broglie wavelength of  $1.24 \times 10^{-12}$  m.  
Give your answer to an appropriate number of significant figures.

answer = ..... J  
(2 marks)



4 **Figure 3** represents the Michelson-Morley interferometer. Interference fringes are seen by an observer looking through the viewing telescope.

**Figure 3**



4 (a) Explain why the interference fringes shift their position if the distance from either of the two mirrors to the semi-silvered block is changed.

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(2 marks)







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