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 2013

Physics A PHYA5/2D

Unit 5D Turning Points in Physics
Section B

Thursday 20 June 2013 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.

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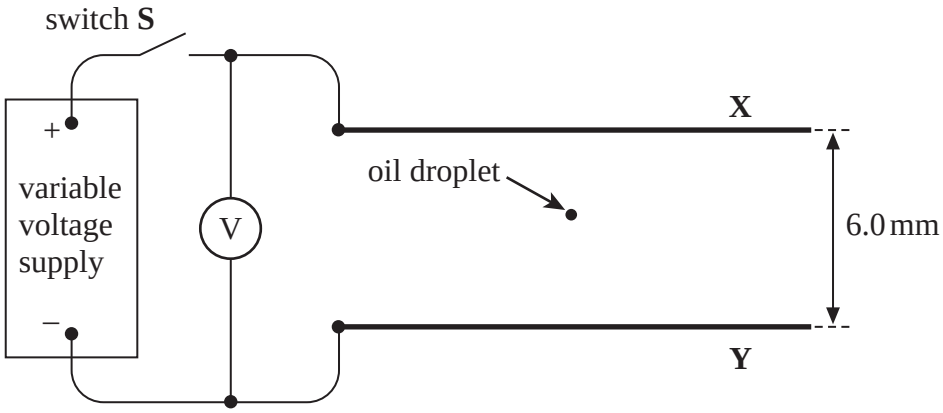
Section B

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

1 A charged oil droplet was observed between two horizontal metal plates **X** and **Y**, as shown in **Figure 1**.

Figure 1



1 (a) (i) With the switch **S** open, the droplet fell vertically at a constant velocity of $1.1 \times 10^{-4}\,\text{m s}^{-1}$. Show that the radius of the droplet is about $1.0 \times 10^{-6}\,\text{m}$. Assume the droplet is spherical.

density of oil, $\rho = 880\,\text{kg m}^{-3}$
viscosity of air, $\eta = 1.8 \times 10^{-5}\,\text{N s m}^{-2}$

(4 marks)

1 (a) (ii) Calculate the mass of the droplet.

mass ..... kg
(1 mark)

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1 (a) (iii) The switch **S** was closed and the potential difference from the voltage supply was adjusted gradually to reduce the downward motion of the droplet. The droplet stopped moving when the potential difference across the plates was 680 V. The spacing between the plates was 6.0 mm.

Calculate the magnitude of the charge on the droplet.

charge C

(3 marks)

1 (b) The mass of another charged droplet was found to be 4.3×10^{-15} kg. With switch **S** closed and the voltage supply at its maximum value of 1000 V, this droplet fell more slowly than when the switch was open but it could not be stopped.

Explain why this droplet could not be held at rest and show that the magnitude of the charge on it was 1.6×10^{-19} C.

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(4 marks)

12

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2 (a) State de Broglie's hypothesis.

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(2 marks)

2 (b) Neutrons in a narrow beam can be diffracted by crystals thereby exhibiting wave behaviour. Calculate the de Broglie wavelength of a neutron of kinetic energy 0.021 eV. Give your answer to an appropriate number of significant figures.

de Broglie wavelength ..... m

(4 marks)

2 (c) Explain why an electron of the same de Broglie wavelength as the neutron in part (b) has much more kinetic energy than 0.021 eV. Assume relativistic effects are negligible.

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(2 marks)

8

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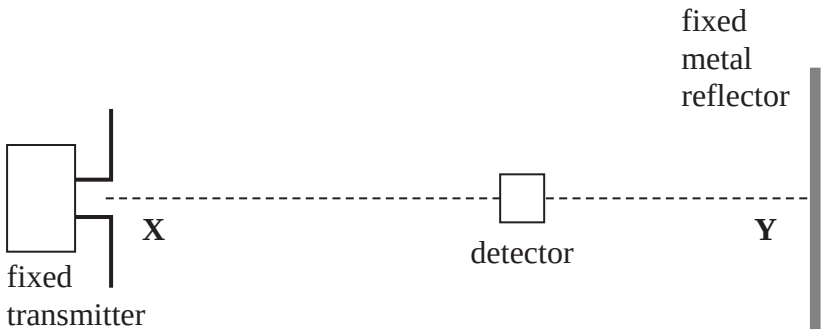
3 In his investigation of radio waves, Hertz created stationary waves by using a large flat metal sheet to reflect radio waves as shown in **Figure 2**.

Figure 2



3 (a) Explain why stationary waves are formed in this arrangement and describe how the wavelength of the radio waves can be determined by moving a suitable detector along **XY**.

The quality of your written communication will be assessed in your answer.

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(6 marks)

Turn over ▶

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3 (b) Hertz knew the frequency of the radio waves from the electrical characteristics of the transmitter. He found the wavelength from the investigation described in part (a) and was then able to calculate the speed of the radio waves. Explain the significance of the result of this calculation.

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(2 marks)

8

4 (a) Calculate the speed of a particle at which its mass is twice its rest mass.

speed ..... $m\,s^{-1}$

(2 marks)

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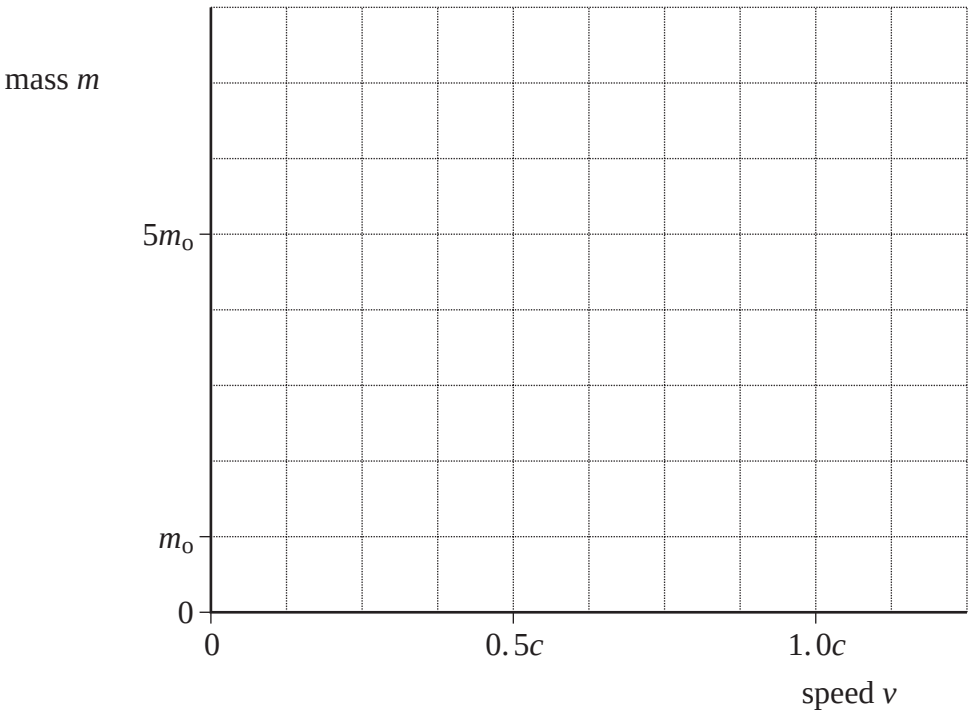
4 (b) Use the axes below to show how the mass m of a particle changes from its rest mass m_o as its speed v increases from zero.
Mark and label on the graph the point **P** where the mass of the particle is twice its rest mass.



(3 marks)

4 (c) By considering the relationship between the energy of a particle and its mass, explain why the theory of special relativity does not allow a matter particle to travel as fast as light.

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(2 marks)

7

END OF QUESTIONS

There are no questions printed on this page

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