AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level PHYSICS A

Unit 5D Turning Points in Physics Section B

Wednesday 21 June 2017 Morning

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.

Materials

For this paper you must have:
- a calculator
- a pencil and a ruler
- a Data and Formulae Booklet (enclosed).

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.

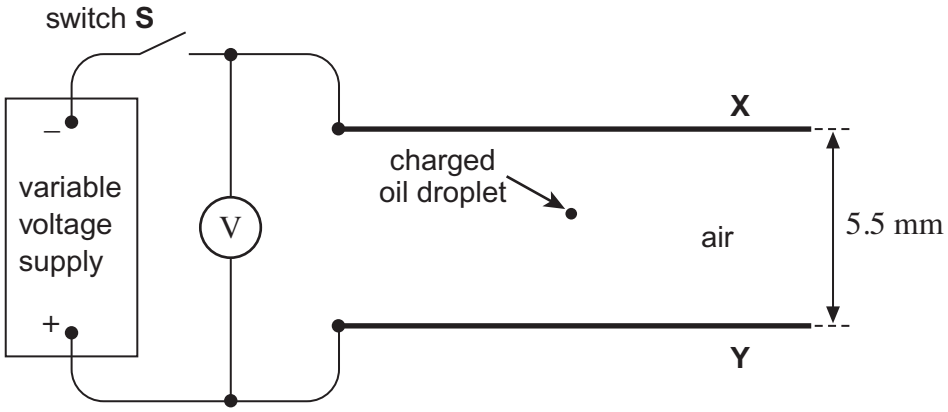
For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
TOTAL	

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** in air, as shown in **Figure 1**.

Figure 1



1 (a) With the switch **S** open, the spherical droplet fell vertically at a constant velocity of $2.1 \times 10^{-4}\,\text{m s}^{-1}$.

Show that the radius of the oil droplet is about $1.4 \times 10^{-6}\,\text{m}$.

density of oil, ρ = $860\,\text{kg m}^{-3}$
viscosity of air, η = $1.8 \times 10^{-5}\,\text{N s m}^{-2}$

[4 marks]

1 (b) (i) The switch **S** was closed and the potential difference from the voltage supply was adjusted gradually to reduce the downward motion of the oil droplet. The oil droplet stopped moving when the potential difference across the plates was $850\ \text{V}$. The spacing between the plates was $5.5\ \text{mm}$.

Calculate the magnitude of the charge on the oil droplet.

[3 marks]

charge = _____ C

1 (b) (ii) The oil droplet was initially neutral.

Identify the number of electrons lost by the oil droplet to give it the charge calculated in part **(b)(i)**. Tick (✓) the correct box.

[1 mark]

2 ☐

4 ☐

6 ☐

8 ☐

8

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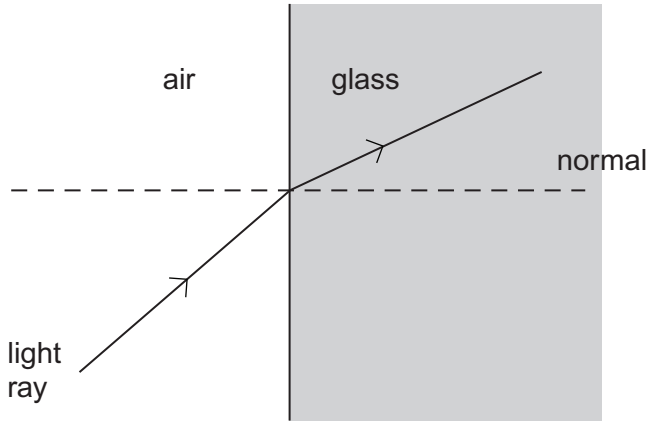
ANSWER IN THE SPACES PROVIDED

2 (a) Newton suggested a theory that light is composed of corpuscles. He used this theory to explain the refraction of a light ray travelling from air to glass as shown in **Figure 2**. Huygens explained the refraction of light using his own theory that light consists of waves.

Figure 2



2 (a) (i) State **one** reason why Huygens' theory of light was rejected for many years after it was first proposed in favour of Newton's corpuscular theory of light.

[1 mark]

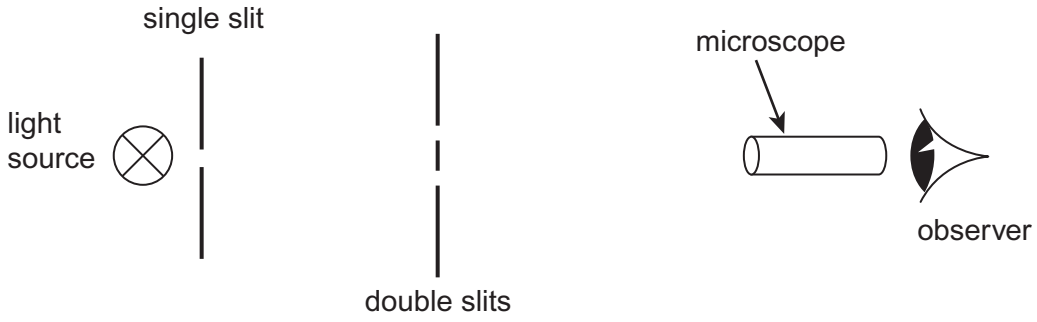
2 (a) (ii) Explain why the eventual measurement of the speed of light in water led to the conclusion that light consists of waves and not corpuscles.

[2 marks]

Question 2 continues on the next page

2 (b) Young demonstrated that a pattern of alternate bright and dark fringes was observed when light from a narrow single slit passed through double slits, as shown in **Figure 3**.

Figure 3



Newton's corpuscular theory predicted incorrectly that just two bright fringes would be formed in this pattern.

Explain, using Huygens' theory, why more than two bright fringes are formed in this pattern.

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

[6 marks]

9

3 (a) Monochromatic light of wavelength $560\ \text{nm}$ is directed at the surface of a certain metal **X** in a photocell, causing a photoelectric current.

When the metal surface is charged positively, the photoelectric current decreases. The current becomes zero when the potential of the surface relative to the collecting electrode is $+0.38\ \text{V}$.

3 (a) (i) Calculate, in J, the maximum kinetic energy of an emitted photoelectron.

[1 mark]

maximum kinetic energy = _____ J

3 (a) (ii) Calculate, in J, the work function of metal **X**.

[3 marks]

work function = _____ J

3 (b) The experiment is repeated using a photocell in which a different metal **Y** is illuminated with light of the same wavelength as in part **(a)**. There is no photoemission when the metal surface is uncharged.

3 (b) (i) Explain this observation.

[3 marks]

3 (b) (ii) Explain how this observation contributes to the failure of the wave theory of light.

[2 marks]

9

Turn over for the next question

4 (a) One of the two postulates of Einstein's theory of special relativity is that physical laws have the same form in all inertial frames of reference.

4 (a) (i) Explain what is meant by this postulate.

[2 marks]

4 (a) (ii) State the other postulate.

[1 mark]

4 (b) An electron leaving an accelerator is travelling at a speed of $0.993c$, where c is the speed of light in a vacuum.

rest mass of an electron = 9.1×10^{-31} kg

4 (b) (i) Calculate the mass of the electron travelling at $0.993c$ in the frame of reference of the accelerator.

[2 marks]

mass = _____ kg

4 (b) (ii) Calculate, in J, the total energy of the electron leaving the accelerator.

[2 marks]

total energy = _____ J

4 (b) (iii) Calculate the kinetic energy of the electron leaving the accelerator.

[2 marks]

kinetic energy = _____ J

9

END OF QUESTIONS

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