A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

A-level

PHYSICS

Paper 3

Section B Turning points in physics

7408/3BD

Monday 3 June 2019 Afternoon

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.

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

JUN197408 3BD 01

For this paper you must have:
- **a pencil and a ruler**
- **a scientific calculator**
- **a Data and Formulae Booklet.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

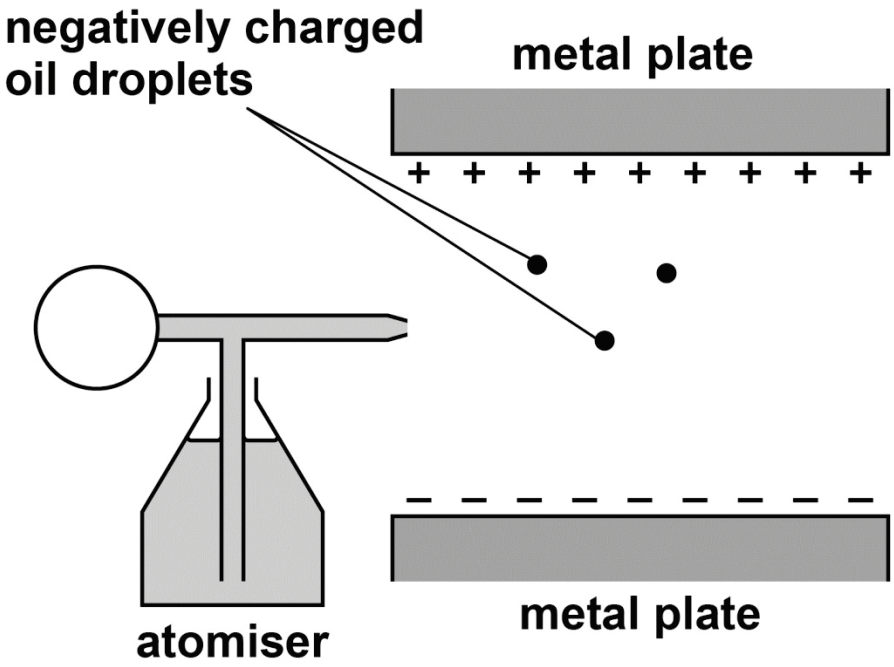
SECTION B

Answer ALL questions in this section.

0 1 **FIGURE 1 shows an experiment to measure the charge of the electron.**

The diagram is NOT drawn to scale.

FIGURE 1



Negatively charged oil droplets are sprayed from the atomiser into the gap between the two horizontal metal plates. A potential difference is applied between the metal plates.

One of the droplets remains stationary.

0 1 . 1 **Identify the forces acting on the stationary droplet.**

In your answer you should state the relationship between the forces.

The upthrust on the droplet due to the air it displaces is negligible. [2 marks]

0 1 . 2 The potential difference between the plates is changed to zero and the droplet falls at a terminal velocity of 1.0×10^{-4} m s^{-1}.

The density of the oil is 880 kg m^{-3}
The viscosity of air is 1.8×10^{-5} N s m^{-2}

Show that the radius of the droplet is about 1×10^{-6} m.

Assume that the droplet is spherical.
[3 marks]

[Turn over]

0 1 . 3 **The potential difference between the plates is restored to its initial value and the droplet becomes stationary.**

The charge on the droplet is -4.8×10^{-19} C.

A student suggests that, if the droplet splits into two spheres of equal size, both spheres would remain stationary.

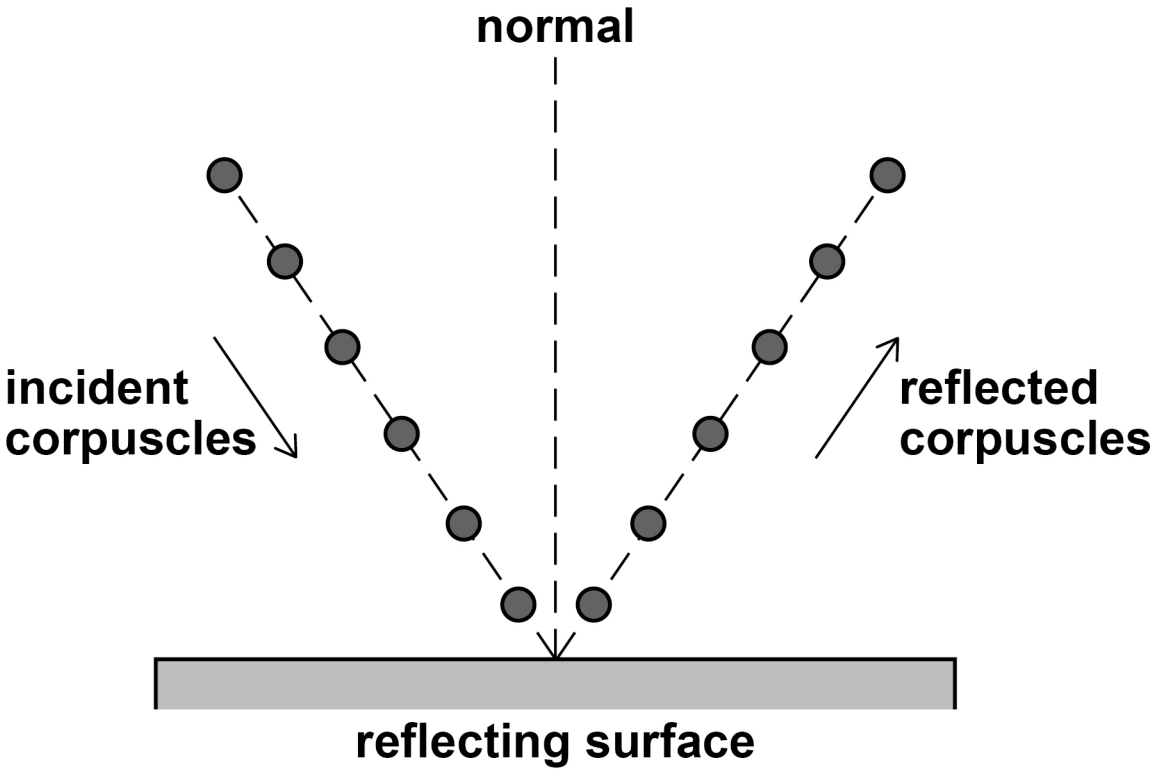
Deduce whether this suggestion is correct.
[3 marks]

8

0 2 **Newton used a corpuscular theory of light to explain reflection.**

FIGURE 2 shows how corpuscles would reflect from a horizontal surface.

FIGURE 2



0 2 . 1 **What happens to the horizontal and vertical components of the velocity of the corpuscles, according to the theory, when they are reflected?**

Tick (✓) ONE box. [1 mark]

Tick the correct box	Horizontal component of velocity	Vertical component of velocity
	Unchanged	Changed
	Changed	Unchanged
	Unchanged	Unchanged
	Changed	Changed

0 2 . 2 **Newton used the corpuscular theory to explain the refraction of light at an interface between air and water.**

Huygens used the wave theory to explain the refraction of light at the interface.

Discuss the evidence that led to the rejection of Newton's corpuscular theory.

In your answer you should include

- **how each theory explains refraction**
- **how experimental evidence led to the acceptance of the wave theory.**

[6 marks]

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[Turn over]

0 2 . 3 **Light is now known to behave as an electromagnetic wave.**

Describe a plane-polarised electromagnetic wave travelling through a vacuum.
You may wish to draw a labelled diagram.
[3 marks]

10

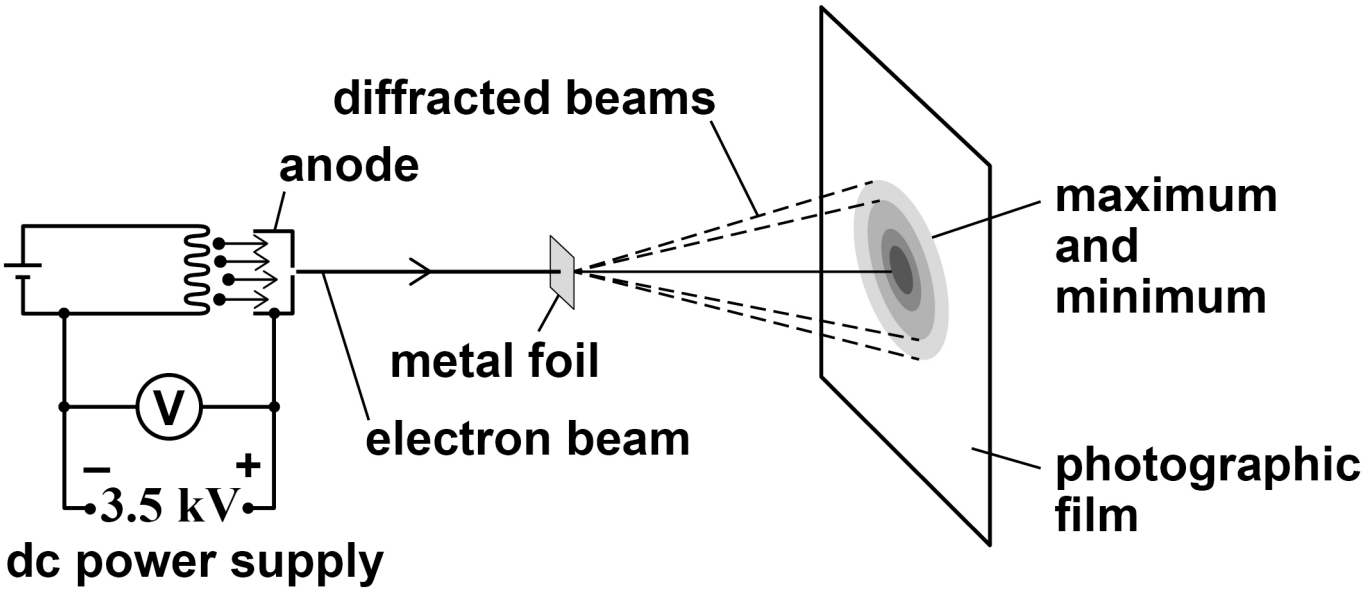
[Turn over]

0 3 **FIGURE 3 shows part of the apparatus used to investigate electron diffraction.**

Electrons were accelerated through a potential difference to form a beam which was then incident on a thin metal foil.

Regions of maximum and minimum intensity formed on a photographic film behind the foil.

FIGURE 3



0 3 . 1 State de Broglie's hypothesis. [2 marks]

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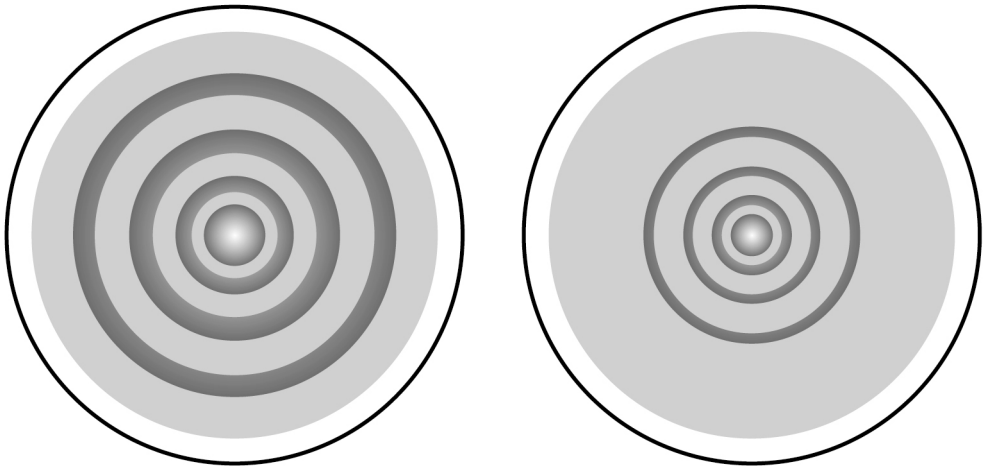
0 3 . 2 **The voltmeter in FIGURE 3 shows a reading of $3.5\ \mathrm{kV}$.**

Determine whether this voltmeter reading is consistent with a de Broglie wavelength for the electrons in the beam of about $0.02\ \mathrm{nm}$. [2 marks]

0 3 . 3 **The experiment is repeated using a similar arrangement to that shown in FIGURE 3, on page 20.**

FIGURE 4 shows the diffraction patterns from the two experiments.

FIGURE 4



first experiment **second experiment**

State and explain TWO independent changes that could be made to the arrangement in FIGURE 3 to produce the result shown for the second experiment in FIGURE 4. [4 marks]

First change _____

_____

_____

_____

Second change

[Turn over]

8

0 4 **TABLE 1 shows data of speed v and kinetic energy E_k for electrons from a modern version of the Bertozzi experiment.**

TABLE 1

v / 10^8 m s^{-1}	E_k / MeV
2.60	0.5
2.73	0.7
2.88	1.3
2.96	2.6
2.99	5.8

0 4 . 1 **Classical mechanics predicts that $E_k \propto v^2$.**

Deduce whether the data in TABLE 1 are consistent with this prediction. [2 marks]

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0 4 . 2 **Discuss how Einstein's theory of special relativity explains the data in TABLE 1, on page 26. [4 marks]**

0 4 . 3 **Calculate, in J, the kinetic energy of one electron travelling at a speed of $0.95c$.**
[3 marks]

kinetic energy = _____ **J**

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END OF QUESTIONS

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
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2	
3	
4	
TOTAL	