

A-level PHYSICS (7408/3BD)

Paper 3 – Section B (Turning points in Physics)

Specimen 2014 Morning Time allowed: 2 hours

Materials

als

- For this paper you must have:
 a pencil
- a perica ruler
- a calculator
- a data and formulae booklet
- a question paper / answer book for Section A.

Instructions

- Answer all questions.
- Show all your working.
- The total time for both sections of this paper is 2 hours.

Information

• The maximum mark for this section is 35.

Please write clearly, in block capitals, to allow character computer recognition.		
Centre number Candidate number Candidate number		
Surname		
Forename(s)		
Candidate signature		

	Section B
	Answer all questions in this section.
0 1	In an experiment to measure the charge of the electron, a spherical charged oil droplet of unknown mass is observed between two horizontal parallel metal plates, as shown in Figure 1 .
	charged oil droplet +
0 1 . 1	The droplet falls vertically at its terminal speed when the potential difference
	(pd) between the plates is zero. A droplet of radius r falls at its terminal velocity, v . Derive an expression for r in terms of v , η , ρ and g , where η is the viscosity of air and ρ is the density of the oil droplet. [2 marks]
0 1 . 2	Explain how the mass of the oil droplet can be calculated from its radius and other relevant data. [1 mark]

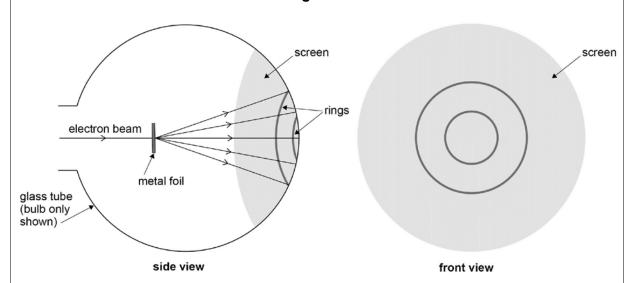
0 1 . 3	A potential difference (pd) is applied across the plates and is adjusted the droplet is held stationary. The two horizontal parallel metal plates 15.0 mm apart. The mass of the droplet is $3.4 \times 10^{-15} \mathrm{kg}$. The droplet is held stationary when the pd across the plates is 1560 V. Calculate the charge of the oil droplet.	s are
	charge =	C
0 1 . 4	A student carries out Millikan's oil drop experiment and obtains the follo	
	results for the charges on the oil drops that were investigated.	
	$-9.6 \times 10^{-19} \mathrm{C}$ $-12.8 \times 10^{-19} \mathrm{C}$ $-6.4 \times 10^{-19} \mathrm{C}$	
	Discuss the extent to which the student's results support Millikan's conclusion and how the student's conclusion should be different. [3 n	narks]

	Figure 2 shows a narrow beam of electrons produced by attracting the electrons emitted from a filament wire, to a positively charged metal plate which has a small hole in it.
	Figure 2
	beam of electrons
0 2 . 1	Explain why an electric current through the filament wire causes the wire to emit electrons. [2 marks]
	Explain why the filament wire and the metal plates must be in an evacuated tube. [1 mark]

0 2 . 3	The potential difference between the filament wire and the metal plate $4800~\mathrm{V}.$	e is
	Calculate the de Broglie wavelength of the electrons in the beam.	4 marks]
	wavelength =	m
	Question 2 continues on the next page	

The beam is directed at a thin metal foil between the metal plate and a fluorescent screen at the end of the tube, as shown in **Figure 3**. The electrons that pass through the metal foil cause a pattern of concentric rings on the screen.

Figure 3



0 2 . 4 The potential difference between the filament and the metal plate is increased. State and explain the effect this has on the diameter of the rings.

	[3 marks

0 3	Maxwell's theory suggested the existence of electravel at a speed of $\sqrt{\frac{1}{\varepsilon_0\mu_0}}$. Hertz later discovered radio waves and perform their properties. Figure 4 shows a radio wave transmitter and a transmitted by a dipole aerial. The detector co-connected to a meter.	ned experiments to investigate
	Figure 4	
signal generato	dipole	metal loop meter
0 3 . 1	Explain how the detection of the wave by the lonature of the radio waves.	detector poop demonstrates the magnetic [2 marks]
0 3 . 2	Explain how the electric nature of the waves er demonstrated.	mitted by the dipole could be [1 mark]

0 3 . 3	Hertz used an arrangement like that shown in Figure 4 to determine the speed of radio waves. Describe how the speed was determined. Go on to discuss how the experiments of Hertz confirmed Maxwell's prediction and the experimental evidence that suggests that light is also an electromagnetic wave. [6 marks]

0 4	One of the two postulates of Einstein's theory of special relativity is that the speed of light in free space is invariant.
0 4 . 1	Explain what is meant by this postulate. [1 mark]
0 4 . 2	State the other postulate. [1 mark]
0 4 . 3	Two detectors are measured to be 34 m apart by an observer in a stationary frame of reference. A beam of π mesons travel in a straight line at a speed of 0.95 c past the two detectors, as shown in Figure 5 .
	detector 1 detector 2 $\pi \text{ mesons}$ Calculate the time taken, in the frame of reference of the observer, for a π meson to travel between the two detectors. [1 mark]
	time =

0 4 . 4	π mesons are unstable and decay with a half-life of 18 ns. It is found in experiments that approximately 75% of the π mesons that pass the first detector decay before reaching the second detector.
	Show how this provides evidence to support the theory of special relativity. In your answer compare the percentage expected by the laboratory observer with and without application of the theory of special relativity.
	[5 marks]
	END OF QUESTIONS
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