Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

(a) Bertozzi's experiment was designed to test the relationship between the kinetic energy of an electron and its speed as predicted by the theory of special relativity.

Describe Bertozzi's experiment.

Your answer should include:
- a diagram of the experimental arrangement
- details of how the kinetic energy and the speed were measured.

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(6)

(b) A scientist conducts an experiment similar to Bertozzi's experiment and reports that when the electron speed is 2.93×10^8 m s^{-1} the measured kinetic energy is 2.4 MeV.

Determine whether these data are consistent with the result expected using the theory of special relativity.

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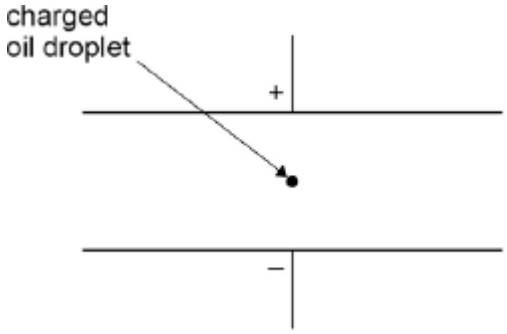
(4)

(Total 10 marks)

Q2.

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 the diagram below.



(a) 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.

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(2)

(b) Explain how the mass of the oil droplet can be calculated from its radius and other relevant data.

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(1)

(c) A potential difference (pd) is applied across the plates and is adjusted until the droplet is held stationary. The two horizontal parallel metal plates are 15.0 mm apart. The mass of the droplet is 3.4×10^{-15} kg.

The droplet is held stationary when the pd across the plates is 1560 V.

Calculate the charge of the oil droplet.

charge = _____ C

(2)

(d) A student carries out Millikan's oil drop experiment and obtains the following results for the charges on the oil drops that were investigated.

-9.6×10^{-19} C $\quad$ -12.8×10^{-19} C $\quad$ -6.4×10^{-19} C

Discuss the extent to which the student's results support Millikan's conclusion and how the student's conclusion should be different.

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(3)

(Total 8 marks)