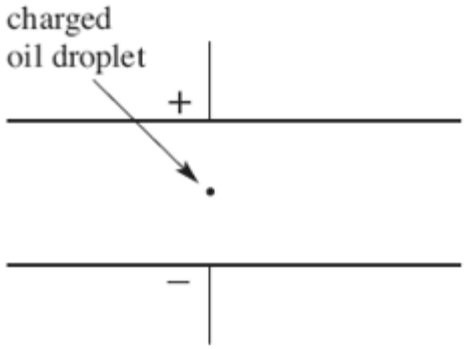
Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

In an experiment to measure the charge of the electron, a charged oil droplet of unknown mass was observed between two horizontal parallel metal plates, as shown in the figure below.



(a) The droplet was observed falling vertically at its terminal speed when the pd between the plates was zero.

(i) By considering the forces acting on the droplet as it falls at its terminal velocity, *v*, show that the radius, *r*, of the droplet is given by

$$r = \left(\frac{9\eta v}{2\rho g}\right)^{\frac{1}{2}}$$

where η is the viscosity of air and ρ is the density of the oil droplet.

(2)

(ii) Explain how the mass of the oil droplet can be determined from its radius, *r*.

_____

_____

_____

(1)

(b) (i) The two horizontal parallel metal plates were 5.0 mm apart. The mass of the droplet was

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6.8×10^{-15} kg. The droplet was held stationary when the plate pd was 690 V.

Calculate the charge of the oil droplet, expressing your answer to an appropriate number of significant figures.

answer_____ C

(3)

(ii) Millikan made the first accurate measurements of the charge carried by charged oil droplets. Outline what Millikan concluded from these measurements.

_____

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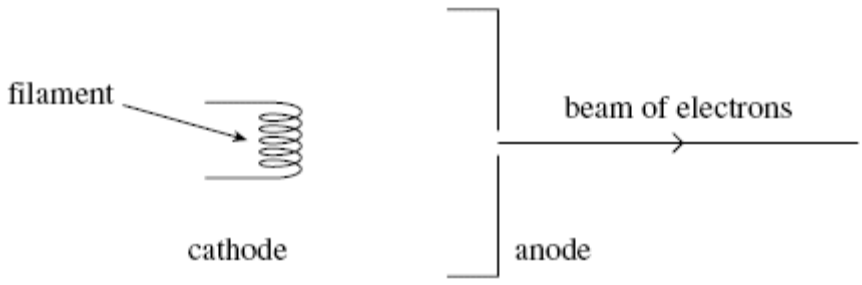
(2)

(Total 8 marks)

Q2.

A narrow beam of electrons is produced in a vacuum tube using an electron gun, part of which is shown in **Figure 1**.

Figure 1



(a) (i) State and explain the effect on the beam of electrons of increasing the filament current.

_____

_____

_____

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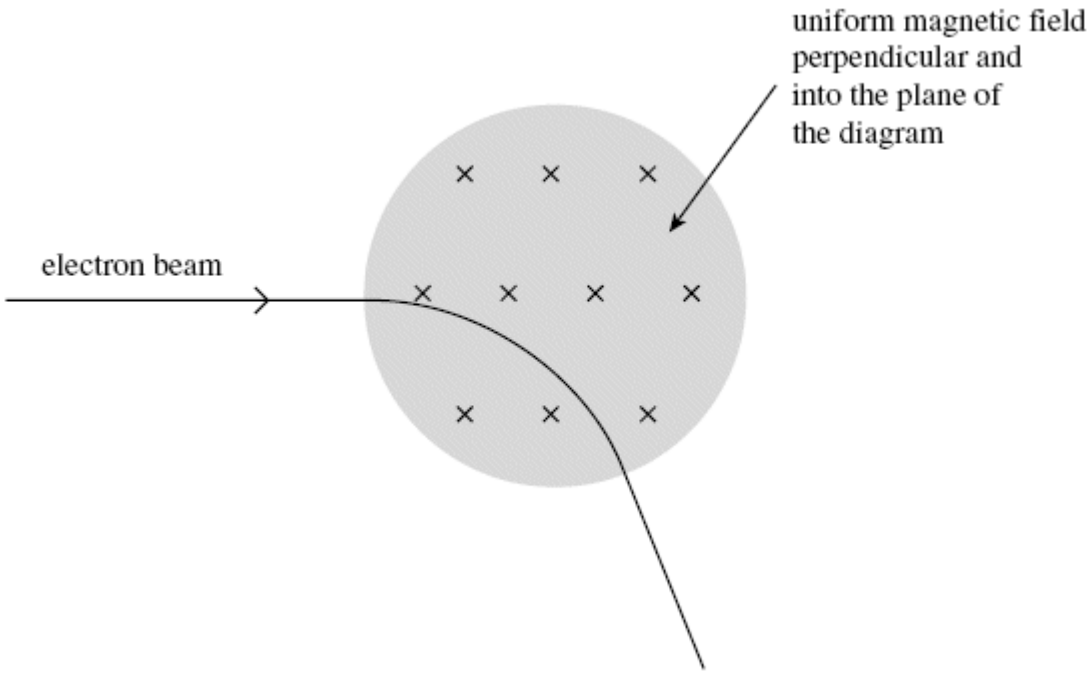
(2)

(ii) State and explain the effect on the beam of electrons of increasing the anode potential.

(2)

(b) The beam of electrons is directed at right angles into a uniform magnetic field as shown in **Figure 2**.

Figure 2



(i) Explain why the electrons move in a circular path at a constant speed in the magnetic field.

(3)

(ii) When the speed of the electrons in the beam is 7.4×10^6 m s^{-1} and the magnetic flux density is 0.60 m T, the radius of curvature of the beam is 68 mm.

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Use these data to calculate the specific charge of the electron, stating an appropriate unit. Give your answer to an appropriate number of significant figures.

answer = _____

(4)

(iii) Discuss the historical relevance of the value of the specific charge of the electron compared with the specific charge of the H^+ ion.

_____

_____

_____

_____

(2)

(Total 13 marks)

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