Electron

For electron, $q = e$, $m = m_e$ | For proton, $q = e$, $m = m_p = 1840\, m_e$

$\therefore$specific charge of electron, $\frac{q}{m} = \frac{e}{m_e}$ | $\therefore$specific charge of electron, $\frac{q}{m} = \frac{e}{m_p} = \frac{e}{1840\, m_e}$

Motion of electron in uniform electric field: $E = \frac{V}{d}$ | $F = qE$ | $a = \frac{qE}{m}$ | $KE = qV$

✓ Vertical deflection (y), $y = \frac{1}{2}\frac{qE}{m}\frac{D^2}{v^2}$ $D = length\ of\ plates$

As electron beam ***grazes***, $y = \frac{d}{2}$

➢ If V is accelerating potential, then $velocity, v = \sqrt{\frac{2eV}{m}}$

Motion of electron in uniform magnetic field: $\vec{F} = q(\vec{v} \times \vec{B})$ | $F = qvBsin\theta$

▪ If $v = 0m/s$ & $\theta = 0^o\ or\ 180^o$ then, $F = 0$ **Magnetic force is zero.**

✓ As electron enters a transverse magnetic field ($\theta = 90^o$), it experiences magnetic force ($F = evB$). This magnetic force behaves as a centripetal force.

Hence, the electron moves in a circular path inside the magnetic field.

In addition, the work done by centripetal force is zero. Hence, the speed of electron is constant.

T cle described by charge particle inside magnetic

$v = \sqrt{\frac{2\, E_k}{m}}$ $r = \frac{mv}{qB} = \frac{v}{\left(\frac{q}{m}\right) B}$ $v = \sqrt{\frac{2\, e\, V}{m}}$

Motion of electron in cross field:

As electron beam passes un deviated (without deflection) through a cross field, then

$$eE = evB$$

Millikan's oil drop experiment: [Type 1]

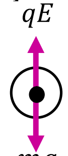
Radius of drop, $r = \sqrt{\frac{9}{2}\frac{\eta v_1}{(\rho - \sigma) g}}$

Charge on oil drop: $q = \frac{6\pi\eta r (v_1 \pm v_2)}{E}$

Millikan's oil drop experiment: [Type 2]

$\eta = 0$ (*not mentioned in question*)

$\sigma = 0$ (*not mentioned in question*)



At equilibrium, $qE = mg$

Here, $q = Ne$

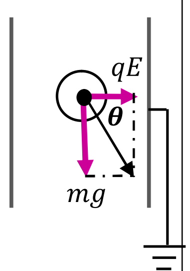
$E = \frac{V}{d}$ $N = number\ of\ electrons$

$mg = \frac{4}{3}\pi r^3 \rho\, g$ | $\rho = density\ of\ drop$

Vertical motion of drop between in vertical plates: [Type 3]

Given that,

θ =angle made by drop with vertical



In figure,

$$\tan\theta = \frac{qE}{mg}$$

Here, $q = Ne$

$E = \frac{V}{d}$

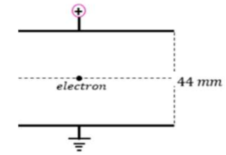
$N = number\ of\ electrons$

$mg = \frac{4}{3}\pi r^3 \rho\, g$ | ρ =*density of drop*

1. a. What is specific charge? Compare the specific charge of electron and proton. 2

b. An electron and a proton enter into a transverse electric field with same velocity. Which particle will have larger deflection. 2

c. The Fig. shows two parallel metal plates, 44mm apart, which have p. d. of 110V applied across them, with the electron beam in it. Find the



i. Electric filed strength between the plates. 1

ii. The magnitude of the force on the electron when it is between the plates. 1

d. A beam of electrons, moving with velocity of 10^7m/s, enters midway between two horizontal parallel plates in the direction parallel to the plates which are 5cm long and 2cm apart and have a pd of V volts between them. Calculate V if the beam is deflected so that it just grazes the edge of the plate. [**90.90 V**] 2

e. Two plane metal plates 4 cm long are held horizontally 3 cm apart in a vacuum, one being vertically above the other. The upper plate is at a potential of 300 V and the lower is earthed. Electrons having a velocity of 1×10^7 ms^{-1} are injected horizontally midway between the plates and in a direction parallel to the 4 cm edge. Calculate the vertical deflection of the electron beam as it emerges from the plates. e/m for electron = 1.8×10^{11} C/kg. [**0.0144m**] 2

2. a. Write the vector form of Lorentz force. Explain why photon passes without deviation in the electric and magnetic fields? 2

b. A proton of energy 10eV is moving in a circular path of radius 11 cm, in a plane at right angles to a uniform magnetic field. Determine the value of the flux density. 2

(Mass of a proton= $1.67 \times 10^{-27}\ Kg$, $e = 1.6 \times 10^{-19} C$)

c. A beam of electron is accelerated from rest through a potential difference of 2000V and then enters a uniform magnetic field which is perpendicular to the direction of the proton beam of the flux density is 0.4 T. Calculate the radius of the path which the beam describes. [Electron mass = $9.1 \times 10^{-3}\ kg$, electronic charge = $-1.6 \times 10^{-19} C$] [**0.0162m**] 2

d. In the ionosphere electron executes 1.4×10^6 revolutions in a second. Find the strength of the magnetic flux density in this region. (Specific charge of electron$1.8 \times 10^{11} C/Kg$) 2

e. In Thomson's experiment, voltage across the plates is 50 V and distance between them is 3 cm. The magnetic field applied to make the beam undeflected is 10 Tesla, what is the velocity of the beam? 2

f. An electron beam passes through a magnetic field 0f 2×10^{-3} T and an electric 3.4×10^4 V/m both acting simultaneously.

i. If the path of the electron remains undeflected, calculate the speed of electrons. 2

ii. If the electric field is removed, what will be the radius of the circular path? 2

3. Millikan's oil drop experiment gives the idea of quantization of charge.

a. Explain what is meant by quantization of charge. 1

b. In a Millikan's oil drop experiment, a drop is observed to fall with a terminal speed 1.4mm/s in the absence of electric field. When a vertical electrical field of 4.9×10^5V/m is applied, the droplet is observed to continue to move downward at a lower terminal speed of 1.21 mm/s. calculate the charge on the drop. Density of oil = 750kg/m^3, viscosity of air = 1.81×10^{-5}, density of air = 1.29 kg/m^3. [**5.21×10^{-19} C**] 2

c. In a Millikan's oil drop experiment, an oil drop of weight 1.5×10^{-14}N is held stationary between plates 10mm apart by applying a p.d. of 470V between the plates. Calculate the charge on the oil drop. 2