Collins Turning Points Questions – C1T

QUESTIONS

6. In an arrangement similar to that shown in Figure 6, an electron beam is subjected to an electric field and a magnetic field at right angles to each other, resulting in no deflection of the beam. The magnetic flux density is 6.5 mT and the electric field is created by a potential difference of 5000 V applied between metal plates separated by a distance of 56 mm. Calculate the speed of the electrons in the beam.

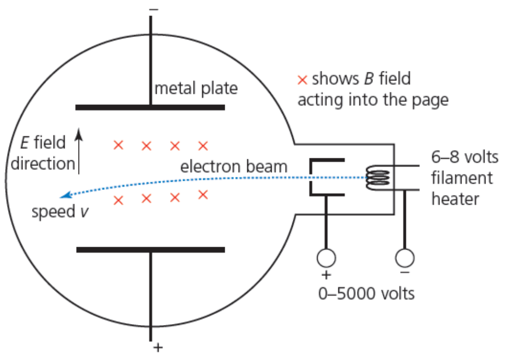

Figure 6 *A cathode ray tube used to determine the ratio e/m*

7. Using the apparatus shown in Figure 6, and maintaining a constant magnetic field, it would be possible to obtain a table of corresponding measurements for the electric field E and the accelerating voltage V that would create a horizontal electron beam. What would be a suitable graph to plot of such measurements to enable a graphical determination of the specific charge on the electron? Explain how a value of e/m would be obtained from the graph.

QUESTIONS

10. Rearrange the equation $\frac{mv^2}{r} = Bev$ to make r the subject and hence predict what changes could be made to make the electron beam describe a circular path of smaller radius.

12. The cyclotron, one of the earliest types of particle accelerators and still used extensively in hospitals, uses a constant magnetic field to bend the path of charged particles to form a circle. Starting at the centre of the cyclotron, the particles repeatedly pass through an electric field, which accelerates them and, as a result, the radius of the particles' circular path increases. Given that the flux density of the magnetic field is 1.5 T and assuming that the particles do not achieve relativistic speeds, determine the radius of the circular path of a beam of protons at the instant that each proton achieves an energy of 1 MeV. [Take the mass of a proton to be 1.67×10^{-27} kg]

QUESTIONS

13. In an apparatus similar to Figure 8, an oil drop is held stationary by an electric field. The strength of the field is 41 000 V m^{-1}. The oil has a density of is 970 kg m^{-3} and the coefficient of viscosity of air is $1.8 \times 10^{-5}\,\text{N s m}^{-2}$. When the electric field is switched off, the oil drop falls with a terminal velocity of $8.85 \times 10^{-5}\,\text{m s}^{-1}$. Determine the radius, the mass and the charge of the oil drop.

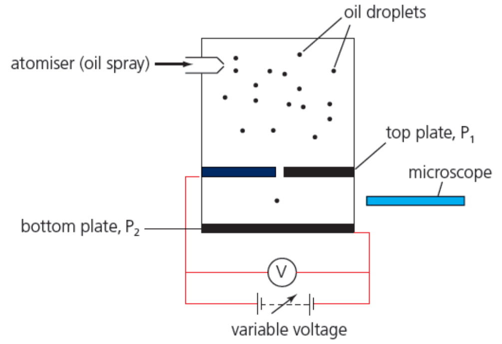

Figure 8 *Schematic view of Millikan's 'oil drop experiment'*

14. A charged oil droplet in Millikan's oil drop experiment is observed to fall with a constant velocity v_1 of $3.98 \times 10^{-5}\,\text{m s}^{-1}$ when an electric field is not applied, and to rise at a constant velocity v_2 of $1.64 \times 10^{-4}\,\text{m s}^{-1}$ when an electric field of $6.65 \times 10^{4}\,\text{N C}^{-1}$ is applied. Determine the radius, the mass and the charge on the drop, given that the density of the oil is 886 kg m^{-3} and the viscosity of the air is $1.81 \times 10^{-5}\,\text{N s m}^{-2}$. Express your answers to an appropriate number of significant figures.