Ch—04 Moving Charges and Magnetism

Daily Practice Problem 05

Q1. A proton, an electron and a helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicular to the plane. Let r_p, r_e and r_{He} be their respective radii, then

(a) $r_e < r_p = r_{He}$

(b) $r_e > r_p = r_{He}$

(c) $r_e < r_p < r_{He}$

(d) $r_e > r_p > r_{He}$

Q2. In an experiment, electrons are accelerated, from rest by applying a voltage of $500\,V$. Calculate the radius of the path, if a magnetic field $100\,mT$ is then applied. (Take, charge of the electron = $1.6 \times 10^{-19}\,C$ and mass of the electron = $9.1 \times 10^{-31}\,kg$)

(a) $7.5 \times 10^{-2}\,m$

(b) $7.5 \times 10^{-4}\,m$

(c) $7.5 \times 10^{-3}\,m$

(d) $7.5\,m$

Q3. Doubly-ionized helium ions are projected with a speed of 10 kms^{-1} in a direction perpendicular to a uniform magnetic field of magnitude $1.0\,T$. Find

(a) the force acting on an ion,

(b) the radius of the circle in which it circulates and

(c) the time taken by an ion to complete the circle.

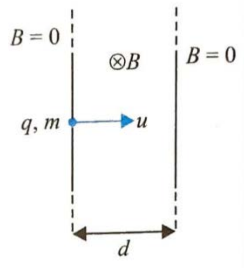
Q4. An electron travels in a circular path of radius $20\,cm$ in a magnetic field $2 \times 10^{-3}\,T$.

(a) Calculate the speed of the electron.

(b) What is the potential difference through which the electron must be accelerated to acquire this speed?

Q5. An electron moving perpendicular to a uniform magnetic field completes a circular orbit in 10^{-6}s. Calculate the value of the magnetic field. Mass of electron = $9 \times 10^{-31}\,kg$.

Q6. A uniform magnetic field of strength B exists in a region of width d. A particle of charge q and mass m is shot perpendicularly (as shown in figure) into the magnetic field. Find the time spent by the particle in the magnetic field if



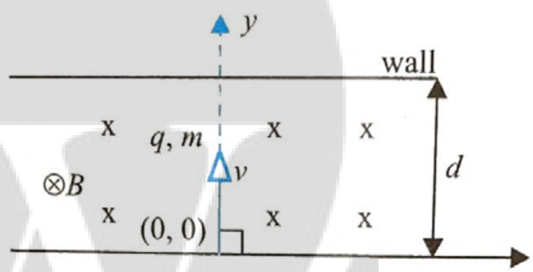
(a) $d > \frac{mu}{qB}$

(b) $d < \frac{mu}{qB}$

Q7. An a-particle is accelerated by a potential difference of $10^4\ V$. Find the change in its direction of motion, if it enters normally in a region of thickness $0.1\ m$ having transverse magnetic induction of $0.1\ tesla$. $(Given: mass\ of\ \alpha - particle: 6.4 \times 10^{-27}\ kg)$.

Q8. A beam of charged particle, having kinetic energy $10^3\ eV$, contains masses $8 \times 10^{-27}\ kg$ and $1.6 \times 10^{-26}\ kg$ emerge from the end of an accelerator tube. There is a plate at distance 10^{-2} m from the end of the tube and placed perpendicular to the beam. Calculate the magnitude of the smallest magnetic field which can prevent the beam from striking the plate.

Q9. In figure, what should be the speed of the charged particle so that it cannot collide with the upper wall? Also, find the coordinates of the point where the particle strikes the lower plate in the limiting case of velocity.



ANSWERS

1. a

2. b

3. (a). $3.2 \times 10^{-15} N$

(b). $2.1 \times 10^{-4} m$

(c). $1.32 \times 10^{-7} s$

4. (i) $7.0 \times 10^{7}\ ms^{-1}$

(ii) $14\ kV$

5. $3.5 \times 10^{-3}\ T$

6. (a) $\frac{\pi m}{qB}$

(b) $\frac{m}{qB} \sin^{-1}\left(\frac{d}{R}\right)$

7. $\theta = 30°$

8. 1.414 T

9. $\frac{qBd}{m}; (-2d, 0, 0)$