Answer on Question 75044, Physics, Electromagnetism

Question:

An alpha particle and a proton having same momentum enter into a region of uniform magnetic field and move in circular paths. The ratio of the radii of curvature of their path r_{alpha}/r_{proton} in the field is:

a) $1/2$

b) $1/4$

c) 1

d) 4

Solution:

There are two forces that act on the charged particle when it moves in the uniform magnetic field: the magnetic force and the radial force. So, using the Newton's second law of motion we can write:

$$qvB = \frac{mv^2}{r},$$

here, q is the charge of the particle, v is the orbital speed of the particle, B is the magnetic field, m is the mass of the particle, r is the radius of the curvature of particle's path.

From this formula, we can find the radius of the curvature of particle's path:

$$r = \frac{mv}{qB} = \frac{p}{qB},$$

here, p is the momentum of the particle.

Since, the both particles (proton and alpha-particle) have the same momentum and the magnetic field is uniform, we can write:

$$r = \frac{p}{qB} \propto \frac{1}{q}.$$

Finally, we can find r_{alpha}/r_{proton}:

$$\frac{r_{alpha}}{r_{proton}} = \frac{\frac{1}{q_{alpha}}}{\frac{1}{q_{proton}}} = \frac{q_{proton}}{q_{alpha}} = \frac{1}{2}.$$

Answer:

a) $\frac{r_{alpha}}{r_{proton}} = \frac{1}{2}$.