3. A proton and an α-particle, having kinetic energies K_p and K_α respectively, enter into a magnetic field at right angles. The ratio of the radii of trajectory of proton to that of α-particle is 2 : 1. The ratio of $K_p : K_\alpha$ is:

[March 18, 2021 (II)]

(a) 1 : 8 (b) 8 : 1 (c) 1 : 4 (d) 4 : 1

Ans

(d) $F = \frac{mV^2}{r}$ and $F = qVB$

$$\therefore \frac{mV^2}{r} = qVB \Rightarrow r = \frac{mV}{qB}$$

or, $r = \frac{\sqrt{2mK}}{qB}$ $(\because p = mV = \sqrt{2mK})$

$$\Rightarrow \frac{r^2q^2B^2}{2m} = K$$

$$K_p = \frac{r_p^2 q_p^2 B^2}{2m_p} \text{ and } K_\alpha = \frac{r_\alpha^2 q_\alpha^2 B^2}{2m_\alpha}$$

$$\therefore \frac{K_p}{K_\alpha} = \frac{r_p^2 q_p^2 m_\alpha}{r_\alpha^2 q_\alpha^2 m_p} = \left(\frac{2}{1}\right)^2 \left(\frac{1}{2}\right)^2 \left(\frac{4}{1}\right)$$

or, $\frac{K_p}{K_\alpha} = 4 : 1$