An alpha-particle and a proton are fired through the same magnetic field which is perpendicular to their velocity. The alpha-particle and the proton move such that the radius of curvature of their path is same. The ratio of their de Broglie wavelength is given by:

(A) 1 : 4 (B) 4 : 1 (C) 1 : 1 (D) 1 : 2

Solution

$$F_B = qvB\sin 90^\circ = qvB$$

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

$$\therefore r = \frac{mv}{qB}$$

de Broglie wavelength $\lambda = \frac{h}{mv} = \frac{h}{qBr}$

$$\frac{\lambda_\alpha}{\lambda_p} = \frac{\frac{h}{q_\alpha Br}}{\frac{h}{q_p Br}} = \frac{q_p}{q_\alpha} = \frac{q_p}{2q_p} = \frac{1}{2}$$

Hence, (D)