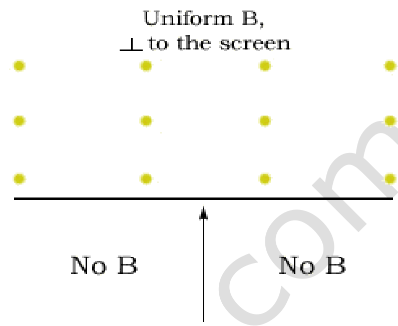
Q- A proton (mass= 1.67×10^{-27} kg, charge= 1.6×10^{-19} C) travelling with speed 1×10^{6} m/s enters a region of space containing a uniform magnetic field of 1.2 T and perpendicular to it. What is the time *t* required for the proton to re-emerge into the field-free region?



The charge q moving with velocity v perpendicular to a magnetic field B experiences a force F given by

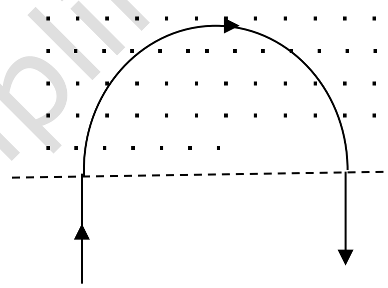
$$F = B*q*v$$

This force is always perpendicular to the direction motion and the direction of field both and hence will not change the magnitude of velocity but only the direction of the motion i.e. behaves centripetal force and the particle will move on a circular path. As the centripetal force is given by mv^2/r or $m\ v\ \omega$, we have

$$F = B*q*v = m\ v\ \omega$$

Gives $\omega = B*q/m$

[here ω is the angular velocity of the particle]



The time of one revolution of the particle will be given by

$$T = 2\ \pi/\omega = 2\pi\ m/Bq$$

And as here the particle will make half revolution in the magnetic field the time elapsed by it in the field is given by

$$t = T/2 = \pi\ m/Bq = \frac{3.14*1.67*10^{-27}}{1.2*1.6*10^{-19}} = 2.73*10^{-8}\ s$$