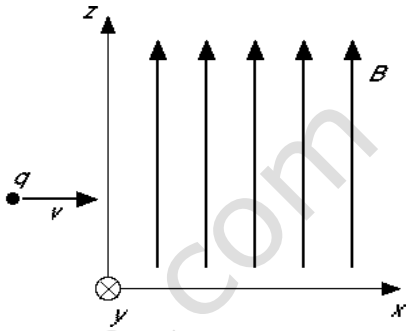
Q- A charged particle (q = +3.5 μC) moves at speed v_0 = 55 m/s in the +x-direction. At x = 0 it enters a region where a uniform magnetic field B = 2.5 T is directed in the +z direction.

(a) What is the magnitude of the magnetic force on the particle?

The magnitude of magnetic force on the particle moving perpendicular to the direction of field is given by



$$F = B\ q\ v$$

Hence $F = 2.5*3.5*10^{-6}*55 = 4.8*10^{-4}$ N

(b) What electric field can make the net force on the particle equal to zero?

The direction of the force on the moving charge particle in a magnetic field is given by Fleming's left-hand rule. The current is in the direction of motion (for a +ve charge) given by middle finger, magnetic field by index finger then the force is in the direction of extended thumb perpendicular to both and hence the direction of the force is out of the paper means negative y direction.

To make the net force on the particle zero, the electric field should apply equal and opposite force hence the force must be equal to **$4.8*10^{-4}$ N** and in the direction of positive y direction.

The force on a charge q due to electric field E is q*E hence the magnitude of the electric field is given by

$$E = F/q = 4.8*10^{-4}/3.5*10^{-6} = 137 \text{ N/C}$$ and the direction is +y

(c) If the incoming particle were replaced by one with the *opposite* electric charge but the same initial velocity, what electric field would be required to ensure a straight-line motion? (Magnetic field is unchanged.)

If the charge is of opposite sign the conventional current will be in opposite direction and the force due to magnetic field will be in + y direction, the magnitude remains same. To balance this force the force due to electric field should be equal and in - y direction. As the charge of the particle is now opposite, the direction of the force is also inverted with the same electric field. Hence the electric field will be the same as in the previous case.