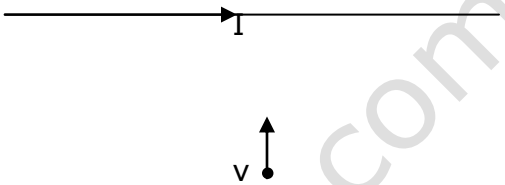
Q- An electron is moving straight towards a long straight wire with a velocity of $2*10^7$m/s. When the electron is 6 cm from the wire, a current I = 12 A suddenly appears in the wire. Find

(a) The magnitude and direction of the of the magnetic field of this current at the position of the electron.

(b) The magnitude and direction of the magnetic force on the electron at this instant.

(a) The magnetic field due to a long thin wire carrying current I at a distance r from it is given by (application of Biot-Savart law)

$$B = \frac{\mu_0 I}{2\pi r}$$



Here I = 12 A and r = 6 cm = 0.06 m thus

$$B = \frac{4\pi*10^{-7}*12.0}{2\pi*0.06} = 4.0 * 10^{-5}\ T$$

The direction of this magnetic field is given by ampere's right hand thumb rule. Holding the wire with right hand such that extended thumb is in the direction of current I, the curled fingers will points in to the page at the position of electron and thus the direction of B field at the position of electron is **in to the page**.

(b) The magnetic force on a charge q moving in a magnetic field B with velocity v is given by Lorentz formula as

$$\vec{F}_M = q(\vec{v} \times \vec{B})$$

As the electron is moving towards the wire and the field is into the page the angle between them is a right angle and hence the magnitude of the force on electron is given by

$$F_M = evB = 1.6 * 10^{-19} * 2 * 10^7 * 4 * 10^{-5} = 1.28 * 10^{-16} N$$

As the charge on electron is negative the direction of the force is given by the direction of $(\vec{B} \times \vec{v})$.

Using right hand thumb rule the direction of the force is to the **right of us.**