Q- An aluminum wire having a cross-sectional area of 6.00 $\times 10^{-6}$ m^2 carries a current of 3.70 A. Find the drift-speed of the electrons in the wire. The density of aluminum is 2.70 g/cm^3. Assume that one conduction electron is supplied by each atom.

The Current density is given by

$j = n*e*v_d$

Hence the current will be

$I = J*A = n*e*v_d*A$

Here n is the number of free electrons per unit volume.

Hence the drift speed will be

$$v_d = \frac{I}{neA}$$

Now the mass of the unit volume = density

Mass of 1 cm^3 of Al = 2.7 gm

Mass of 1 m^3 of Al = $2.7*10^6$ gm

As the molar mass of Al is 26.9815 the number of moles in 1 m^3 of Al will be

$= 2.7*10^6/26.9815$ moles = $1.0007*10^5$ moles

Hence number of atoms in 1 m^3 of Al = $1.0007*10^5*6.023*10^{23} = 6.027*10^{28}$

As one conduction atom is given by each atom, number of free (conduction) electrons in 1 m^3 will be

$n = 6.027*10^{28}$

Thus the drift speed will be

$$v_d = \frac{I}{neA} = \frac{3.70}{\left(6.027*10^{28}\right)*\left(1.6*10^{-19}\right)*6.00*10^{-6}} = 6.395*10^{-5}\ \text{m/s}$$

$= 6.4*10^{-2}$ mm/s