Problem 27.3

Drift velocity? This is a little obscure. Follow along.

The equation that relates the drift velocity to the current "I" is:

$$I = nqAv_d$$

where *n* be the number of charge carriers per unit volume (and in this case, that number is also the number of free charges), *q* the charge on one charge and *A* the cross-sectional area of the wire.

Knowing the mass density ρ (this is in grams/cm^3) of aluminum, we can write:

$$\rho = nm$$

where *n is the number of atoms per volume* and *m* is the mass of an atom. (Obscure? Yes, but that's why you are looking at the solutions.). In other words, given ρ , we can determine *n* if we can figure out the mass of each atom. That we can do by using Avogadro's number and the fact that the molar mass of aluminum is 27 grams. (Again, obscure? You bet!) Using all of that information, we can write:

The mass per atom:

$$m = \frac{27 \text{ grams}}{6.02\text{x}10^{23}}$$
$$= 4.49\text{x}10^{-23}$$

With the mass per atom, we can write:

$$\rho = nm$$
$$\Rightarrow \quad n = \frac{\rho}{m}$$
$$\Rightarrow \quad n = \frac{2.7 \text{ g/cm}^3}{4.49\text{x}10^{-23} \text{ g/atom}}$$
$$= 6.02\text{x}10^{22} \text{ atoms/cm}^3$$
$$= 6.02\text{x}10^{28} \text{ atoms/m}^3$$

With all that, we can write:

$$I = nqAv_d$$

$$\Rightarrow \quad v_d = \frac{I}{nqA}$$

$$\Rightarrow \quad v_d = \frac{5A}{\left(6.02x10^{28}\,m^{-3}\right)\left(1.6x10^{-19}\,C\,/\right)\left(4x10^{-6}\,m^{2}\right)}$$

$$= .13\ m/s$$

I doubt you will ever see a problem like this on an AP test. Its use, as best I can tell, is really only to make you think outside the box . . . (which is never bad).