21.1 The charge is

$$\Delta Q = I \times \Delta t = 30 \times 10^{-6} A \times 40 s = 1.2 \times 10^{-3} C.$$

So the number of electrons is:

$$\frac{Q}{e} = \frac{1.2 \times 10^{-3} C}{1.6 \times 10^{-19} C} = 7.5 \times 10^{15}.$$

21.5 From the periodic table of the elements, we can find the molar mass of aluminum is 27g/mol, which means the mass of one mole aluminum atoms is 27g. We also know that one mole of any substance contains Avogadro's number($6.02 \times 10^{23}/mol$) of atoms, so the mass of each aluminum atom is:

$$\frac{27 g/mol}{6.02 \times 10^{23}/mol} = 4.5 \times 10^{-23} g.$$

With the density $2.7 g/cm^3$, now we can find the number density of aluminum atom:

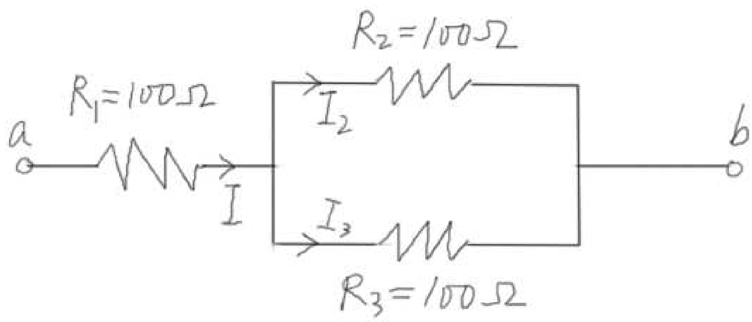
$$n = \frac{2.7 g/cm^3}{4.5 \times 10^{-23} g} = 6 \times 10^{22}/cm^3 = 6 \times 10^{28}/m^3.$$

Because one conduction electron is supplied by each atom, the number density of conduction electron equals the number density of aluminum atom. So from $I = nqv_d A$, we have:

$$v_d = \frac{I}{nqA} = \frac{5A}{6 \times 10^{28}/m^3 \times 1.6 \times 10^{-19} C \times 4 \times 10^{-6} m^2} = 1.3 \times 10^{-4} m/s$$

21.30 and 21.31 are on next page.

21.30



(a)From $P = I^2R$ and all three resistors have the same R, we know that the current that pass through each of them should be smaller than:

$$I = \sqrt{P/R} = \sqrt{25W/100\Omega} = 0.5A.$$

But I_2 and I_3 are always smaller than I_1(in this case $I_2 = I_3 = I_1/2$), so the maximum voltage is obtained when $I_1 = 0.5A$. Assume that the equivalent resistance of R_2 and R_3 is R_{eq}, and they satisfy:

$$\frac{1}{R_{eq}} = \frac{1}{R_2} + \frac{1}{R_3},$$

so we can get $R_{eq} = 50\Omega$. So the total resistance of these three resistors is:

$$R = R_1 + R_{eq} = 100\Omega + 50\Omega = 150\Omega.$$

So the voltage between a and b is $0.5A \times 150\Omega = 75V$.
(b)For R_1:

$$P_1 = I_1^2 R_1 = (0.5A)^2 \times 100\Omega = 25W.$$

For R_2:

$$P_2 = I_2^2 R_2 = (0.5A/2)^2 \times 100\Omega = 6.25W.$$

For R_3:

$$P_3 = I_3^2 R_3 = (0.5A/2)^2 \times 100\Omega = 6.25W.$$

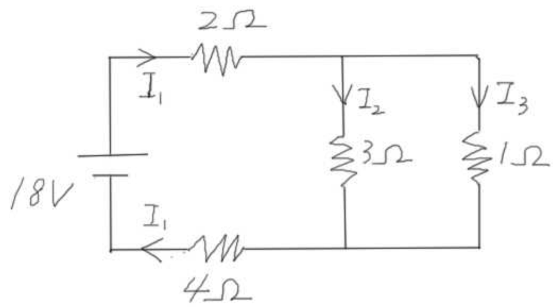
So the total power delivered is:

$$P = P_1 + P_2 + P_3 = 25W + 6.25W + 6.25W = 37.5W.$$

Another way to calculate the total power is to use the total current I_1 and the total resistance R:

$$P = I_1^2 R = (0.5A)^2 \times 150\Omega = 37.5W.$$

21.31



First, assume that the equivalent resistance of 3Ω and 1Ω is R_{eq}, then they satisfy:

$$\frac{1}{R_{eq}} = \frac{1}{3\Omega} + \frac{1}{1\Omega}, \tag{1}$$

so we can get $R_{eq} = 0.75\Omega$. So the total resistance of these four resistors is:

$$R = 2\Omega + 0.75\Omega + 4\Omega = 6.75\Omega. \tag{2}$$

So we can get the total current I_1:

$$I_1 = \frac{18V}{6.75\Omega} = 2.67A. \tag{3}$$

Then we need to calculate I_2 and I_3. First, according to conservation of charge, we have

$$I_1 = I_2 + I_3. \tag{4}$$

Then, because 3Ω and 1Ω are connected in parallel, so they have the same voltage:

$$\Delta V = 3\Omega \times I_2 = 1\Omega \times I_3. \tag{5}$$

From Eqn.(4)(5) we can get $I_2 = 0.67A$ and $I_3 = 2A$.
So for 2Ω:

$$P = I_1^2 \times 2\Omega = (2.67A)^2 \times 2\Omega = 14.3W. \tag{6}$$

For 4Ω:

$$P = I_1^2 \times 4\Omega = (2.67A)^2 \times 4\Omega = 28.6W. \tag{7}$$

For 3Ω:

$$P = I_2^2 \times 3\Omega = (0.67A)^2 \times 3\Omega = 1.35W. \tag{8}$$

For 1Ω:

$$P = I_3^2 \times 1\Omega = (2A)^2 \times 1\Omega = 4W. \tag{9}$$