In a copper wire, with $\rho = 1.7 \times 10^{-8}$ $\Omega\cdot$m, the electron density per unit volume is $8.48 \times 10^{28}$ per cubic meter. If the electron drift speed is 6 mm/s, what is the electric field in the copper wire?

A tungsten wire has a resistance of 19 Ohms at 20°C and a resistance of 140 Ohms at a much higher T. If the function $R(T)$ is linear over this range and $\alpha$ is 0.0045/K, what is the temperature T?

A 160 km long wire from a power plant carries a current of 1000 A at 200 kV. If the resistance of the wire is 0.31 $\Omega$/km, how much power is wasted by heating the wire?

A resistor dissipates 0.5 W at 3 V. How much will it dissipate at 1 V?
Solutions to current problems:

(1) We are given $v_d$, the resistivity $\rho$ and the density of charge carriers, $n$. In terms of the current density $j = I/A$ we can write $E = \rho j = \rho n q v_d$. Here $q$ is the magnitude of the electron charge. So putting in the given numbers, we find $E$ is 1.38 N/C.

(2) We are given the value of $\alpha$, the coefficient of thermal increase in resistance, for Tungsten. We are given the resistance for 20° C, and we are asked for the temperature when the resistance becomes 140 Ω. Since $R = R_0[1 + \alpha(\ell - T_0)]$, all we have to do is solve for $T = (1/\alpha)[(R/R_0) - 1] + T_0$, which gives 1435° C.

(3) We are given the current in a power line, and the resistance per unit length, $r$, as well as the length, $\ell$. Thus $P = I^2R = I^2r\ell$, and plugging in the supplied numbers we find the power lost is about $5 \times 10^7$ Watts.

(4) We are given the power dissipated in a resistor at 3 Volts PD and are asked, if the resistance does not change, what’s the power lost at 1 Volt?

Well, $P = I V = V^2/R$, so we have $P_f/P_i = (V_f^2/R)/(V_i^2/R) = (V_f/V_i)^2 = (1/3)^2 = 1/9$, so the answer is $P_f = P_i/9 = 0.056$ Watts.