AP Physics, Spring 2018
Current & Resistance Solution Set, Cha. 26 # 9,16,35,42,53
due Fri. 3/2

9. We use $v_d = J/ne = i/Ane$. Thus,

$$t = \frac{L}{v_d} = \frac{L}{i/Ane} = \frac{LAne}{i} = \frac{(0.85\,\text{m})\left(0.21\times10^{-14}\,\text{m}^2\right)\left(8.47\times10^{28}/\text{m}^3\right)\left(1.60\times10^{-19}\,\text{C}\right)}{300\,\text{A}}$$
$$= 8.1\times10^2\,\text{s} = 13\,\text{min}.$$

16. (a) $i = V/R = 23.0\ \text{V}/15.0 \times 10^{-3}\ \Omega = 1.53 \times 10^3\ \text{A}$.

(b) The cross-sectional area is $A = \pi r^2 = \frac{1}{4}\pi D^2$. Thus, the magnitude of the current density vector is

$$J = \frac{i}{A} = \frac{4i}{\pi D^2} = \frac{4\left(1.53\times10^{-3}\ \text{A}\right)}{\pi\left(6.00\times10^{-3}\ \text{m}\right)^2} = 5.41\times10^7\ \text{A}/\text{m}^2.$$

(c) The resistivity is

$$\rho = RA/L = \left(15.0\times10^{-3}\Omega\right)(\pi)\left(6.00\times10^{3}\ \text{m}\right)^2/[4(4.00\ \text{m})] = 10.6\times10^{-8}\ \Omega\cdot\text{m}.$$

(d) The material is platinum.

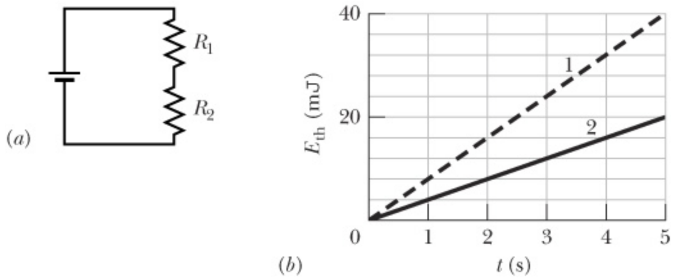
35. (a) Electrical energy is converted to heat at a rate given by

$$P = \frac{V^2}{R},$$

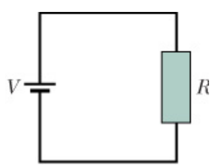
where V is the potential difference across the heater and R is the resistance of the heater. Thus,

$$P = \frac{(120\ \text{V})^2}{14\ \Omega} = 1.0\times10^3\ \text{W} = 1.0\ \text{kW}.$$

(b) The cost is given by $(1.0\,\text{kW})(5.0\,\text{h})(5.0\,\text{cents/kW}\cdot\text{h}) = \text{US\$}0.25$.



42. The slopes of the lines yield P_1 = 8 mW and P_2 = 4 mW. Their sum (by energy conservation) must be equal to that supplied by the battery: P_{batt} = (8 + 4) mW = 12 mW.



53. (a) Referring to Fig. 26-34, the electric field would point down (towards the bottom of the page) in the strip, which means the current density vector would point down, too (by Eq. 26-11). This implies (since electrons are negatively charged) that the conduction-electrons would be "drifting" upward in the strip.

(b) Eq. 24-6 immediately gives 12 eV, or (using $e = 1.60 \times 10^{-19}$ C) 1.9×10^{-18} J for the work done by the field (which equals, in magnitude, the potential energy change of the electron).

(c) Since the electrons don't (on average) gain kinetic energy as a result of this work done, it is generally dissipated as heat. The answer is as in part (b): 12 eV or 1.9×10^{-18} J.