2. The current in the circuit is

$$i = (150 \text{ V} - 50 \text{ V})/(3.0\ \Omega + 2.0\ \Omega) = 20 \text{ A}.$$

So from $V_Q + 150 \text{ V} - (2.0\ \Omega)i = V_P$, we get $V_Q = 100 \text{ V} + (2.0\ \Omega)(20 \text{ A}) - 150 \text{ V} = -10 \text{ V}$.

3. (a) The potential difference is $V = \varepsilon + ir = 12 \text{ V} + (50 \text{ A})(0.040\ \Omega) = 14 \text{ V}$.

(b) $P = i^2 r = (50 \text{ A})^2(0.040\ \Omega) = 1.0\times10^2 \text{ W}$.

(c) $P' = iV = (50 \text{ A})(12 \text{ V}) = 6.0\times10^2 \text{ W}$.

(d) In this case $V = \varepsilon - ir = 12 \text{ V} - (50 \text{ A})(0.040\ \Omega) = 10 \text{ V}$.

(e) $P_r = i^2 r = (50 \text{ A})^2(0.040\ \Omega) = 1.0\times10^2 \text{ W}$.

6. (a) The cost is $(100 \text{ W} \cdot 8.0 \text{ h}/2.0 \text{ W} \cdot \text{h})(\$0.80) = \$3.2 \times 10^2$.

(b) The cost is $(100 \text{ W} \cdot 8.0 \text{ h}/10^3 \text{ W} \cdot \text{h})(\$0.06) = \$0.048 = 4.8$ cents.

12. (a) For each wire, $R_{\text{wire}} = \rho L/A$ where $A = \pi r^2$. Consequently, we have

$$R_{\text{wire}} = (1.69 \times 10^{-8}\ \Omega\cdot\text{m})(0.200 \text{ m})/\pi(0.00100 \text{ m})^2 = 0.0011\ \Omega.$$

The total resistive load on the battery is therefore

$$R_{\text{tot}} = 2R_{\text{wire}} + R = 2(0.0011\ \Omega) + 6.00\ \Omega = 6.0022\ \Omega.$$

Dividing this into the battery emf gives the current

$$i = \frac{\varepsilon}{R_{\text{tot}}} = \frac{12.0 \text{ V}}{6.0022\Omega} = 1.9993 \text{ A}.$$

The voltage across the $R = 6.00\ \Omega$ resistor is therefore

$$V = iR = (1.9993 \text{ A})(6.00\ \Omega) = 11.996 \text{ V} \approx 12.0 \text{ V}.$$

(b) Similarly, we find the voltage-drop across each wire to be

$$V_{\text{wire}} = iR_{\text{wire}} = (1.9993 \text{ A})(0.0011\ \Omega) = 2.15 \text{ mV}.$$

(c) $P = i^2 R = (1.9993 \text{ A})(6.00\ \Omega)^2 = 23.98 \text{ W} \approx 24.0 \text{ W}$.

(d) Similarly, we find the power dissipated in each wire to be 4.30 mW.

16. (a) Let the emf of the solar cell be ε and the output voltage be V. Thus,

$$V = \varepsilon - ir = \varepsilon - \left(\frac{V}{R}\right) r$$

for both cases. Numerically, we get

$$0.10\text{ V} = \varepsilon - (0.10\text{ V}/500\ \Omega)r$$
$$0.15\text{ V} = \varepsilon - (0.15\text{ V}/1000\ \Omega)r.$$

We solve for ε and r.

(a) $r = 1.0\times10^3\ \Omega$.

(b) $\varepsilon = 0.30$ V.

(c) The efficiency is

$$\frac{V^2/R}{P_{\text{received}}} = \frac{0.15\text{V}}{(1000\Omega)\left(5.0\,\text{cm}^2\right)\left(2.0\times10^{-3}\,\text{W/cm}^2\right)} = 2.3\times10^{-3} = 0.23\%.$$