25.2

(a) $J = n v_d e$

$J = \frac{1}{A}\frac{Q}{t} = \frac{420\,C}{80\times 60\,s}\;\frac{1}{\pi(2.6\times10^{-3}\,m)^2}$

$= 4120.14\ C/m^2/s$

$I = JA = 0.088\ A$

(b) $v_d = \frac{J}{ne} = \frac{4120.14\ C/m^2/s}{(5.8\times10^{28}\ el/m^3)\times(1.60\times10^{-19}\ C/el)}$

$= 4.44\times10^{-7}\ m/s$

25.33

(a) With no current, the voltmeter reading is simply the battery's emf: $\mathcal{E} = 3.08\ V$.

(b) The voltage over the internal resistance is

$V_r = 3.08\,V - 2.97\,V = 0.11\ V$

$\Rightarrow r = \frac{V}{I} = \frac{0.11\,V}{1.65\,A} = 0.067\,\Omega$

(c) $V_R = 2.97\,V = (1.65\,A)R$

$R = \frac{2.97\,V}{1.65\,A} = 1.8\,\Omega$

**25.51**

(a) $I = \dfrac{V}{R} = \dfrac{12\,V}{6\,\Omega} = 2.0\,A$

$P = \varepsilon I = (12V)(2.0A) = 24\,W$

(b) Dissipated power is $P = I^2 r$

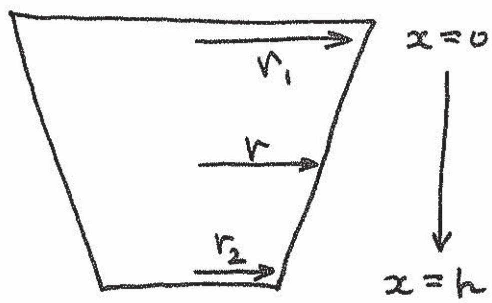
$= (2.0A)^2 (1.0\,\Omega)$

$= 4.0\,W$

(c) Delivered power is $24W - 4W = 20W$.

**25.65**

(a)




$$dR \left( = \frac{\rho L}{A} \right) = \frac{\rho\, dx}{\pi r^2} \quad \text{where} \quad r = r_1 - \left( \frac{r_1 - r_2}{h} \right) x$$

$$\therefore \; R = \int_0^h \frac{\rho\, dx}{\pi \left( r_1 - \left( \frac{r_1 - r_2}{h} \right) x \right)^2}$$

$$= -\frac{\rho h}{\pi (r_1 - r_2)} \int_{r_1}^{r_2} \frac{du}{u^2}$$

$$= \frac{\rho h}{\pi (r_1 - r_2)} \left[ \frac{1}{u} \right]_{r_1}^{r_2}$$

$$R = \frac{\rho h}{\pi} \left( \frac{1}{r_1 r_2} \right)$$

(b) When $r_1 = r_2$, and $r_1 \equiv r_2 \equiv r$,

$$R = \frac{\rho h}{\pi r^2} \left( = \frac{\rho L}{A} \right)$$

**25.68**

(a) $I = \frac{\Sigma \mathcal{E}}{\Sigma R} = \frac{8.0\text{ V} - 4.0\text{ V}}{24.0\ \Omega}$

$= 0.167\text{ A}$

$V_{ad} = 8.00\text{ V} - (0.167\text{ A})(8.50\ \Omega)$

$= 6.58\text{ V}$

(b) The terminal voltage is

$V_{bc} = +4.00\text{ V} + (0.167\text{ A})(0.50\ \Omega)$

$= +4.08\text{ V}$

(c) Adding another battery at point d in the opposite sense to the 8.0 V battery gives

$I = \frac{\Sigma \mathcal{E}}{\Sigma R} = \frac{10.3\text{ V} - 8.0\text{ V} + 4.0\text{ V}}{24.5\ \Omega}$

$= 0.257\text{ A}$

so $V_{bc} = 4.00\text{ V} - (0.257\text{ A})(0.50\ \Omega)$

$= 3.87\text{ V}.$

**25.80**

(a) $R_{steel} = \frac{\rho L}{A} = \frac{(2.0\times10^{-7}\ \Omega\cdot\text{m})(2.0\text{ m})}{(\pi/4)(0.018\text{ m})^2}$

$= 1.57\times10^{-3}\ \Omega$

$R_{Cu} = \frac{\rho L}{A} = \frac{(1.72\times10^{-8}\ \Omega\cdot\text{m})(35\text{ m})}{(\pi/4)(0.008\text{ m})^2}$

$= 0.012\ \Omega$

$V = IR = I(R_{steel} + R_{Cu})$

$= (15\,000\text{ A})(1.57\times10^{-3}\ \Omega + 0.012\ \Omega)$

$= 204\text{ V}$

(b) $E = Pt = I^2Rt = (15000\text{ A})^2(0.0136\ \Omega)(65\times10^{-6}\text{ s})$

$= 199\text{ J}.$