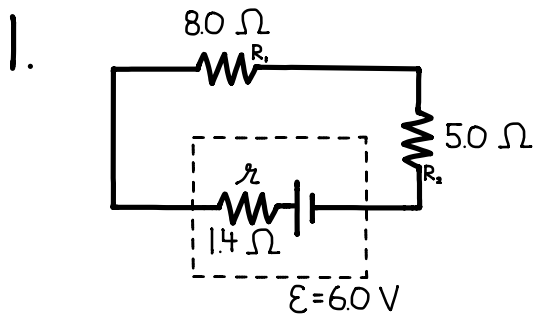


# TERMINAL VOLTAGE AND MORE - SOLUTIONS

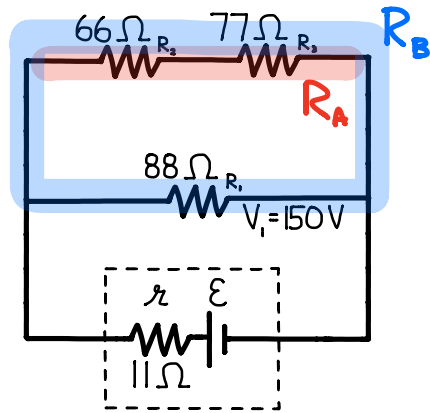


$$\begin{aligned}\textcircled{1} R_T &= r + R_1 + R_2 \\ &= 1.4 + 80 + 5.0 \\ &= 14.4\ \Omega\end{aligned}$$

$$\begin{aligned}\textcircled{2} V_T &= I_T R_T \\ I_T &= \frac{\mathcal{E}}{R_T} \\ &= \frac{6.0}{14.4} \\ &= 0.41\bar{6}\text{ A}\end{aligned}$$

$$\begin{aligned}\textcircled{3} V_{\text{TERMINAL}} &= \mathcal{E} - I_T r \\ &= 6.0 - (0.41\bar{6})(1.4) \\ &= 5.4\text{ V}\end{aligned}$$

2.



$$\begin{aligned} \textcircled{1} \quad R_A &= R_2 + R_3 \\ &= 66 + 77 \\ &= 143 \, \Omega \end{aligned}$$

$$\begin{aligned} \textcircled{2} \quad V_B &= V_1 = V_A \\ V_B &= 150 \text{ V} \\ V_A &= 150 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{3} \quad V_1 &= I_1 R_1 \\ I_1 &= \frac{V_1}{R_1} \\ &= \frac{150}{88} \\ &= 1.7045 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{4} \quad V_A &= I_A R_A \\ I_A &= \frac{V_A}{R_A} \\ &= \frac{150}{143} \\ &= 1.0450 \text{ A} \end{aligned}$$

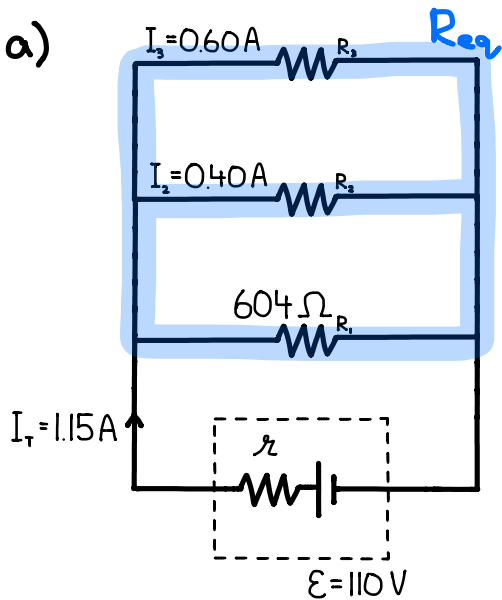
$$\begin{aligned} \textcircled{5} \quad I_B &= I_1 + I_A \\ &= 1.7045 + 1.0450 \\ &= 2.7535 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{6} \quad I_T &= I_r = I_B \\ I_r &= 2.7535 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{7} \quad V_r &= I_r r \\ &= (2.7535)(11) \\ &= 30.2885 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{8} \quad \mathcal{E} &= V_r + V_B \\ &= 30.2885 + 150 \\ &= 180 \text{ V} \end{aligned}$$

3. a)



$$\begin{aligned} \textcircled{1} \quad I_T &= I_1 + I_2 + I_3 \\ I_1 &= I_T - I_2 - I_3 \\ &= 1.15 - 0.40 - 0.60 \\ &= 0.15 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{2} \quad V_1 &= I_1 R_1 \\ &= (0.15)(604) \\ &= 90.6 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{3} \quad V_{eq} &= V_1 = V_2 = V_3 \\ V_{eq} &= 90.6 \text{ V} \end{aligned}$$

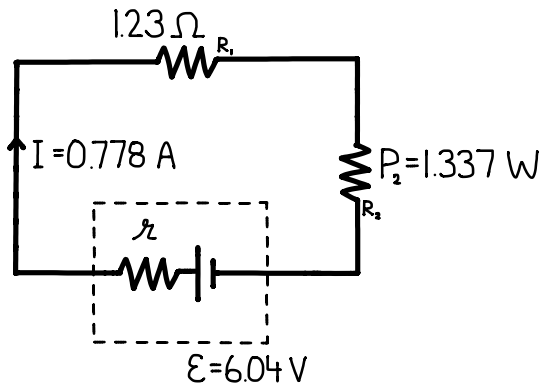
$$\begin{aligned} \textcircled{4} \quad V_T &= V_r + V_{eq} \\ V_r &= V_T - V_{eq} \\ &= 110 - 90.6 \\ &= 19.4 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{5} \quad I_T &= I_r = I_{eq} \\ I_r &= 1.15 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{6} \quad V_r &= I_r r \\ r &= \frac{V_r}{I_r} \\ &= \frac{19.4}{1.15} \\ &= 17 \Omega \end{aligned}$$

$$\begin{aligned} \text{b) } P_r &= I_r V_r \\ &= (1.15)(19.4) \\ &= 22 \text{ W} \end{aligned}$$

4.



$$\textcircled{1} \quad I_T = I_r = I_1 = I_2$$

$$I_r = 0.778 \text{ A}$$

$$I_1 = 0.778 \text{ A}$$

$$I_2 = 0.778 \text{ A}$$

$$\textcircled{2} \quad P_2 = I_2^2 R_2$$

$$R_2 = \frac{P_2}{I_2^2}$$

$$= \frac{1.337}{0.778^2}$$

$$= 2.2089 \Omega$$

$$\textcircled{3} \quad V_T = I_T R_T$$

$$R_T = \frac{V_T}{I_T}$$

$$= \frac{6.04}{0.778}$$

$$= 7.7635 \Omega$$

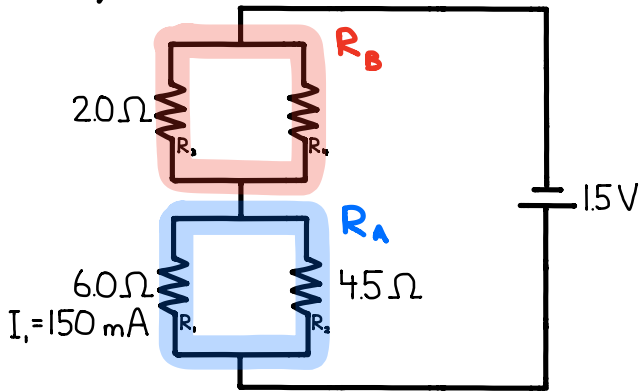
$$\textcircled{4} \quad R_T = r + R_1 + R_2$$

$$r = R_T - R_1 - R_2$$

$$= 7.7635 - 1.23 - 2.2089$$

$$= 4.32 \Omega$$

5. a)



$$\begin{aligned} \textcircled{1} \quad V_1 &= I_1 R_1 \\ &= (0.15)(6.0) \\ &= 0.90 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{2} \quad V_A &= V_1 = V_2 \\ V_A &= 0.90 \text{ V} \\ V_2 &= 0.90 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{3} \quad V_2 &= I_2 R_2 \\ I_2 &= \frac{V_2}{R_2} \\ &= \frac{0.90}{4.5} \\ &= 0.20 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{4} \quad V_T &= V_A + V_B \\ V_B &= V_T - V_A \\ &= 1.5 - 0.90 \\ &= 0.6 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{5} \quad V_B &= V_3 = V_4 \\ V_3 &= 0.6 \text{ V} \\ V_4 &= 0.6 \text{ V} \end{aligned}$$

$$\begin{aligned} \textcircled{6} \quad V_3 &= I_3 R_3 \\ I_3 &= \frac{V_3}{R_3} \\ &= \frac{0.6}{2.0} \\ &= 0.3 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{7} \quad I_A &= I_1 + I_2 \\ &= 0.15 + 0.20 \\ &= 0.35 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{8} \quad I_T &= I_A = I_B \\ I_B &= 0.35 \text{ A} \end{aligned}$$

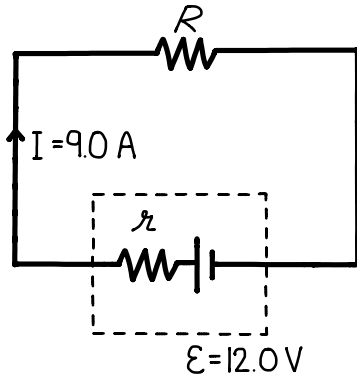
$$\begin{aligned} \textcircled{9} \quad I_B &= I_3 + I_4 \\ I_4 &= I_B - I_3 \\ &= 0.35 - 0.3 \\ &= 0.05 \text{ A} \end{aligned}$$

$$\begin{aligned} \textcircled{10} \quad I &= \frac{Q}{t} \quad 1 \text{ hour} = 3600 \text{ s} \\ Q &= I t \\ &= (0.05)(3600) \\ &= 180 \text{ C} \end{aligned}$$

$$\begin{aligned} \text{b) } P_4 &= I_4 V_4 \\ &= (0.05)(0.6) \\ &= 0.03 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{c) } P &= \frac{E}{t} \\ E &= Pt \\ &= (0.03)(3600) \\ &= 108 \text{ J} \end{aligned}$$

6.



$$R_T = R + r$$

$$V_T = I_T R_T$$

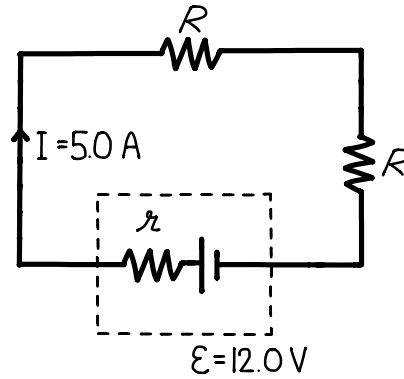
$$R_T = \frac{V_T}{I_T}$$

$$= \frac{12.0}{9.0}$$

$$= 1.\bar{33} \Omega$$

$$(R + r = 1.\bar{33}) \times 2$$

$$2R + 2r = 2.\bar{66}$$



$$R_T = 2R + r$$

$$V_T = I_T R_T$$

$$R_T = \frac{V_T}{I_T}$$

$$= \frac{12.0}{5.0}$$

$$= 2.4 \Omega$$

$$2R + r = 2.4$$

$$\begin{array}{r} 2R + 2r = 2.\bar{66} \\ -(2R + r = 2.4) \\ \hline r = 0.2\bar{6} \end{array}$$

$$\rightarrow 0.27 \Omega$$