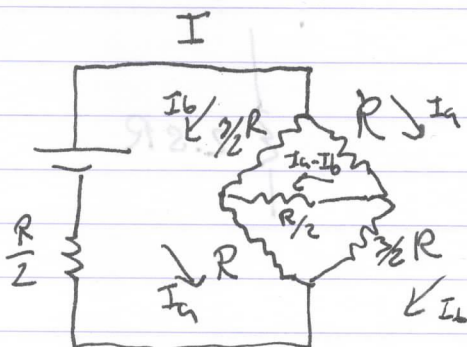Solutions to Practice Quiz 5

Problem 1

By symmetry the currents through Resistances R must be the same. Likewise for resistances $\frac{3R}{2}$. Also, $I = I_a + I_b$

We start doing loops.

$$\begin{cases} -I_b \frac{3}{2}R + \frac{R}{2}(I_a - I_b) + R I_a = 0 \\ -(I_b + I_a)\frac{R}{2} + \varepsilon - R I_a - R\frac{3}{2} I_b = 0 \end{cases}$$

$$\begin{cases} -2 I_b + I_a \frac{3}{2} = 0 \\ \frac{3}{2} I_a + 2 I_b = \frac{20}{R} = 2 \end{cases}$$
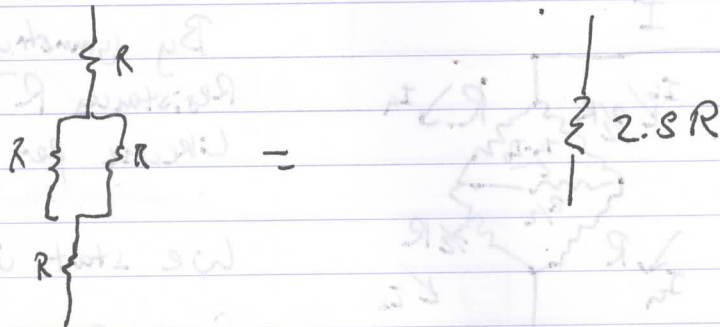
$$3 I_a = 2 \quad \to \quad I_a = \frac{2}{3} \text{ A}$$

$I_b = \frac{1}{2} \text{ A}$

(b) Power is additive. Compare loss vs. gain.

$$\varepsilon I \overset{?}{=} \frac{R}{2}(I_a + I_b)^2 + 2 \times \frac{3}{2}R I_b^2 + 2R I_a^2 + \frac{R}{2}(I_a - I_b)^2$$

$$\varepsilon I = (I_a^2 + I_b^2 + 3 I_b^2 + 2 I_a^2) = R(3(\frac{4}{9}) + 4(\frac{1}{4}))$$

$$20\frac{7}{6} = 10(\frac{4}{3} + \frac{3}{3}) = 10\frac{7}{3} \checkmark$$

Problem 2. Pick the loop that is all batterys
(plus the resistance you are interested in).

$$-\mathcal{E} + \mathcal{E} + \mathcal{E} - \mathcal{E} + \mathcal{E} - \mathcal{E} - \mathcal{E} - \mathcal{E} - \mathcal{E} - \mathcal{E} - i\,2.5R = 0$$

$$-4\mathcal{E} = i\,2.5R \quad \Rightarrow \quad i = \frac{4}{2.5}\,\frac{\mathcal{E}}{R} = \frac{4}{2.5}\,\frac{40}{4} = 4A$$

Problem 3.   S → students ?

$T_0 \rightarrow$ Teacher hi

$T_1 \rightarrow$ reader panel

$\dfrac{T_0}{S} = \dfrac{2}{25}$ $T_0 + 2 = \dfrac{3}{50}\,S$

$T_1 = T_0 + 2$ $T_0 = \dfrac{2}{25}\,S$

$\dfrac{T_1}{S} = \dfrac{3}{50}$ $\left(\dfrac{2}{25} + \dfrac{3}{50}\right)S = +2$

$$\boxed{S = \dfrac{+2}{\left(\dfrac{2}{25} - \dfrac{3}{50}\right)} = 100}$$