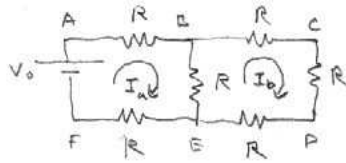


7.



$$\text{KVL: } \begin{cases} -V_0 + 2RI_a + R(I_a - I_b) = 0 & \text{2 eqs} \\ -V_0 + 2RI_a + 3RI_b = 0 & \text{2 unknowns} \end{cases}$$

$$\text{solve } i_a = \frac{4}{11} \frac{V_0}{R} \quad i_b = \frac{1}{11} \frac{V_0}{R}$$

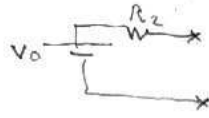
$$V_{AB} = V_{EF} = \frac{4}{11} V_0 \quad V_{BC} = \frac{1}{11} V_0 = V_{CD} = V_{DE} \quad V_{BE} = \frac{3}{11} \frac{V_0}{R}$$

$$I_{AB} = I_{FE} = \frac{4}{11} \frac{V_0}{R} \quad I_{BC} = I_{CD} = I_{DE} = \frac{1}{11} \frac{V_0}{R} \quad I_{BE} = \frac{3}{11} \frac{V_0}{R}$$

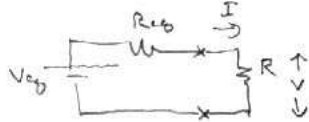
16.

1) open circuit voltage : $V_{oc} = V_0$

2) short battery : $R_{eq} = R_1 || 0 + R_2 = R_2$



17.

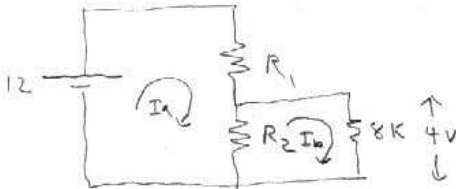


$$\text{KVL: } -V_{oc} + I R_{eq} + V = 0$$

$$\text{plugging in points } \begin{cases} (2I_b, V_b): -V_{oc} + 2I_b R_{eq} + V_b = 0 & \text{2 eqs in } \\ (I_b, 5V_b): -V_{oc} + I_b R_{eq} + 5V_b = 0 & \text{2 unknowns} \end{cases}$$

$$\text{solving } V_{oc} = 9V_b \quad R_{eq} = 4 \frac{V_b}{I_b}$$

20



$$I_b 8000 - 4 = 0$$

$$I_b = \frac{4}{8000} = 0.5 \text{ mA}$$

$$\text{KVL: } -12 + I_a R_1 + 4 = 0 \Rightarrow I_a = \frac{8}{R_1}$$

$$R_2 (I_a - I_b) - 4 = 0$$

plugging in I_a & I_b

$$R_2 \left(\frac{8}{R_1} - 0.0005 \right) = 4 \quad \text{or} \quad R_2 = \frac{4 R_1}{8 - 0.0005 R_1}$$

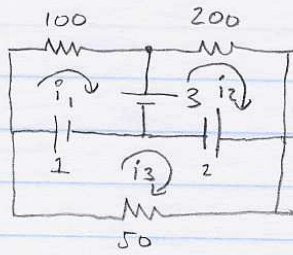
choice of R_1 arbitrary

$$\text{as } R_1 \rightarrow 0 \quad R_2 = \frac{1}{2} R_1$$

$$\text{let } R_1 = 1000 \Omega \Rightarrow R_2 = 50.3 \Omega$$

$$R_1 = 100 \Omega \Rightarrow R_2 = 50.03 \Omega$$

2)



$$\text{KVL: } 1-2 + 50 i_3 = 0 \Rightarrow i_3 = 0.02 \text{ A}$$

$$3-1 + 100 i_1 = 0 \Rightarrow i_1 = -0.02 \text{ A}$$

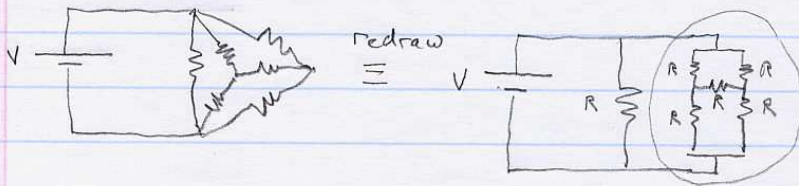
$$2-3 + 200 i_2 = 0 \Rightarrow i_2 = 0.005 \text{ A}$$

1V battery: $i_1 - i_3 = -0.04 \text{ A}$ charging

2V battery: $i_3 - i_2 = 0.015 \text{ A}$ discharging

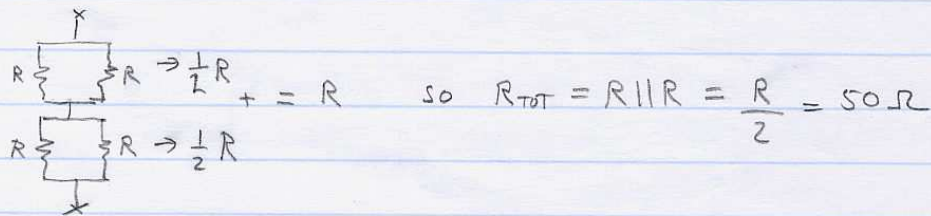
3V battery: $i_2 - i_1 = 0.025 \text{ A}$ discharging

3) Flatten and add voltage source

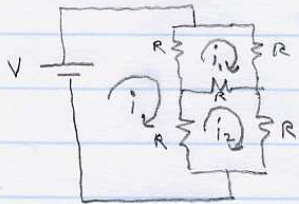


can find resistance of circled in 2 ways a) and b)

a) symmetry rotation about x-x changes nothing \Rightarrow current in horizontal resistor is zero (looks like conductor)



b) brute force



$$\begin{aligned} \text{KVL: } -V + R(2i - i_1 - i_2) &= 0 \quad (1) \\ R(3i_1 - i - i_2) &= 0 \quad (2) \\ R(3i_2 - i - i_1) &= 0 \quad (3) \end{aligned}$$

$$\begin{aligned} (2) - (3) &\Rightarrow i_1 - i_2 = 0 \Rightarrow i_1 = i_2 \text{ plug into (2)} \\ (2) \quad 3i_1 - i - i_2 &= 2i_1 - i = 0 \Rightarrow i = 2i_1 = 2i_2 \end{aligned}$$

$$\text{plug into (1)} \quad -V + R(2i - \frac{i}{2} - \frac{i}{2}) = -V + iR = 0$$

$$\text{so once again } R_{TOT} = R \parallel R = \frac{R}{2} = 50 \Omega$$