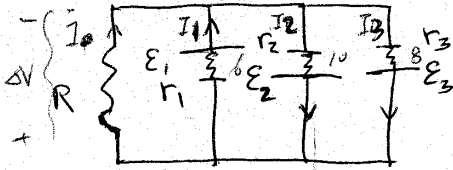


Pink

6. (20 pts) For the circuit below, take $\mathcal{E}_1 = 6 \text{ V}$, $\mathcal{E}_2 = 10 \text{ V}$, $\mathcal{E}_3 = 8 \text{ V}$, $r_1 = 0.02 \Omega$, $r_2 = 0.01 \Omega$, $r_3 = 0.02 \Omega$, $R = 0.04 \Omega$. (1) Indicate your definitions of the directions of positive currents and of the positive side of the voltage ΔV across R . (2) Analyze the circuit using Kirchhoff's rules. (3) Solve for the voltage across R . (4) Find the current through R and the currents provided by each of the batteries.



$$I_0 + I_{1\downarrow} = I_{2\downarrow} + I_{3\downarrow}$$

$$\frac{\Delta V}{R} + \mathcal{E}_1$$

$$-\mathcal{E}_1 + I_0 r_1 = I_0 R = \mathcal{E}_2 - I_2 r_2 - \mathcal{E}_3 - I_3 r_3$$

$$\frac{\Delta V}{R} + \frac{\mathcal{E}_1 + \Delta V}{r_1} = \frac{\mathcal{E}_2 - \Delta V}{r_2} + \frac{\mathcal{E}_3 - \Delta V}{r_3}$$

$$\Rightarrow \Delta V \left(\frac{1}{R} + \frac{1}{r_2} + \frac{1}{r_1} + \frac{1}{r_3} \right) = \frac{\mathcal{E}_2}{r_2} + \frac{\mathcal{E}_3}{r_3} - \frac{\mathcal{E}_1}{r_1}$$

$$\Rightarrow \Delta V (25 + 100 + 50 + 50) = 1000 + 400 - 300$$

$$\Rightarrow \Delta V = \frac{1100}{225} = 4.889 \text{ V}$$

$$I = \frac{\Delta V}{R} = 122.23 \text{ A}, I_1 = \frac{\mathcal{E}_1 + \Delta V}{r_1} = 544.45 \text{ A}, I_2 = \frac{\mathcal{E}_2 - \Delta V}{r_2} = 511.10 \text{ A}, I_3 = \frac{\mathcal{E}_3 - \Delta V}{r_3} = 155.55 \text{ A}$$

7. (15 pts) You are given 60 identical voltaic cells with 1.5 V emf and and 0.2 ohm internal resistance. Determine the maximum current that can be provided when these are connected so that they constitute an 18 V battery. Determine the effective internal resistance of this battery.

$$\frac{18}{1.5} = 12, \frac{60}{12} = 5$$

use 12 cells in series. Then use 4 sets of these in parallel

$$\text{For one cell } I_{\max} = \frac{1.5 \text{ V}}{0.2 \Omega} = 7.5 \text{ A}$$

$$\text{So the maximum current is } 5 I_{\max} = 37.5$$

effective internal resistance

$$r_{\text{eff}} = \frac{r \cdot 12}{5} = 0.48 \Omega$$