Unit Exam II: Problem #1 (Spring '18)

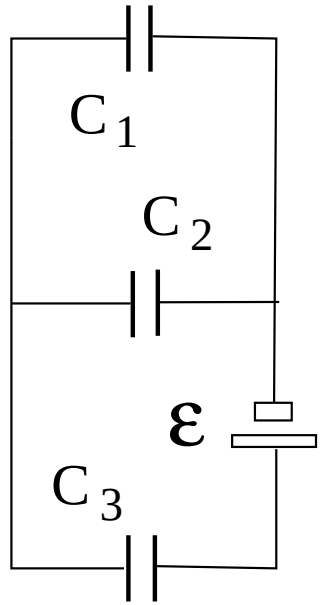
The circuit shown has reached equilibrium.
The specifications are $\mathcal{E} = 12$V [18V], $C_1 = C_2 = C_3 = 5$nF [4nF]

(a) Find the equivalent capacitance C_{eq}.

(b) Find the charge Q_2 on capacitor C_2.

(c) Find the voltage V_3 across capacitor C_3.

(d) Find the total energy U stored in the capacitors.



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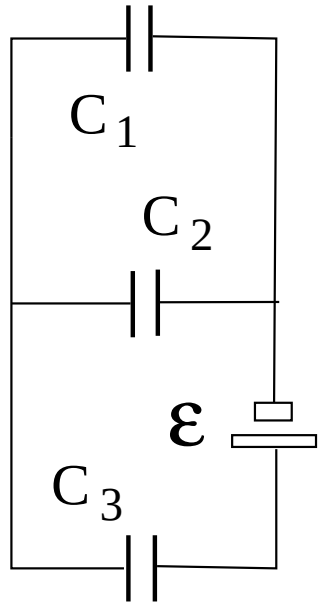


Solution:

(a) $C_{12} = C_1 + C_2 = 10\text{nF}$ [8nF].

$$C_{eq} = \left(\frac{1}{C_{12}} + \frac{1}{C_3}\right)^{-1} = \frac{10}{3}\text{nF}\left[\frac{8}{3}\text{nF}\right].$$

(b) $Q_3 = Q_{12} = \mathcal{E}C_{eq} = 40\text{nC}$ [48nC], $\quad Q_1 = Q_2 = \frac{1}{2}Q_{12} = 20\text{nC}$ [24nC].

(c) $V_3 = \frac{Q_3}{C_3} = 8\text{V}$ [12V], $\quad V_1 = V_2 = \frac{Q_1}{C_1} = \frac{Q_2}{C_2} = 4\text{V}$ [6V].

(d) $U = \frac{1}{2}C_{eq}\mathcal{E}^2 = 240\text{nJ}$ [432nJ].

Unit Exam II: Problem #2 (Spring '18)

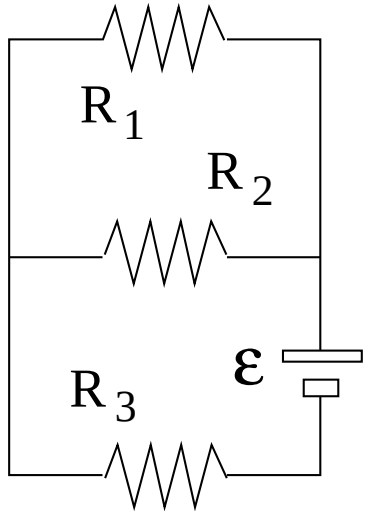
The circuit shown is in a steady state.
The specifications are $\mathcal{E} = 12\text{V}$ [18V], $R_1 = R_2 = R_3 = 5\Omega$ [4Ω].

(a) Find the equivalent resistance R_{eq}.

(b) Find the currents I_1 through resistor R_1.

(c) Find the voltage V_3 across resistor R_3.

(d) Find the power P produced by the battery.



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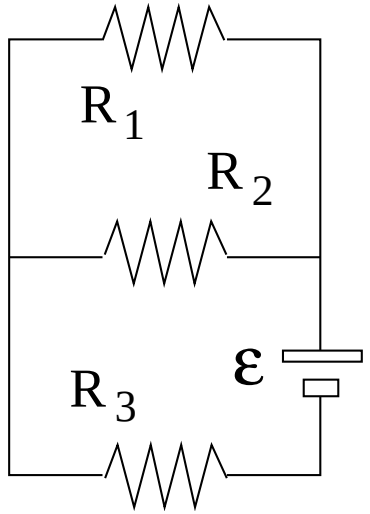


Solution:

(a) $R_{12} = \left(\dfrac{1}{R_1} + \dfrac{1}{R_3}\right)^{-1} = 2.5\Omega\ [2.0\Omega], \quad R_{eq} = R_{12} + R_3 = 7.5\Omega\ [6.0\Omega].$

(b) $I_3 = I_{12} = \dfrac{\mathcal{E}}{R_{eq}} = 1.6\text{A}\ [3.0\text{A}], \quad I_1 = I_2 = \dfrac{1}{2} I_{12} = 0.8\text{A}\ [1.5\text{A}].$

(c) $V_3 = R_3 I_3 = 8\text{V}\ [12\text{V}], \quad V_1 = V_2 = R_1 I_1 = R_2 I_2 = 4\text{V}\ [6\text{V}].$

(d) $P = \dfrac{\mathcal{E}^2}{R_{eq}} = R_{eq} I_3^2 = 19.2\text{W}\ [54.0\text{W}].$

Unit Exam II: Problem #3 (Spring '18)

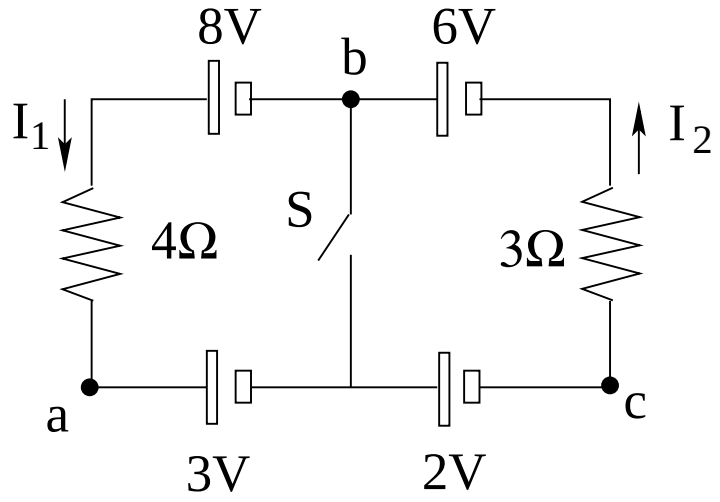
This circuit is in a steady state with the switch S either open or closed.

(a) Find the currents I_1 and I_2 when the switch is open.

(b) Find the currents I_1 and I_2 when the switch is closed.

(c) Find the voltages $V_a - V_b$ and $V_b - V_c$ when the switch is open.

(d) Find the voltages $V_a - V_b$ and $V_b - V_c$ when the switch is closed.



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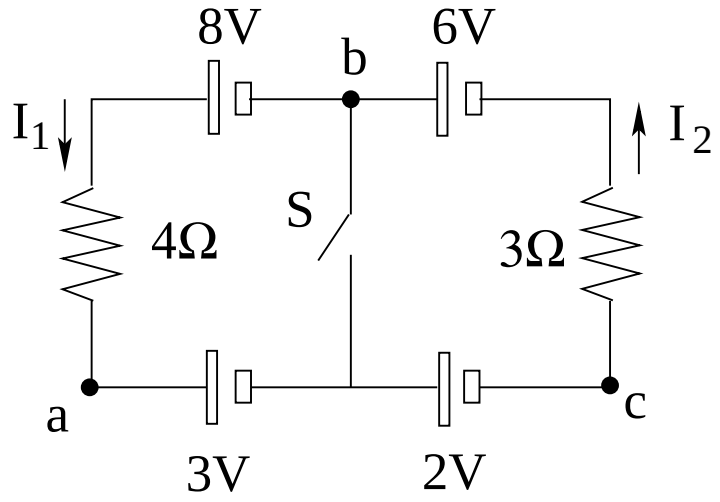

Solution:

(a) $I_1 = I_2 = \dfrac{6\text{V} + 8\text{V} - 3\text{V} - 2\text{V}}{3\Omega + 4\Omega} = \dfrac{9}{7}\text{A} = 1.29\text{A}.$

(b) $I_1 = \dfrac{8\text{V} - 3\text{V}}{4\Omega} = \dfrac{5}{4}\text{A} = 1.25\text{A}, \quad I_2 = \dfrac{6\text{V} - 2\text{V}}{3\Omega} = \dfrac{4}{3}\text{A} = 1.33\text{A}.$

(c) $V_a - V_b = 8\text{V} - (1.29\text{A})(4\Omega) = 2.84\text{V}, \quad V_b - V_c = 6\text{V} - (1.29\text{A})(3\Omega) = 2.13\text{V}.$

(d) $V_a - V_b = 3\text{V}, \quad V_b - V_c = 2\text{V}.$