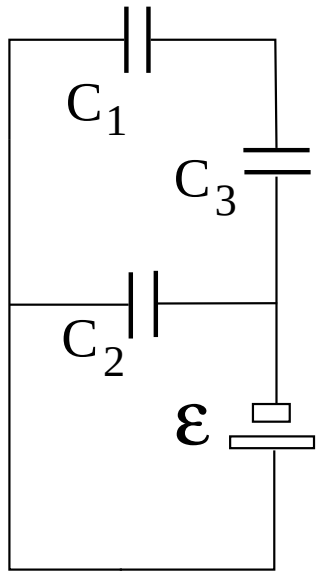
Unit Exam II: Problem #1 (Fall '18)

The circuit shown has reached equilibrium.
The specifications are $\mathcal{E} = 12$V [14V], $C_1 = C_2 = C_3 = 7$nF [5nF]

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

(b) Find the charges Q_1, Q_2, Q_3 on capacitors 1, 2, 3, respectively.

(c) Find the voltages V_1, V_2, V_3 across capacitors 1, 2, 3, respectively.



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

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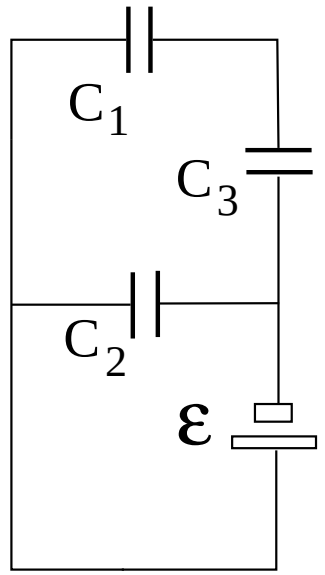


(a) Find the equivalent capacitance C_{eq}.

(b) Find the charges Q_1, Q_2, Q_3 on capacitors 1, 2, 3, respectively.

(c) Find the voltages V_1, V_2, V_3 across capacitors 1, 2, 3, respectively.

Solution:

(a) $C_{13} = \left(\frac{1}{C_1} + \frac{1}{C_3}\right)^{-1} = \frac{7}{2}\text{nF}\ \left[\frac{5}{2}\text{nF}\right].$

$C_{eq} = C_{13} + C_2 = \frac{21}{2}\text{nF}\ \left[\frac{15}{2}\text{nF}\right].$

(b) $Q_1 = Q_3 = \mathcal{E}C_{13} = 42\text{nC}\ [35\text{nC}], \quad Q_2 = \mathcal{E}C_2 = 84\text{nC}\ [70\text{nC}].$

(c) $V_1 = \frac{Q_1}{C_1} = 6\text{V}\ [7\text{V}], \quad V_2 = \frac{Q_2}{C_2} = 12\text{V}\ [14\text{V}], \quad V_3 = \frac{Q_3}{C_3} = 6\text{V}\ [7\text{V}].$

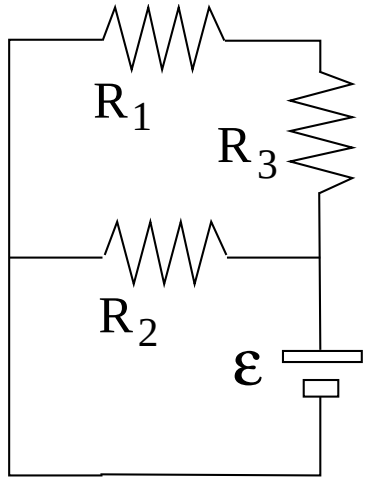
Unit Exam II: Problem #2 (Fall '18)

The circuit shown is in a steady state.
The specifications are $\mathcal{E} = 12\text{V}$ [14V], $R_1 = R_2 = R_3 = 7\Omega$ [5Ω].

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

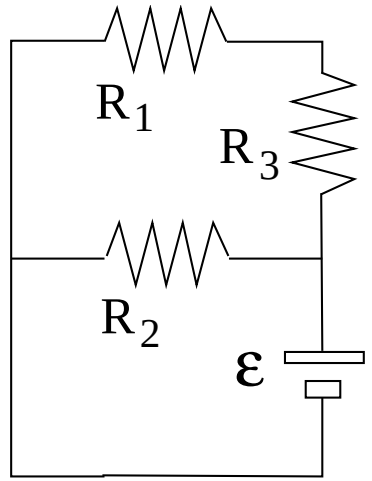
(b) Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.

(c) Find the voltages V_1, V_2, V_3 across resistors 1, 2, 3, respectively.



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

The circuit shown is in a steady state.
The specifications are $\mathcal{E} = 12\text{V}$ [14V], $R_1 = R_2 = R_3 = 7\Omega$ [5Ω].



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

(b) Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.

(c) Find the voltages V_1, V_2, V_3 across resistors 1, 2, 3, respectively.

Solution:

(a) $R_{13} = R_1 + R_3 = 14\Omega$ [10A], $\quad R_{eq} = \left(\dfrac{1}{R_{13}} + \dfrac{1}{R_2}\right)^{-1} = 4.67\Omega$ [3.33A].

(b) $I_1 = I_3 = \dfrac{\mathcal{E}}{R_{13}} = 0.857\text{A}$ [1.40A], $\quad I_2 = \dfrac{\mathcal{E}}{R_2} = 1.71\text{A}$ [2.80A].

(c) $V_1 = R_1 I_1 = 6\text{V}$ [7V], $\quad V_2 = R_2 I_2 = 12\text{V}$ [14V], $\quad V_3 = R_3 I_3 = 6\text{V}$ [7V].

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

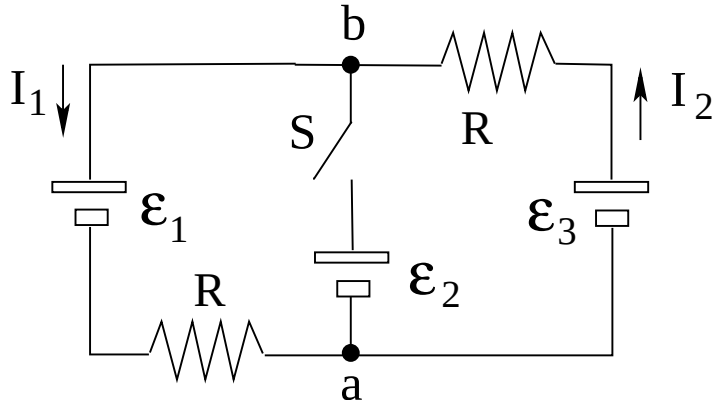
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4$V [3V], $\mathcal{E}_2 = 6$V [7V], $\mathcal{E}_3 = 10$V [9V], $R = 7\Omega$ [11Ω].

(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 $V_b - V_a$ when the switch is open.

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



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

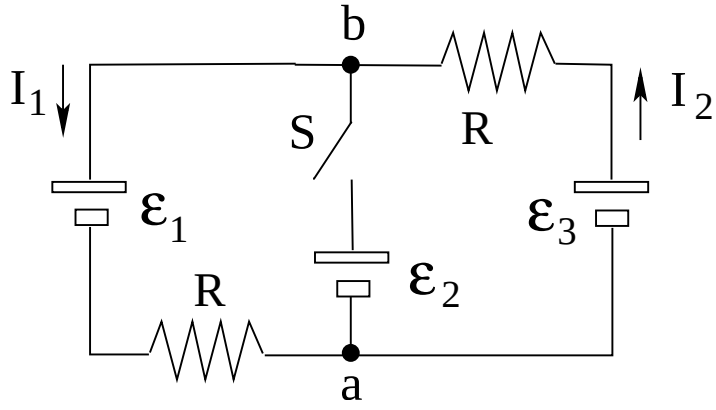
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4\text{V}$ [3V], $\mathcal{E}_2 = 6\text{V}$ [7V], $\mathcal{E}_3 = 10\text{V}$ [9V], $R = 7\Omega$ [11Ω].

(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 $V_b - V_a$ when the switch is open.

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



Solution:

(a) $I_1 = I_2 = \dfrac{10\text{V} - 4\text{V}}{7\Omega + 7\Omega} = 0.429\text{A}$

$\left[I_1 = I_2 = \dfrac{9\text{V} - 3\text{V}}{11\Omega + 11\Omega} = 0.273\text{A}\right]$

(b) $I_1 = \dfrac{6\text{V} - 4\text{V}}{7\Omega} = 0.286\text{A}, \quad I_2 = \dfrac{10\text{V} - 6\text{V}}{7\Omega} = 0.571\text{A}$

$\left[I_1 = \dfrac{7\text{V} - 3\text{V}}{11\Omega} = 0.364\text{A}, \quad I_2 = \dfrac{9\text{V} - 7\text{V}}{11\Omega} = 0.182\text{A}\right]$

(c) $V_b - V_a = (0.429\text{A})(7\Omega) + 4\text{V} = 10\text{V} - (0.429\text{A})(7\Omega) = 7\text{V}$
$[V_b - V_a = (0.273\text{A})(11\Omega) + 3\text{V} = 9\text{V} - (0.273\text{A})(11\Omega) = 6\text{V}]$

(d) $V_b - V_a = 6\text{V} \quad [V_b - V_a = 7\text{V}]$