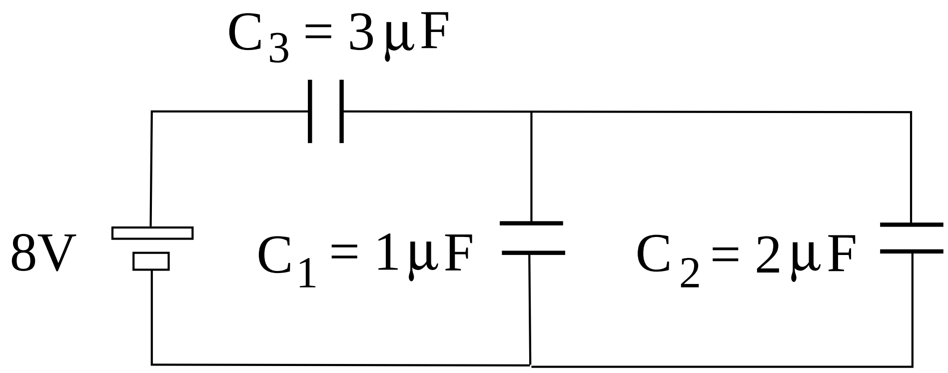
Intermediate Exam II: Problem #1 (Spring '05)

The circuit of capacitors connected to a battery is at equilibrium.

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

(b) Find the voltage V_3 across capacitor C_3.

(c) Find the the charge Q_2 on capacitor C_2.



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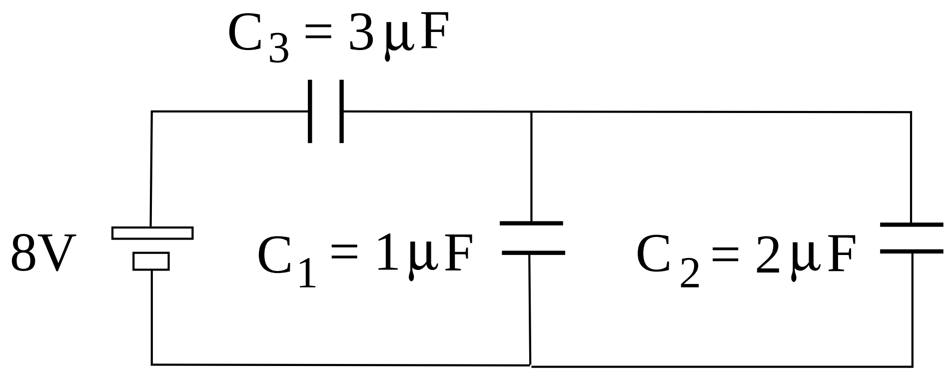


Solution:

(a) $C_{12} = C_1 + C_2 = 3\mu\text{F}, \quad C_{eq} = \left(\frac{1}{C_{12}} + \frac{1}{C_3}\right)^{-1} = 1.5\mu\text{F}.$

(b) $Q_3 = Q_{12} = Q_{eq} = C_{eq}(8\text{V}) = 12\mu\text{C}$

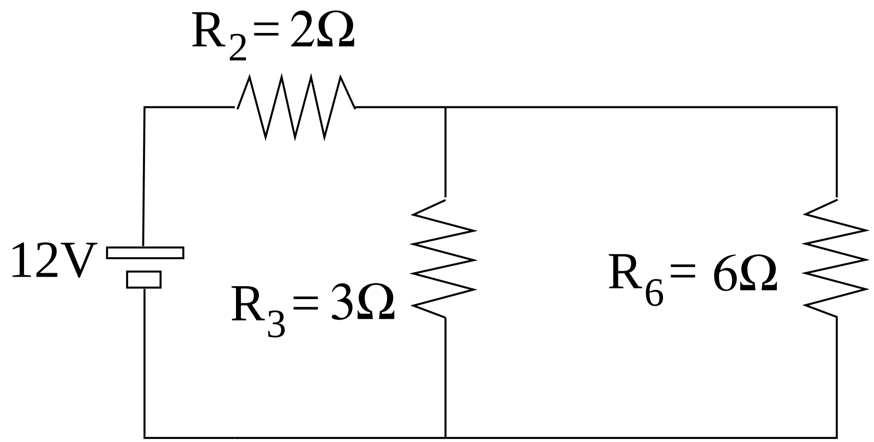
$\Rightarrow V_3 = \frac{Q_3}{C_3} = \frac{12\mu\text{C}}{3\mu\text{F}} = 4\text{V}.$

(c) $Q_2 = V_2 C_2 = 8\mu\text{C}.$

Consider the electrical circuit shown.

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

(b) Find the current I_3 through resistor R_3.

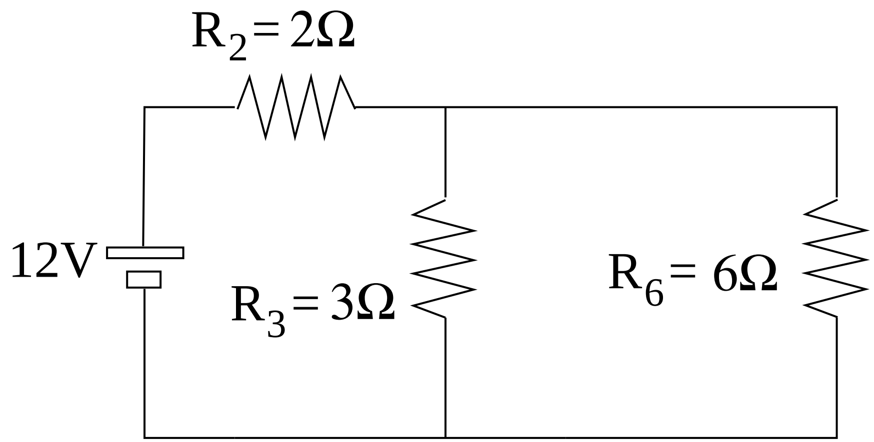


Intermediate Exam II: Problem #2 (Spring ’05)

Consider the electrical circuit shown.

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

(b) Find the current I_3 through resistor R_3.



Solution:

(a) $R_{36} = \left(\frac{1}{R_3} + \frac{1}{R_6}\right)^{-1} = 2\Omega, \quad R_{eq} = R_2 + R_{36} = 4\Omega.$

(b) $I_2 = I_{36} = \frac{12\text{V}}{R_{eq}} = 3\text{A}$

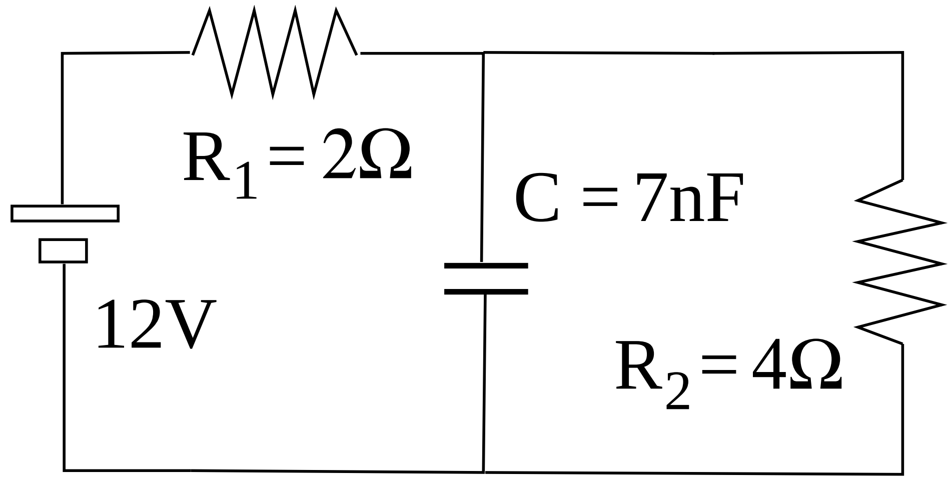
$\Rightarrow V_3 = V_{36} = I_{36}R_{36} = 6\text{V} \quad \Rightarrow I_3 = \frac{V_3}{R_3} = 2\text{A}.$

Intermediate Exam II: Problem #3 (Spring '05)

This RC circuit has been running for a long time.

(a) Find the current I_2 through the resistor R_2.

(b) Find the voltage V_C across the capacitor.



Intermediate Exam II: Problem #3 (Spring '05)

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(a) Find the current I_2 through the resistor R_2.

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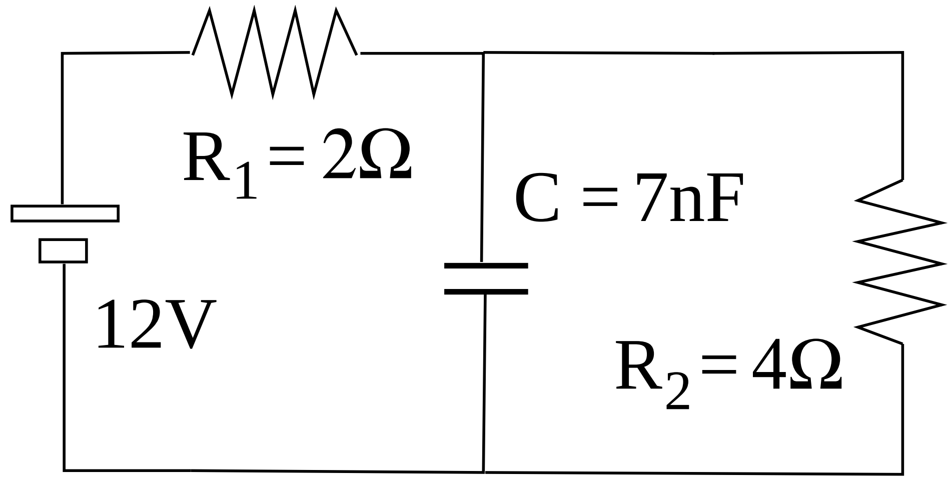


Solution:

(a) $I_C = 0, \quad I_2 = \dfrac{\mathcal{E}}{R_1 + R_2} = \dfrac{12\mathrm{V}}{6\Omega} = 2\mathrm{A}.$

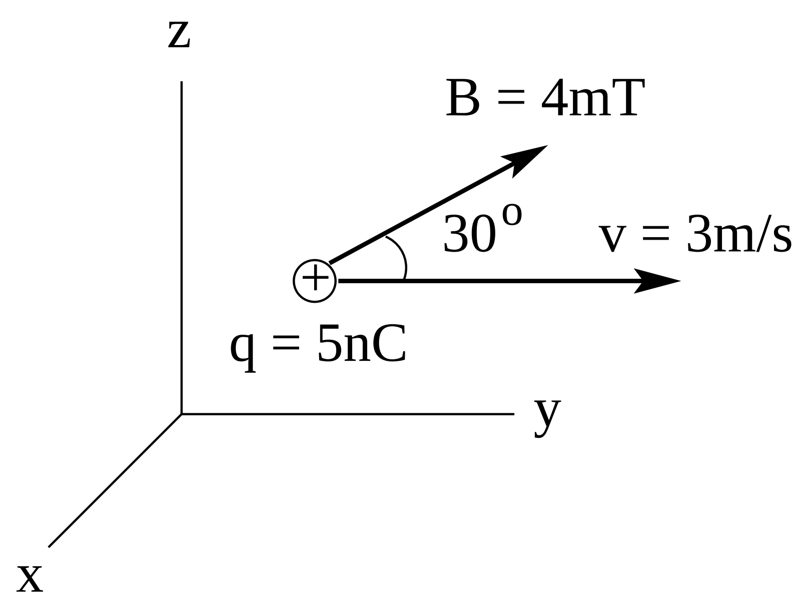
(b) $V_C = V_2 = I_2 R_2 = (2\mathrm{A})(4\Omega) = 8\mathrm{V}.$

Intermediate Exam II: Problem #4 (Spring '05)

Consider a charged particle moving in a uniform magnetic field as shown. The velocity is in y-direction and the magnetic field in the yz-plane at 30° from the y-direction.

(a) Find the direction of the magnetic force acting on the particle.

(b) Find the magnitude of the magnetic force acting on the particle.



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(a) Find the direction of the magnetic force acting on the particle.

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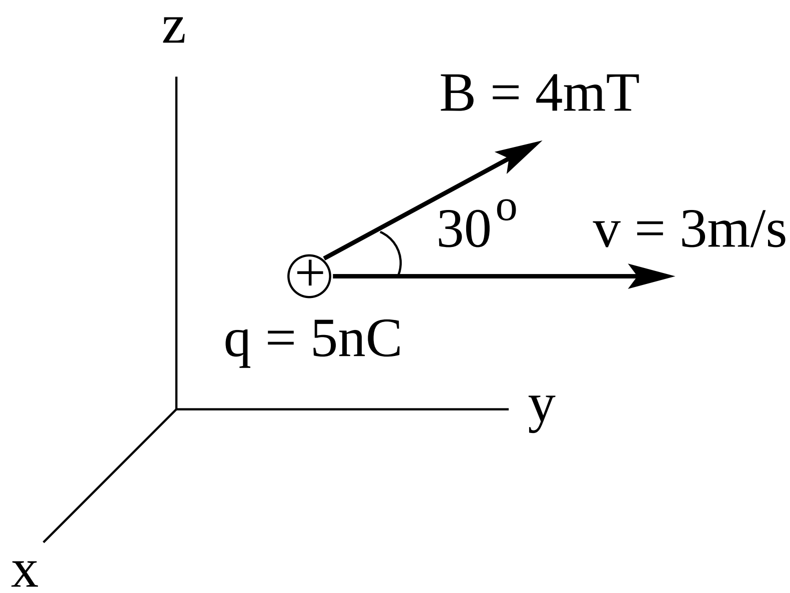


Solution:

(a) Use the right-hand rule: positive x-direction (front, out of page).

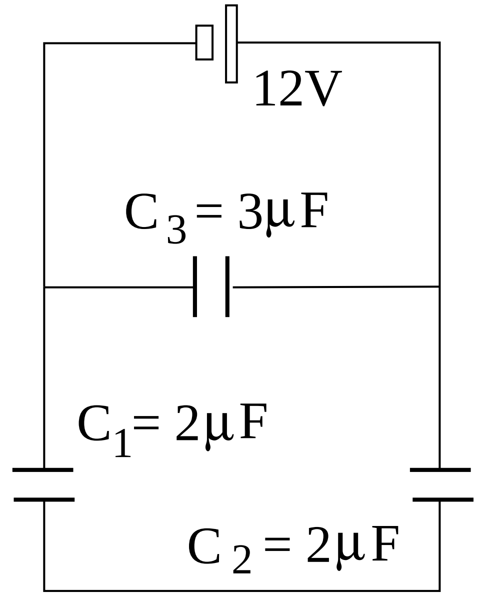
(b) $F = qvB\sin 30^\circ = (5 \times 10^{-9}\mathrm{C})(3\mathrm{m/s})(4 \times 10^{-3}\mathrm{T})(0.5) = 3 \times 10^{-11}\mathrm{N}.$

Intermediate Exam II: Problem #1 (Spring '06)

The circuit of capacitors connected to a battery is at equilibrium.

(a) Find the charge Q_3 on capacitor C_3.

(b) Find the charge Q_2 on capacitor C_2.

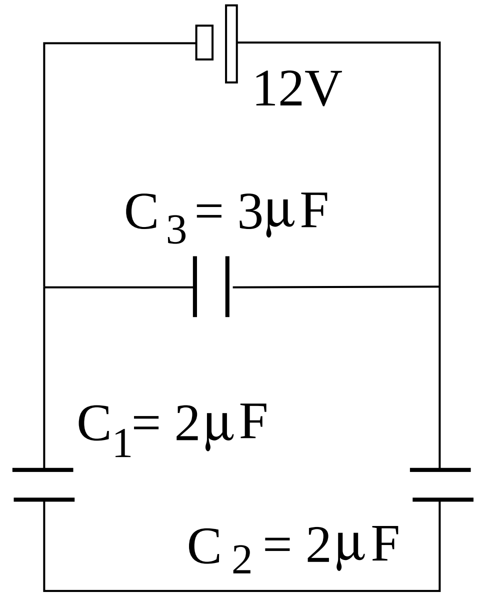


Intermediate Exam II: Problem #1 (Spring '06)

The circuit of capacitors connected to a battery is at equilibrium.

(a) Find the charge Q_3 on capacitor C_3.

(b) Find the charge Q_2 on capacitor C_2.



Solution:

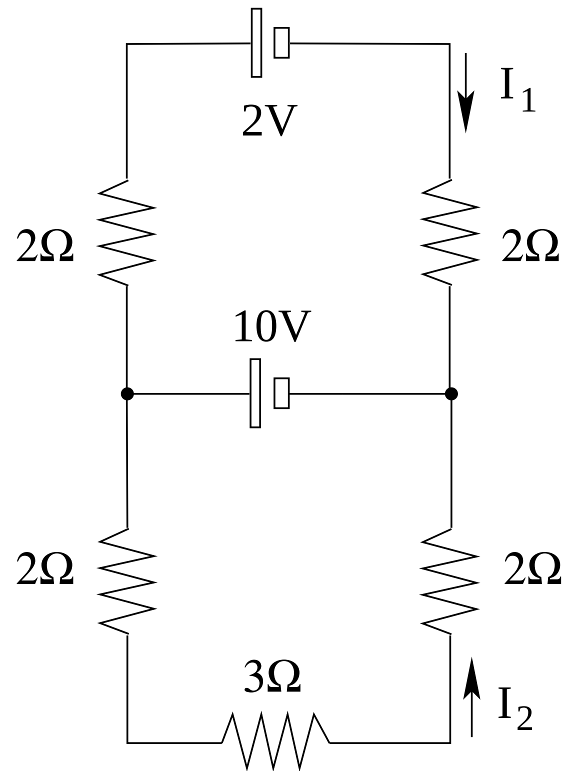
(a) $Q_3 = C_3(12\text{V}) = (3\mu\text{F})(12\text{V}) = 36\mu\text{C}$.

(b) $Q_2 = Q_{12} = C_{12}(12\text{V}) = (1\mu\text{F})(12\text{V}) = 12\mu\text{C}$.

Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.

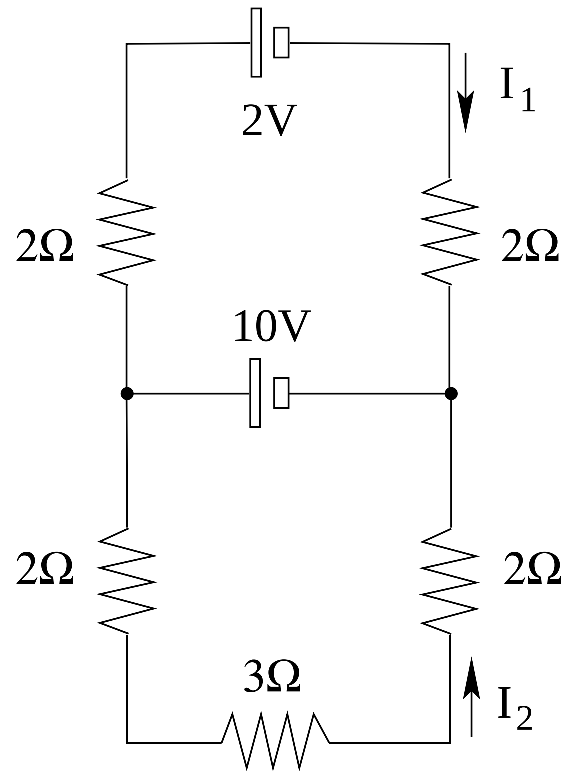


Intermediate Exam II: Problem #2 (Spring ’06)

Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.



Solution:

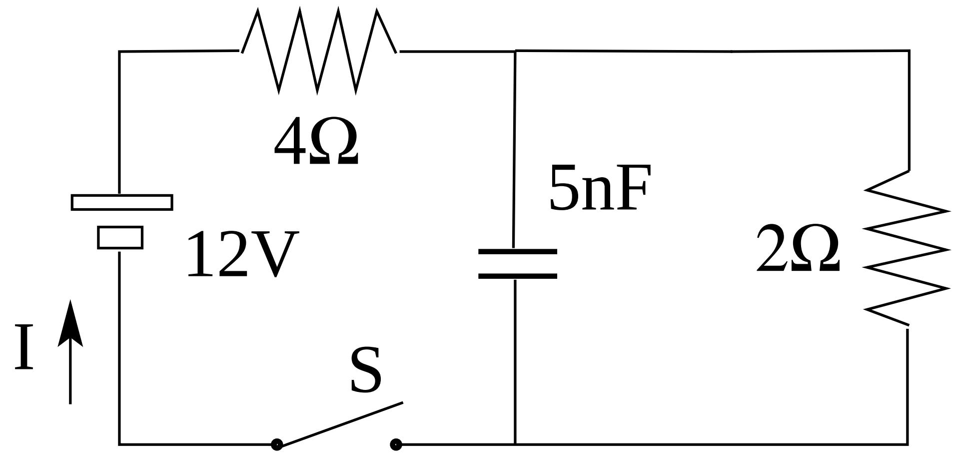
(a) $-(2\Omega)(I_1) + 10\text{V} - (2\Omega)(I_1) - 2\text{V} = 0 \quad \Rightarrow \; I_1 = \dfrac{8\text{V}}{4\Omega} = 2\text{A}.$

(b) $-(2\Omega)(I_2) + 10\text{V} - (2\Omega)(I_2) - (3\Omega)(I_2) = 0 \quad \Rightarrow \; I_2 = \dfrac{10\text{V}}{7\Omega} = 1.43\text{A}.$

In this RC circuit the switch S is initially open as shown.

(a) Find the current I right after the switch has been closed.

(b) Find the current I a very long time later.



Intermediate Exam II: Problem #3 (Spring '06)

In this RC circuit the switch S is initially open as shown.

(a) Find the current I right after the switch has been closed.

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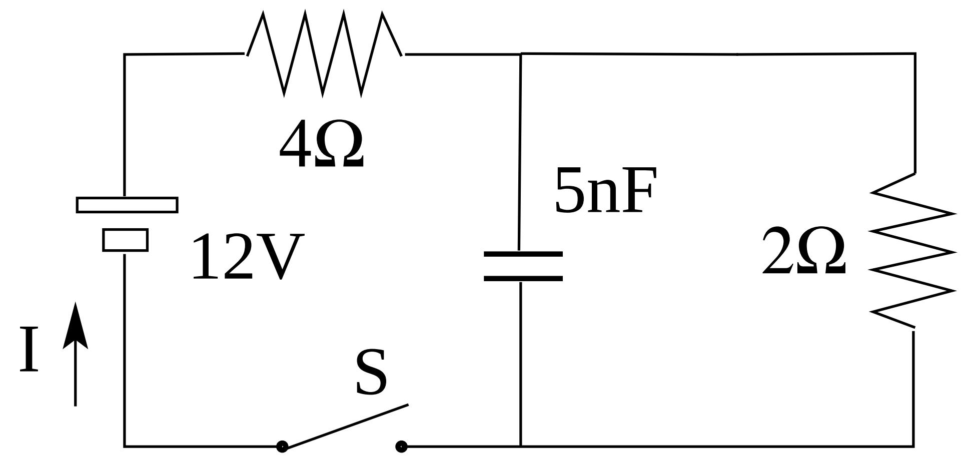


Solution:

(a) No current through 2Ω-resistor: $I = \dfrac{12\mathrm{V}}{4\Omega} = 3\mathrm{A}.$

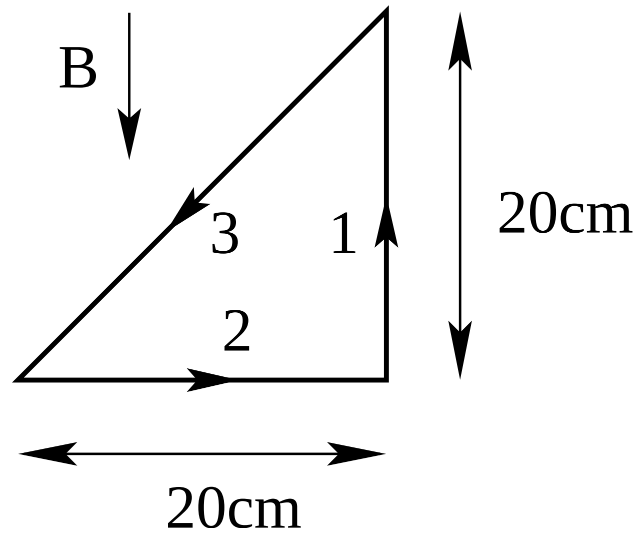
(b) No current through capacitor: $I = \dfrac{12\mathrm{V}}{6\Omega} = 2\mathrm{A}.$

Intermediate Exam II: Problem #4 (Spring '06)

A current loop in the form of a right triangle is placed in a uniform magnetic field of magnitude $B = 30$mT as shown. The current in the loop is $I = 0.4$A in the direction indicated.

(a) Find magnitude and direction of the force $\vec{F}_1$ on side 1 of the triangle.

(b) Find magnitude and direction of the force $\vec{F}_2$ on side 2 of the triangle.



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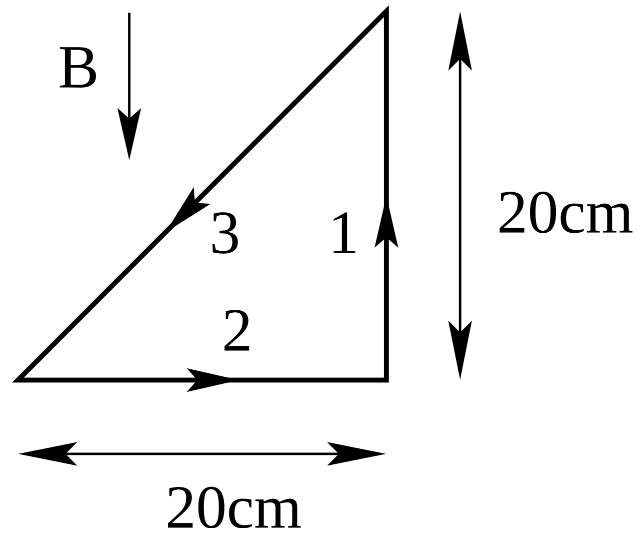
(b) Find magnitude and direction of the force $\vec{F}_2$ on side 2 of the triangle.



Solution:

(a) $\vec{F}_1 = I\vec{L} \times \vec{B} = 0$ (angle between $\vec{L}$ and $\vec{B}$ is $180°$).

(b) $F_2 = ILB = (0.4\text{A})(0.2\text{m})(30 \times 10^{-3}\text{T}) = 2.4 \times 10^{-3}\text{N}$.
Direction of $\vec{F}_2$: $\otimes$ (into plane).

Unit Exam II: Problem #1 (Spring ’07)

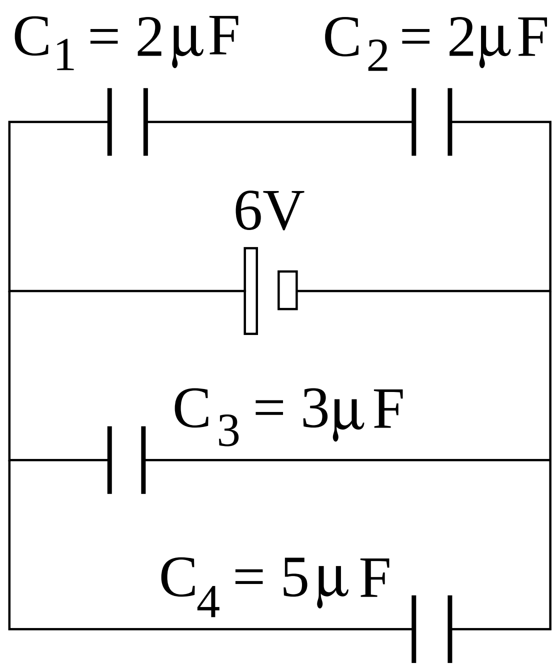
Consider the configuration of two point charges as shown.

(a) Find the energy U_3 stored on capacitor C_3.

(b) Find the voltage V_4 across capacitor C_4.

(c) Find the voltage V_2 across capacitor C_2.

(d) Find the charge Q_1 on capacitor C_1.



Unit Exam II: Problem #1 (Spring '07)

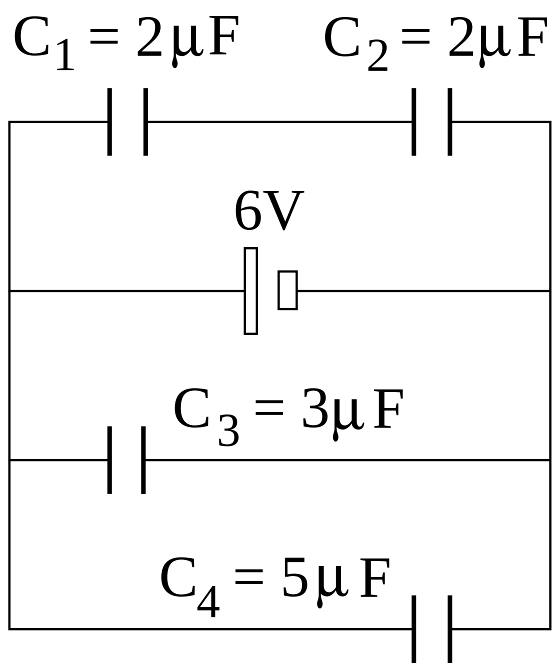
Consider the configuration of two point charges as shown.

(a) Find the energy U_3 stored on capacitor C_3.

(b) Find the voltage V_4 across capacitor C_4.

(c) Find the voltage V_2 across capacitor C_2.

(d) Find the charge Q_1 on capacitor C_1.



Solution:

(a) $U_3 = \frac{1}{2}(3\mu\text{F})(6\text{V})^2 = 54\mu\text{J}$.

(b) $V_4 = 6\text{V}$.

(c) $V_2 = \frac{1}{2}6\text{V} = 3\text{V}$.

(d) $Q_1 = (2\mu\text{F})(3\text{V}) = 6\mu\text{C}$.

Unit Exam II: Problem #2 (Spring ’07)

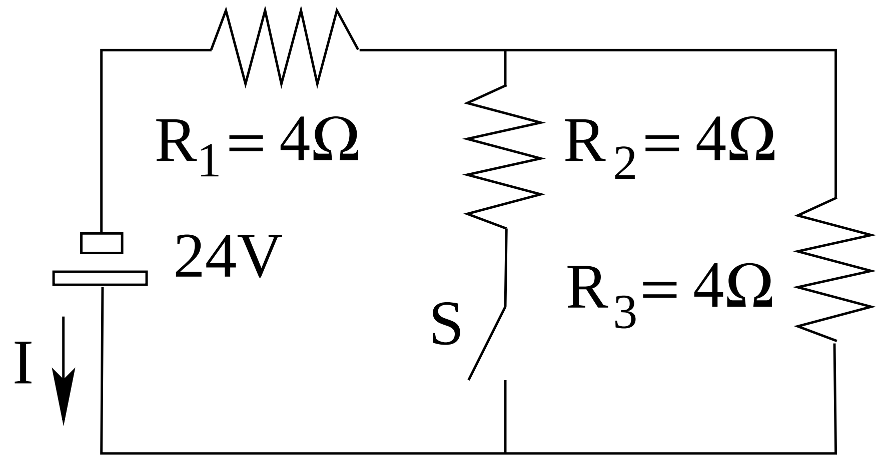
Consider the electric circuit shown.

(a) Find the current I when the switch S is open.

(b) Find the power P_3 dissipated in resisistor R_3 when the switch is open.

(c) Find the current I when the switch S is closed.

(d) Find the power P_3 dissipated in resisistor R_3 when the switch is closed.



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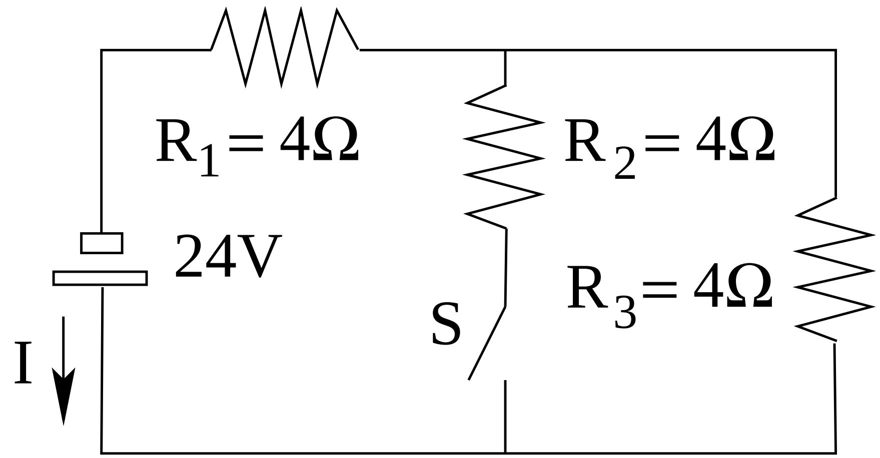
(d) Find the power P_3 dissipated in resisistor R_3 when the switch is closed.



Solution:

(a) $I = \dfrac{24\text{V}}{8\Omega} = 3\text{A}.$

(b) $P_3 = (3\text{A})^2(4\Omega) = 36\text{W}.$

(c) $I = \dfrac{24\text{V}}{6\Omega} = 4\text{A}.$

(d) $P_3 = (2\text{A})^2(4\Omega) = 16\text{W}.$

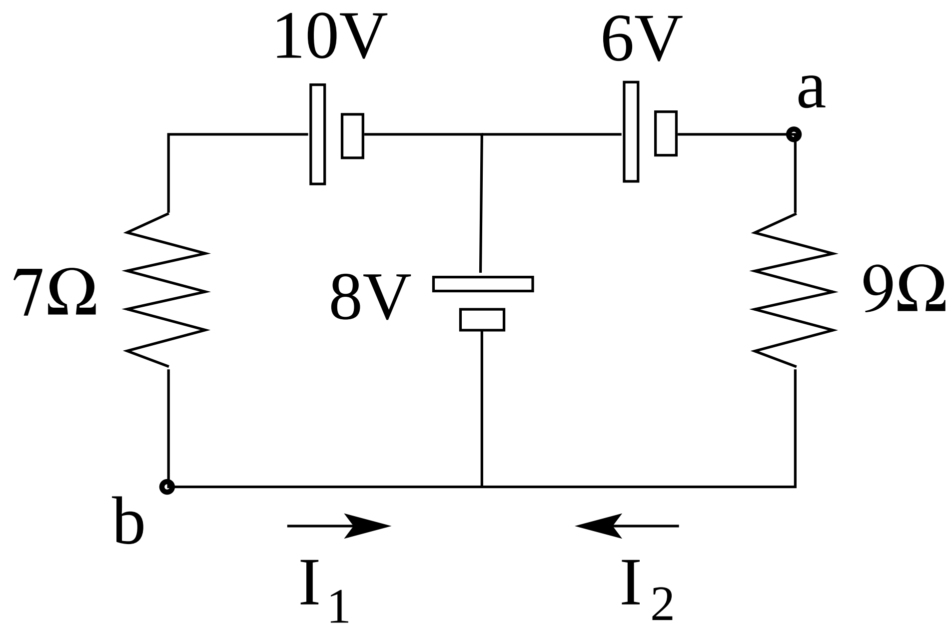
Unit Exam II: Problem #3 (Spring ’07)

Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.

(c) Find the potential difference $V_a - V_b$.

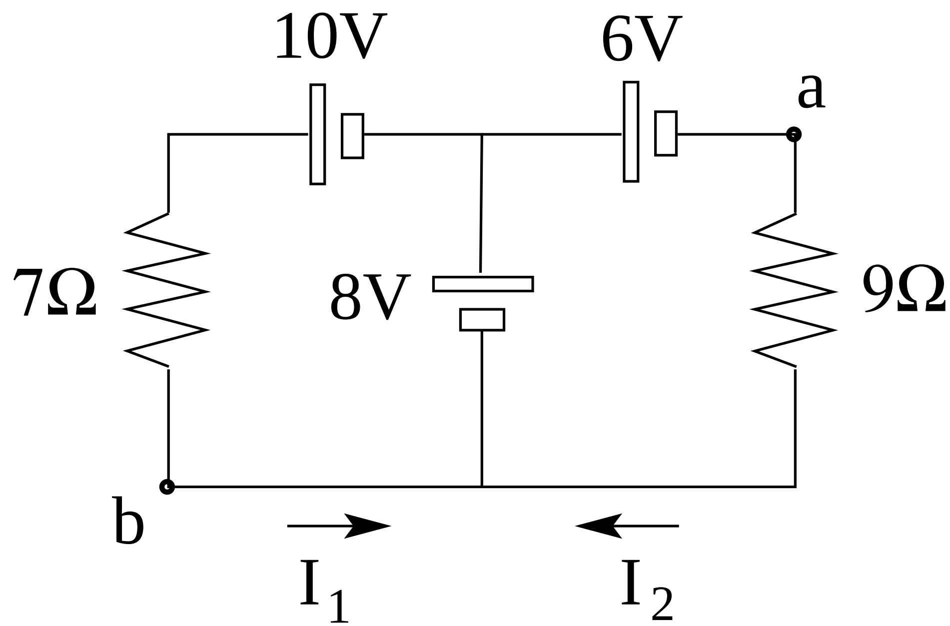


Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.

(c) Find the potential difference $V_a - V_b$.



Solution:

(a) $I_1 = \dfrac{8\text{V} + 10\text{V}}{7\Omega} = 2.57\text{A}.$

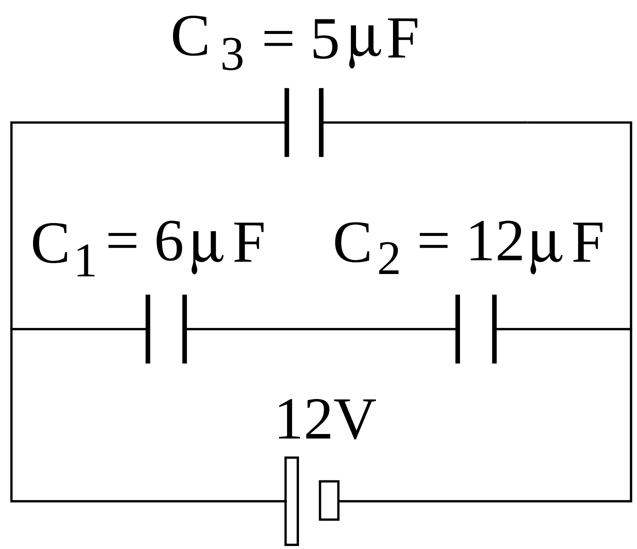
(b) $I_2 = \dfrac{8\text{V} - 6\text{V}}{9\Omega} = 0.22\text{A}.$

(c) $V_a - V_b = 8\text{V} - 6\text{V} = 2\text{V}.$

Unit Exam II: Problem #1 (Spring '08)

The circuit of capacitors is at equilibrium.

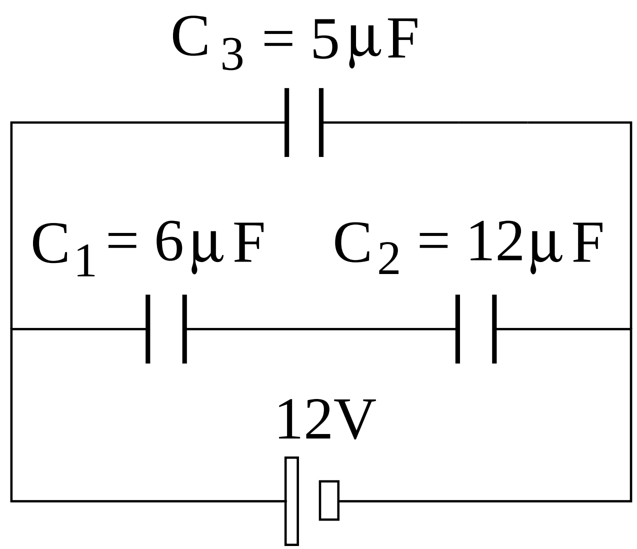
(a) Find the charge Q_1 on capacitor 1 and the charge Q_2 on capacitor 2.
(b) Find the voltage V_1 across capacitor 1 and the voltage V_2 across capacitor 2.
(c) Find the charge Q_3 and the energy U_3 on capacitor 3.



Unit Exam II: Problem #1 (Spring '08)

The circuit of capacitors is at equilibrium.

(a) Find the charge Q_1 on capacitor 1 and the charge Q_2 on capacitor 2.
(b) Find the voltage V_1 across capacitor 1 and the voltage V_2 across capacitor 2.
(c) Find the charge Q_3 and the energy U_3 on capacitor 3.



Solution:

(a) $C_{12} = \left(\frac{1}{6\mu\mathrm{F}} + \frac{1}{12\mu\mathrm{F}}\right)^{-1} = 4\mu\mathrm{F},$

$Q_1 = Q_2 = Q_{12} = (4\mu\mathrm{F})(12\mathrm{V}) = 48\mu\mathrm{C}.$

(b) $V_1 = \frac{Q_1}{C_1} = \frac{48\mu\mathrm{C}}{6\mu\mathrm{F}} = 8\mathrm{V},$

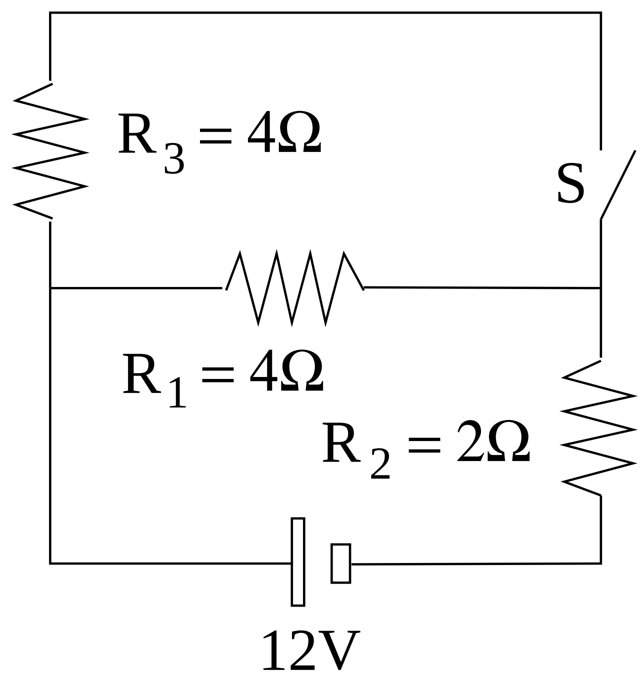
$V_2 = \frac{Q_2}{C_2} = \frac{48\mu\mathrm{C}}{12\mu\mathrm{F}} = 4\mathrm{V}.$

(c) $Q_3 = (5\mu\mathrm{F})(12\mathrm{V}) = 60\mu\mathrm{C},$

$U_3 = \frac{1}{2}(5\mu\mathrm{F})(12\mathrm{V})^2 = 360\mu\mathrm{J}.$

Consider the electric circuit shown. Find the current I_1 through resistor 1 and the voltage V_1 across it

(a) when the switch S is open,
(b) when the switch S is closed.
(c) Find the equivalent resistance R_{eq} of the circuit and the total power P dissipated in it when the switch S is closed.



Consider the electric circuit shown. Find the current I_1 through resistor 1 and the voltage V_1 across it

(a) when the switch S is open,
(b) when the switch S is closed.
(c) Find the equivalent resistance R_{eq} of the circuit and the total power P dissipated in it when the switch S is closed.

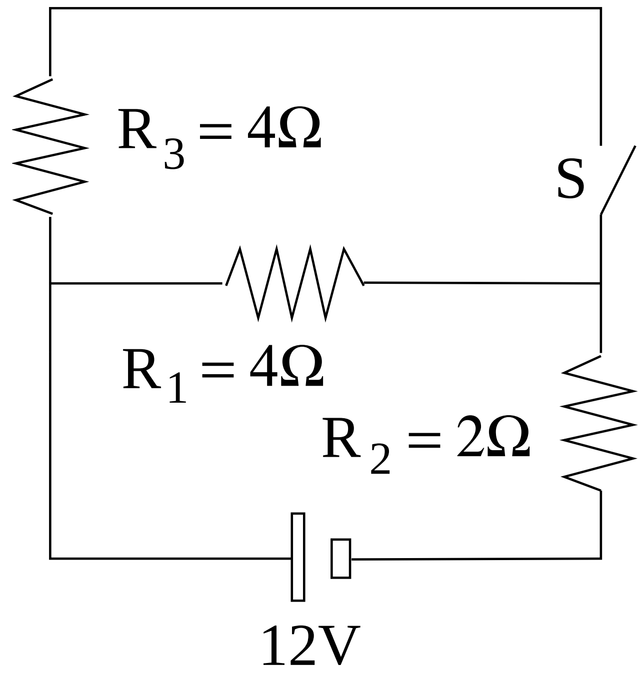
Solution:

(a) $I_1 = \dfrac{12\text{V}}{4\Omega + 2\Omega} = 2\text{A}, \quad V_1 = (4\Omega)(2\text{A}) = 8\text{V}.$

(b) $I_1 = \dfrac{1}{2}\,\dfrac{12\text{V}}{2\Omega + 2\Omega} = 1.5\text{A}, \quad V_1 = (4\Omega)(1.5\text{A}) = 6\text{V}.$

(c) $R_{eq} = \left(\dfrac{1}{4\Omega} + \dfrac{1}{4\Omega}\right)^{-1} + 2\Omega = 4\Omega,$

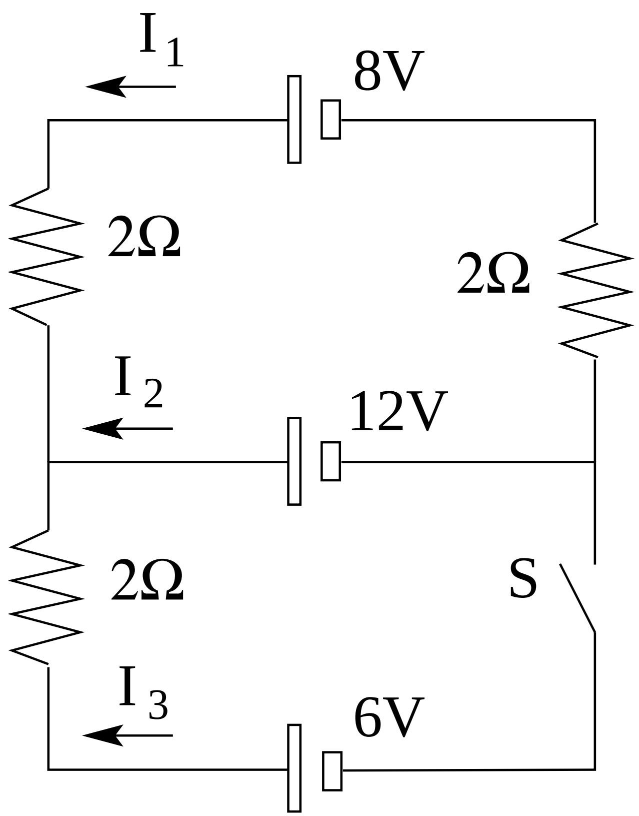
$P = \dfrac{(12\text{V})^2}{4\Omega} = 36\text{W}.$



Consider the electric circuit shown. Find the currents I_1, I_2, and I_3

(a) with the switch S open,

(b) with the switch S closed.



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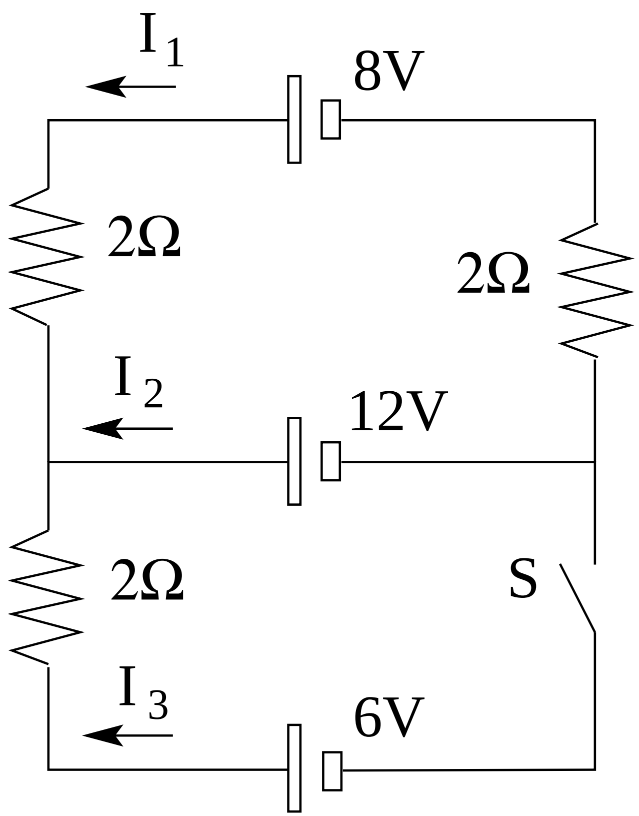
(a) with the switch S open,

(b) with the switch S closed.



Solution:

(a) $I_1 = \dfrac{8\text{V} - 12\text{V}}{4\Omega} = -1\text{A},$

$I_2 = -I_1 = +1\text{A}.$

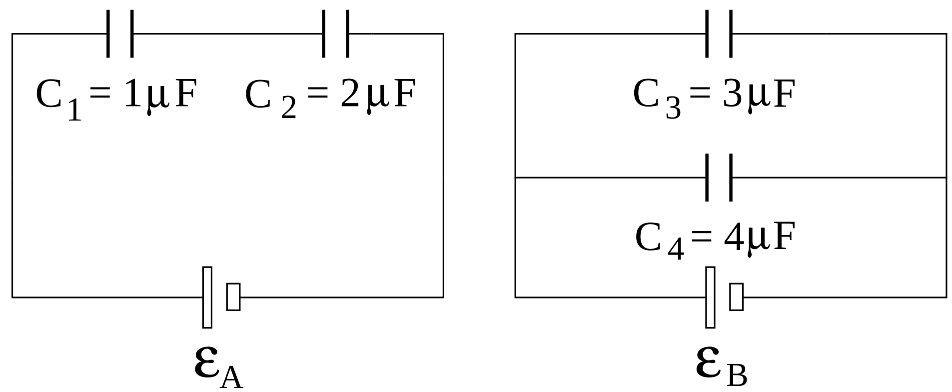
$I_3 = 0.$

(b) $I_1 = \dfrac{8\text{V} - 12\text{V}}{4\Omega} = -1\text{A},$

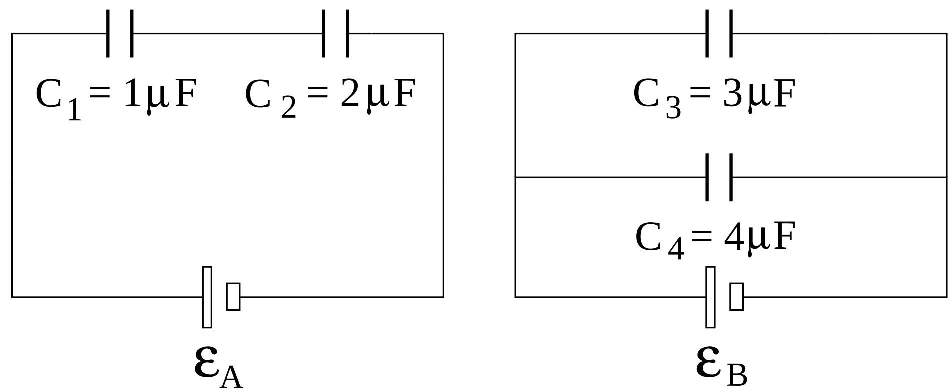
$I_3 = \dfrac{6\text{V} - 12\text{V}}{2\Omega} = -3\text{A}.$

$I_2 = -I_1 - I_3 = +4\text{A}.$

Both capacitor circuits are at equilibrium.
(a) In the circuit on the left, the voltage across capacitor 1 is $V_1 = 8\mathrm{V}$. Find the charge Q_1 on capacitor 1, the charge Q_2 on capacitor 2, and the voltage V_2 across capacitor 2. Find the emf $\mathcal{E}_A$ supplied by the battery.
(b) In the circuit on the right, the charge on capacitor 3 is $Q_3 = 6\mu\mathrm{C}$. Find the voltage V_3 across capacitor 3, the voltage V_4 across capacitor 4, and the charge Q_4 on capacitor 4. Find the emf $\mathcal{E}_B$ supplied by the battery.



Both capacitor circuits are at equilibrium.
(a) In the circuit on the left, the voltage across capacitor 1 is $V_1 = 8\text{V}$. Find the charge Q_1 on capacitor 1, the charge Q_2 on capacitor 2, and the voltage V_2 across capacitor 2. Find the emf $\mathcal{E}_A$ supplied by the battery.
(b) In the circuit on the right, the charge on capacitor 3 is $Q_3 = 6\mu\text{C}$. Find the voltage V_3 across capacitor 3, the voltage V_4 across capacitor 4, and the charge Q_4 on capacitor 4. Find the emf $\mathcal{E}_B$ supplied by the battery.



Solution:

(a) $Q_1 = (1\mu\text{F})(8\text{V}) = 8\mu\text{C}, \qquad Q_2 = Q_1 = 8\mu\text{C},$

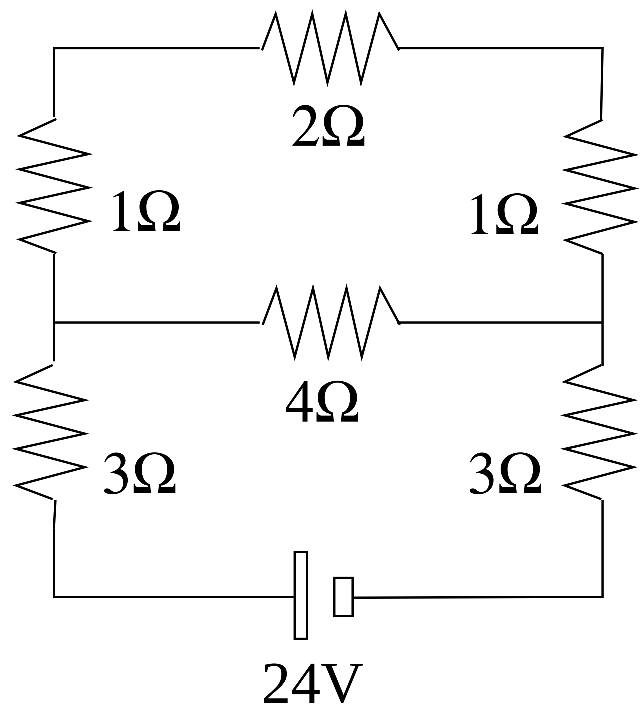
$$V_2 = \frac{8\mu\text{C}}{2\mu\text{F}} = 4\text{V}, \qquad \mathcal{E}_A = 8\text{V} + 4\text{V} = 12\text{V}.$$

(b) $V_3 = \dfrac{6\mu\text{C}}{3\mu\text{F}} = 2\text{V}, \qquad V_4 = V_3 = 2\text{V},$

$$Q_4 = (2\text{V})(4\mu\text{F}) = 8\mu\text{C}, \qquad \mathcal{E}_B = V_3 = V_4 = 2\text{V}.$$

Unit Exam II: Problem #2 (Spring ’09)

Consider the resistor circuit shown.
(a) Find the equivalent resistance R_{eq}.
(b) Find the power P supplied by the battery.
(c) Find the current I_4 through the 4Ω-resistor.
(d) Find the voltage V_2 across the 2Ω-resistor.



Unit Exam II: Problem #2 (Spring '09)

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(a) Find the equivalent resistance R_{eq}.
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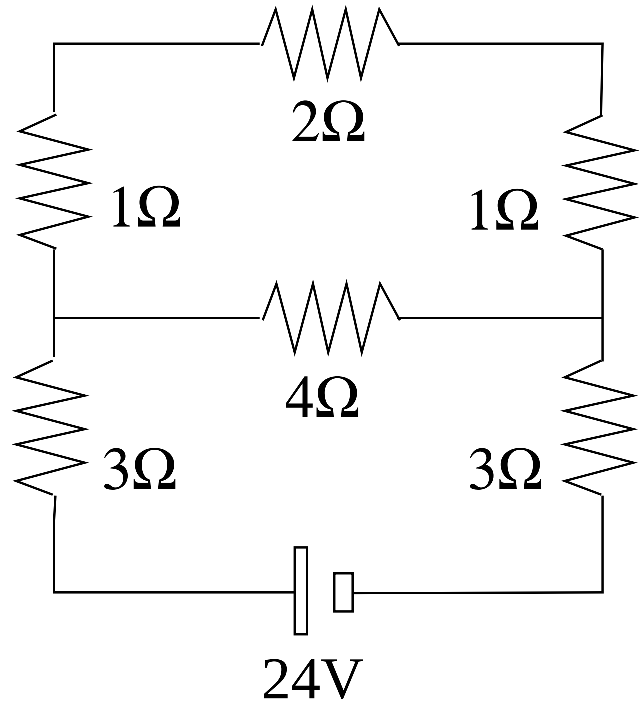
(c) Find the current I_4 through the 4Ω-resistor.
(d) Find the voltage V_2 across the 2Ω-resistor.



Solution:

(a) $R_{eq} = 8\Omega.$

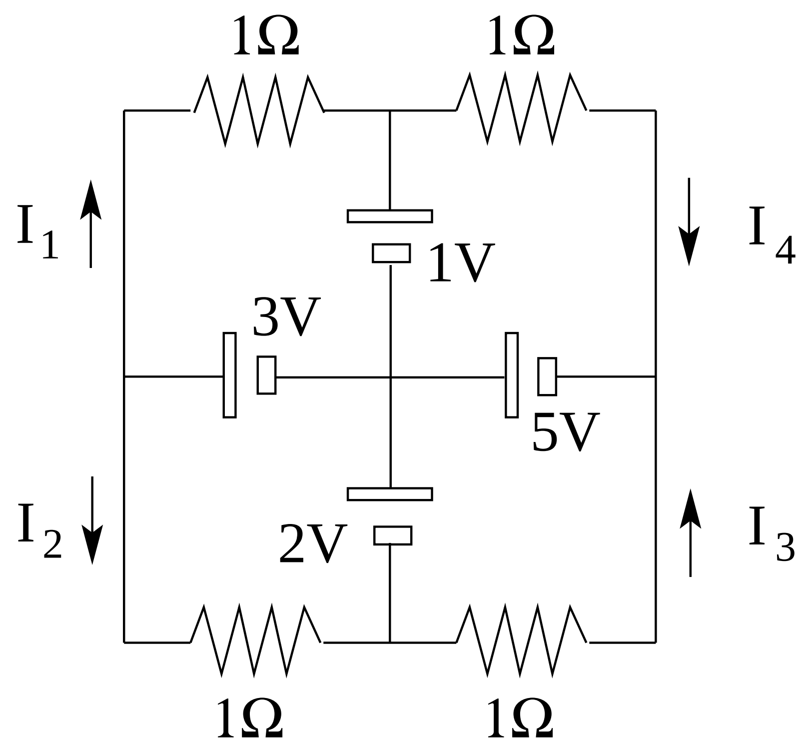
(b) $P = \dfrac{(24\text{V})^2}{8\Omega} = 72\text{W}.$

(c) $I_4 = \dfrac{1}{2}\dfrac{24\text{V}}{8\Omega} = 1.5\text{A}.$

(d) $V_2 = (1.5\text{A})(2\Omega) = 3\text{V}.$

Unit Exam II: Problem #3 (Spring ’09)

Consider the electric circuit shown.
Find the currents I_1, I_2, I_3, and I_4.



Unit Exam II: Problem #3 (Spring '09)

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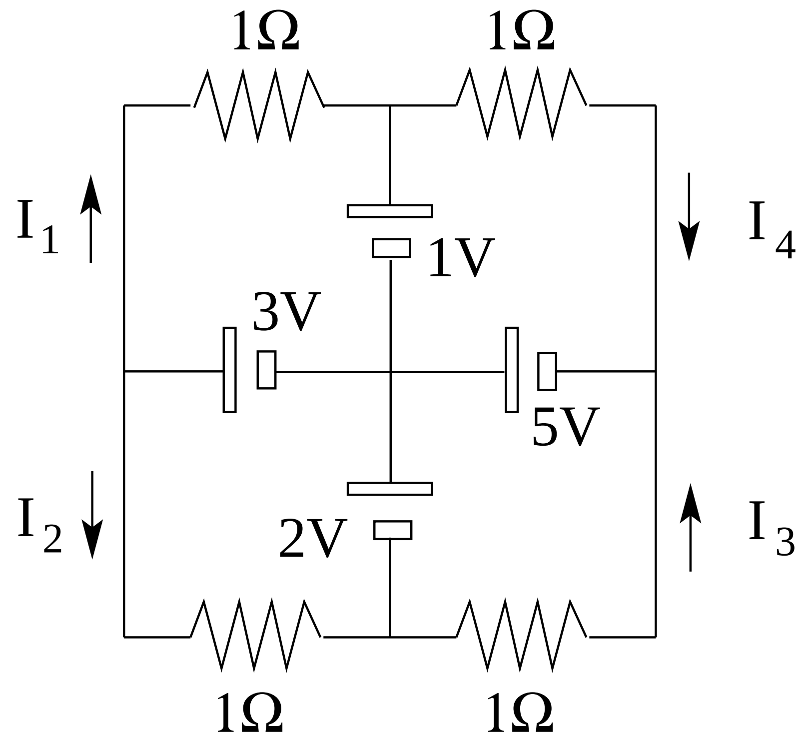
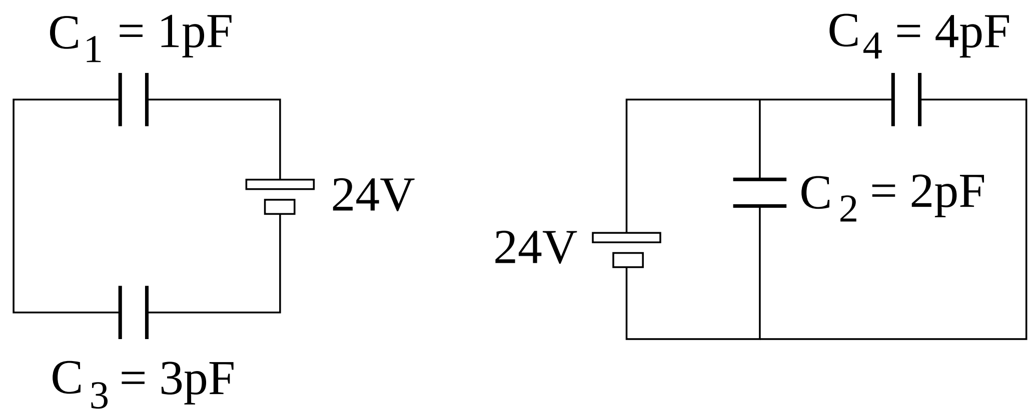


Solution:
Use loops along quadrants in assumed current directions.
Start at center.

$$+3\text{V} - I_1(1\Omega) - 1\text{V} = 0 \quad \Rightarrow \quad I_1 = 2\text{A}.$$
$$+3\text{V} - I_2(1\Omega) + 2\text{V} = 0 \quad \Rightarrow \quad I_2 = 5\text{A}.$$
$$-2\text{V} - I_3(1\Omega) + 5\text{V} = 0 \quad \Rightarrow \quad I_3 = 3\text{A}.$$
$$+1\text{V} - I_4(1\Omega) + 5\text{V} = 0 \quad \Rightarrow \quad I_4 = 6\text{A}.$$

Unit Exam II: Problem #1 (Spring ’11)

Both capacitor circuits are at equilibrium.
(a) Find the charge Q_1 on capacitor 1.
(b) Find the voltage V_3 across capacitor 3.
(c) Find the charge Q_2 on capacitor 2.
(d) Find the energy U_4 stored on capacitor 4.



Unit Exam II: Problem #1 (Spring ’11)

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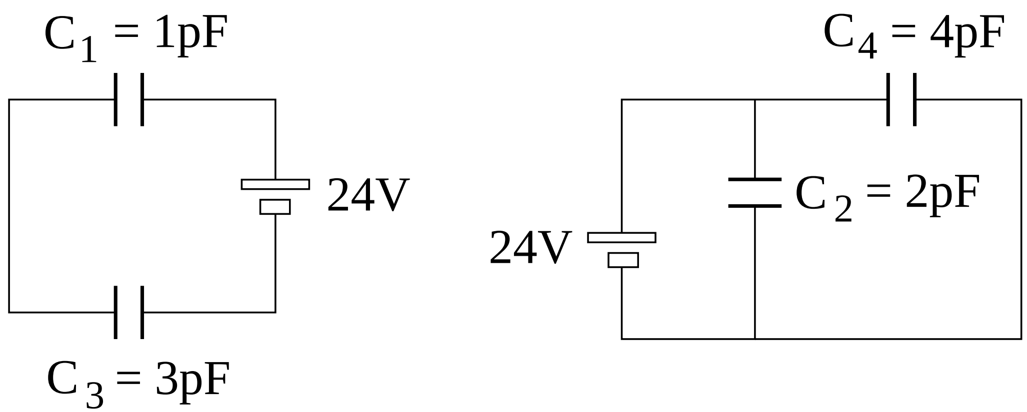


Solution:

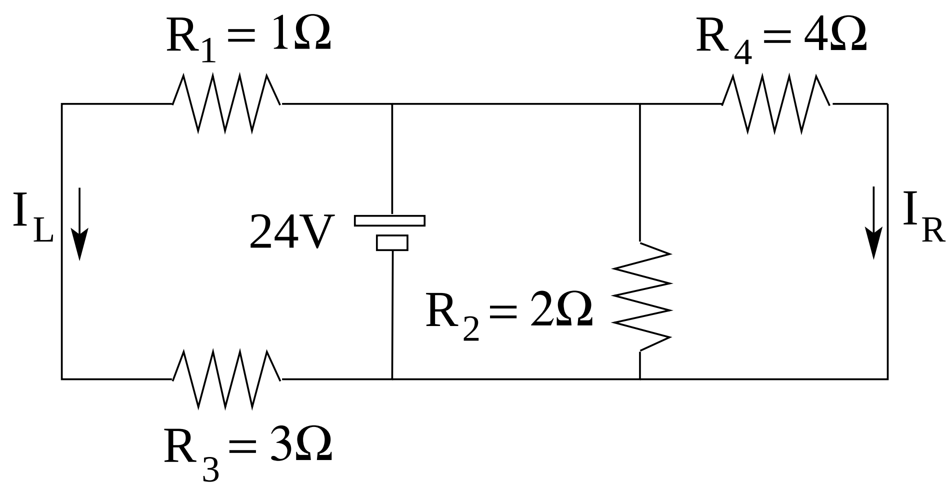
(a) $C_{13} = \left(\frac{1}{C_1} + \frac{1}{C_3}\right)^{-1} = 0.75\text{pF}, \quad Q_1 = Q_3 = Q_{13} = (24\text{V})(0.75\text{pF}) = 18\text{pC}.$

(b) $V_3 = \frac{Q_3}{C_3} = \frac{18\text{pC}}{3\text{pF}} = 6\text{V}.$

(c) $Q_2 = (24\text{V})(2\text{pF}) = 48\text{pC}.$

(d) $U_4 = \frac{1}{2}C_4V_4^2 = \frac{1}{2}(4\text{pF})(24\text{V})^2 = 1152\text{pJ}.$

Consider the resistor circuit shown.
(a) Find the current I_L on the left.
(b) Find the current I_R on the right.
(c) Find the equivalent resistance R_{eq} of all four resistors.
(d) Find the power P_2 dissipated in resistor 2.



Consider the resistor circuit shown.
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(b) Find the current I_R on the right.
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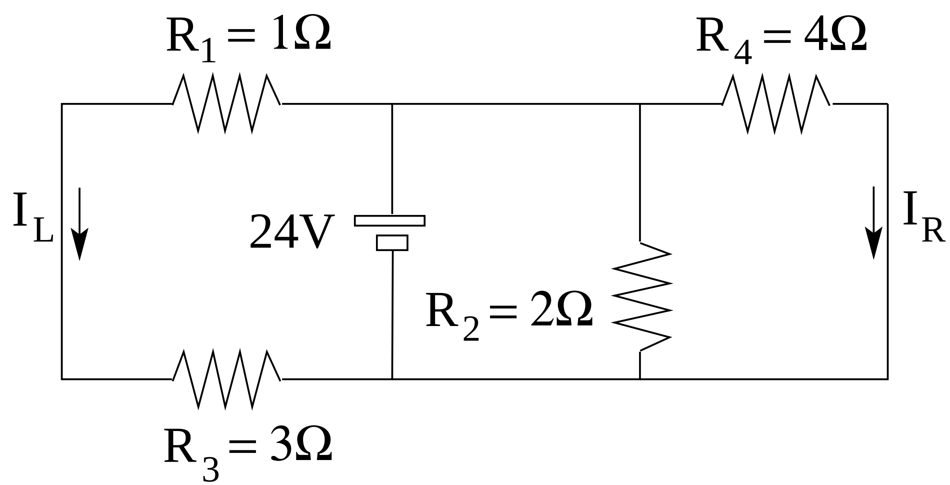


Solution:

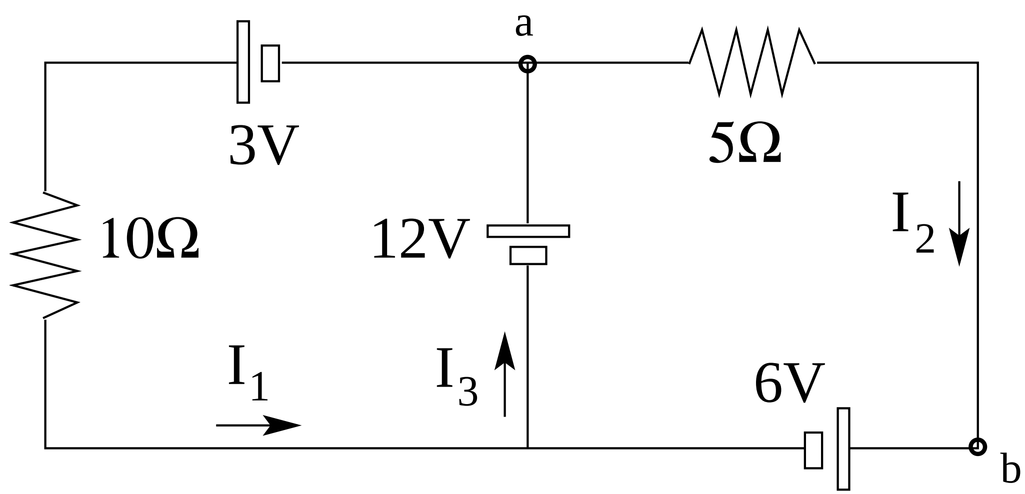
(a) $I_L = \dfrac{24\text{V}}{1\Omega + 3\Omega} = 6\text{A}.$

(b) $I_R = \dfrac{24\text{V}}{4\Omega} = 6\text{A}.$

(c) $R_{eq} = \left(\dfrac{1}{1\Omega + 3\Omega} + \dfrac{1}{2\Omega} + \dfrac{1}{4\Omega}\right)^{-1} = 1\Omega.$

(d) $P_2 = \dfrac{(24\text{V})^2}{2\Omega} = 288\text{W}.$

Consider the electric circuit shown.
(a) Find the current I_1.
(b) Find the current I_2.
(c) Find the current I_3.
(d) Find the potential difference $V_a - V_b$.



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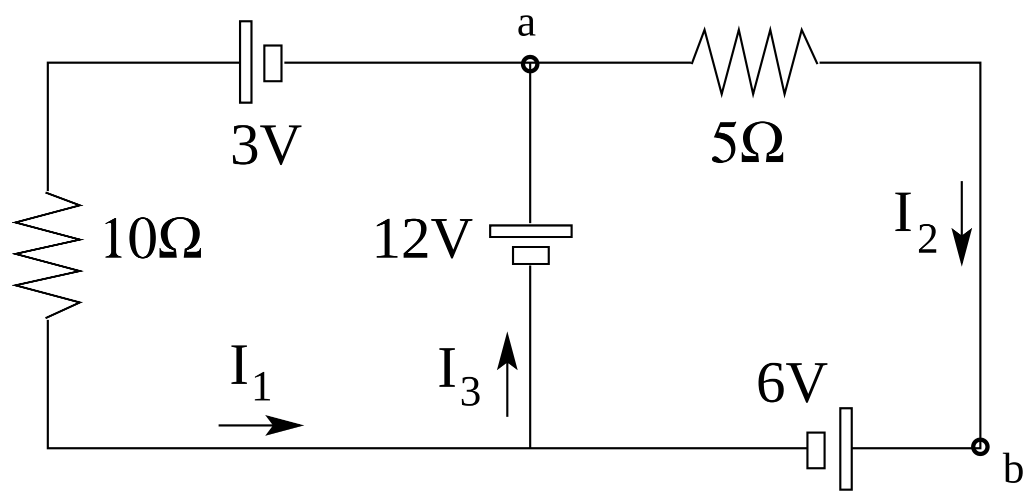


Solution:

(a) $12\text{V} + 3\text{V} - I_1(10\Omega) = 0 \quad \Rightarrow I_1 = \dfrac{15\text{V}}{10\Omega} = 1.5\text{A}.$

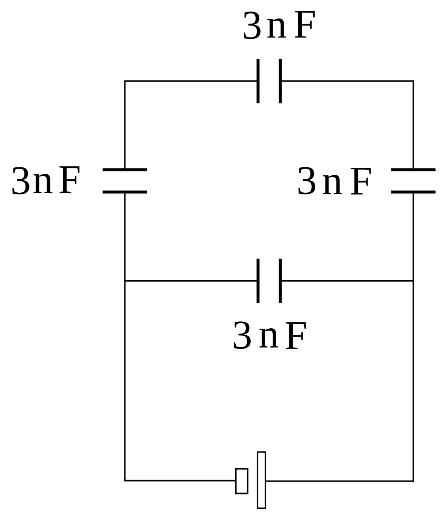
(b) $-6\text{V} + 12\text{V} - I_2(5\Omega) = 0 \quad \Rightarrow I_1 = \dfrac{6\text{V}}{5\Omega} = 1.2\text{A}.$

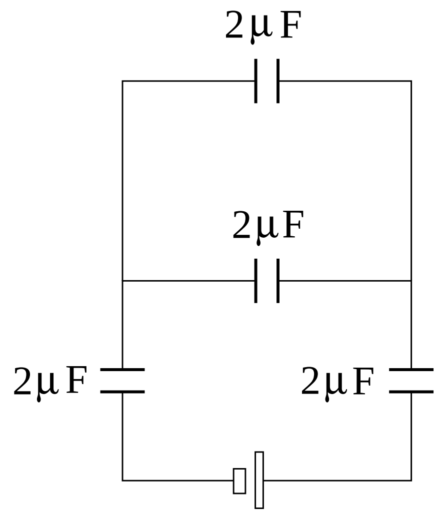
(c) $I_3 = I_1 + I_2 = 2.7\text{A}.$

(d) $V_a - V_b = -6\text{V} + 12\text{V} = 6\text{V}.$

Unit Exam II: Problem #1 (Spring ’12)

Find the equivalent capacitances C_{eq} of the two capacitor circuits.





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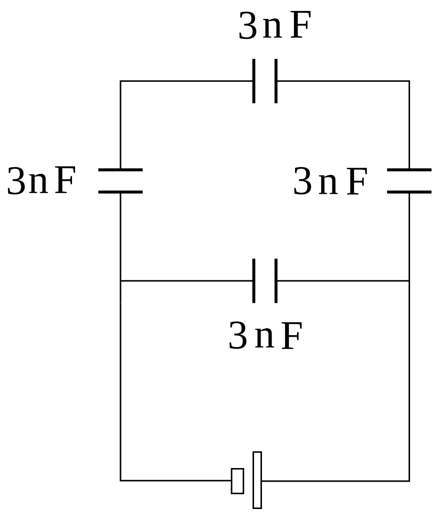
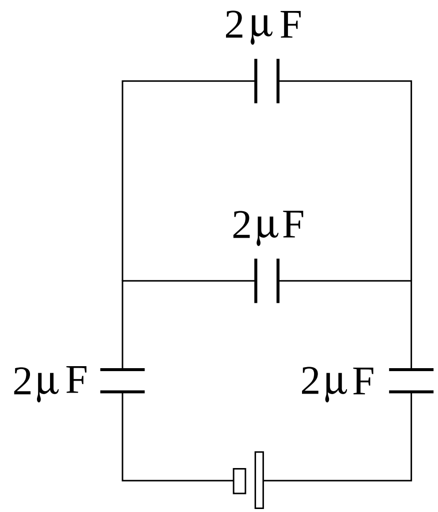




Solution:

- $C_{eq} = 3\text{nF} + \left(\frac{1}{3\text{nF}} + \frac{1}{3\text{nF}} + \frac{1}{3\text{nF}}\right)^{-1} = 4\text{nF}.$
- $C_{eq} = \left(\frac{1}{2\mu\text{F}} + \frac{1}{2\mu\text{F} + 2\mu\text{F}} + \frac{1}{2\mu\text{F}}\right)^{-1} = \frac{4}{5}\mu\text{F}.$

Unit Exam II: Problem #2 (Spring ’12)

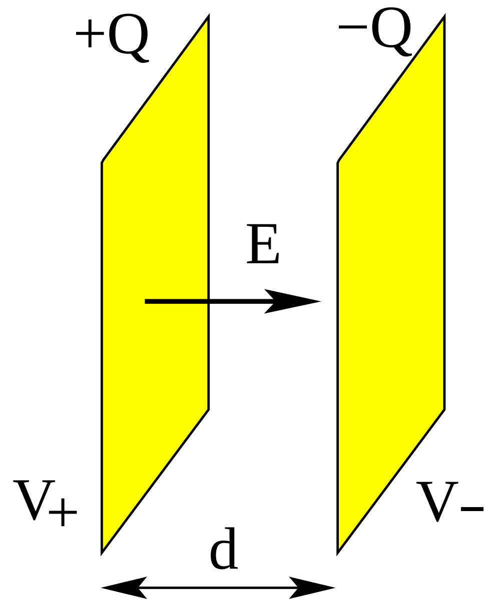
Consider a parallel-plate capacitor of capacitance $C = 6$pF with plates separated a distance $d = 1$mm and a potential difference $V = V_+ - V_- = 3$V between them.

(a) Find the magnitude E of the electric field between the plates.

(b) Find the amount Q of charge on each plate.

(c) Find the energy U stored on the capacitor.

(d) Find the area A of each plate.



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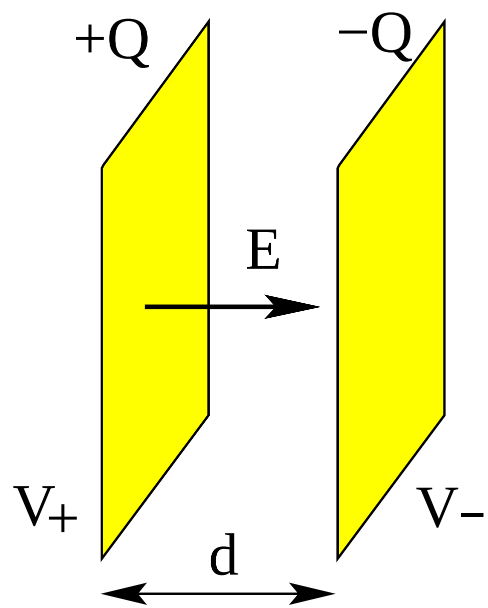


Solution:

(a) $E = \dfrac{V}{d} = \dfrac{3\mathrm{V}}{1\mathrm{mm}} = 3000\mathrm{V/m}.$

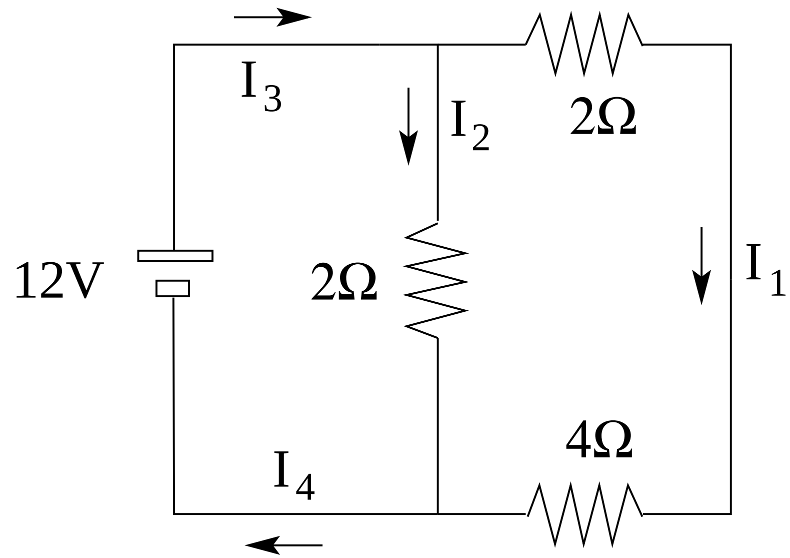
(b) $Q = CV = (6\mathrm{pF})(3\mathrm{V}) = 18\mathrm{pC}.$

(c) $U = \dfrac{1}{2}QV = 0.5(18\mathrm{pC})(3\mathrm{V}) = 27\mathrm{pJ}.$

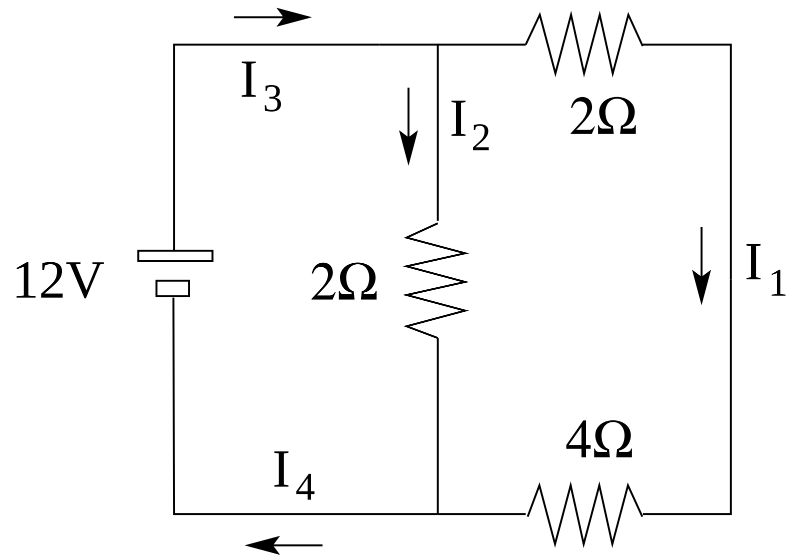
(d) $A = \dfrac{Cd}{\epsilon_0} = \dfrac{(6\mathrm{pF})(1\mathrm{mm})}{8.85\times10^{-12}\mathrm{C^2N^{-1}m^{-2}}} = 6.78\times10^{-4}\mathrm{m}^2.$

Unit Exam II: Problem #3 (Spring ’12)

Consider the electric circuit shown. Find the currents I_1, I_2, I_3, and I_4



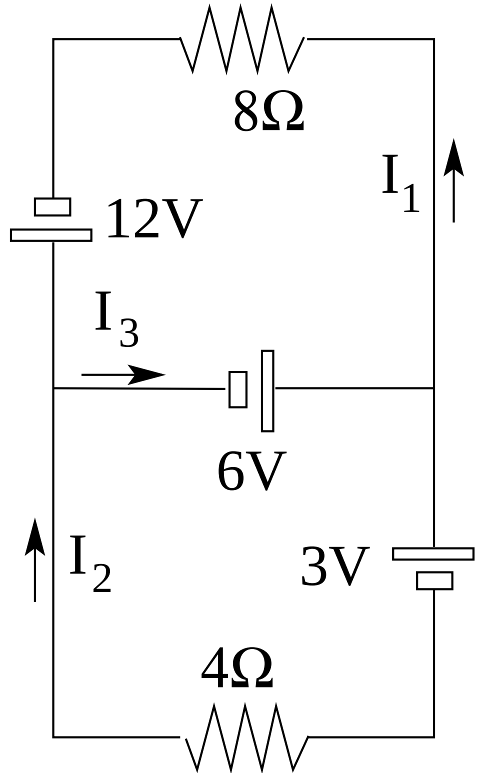
Consider the electric circuit shown. Find the currents I_1, I_2, I_3, and I_4



Solution:

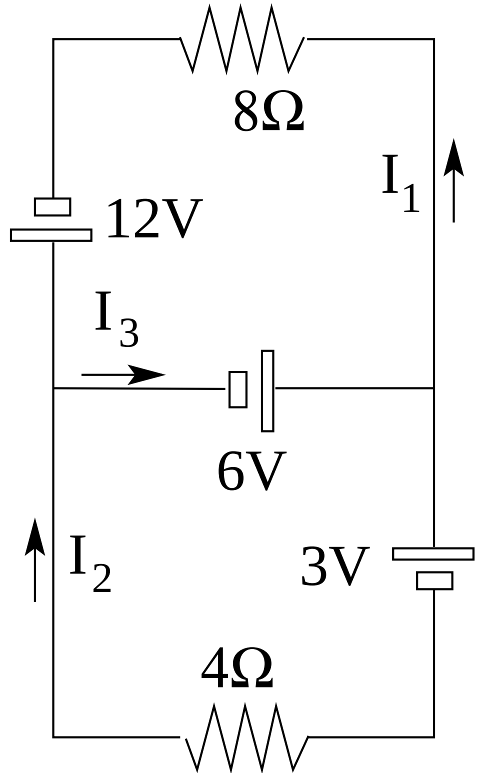
- $I_1 = \dfrac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}.$
- $I_2 = \dfrac{12\text{V}}{2\Omega} = 6\text{A}.$
- $I_3 = I_4 = I_1 + I_2 = 8\text{A}.$

Consider the electric circuit shown. Find the currents I_1, I_2, and I_3



Unit Exam II: Problem #4 (Spring '12)

Consider the electric circuit shown. Find the currents I_1, I_2, and I_3

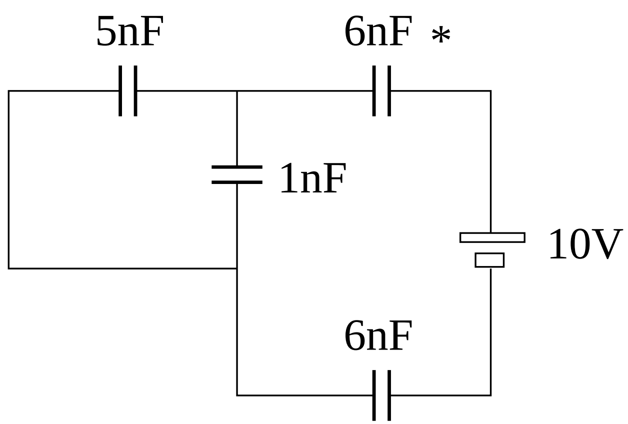


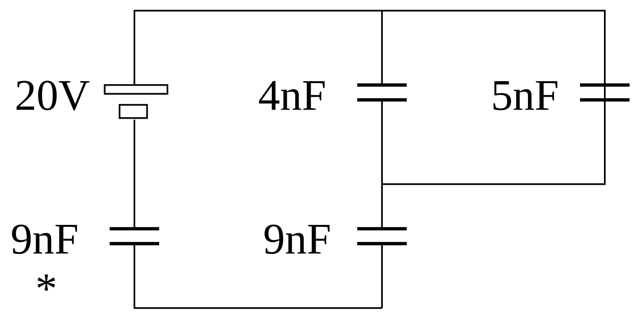
Solution:

- $12\text{V} + 6\text{V} - (8\Omega)I_1 = 0 \quad \Rightarrow \; I_1 = \frac{9}{4}\text{A} = 2.25\text{A}.$
- $6\text{V} - 3\text{V} - (4\Omega)I_2 = 0 \quad \Rightarrow \; I_2 = \frac{3}{4}\text{A} = 0.75\text{A}.$
- $I_3 = I_1 + I_2 = 3.00\text{A}.$

Unit Exam II: Problem #1 (Spring ’13)

Consider the capacitor circuit shown at equilibrium.
(a) Find the equivalent capacitance C_{eq}.
(b) Find the total energy U stored in the four capacitors.
(c) Find the voltage V_* across the capacitor marked by an asterisk.





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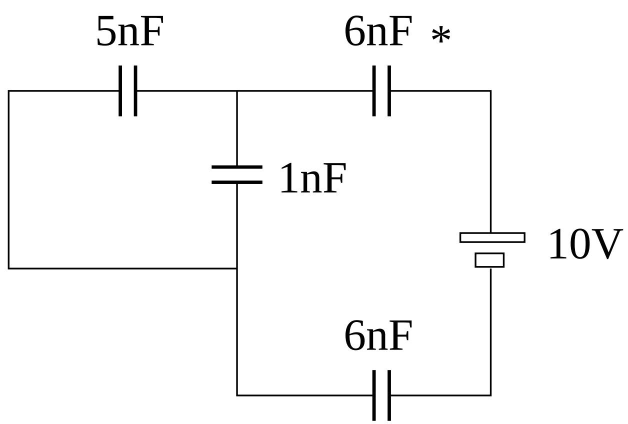
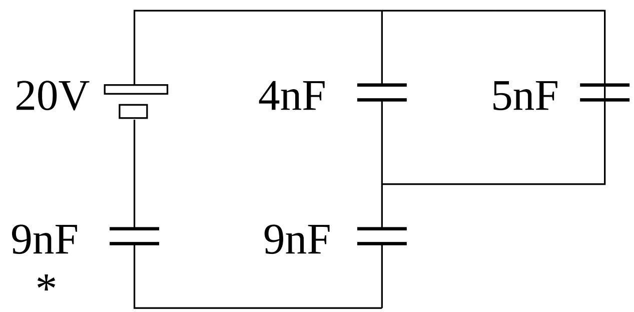




Solution:

$$C_{eq} = \left(\frac{1}{5\text{nF} + 1\text{nF}} + \frac{1}{6\text{nF}} + \frac{1}{6\text{nF}}\right)^{-1} = 2\text{nF}$$

$$U = \frac{1}{2}(2\text{nF})(10\text{V})^2 = 100\text{nJ}$$

$$V_* = \frac{10}{3}\text{V} = 3.33\text{V}$$

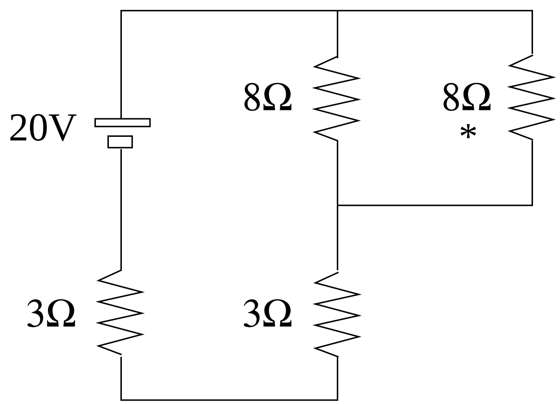
$$C_{eq} = \left(\frac{1}{4\text{nF} + 5\text{nF}} + \frac{1}{9\text{nF}} + \frac{1}{9\text{nF}}\right)^{-1} = 3\text{nF}$$

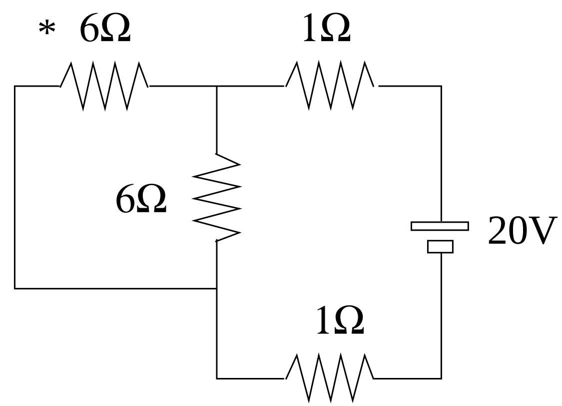
$$U = \frac{1}{2}(3\text{nF})(20\text{V})^2 = 600\text{nJ}$$

$$V_* = \frac{20}{3}\text{V} = 6.67\text{V}$$

Unit Exam II: Problem #2 (Spring ’13)

Consider the resistor circuit shown.
(a) Find the equivalent resistance R_{eq}.
(b) Find the current I flowing through the battery.
(c) Find the voltage V_* across the resistor marked by an asterisk.





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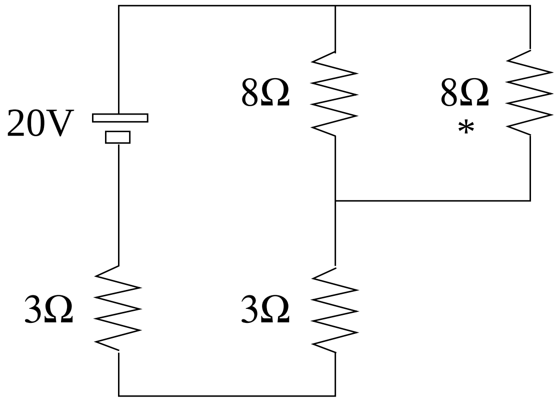
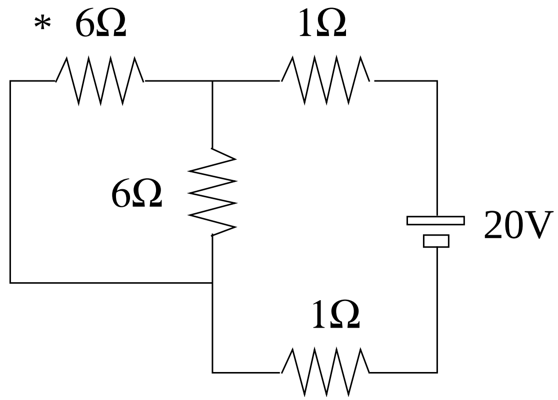




Solution:

$$R_{eq} = \left(\frac{1}{8\Omega} + \frac{1}{8\Omega}\right)^{-1} + 3\Omega + 3\Omega = 10\Omega$$

$$I = \frac{20\text{V}}{10\Omega} = 2\text{A}$$

$$V_* = (1\text{A})(8\Omega) = 8\text{V}$$

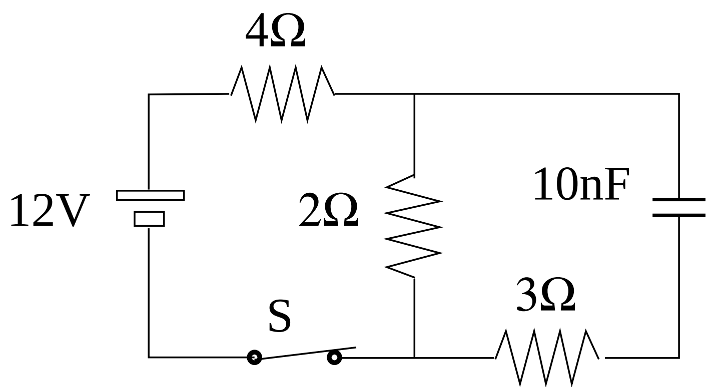
$$R_{eq} = \left(\frac{1}{6\Omega} + \frac{1}{6\Omega}\right)^{-1} + 1\Omega + 1\Omega = 5\Omega$$

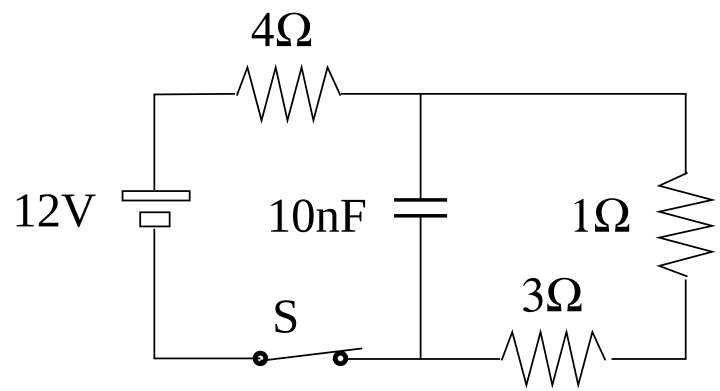
$$I = \frac{20\text{V}}{5\Omega} = 4\text{A}$$

$$V_* = (2\text{A})(6\Omega) = 12\text{V}$$

Unit Exam II: Problem #3 (Spring '13)

Consider the RC circuit shown. The switch has been closed for a long time.
(a) Find the current I_B flowing through the battery.
(b) Find the voltage V_C across the capacitor.
(c) Find the charge Q on the capacitor.
(d) Find the current I_3 flowing through the 3Ω-resistor right after the switch has been opened.





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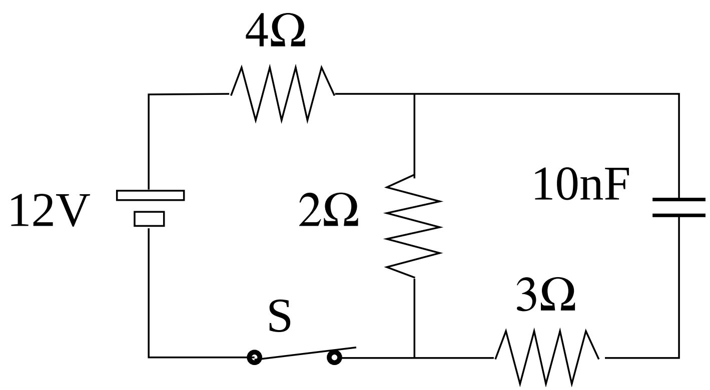
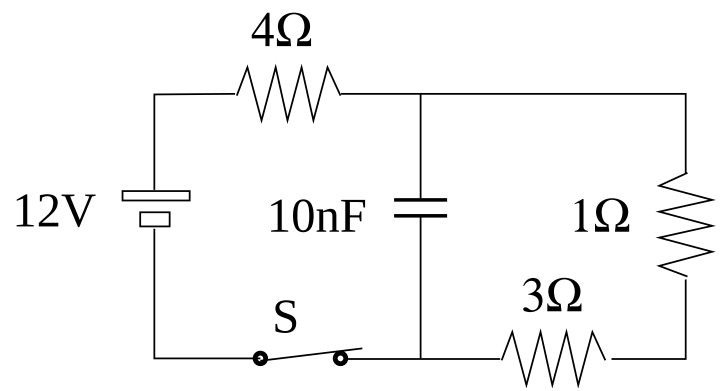




Solution:

$$I_B = \frac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}$$

$$V_C = (2\text{A})(2\Omega) = 4\text{V}$$

$$Q = (4\text{V})(10\text{nF}) = 40\text{nC}$$

$$I_3 = \frac{4\text{V}}{2\Omega + 3\Omega} = 0.8\text{A}$$

$$I_B = \frac{12\text{V}}{3\Omega + 1\Omega + 4\Omega} = 1.5\text{A}$$

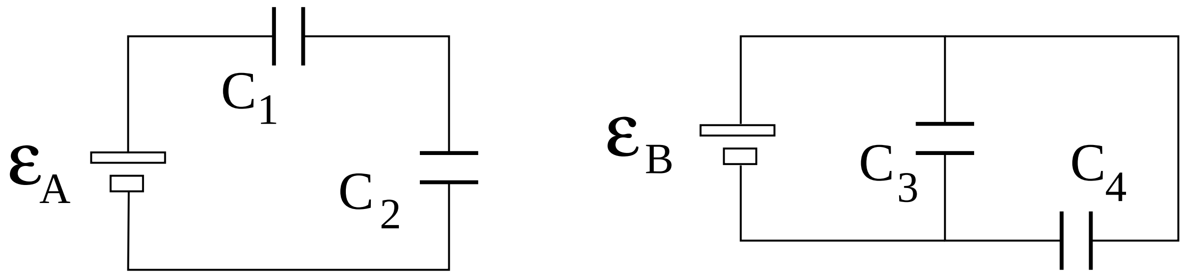
$$V_C = (1.5\text{A})(3\Omega + 1\Omega) = 6\text{V}$$

$$Q = (6\text{V})(10\text{nF}) = 60\text{nC}$$

$$I_3 = \frac{6\text{V}}{3\Omega + 1\Omega} = 1.5\text{A}$$

Unit Exam II: Problem #1 (Spring ’14)

Both capacitor circuits, charged up by batteries as shown, are now at equilibrium. The charge on capacitor $C_1 = 6$pF [8pF] is $Q_1 = 18$pC [16pF] and charge on capacitor $C_4 = 8$pF [4pf] is $Q_4 = 16$pC [12pF].
(a) Find the voltage V_2 across capacitor $C_2 = 4$pF.
(b) Find the emf $\mathcal{E}_A$ supplied by the battery.
(c) Find the charge Q_3 on capacitor $C_3 = 3$pF.
(d) Find the emf $\mathcal{E}_B$ supplied by the battery.



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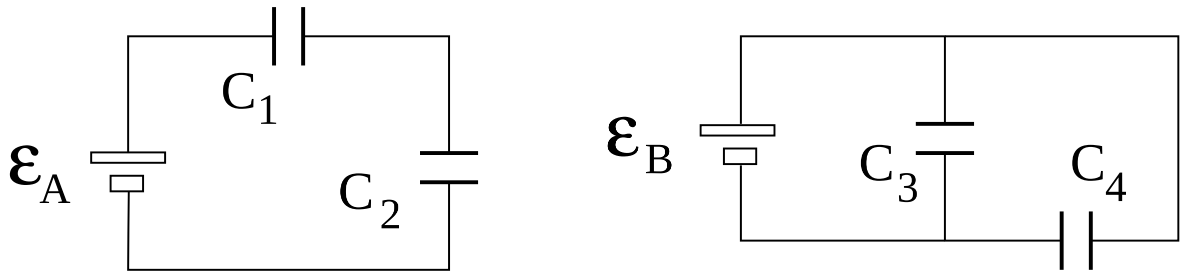
(a) Find the voltage V_2 across capacitor $C_2 = 4$pF.
(b) Find the emf $\mathcal{E}_A$ supplied by the battery.
(c) Find the charge Q_3 on capacitor $C_3 = 3$pF.
(d) Find the emf $\mathcal{E}_B$ supplied by the battery.



Solution:

(a) $Q_2 = Q_1 = 18\text{pC}, \quad [16\text{pC}], \quad V_2 = \dfrac{Q_2}{C_2} = 4.5\text{V} \quad [4\text{V}].$

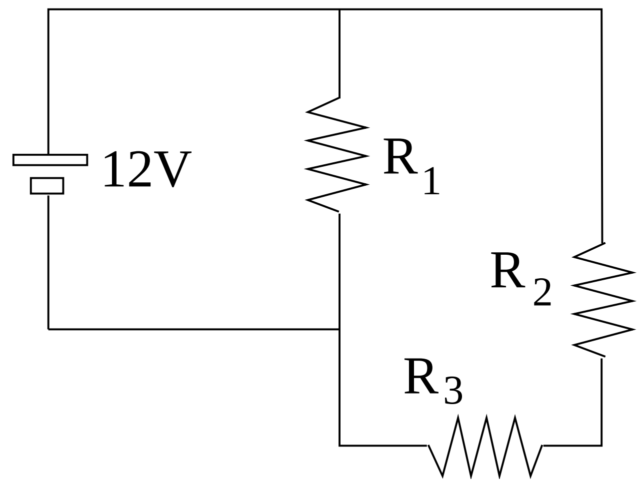
(b) $\mathcal{E}_A = V_1 + V_2 = 3\text{V} + 4.5\text{V} = 7.5\text{V} \quad [2\text{V} + 4\text{V} = 6\text{V}].$

(c) $V_3 = V_4 = \dfrac{Q_4}{C_4} = 2\text{V} \quad [3\text{V}], \quad Q_3 = V_3 C_3 = 6\text{pC} \quad [9\text{pC}].$

(d) $\mathcal{E}_B = V_3 = V_4 = 2\text{V} \quad [3\text{V}].$

Unit Exam II: Problem #2 (Spring ’14)

Consider the resistor circuit shown with $R_1 = 2\Omega$ [3Ω], $R_2 = 3\Omega$ [2Ω], and $R_3 = 1\Omega$.
(a) Find the current I_2 through resistor R_2.
(b) Find the voltage V_3 across resitor R_3.
(c) Find the power P_1 dissipated in resistor R_1.
(d) Find the equivalent resistance R_{eq}.



Unit Exam II: Problem #2 (Spring ’14)

Consider the resistor circuit shown with $R_1 = 2\Omega$ [3Ω], $R_2 = 3\Omega$ [2Ω], and $R_3 = 1\Omega$.
(a) Find the current I_2 through resistor R_2.
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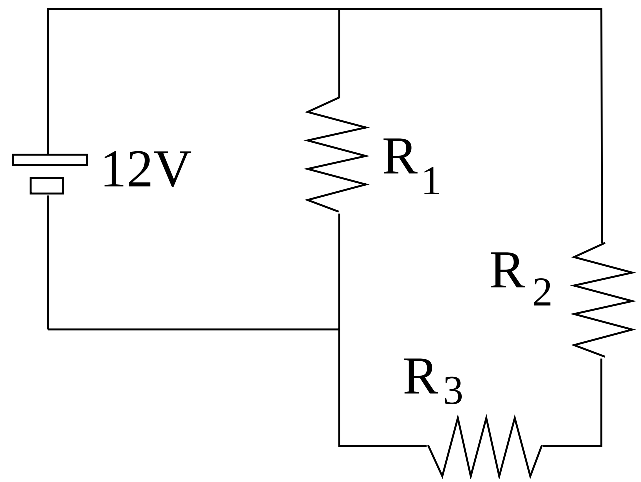


Solution:

(a) $I_2 = \dfrac{12\mathrm{V}}{3\Omega + 1\Omega} = 3\mathrm{A} \quad \left[\dfrac{12\mathrm{V}}{2\Omega + 1\Omega} = 4\mathrm{A}\right].$

(b) $V_3 = (3\mathrm{A})(1\Omega) = 3\mathrm{V} \quad [(4\mathrm{A})(1\Omega) = 4\mathrm{V}].$

(c) $P_1 = \dfrac{(12\mathrm{V})^2}{2\Omega} = 72\mathrm{W} \quad \left[\dfrac{(12\mathrm{V})^2}{3\Omega} = 48\mathrm{W}\right].$

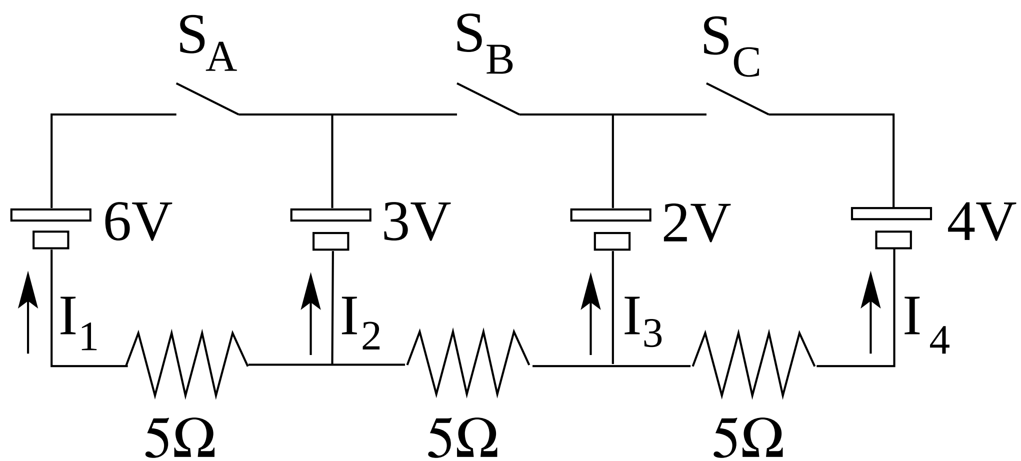
(d) $R_{eq} = \left(\dfrac{1}{2\Omega} + \dfrac{1}{3\Omega + 1\Omega}\right)^{-1} = \dfrac{4}{3}\,\Omega \quad \left[\left(\dfrac{1}{3\Omega} + \dfrac{1}{2\Omega + 1\Omega}\right)^{-1} = \dfrac{3}{2}\,\Omega\right].$

Unit Exam II: Problem #3 (Spring '14)

Consider the electric circuit shown. Find the currents I_1, I_2, I_3, I_4 when ...

(a) only switch S_A is closed,
(b) only switch S_B is closed,
(c) switches S_A and S_B are closed.

(a) only switch S_C is closed,
(b) only switch S_B is closed,
(c) switches S_B and S_C are closed.

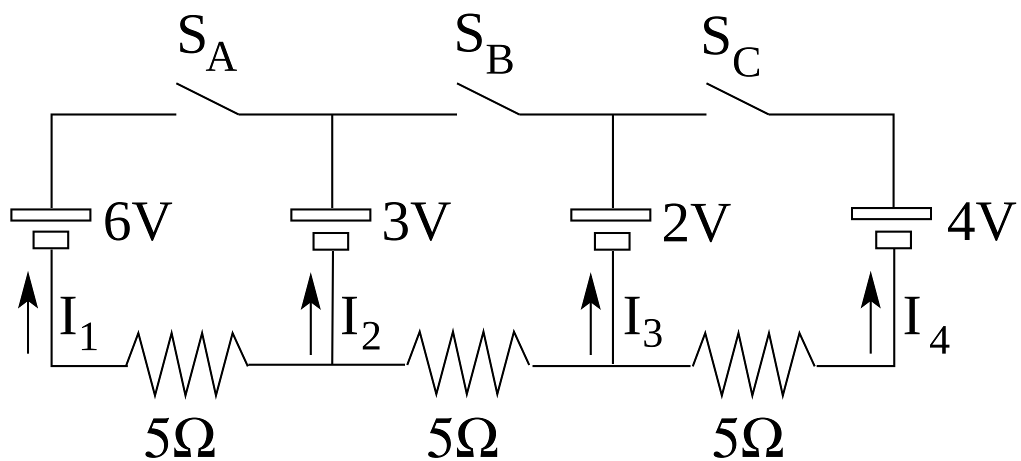


Unit Exam II: Problem #3 (Spring '14)

Consider the electric circuit shown. Find the currents I_1, I_2, I_3, I_4 when ...

(a) only switch S_A is closed,
(b) only switch S_B is closed,
(c) switches S_A and S_B are closed.

(a) only switch S_C is closed,
(b) only switch S_B is closed,
(c) switches S_B and S_C are closed.



Solution:

(a) $I_1 = 0.6\text{A},\ I_2 = -0.6\text{A},\ I_3 = 0,\ I_4 = 0.$

(b) $I_1 = 0,\ I_2 = 0.2\text{A},\ I_3 = -0.2\text{A},\ I_4 = 0.$

(c) $I_1 = 0.6\text{A}, I_2 = -0.4\text{A},$
$I_3 = -0.2\text{A},\ I_4 = 0.$

(a) $I_1 = 0,\ I_2 = 0,\ I_3 = -0.4\text{A},\ I_4 = 0.4\text{A}.$

(b) $I_1 = 0,\ I_2 = 0.2\text{A},\ I_3 = -0.2\text{A},\ I_4 = 0.$

(c) $I_1 = 0,\ I_2 = 0.2\text{A},$
$I_3 = -0.6\text{A},\ I_4 = 0.4\text{A}.$

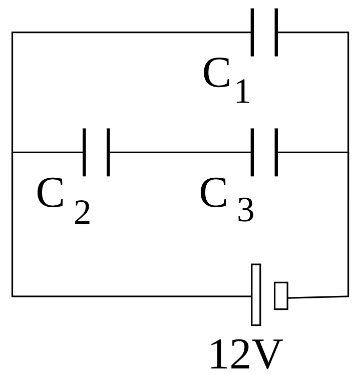
Both capacitor circuits, charged up by batteries as shown, are now at equilibrium. Each of the six capacitors has a 2pF capacitance.

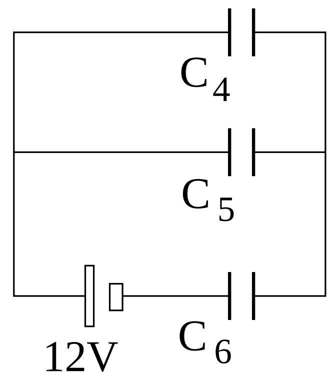
(a) Find the equivalent capacitance of the circuit on the left.

(b) Find the voltages V_1, V_2, V_3 across capacitors C_1, C_2, C_3, respectively.

(c) Find the equivalent capacitance of the circuit on the right.

(d) Find the charges Q_4, Q_5, Q_6 on capacitors C_4, C_5, C_6, respectively.

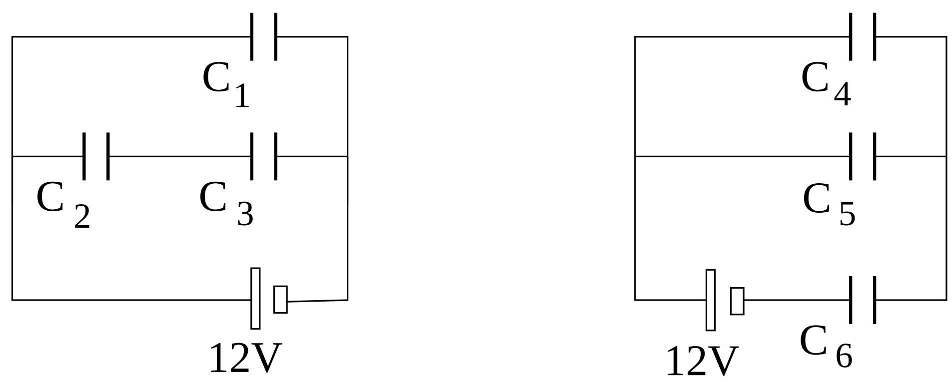




Unit Exam II: Problem #1 (Fall ’14)

Both capacitor circuits, charged up by batteries as shown, are now at equilibrium. Each of the six capacitors has a 2pF capacitance.

(a) Find the equivalent capacitance of the circuit on the left.
(b) Find the voltages V_1, V_2, V_3 across capacitors C_1, C_2, C_3, respectively.
(c) Find the equivalent capacitance of the circuit on the right.
(d) Find the charges Q_4, Q_5, Q_6 on capacitors C_4, C_5, C_6, respectively.



Solution:

(a) $C_{eq} = 2\text{pF} + \left(\frac{1}{2\text{pF}} + \frac{1}{2\text{pF}}\right)^{-1} = 3\text{pF}.$

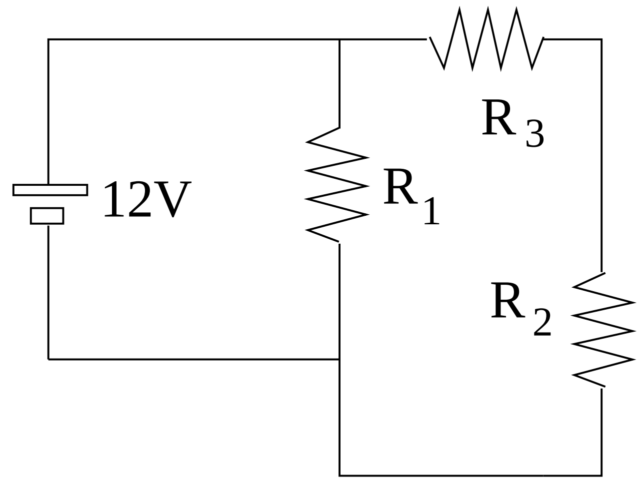
(b) $V_1 = 12\text{V}, \quad V_2 = V_3 = 6\text{V}$

(c) $C_{eq} = \left(\frac{1}{2\text{pF} + 2\text{pF}} + \frac{1}{2\text{pF}}\right)^{-1} = \frac{4}{3}\text{pF}.$

(d) $Q_{45} = Q_6 = C_{eq}(12\text{V}) = 16\text{pC} \quad \Rightarrow \; Q_4 = Q_5 = 8\text{pC}.$

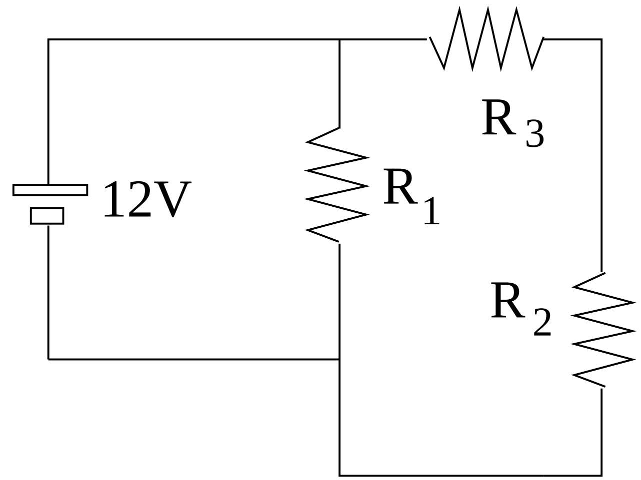
Unit Exam II: Problem #2 (Fall ’14)

Consider the resistor circuit shown with $R_1 = 5\Omega$, $R_2 = 1\Omega$, and $R_3 = 3\Omega$.
(a) Find the equivalent resistance R_{eq}.
(b) Find the currents I_1, I_2, I_3 through resistors R_1, R_2, R_3, respectively.
(c) Find the voltages V_1, V_2, V_3 across resistors R_1, R_2, R_3, respectively.



Unit Exam II: Problem #2 (Fall '14)

Consider the resistor circuit shown with $R_1 = 5\Omega$, $R_2 = 1\Omega$, and $R_3 = 3\Omega$.
(a) Find the equivalent resistance R_{eq}.
(b) Find the currents I_1, I_2, I_3 through resistors R_1, R_2, R_3, respectively.
(c) Find the voltages V_1, V_2, V_3 across resistors R_1, R_2, R_3, respectively.



Solution:

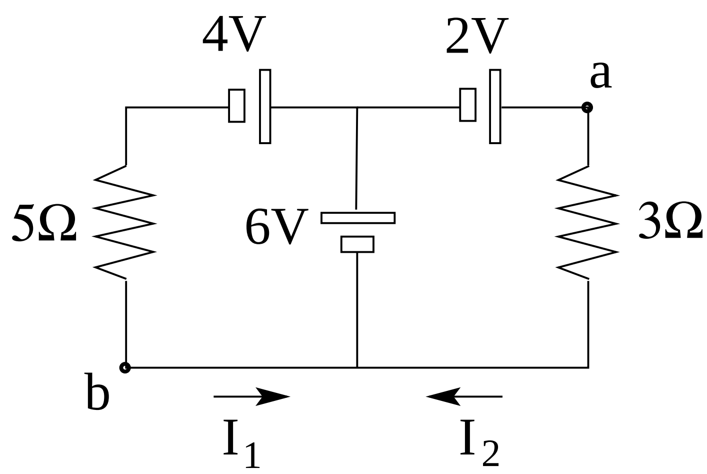
(a) $R_{eq} = \left(\frac{1}{1\Omega + 3\Omega} + \frac{1}{5\Omega}\right)^{-1} = \frac{20}{9}\,\Omega = 2.22\Omega.$

(b) $I_1 = \frac{12\text{V}}{5\Omega} = 2.4\text{A}, \quad I_2 = I_3 = \frac{12\text{V}}{1\Omega + 3\Omega} = 3\text{A}.$

(c) $V_1 = R_1 I_1 = 12\text{V}, \quad V_2 = R_2 I_2 = 3\text{V}, \quad V_3 = R_3 I_3 = 9\text{V}.$

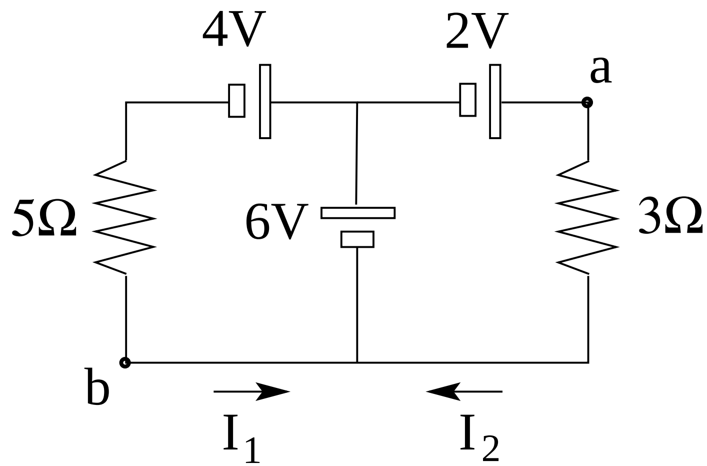
Unit Exam II: Problem #3 (Fall ’14)

Consider the two-loop circuit shown.
(a) Find the current I_1.
(b) Find the current I_2.
(c) Find the potential difference $V_a - V_b$.



Unit Exam II: Problem #3 (Fall ’14)

Consider the two-loop circuit shown.
(a) Find the current I_1.
(b) Find the current I_2.
(c) Find the potential difference $V_a - V_b$.



Solution:

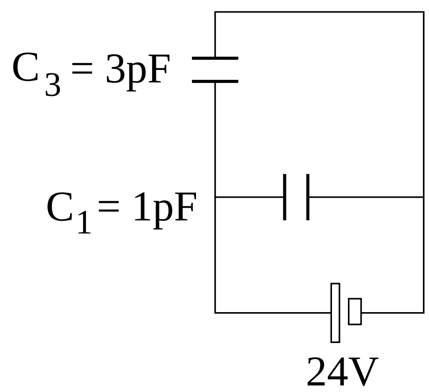
(a) $I_1 = \dfrac{6\mathrm{V} - 4\mathrm{V}}{5\Omega} = 0.4\mathrm{A}.$

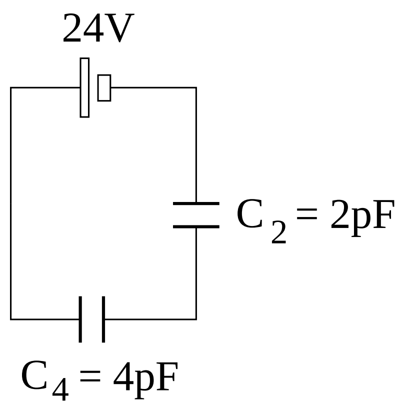
(b) $I_2 = \dfrac{6\mathrm{V} + 2\mathrm{V}}{3\Omega} = 2.67\mathrm{A}.$

(c) $V_a - V_b = 6\mathrm{V} + 2\mathrm{V} = 8\mathrm{V}.$

Unit Exam II: Problem #1 (Spring ’15)

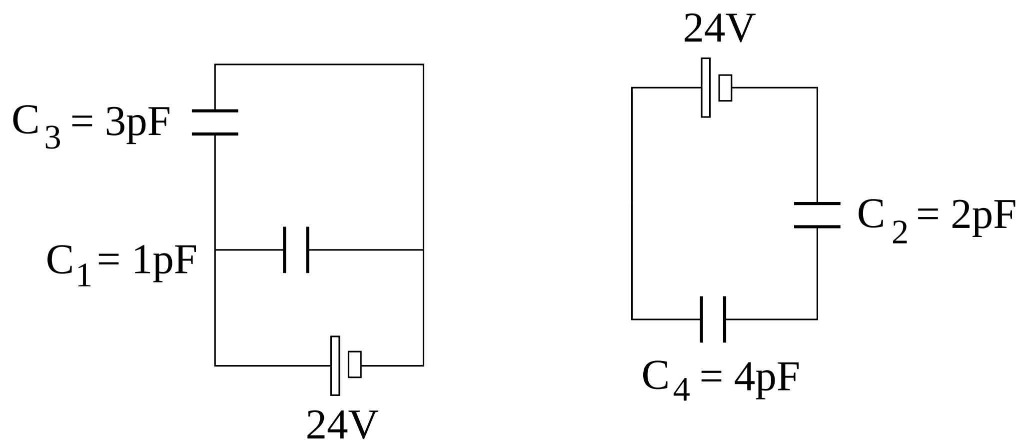
Both capacitor circuits are at equilibrium.
(a) Find the charge Q_1 on capacitor 1.
(b) Find the energy U_3 stored on capacitor 3.
(c) Find the charge Q_2 on capacitor 2.
(d) Find the voltage V_4 across capacitor 4.





Unit Exam II: Problem #1 (Spring '15)

Both capacitor circuits are at equilibrium.
(a) Find the charge Q_1 on capacitor 1.
(b) Find the energy U_3 stored on capacitor 3.
(c) Find the charge Q_2 on capacitor 2.
(d) Find the voltage V_4 across capacitor 4.



Solution:

(a) $Q_1 = C_1 V_1 = (1\text{pF})(24\text{V}) = 24\text{pC}.$

(b) $U_3 = \frac{1}{2} C_3 V_3^2 = \frac{1}{2}(3\text{pF})(24\text{V})^2 = 864\text{pJ}.$

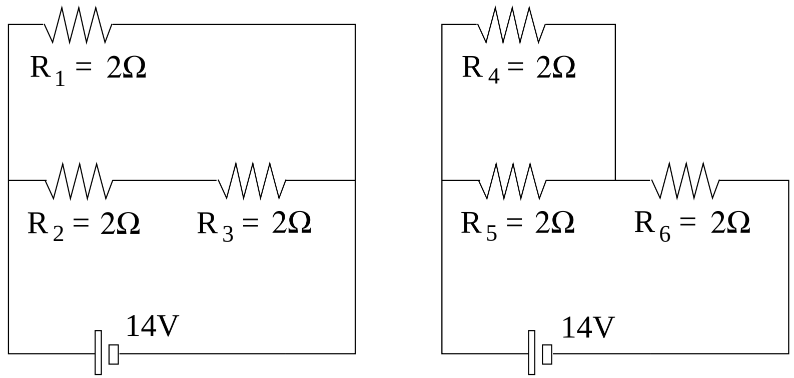
(c) $C_{24} = \left(\frac{1}{C_2} + \frac{1}{C_4}\right)^{-1} = \frac{4}{3}\text{pF},$

$Q_2 = Q_4 = Q_{24} = C_{24} V_{24} = \left(\frac{4}{3}\text{pF}\right)(24\text{V}) = 32\text{pC}.$

(d) $V_4 = \frac{Q_4}{C_4} = \frac{32\text{pC}}{4\text{pF}} = 8\text{V}.$

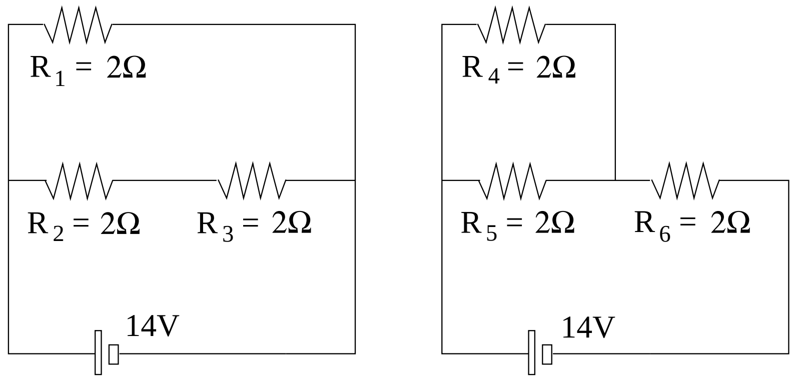
Unit Exam II: Problem #2 (Spring '15)

In the two resistor circuits shown find the equivalent resistances R_{123} (left) and R_{456} (right). Then find the currents I_1, I_2, I_3 through the individual resistors on the left. and the currents I_4, I_5, I_6 through the individual resistors on the right.



Unit Exam II: Problem #2 (Spring ’15)

In the two resistor circuits shown find the equivalent resistances R_{123} (left) and R_{456} (right). Then find the currents I_1, I_2, I_3 through the individual resistors on the left. and the currents I_4, I_5, I_6 through the individual resistors on the right.



Solution:

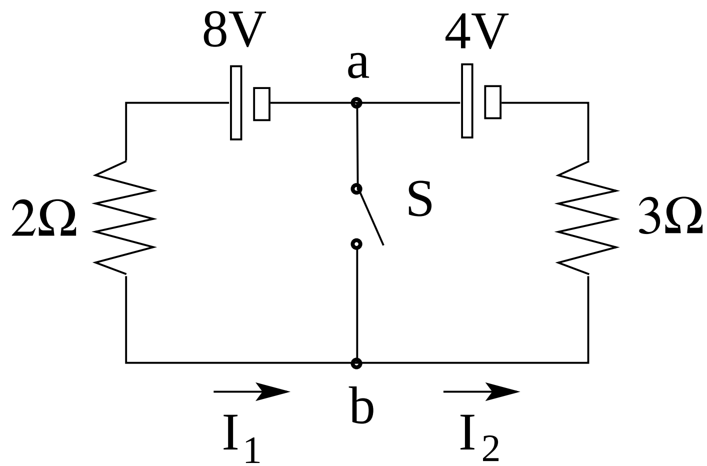
- $R_{23} = 2\Omega + 2\Omega = 4\Omega, \quad R_{123} = \left(\frac{1}{2\Omega} + \frac{1}{4\Omega}\right)^{-1} = \frac{4}{3}\Omega$
- $R_{45} = \left(\frac{1}{2\Omega} + \frac{1}{2\Omega}\right)^{-1} = 1\Omega, \quad R_{456} = R_{45} + R_6 = 3\Omega$
- $I_1 = \frac{14\text{V}}{2\Omega} = 7\text{A}, \quad I_2 = I_3 = \frac{14\text{V}}{4\Omega} = 3.5\text{A}$
- $I_6 = I_{45} = \frac{14\text{V}}{3\Omega} = 4.67\text{A}, \quad I_4 = I_5 = \frac{1}{2} I_6 = 2.33\text{A}$

Unit Exam II: Problem #3 (Spring ’15)

In the circuit shown find the currents I_1, I_2, and the potential difference $V_b - V_a$

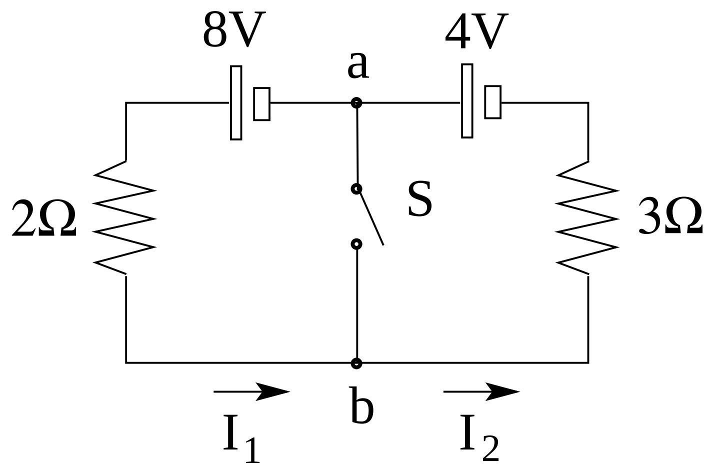
(a) if the switch S is open,

(b) if the switch S is closed.



Unit Exam II: Problem #3 (Spring ’15)

In the circuit shown find the currents I_1, I_2, and the potential difference $V_b - V_a$
(a) if the switch S is open,
(b) if the switch S is closed.



Solution:

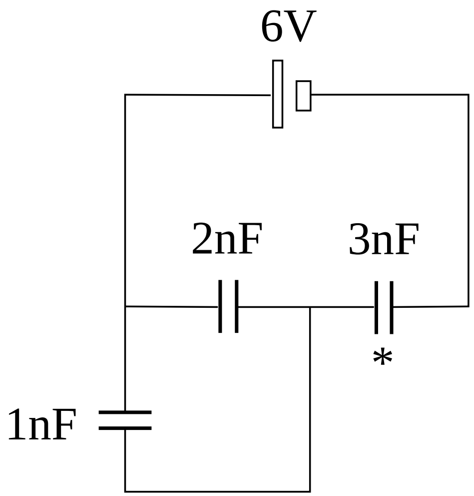
(a) $I_1 = I_2 = \dfrac{12\text{V}}{5\Omega} = 2.4\text{A}$

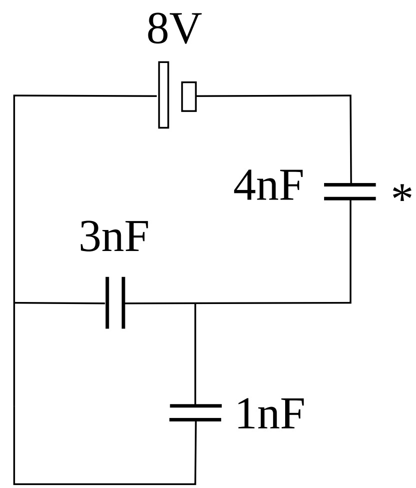
$V_b - V_a = 8\text{V} - (2.4\text{A})(2\Omega) = -4\text{V} + (2.4\text{A})(3\Omega) = 3.2\text{V}.$

(b) $I_1 = \dfrac{8\text{V}}{2\Omega} = 4\text{A}, \quad I_2 = \dfrac{4\text{V}}{3\Omega} = 1.33\text{A}, \quad V_b - V_a = 0.$

Unit Exam II: Problem #1 (Fall ’15)

Consider the capacitor circuit shown at equilibrium. (a) Find the equivalent capacitance C_{eq}. (b) Find the total energy U stored in the three capacitors. (c) Find the voltage V_* across the capacitor marked by an asterisk. (d) Find the voltage V_1 across the 1nF-capacitor.





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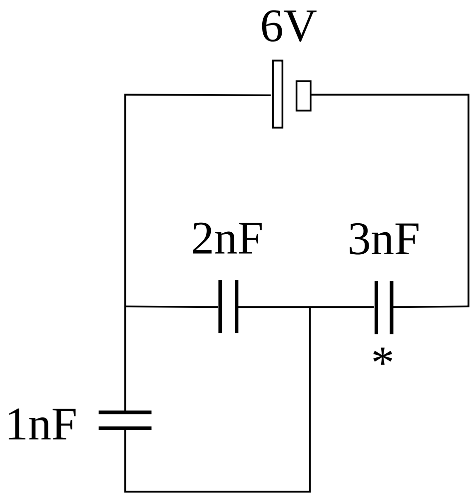
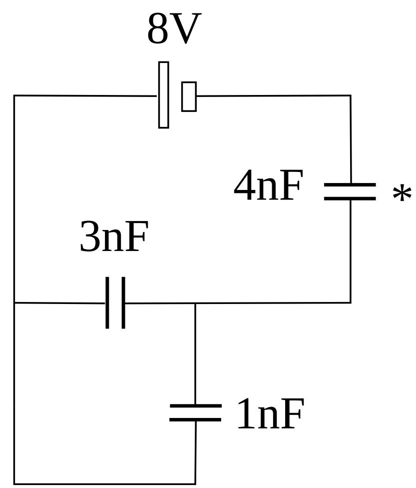




Solution:

(a) $C_{eq} = \left(\dfrac{1}{1\text{nF} + 2\text{nF}} + \dfrac{1}{3\text{nF}}\right)^{-1} = 1.5\text{nF}$

(b) $U = \dfrac{1}{2}(1.5\text{nF})(6\text{V})^2 = 27\text{nJ}$

(c) $V_* = \dfrac{1}{2}6\text{V} = 3\text{V}$

(d) $V_1 = 6\text{V} - 3\text{V} = 3\text{V}$

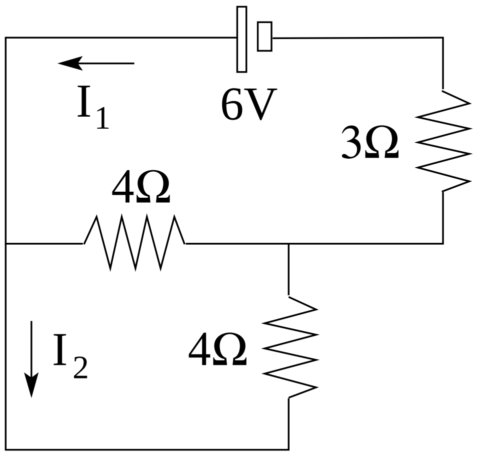
(a) $C_{eq} = \left(\dfrac{1}{3\text{nF} + 1\text{nF}} + \dfrac{1}{4\text{nF}}\right)^{-1} = 2\text{nF}$

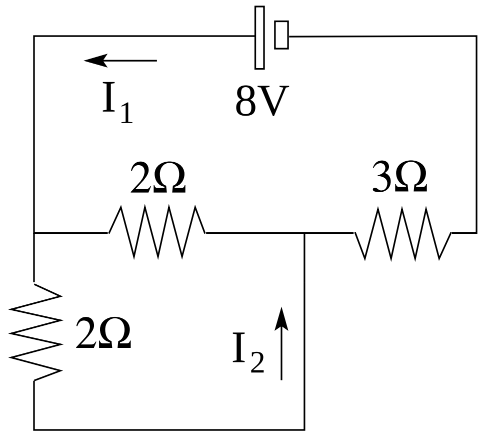
(b) $U = \dfrac{1}{2}(2\text{nF})(8\text{V})^2 = 64\text{nJ}$

(c) $V_* = \dfrac{1}{2}8\text{V} = 4\text{V}$

(d) $V_1 = 8\text{V} - 4\text{V} = 4\text{V}$

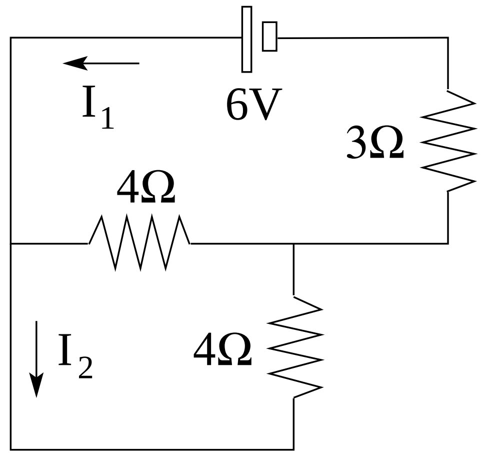
Consider the resistor circuit shown. (a) Find the equivalent resistance R_{eq}. (b) Find the currents I_1 and I_2. (c) Find the power P supplied by the battery.

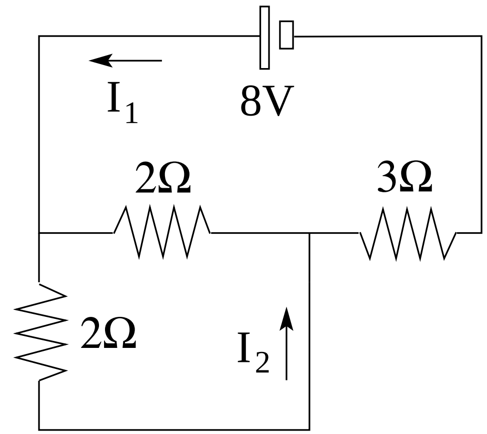




Unit Exam II: Problem #2 (Fall '15)

Consider the resistor circuit shown. (a) Find the equivalent resistance R_{eq}. (b) Find the currents I_1 and I_2. (c) Find the power P supplied by the battery.





Solution:

(a) $R_{eq} = \left(\frac{1}{4\Omega} + \frac{1}{4\Omega}\right)^{-1} + 3\Omega = 5\Omega$

(b) $I_1 = \frac{6\text{V}}{5\Omega} = 1.2\text{A}, \quad I_2 = \frac{1}{2} I_1 = 0.6\text{A}$

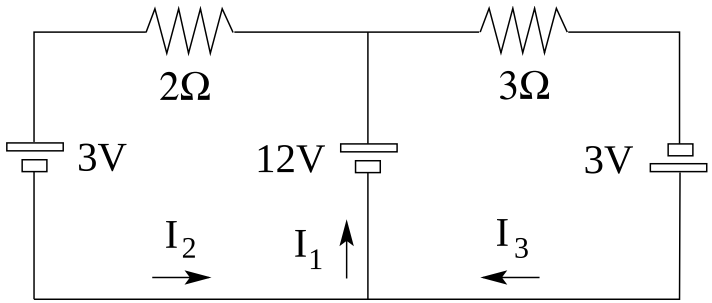
(c) $P = (1.2\text{A})(6\text{V}) = 7.2\text{W}$

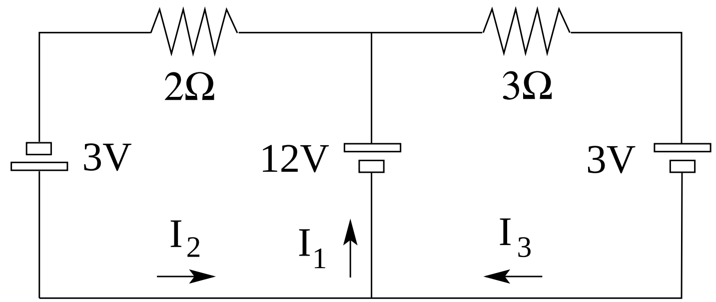
(a) $R_{eq} = \left(\frac{1}{2\Omega} + \frac{1}{2\Omega}\right)^{-1} + 3\Omega = 4\Omega$

(b) $I_1 = \frac{8\text{V}}{4\Omega} = 2\text{A}, \quad I_2 = \frac{1}{2} I_1 = 1\text{A}$

(c) $P = (2\text{A})(8\text{V}) = 16\text{W}$

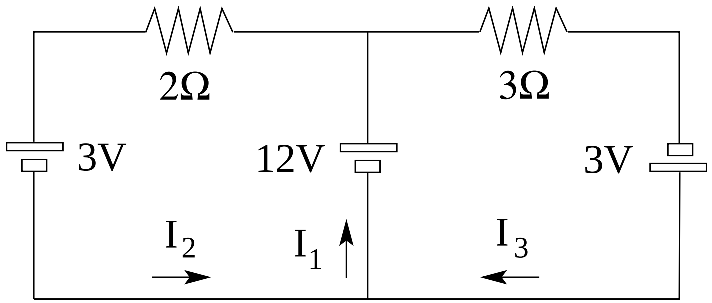
Consider the electric circuit shown.
Find the currents I_1, I_2, I_3.

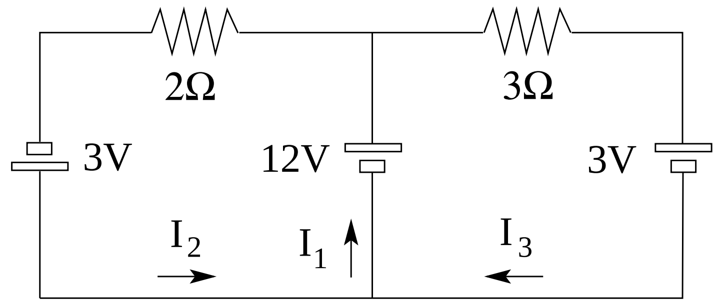




Unit Exam II: Problem #3 (Fall ’15)

Consider the electric circuit shown.
Find the currents I_1, I_2, I_3.





Solution:

$$12\text{V} - I_2(2\Omega) - 3\text{V} = 0$$
$$\Rightarrow \; I_2 = \frac{9\text{V}}{2\Omega} = 4.5\text{A}$$
$$12\text{V} - I_3(3\Omega) + 3\text{V} = 0$$
$$\Rightarrow \; I_3 = \frac{15\text{V}}{3\Omega} = 5\text{A}.$$
$$I_1 = I_2 + I_3 = 9.5\text{A}$$

$$12\text{V} - I_2(2\Omega) + 3\text{V} = 0$$
$$\Rightarrow \; I_2 = \frac{15\text{V}}{2\Omega} = 7.5\text{A}.$$
$$12\text{V} - I_3(3\Omega) - 3\text{V} = 0$$
$$\Rightarrow \; I_3 = \frac{9\text{V}}{3\Omega} = 3\text{A}.$$
$$I_1 = I_2 + I_3 = 10.5\text{A}$$

Unit Exam II: Problem #1 (Spring ’16)

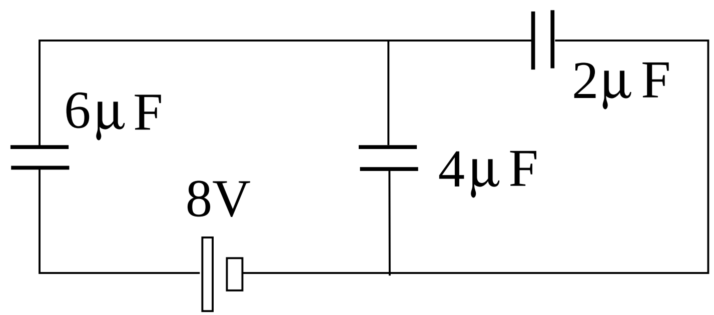
The circuit of capacitors connected to a battery is at equilibrium.

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

(b) Find the total energy U stored in the three capacitors.

(c) Find the charge Q_6 on the capacitor on the left.

(d) Find the the voltages V_2 and V_4 across the two capacitor on the right.



Unit Exam II: Problem #1 (Spring ’16)

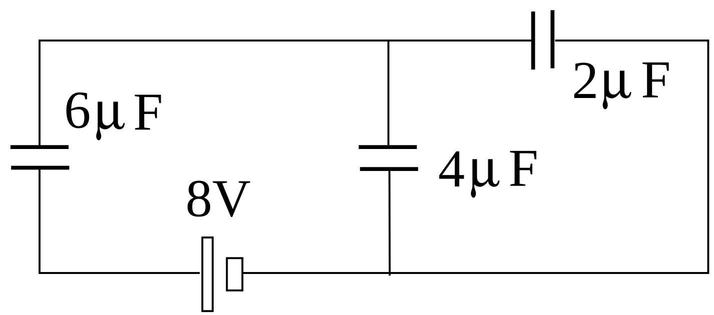
The circuit of capacitors connected to a battery is at equilibrium.

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

(b) Find the total energy U stored in the three capacitors.

(c) Find the charge Q_6 on the capacitor on the left.

(d) Find the the voltages V_2 and V_4 across the two capacitor on the right.



Solution:

(a) $C_{eq} = \left(\frac{1}{2\mu\text{F} + 4\mu\text{F}} + \frac{1}{6\mu\text{F}} \right)^{-1} = 3\mu\text{F}.$

(b) $U = \frac{1}{2}(3\mu\text{F})(8\text{V})^2 = 96\mu\text{J}.$

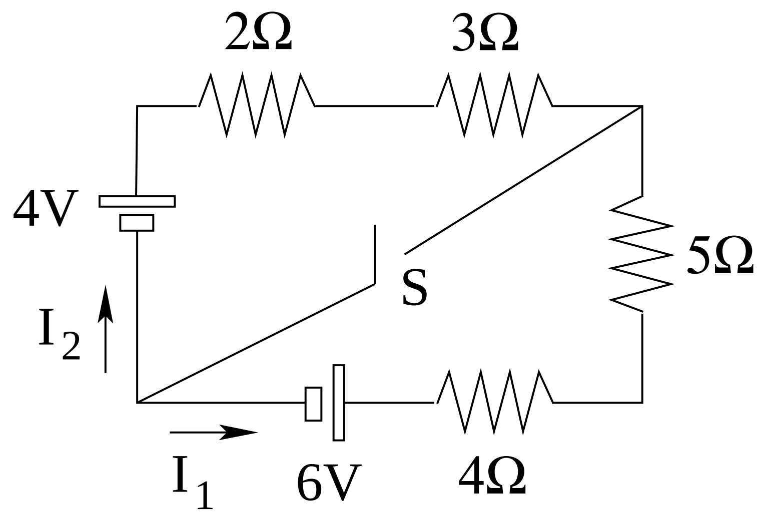
(c) $Q_6 = (8\text{V})(3\mu\text{F}) = 24\mu\text{C}.$

(d) $V_2 = V_4 = \frac{1}{2}(8\text{V}) = 4\text{V}.$

Consider the electrical circuit shown.

(a) Find the current I_1 when the switch S is open.

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

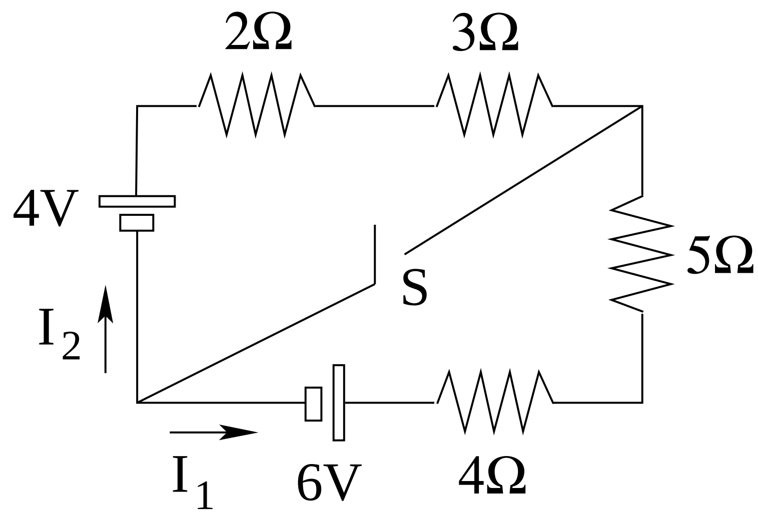


Unit Exam II: Problem #2 (Spring ’16)

Consider the electrical circuit shown.

(a) Find the current I_1 when the switch S is open.

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



Solution:

(a) $I_1 = \dfrac{6\text{V} - 4\text{V}}{4\Omega + 5\Omega + 3\Omega + 2\Omega} = 0.143\text{A}.$

(b) $I_1 = \dfrac{6\text{V}}{4\Omega + 5\Omega} = 0.667\text{A}, \quad I_2 = \dfrac{4\text{V}}{3\Omega + 2\Omega} = 0.8\text{A}.$

Unit Exam II: Problem #3 (Spring ’15)

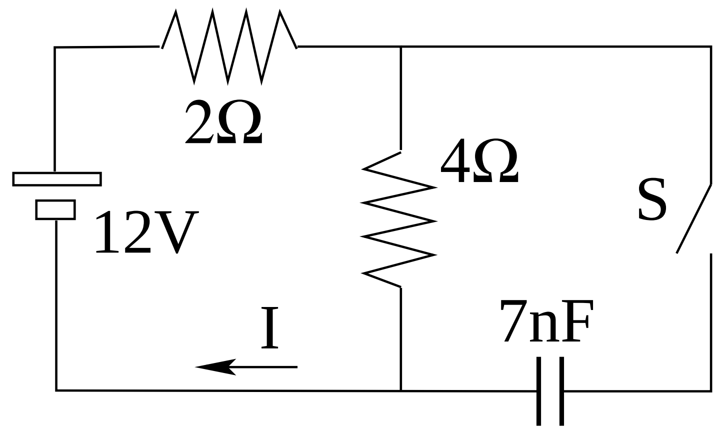
This RC circuit has been running for a long time with the switch open.

(a) Find the current I while the switch is still open.

(b) Find the current I right after the switch has been closed.

(c) Find the current I a long time later.

(d) Find the charge Q on the capacitor also a long time later.



Unit Exam II: Problem #3 (Spring ’15)

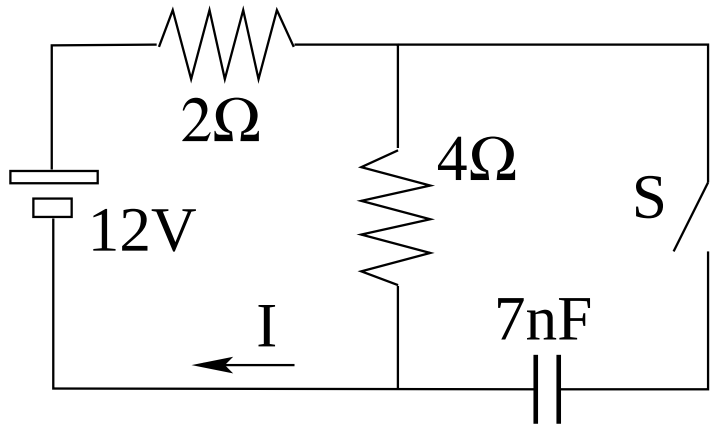
This RC circuit has been running for a long time with the switch open.

(a) Find the current I while the switch is still open.

(b) Find the current I right after the switch has been closed.

(c) Find the current I a long time later.

(d) Find the charge Q on the capacitor also a long time later.



Solution:

(a) $I = \dfrac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}.$

(b) $I = \dfrac{12\text{V}}{2\Omega} = 6\text{A}.$

(c) $I = \dfrac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}.$

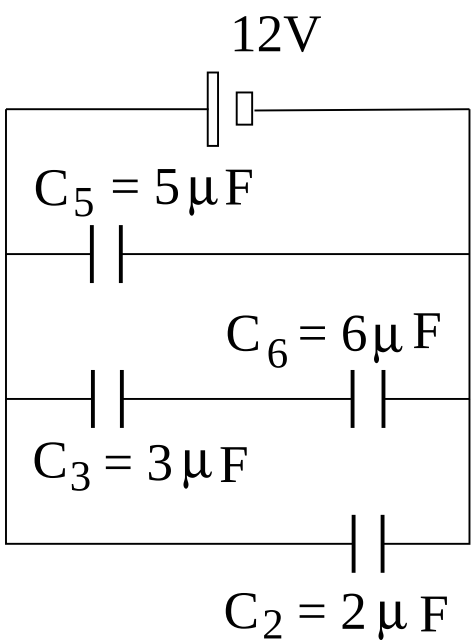
(d) $Q = (8\text{V})(7\text{nF}) = 56\text{nC}.$

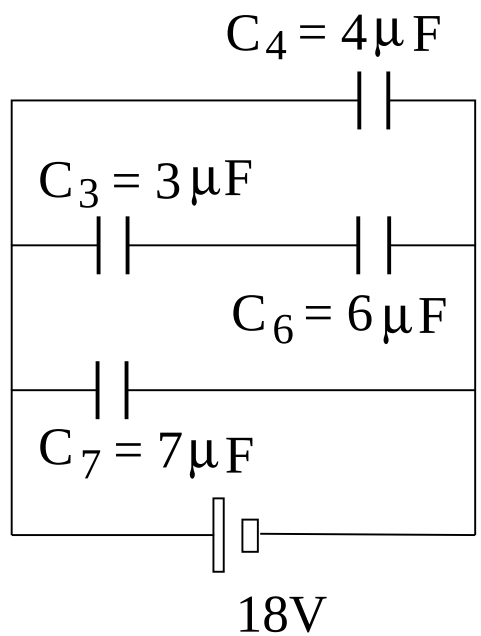
Unit Exam II: Problem #1 (Fall '16)

The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

(a) the voltage V_2 across capacitor C_2,
(b) the energy U_5 on capacitor C_5,
(c) the charge Q_3 on capacitor C_3,
(d) the equivalent capacitance C_{eq}.

(a) the voltage V_4 across capacitor C_4,
(b) the energy U_7 on capacitor C_7,
(c) the charge Q_6 on capacitor C_6,
(d) the equivalent capacitance C_{eq}.





The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

(a) the voltage V_2 across capacitor C_2,
(b) the energy U_5 on capacitor C_5,
(c) the charge Q_3 on capacitor C_3,
(d) the equivalent capacitance C_{eq}.

(a) the voltage V_4 across capacitor C_4,
(b) the energy U_7 on capacitor C_7,
(c) the charge Q_6 on capacitor C_6,
(d) the equivalent capacitance C_{eq}.

Solution:

(a) $V_2 = 12\text{V}$.

(b) $U_5 = \frac{1}{2}(5\mu\text{F})(12\text{V})^2 = 360\mu\text{J}$.

(c) $C_{36} = 2\mu\text{F}$
$\Rightarrow \; Q_3 = Q_{36} = (12\text{V})(2\mu\text{F}) = 24\mu\text{C}$.

(d) $C_{eq} = C_5 + C_{36} + C_2 = 9\mu\text{F}$.

(a) $V_4 = 18\text{V}$.

(b) $U_7 = \frac{1}{2}(7\mu\text{F})(18\text{V})^2 = 1134\mu\text{J}$.

(c) $C_{36} = 2\mu\text{F}$
$\Rightarrow \; Q_6 = Q_{36} = (18\text{V})(2\mu\text{F}) = 36\mu\text{C}$.

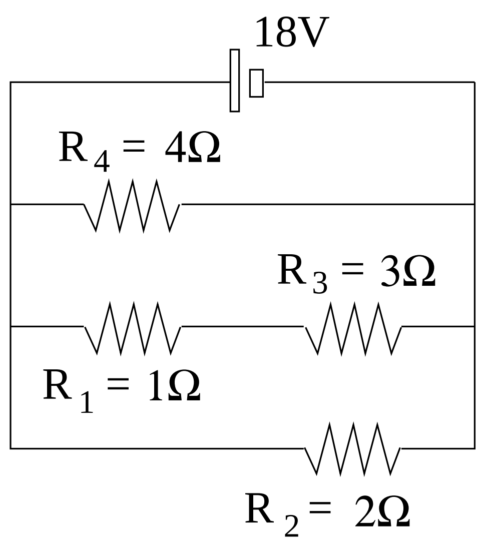
(d) $C_{eq} = C_4 + C_{36} + C_7 = 13\mu\text{F}$.

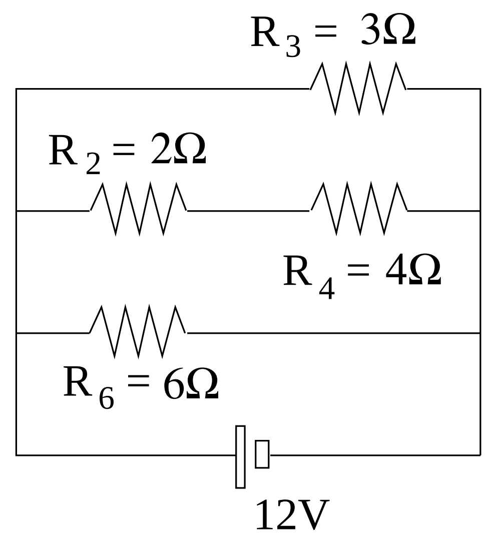
Unit Exam II: Problem #2 (Fall ’16)

This resistor circuit is in a state of steady currents. Find ...

(a) the voltage V_2 across resistor R_2,
(b) the power P_4 dissipated in resistor R_4,
(c) the current I_3 flowing through resistor R_3
(d) the equivalent resistance R_{eq}.

(a) the voltage V_3 across resistor R_3,
(b) the power P_6 dissipated in resistor R_6,
(c) the current I_4 flowing through resistor R_4,
(d) the equivalent resistance R_{eq}.





Unit Exam II: Problem #2 (Fall '16)

This resistor circuit is in a state of steady currents. Find ...

(a) the voltage V_2 across resistor R_2,
(b) the power P_4 dissipated in resistor R_4,
(c) the current I_3 flowing through resistor R_3
(d) the equivalent resistance R_{eq}.

(a) the voltage V_3 across resistor R_3,
(b) the power P_6 dissipated in resistor R_6,
(c) the current I_4 flowing through resistor R_4,
(d) the equivalent resistance R_{eq}.

Solution:

(a) $V_2 = 18\text{V}$.

(b) $P_4 = \dfrac{18\text{V}^2}{4\Omega} = 81\text{W}$.

(c) $I_3 = \dfrac{18\text{V}}{3\Omega + 1\Omega} = 4.5\text{A}$.

(d) $R_{eq} = \left(\dfrac{1}{4\Omega} + \dfrac{1}{1\Omega + 3\Omega} + \dfrac{1}{2\Omega}\right)^{-1} = 1\Omega$.

(a) $V_3 = 12\text{V}$

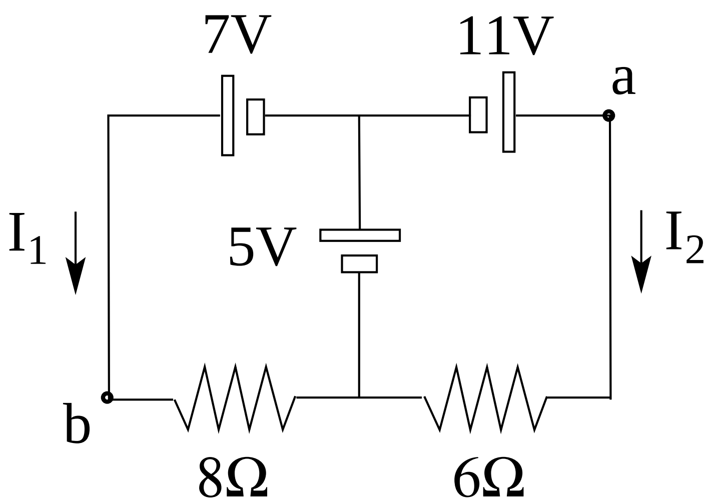
(b) $P_6 = \dfrac{12\text{V}^2}{6\Omega} = 24\text{W}$.

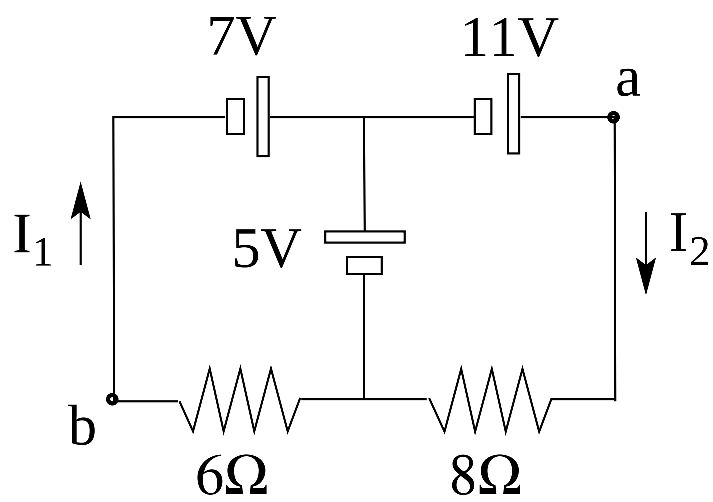
(c) $I_4 = \dfrac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}$.

(d) $R_{eq} = \left(\dfrac{1}{3\Omega} + \dfrac{1}{2\Omega + 4\Omega} + \dfrac{1}{6\Omega}\right)^{-1} = 1.5\Omega$

Unit Exam II: Problem #3 (Fall ’16)

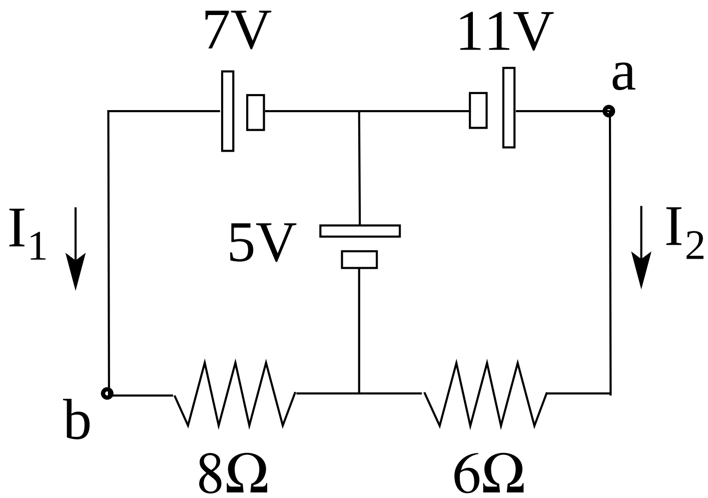
This two-loop resistor circuit is in a state of steady currents. Find ...
(a) the current I_1,
(b) the current I_2,
(c) the potential difference $V_a - V_b$.

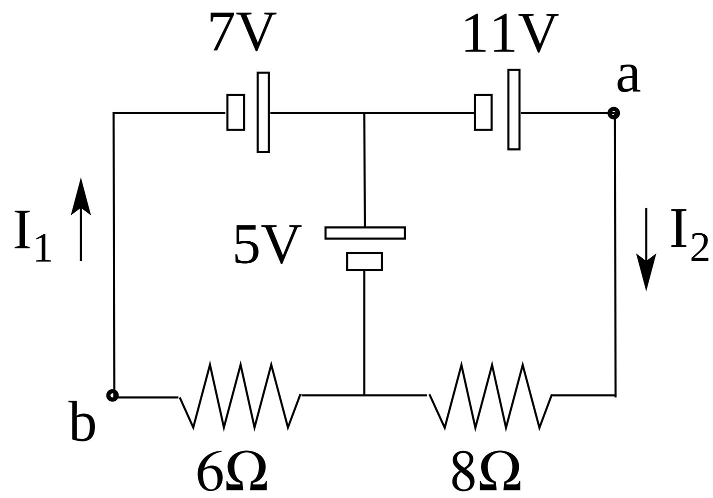




Unit Exam II: Problem #3 (Fall '16)

This two-loop resistor circuit is in a state of steady currents. Find ...
(a) the current I_1,
(b) the current I_2,
(c) the potential difference $V_a - V_b$.





Solution:

(a) $I_1 = \dfrac{5\text{V} + 7\text{V}}{8\Omega} = +1.5\text{A}.$

(b) $I_2 = \dfrac{5\text{V} + 11\text{V}}{6\Omega} = +2.67\text{A}.$

(c) $V_a - V_b = -7\text{V} + 11\text{V} = +4\text{V}.$

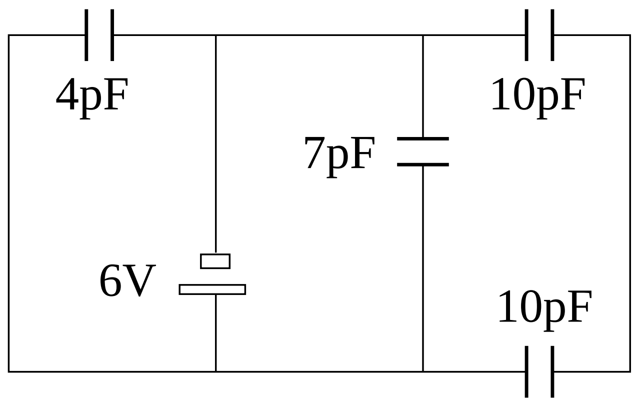
(a) $I_1 = \dfrac{7\text{V} - 5\text{V}}{6\Omega} = +0.333\text{A}.$

(b) $I_2 = \dfrac{5\text{V} + 11\text{V}}{8\Omega} = +2\text{A}.$

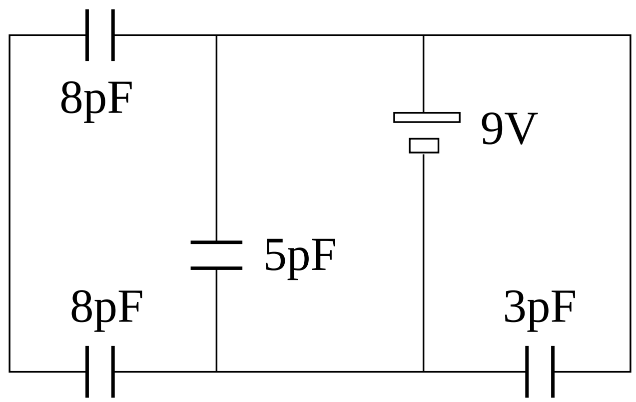
(c) $V_a - V_b = 7\text{V} + 11\text{V} = +18\text{V}.$

The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

(a) the charge Q_4 on the 4pF-capacitor,
(b) the energy U_7 on the 7pF-capacitor,
(c) the voltage V_{10} across the upper 10pF-capacitor,
(d) the equivalent capacitance C_{eq}.



(a) the charge Q_3 on the 3pF-capacitor,
(b) the energy U_5 on the 5pF-capacitor,
(c) the voltage V_8 across the lower 8pF-capacitor,
(d) the equivalent capacitance C_{eq}.



Unit Exam II: Problem #1 (Spring '17)

The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

(a) the charge Q_4 on the 4pF-capacitor,
(b) the energy U_7 on the 7pF-capacitor,
(c) the voltage V_{10} across the upper 10pF-capacitor,
(d) the equivalent capacitance C_{eq}.

(a) the charge Q_3 on the 3pF-capacitor,
(b) the energy U_5 on the 5pF-capacitor,
(c) the voltage V_8 across the lower 8pF-capacitor,
(d) the equivalent capacitance C_{eq}.

Solution:

(a) $Q_4 = (6\mathrm{V})(4\mathrm{pF}) = 24\mathrm{pC}.$

(b) $U_7 = \frac{1}{2}(7\mathrm{pF})(6\mathrm{V})^2 = 126\mathrm{pJ}.$

(c) $V_{10} = \frac{1}{2}\,6\mathrm{V} = 3\mathrm{V}.$

(d) $C_{eq} = 4\mathrm{pF} + 7\mathrm{pF} + 5\mathrm{pF} = 16\mathrm{pF}.$

(a) $Q_3 = (9\mathrm{V})(3\mathrm{pF}) = 27\mathrm{pC}.$

(b) $U_5 = \frac{1}{2}(5\mathrm{pF})(9\mathrm{V})^2 = 202.5\mathrm{pJ}.$

(c) $V_8 = \frac{1}{2}\,9\mathrm{V} = 4.5\mathrm{V}.$

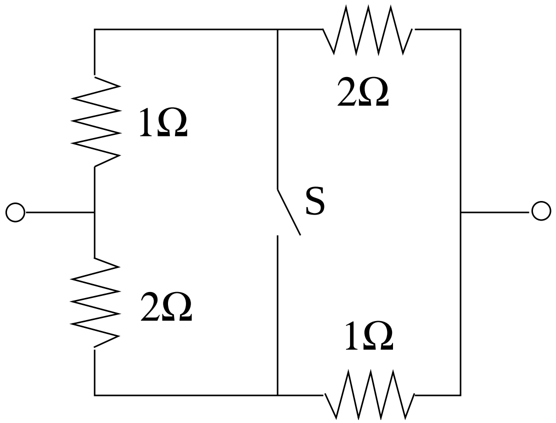
(d) $C_{eq} = 3\mathrm{pF} + 5\mathrm{pF} + 4\mathrm{pF} = 12\mathrm{pF}.$

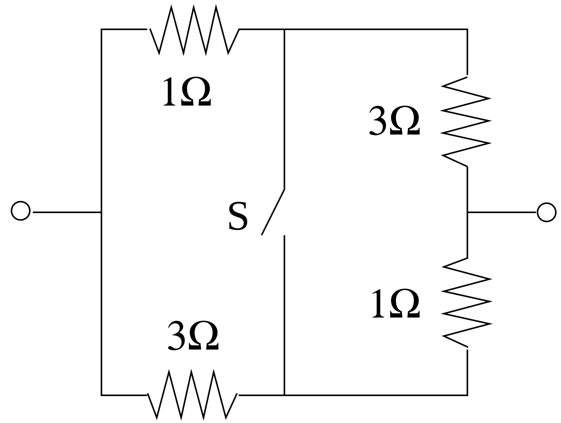
Unit Exam II: Problem #2 (Spring '17)

Consider this circuit with two terminals, four resistors, and one switch.

(a) Find the equivalent resistance $R_{\mathrm{eq}}^{(\mathrm{open})}$ when the switch is open.

(b) Find the equivalent resistance $R_{\mathrm{eq}}^{(\mathrm{closed})}$ when the switch is closed.

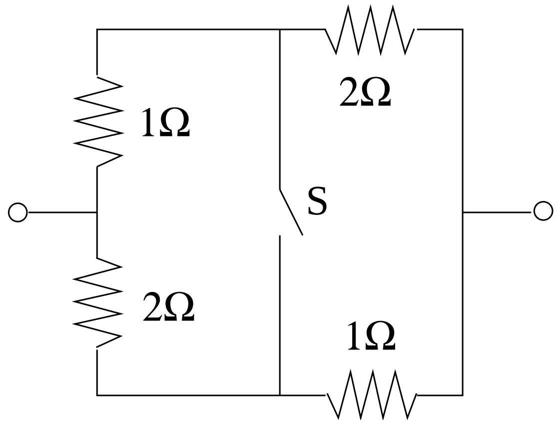


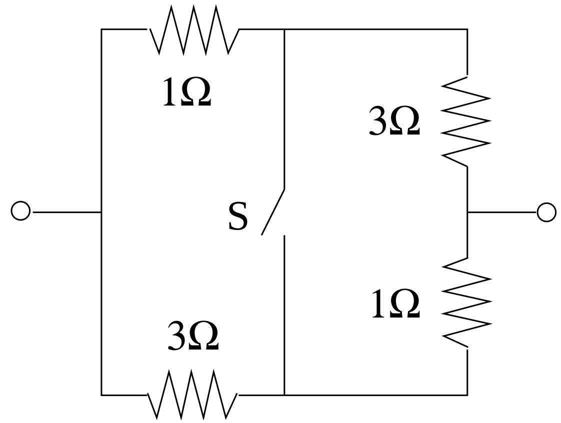


Consider this circuit with two terminals, four resistors, and one switch.

(a) Find the equivalent resistance $R_{\mathrm{eq}}^{(\mathrm{open})}$ when the switch is open.

(b) Find the equivalent resistance $R_{\mathrm{eq}}^{(\mathrm{closed})}$ when the switch is closed.





Solution:

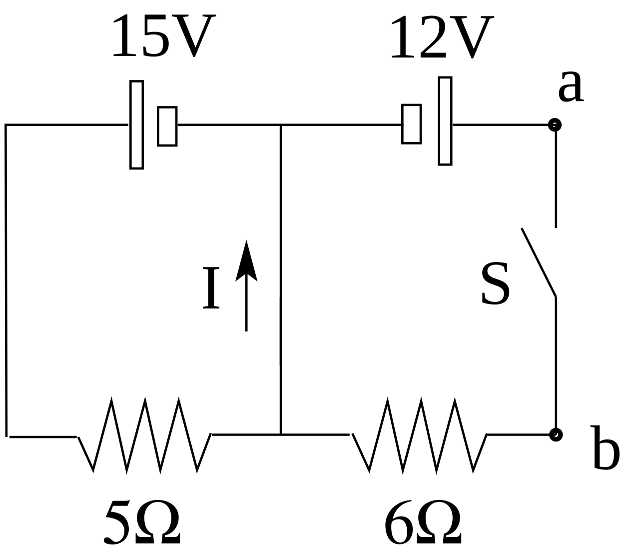
$$R_{\mathrm{eq}}^{(\mathrm{open})} = \left(\frac{1}{1\Omega + 2\Omega} + \frac{1}{1\Omega + 2\Omega}\right)^{-1} = \frac{3}{2}\Omega.$$

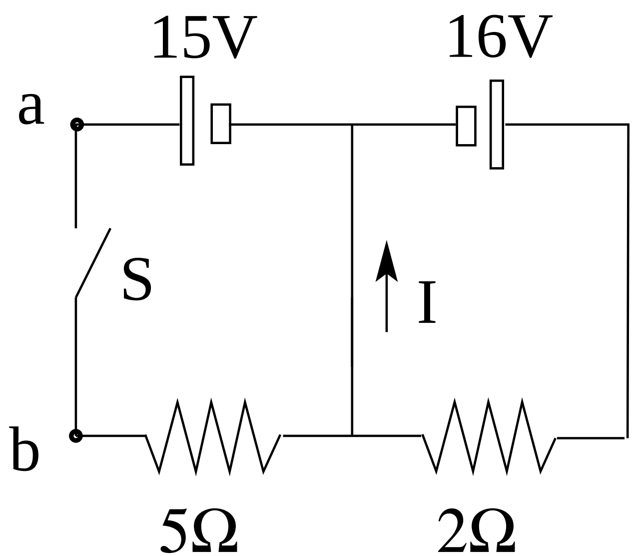
$$R_{\mathrm{eq}}^{(\mathrm{closed})} = \left(\frac{1}{1\Omega} + \frac{1}{2\Omega}\right)^{-1} + \left(\frac{1}{1\Omega} + \frac{1}{2\Omega}\right)^{-1} = \frac{4}{3}\Omega.$$

$$R_{\mathrm{eq}}^{(\mathrm{open})} = \left(\frac{1}{1\Omega + 3\Omega} + \frac{1}{1\Omega + 3\Omega}\right)^{-1} = 2\Omega.$$

$$R_{\mathrm{eq}}^{(\mathrm{closed})} = \left(\frac{1}{1\Omega} + \frac{1}{3\Omega}\right)^{-1} + \left(\frac{1}{1\Omega} + \frac{1}{3\Omega}\right)^{-1} = \frac{3}{2}\Omega.$$

Consider this circuit with two batteries, two resistors, and one switch.
(a) Find the current I when the switch is open.
(b) Find the current I when the switch is closed.
(c) Find the potential difference $V_a - V_b$ when the switch is open.
(d) Find the potential difference $V_a - V_b$ when the switch is closed.





Unit Exam II: Problem #3 (Spring '17)

Consider this circuit with two batteries, two resistors, and one switch.
(a) Find the current I when the switch is open.
(b) Find the current I when the switch is closed.
(c) Find the potential difference $V_a - V_b$ when the switch is open.
(d) Find the potential difference $V_a - V_b$ when the switch is closed.

Solution:

(a) $I = \dfrac{15\text{V}}{5\Omega} = 3\text{A}.$

(b) $I = \dfrac{15\text{V}}{5\Omega} + \dfrac{12\text{V}}{6\Omega} = 3\text{A} + 2\text{A} = 5\text{A}.$

(c) $V_a - V_b = 12\text{V}.$

(d) $V_a - V_b = 0.$

(a) $I = \dfrac{16\text{V}}{2\Omega} = 8\text{A}.$

(b) $I = \dfrac{16\text{V}}{2\Omega} + \dfrac{15\text{V}}{5\Omega} = 8\text{A} + 3\text{A} = 11\text{A}.$

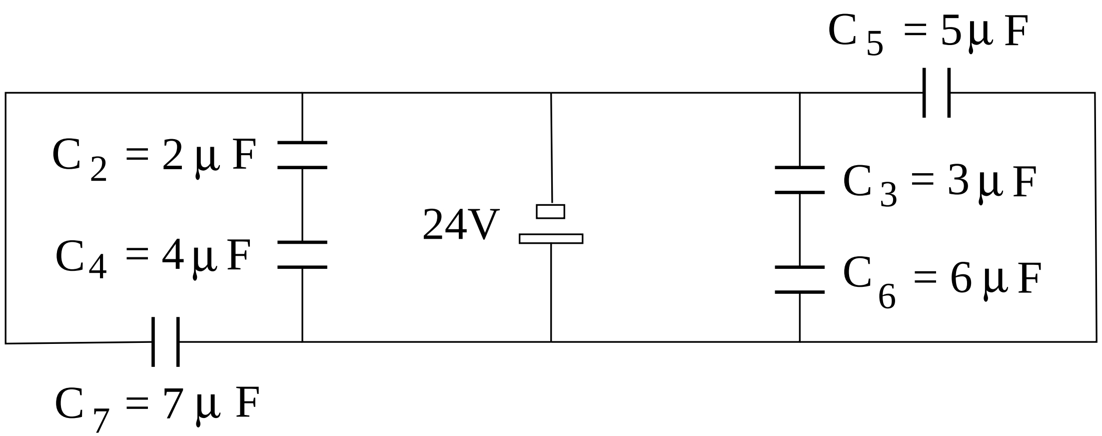
(c) $V_a - V_b = 15\text{V}.$

(d) $V_a - V_b = 0.$

Unit Exam II: Problem #1 (Fall ’17)

This circuit is at equilibrium.

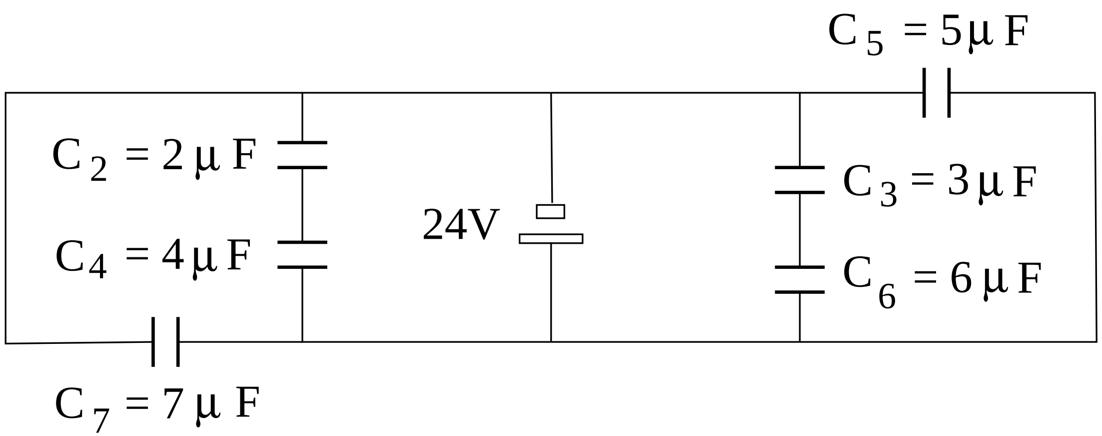
- Find the charge Q_7 on capacitor C_7 [Q_5 on C_5].
- Find the energy U_5 on capacitor C_5 [U_7 on C_7].
- Find the voltages V_2, V_4 across capacitors C_2, C_4 [V_3, V_6 across C_3, C_6].



Unit Exam II: Problem #1 (Fall ’17)

This circuit is at equilibrium.

- Find the charge Q_7 on capacitor C_7 [Q_5 on C_5].
- Find the energy U_5 on capacitor C_5 [U_7 on C_7].
- Find the voltages V_2, V_4 across capacitors C_2, C_4 [V_3, V_6 across C_3, C_6].



Solution:

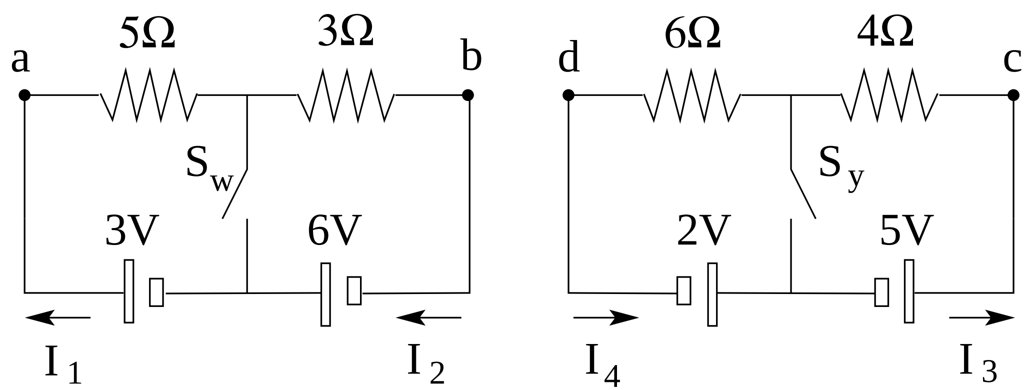
- $Q_7 = (24\text{V})(7\mu\text{F}) = 168\mu\text{C} \quad [Q_5 = (24\text{V})(5\mu\text{F}) = 120\mu\text{C}]$
- $U_5 = \frac{1}{2}(5\mu\text{F})(24\text{V})^2 = 1440\mu\text{J} \quad \left[U_7 = \frac{1}{2}(7\mu\text{F})(24\text{V})^2 = 2016\mu\text{J}\right]$
- $V_2 + V_4 = 24\text{V}, \quad V_2C_2 = V_4C_4 \quad \Rightarrow V_2 = 16\text{V}, \quad V_4 = 8\text{V}$
  $[V_3 + V_6 = 24\text{V}, \quad V_3C_3 = V_6C_6 \quad \Rightarrow V_3 = 16\text{V}, \quad V_6 = 8\text{V}]$

Unit Exam II: Problem #2 (Fall ’17)

Consider the resistor circuit on the left [right].
Find the currents I_1, I_2 [I_3, I_4] and the potential difference $V_a - V_b$ [$V_c - V_d$]

(a) when the switch S_w [S_y] is open,

(b) when the switch S_w [S_y] is closed

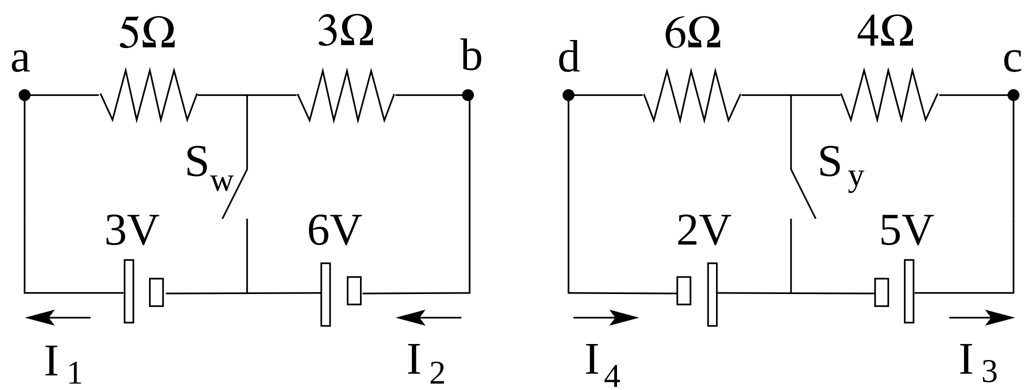


Unit Exam II: Problem #2 (Fall ’17)

Consider the resistor circuit on the left [right].
Find the currents I_1, I_2 [I_3, I_4] and the potential difference $V_a - V_b$ [$V_c - V_d$]

(a) when the switch S_w [S_y] is open,

(b) when the switch S_w [S_y] is closed



Solution:

(a) $I_1 = I_2 = \dfrac{3\mathrm{V} + 6\mathrm{V}}{5\Omega + 3\Omega} = 1.125\mathrm{A}, \quad V_a - V_b = 9V.$

$\left[I_3 = I_4 = \dfrac{2\mathrm{V} + 5\mathrm{V}}{6\Omega + 4\Omega} = 0.7\mathrm{A}, \quad V_c - V_d = 7V. \right]$

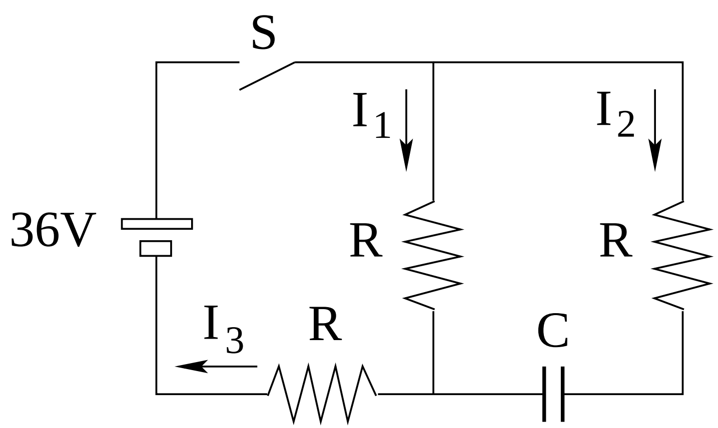
(b) $I_1 = \dfrac{3\mathrm{V}}{5\Omega} = 0.6\mathrm{A}, \quad I_2 = \dfrac{6\mathrm{V}}{3\Omega} = 2\mathrm{A}, \quad V_a - V_b = 9V.$

$\left[I_3 = \dfrac{5\mathrm{V}}{4\Omega} = 1.25\mathrm{A}, \quad I_4 = \dfrac{2\mathrm{V}}{6\Omega} = 0.333\mathrm{A}, \quad V_c - V_d = 7V. \right]$

The switch S of this circuit has been open for a long time. The capacitor has capacitance $C = 6$pF [$C = 4$pF]. Each resistor has resistance $R = 6\Omega$ [$R = 4\Omega$].

(a) Find the currents I_1, I_2, I_3 right after the switch has been closed.

(b) Find the currents I_1, I_2, I_3 a long time later



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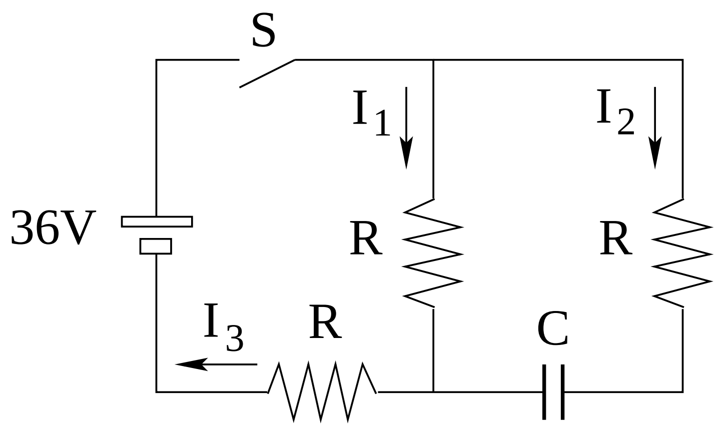
(a) Find the currents I_1, I_2, I_3 right after the switch has been closed.

(b) Find the currents I_1, I_2, I_3 a long time later



Solution:

(a) no voltage across capacitor: $R_{eq} = 9\Omega \quad [R_{eq} = 6\Omega]$

$$I_3 = I_1 + I_2 = \frac{36\text{V}}{9\Omega} = 4\text{A}, \quad I_1 = I_2 = 2\text{A} \quad \left[I_3 = I_1 + I_2 = \frac{36\text{V}}{6\Omega} = 6\text{A}, \quad I_1 = I_2 = 3\text{A} \right].$$

(b) no current through capacitor: $R_{eq} = 12\Omega \quad [R_{eq} = 8\Omega]$

$$I_1 = I_3 = \frac{36\text{V}}{12\Omega} = 3\text{A}, \quad I_2 = 0, \quad \left[I_1 = I_3 = \frac{36\text{V}}{8\Omega} = 4.5\text{A}, \quad I_2 = 0 \right].$$

Unit Exam II: Problem #1 (Spring ’18)

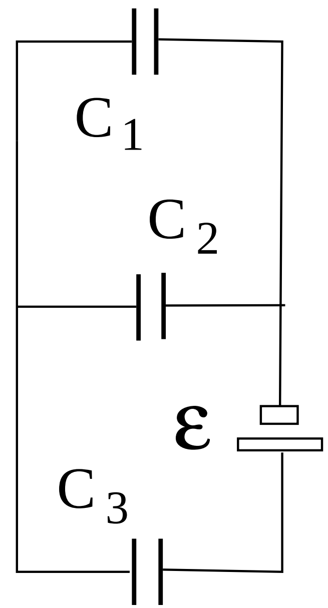
The circuit shown has reached equilibrium.
The specifications are $\mathcal{E} = 12$V [18V], $C_1 = C_2 = C_3 = 5$nF [4nF]

(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.



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

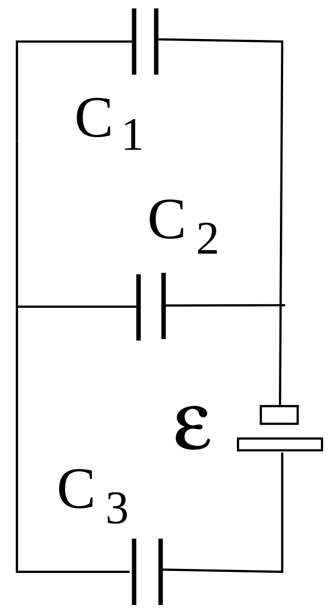
The circuit shown has reached equilibrium.
The specifications are $\mathcal{E} = 12$V [18V], $C_1 = C_2 = C_3 = 5$nF [4nF]

(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.



Solution:

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

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

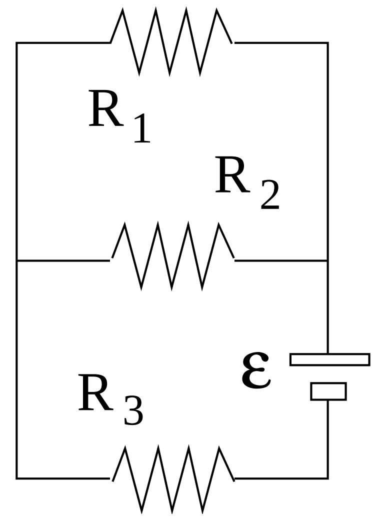
(b) $Q_3 = Q_{12} = \mathcal{E}C_{eq} = 40\text{nC}\ [48\text{nC}], \quad Q_1 = Q_2 = \frac{1}{2}Q_{12} = 20\text{nC}\ [24\text{nC}].$

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

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

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}.

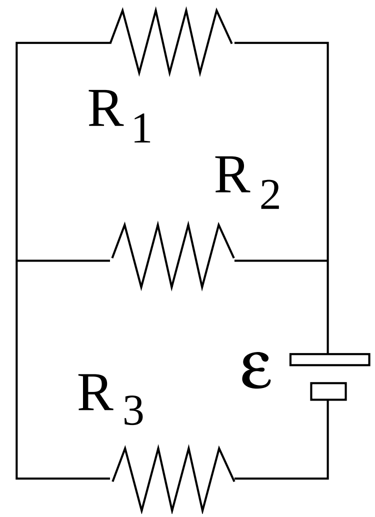
(b) Find the currents I_1 through resistor R_1.

(c) Find the voltage V_3 across resistor R_3.

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

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.

Solution:

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

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

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

Unit Exam II: Problem #3 (Spring ’18)

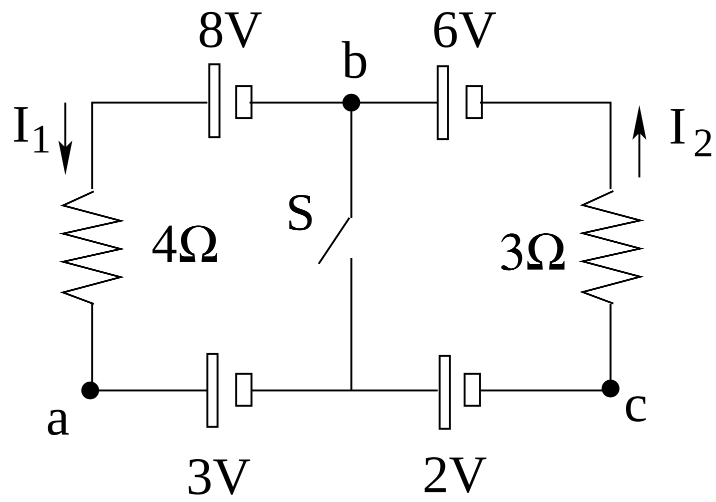
This circuit is in a steady state with the switch S either open or closed.

(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.



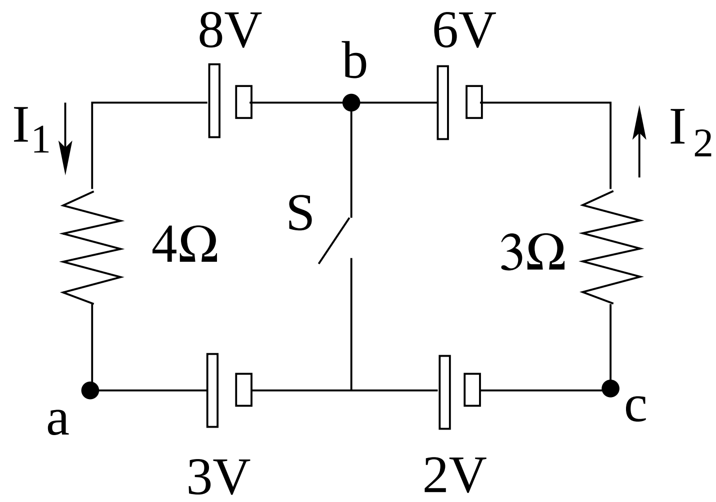
This circuit is in a steady state with the switch S either open or closed.

(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.



Solution:

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

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

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

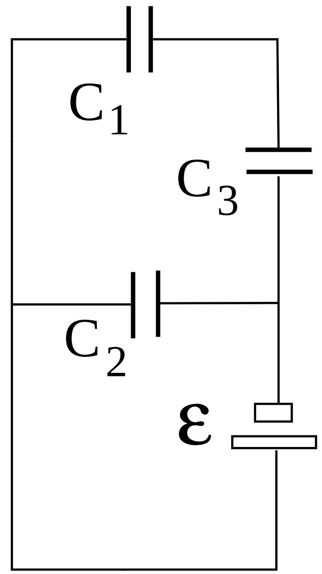
(d) $V_a - V_b = 3\mathrm{V}, \quad V_b - V_c = 2\mathrm{V}.$

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.



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

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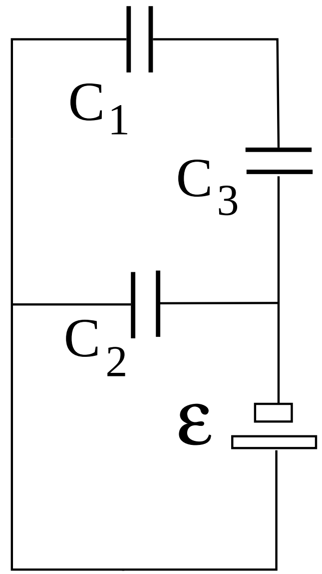


Solution:

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

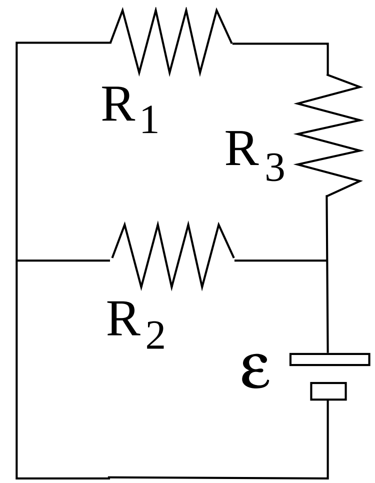
Unit Exam II: Problem #2 (Fall '18)

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

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

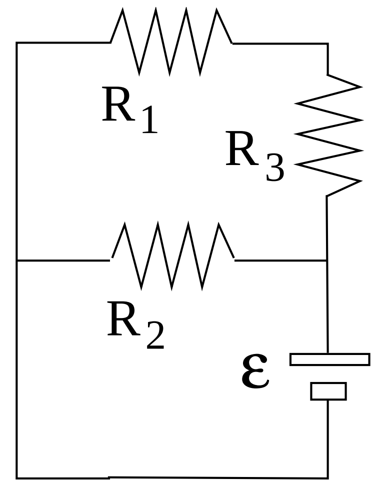
(b) Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.

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

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

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

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

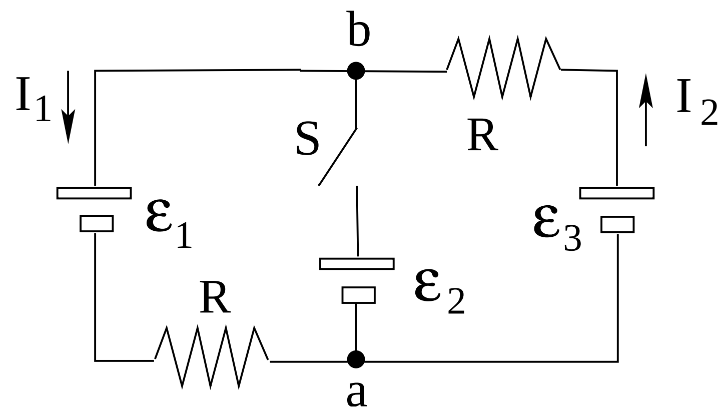
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4$V [3V], $\mathcal{E}_2 = 6$V [7V], $\mathcal{E}_3 = 10$V [9V], $R = 7\Omega$ [11Ω].

(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)

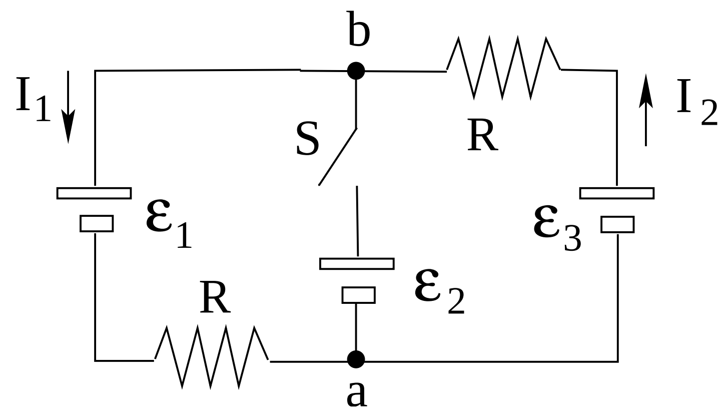
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4$V [3V], $\mathcal{E}_2 = 6$V [7V], $\mathcal{E}_3 = 10$V [9V], $R = 7\Omega$ [11Ω].

(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.



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

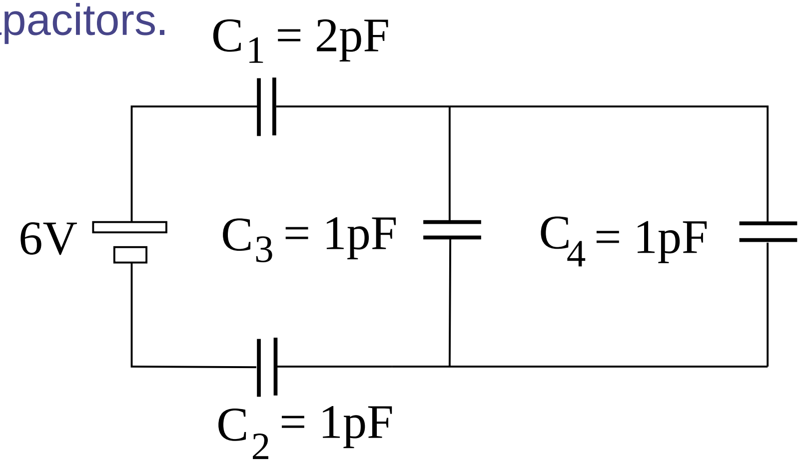
Unit Exam II: Problem #1 (Spring '19)

The circuit shown has reached equilibrium.

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

(b) Find the charges Q_1, Q_2, Q_3, Q_4 on the four capacitors.

(c) Find the voltages V_1, V_2, V_3, V_4 across the four capacitors.



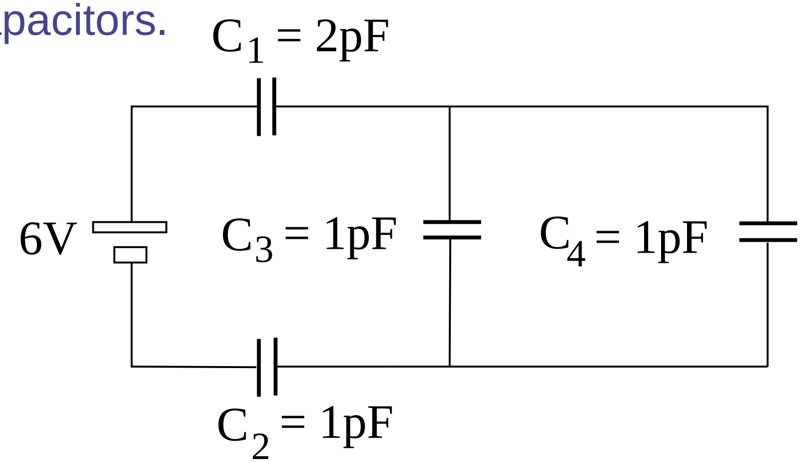
Unit Exam II: Problem #1 (Spring ’19)

The circuit shown has reached equilibrium.

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

(b) Find the charges Q_1, Q_2, Q_3, Q_4 on the four capacitors.

(c) Find the voltages V_1, V_2, V_3, V_4 across the four capacitors.



Solution:

(a) $C_{34} = C_3 + C_4 = 2\text{pF}, \quad C_{eq} = \left(\frac{1}{C_1} + \frac{1}{C_{34}} + \frac{1}{C_2}\right)^{-1} = \frac{1}{2}\text{pF}.$

(b) $Q_1 = Q_2 = Q_{34} = C_{eq}(6\text{V}) = 3\text{pC}, \quad Q_3 = Q_4 = \frac{1}{2}Q_{34} = 1.5\text{pC}.$

(c) $V_1 = \frac{Q_1}{C_1} = 1.5\text{V}, \quad V_2 = \frac{Q_2}{C_2} = 3\text{V}, \quad V_3 = \frac{Q_3}{C_3} = 1.5\text{V}, \quad V_4 = \frac{Q_4}{C_4} = 1.5\text{V}.$

Unit Exam II: Problem #2 (Spring ’19)

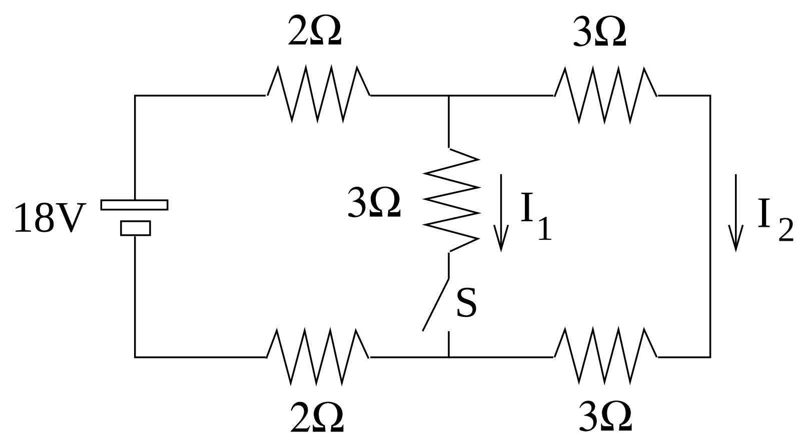
The circuit shown is in a steady state with the switch S either open or closed.

(a) Find the equivalent resistance R_{eq} when the switch is open.

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

(c) Find the equivalent resistance R_{eq} when the switch is closed.

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



Unit Exam II: Problem #2 (Spring ’19)

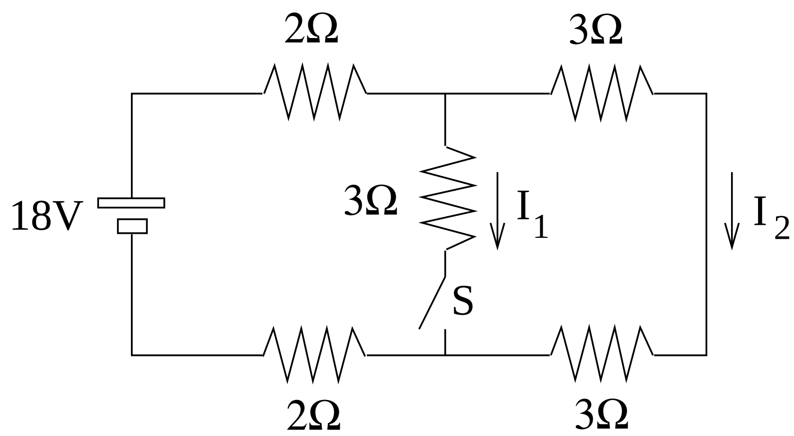
The circuit shown is in a steady state with the switch S either open or closed.

(a) Find the equivalent resistance R_{eq} when the switch is open.

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

(c) Find the equivalent resistance R_{eq} when the switch is closed.

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



Solution:

(a) $R_{eq} = 2\Omega + 3\Omega + 3\Omega + 2\Omega = 10\Omega.$

(b) $I_1 = 0, \quad I_2 = \dfrac{18\text{V}}{10\Omega} = 1.8\text{A}.$

(c) $R_{eq} = 2\Omega + \left(\dfrac{1}{3\Omega} + \dfrac{1}{3\Omega + 3\Omega}\right)^{-1} + 2\Omega = 6\Omega.$

(d) $I_1 = \dfrac{6\text{V}}{3\Omega} = 2\text{A}, \quad I_2 = \dfrac{6\text{V}}{3\Omega + 3\Omega} = 1\text{A}.$

Unit Exam II: Problem #3 (Spring '19)

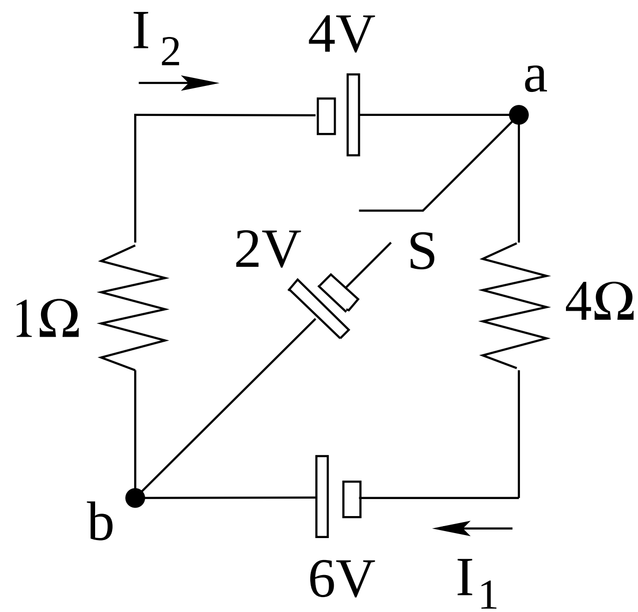
This circuit is in a steady state with the switch S either open or closed.

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

(b) Find the voltage $V_a - V_b$ when the switch is open.

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

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



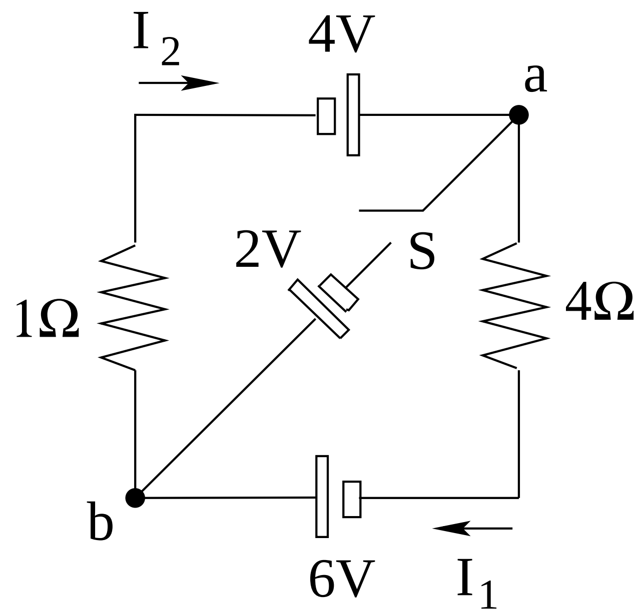
This circuit is in a steady state with the switch S either open or closed.

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

(b) Find the voltage $V_a - V_b$ when the switch is open.

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

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



Solution:

(a) $I_1 = I_2 = \dfrac{4\text{V} + 6\text{V}}{1\Omega + 4\Omega} = 2\text{A}.$

(b) $V_a - V_b = -(1\Omega)(2\text{A}) + 4\text{V} = 2\text{V}, \quad V_a - V_b = -6\text{V} + (4\Omega)(2\text{A}) = 2\text{V}.$

(c) $I_1 = \dfrac{6\text{V} - 2\text{V}}{4\Omega} = 1\text{A}, \quad I_2 = \dfrac{4\text{V} + 2\text{V}}{1\Omega} = 6\text{A}.$

(d) $V_a - V_b = -2\text{V}.$