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E2. Previous Unit Exams 2

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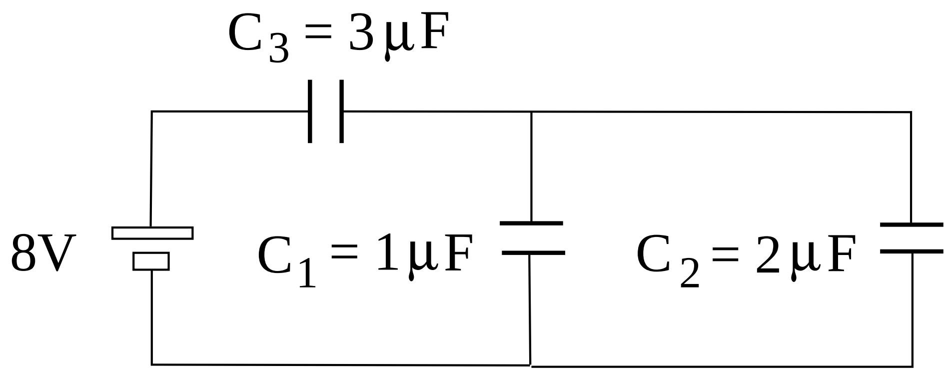
Abstract
Exam slides 2 for Elementary Physics II (PHY 204), taught by Gerhard Müller at the University of Rhode Island.
Some of the slides contain figures from the textbook, Paul A. Tipler and Gene Mosca. *Physics for Scientists and Engineers*, 5th/6th editions. The copyright to these figures is owned by W.H. Freeman. We acknowledge permission from W.H. Freeman to use them on this course web page. The textbook figures are not to be used or copied for any purpose outside this class without direct permission from W.H. Freeman.

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.



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}.

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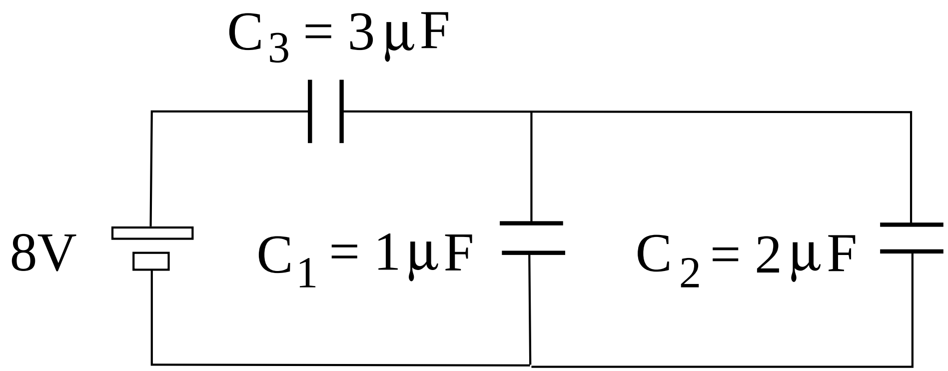


Solution:

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

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

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

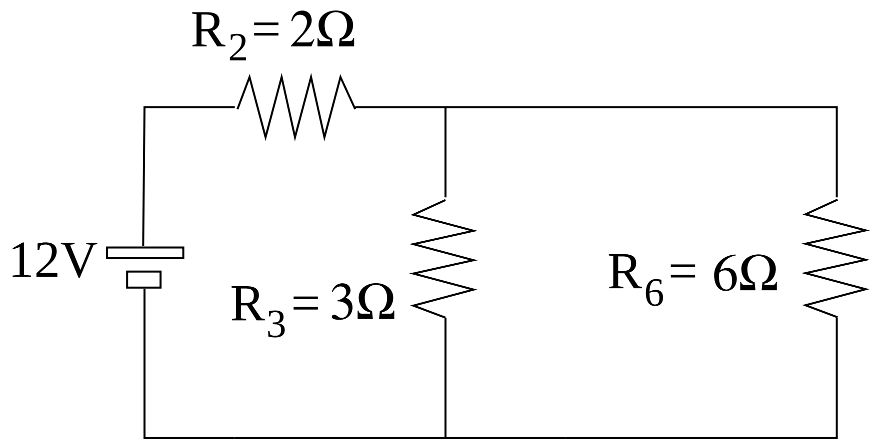
(c) $Q_2 = V_2 C_2 = 8\mu\mathrm{C}.$

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.



Consider the electrical circuit shown.

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

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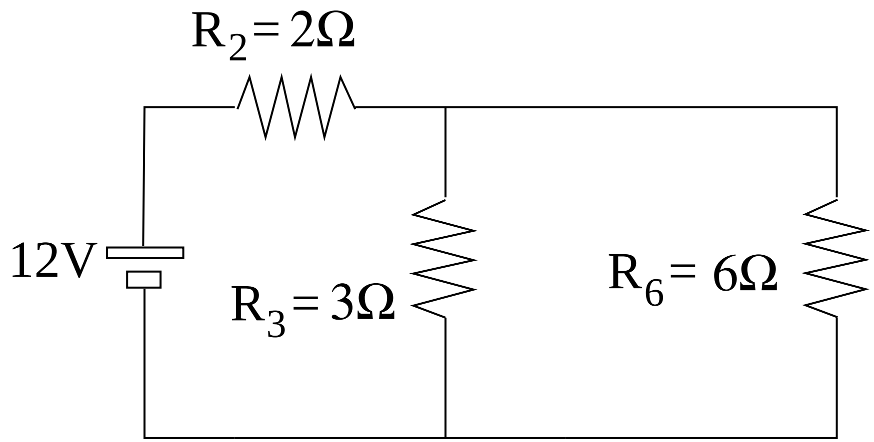


Solution:

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

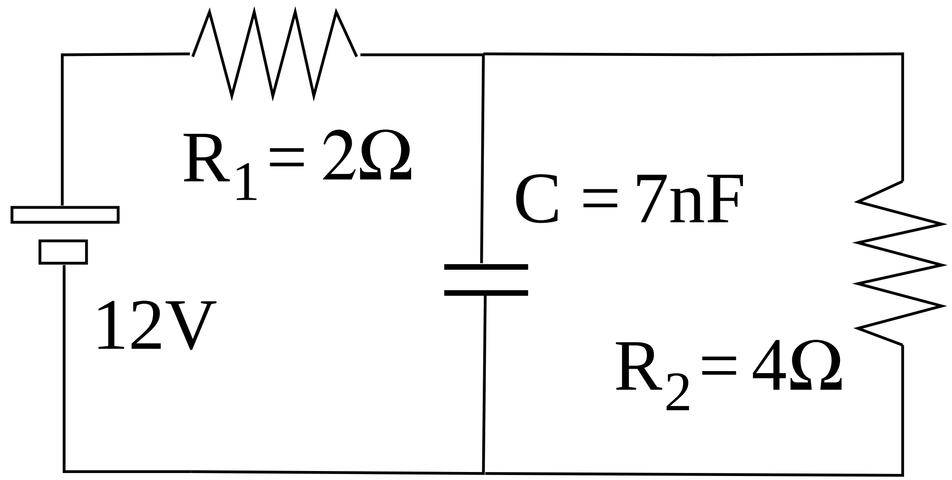
$\Rightarrow V_3 = V_{36} = I_{36}R_{36} = 6\text{V} \quad \Rightarrow I_3 = \frac{V_3}{R_3} = 2\text{A}.$

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.

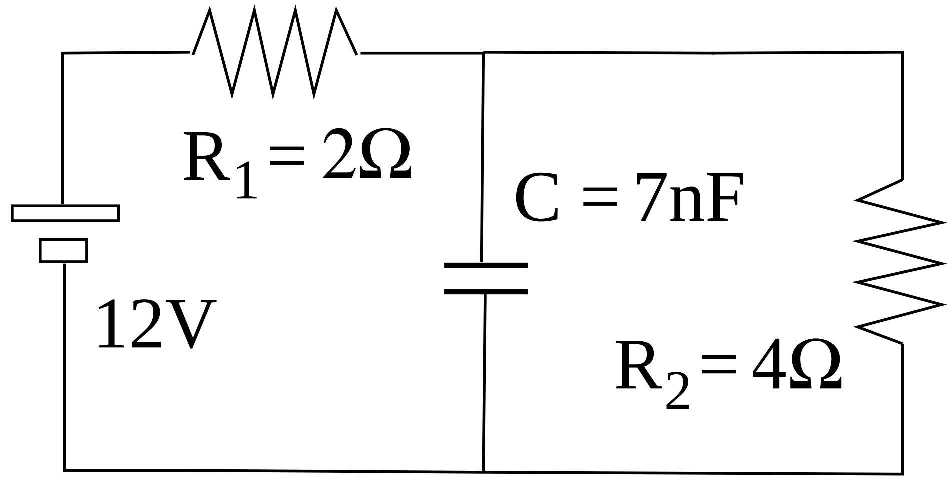
(b) Find the voltage V_C across the capacitor.



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.



Solution:

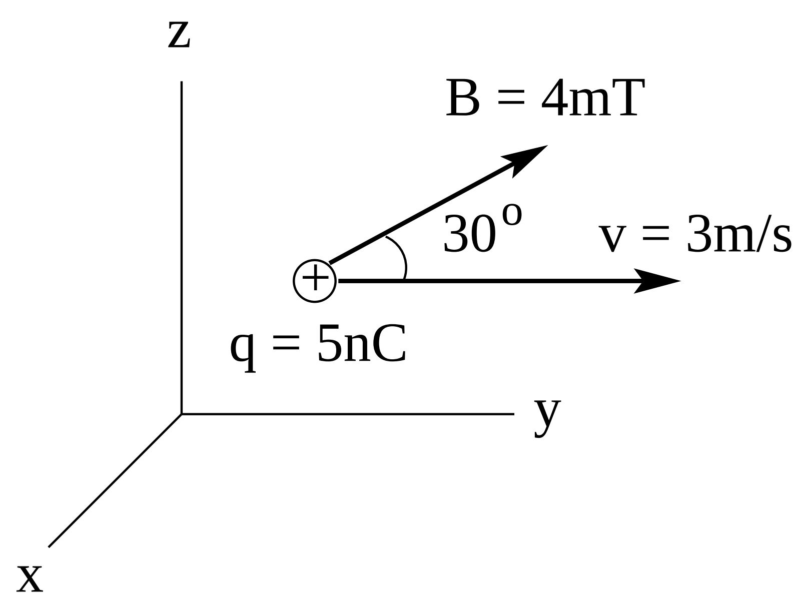
(a) $I_C = 0, \quad I_2 = \dfrac{\mathcal{E}}{R_1 + R_2} = \dfrac{12\text{V}}{6\Omega} = 2\text{A}.$

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

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.

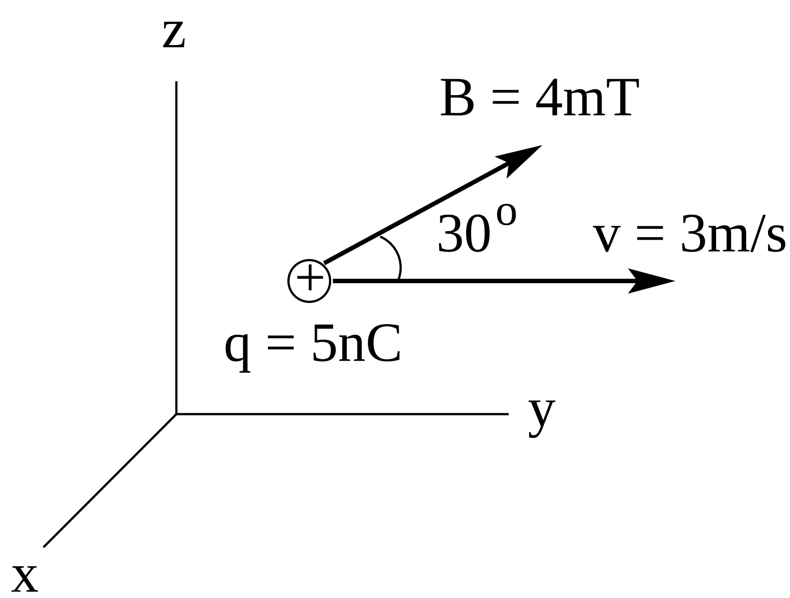


Intermediate Exam II: Problem #4 (Spring ’05)

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.



Solution:

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

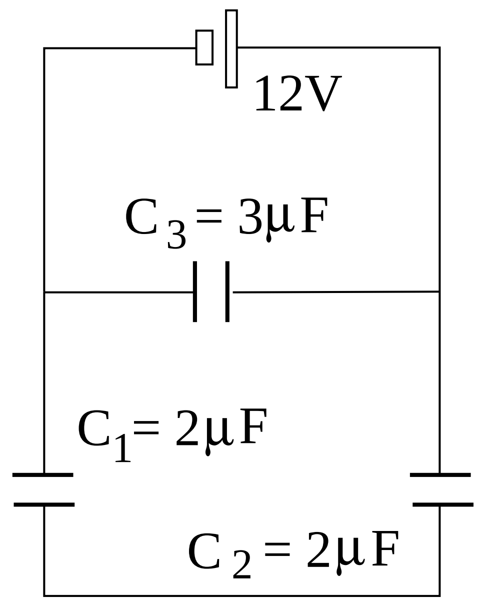
(b) $F = qvB\sin 30° = (5\times10^{-9}\mathrm{C})(3\mathrm{m/s})(4\times10^{-3}\mathrm{T})(0.5) = 3\times10^{-11}\mathrm{N}.$

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.

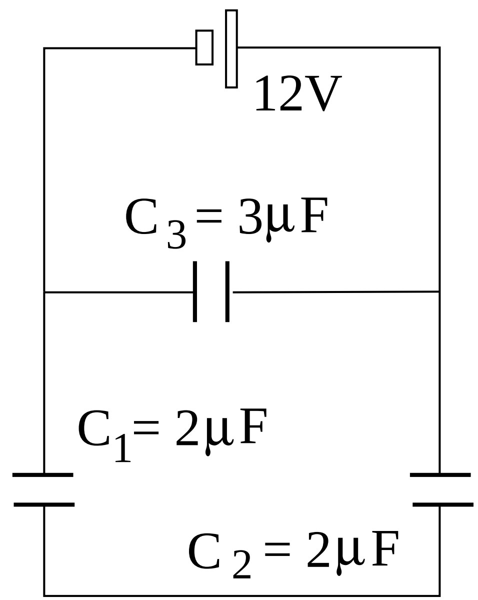


Intermediate Exam II: Problem #1 (Spring '06)

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:

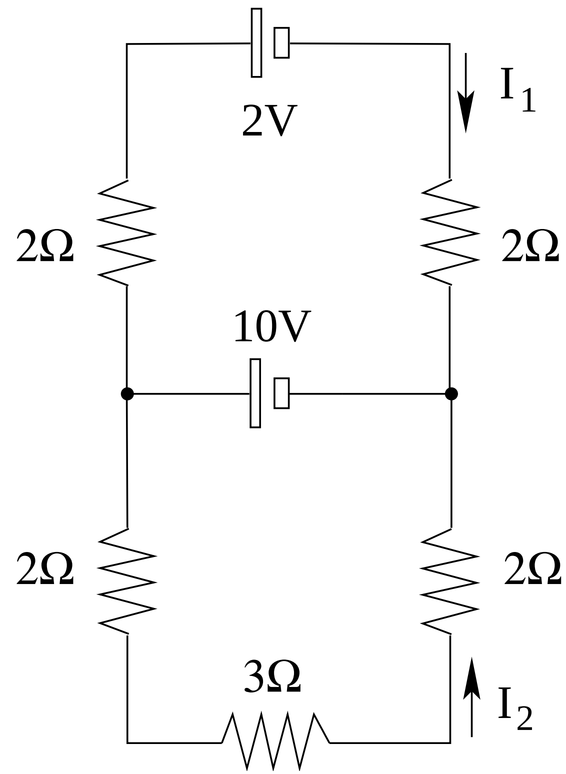
(a) $Q_3 = C_3(12\text{V}) = (3\mu\text{F})(12\text{V}) = 36\mu\text{C}$.

(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.



Consider the two-loop circuit shown.

(a) Find the current I_1.

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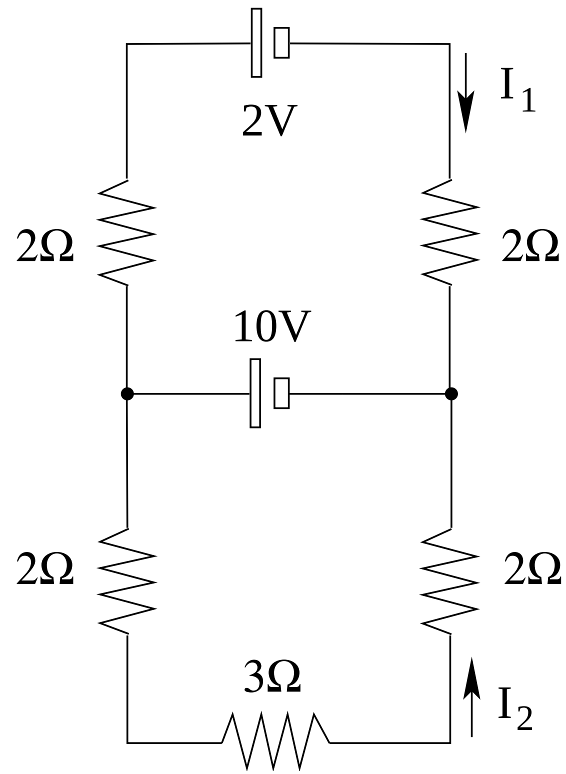


Solution:

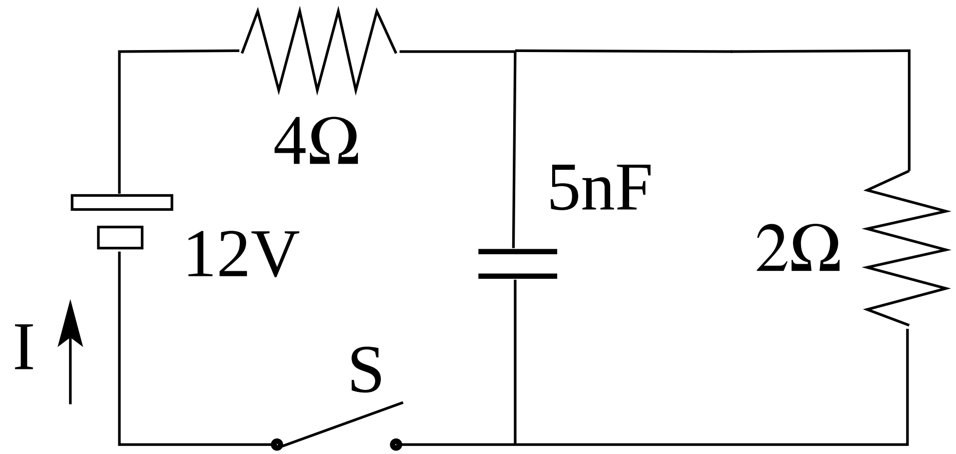
(a) $-(2\Omega)(I_1) + 10\text{V} - (2\Omega)(I_1) - 2\text{V} = 0 \quad \Rightarrow \; I_1 = \dfrac{8\text{V}}{4\Omega} = 2\text{A}.$

(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.

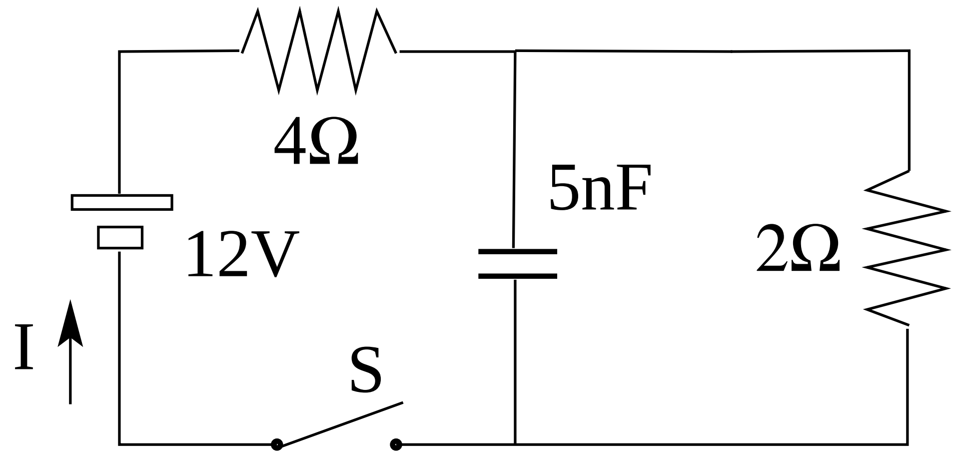


Intermediate Exam II: Problem #3 (Spring ’06)

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

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

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



Solution:

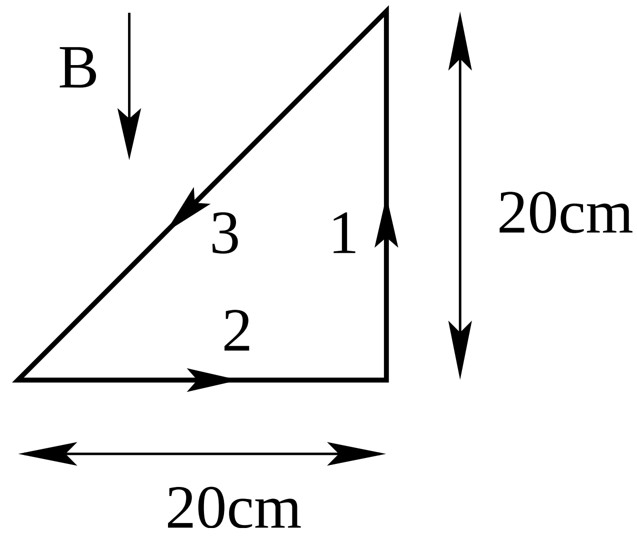
(a) No current through 2Ω-resistor: $I = \dfrac{12\text{V}}{4\Omega} = 3\text{A}.$

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

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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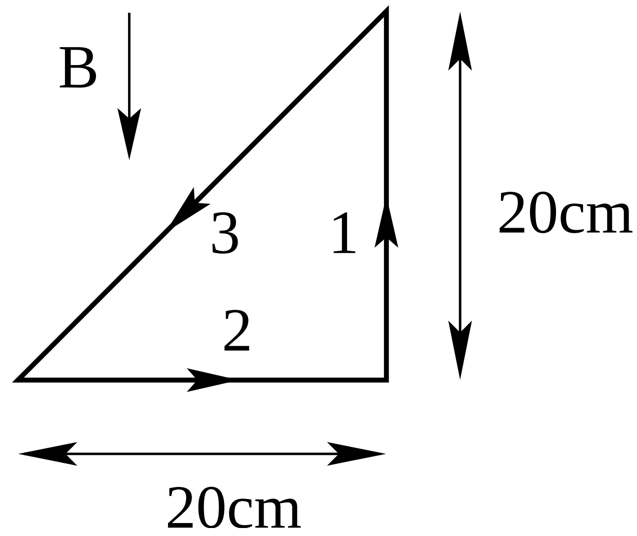


Solution:

(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).

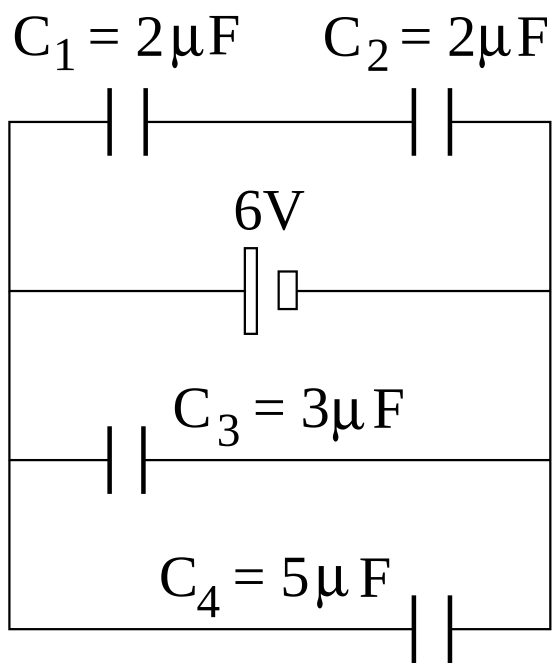
Consider the configuration of two point charges as shown.

(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.



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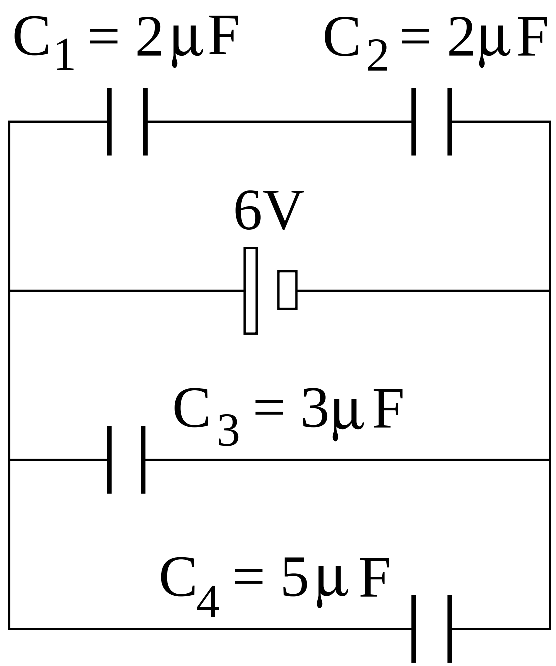


Solution:

(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)

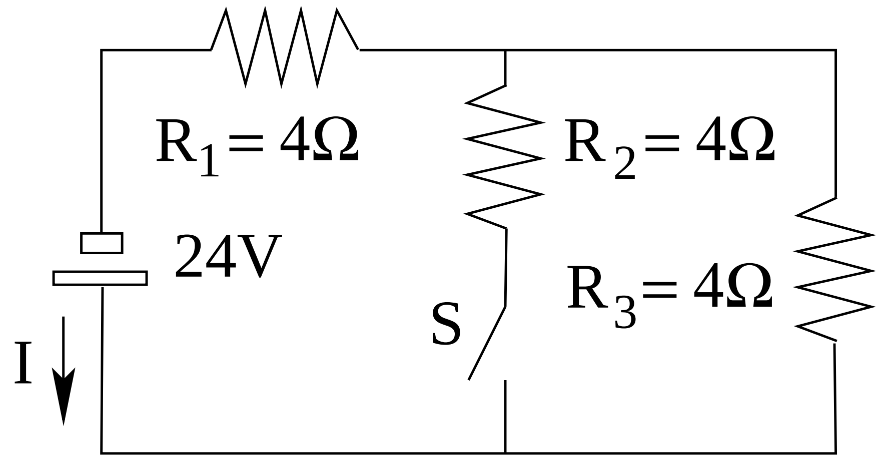
Consider the electric circuit shown.

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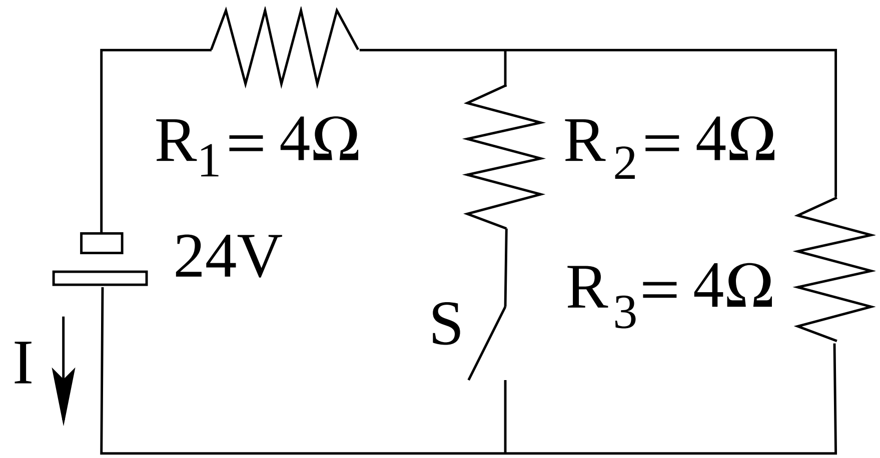
(c) Find the current I when the switch S is closed.

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



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

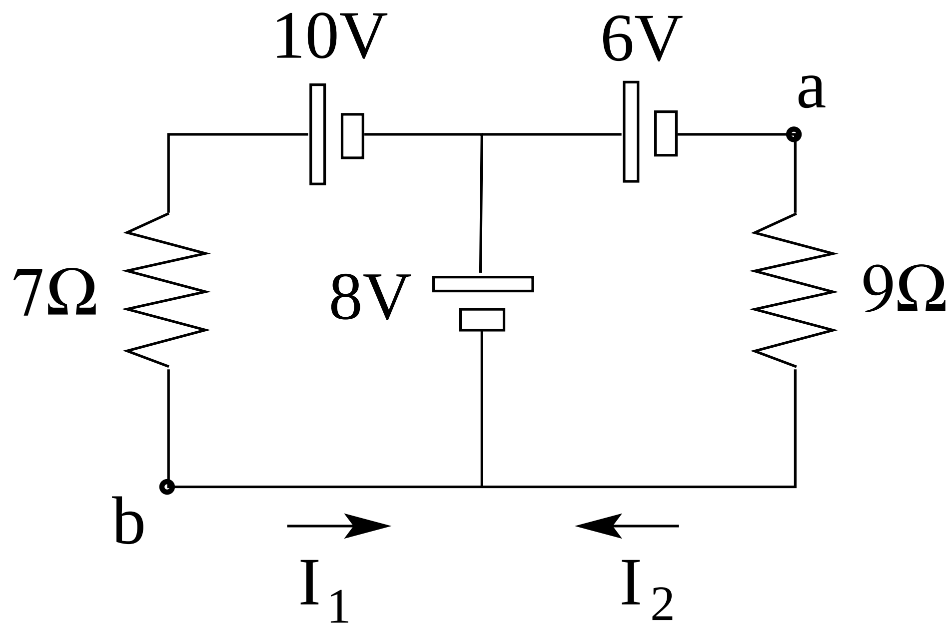
(d) $P_3 = (2\text{A})^2(4\Omega) = 16\text{W}.$

Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.

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

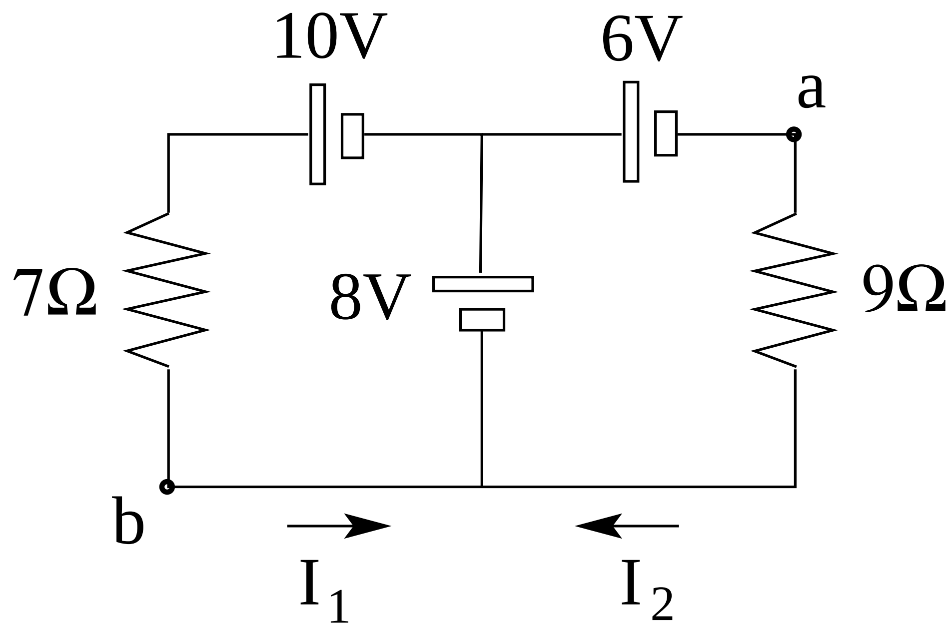


Consider the two-loop circuit shown.

(a) Find the current I_1.

(b) Find the current I_2.

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



Solution:

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

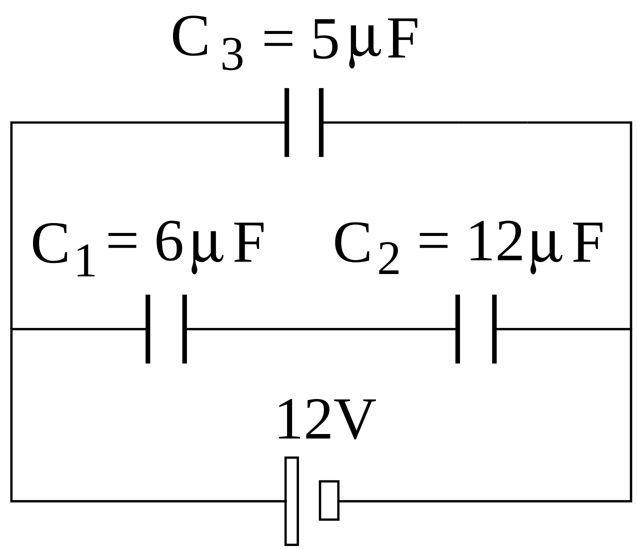
(b) $I_2 = \dfrac{8\mathrm{V} - 6\mathrm{V}}{9\Omega} = 0.22\mathrm{A}.$

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

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.



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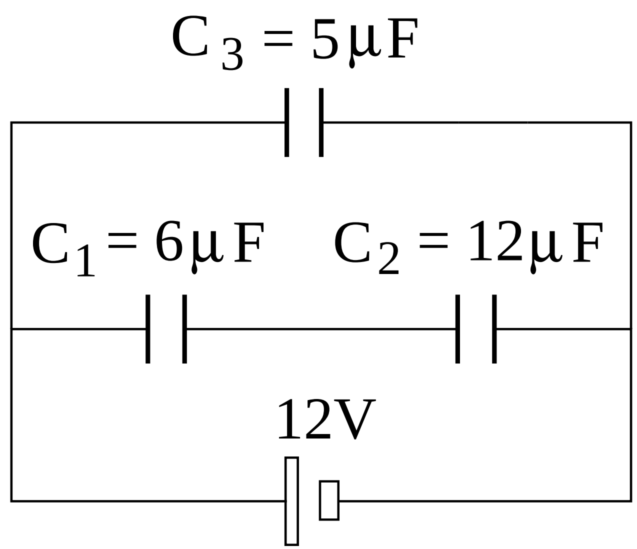
(c) Find the charge Q_3 and the energy U_3 on capacitor 3.



Solution:

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

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

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

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

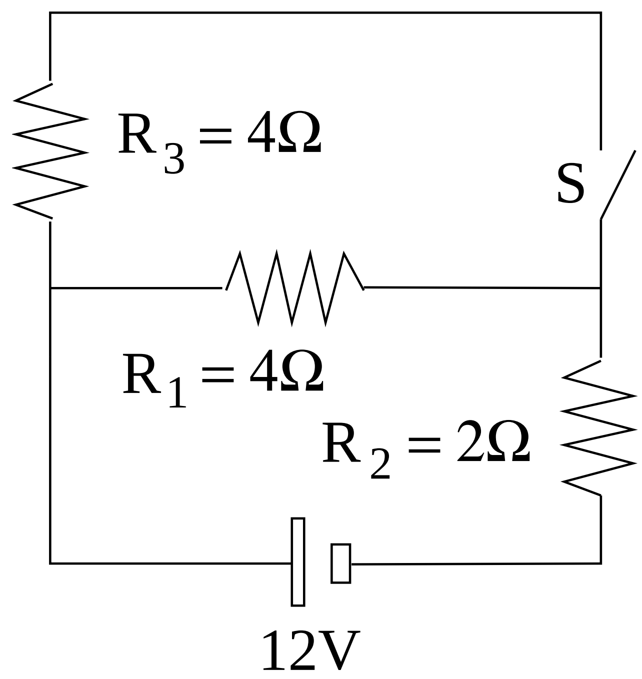
(c) $Q_3 = (5\mu\text{F})(12\text{V}) = 60\mu\text{C},$

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

Unit Exam II: Problem #2 (Spring '08)

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.



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(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.

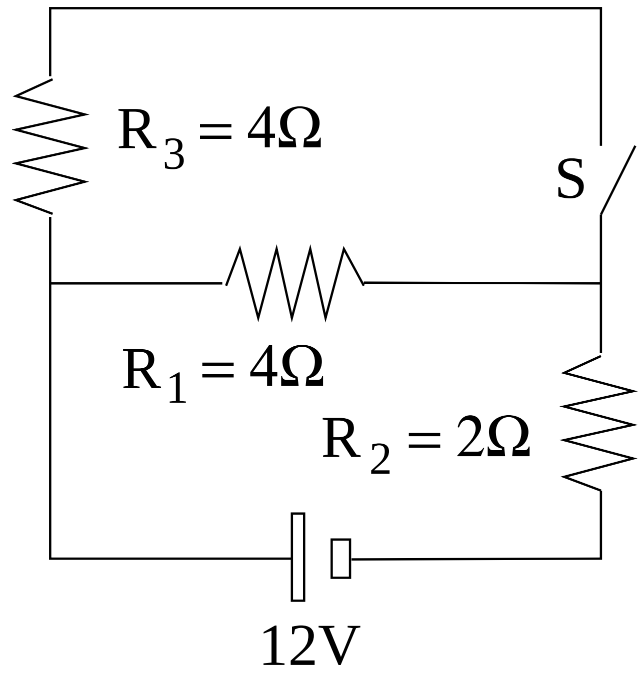
Solution:

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

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

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

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

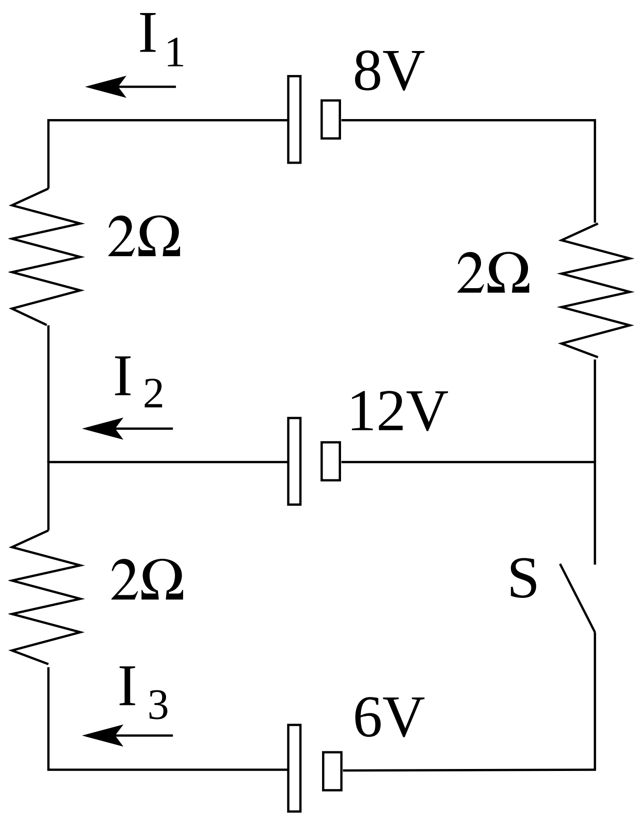


Unit Exam II: Problem #3 (Spring ’08)

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

(a) with the switch S open,

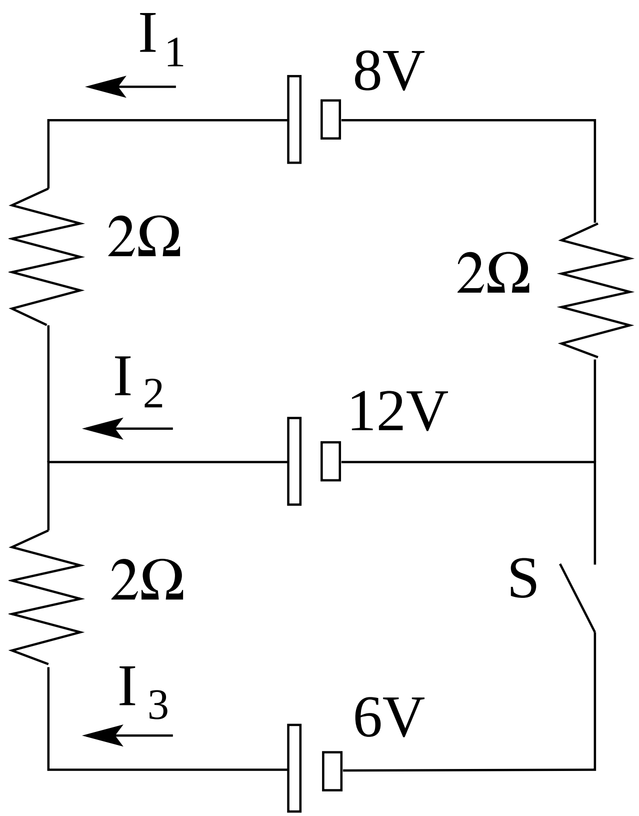
(b) with the switch S closed.



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.



Solution:

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

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

$I_3 = 0.$

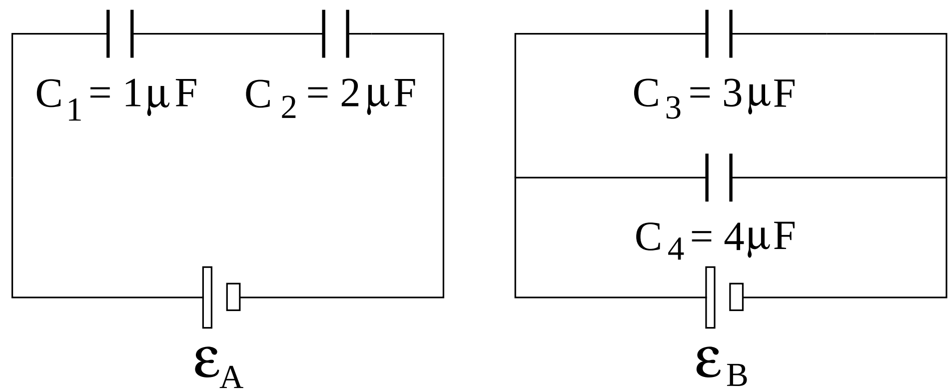
(b) $I_1 = \dfrac{8\mathrm{V} - 12\mathrm{V}}{4\Omega} = -1\mathrm{A},$

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

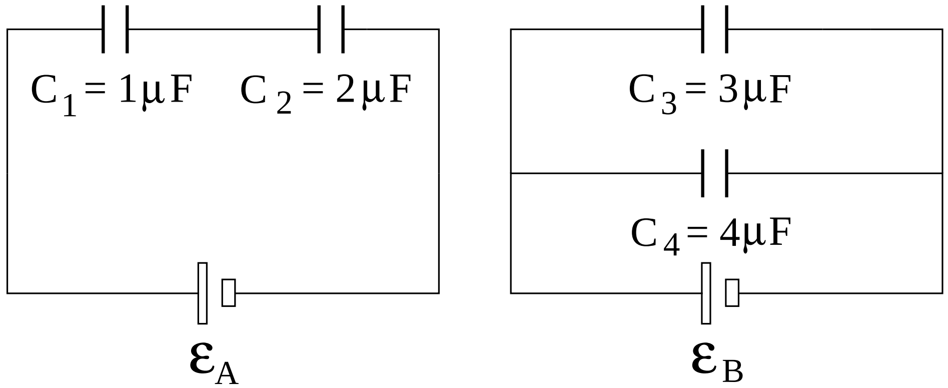
$I_2 = -I_1 - I_3 = +4\mathrm{A}.$

Unit Exam II: Problem #1 (Spring ’09)

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:

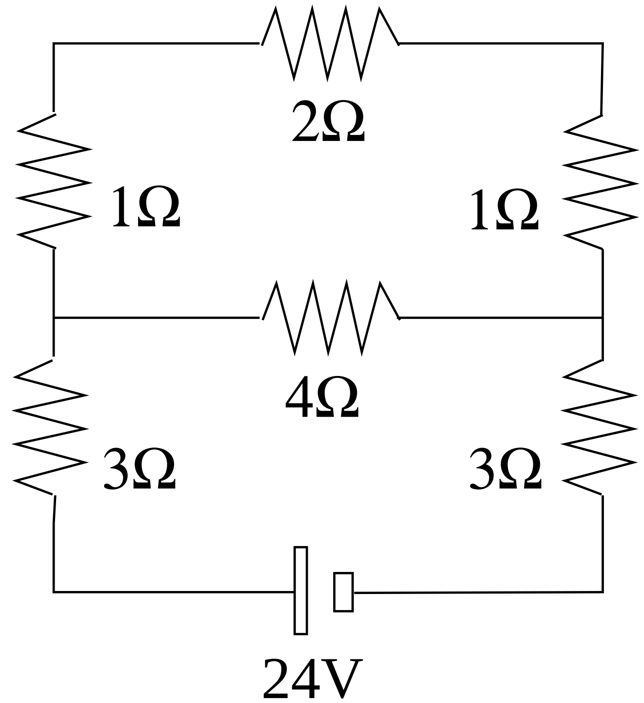
(a) $Q_1 = (1\mu\text{F})(8\text{V}) = 8\mu\text{C}, \qquad Q_2 = Q_1 = 8\mu\text{C},$

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

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

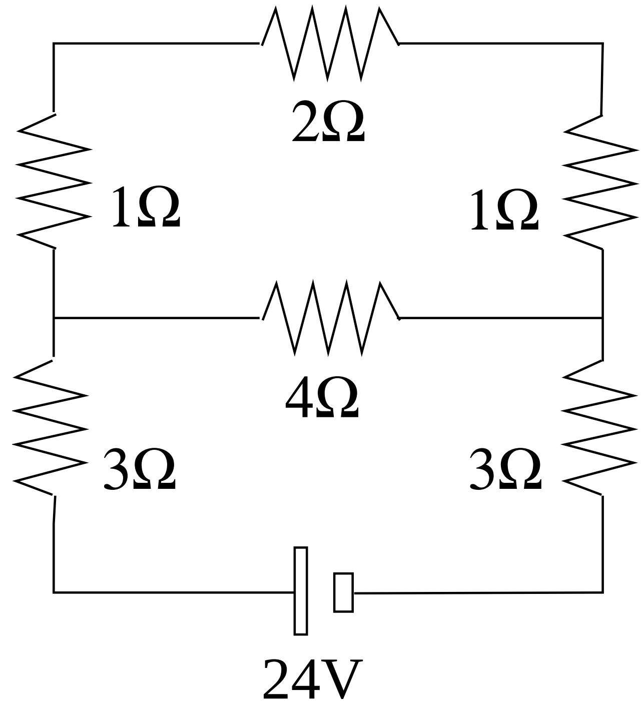
$$Q_4 = (2\text{V})(4\mu\text{F}) = 8\mu\text{C}, \qquad \mathcal{E}_B = V_3 = V_4 = 2\text{V}.$$

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)

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.



Solution:

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

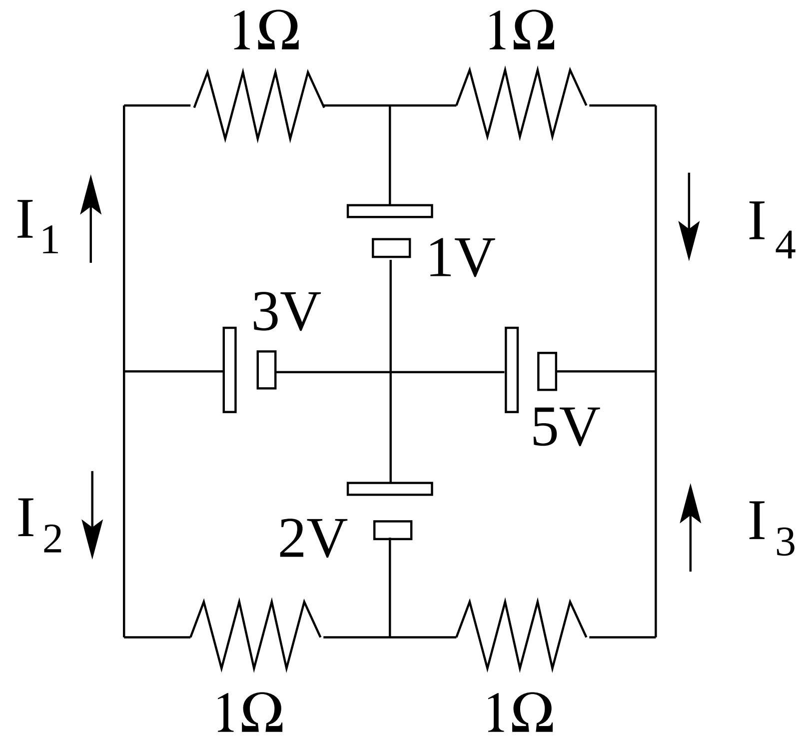
(b) $P = \dfrac{(24\mathrm{V})^2}{8\Omega} = 72\mathrm{W}.$

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

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

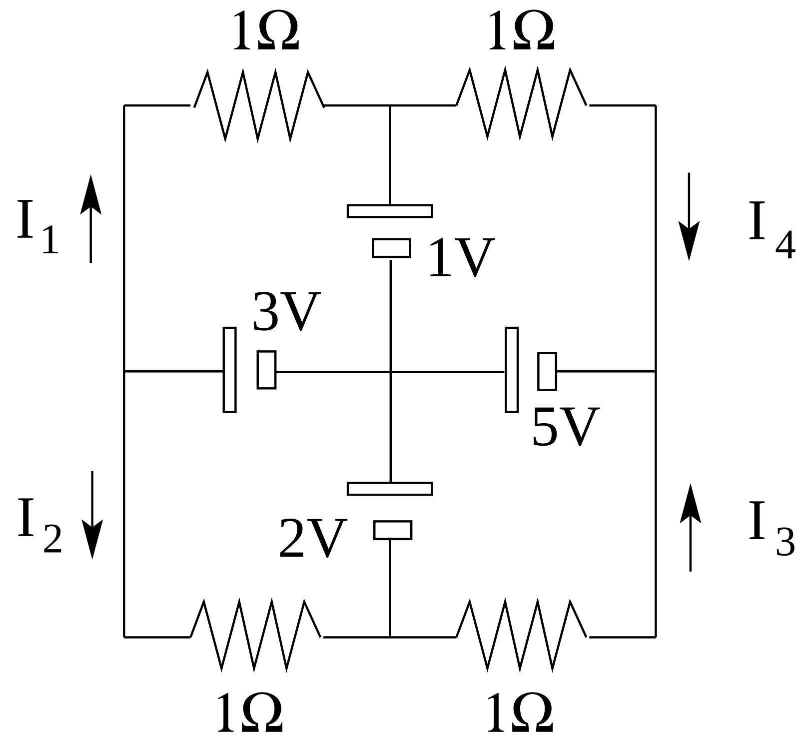
Unit Exam II: Problem #3 (Spring '09)

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



Unit Exam II: Problem #3 (Spring ’09)

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



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

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

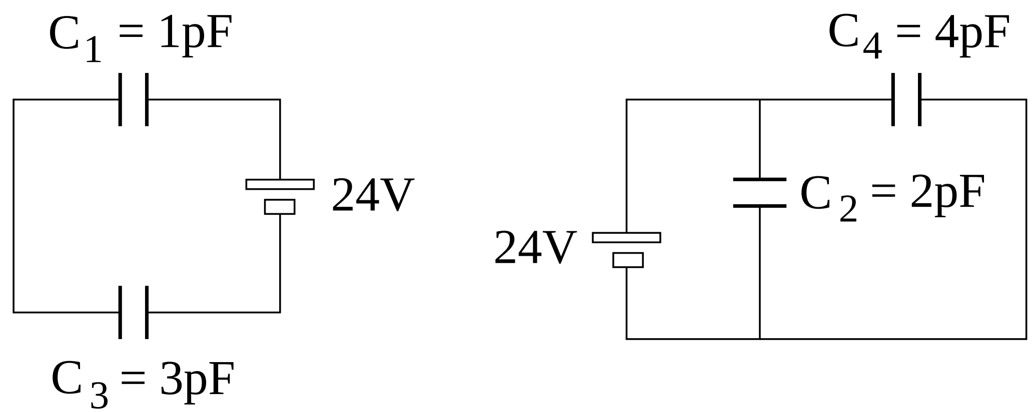
$$+3\text{V} - I_2(1\Omega) + 2\text{V} = 0 \quad \Rightarrow \quad I_2 = 5\text{A}.$$

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

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

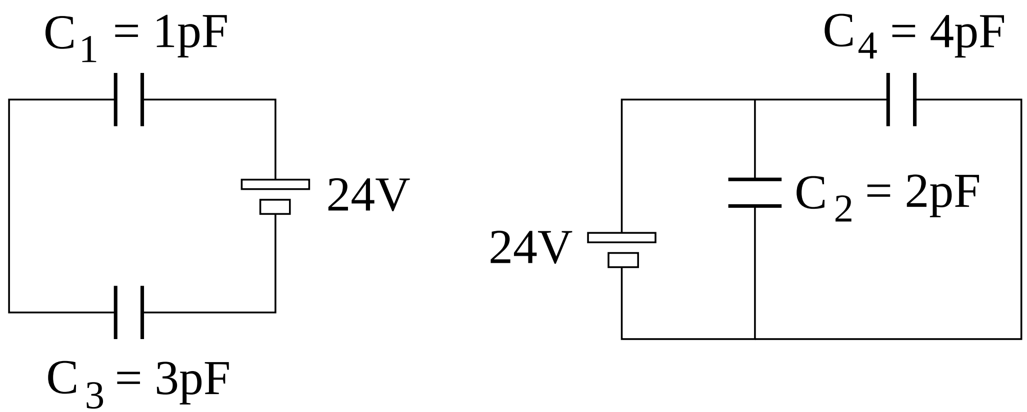
Unit Exam II: Problem #1 (Spring '11)

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)

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.



Solution:

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

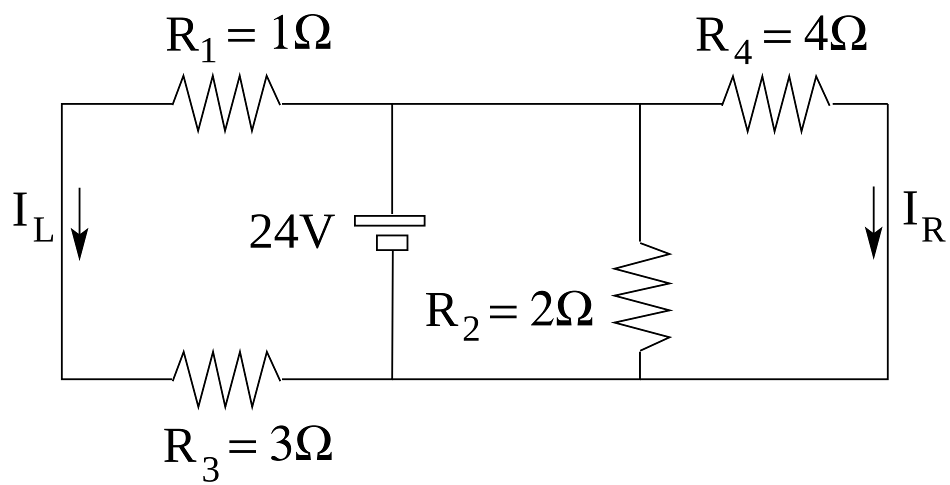
(b) $V_3 = \frac{Q_3}{C_3} = \frac{18\text{pC}}{3\text{pF}} = 6\text{V}.$

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

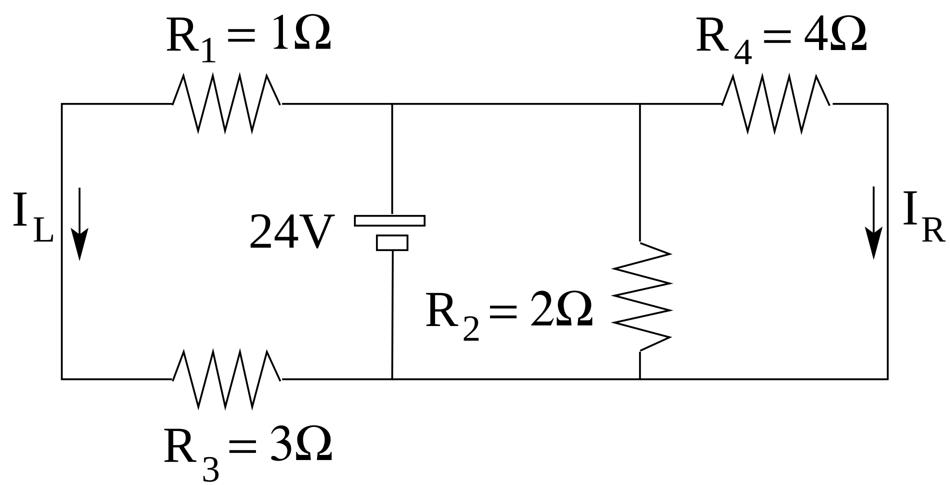
(d) $U_4 = \frac{1}{2}C_4V_4^2 = \frac{1}{2}(4\text{pF})(24\text{V})^2 = 1152\text{pJ}.$

Unit Exam II: Problem #2 (Spring '11)

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.
(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.



Solution:

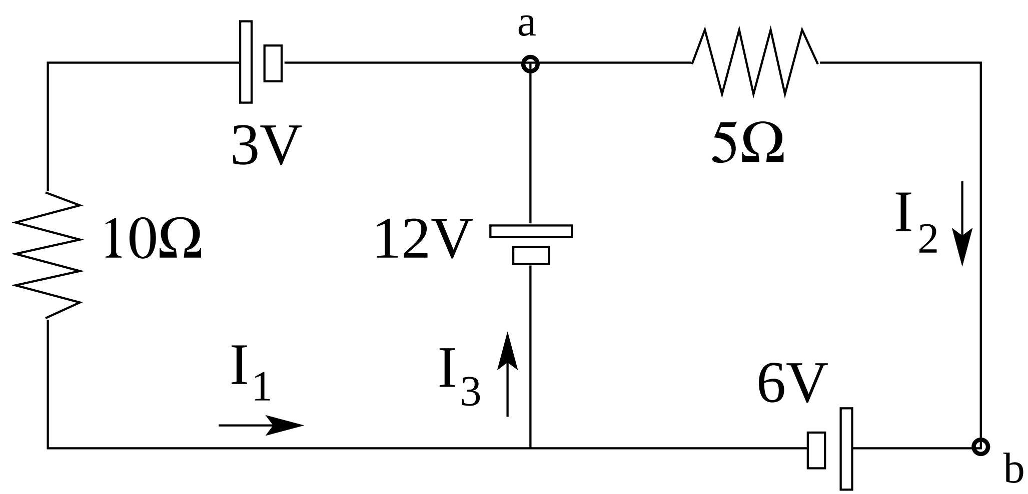
(a) $I_L = \dfrac{24\mathrm{V}}{1\Omega + 3\Omega} = 6\mathrm{A}.$

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

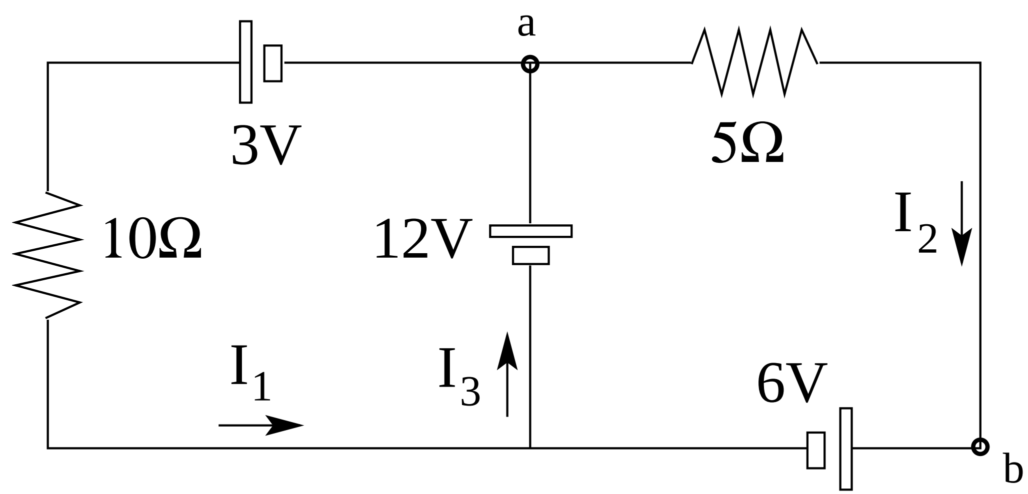
(c) $R_{eq} = \left(\dfrac{1}{1\Omega + 3\Omega} + \dfrac{1}{2\Omega} + \dfrac{1}{4\Omega}\right)^{-1} = 1\Omega.$

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

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 $V_a - V_b$.



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 $V_a - V_b$.



Solution:

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

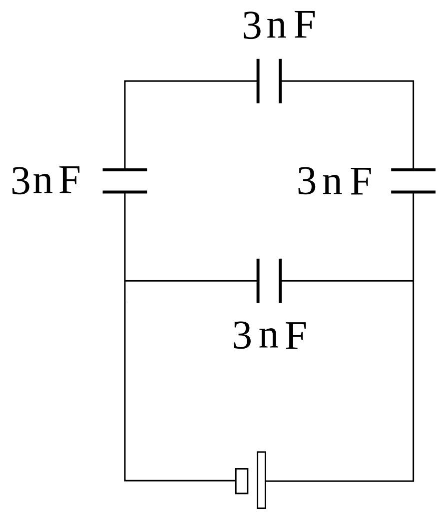
(b) $-6\text{V} + 12\text{V} - I_2(5\Omega) = 0 \quad \Rightarrow \; I_1 = \dfrac{6\text{V}}{5\Omega} = 1.2\text{A}.$

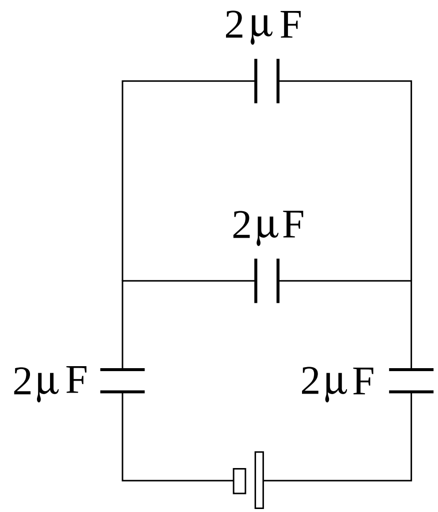
(c) $I_3 = I_1 + I_2 = 2.7\text{A}.$

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

Unit Exam II: Problem #1 (Spring ’12)

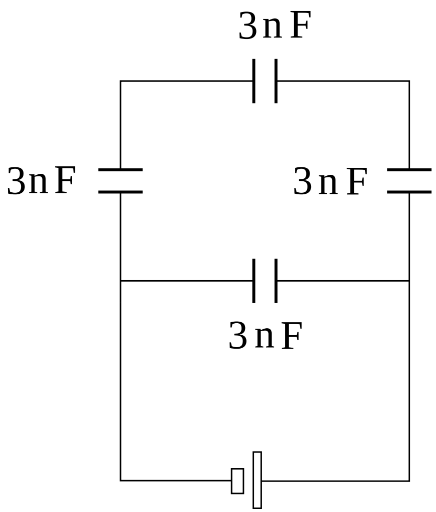
Find the equivalent capacitances C_{eq} of the two capacitor circuits.

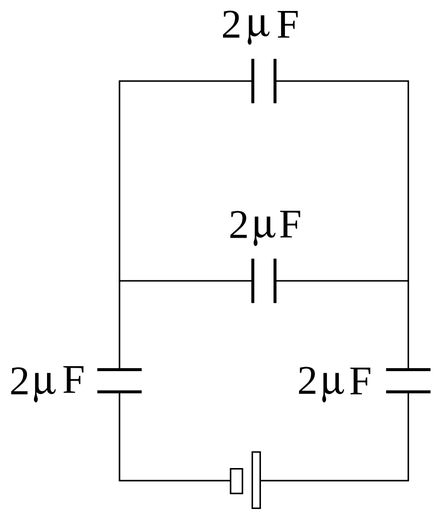




Unit Exam II: Problem #1 (Spring ’12)

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





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)

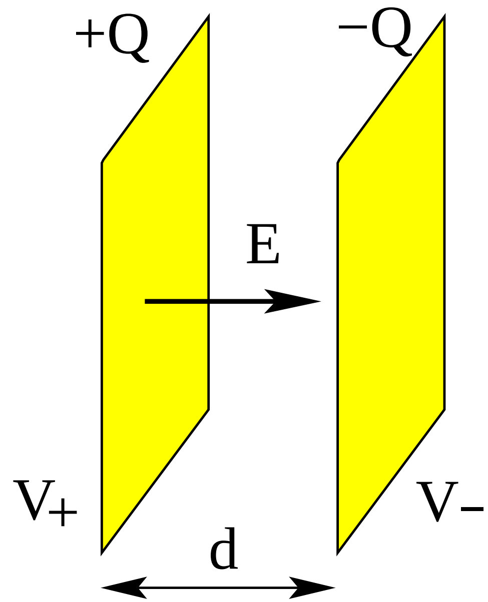
Consider a parallel-plate capacitor of capacitance $C = 6$pF with plates separated a distance $d = 1$mm and a potential difference $V = V_+ - V_- = 3$V between them.

(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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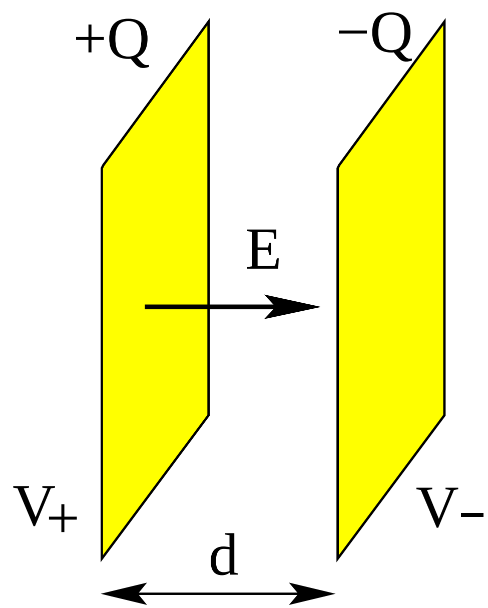
(a) Find the magnitude E of the electric field between the plates.
(b) Find the amount Q of charge on each plate.
(c) Find the energy U stored on the capacitor.
(d) Find the area A of each plate.



Solution:

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

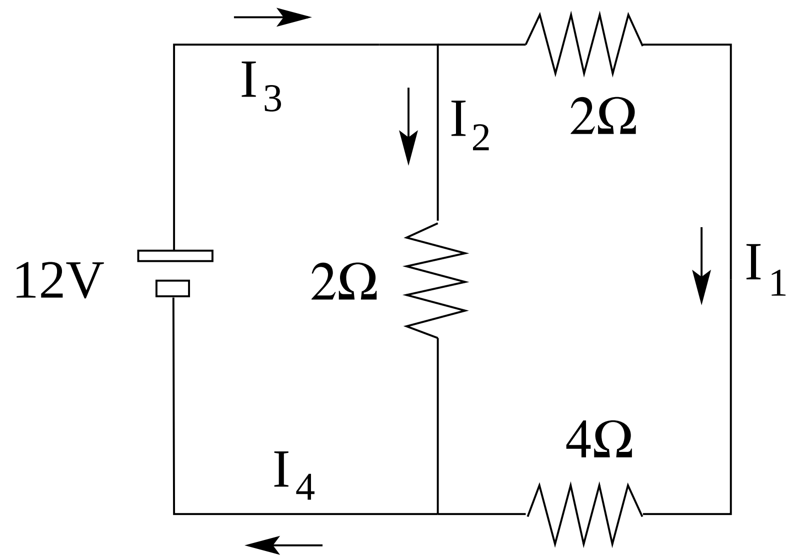
(b) $Q = CV = (6\mathrm{pF})(3\mathrm{V}) = 18\mathrm{pC}.$

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

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

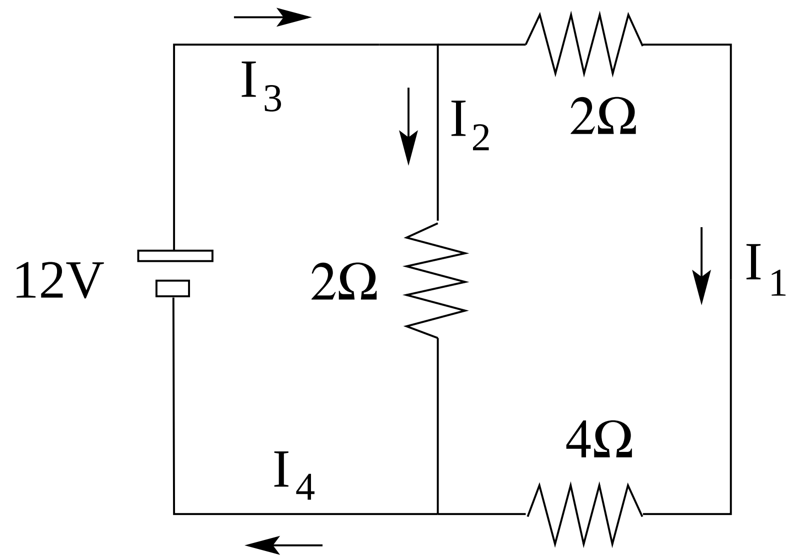
Unit Exam II: Problem #3 (Spring '12)

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



Unit Exam II: Problem #3 (Spring '12)

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

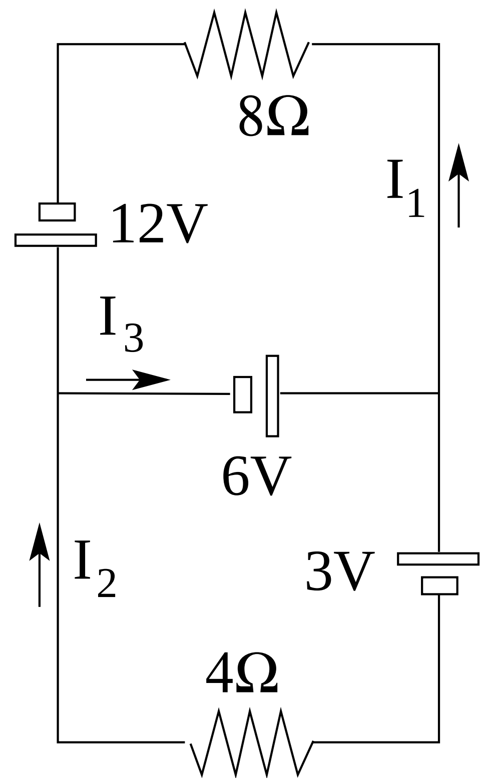


Solution:

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

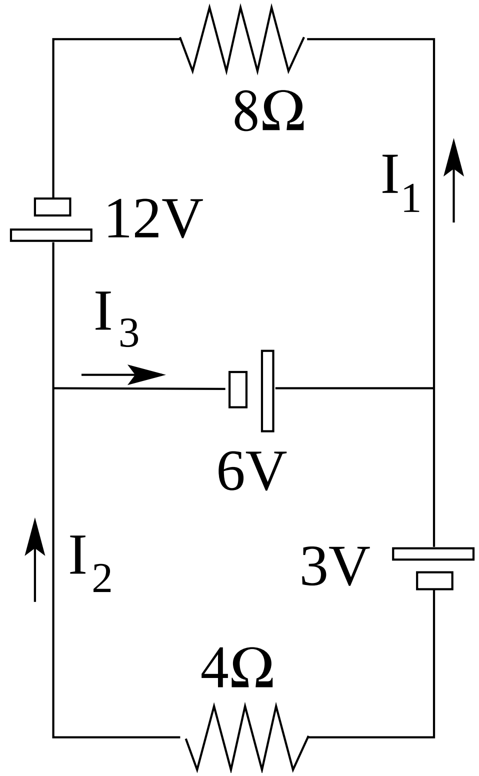
Unit Exam II: Problem #4 (Spring '12)

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



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

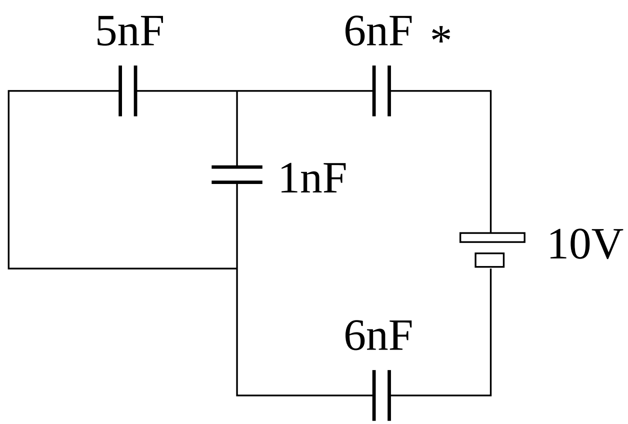
Consider the electric circuit shown. Find the currents I_1, I_2, and I_3

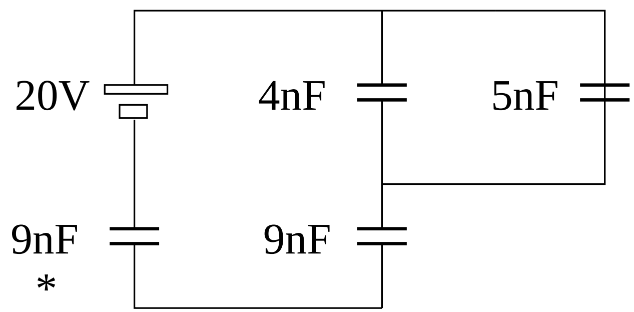


Solution:

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

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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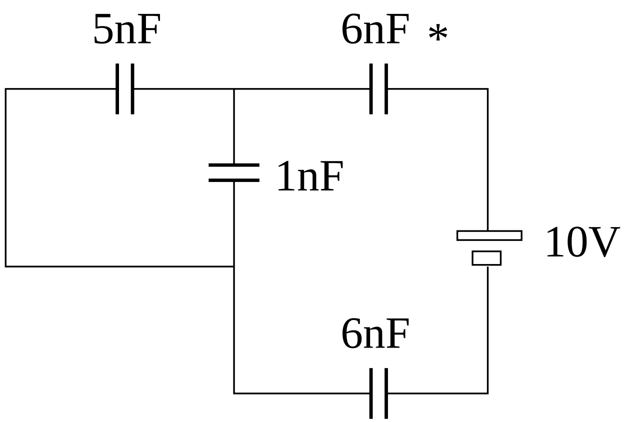
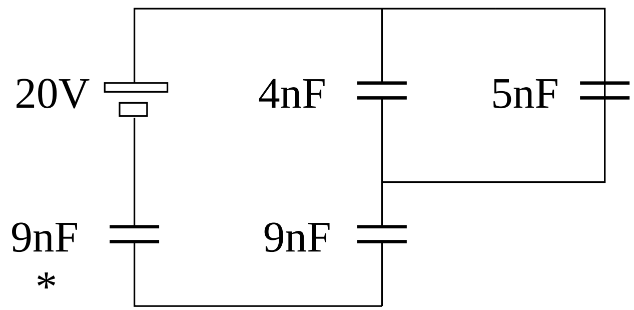




Solution:

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

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

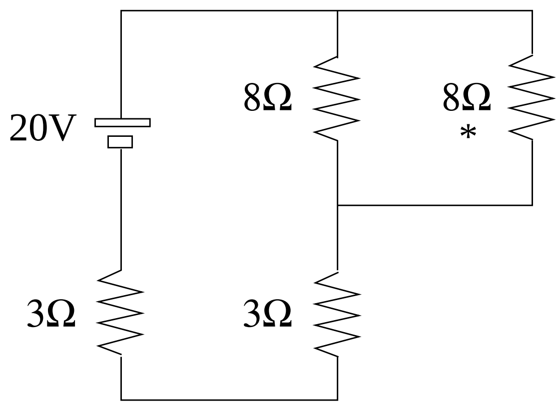
$$V_* = \frac{10}{3}\text{V} = 3.33\text{V}$$

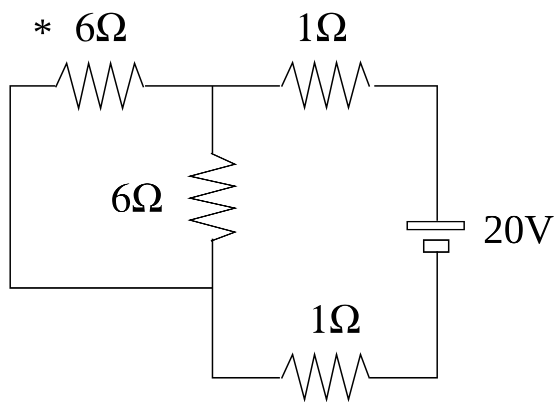
$$C_{eq} = \left(\frac{1}{4\text{nF} + 5\text{nF}} + \frac{1}{9\text{nF}} + \frac{1}{9\text{nF}}\right)^{-1} = 3\text{nF}$$

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

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

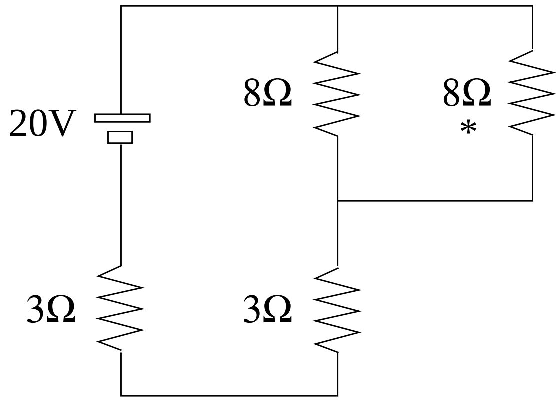
Consider the resistor circuit shown.
(a) Find the equivalent resistance R_{eq}.
(b) Find the current I flowing through the battery.
(c) Find the voltage V_* across the resistor marked by an asterisk.

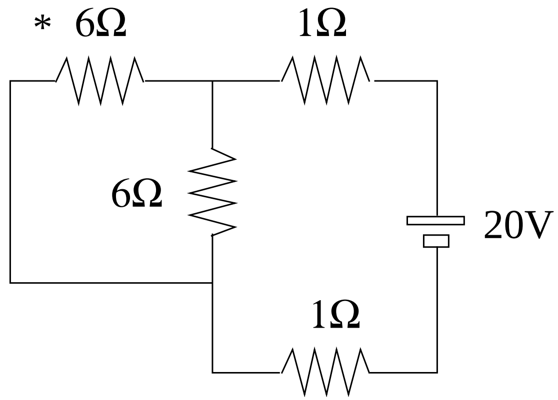




Unit Exam II: Problem #2 (Spring ’13)

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.





Solution:

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

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

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

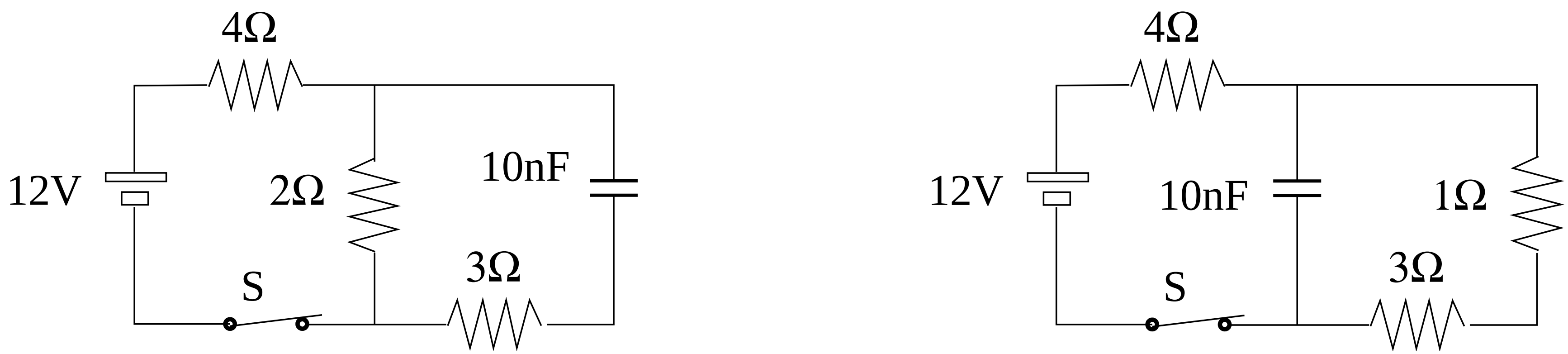
$$R_{eq} = \left(\frac{1}{6\Omega} + \frac{1}{6\Omega}\right)^{-1} + 1\Omega + 1\Omega = 5\Omega$$

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

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

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.



Unit Exam II: Problem #3 (Spring ’13)

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(a) Find the current I_B flowing through the battery.
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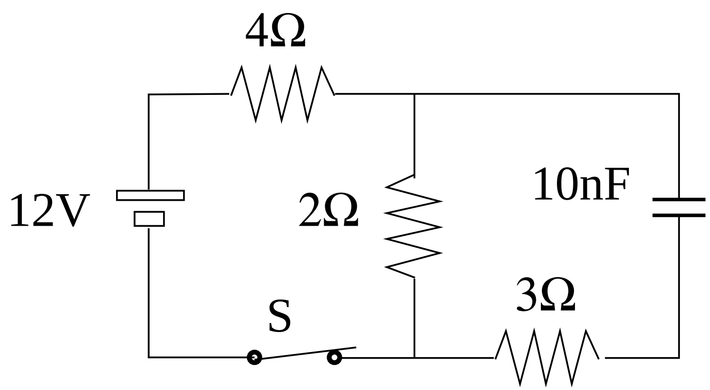
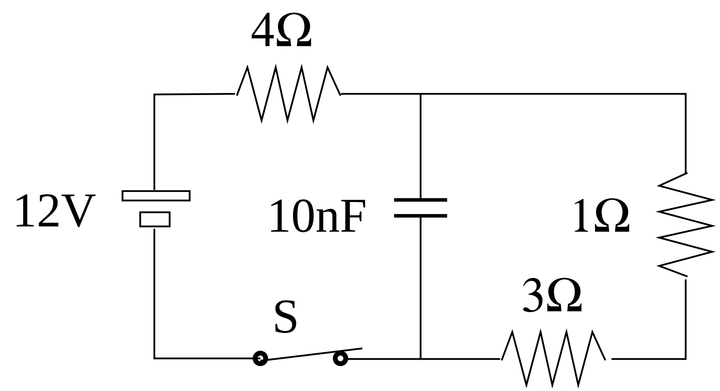




Solution:

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

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

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

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

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

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

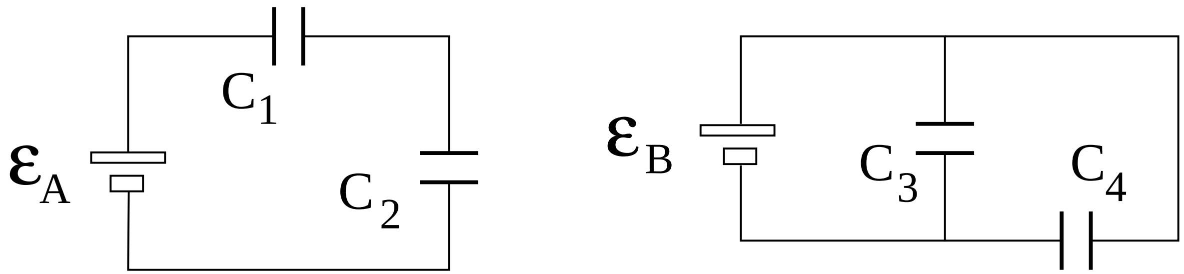
$$Q = (6\text{V})(10\text{nF}) = 60\text{nC}$$

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

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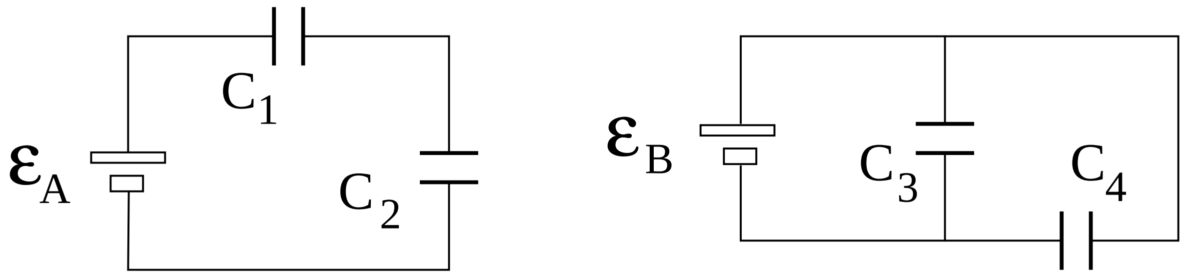
(a) Find the voltage V_2 across capacitor $C_2 = 4$pF.
(b) Find the emf $\mathcal{E}_A$ supplied by the battery.
(c) Find the charge Q_3 on capacitor $C_3 = 3$pF.
(d) Find the emf $\mathcal{E}_B$ supplied by the battery.



Solution:

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

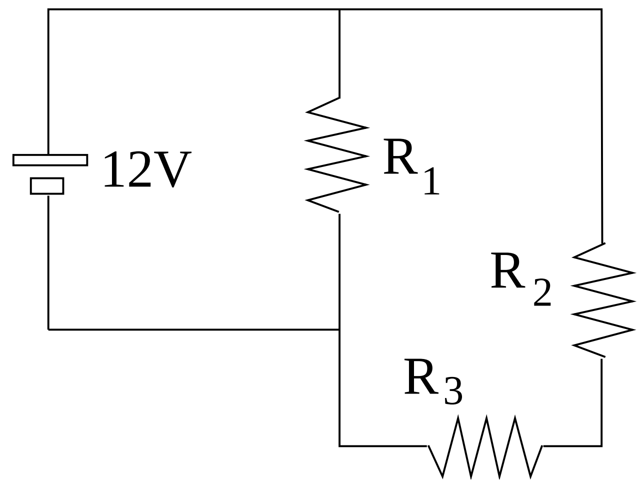
(b) $\mathcal{E}_A = V_1 + V_2 = 3\text{V} + 4.5\text{V} = 7.5\text{V} \quad [2\text{V} + 4\text{V} = 6\text{V}].$

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

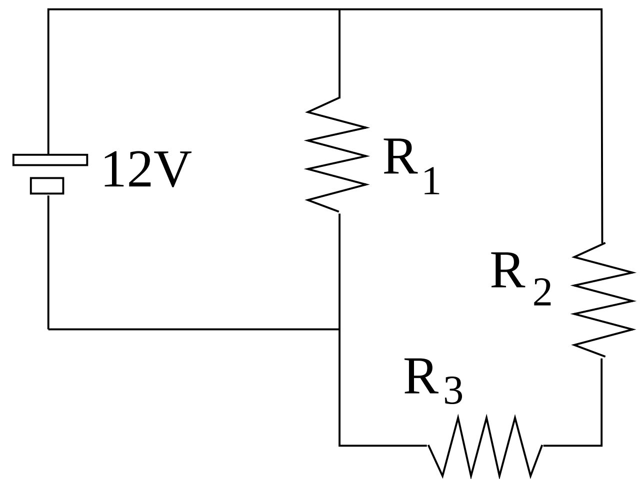
Unit Exam II: Problem #2 (Spring '14)

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.
(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}.



Solution:

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

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

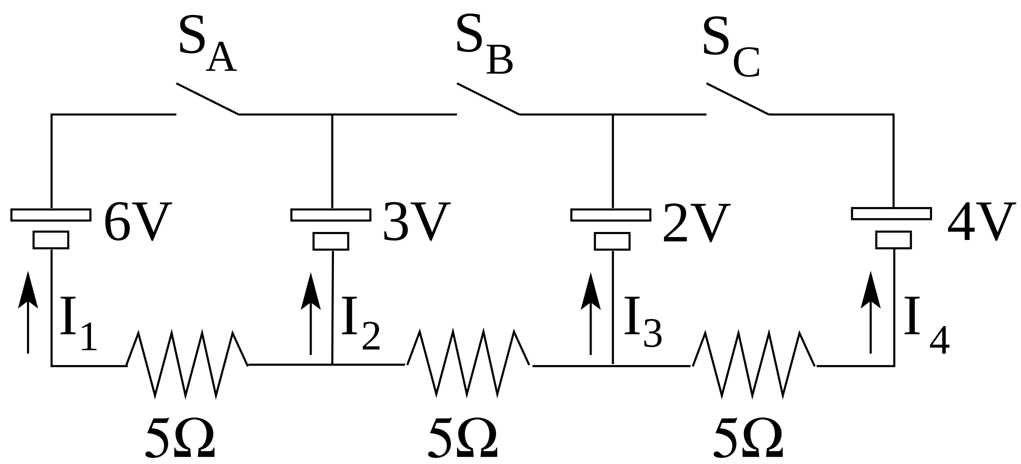
(c) $P_1 = \dfrac{(12\text{V})^2}{2\Omega} = 72\text{W} \quad \left[\dfrac{(12\text{V})^2}{3\Omega} = 48\text{W}\right].$

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

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.

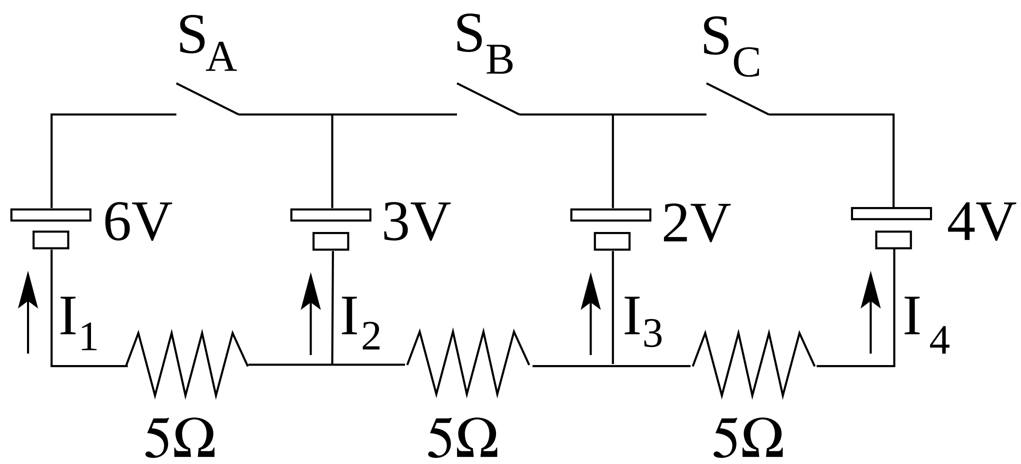
(a) only switch S_C is closed,
(b) only switch S_B is closed,
(c) switches S_B and S_C are closed.



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

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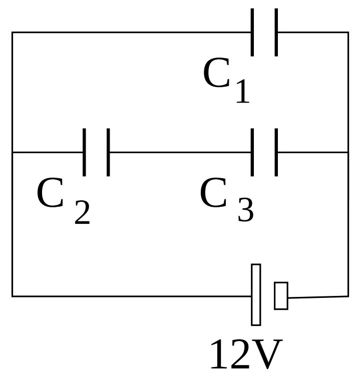
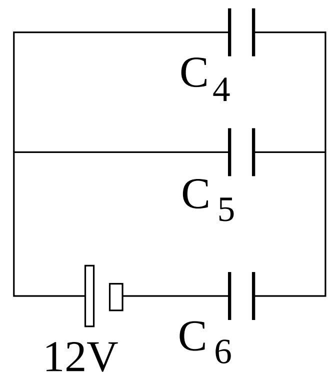
$I_3 = -0.6\text{A},\ I_4 = 0.4\text{A}.$

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.





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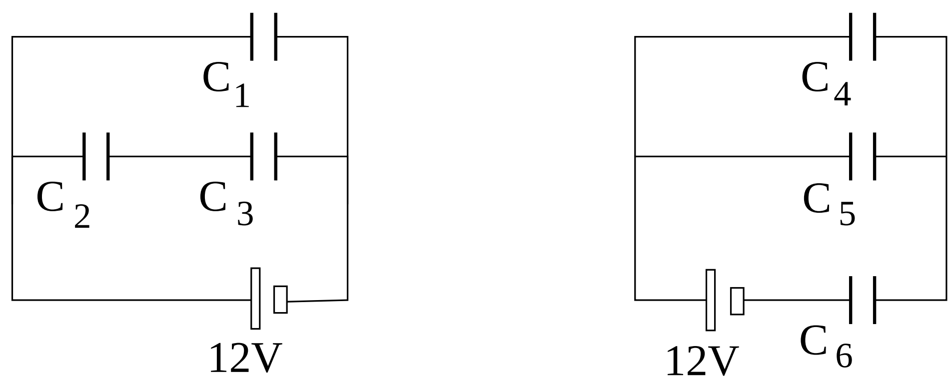
(c) Find the equivalent capacitance of the circuit on the right.
(d) Find the charges Q_4, Q_5, Q_6 on capacitors C_4, C_5, C_6, respectively.



Solution:

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

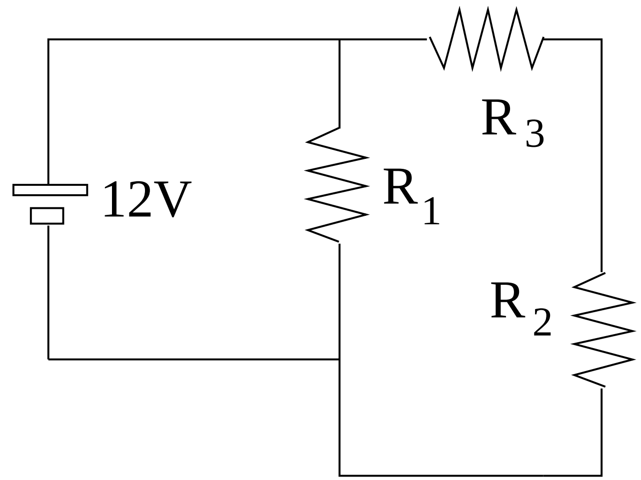
(b) $V_1 = 12\text{V}, \quad V_2 = V_3 = 6\text{V}$

(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.



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(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.
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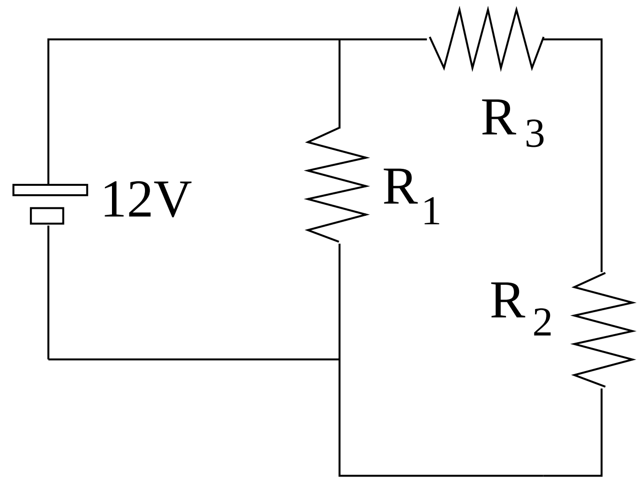


Solution:

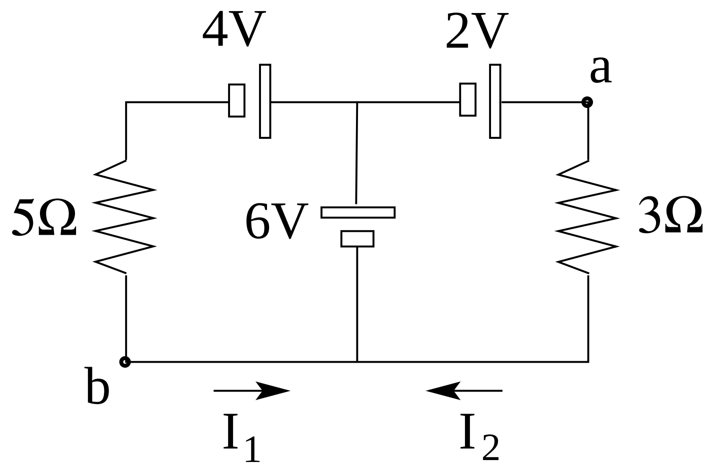
(a) $R_{eq} = \left(\frac{1}{1\Omega + 3\Omega} + \frac{1}{5\Omega}\right)^{-1} = \frac{20}{9}\Omega = 2.22\Omega.$

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

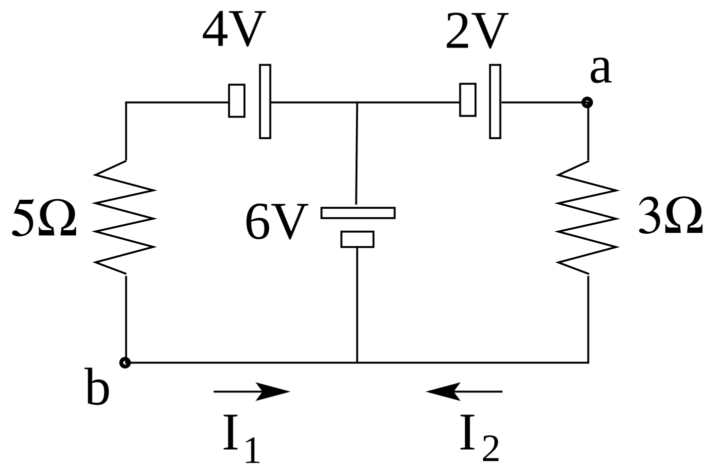
(c) $V_1 = R_1 I_1 = 12\text{V}, \quad V_2 = R_2 I_2 = 3\text{V}, \quad V_3 = R_3 I_3 = 9\text{V}.$

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 $V_a - V_b$.



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:

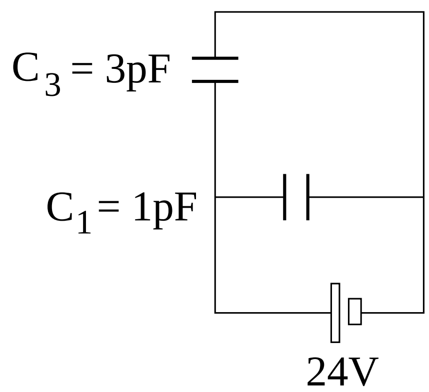
(a) $I_1 = \dfrac{6\text{V} - 4\text{V}}{5\Omega} = 0.4\text{A}.$

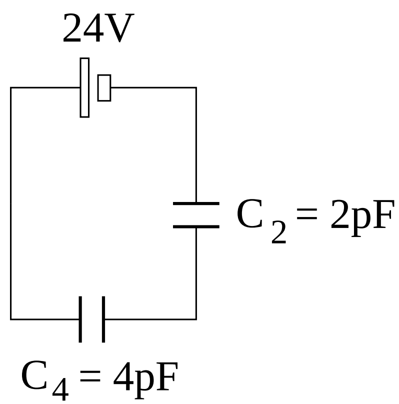
(b) $I_2 = \dfrac{6\text{V} + 2\text{V}}{3\Omega} = 2.67\text{A}.$

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

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)

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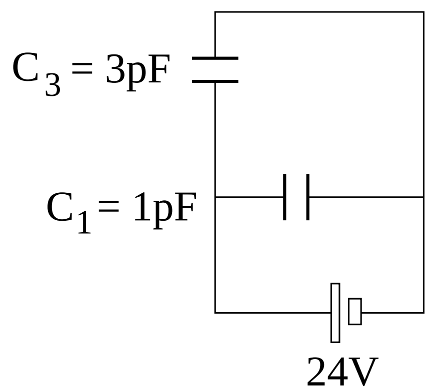
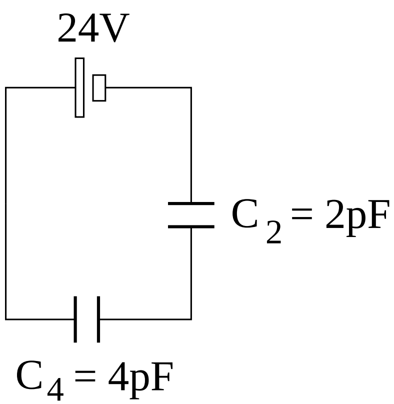




Solution:

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

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

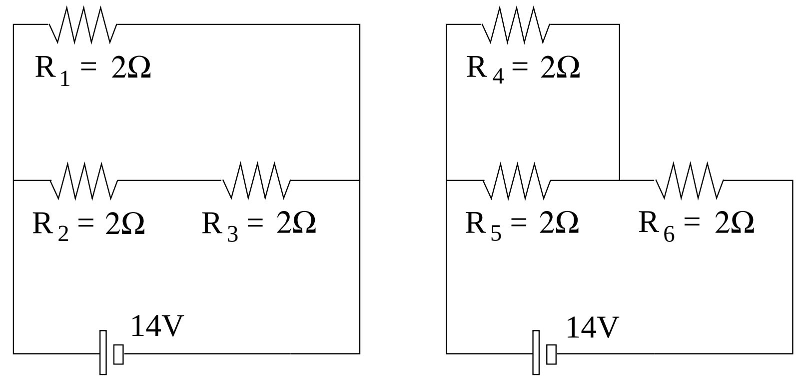
(c) $C_{24} = \left(\frac{1}{C_2} + \frac{1}{C_4}\right)^{-1} = \frac{4}{3}\text{pF},$

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

(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.



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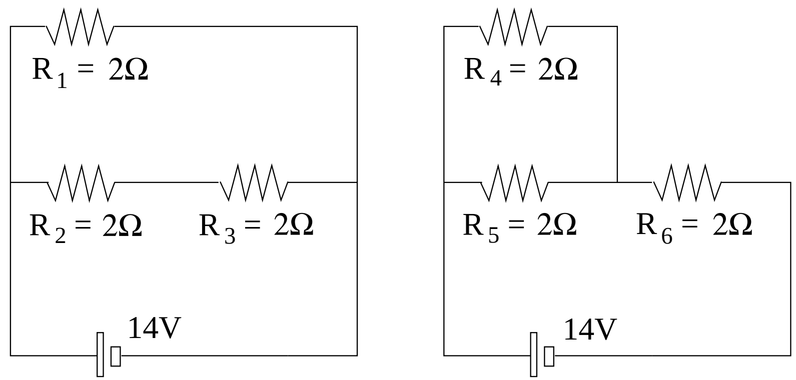
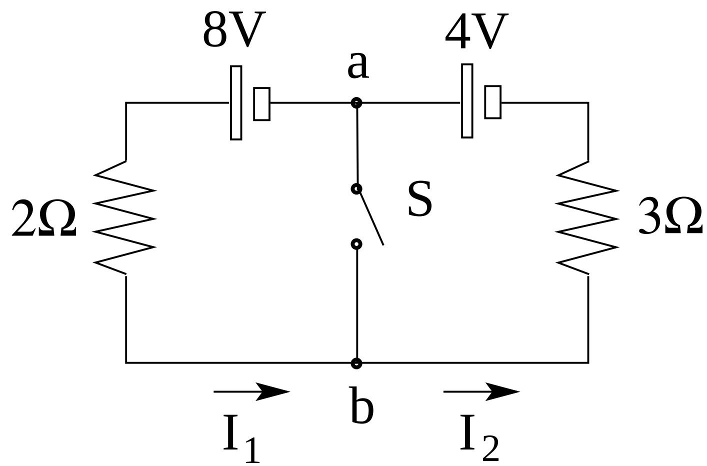


Solution:

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

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.



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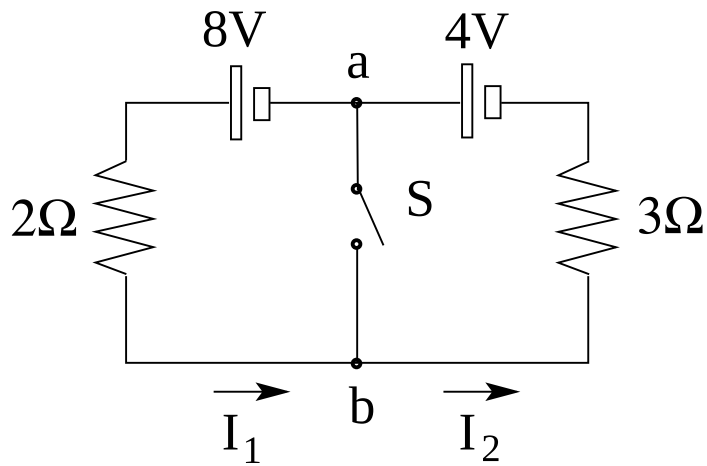


Solution:

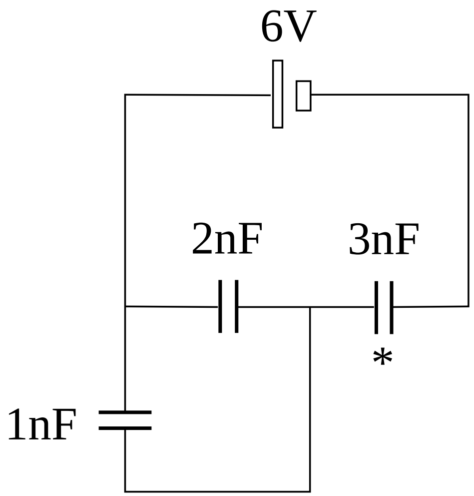
(a) $I_1 = I_2 = \dfrac{12\text{V}}{5\Omega} = 2.4\text{A}$

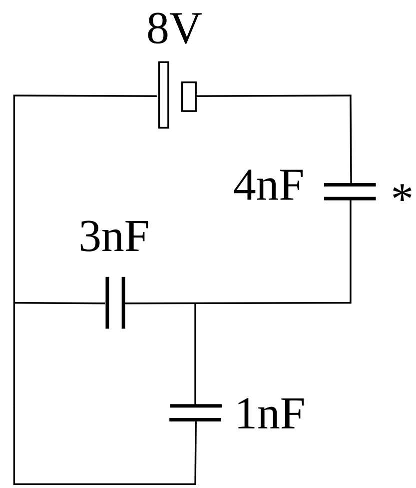
$V_b - V_a = 8\text{V} - (2.4\text{A})(2\Omega) = -4\text{V} + (2.4\text{A})(3\Omega) = 3.2\text{V}.$

(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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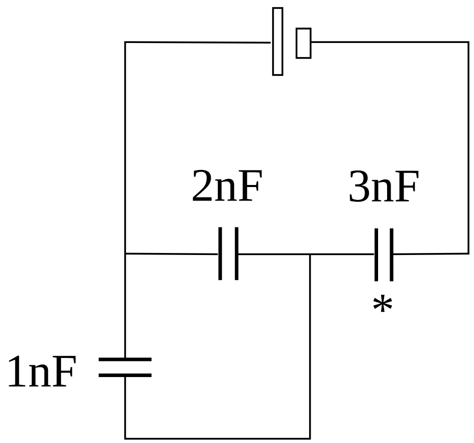
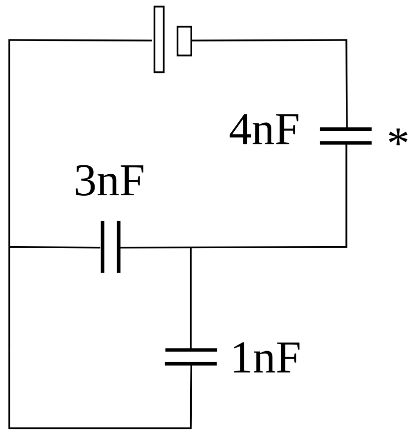




Solution:

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

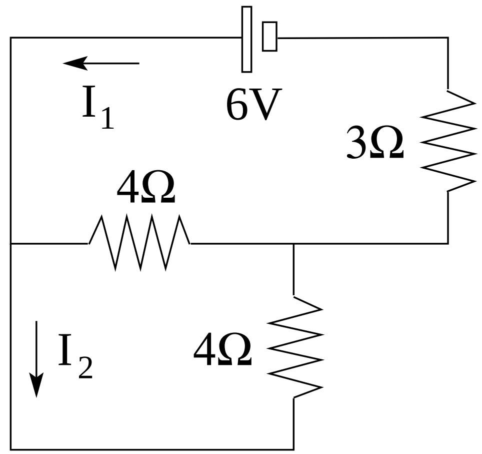
(a) $C_{eq} = \left(\dfrac{1}{3\text{nF} + 1\text{nF}} + \dfrac{1}{4\text{nF}}\right)^{-1} = 2\text{nF}$

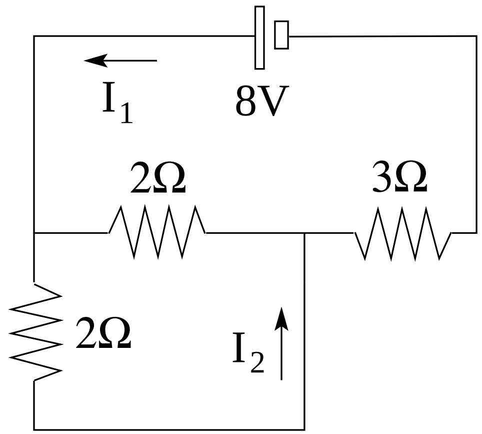
(b) $U = \dfrac{1}{2}(2\text{nF})(8\text{V})^2 = 64\text{nJ}$

(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.





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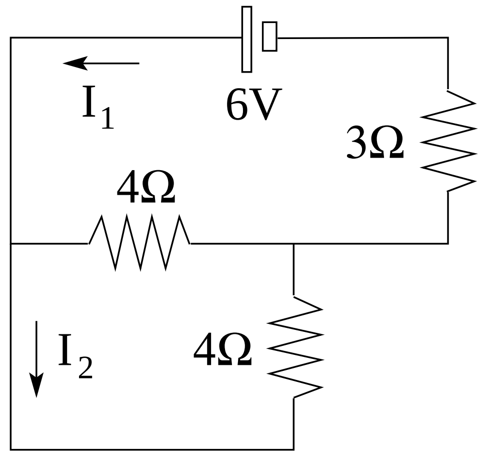
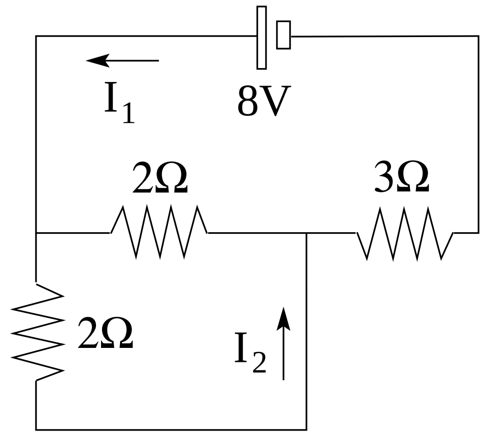




Solution:

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

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

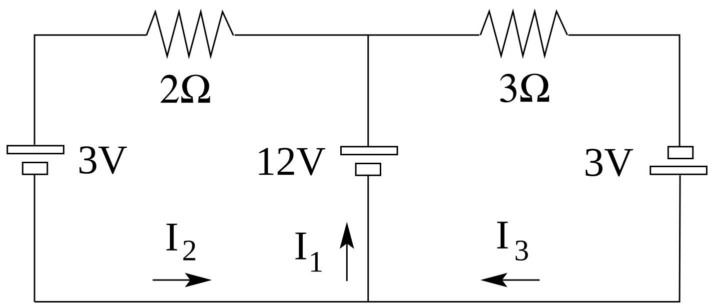
(c) $P = (1.2\text{A})(6\text{V}) = 7.2\text{W}$

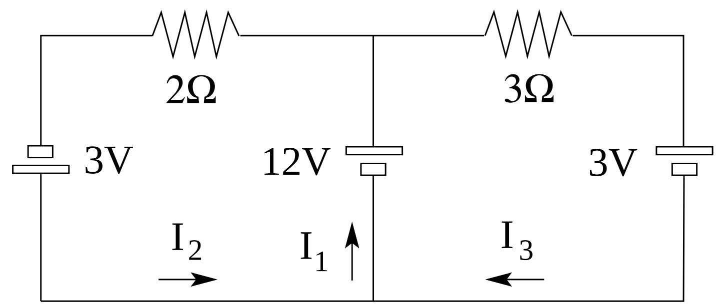
(a) $R_{eq} = \left(\frac{1}{2\Omega} + \frac{1}{2\Omega}\right)^{-1} + 3\Omega = 4\Omega$

(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.





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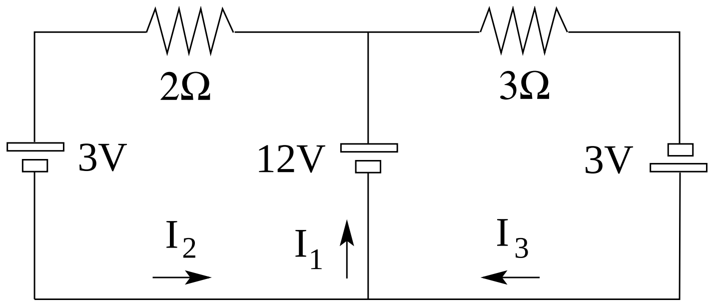
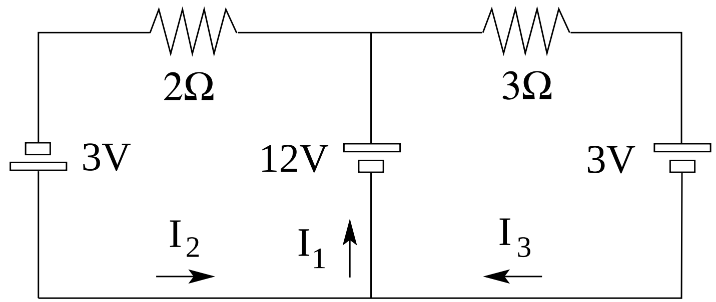




Solution:

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

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

Unit Exam II: Problem #1 (Spring ’16)

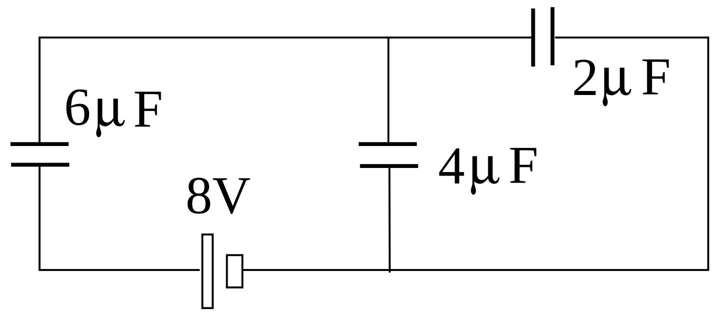
The circuit of capacitors connected to a battery is at equilibrium.

(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.



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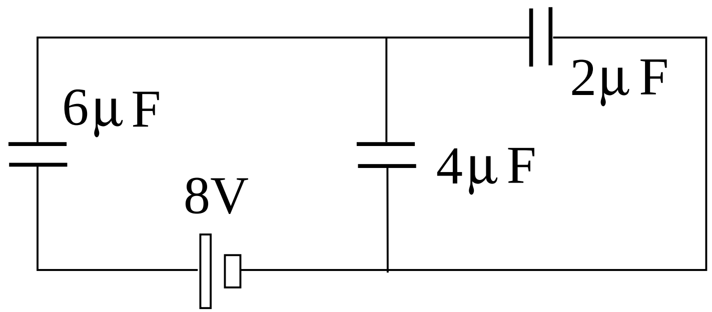


Solution:

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

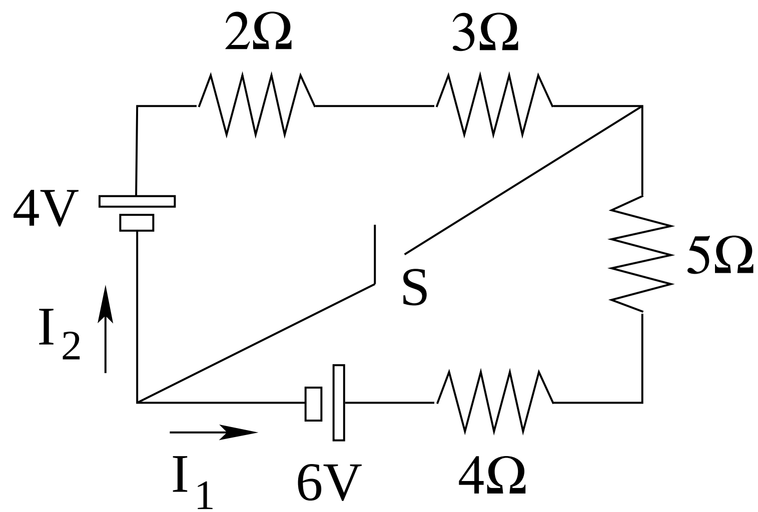
(d) $V_2 = V_4 = \frac{1}{2}(8\text{V}) = 4\text{V}.$

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.



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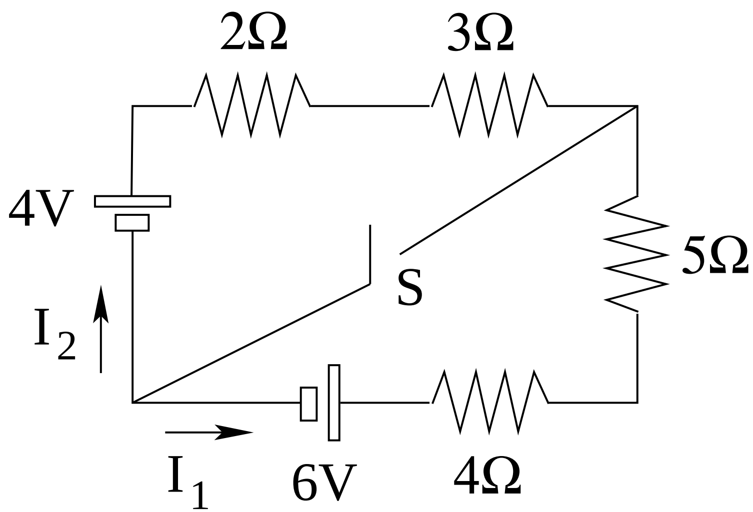
(b) Find the currents I_1 and I_2 when the switch S is closed.



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)

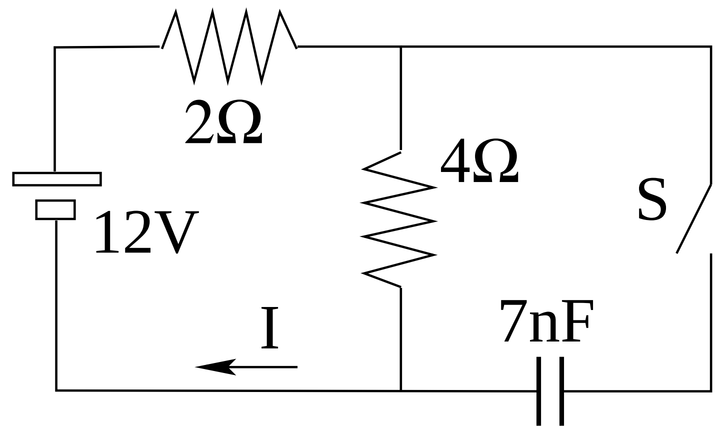
This RC circuit has been running for a long time with the switch open.

(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.



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

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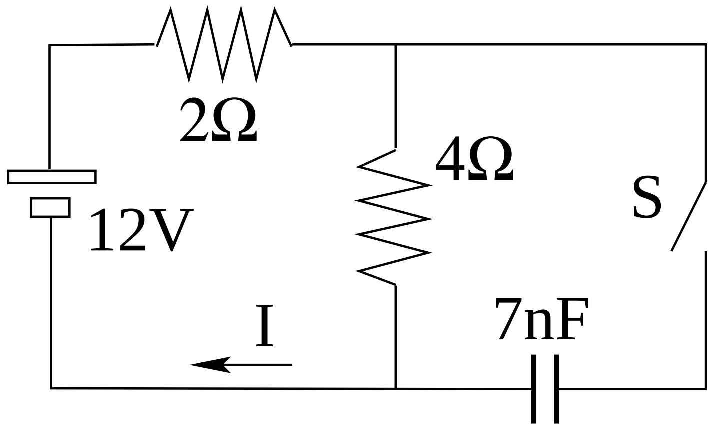


Solution:

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

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

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

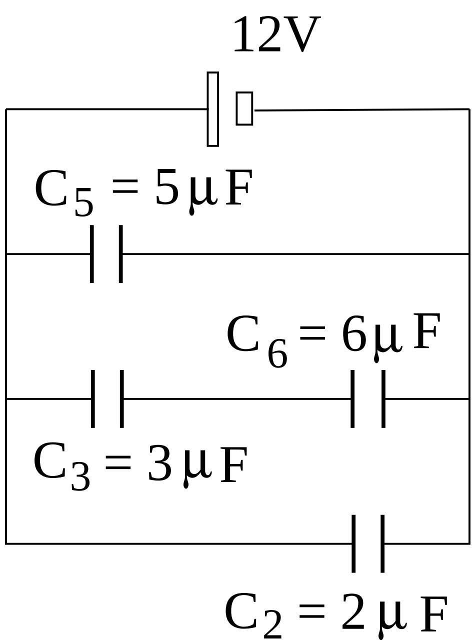
(d) $Q = (8\mathrm{V})(7\mathrm{nF}) = 56\mathrm{nC}.$

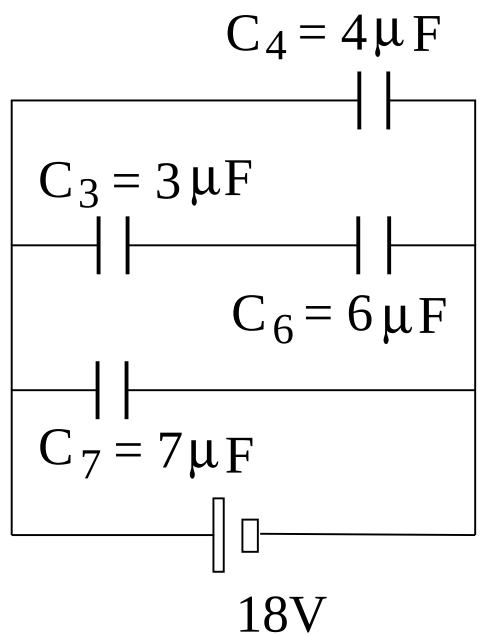
Unit Exam II: Problem #1 (Fall ’16)

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}.





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}.

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

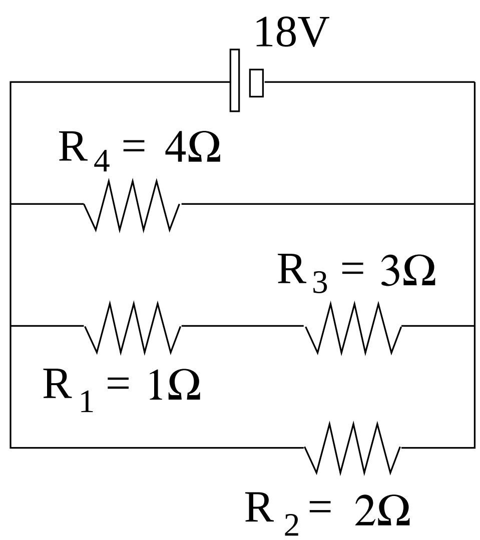
(c) $C_{36} = 2\mu\text{F}$
$\Rightarrow\ Q_6 = Q_{36} = (18\text{V})(2\mu\text{F}) = 36\mu\text{C}$.

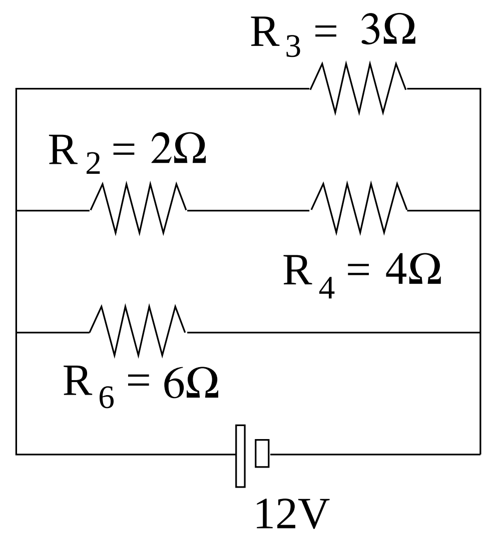
(d) $C_{eq} = C_4 + C_{36} + C_7 = 13\mu\text{F}$.

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}.





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

(a) the voltage V_2 across resistor R_2,
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(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) $V_3 = 12\text{V}$

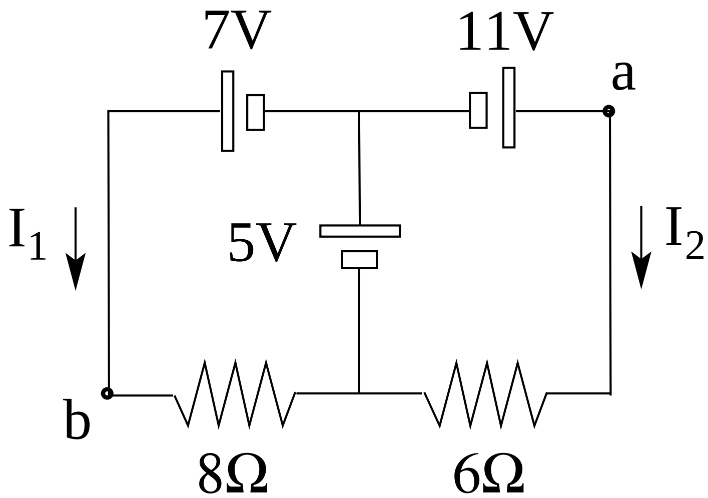
(b) $P_6 = \dfrac{12\text{V}^2}{6\Omega} = 24\text{W}.$

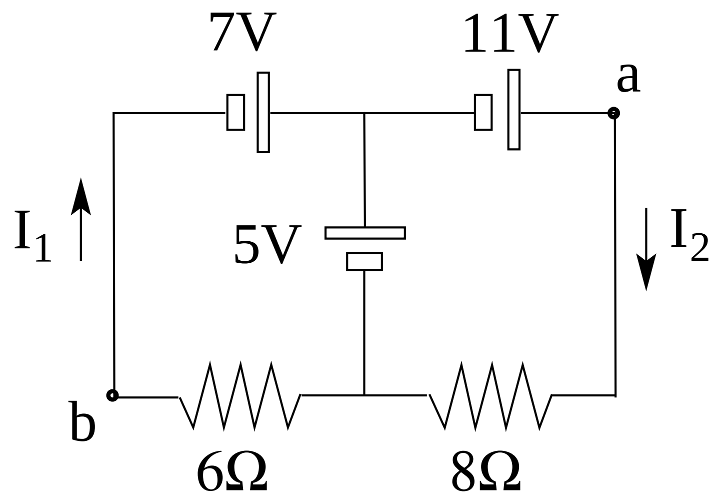
(c) $I_4 = \dfrac{12\text{V}}{2\Omega + 4\Omega} = 2\text{A}.$

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

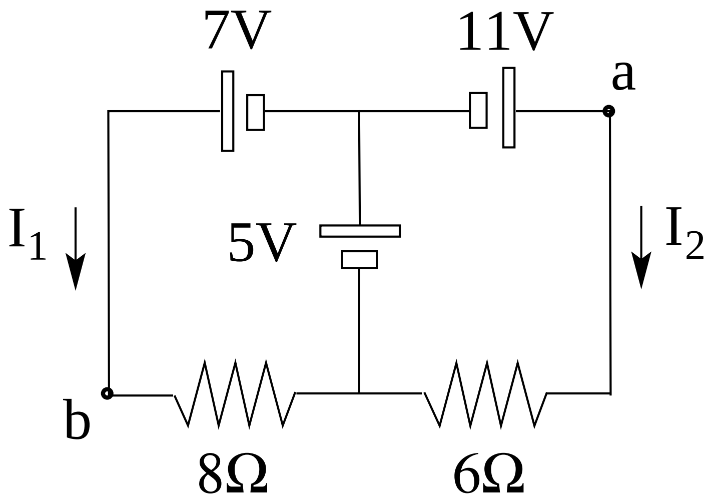
Unit Exam II: Problem #3 (Fall ’16)

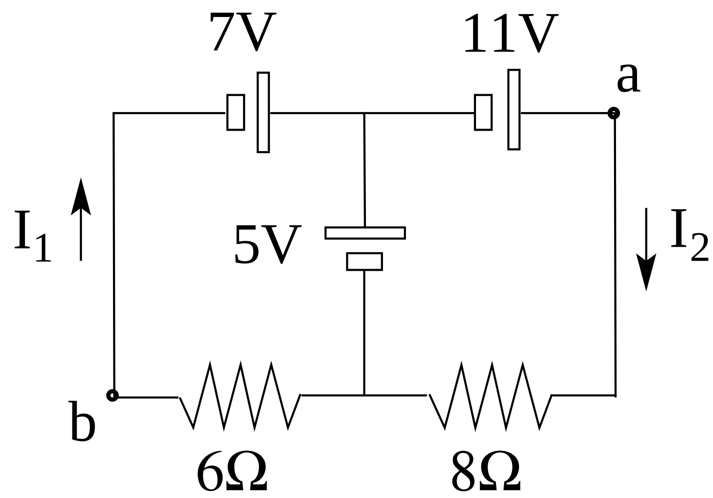
This two-loop resistor circuit is in a state of steady currents. Find ...
(a) the current I_1,
(b) the current I_2,
(c) the potential difference $V_a - V_b$.





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

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

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

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

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

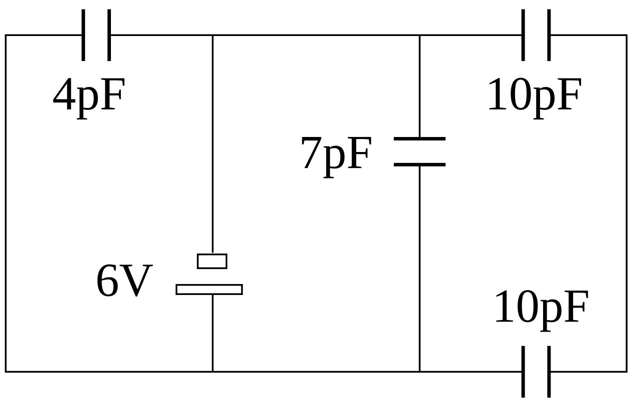
(c) $V_a - V_b = 7\mathrm{V} + 11\mathrm{V} = +18\mathrm{V}.$

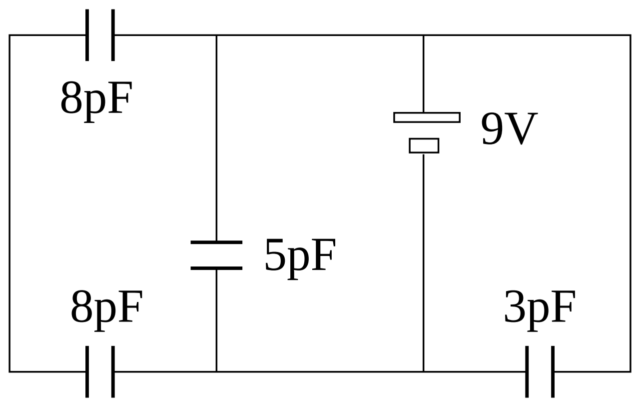
Unit Exam II: Problem #1 (Spring ’17)

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}.





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

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

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

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

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

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

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

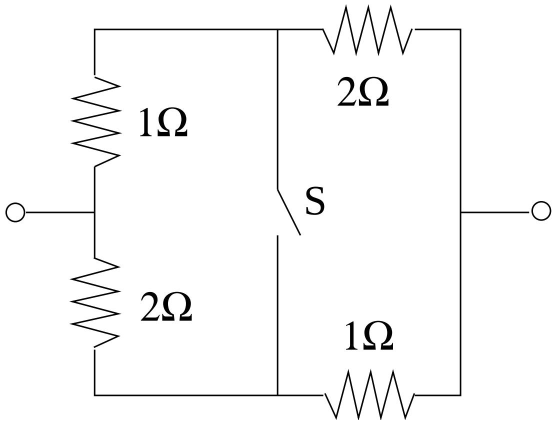
(d) $C_{eq} = 3\text{pF} + 5\text{pF} + 4\text{pF} = 12\text{pF}.$

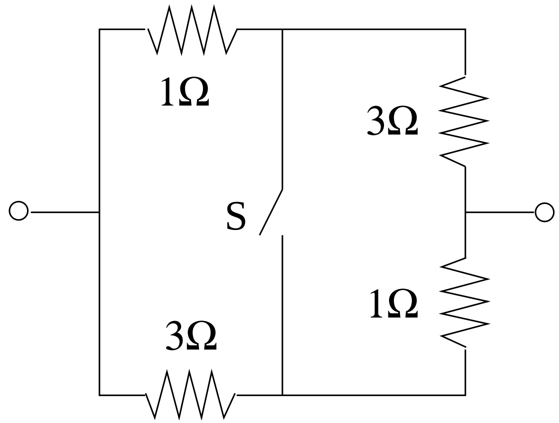
Unit Exam II: Problem #2 (Spring ’17)

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.

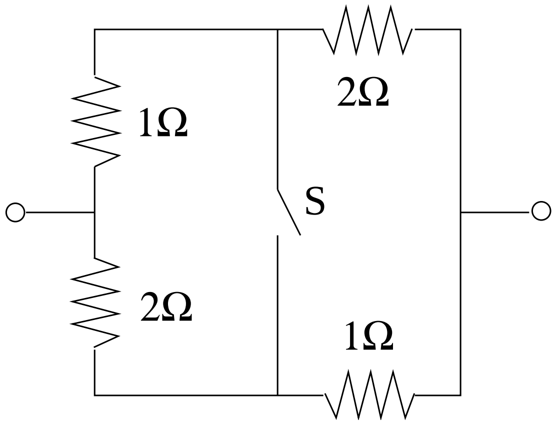


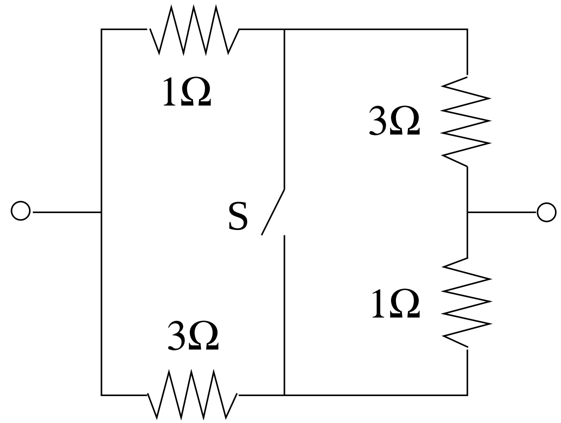


Consider this circuit with two terminals, four resistors, and one switch.

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

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





Solution:

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

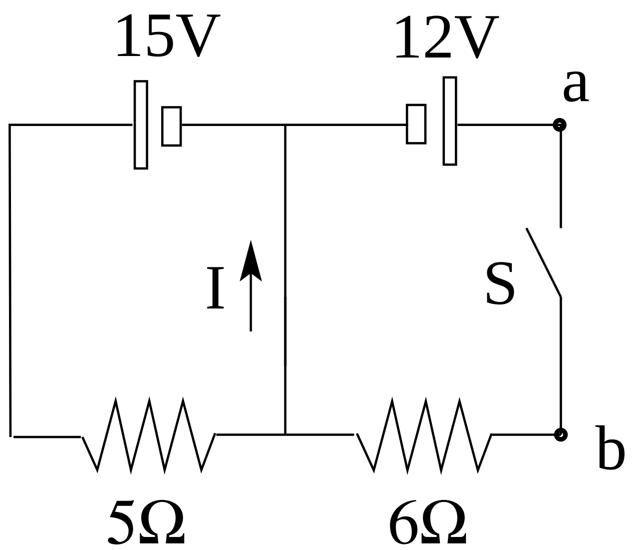
$$R_{\rm eq}^{\rm (closed)} = \left(\frac{1}{1\Omega} + \frac{1}{2\Omega}\right)^{-1} + \left(\frac{1}{1\Omega} + \frac{1}{2\Omega}\right)^{-1} = \frac{4}{3}\Omega.$$

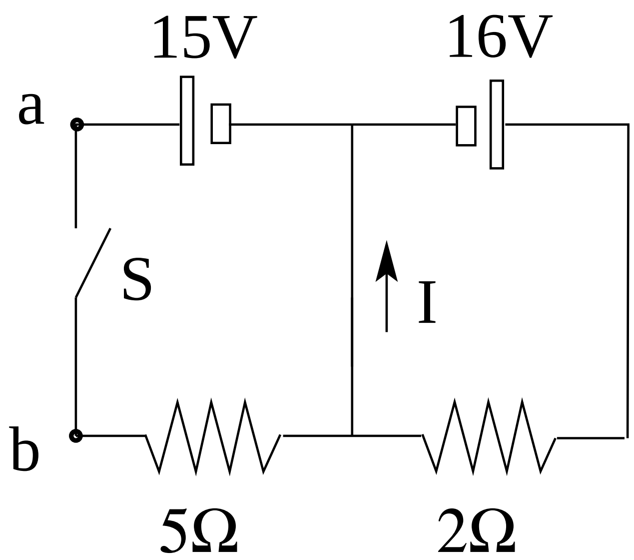
$$R_{\rm eq}^{\rm (open)} = \left(\frac{1}{1\Omega + 3\Omega} + \frac{1}{1\Omega + 3\Omega}\right)^{-1} = 2\Omega.$$

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

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.





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) $I = \dfrac{15\mathrm{V}}{5\Omega} = 3\mathrm{A}.$

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

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

(d) $V_a - V_b = 0.$

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

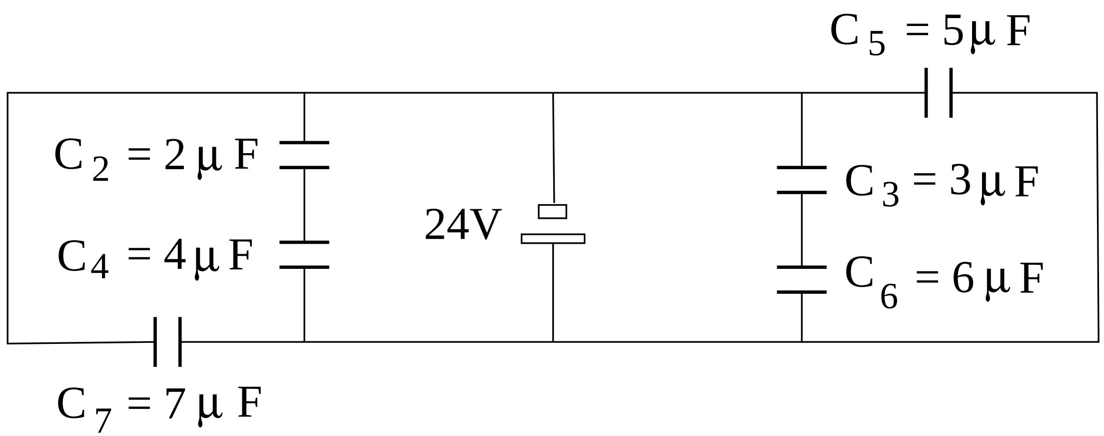
(b) $I = \dfrac{16\mathrm{V}}{2\Omega} + \dfrac{15\mathrm{V}}{5\Omega} = 8\mathrm{A} + 3\mathrm{A} = 11\mathrm{A}.$

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

(d) $V_a - V_b = 0.$

This circuit is at equilibrium.

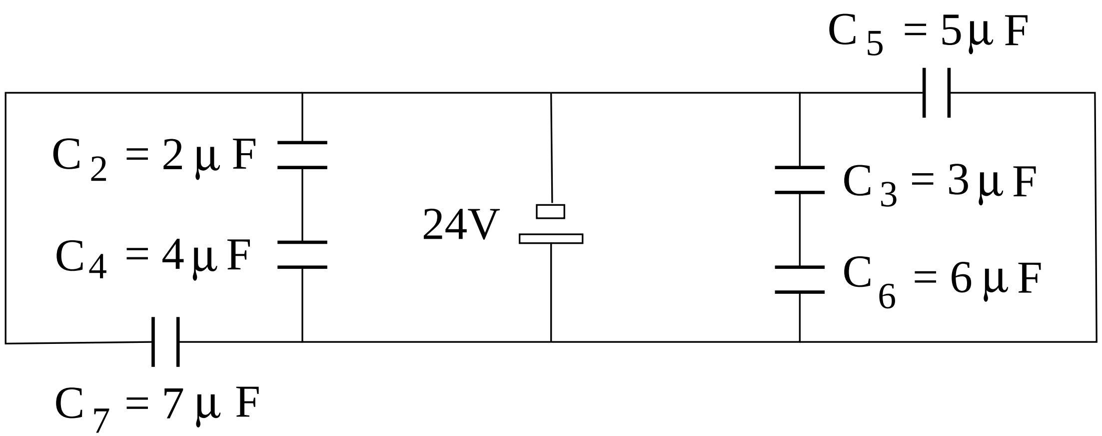
- Find the charge Q_7 on capacitor C_7 [Q_5 on C_5].
- Find the energy U_5 on capacitor C_5 [U_7 on C_7].
- Find the voltages V_2, V_4 across capacitors C_2, C_4 [V_3, V_6 across C_3, C_6].



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:

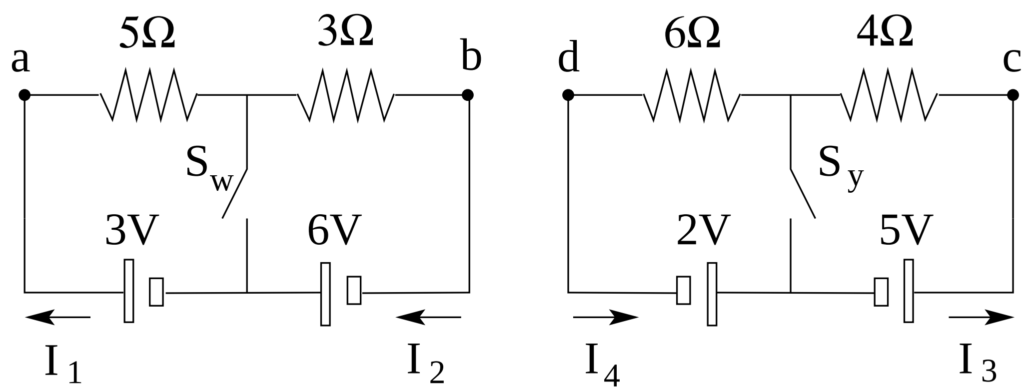
- $Q_7 = (24\text{V})(7\mu\text{F}) = 168\mu\text{C} \quad [Q_5 = (24\text{V})(5\mu\text{F}) = 120\mu\text{C}]$
- $U_5 = \frac{1}{2}(5\mu\text{F})(24\text{V})^2 = 1440\mu\text{J} \quad \left[U_7 = \frac{1}{2}(7\mu\text{F})(24\text{V})^2 = 2016\mu\text{J}\right]$
- $V_2 + V_4 = 24\text{V}, \quad V_2C_2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

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



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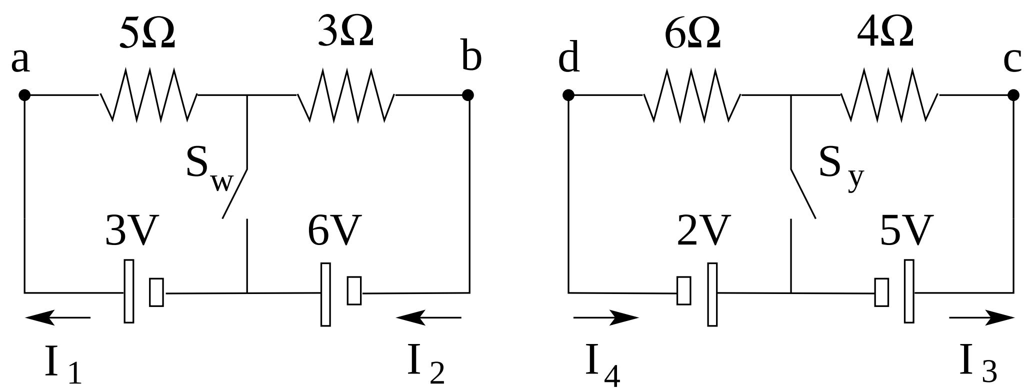


Solution:

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

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

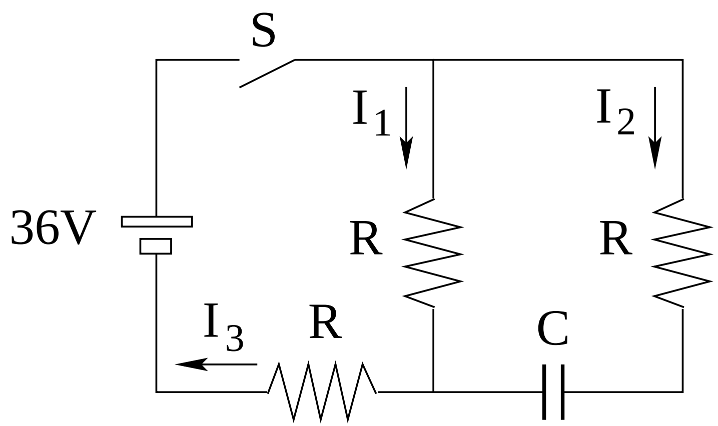
(b) $I_1 = \dfrac{3\text{V}}{5\Omega} = 0.6\text{A}, \quad I_2 = \dfrac{6\text{V}}{3\Omega} = 2\text{A}, \quad V_a - V_b = 9V.$

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

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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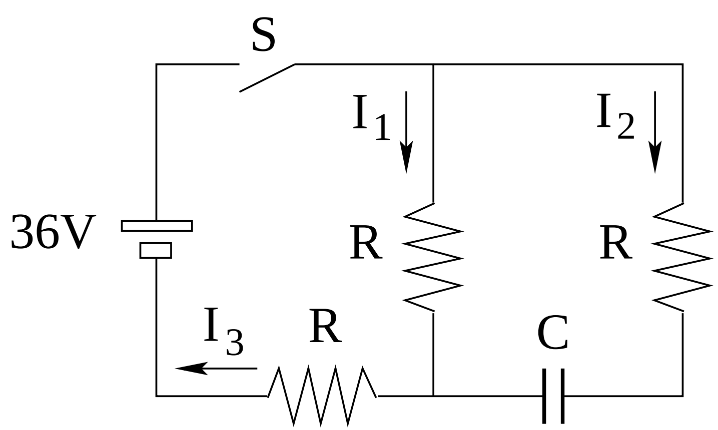


Solution:

(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)

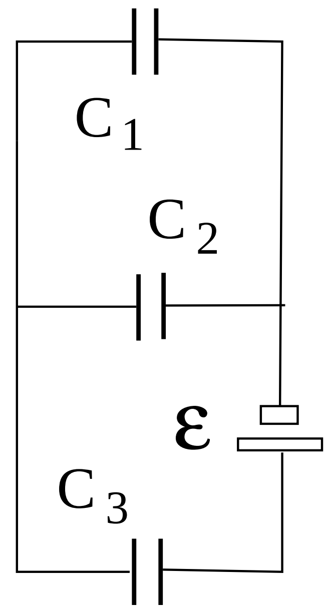
The circuit shown has reached equilibrium.
The specifications are $\mathcal{E} = 12$V [18V], $C_1 = C_2 = C_3 = 5$nF [4nF]

(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.



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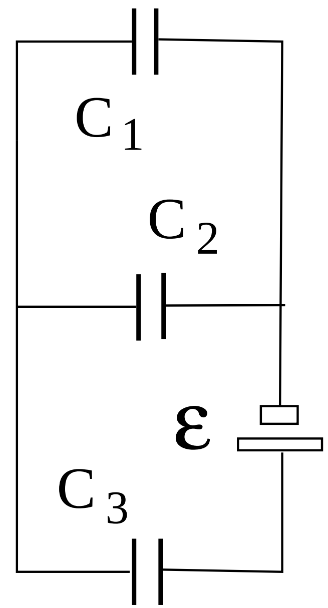


Solution:

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

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

Unit Exam II: Problem #2 (Spring ’18)

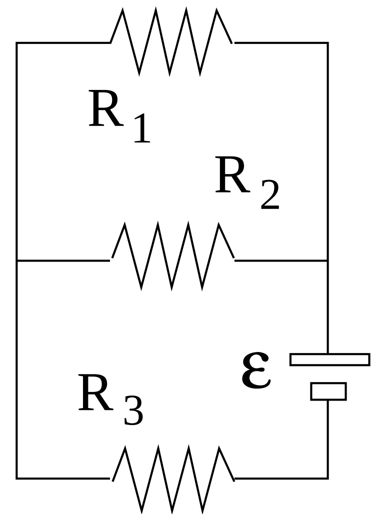
The circuit shown is in a steady state.
The specifications are $\mathcal{E} = 12$V [18V], $R_1 = R_2 = R_3 = 5\Omega$ [4Ω].

(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}.

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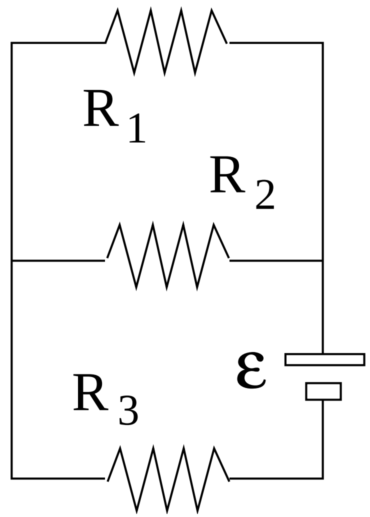


Solution:

(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)

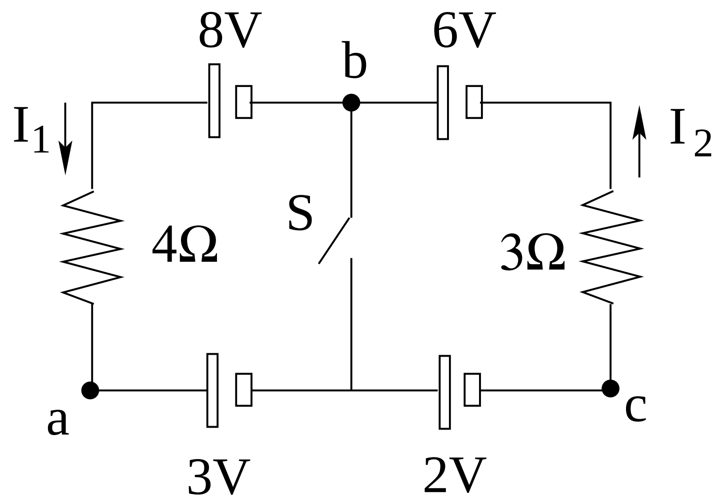
This circuit is in a steady state with the switch S either open or closed.

(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.



Unit Exam II: Problem #3 (Spring ’18)

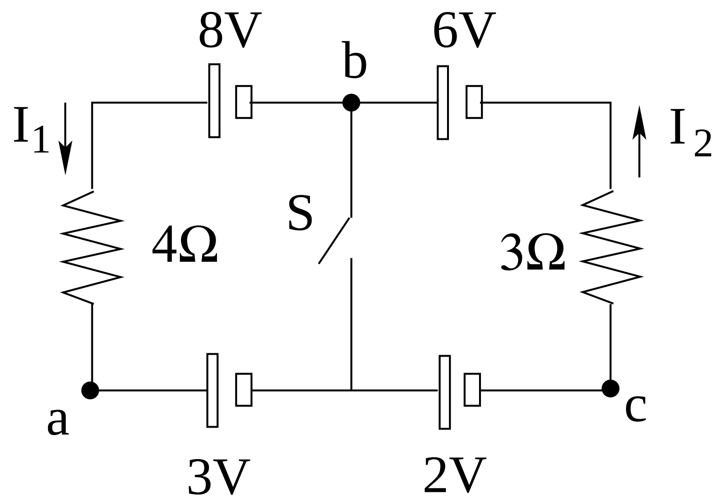
This circuit is in a steady state with the switch S either open or closed.

(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.



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

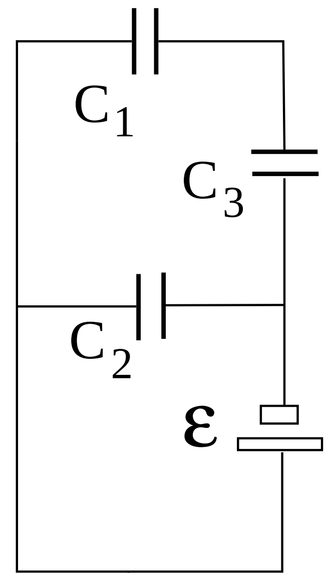
Unit Exam II: Problem #1 (Fall ’18)

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.



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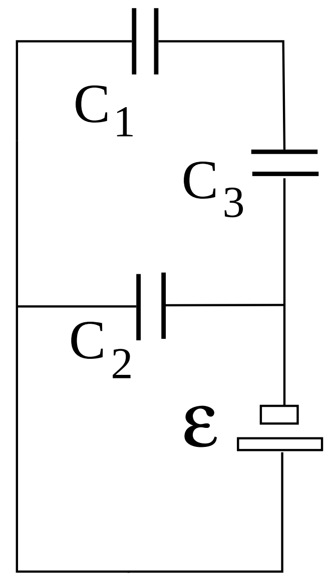


(a) Find the equivalent capacitance C_{eq}.

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

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

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

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

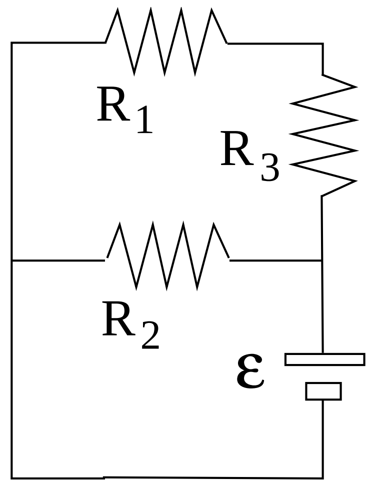
Unit Exam II: Problem #2 (Fall ’18)

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}.

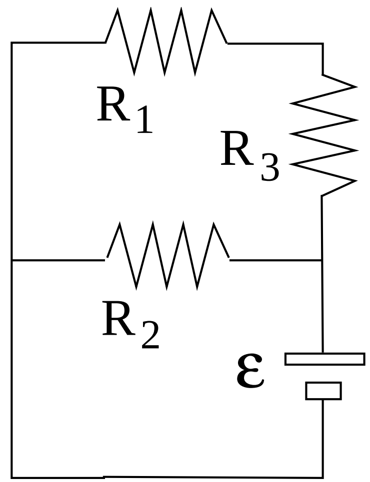
(b) Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.

(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)

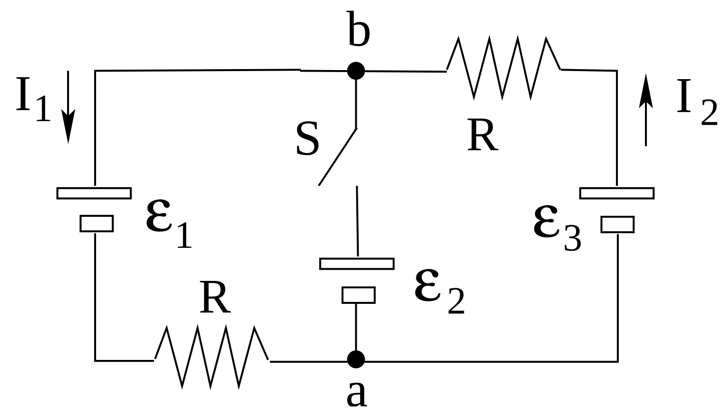
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4$V [3V], $\mathcal{E}_2 = 6$V [7V], $\mathcal{E}_3 = 10$V [9V], $R = 7\Omega$ [11Ω].

(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.



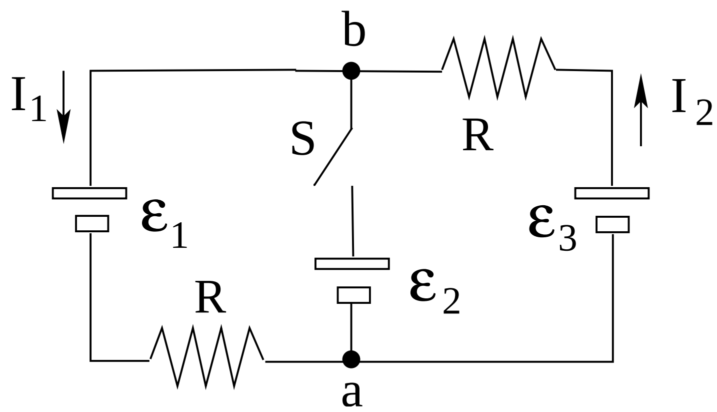
This circuit is in a steady state with the switch S either open or closed.
The specifications are $\mathcal{E}_1 = 4$V [3V], $\mathcal{E}_2 = 6$V [7V], $\mathcal{E}_3 = 10$V [9V], $R = 7\Omega$ [11Ω].

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

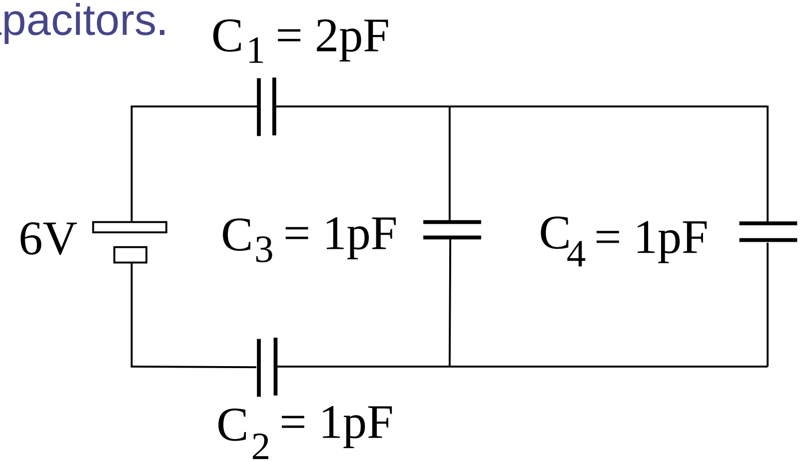
Unit Exam II: Problem #1 (Spring '19)

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}.

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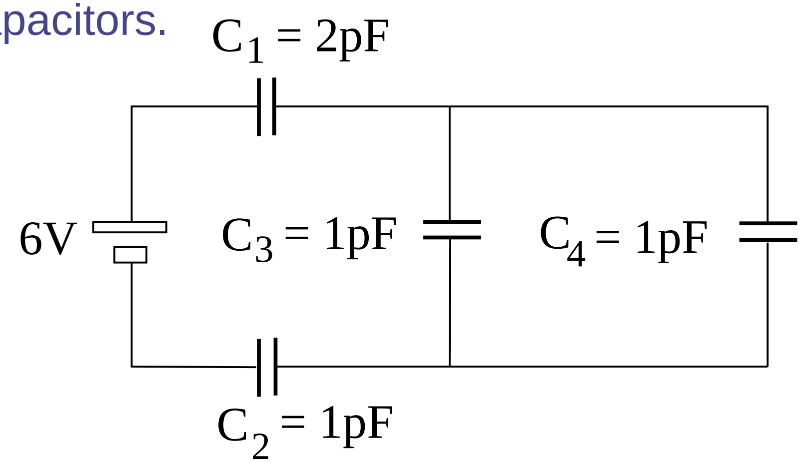
(c) Find the voltages V_1, V_2, V_3, V_4 across the four capacitors.



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)

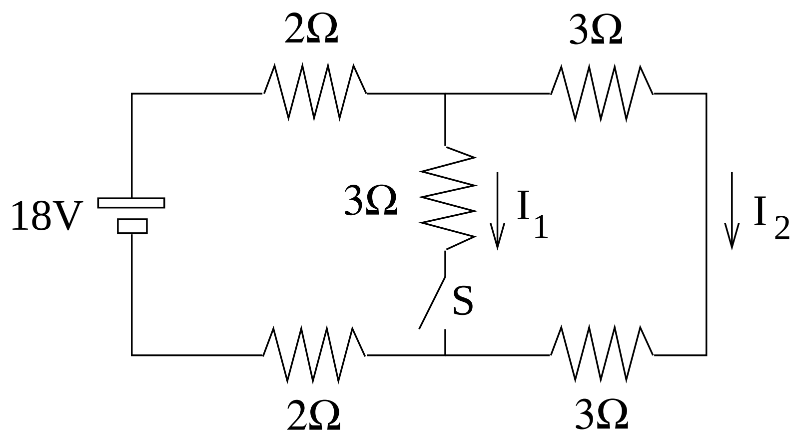
The circuit shown is in a steady state with the switch S either open or closed.

(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)

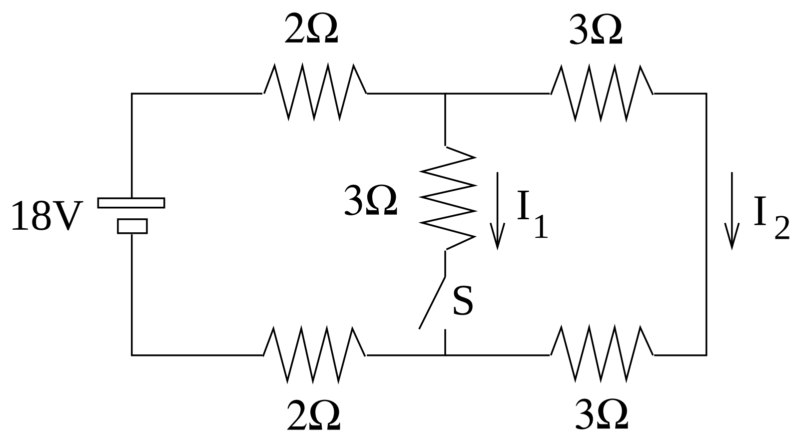
The circuit shown is in a steady state with the switch S either open or closed.

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

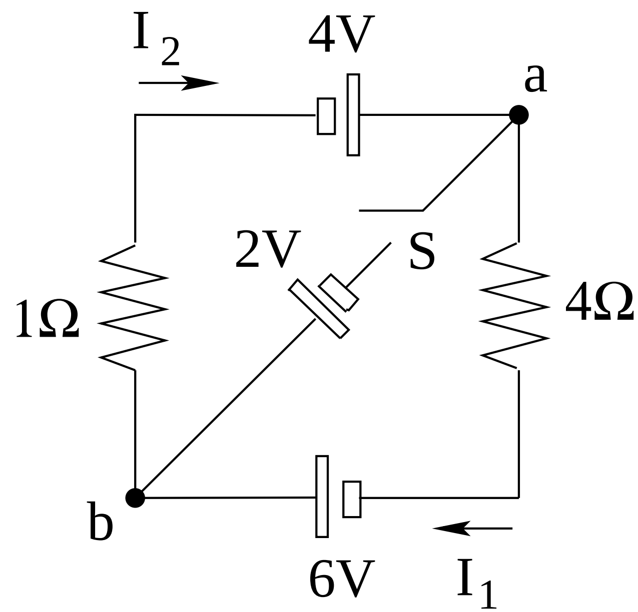
This circuit is in a steady state with the switch S either open or closed.

(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.



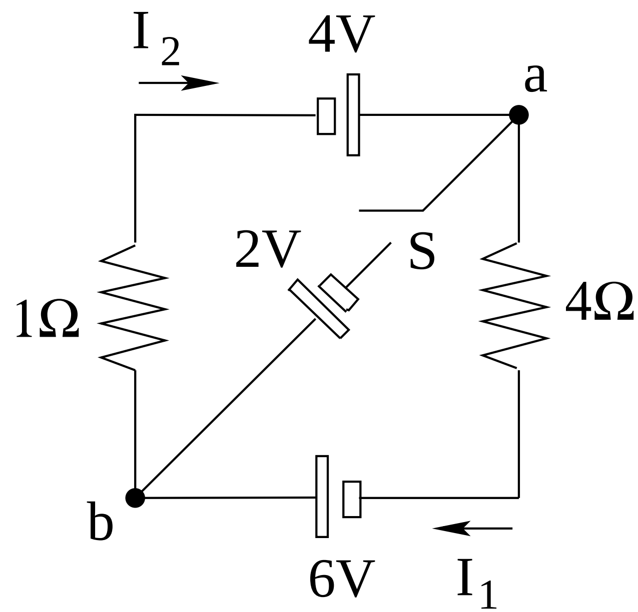
This circuit is in a steady state with the switch S either open or closed.

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