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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.

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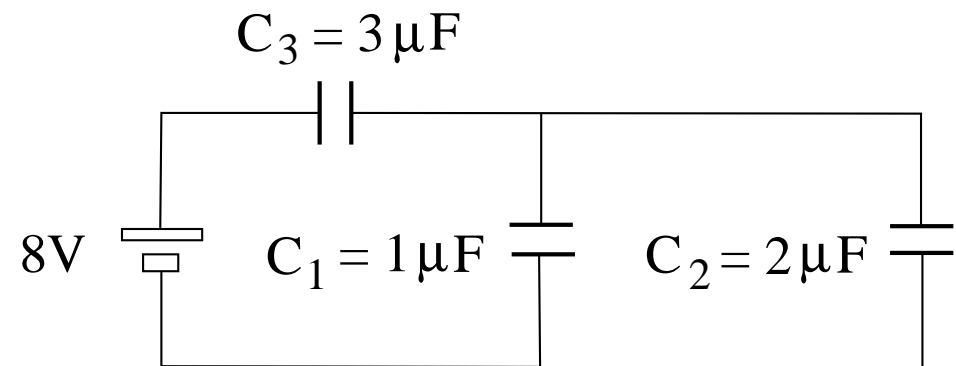
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Intermediate Exam II: Problem #1 (Spring '05)



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 .

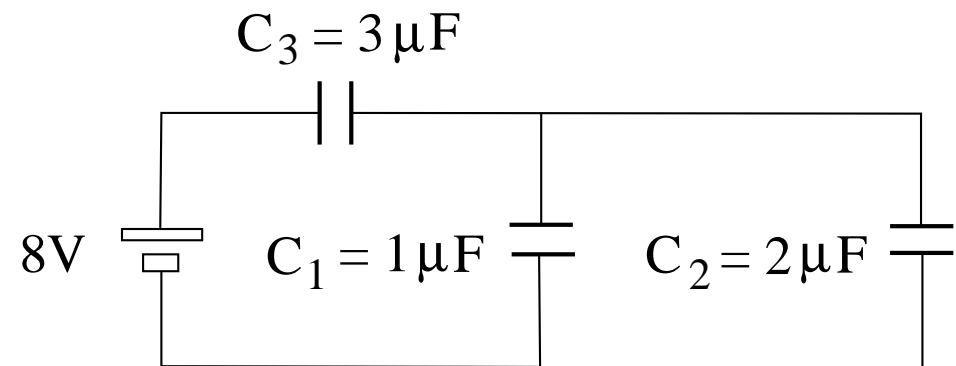


Intermediate Exam II: Problem #1 (Spring '05)



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

- Find the equivalent capacitance C_{eq} .
- Find the voltage V_3 across capacitor C_3 .
- Find the the charge Q_2 on capacitor C_2 .



Solution:

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

$$(b) \quad Q_3 = Q_{12} = Q_{eq} = C_{eq}(8\text{V}) = 12 \mu\text{C}$$
$$\Rightarrow V_3 = \frac{Q_3}{C_3} = \frac{12 \mu\text{C}}{3 \mu\text{F}} = 4\text{V}.$$

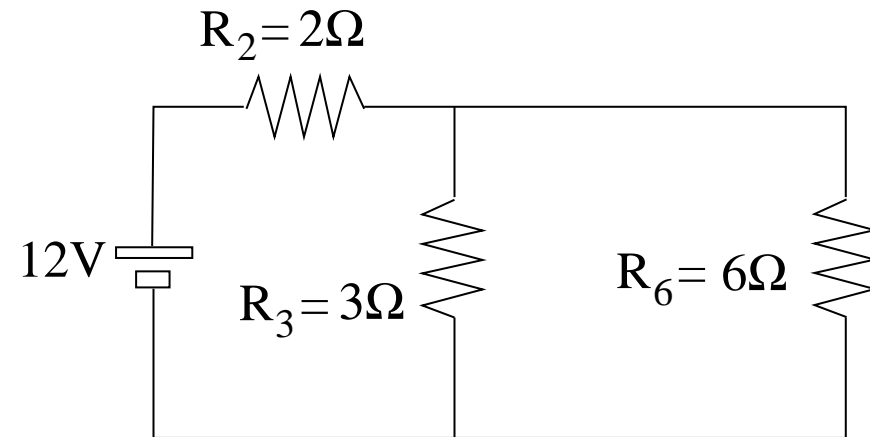
$$(c) \quad Q_2 = V_2 C_2 = 8 \mu\text{C}.$$

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 .

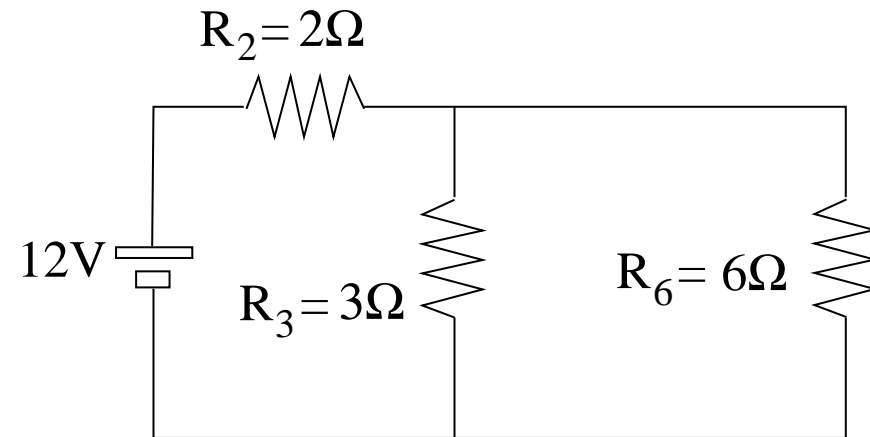


Intermediate Exam II: Problem #2 (Spring '05)



Consider the electrical circuit shown.

- (a) Find the equivalent resistance R_{eq} .
- (b) Find the current I_3 through resistor R_3 .



Solution:

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

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

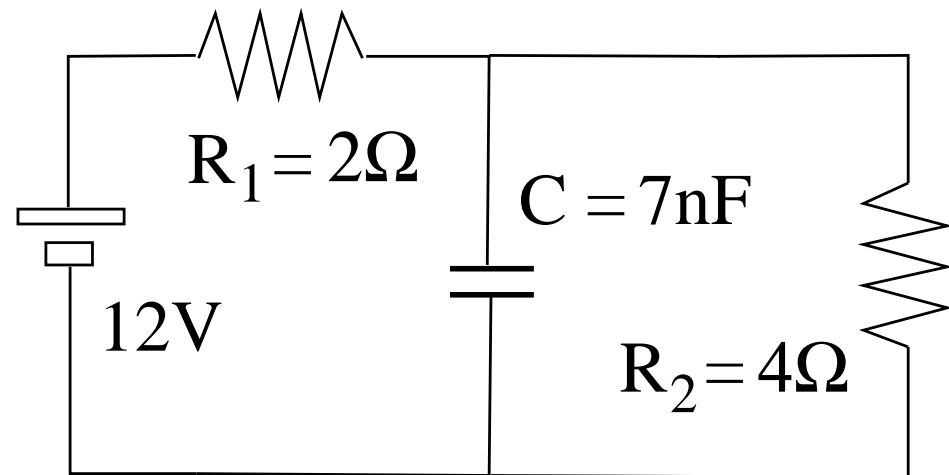
$$\Rightarrow V_3 = V_{36} = I_{36}R_{36} = 6V \quad \Rightarrow I_3 = \frac{V_3}{R_3} = 2A.$$

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.

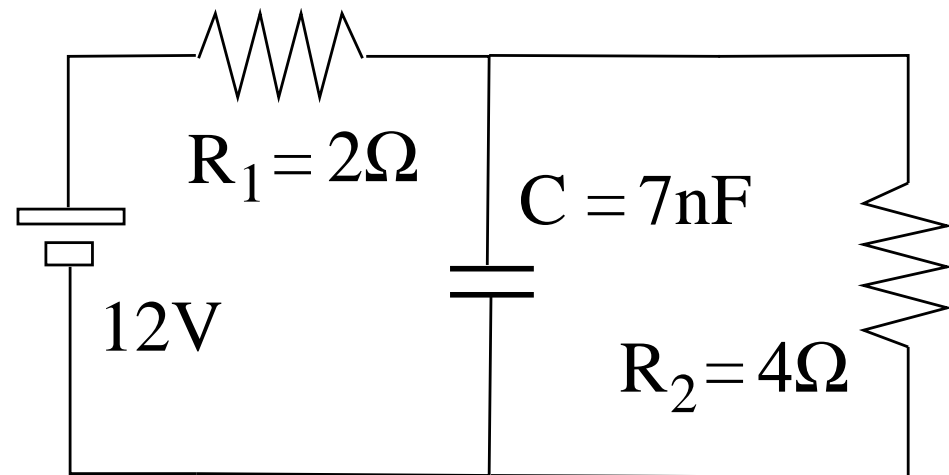


Intermediate Exam II: Problem #3 (Spring '05)



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

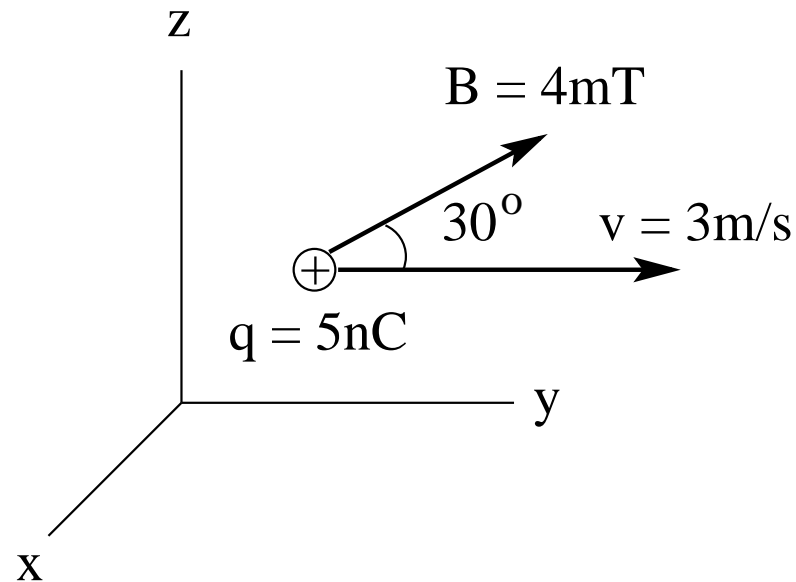
(b) $V_C = V_2 = I_2 R_2 = (2\text{A})(4\Omega) = 8\text{V}$.

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.

- Find the direction of the magnetic force acting on the particle.
- Find the magnitude of the magnetic force acting on the particle.

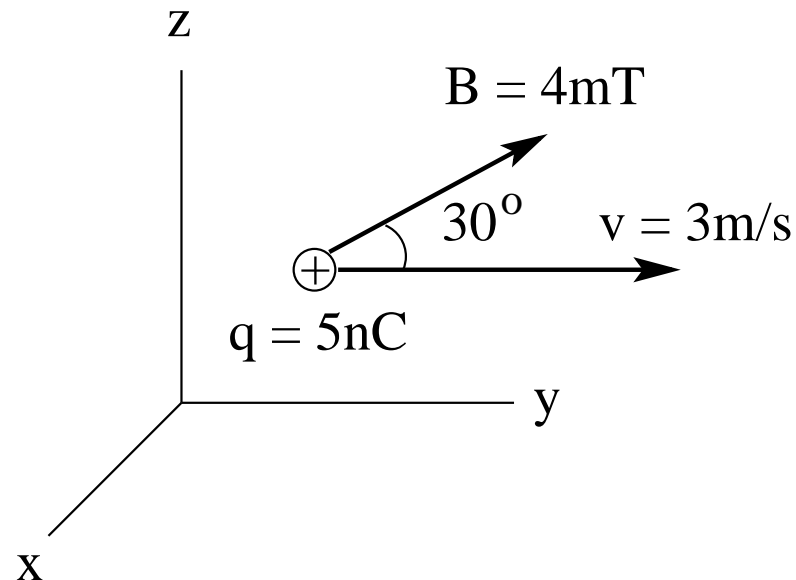


Intermediate Exam II: Problem #4 (Spring '05)



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.

- Find the direction of the magnetic force acting on the particle.
- Find the magnitude of the magnetic force acting on the particle.



Solution:

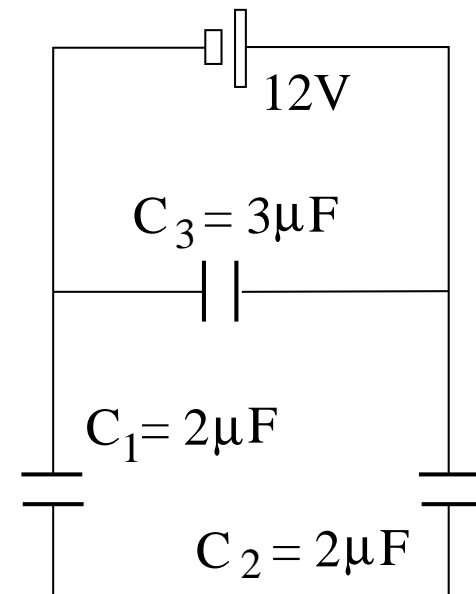
- Use the right-hand rule: positive x -direction (front, out of page).
- $F = qvB \sin 30^\circ = (5 \times 10^{-9}\text{C})(3\text{m/s})(4 \times 10^{-3}\text{T})(0.5) = 3 \times 10^{-11}\text{N}$.

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 .

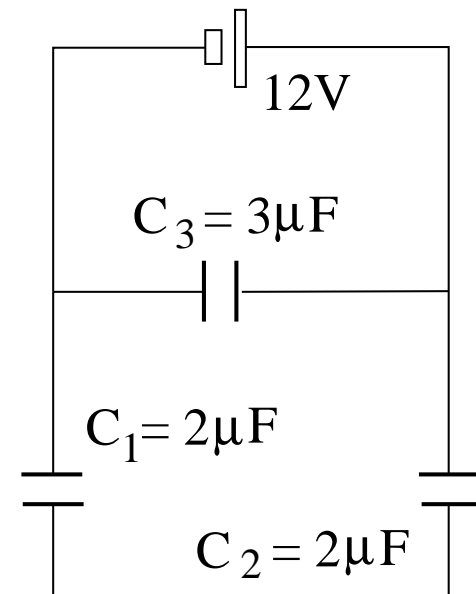


Intermediate Exam II: Problem #1 (Spring '06)



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:

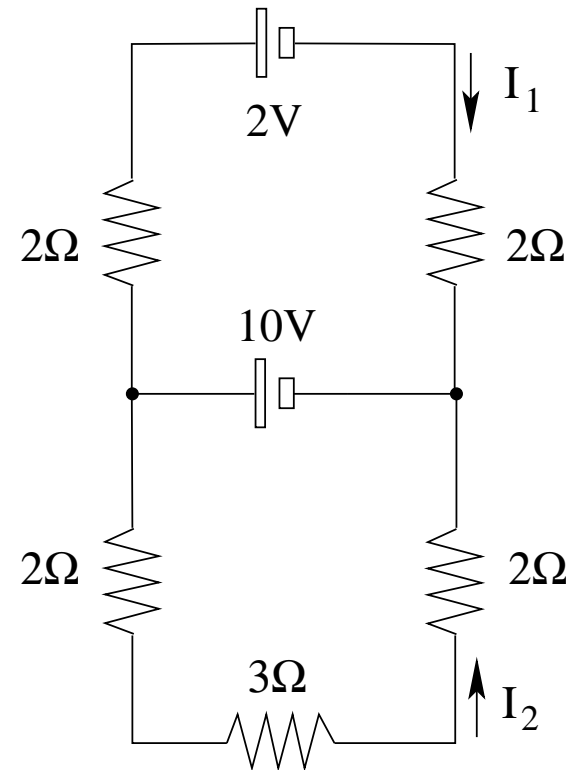
- (a) $Q_3 = C_3(12\text{V}) = (3\mu\text{F})(12\text{V}) = 36\mu\text{C}$.
- (b) $Q_2 = Q_{12} = C_{12}(12\text{V}) = (1\mu\text{F})(12\text{V}) = 12\mu\text{C}$.

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 .

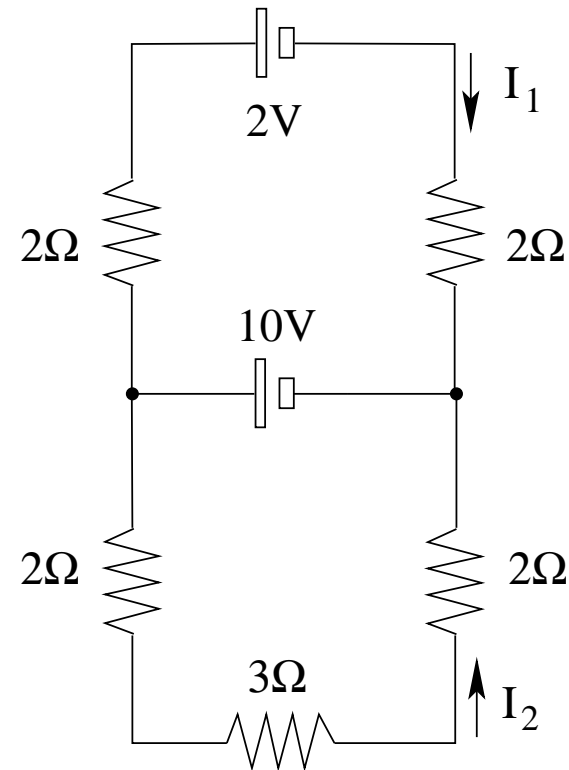


Intermediate Exam II: Problem #2 (Spring '06)



Consider the two-loop circuit shown.

- (a) Find the current I_1 .
- (b) Find the current I_2 .



Solution:

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

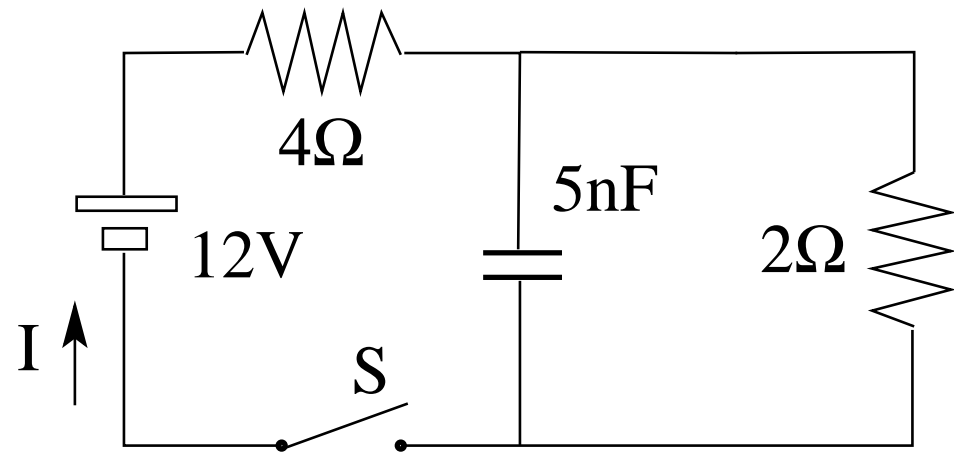
$$(b) \quad -(2\Omega)(I_2) + 10V - (2\Omega)(I_2) - (3\Omega)(I_2) = 0 \quad \Rightarrow \quad I_2 = \frac{10V}{7\Omega} = 1.43A.$$

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.

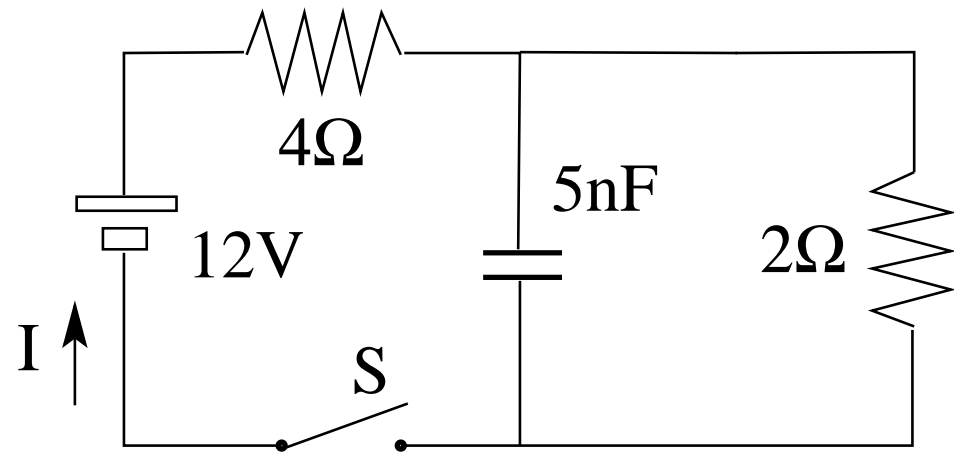


Intermediate Exam II: Problem #3 (Spring '06)



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:

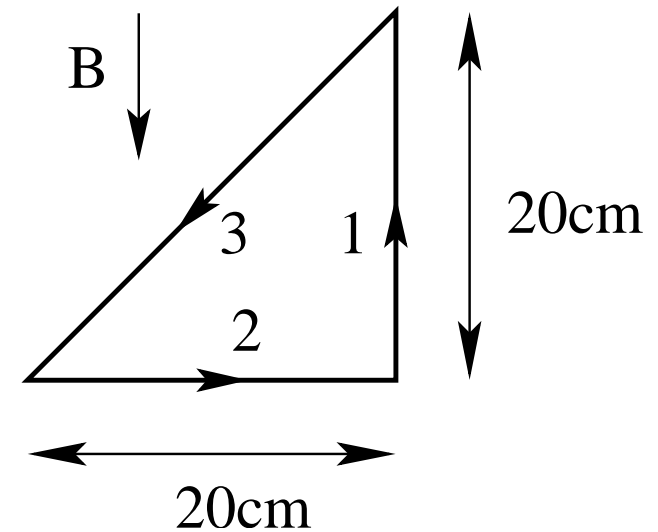
- (a) No current through 2Ω -resistor: $I = \frac{12\text{V}}{4\Omega} = 3\text{A}$.
- (b) No current through capacitor: $I = \frac{12\text{V}}{6\Omega} = 2\text{A}$.

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 $B = 30\text{mT}$ as shown. The current in the loop is $I = 0.4\text{A}$ 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.

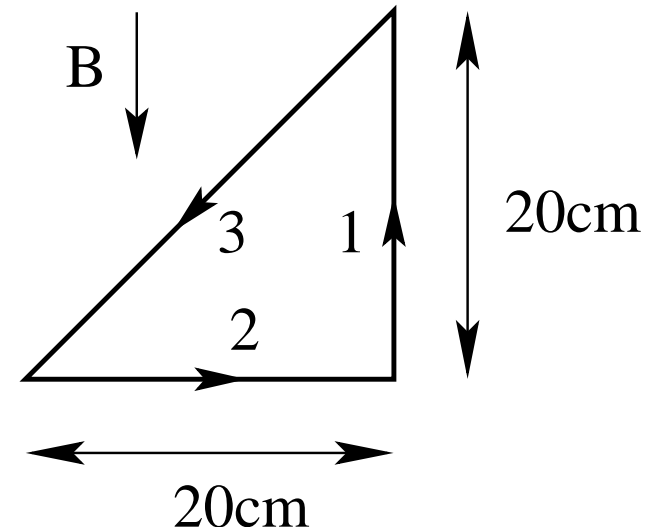


Intermediate Exam II: Problem #4 (Spring '06)



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



Solution:

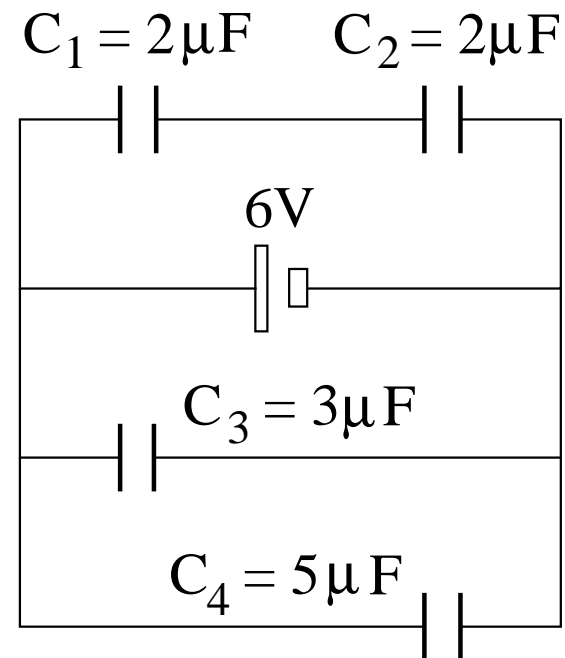
- (a) $\vec{F}_1 = I\vec{L} \times \vec{B} = 0$ (angle between \vec{L} and \vec{B} is 180°).
- (b) $F_2 = ILB = (0.4\text{A})(0.2\text{m})(30 \times 10^{-3}\text{T}) = 2.4 \times 10^{-3}\text{N}$.
Direction of \vec{F}_2 : \otimes (into plane).

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 .

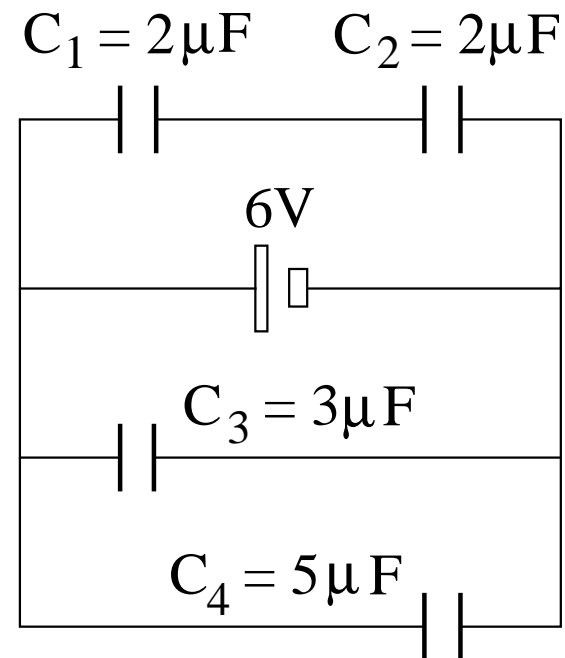
Solution:

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

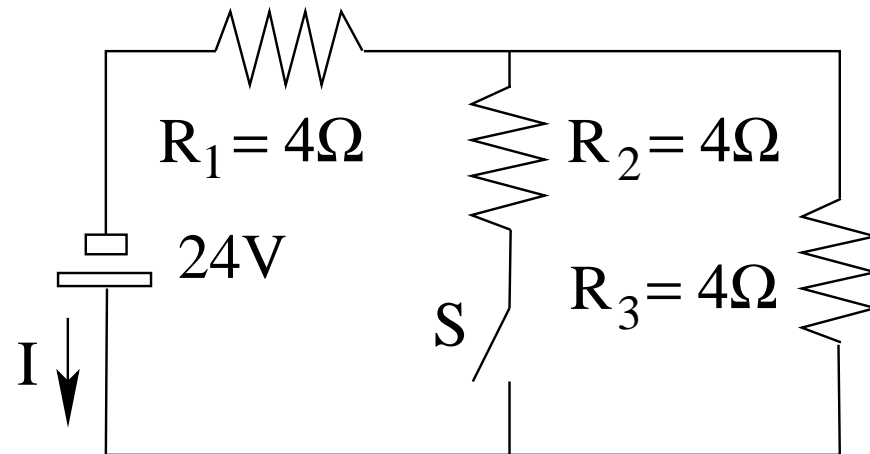


Unit Exam II: Problem #2 (Spring '07)



Consider the electric circuit shown.

- (a) Find the current I when the switch S is open.
- (b) Find the power P_3 dissipated in resistor 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 resistor R_3 when the switch is closed.



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 resistor 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 resistor R_3 when the switch is closed.

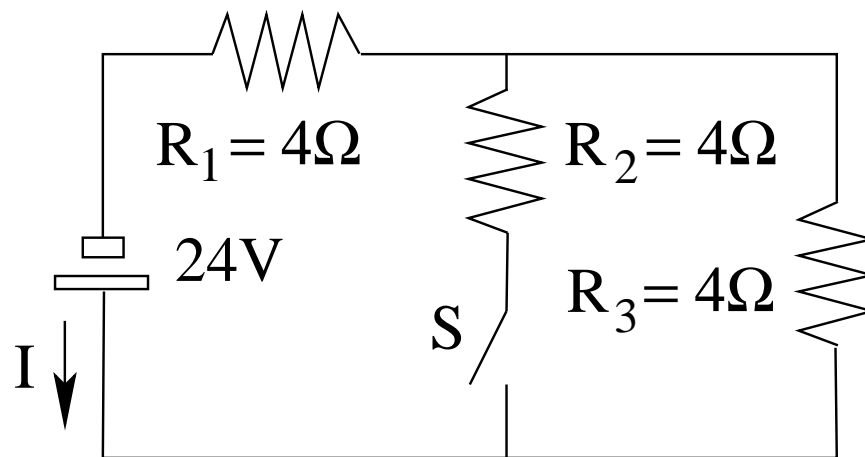
Solution:

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

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

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

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

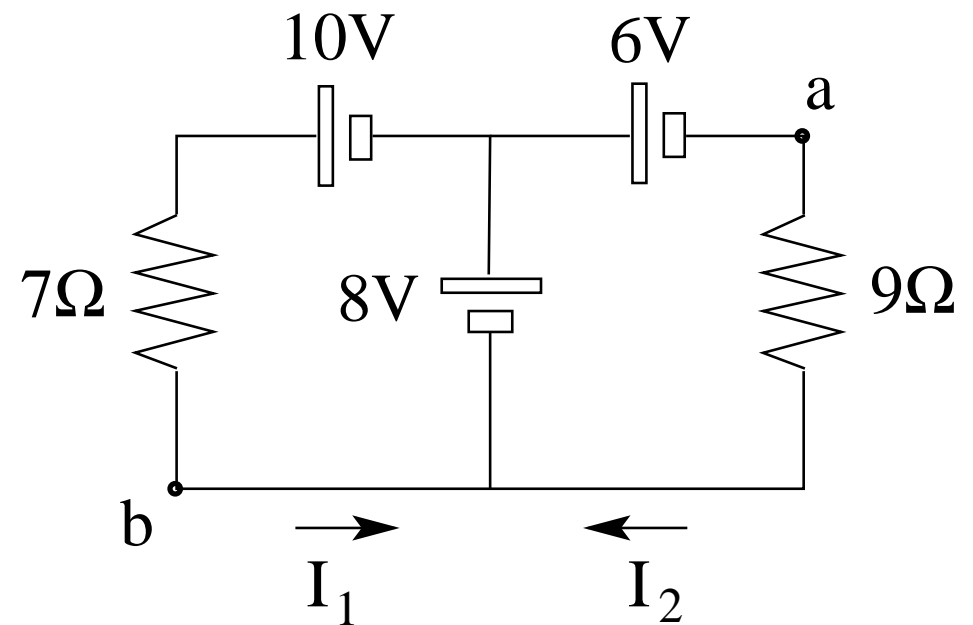


Unit Exam II: Problem #3 (Spring '07)



Consider the two-loop circuit shown.

- (a) Find the current I_1 .
- (b) Find the current I_2 .
- (c) Find the potential difference $V_a - V_b$.



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



Consider the two-loop circuit shown.

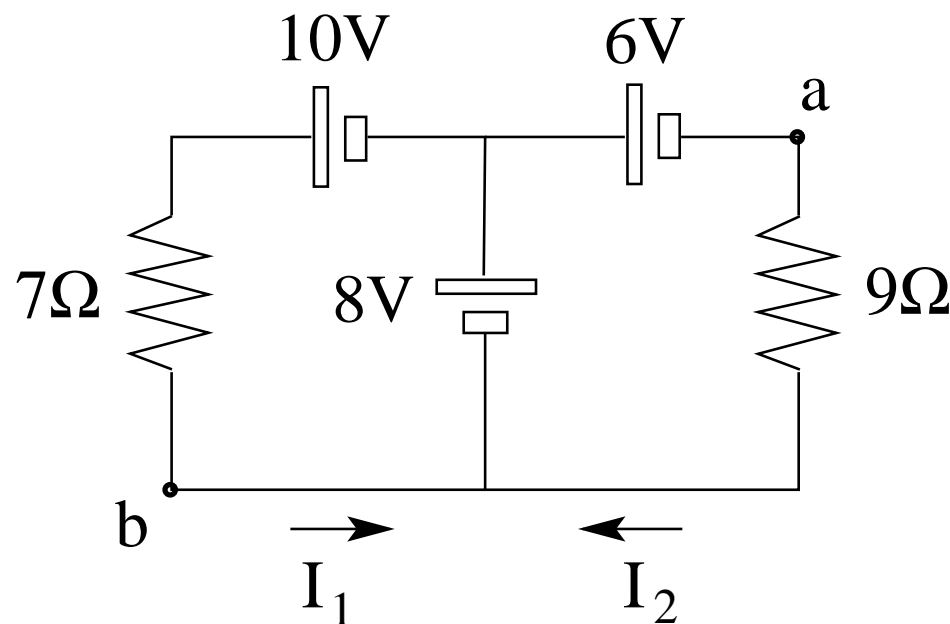
- (a) Find the current I_1 .
- (b) Find the current I_2 .
- (c) Find the potential difference $V_a - V_b$.

Solution:

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

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

(c)
$$V_a - V_b = 8V - 6V = 2V.$$

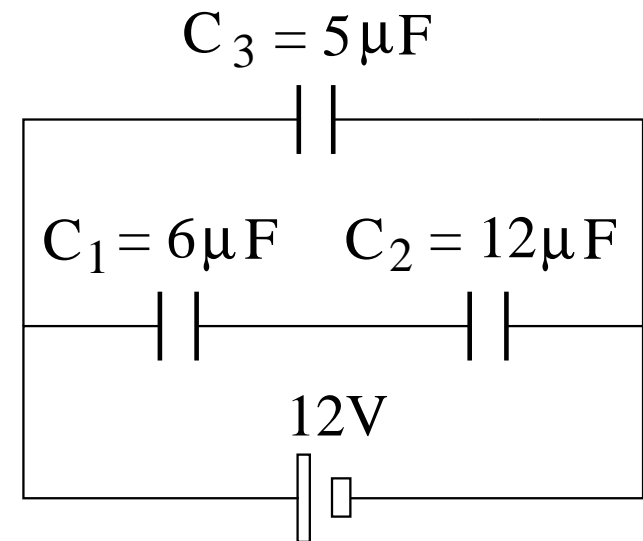


Unit Exam II: Problem #1 (Spring '08)



The circuit of capacitors is at equilibrium.

- Find the charge Q_1 on capacitor 1 and the charge Q_2 on capacitor 2.
- Find the voltage V_1 across capacitor 1 and the voltage V_2 across capacitor 2.
- 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.

- Find the charge Q_1 on capacitor 1 and the charge Q_2 on capacitor 2.
- Find the voltage V_1 across capacitor 1 and the voltage V_2 across capacitor 2.
- Find the charge Q_3 and the energy U_3 on capacitor 3.

Solution:

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

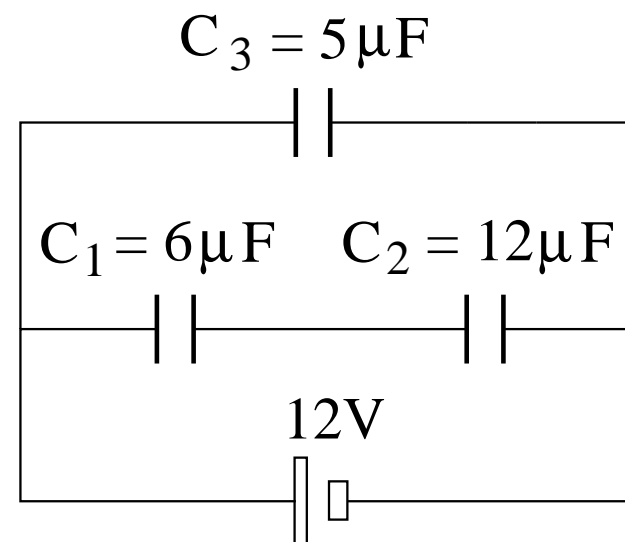
$$Q_1 = Q_2 = Q_{12} = (4\mu\text{F})(12\text{V}) = 48\mu\text{C}.$$

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

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

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

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

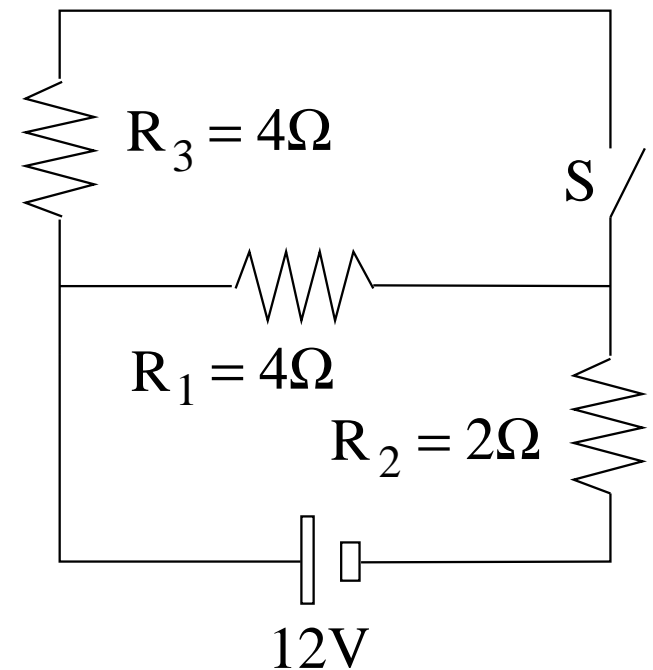


Unit Exam II: Problem #2 (Spring '08)



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

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



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

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

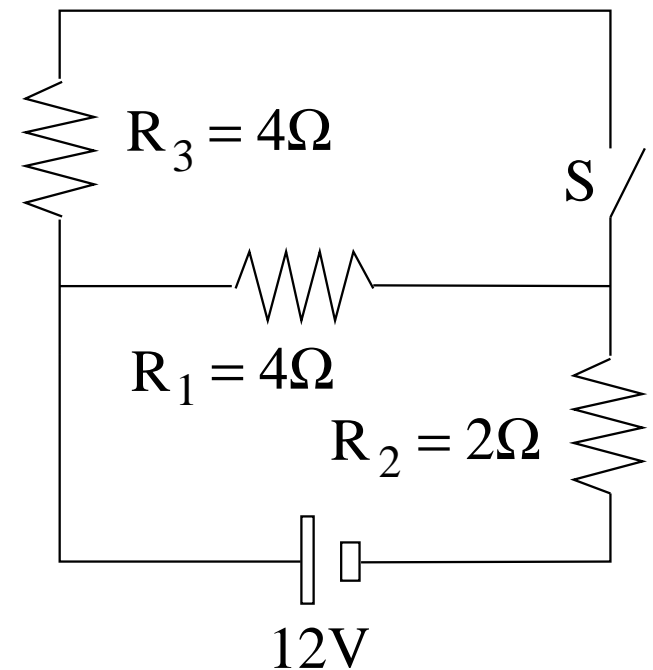
Solution:

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

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

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

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

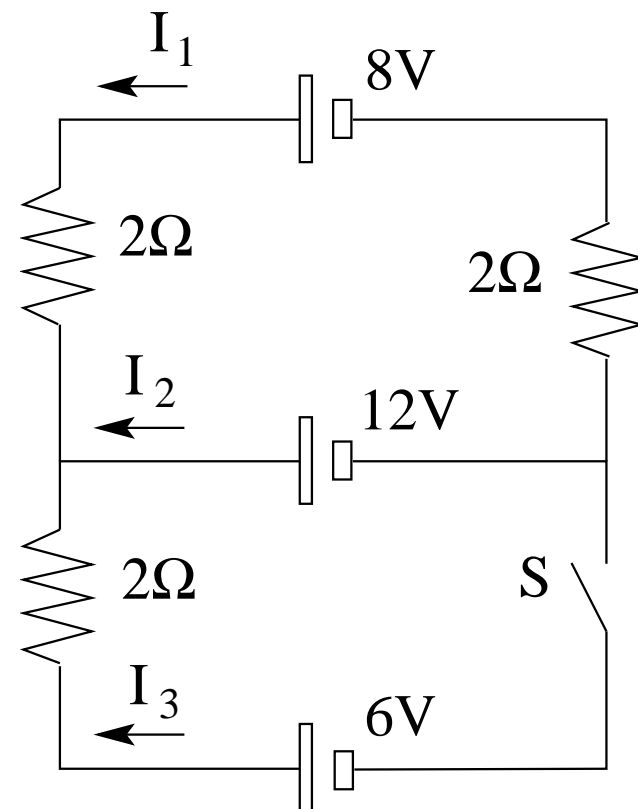


Unit Exam II: Problem #3 (Spring '08)



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.



Unit Exam II: Problem #3 (Spring '08)



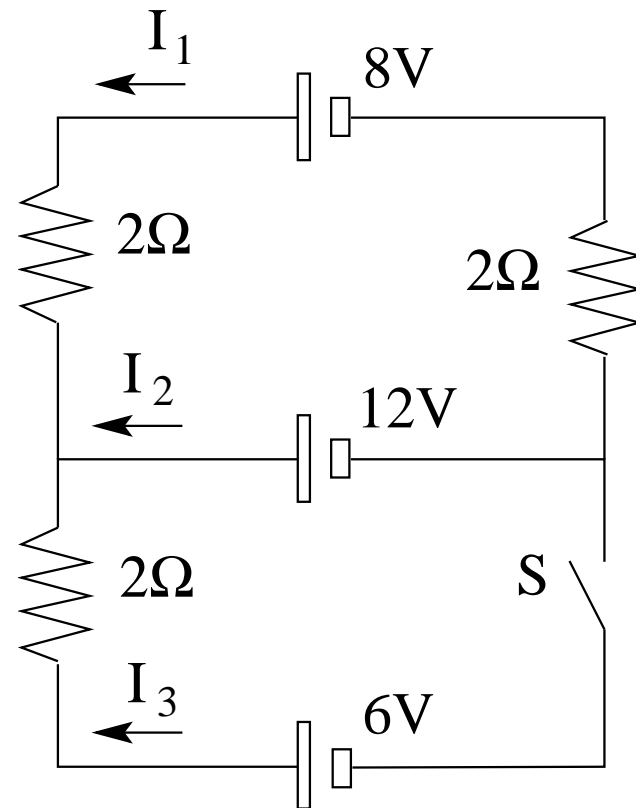
Consider the electric circuit shown. Find the currents I_1 , I_2 , and I_3

- (a) with the switch S open,
- (b) with the switch S closed.

Solution:

(a)
$$I_1 = \frac{8V - 12V}{4\Omega} = -1A,$$
$$I_2 = -I_1 = +1A.$$
$$I_3 = 0.$$

(b)
$$I_1 = \frac{8V - 12V}{4\Omega} = -1A,$$
$$I_3 = \frac{6V - 12V}{2\Omega} = -3A.$$
$$I_2 = -I_1 - I_3 = +4A.$$



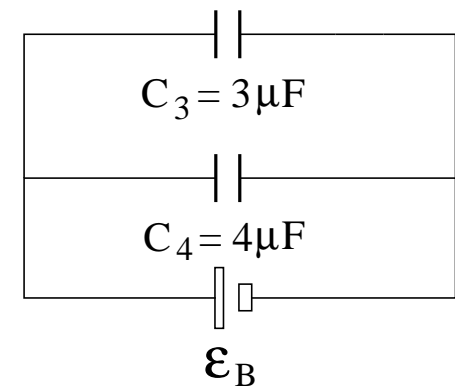
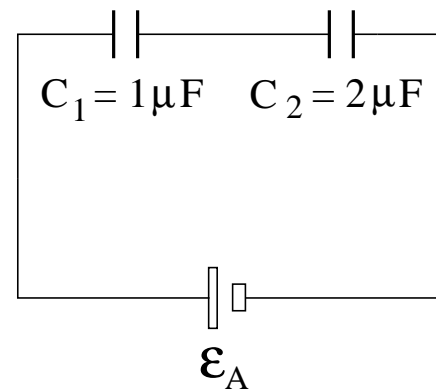
Unit Exam II: Problem #1 (Spring '09)



Both capacitor circuits are at equilibrium.

(a) In the circuit on the left, the voltage across capacitor 1 is $V_1 = 8V$. 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 $Q_3 = 6\mu C$. 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.



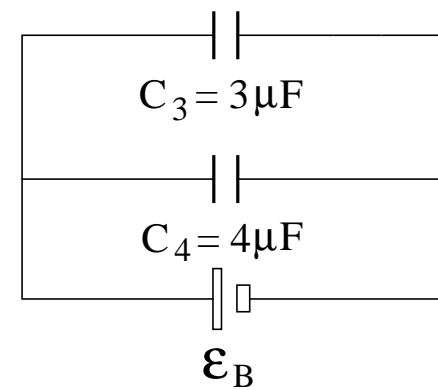
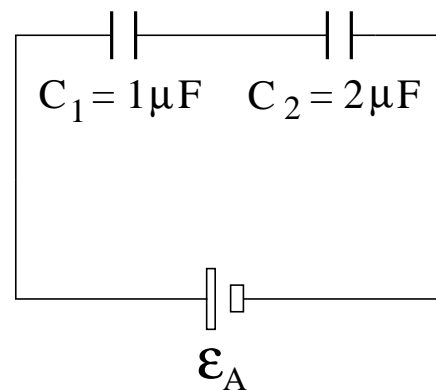
Unit Exam II: Problem #1 (Spring '09)



Both capacitor circuits are at equilibrium.

(a) In the circuit on the left, the voltage across capacitor 1 is $V_1 = 8V$. 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 $Q_3 = 6\mu C$. 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:

$$(a) \quad Q_1 = (1\mu F)(8V) = 8\mu C, \quad Q_2 = Q_1 = 8\mu C,$$
$$V_2 = \frac{8\mu C}{2\mu F} = 4V, \quad \mathcal{E}_A = 8V + 4V = 12V.$$

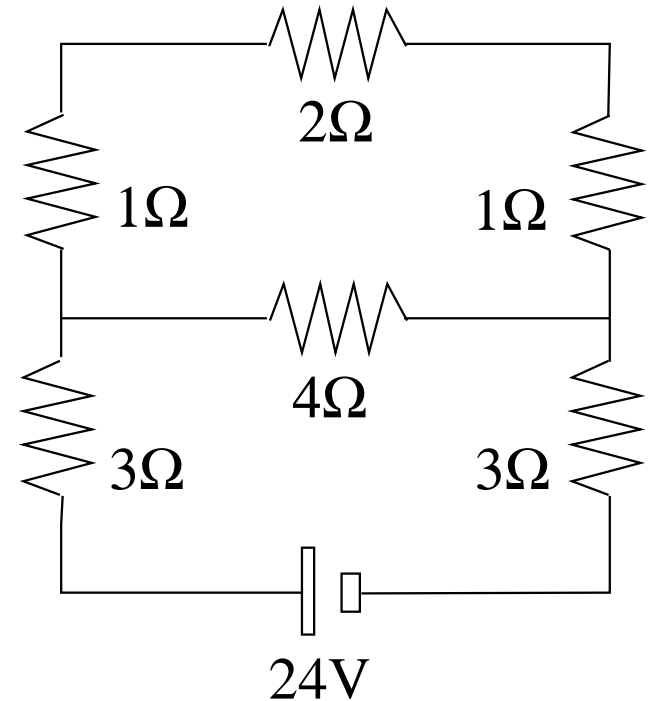
$$(b) \quad V_3 = \frac{6\mu C}{3\mu F} = 2V, \quad V_4 = V_3 = 2V,$$
$$Q_4 = (2V)(4\mu F) = 8\mu C, \quad \mathcal{E}_B = V_3 = V_4 = 2V.$$

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)

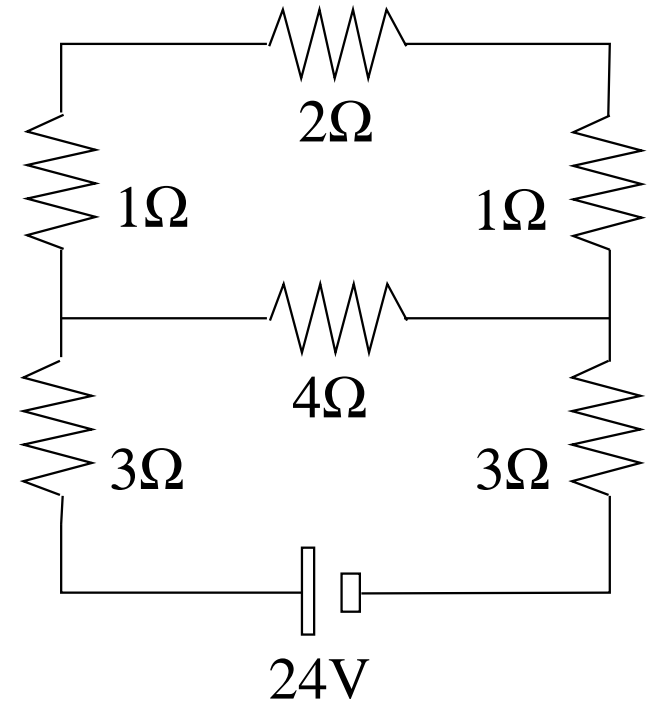


Consider the resistor circuit shown.

- (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:

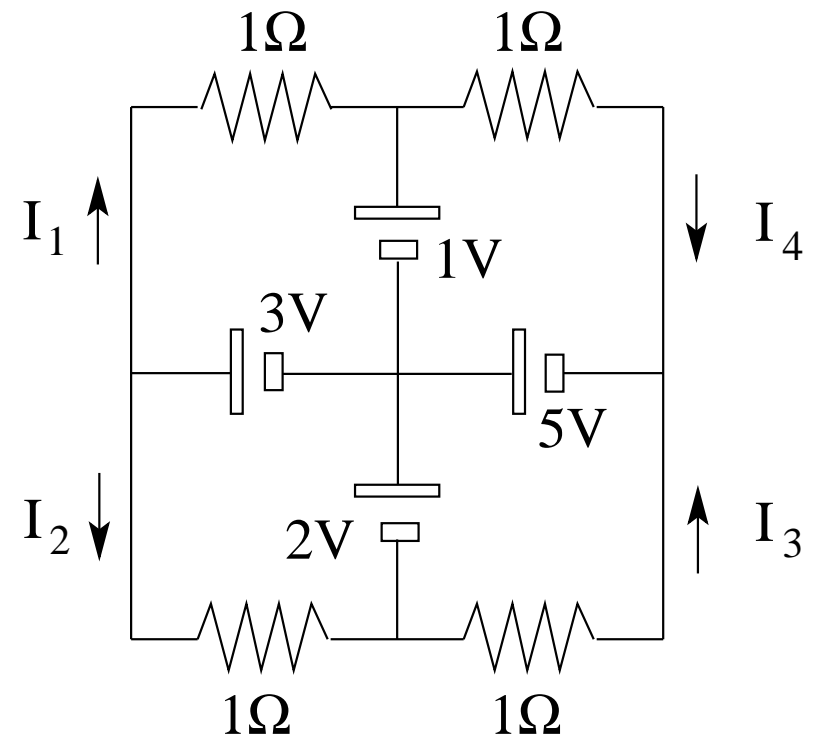
- (a) $R_{eq} = 8\Omega$.
- (b) $P = \frac{(24V)^2}{8\Omega} = 72W$.
- (c) $I_4 = \frac{1}{2} \frac{24V}{8\Omega} = 1.5A$.
- (d) $V_2 = (1.5A)(2\Omega) = 3V$.



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:

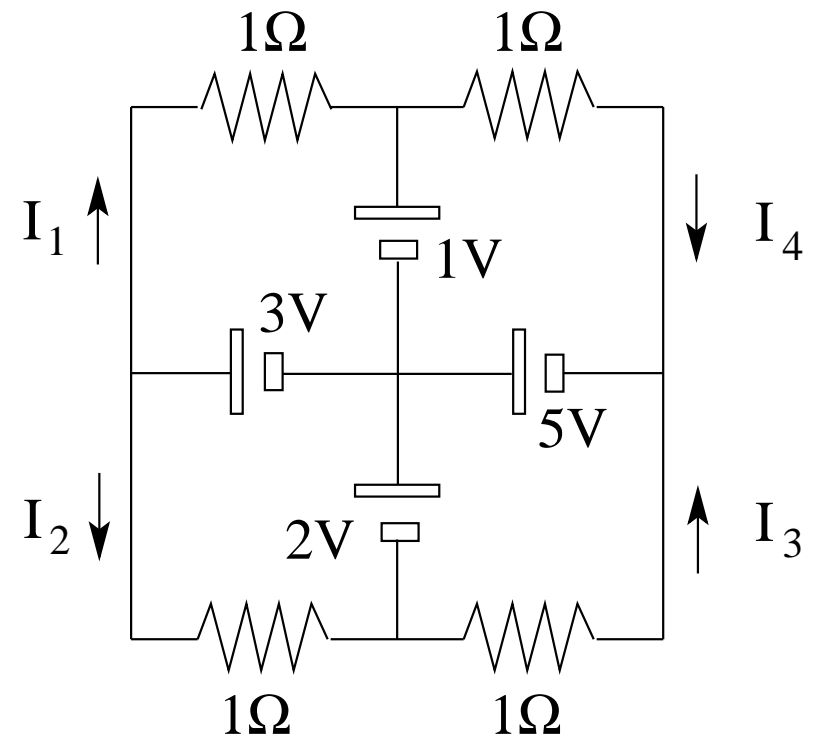
Use loops along quadrants in assumed current directions.
Start at center.

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

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

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

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

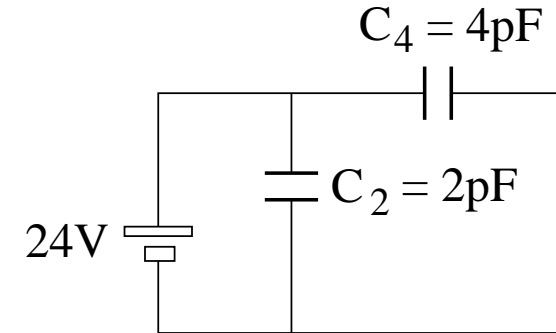
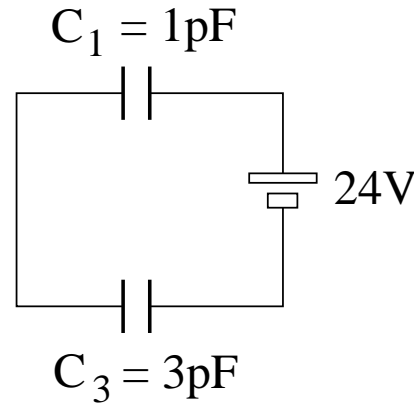


Unit Exam II: Problem #1 (Spring '11)



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.

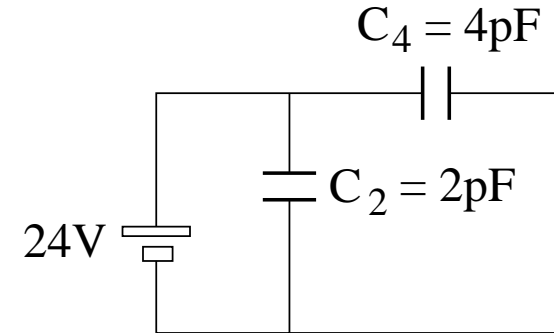
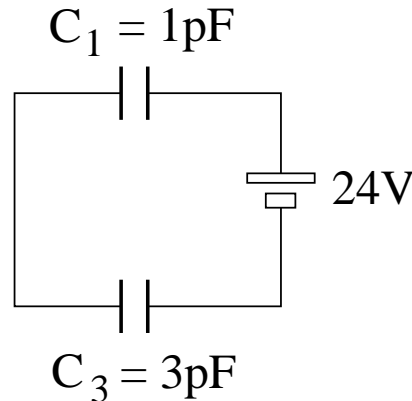


Unit Exam II: Problem #1 (Spring '11)



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:

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

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

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

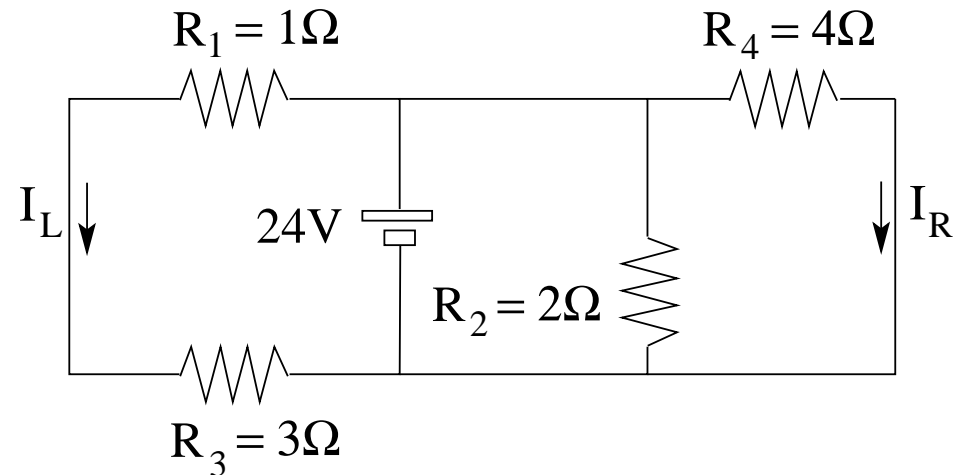
$$(d) \quad U_4 = \frac{1}{2}C_4V_4^2 = \frac{1}{2}(4\text{pF})(24\text{V})^2 = 1152\text{pJ}.$$

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.



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.

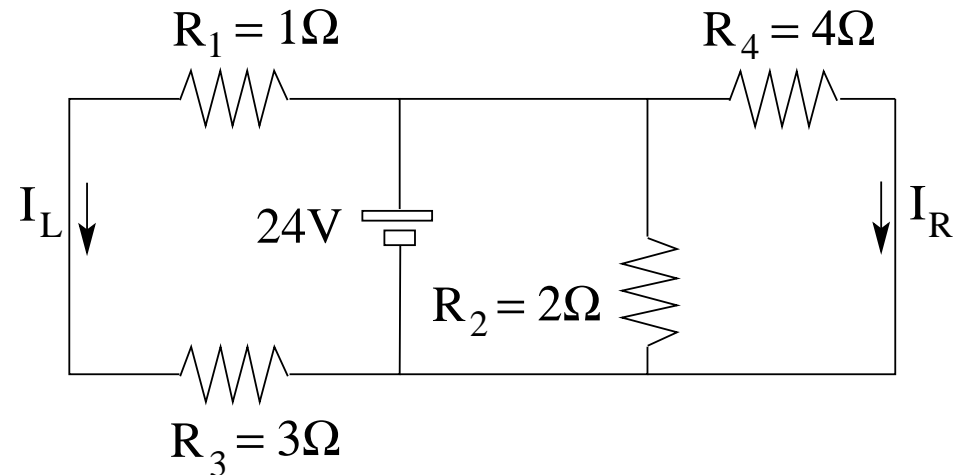
Solution:

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

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

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

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

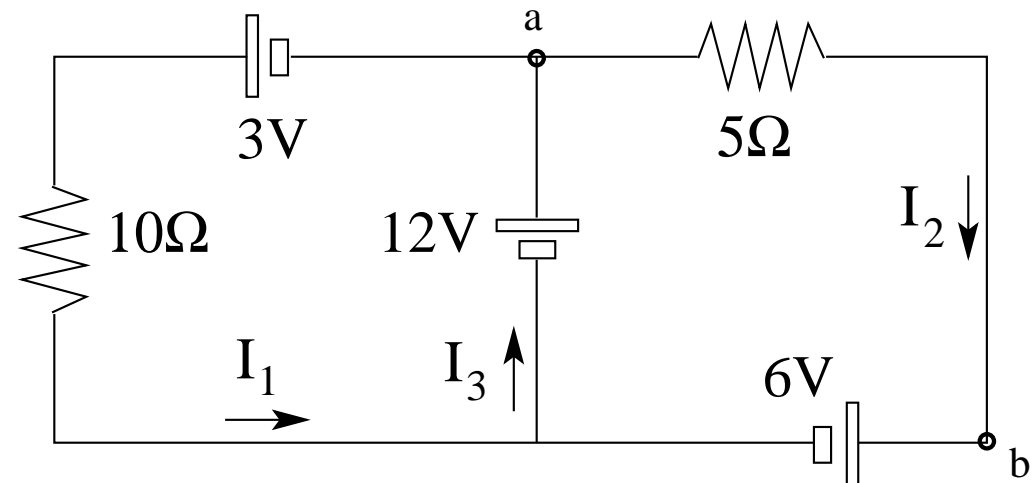


Unit Exam II: Problem #3 (Spring '11)



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 $V_a - V_b$.

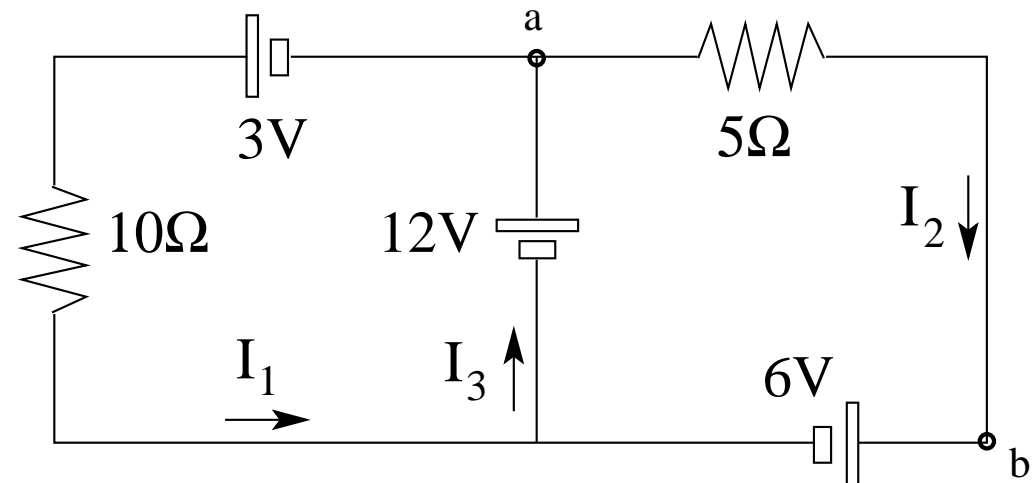


Unit Exam II: Problem #3 (Spring '11)



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:

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

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

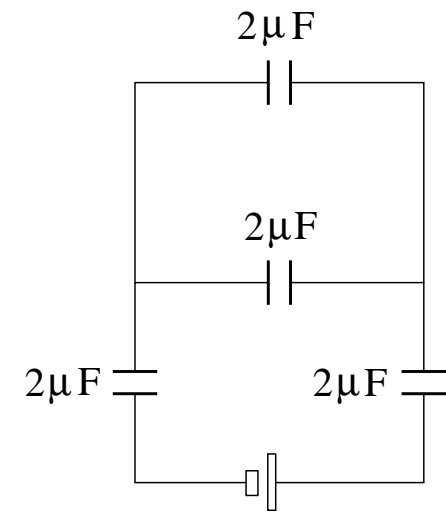
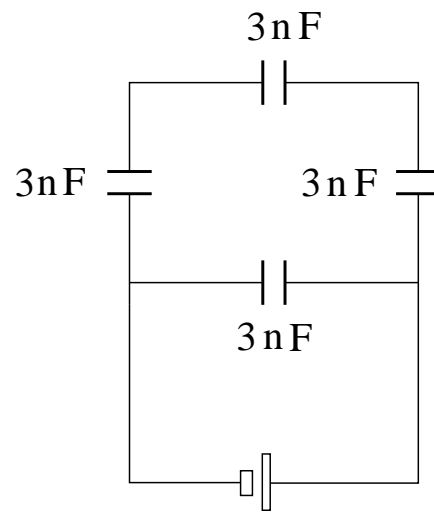
$$(c) \quad I_3 = I_1 + I_2 = 2.7A.$$

$$(d) \quad V_a - V_b = -6V + 12V = 6V.$$

Unit Exam II: Problem #1 (Spring '12)



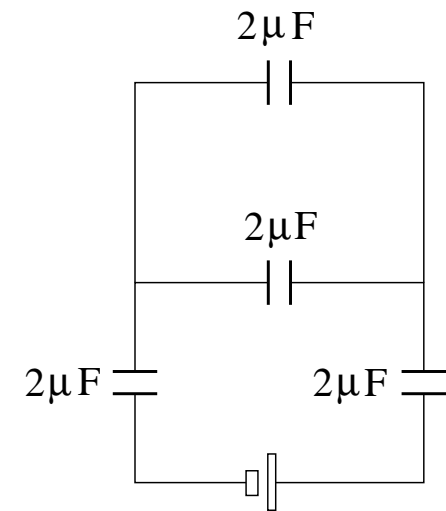
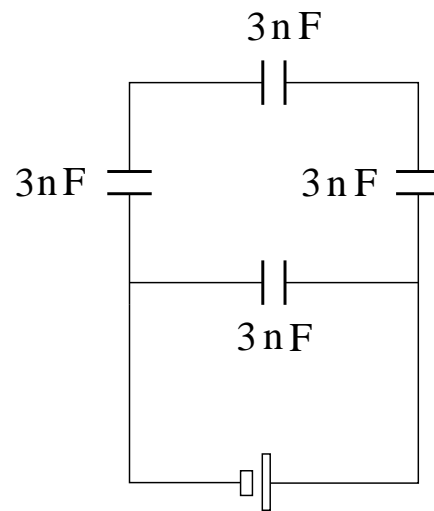
Find the equivalent capacitances C_{eq} of the two capacitor circuits.



Unit Exam II: Problem #1 (Spring '12)



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



Solution:

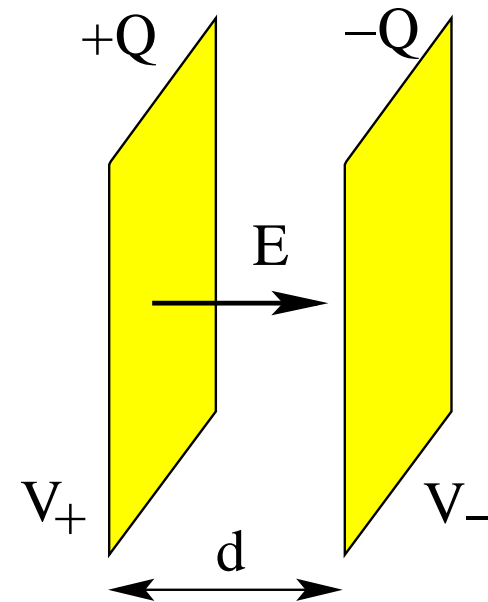
- $C_{eq} = 3\text{nF} + \left(\frac{1}{3\text{nF}} + \frac{1}{3\text{nF}} + \frac{1}{3\text{nF}} \right)^{-1} = 4\text{nF}.$
- $C_{eq} = \left(\frac{1}{2\mu\text{F}} + \frac{1}{2\mu\text{F} + 2\mu\text{F}} + \frac{1}{2\mu\text{F}} \right)^{-1} = \frac{4}{5}\mu\text{F}.$

Unit Exam II: Problem #2 (Spring '12)



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



Unit Exam II: Problem #2 (Spring '12)



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

- Find the magnitude E of the electric field between the plates.
- Find the amount Q of charge on each plate.
- Find the energy U stored on the capacitor.
- Find the area A of each plate.

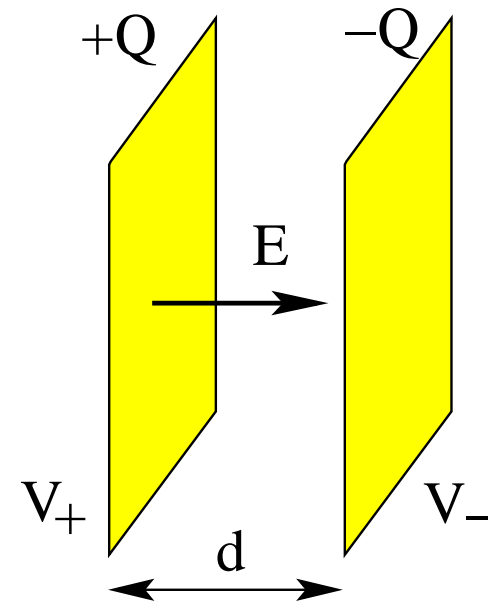
Solution:

$$(a) \quad E = \frac{V}{d} = \frac{3\text{V}}{1\text{mm}} = 3000\text{V/m}.$$

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

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

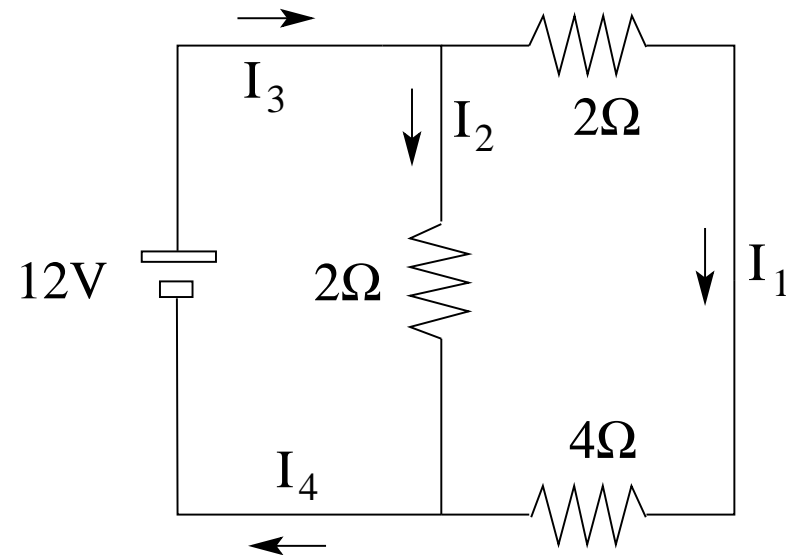
$$(d) \quad A = \frac{Cd}{\epsilon_0} = \frac{(6\text{pF})(1\text{mm})}{8.85 \times 10^{-12}\text{C}^2\text{N}^{-1}\text{m}^{-2}} = 6.78 \times 10^{-4}\text{m}^2.$$



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



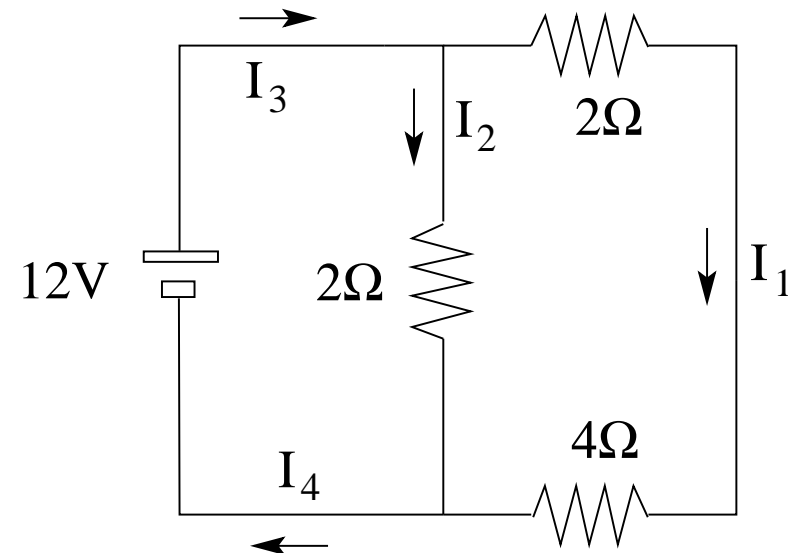
Consider the electric circuit shown. Find the currents I_1 , I_2 , I_3 , and I_4



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



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



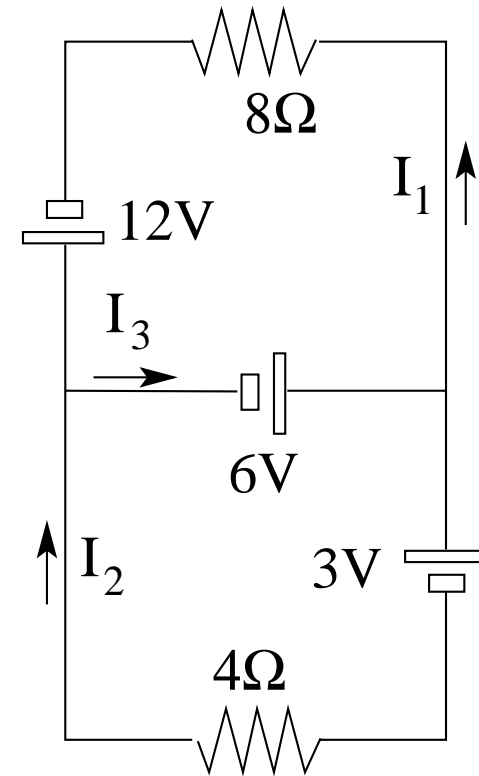
Solution:

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

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



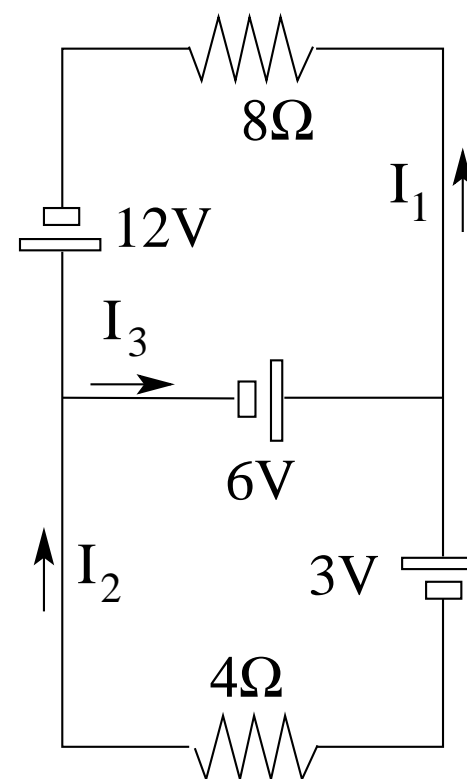
Consider the electric circuit shown. Find the currents I_1 , I_2 , and I_3



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



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



Solution:

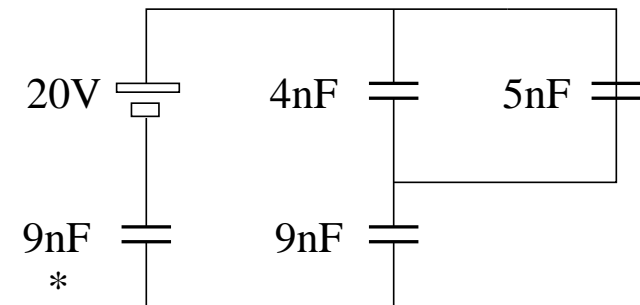
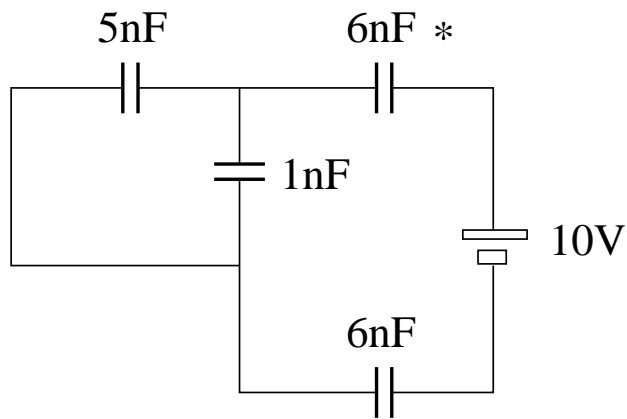
- $12V + 6V - (8\Omega)I_1 = 0 \Rightarrow I_1 = \frac{9}{4}A = 2.25A.$
- $6V - 3V - (4\Omega)I_2 = 0 \Rightarrow I_2 = \frac{3}{4}A = 0.75A.$
- $I_3 = I_1 + I_2 = 3.00A.$

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.

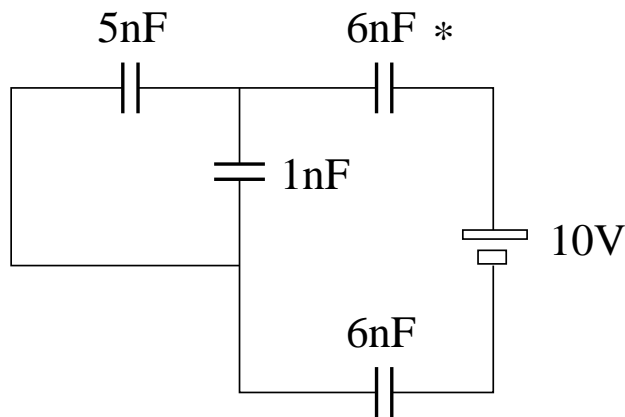


Unit Exam II: Problem #1 (Spring '13)



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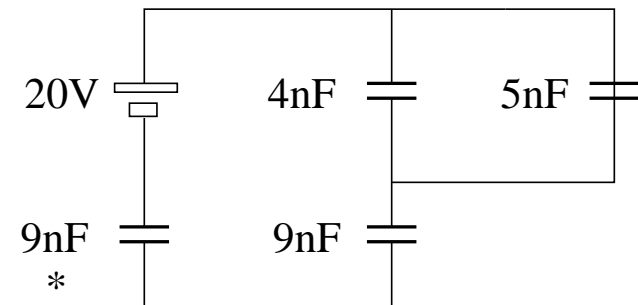


Solution:

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

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

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



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

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

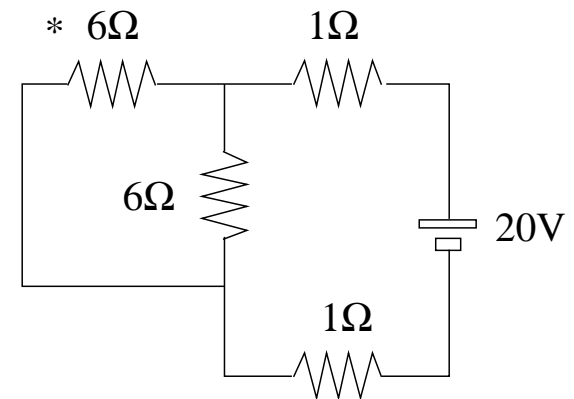
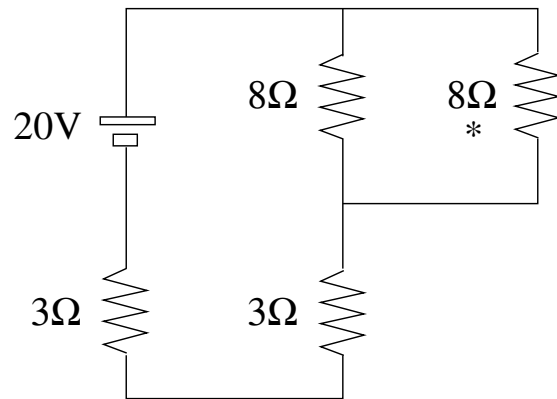
$$V_* = \frac{20}{3}\text{V} = 6.67\text{V}$$

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.

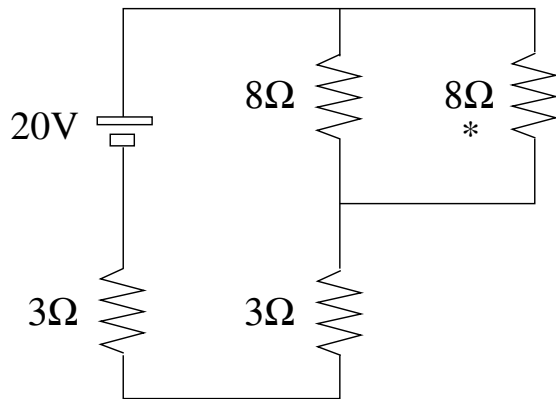


Unit Exam II: Problem #2 (Spring '13)



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.

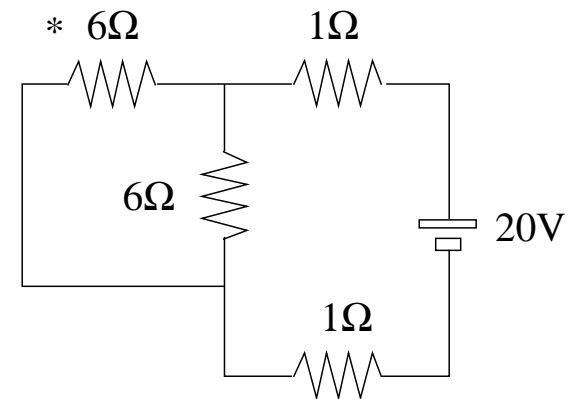


Solution:

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

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

$$V_* = (2A)(8\Omega) = 16V$$



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

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

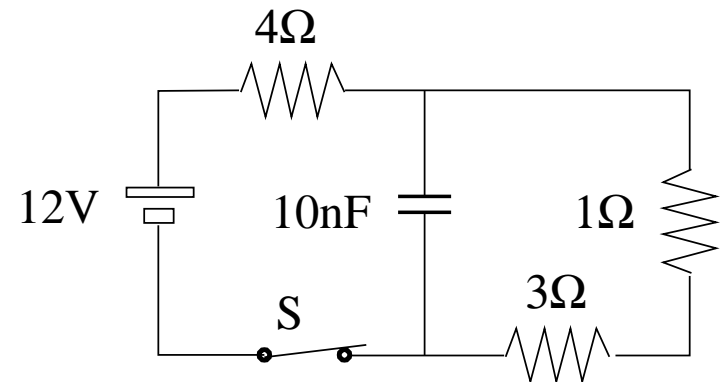
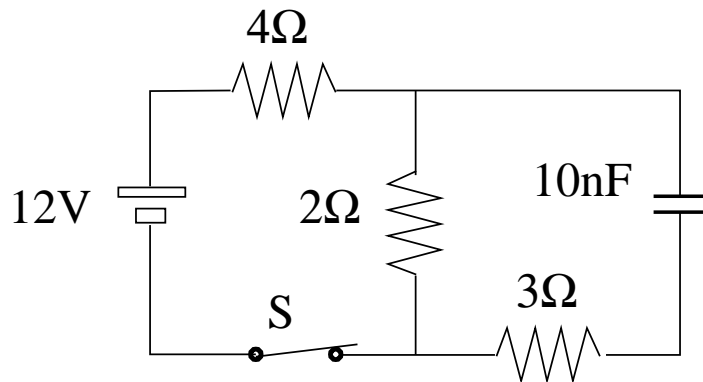
$$V_* = (4A)(6\Omega) = 24V$$

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.

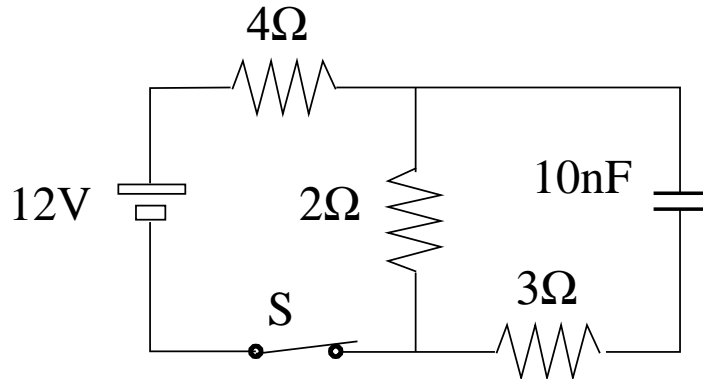


Unit Exam II: Problem #3 (Spring '13)



Consider the RC circuit shown. The switch has been closed for a long time.

- Find the current I_B flowing through the battery.
- Find the voltage V_C across the capacitor.
- Find the charge Q on the capacitor.
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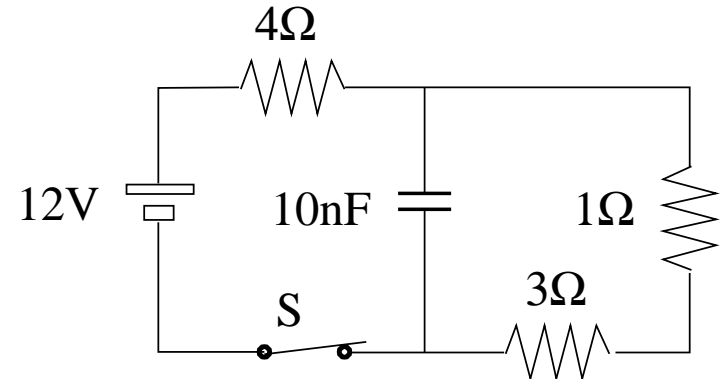
Solution:

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

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

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

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



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

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

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

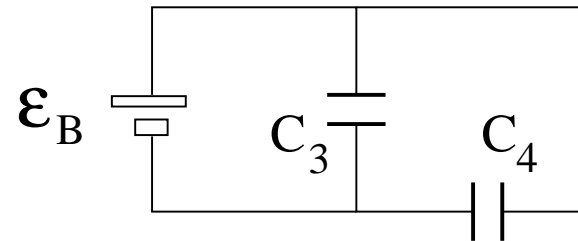
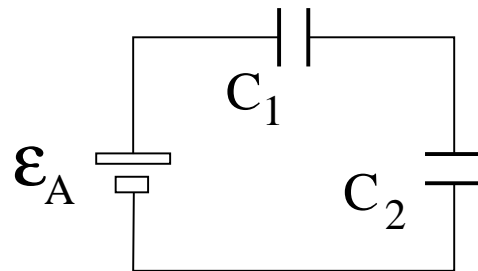
$$I_3 = \frac{6\text{V}}{3\Omega + 1\Omega} = 1.5\text{A}$$

Unit Exam II: Problem #1 (Spring '14)



Both capacitor circuits, charged up by batteries as shown, are now at equilibrium. The charge on capacitor $C_1 = 6\text{pF}$ [8pF] is $Q_1 = 18\text{pC}$ [16pF] and charge on capacitor $C_4 = 8\text{pF}$ [4pF] is $Q_4 = 16\text{pC}$ [12pF].

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

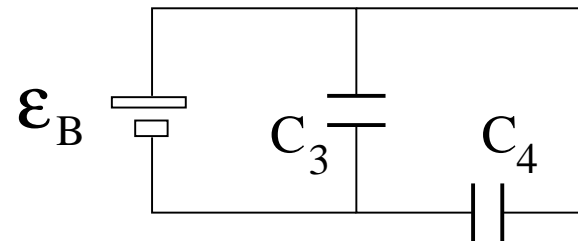
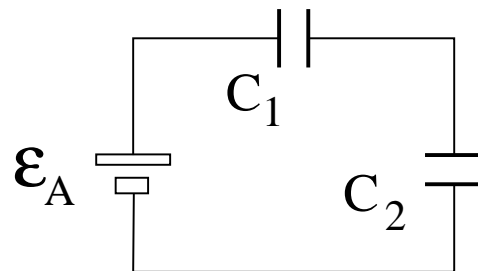


Unit Exam II: Problem #1 (Spring '14)



Both capacitor circuits, charged up by batteries as shown, are now at equilibrium. The charge on capacitor $C_1 = 6\text{pF}$ [8pF] is $Q_1 = 18\text{pC}$ [16pF] and charge on capacitor $C_4 = 8\text{pF}$ [4pF] is $Q_4 = 16\text{pC}$ [12pF].

- Find the voltage V_2 across capacitor $C_2 = 4\text{pF}$.
- Find the emf \mathcal{E}_A supplied by the battery.
- Find the charge Q_3 on capacitor $C_3 = 3\text{pF}$.
- Find the emf \mathcal{E}_B supplied by the battery.



Solution:

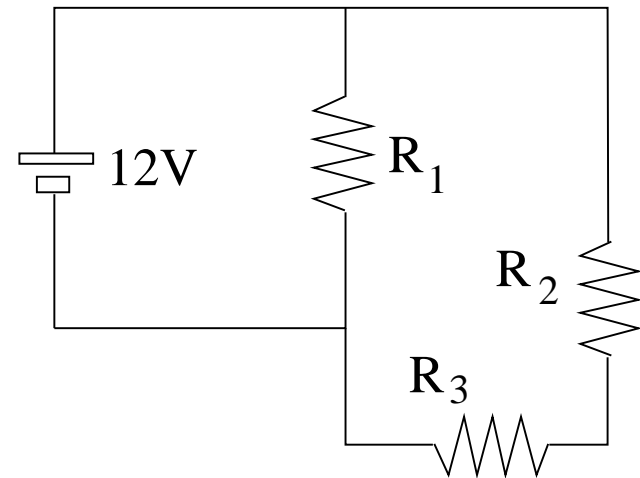
- $Q_2 = Q_1 = 18\text{pC}$, [16pC], $V_2 = \frac{Q_2}{C_2} = 4.5\text{V}$ [4V].
- $\mathcal{E}_A = V_1 + V_2 = 3\text{V} + 4.5\text{V} = 7.5\text{V}$ [2V + 4V = 6V].
- $V_3 = V_4 = \frac{Q_4}{C_4} = 2\text{V}$ [3V], $Q_3 = V_3 C_3 = 6\text{pC}$ [9pC].
- $\mathcal{E}_B = V_3 = V_4 = 2\text{V}$ [3V].

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 resistor R_3 .
- (c) Find the power P_1 dissipated in resistor R_1 .
- (d) Find the equivalent resistance R_{eq} .

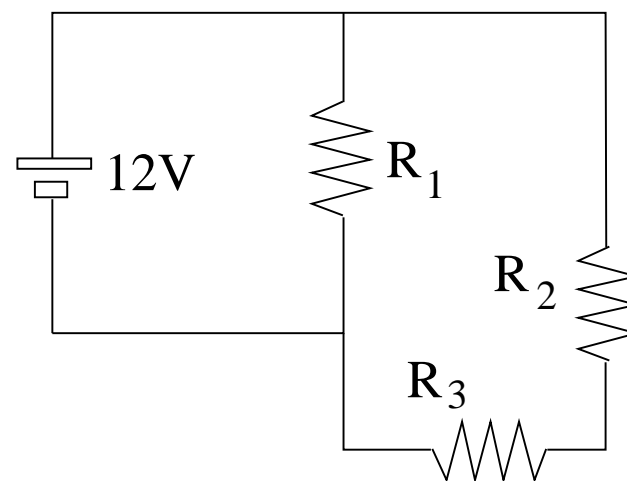


Unit Exam II: Problem #2 (Spring '14)



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 resistor R_3 .
- (c) Find the power P_1 dissipated in resistor R_1 .
- (d) Find the equivalent resistance R_{eq} .



Solution:

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

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

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

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

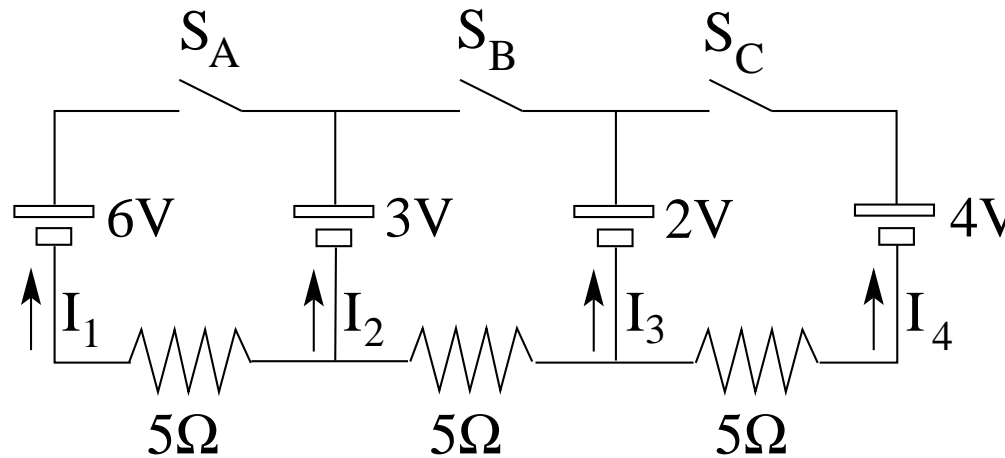
Unit Exam II: Problem #3 (Spring '14)



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.



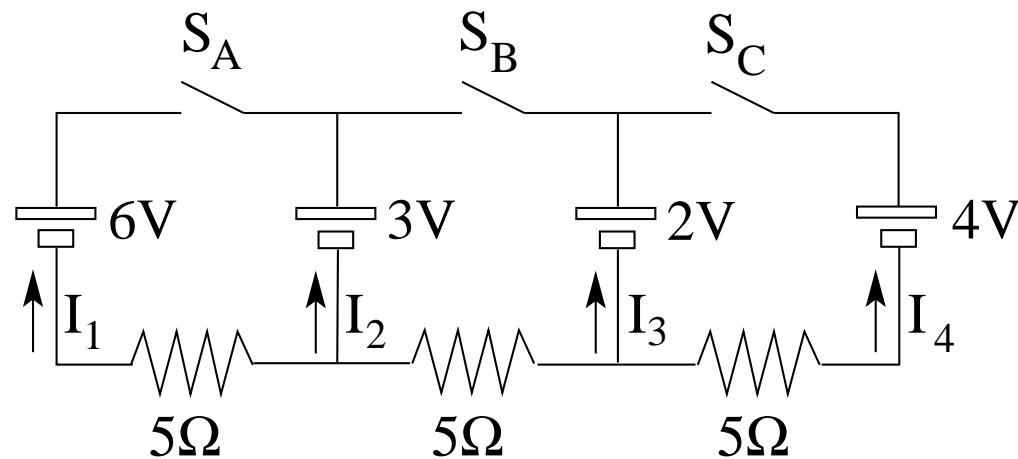
Unit Exam II: Problem #3 (Spring '14)



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:

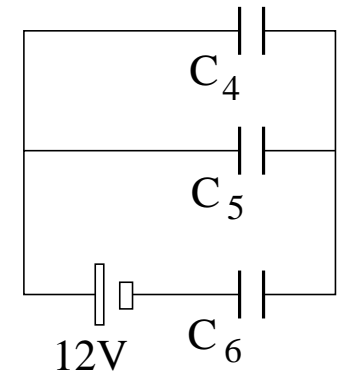
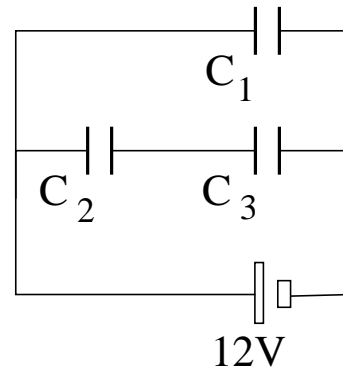
- | | |
|--|---|
| (a) $I_1 = 0.6\text{A}, I_2 = -0.6\text{A}, I_3 = 0, I_4 = 0.$ | (a) $I_1 = 0, I_2 = 0, I_3 = -0.4\text{A}, I_4 = 0.4\text{A}.$ |
| (b) $I_1 = 0, I_2 = 0.2\text{A}, I_3 = -0.2\text{A}, I_4 = 0.$ | (b) $I_1 = 0, I_2 = 0.2\text{A}, I_3 = -0.2\text{A}, I_4 = 0.$ |
| (c) $I_1 = 0.6\text{A},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

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.

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

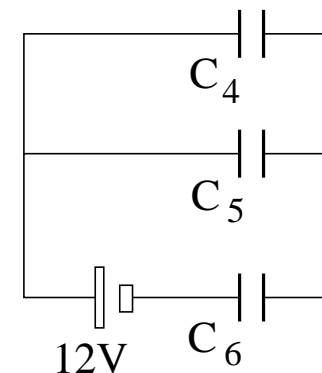
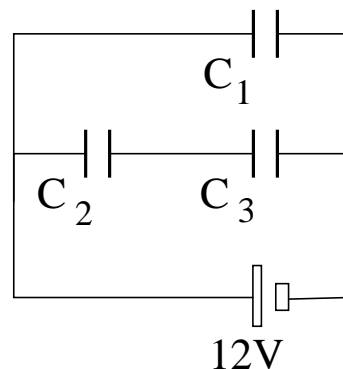


Unit Exam II: Problem #1 (Fall '14)



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:

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

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

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

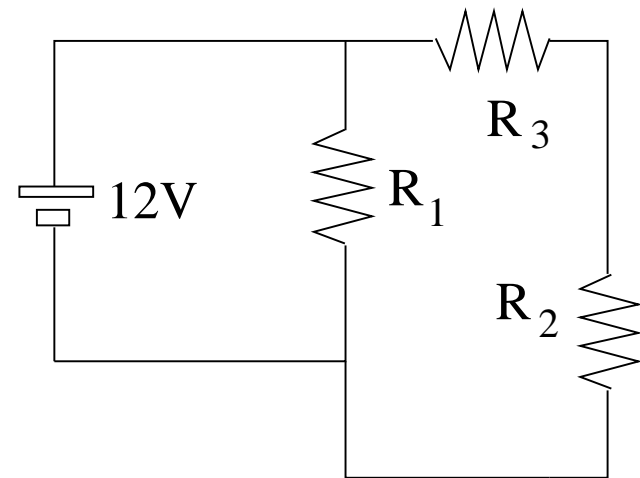
$$(d) Q_{45} = Q_6 = C_{eq}(12\text{V}) = 16\text{pC} \quad \Rightarrow \quad Q_4 = Q_5 = 8\text{pC}.$$

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.

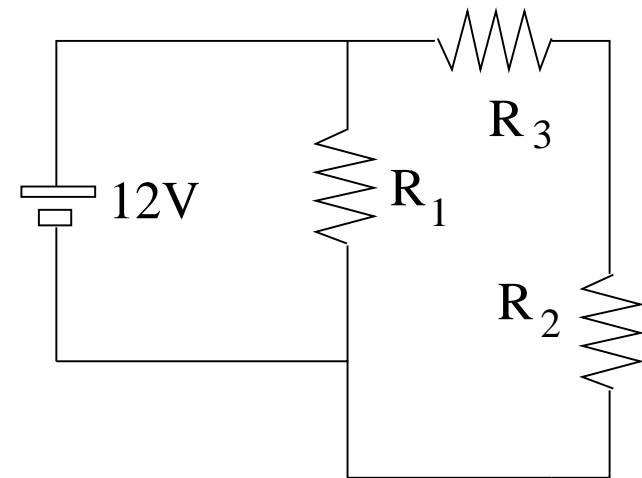


Unit Exam II: Problem #2 (Fall '14)



Consider the resistor circuit shown with $R_1 = 5\Omega$, $R_2 = 1\Omega$, and $R_3 = 3\Omega$.

- Find the equivalent resistance R_{eq} .
- Find the currents I_1 , I_2 , I_3 through resistors R_1 , R_2 , R_3 , respectively.
- Find the voltages V_1 , V_2 , V_3 across resistors R_1 , R_2 , R_3 , respectively.



Solution:

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

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

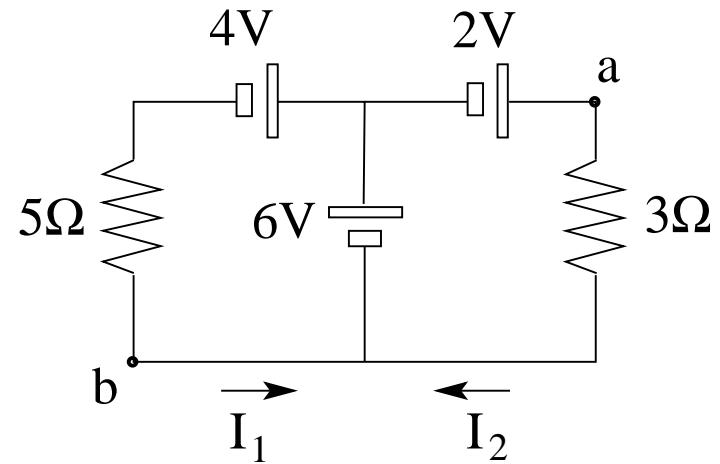
$$(c) V_1 = R_1 I_1 = 12V, \quad V_2 = R_2 I_2 = 3V, \quad V_3 = R_3 I_3 = 9V.$$

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 $V_a - V_b$.

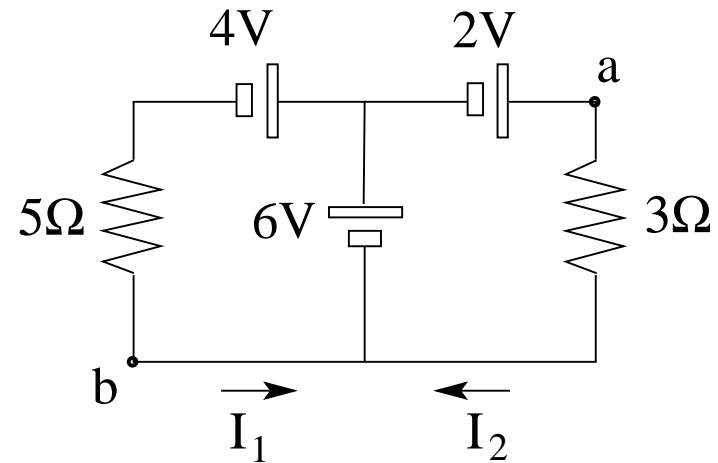


Unit Exam II: Problem #3 (Fall '14)



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:

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

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

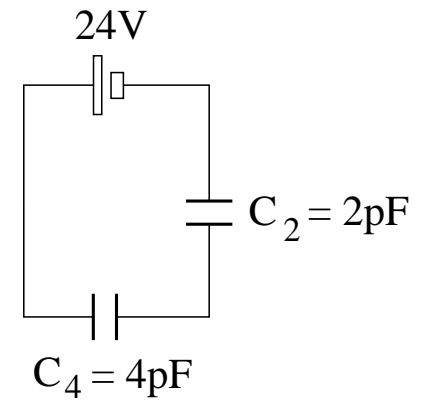
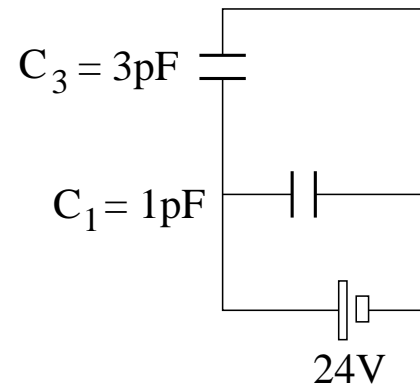
$$(c) V_a - V_b = 6V + 2V = 8V.$$

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:

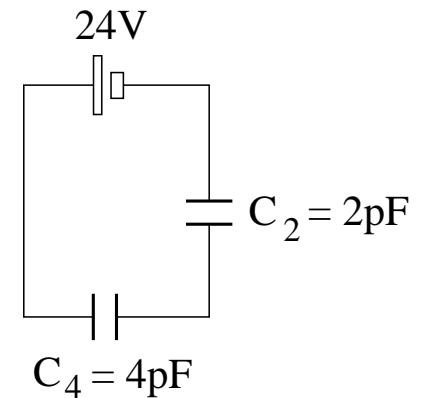
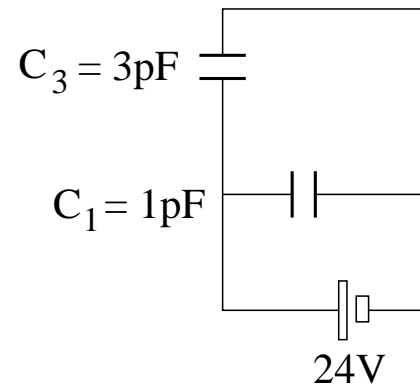
(a) $Q_1 = C_1 V_1 = (1\text{pF})(24\text{V}) = 24\text{pC}.$

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

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

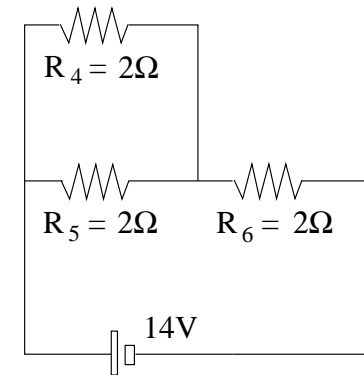
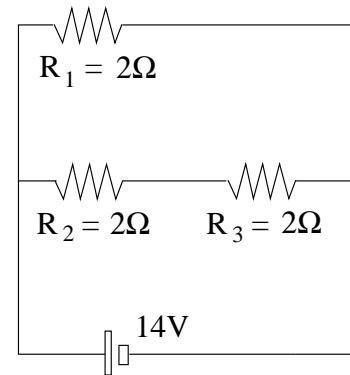
(d) $V_4 = \frac{Q_4}{C_4} = \frac{32\text{pC}}{4\text{pF}} = 8\text{V}.$



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



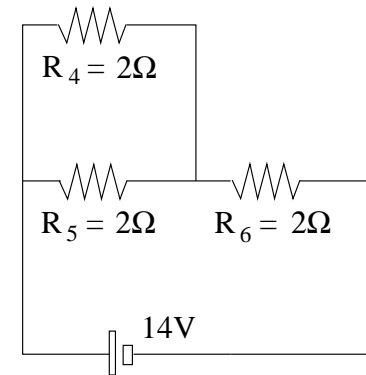
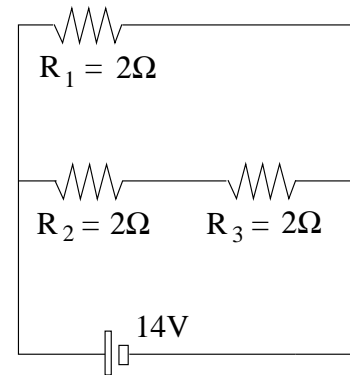
In the two resistor circuits shown find the equivalent resistances R_{123} (left) and R_{456} (right). Then find the currents I_1, I_2, I_3 through the individual resistors on the left. and the currents I_4, I_5, I_6 through the individual resistors on the right.



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.



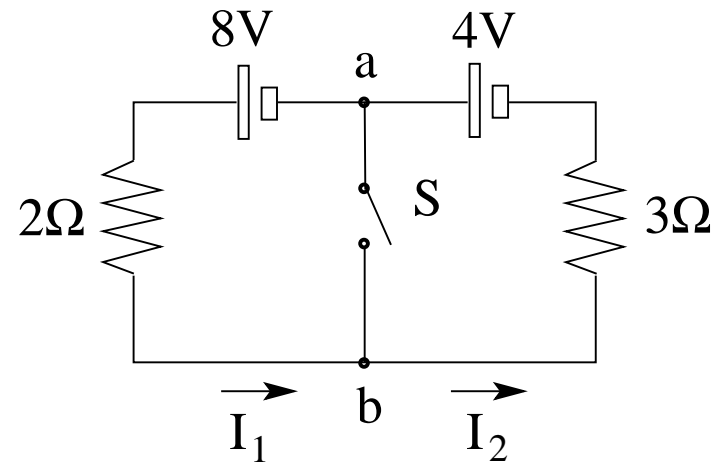
Solution:

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

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.



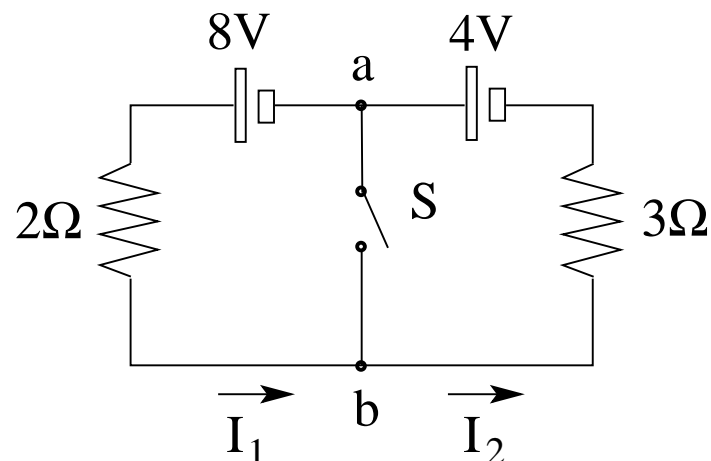
Unit Exam II: Problem #3 (Spring '15)



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:

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

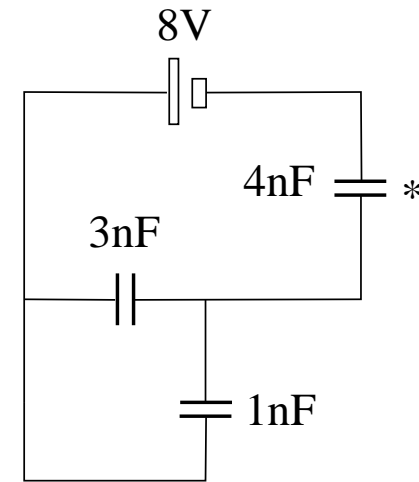
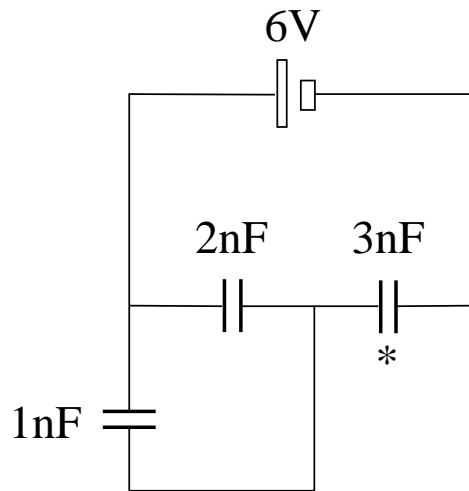
$$V_b - V_a = 8V - (2.4A)(2\Omega) = -4V + (2.4A)(3\Omega) = 3.2V.$$

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

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



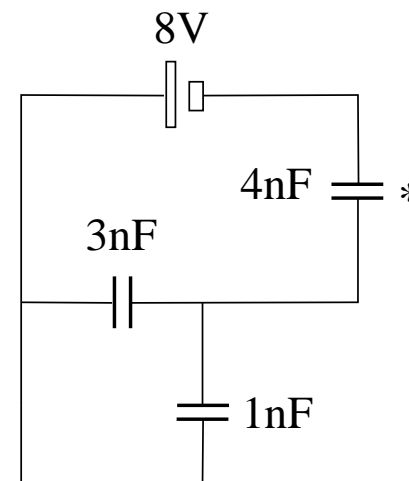
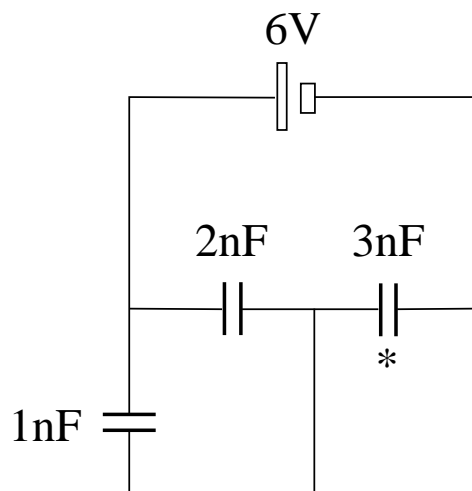
Consider the capacitor circuit shown at equilibrium. (a) Find the equivalent capacitance C_{eq} . (b) Find the total energy U stored in the three capacitors. (c) Find the voltage V_* across the capacitor marked by an asterisk. (d) Find the voltage V_1 across the 1nF-capacitor.



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.



Solution:

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

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

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

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

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

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

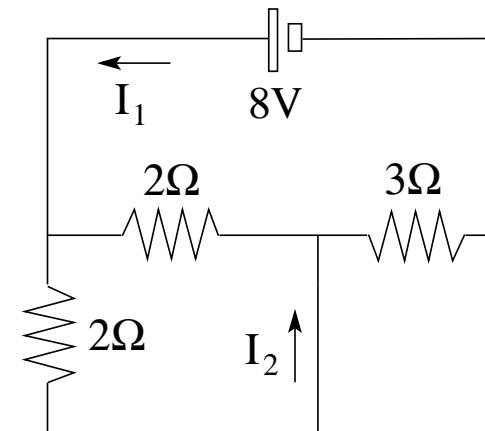
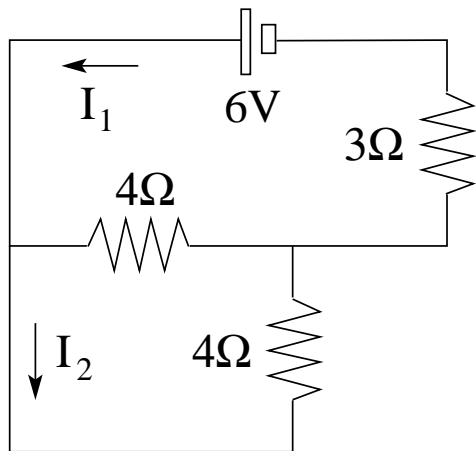
$$(c) V_* = \frac{1}{2} 8\text{V} = 4\text{V}$$

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

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



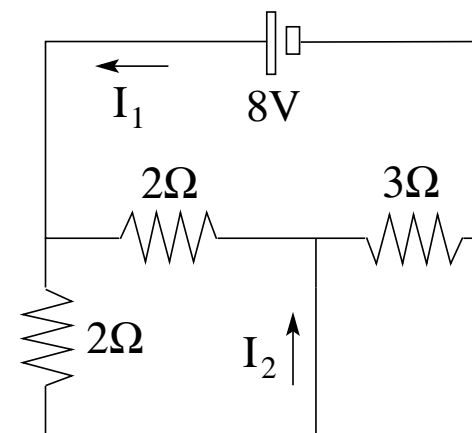
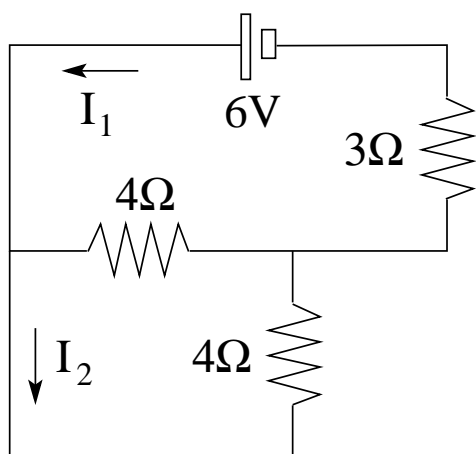
Consider the resistor circuit shown. (a) Find the equivalent resistance R_{eq} . (b) Find the currents I_1 and I_2 . (c) Find the power P supplied by the battery.



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:

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

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

$$(c) P = (1.2A)(6V) = 7.2W$$

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

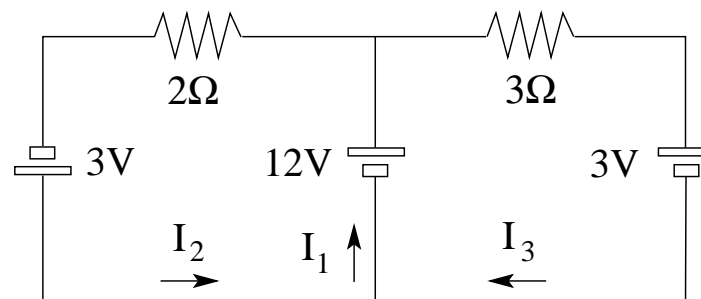
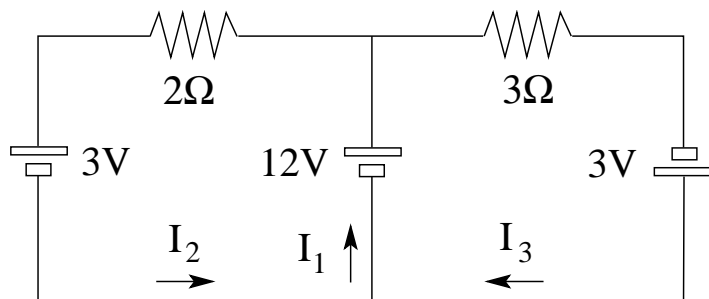
$$(b) I_1 = \frac{8V}{4\Omega} = 2A, \quad I_2 = \frac{1}{2}I_1 = 1A$$

$$(c) P = (2A)(8V) = 16W$$

Unit Exam II: Problem #3 (Fall '15)



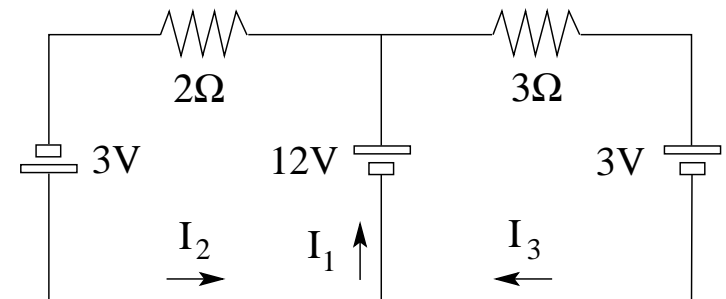
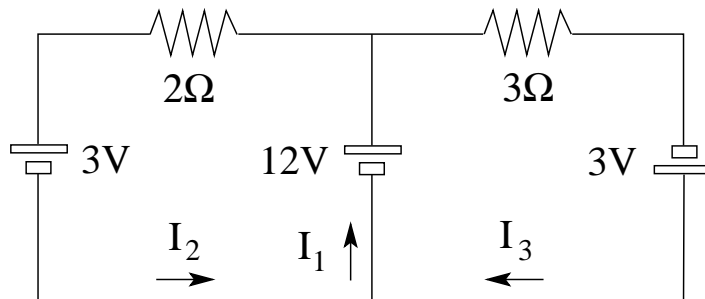
Consider the electric circuit shown.
Find the currents I_1 , I_2 , I_3 .



Unit Exam II: Problem #3 (Fall '15)



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



Solution:

$$12V - I_2(2\Omega) - 3V = 0$$

$$\Rightarrow I_2 = \frac{9V}{2\Omega} = 4.5A$$

$$12V - I_3(3\Omega) + 3V = 0$$

$$\Rightarrow I_3 = \frac{15V}{3\Omega} = 5A.$$

$$I_1 = I_2 + I_3 = 9.5A$$

$$12V - I_2(2\Omega) + 3V = 0$$

$$\Rightarrow I_2 = \frac{15V}{2\Omega} = 7.5A.$$

$$12V - I_3(3\Omega) - 3V = 0$$

$$\Rightarrow I_3 = \frac{9V}{3\Omega} = 3A.$$

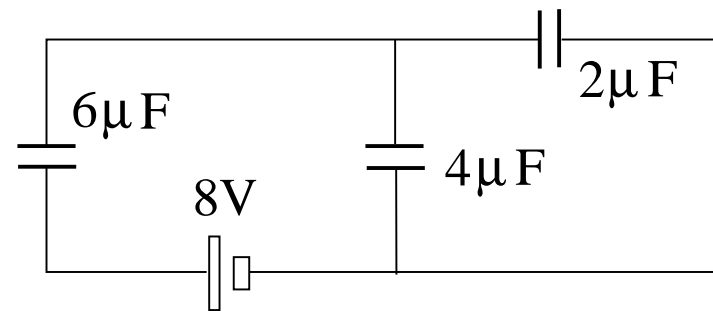
$$I_1 = I_2 + I_3 = 10.5A$$

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 voltages V_2 and V_4 across the two capacitors 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 voltages V_2 and V_4 across the two capacitors on the right.

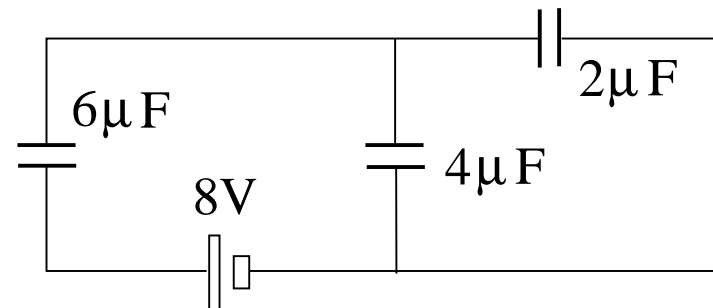
Solution:

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

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

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

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

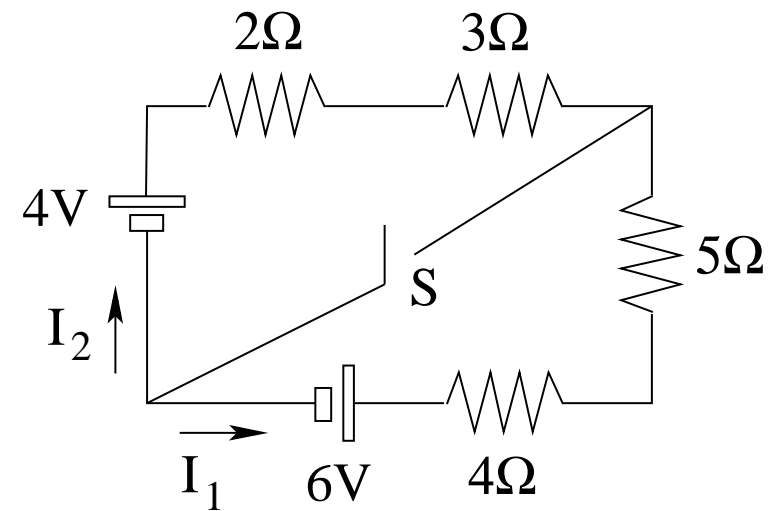


Unit Exam II: Problem #2 (Spring '16)



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.

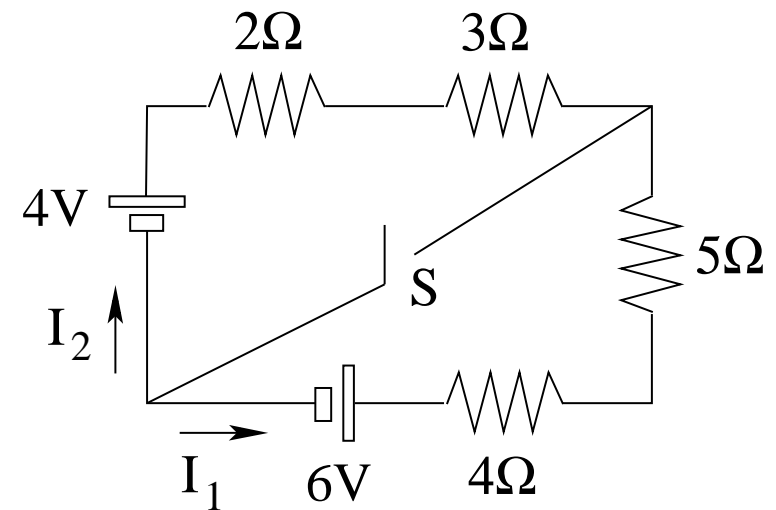


Unit Exam II: Problem #2 (Spring '16)



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:

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

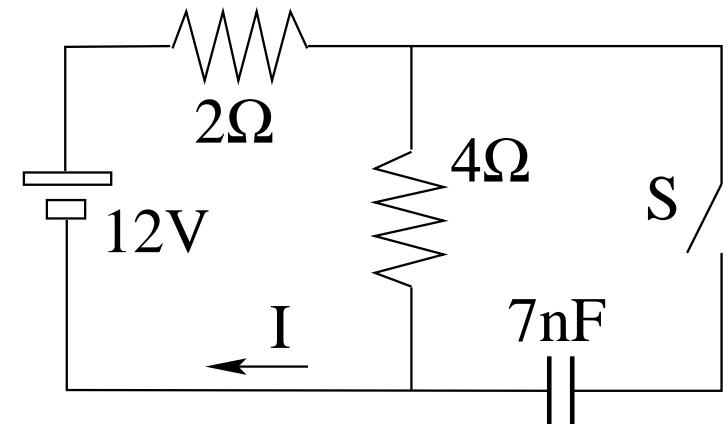
$$(b) \quad I_1 = \frac{6V}{4\Omega + 5\Omega} = 0.667A, \quad I_2 = \frac{4V}{3\Omega + 2\Omega} = 0.8A.$$

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.

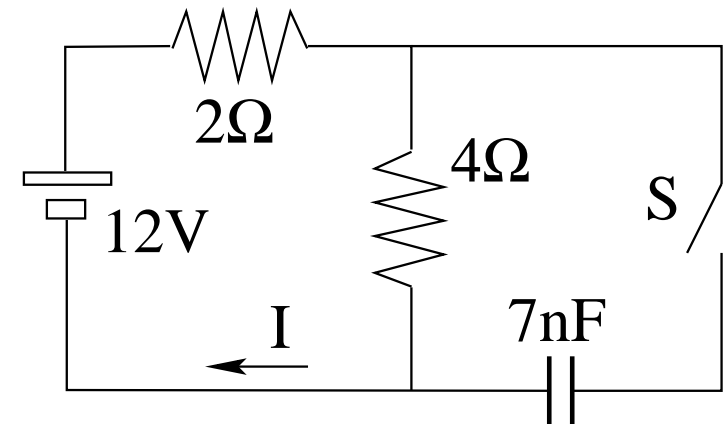
Solution:

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

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

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

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

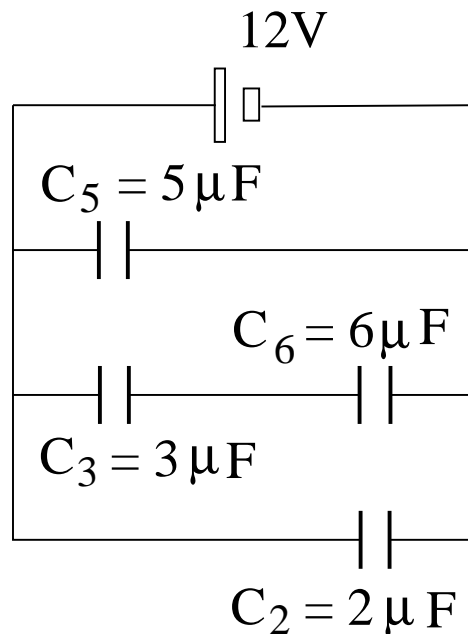


Unit Exam II: Problem #1 (Fall '16)

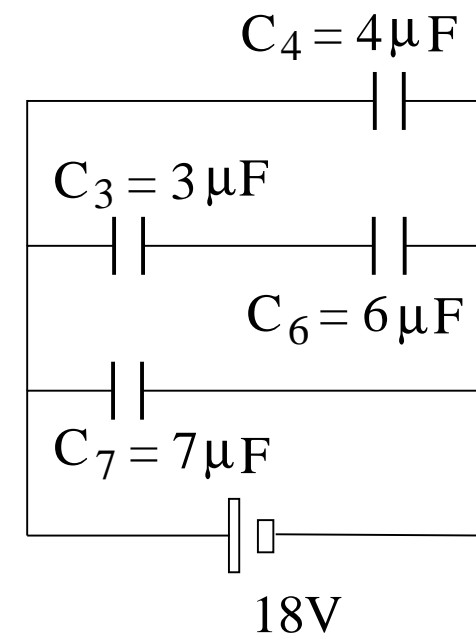


The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

- (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} .



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

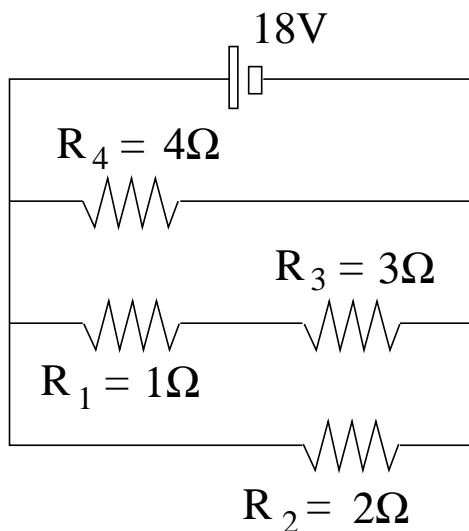
- (a) $V_4 = 18\text{V}$.
- (b) $U_7 = \frac{1}{2}(7\mu\text{F})(18\text{V})^2 = 1134\mu\text{J}$.
- (c) $C_{36} = 2\mu\text{F}$
 $\Rightarrow Q_6 = Q_{36} = (18\text{V})(2\mu\text{F}) = 36\mu\text{C}$.
- (d) $C_{eq} = C_4 + C_{36} + C_7 = 13\mu\text{F}$.

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

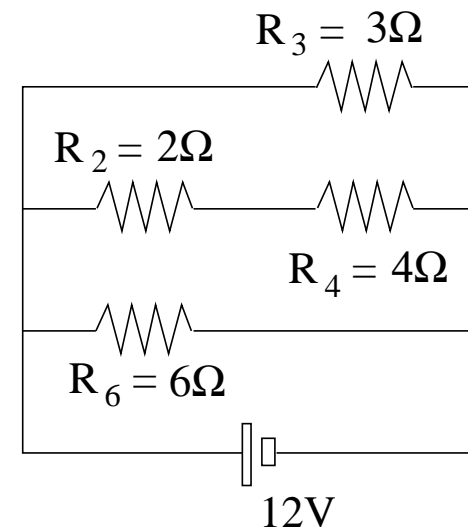


This resistor circuit is in a state of steady currents. Find ...

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

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

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

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

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

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

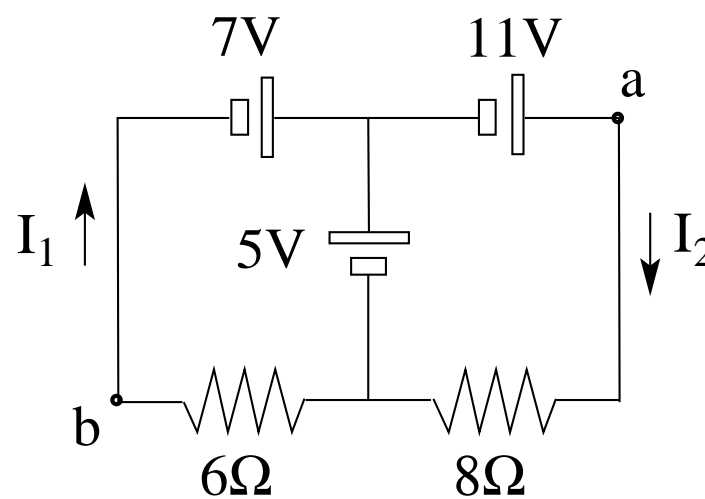
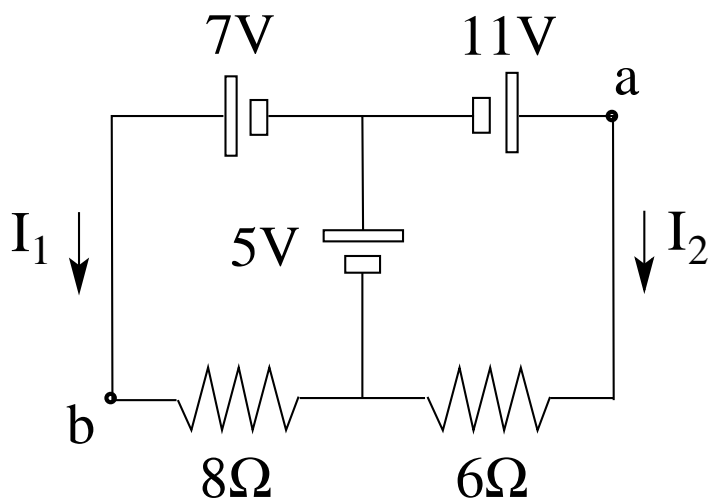
(d) $R_{eq} = \left(\frac{1}{3\Omega} + \frac{1}{2\Omega + 4\Omega} + \frac{1}{6\Omega} \right)^{-1} = 1.5\Omega$

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 $V_a - V_b$.

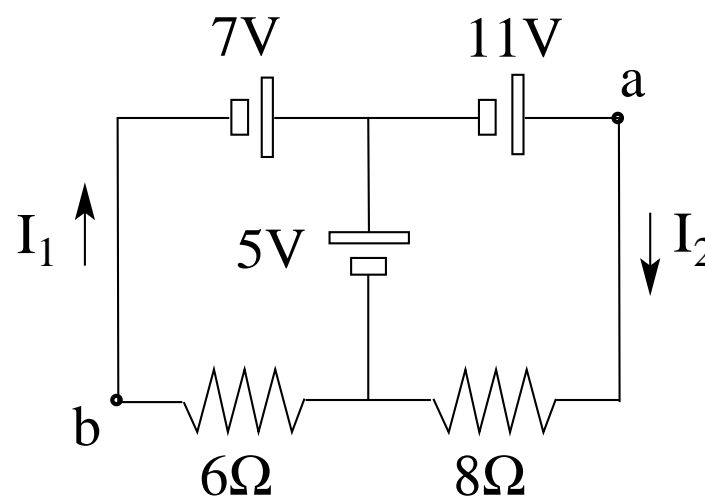
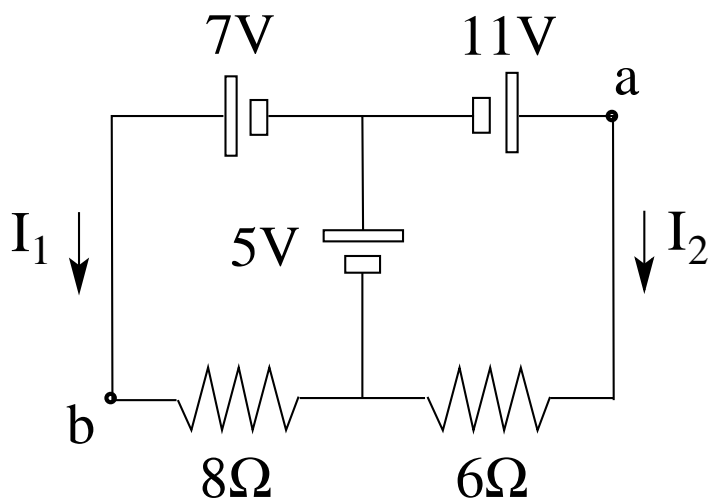


Unit Exam II: Problem #3 (Fall '16)



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

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

(c) $V_a - V_b = -7V + 11V = +4V.$

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

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

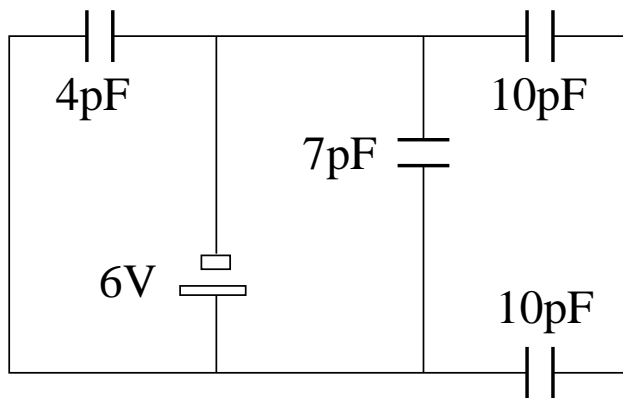
(c) $V_a - V_b = 7V + 11V = +18V.$

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

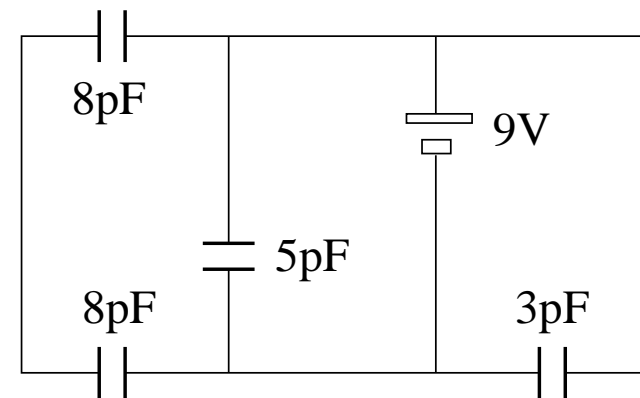


The capacitors (initially discharged) have been connected to the battery. The circuit is now at equilibrium. Find ...

- (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} .



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) $Q_4 = (6V)(4pF) = 24pC.$

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

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

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

(a) $Q_3 = (9V)(3pF) = 27pC.$

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

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

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

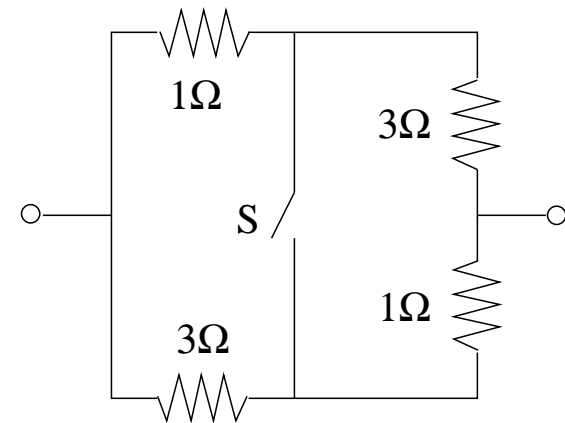
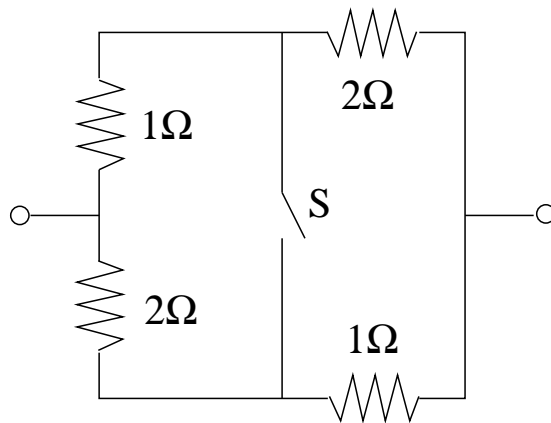
Unit Exam II: Problem #2 (Spring '17)



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

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

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



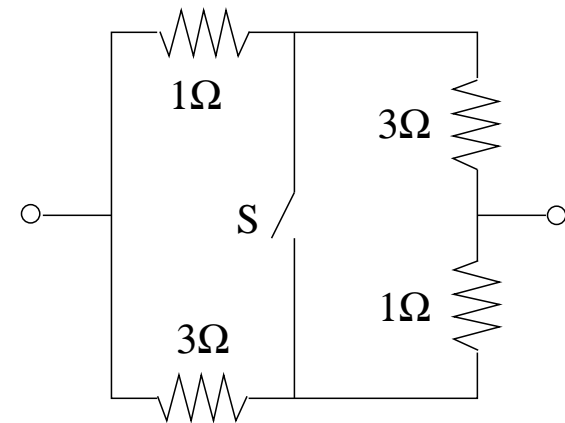
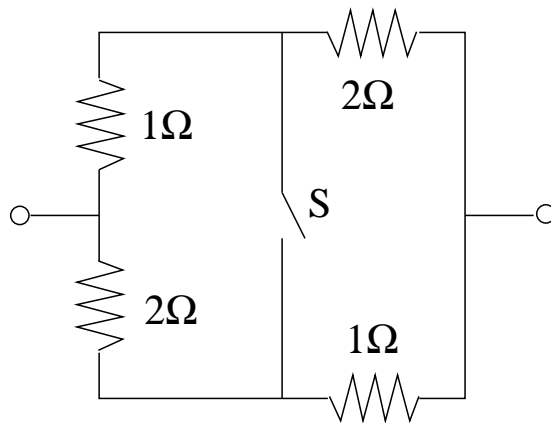
Unit Exam II: Problem #2 (Spring '17)



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

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

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



Solution:

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

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

$$\begin{aligned} R_{\text{eq}}^{(\text{closed})} &= \left(\frac{1}{1\Omega} + \frac{1}{2\Omega} \right)^{-1} + \left(\frac{1}{1\Omega} + \frac{1}{2\Omega} \right)^{-1} \\ &= \frac{4}{3}\Omega. \end{aligned}$$

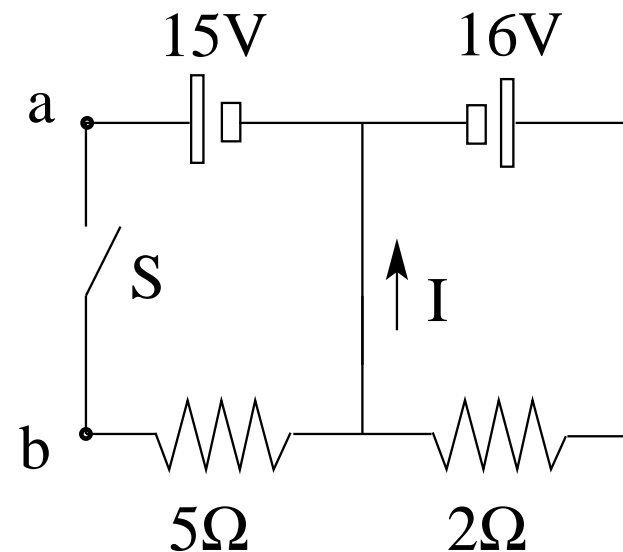
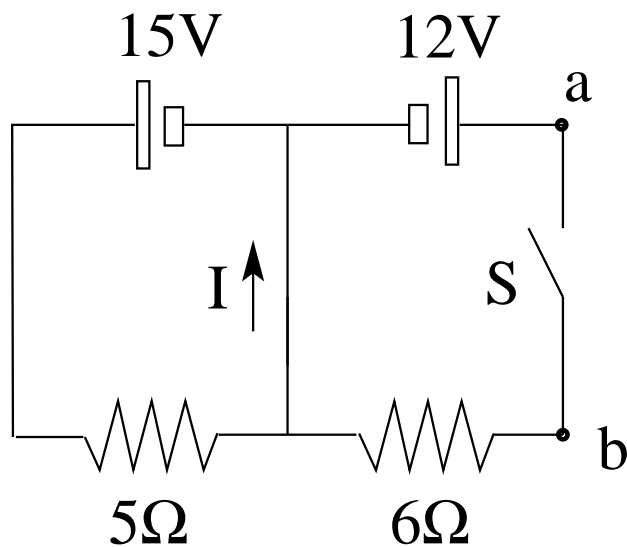
$$\begin{aligned} R_{\text{eq}}^{(\text{closed})} &= \left(\frac{1}{1\Omega} + \frac{1}{3\Omega} \right)^{-1} + \left(\frac{1}{1\Omega} + \frac{1}{3\Omega} \right)^{-1} \\ &= \frac{3}{2}\Omega. \end{aligned}$$

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:

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

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

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

$$(d) \quad V_a - V_b = 0.$$

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

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

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

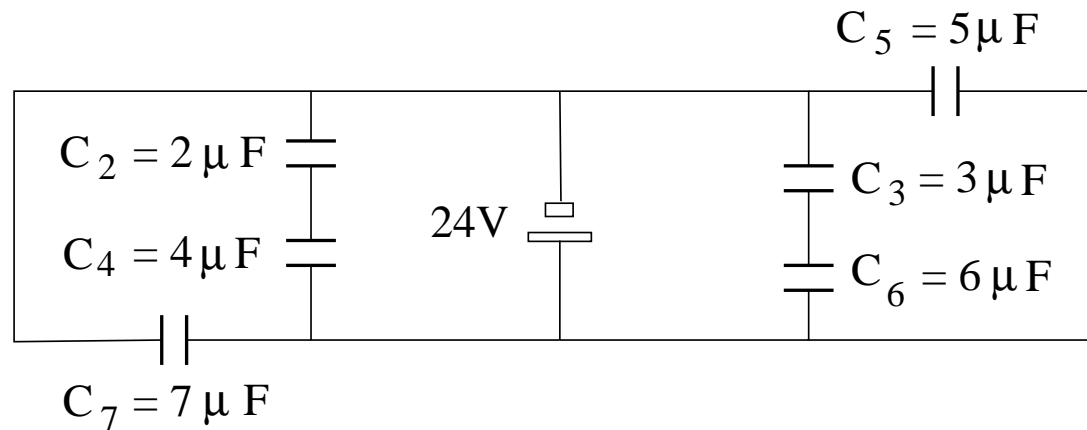
$$(d) \quad V_a - V_b = 0.$$

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].

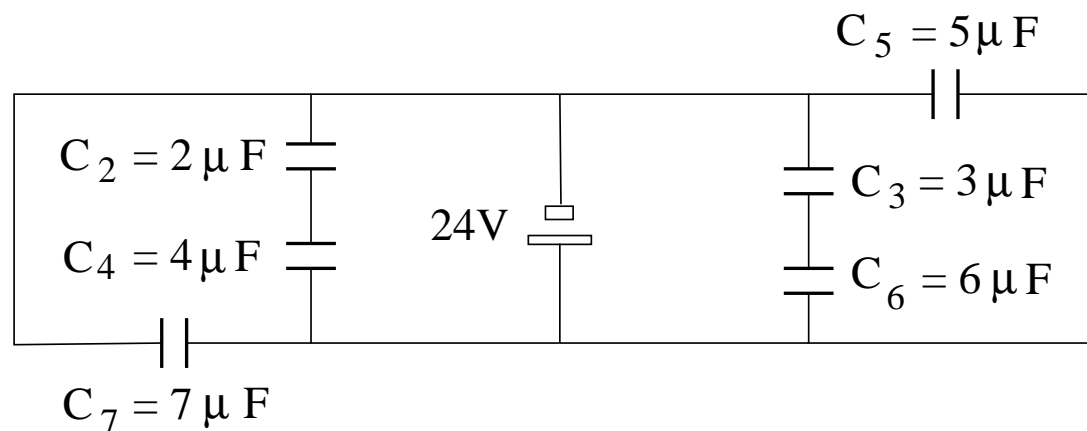


Unit Exam II: Problem #1 (Fall '17)



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:

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

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

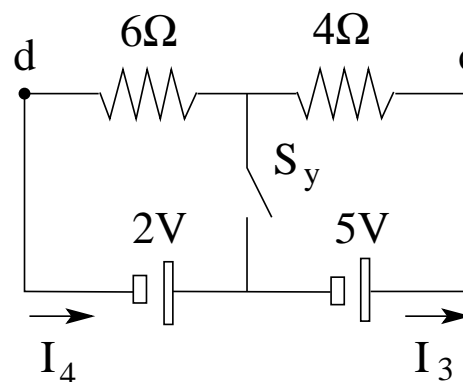
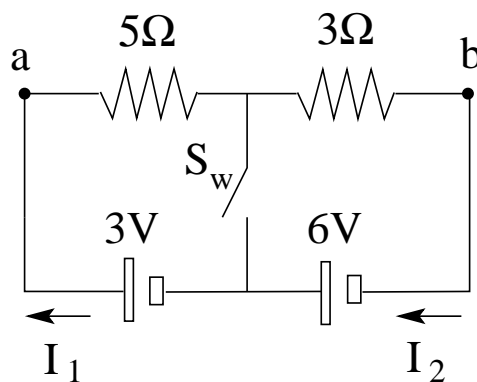


Consider the resistor circuit on the left [right].

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)

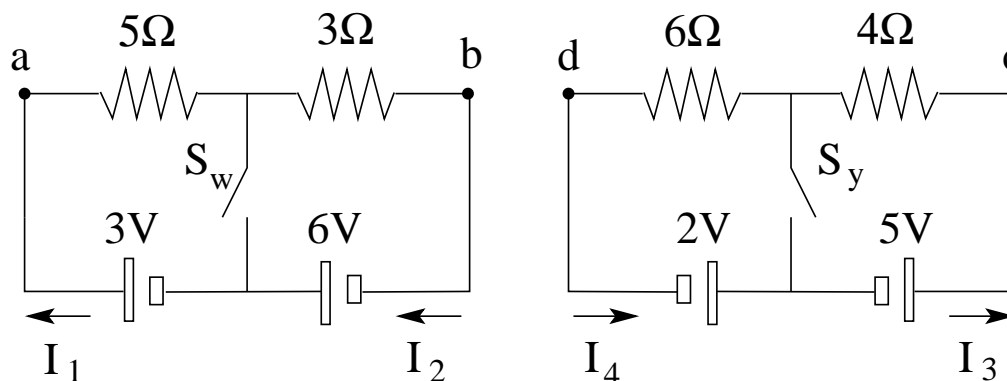


Consider the resistor circuit on the left [right].

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:

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

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

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

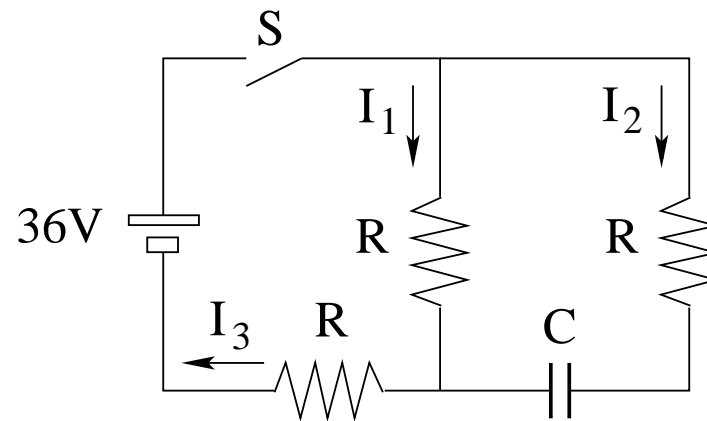
$$\left[I_3 = \frac{5V}{4\Omega} = 1.25A, \quad I_4 = \frac{2V}{6\Omega} = 0.333A, \quad V_c - V_d = 7V. \right]$$

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



The switch S of this circuit has been open for a long time. The capacitor has capacitance $C = 6\text{pF}$ [$C = 4\text{pF}$]. 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

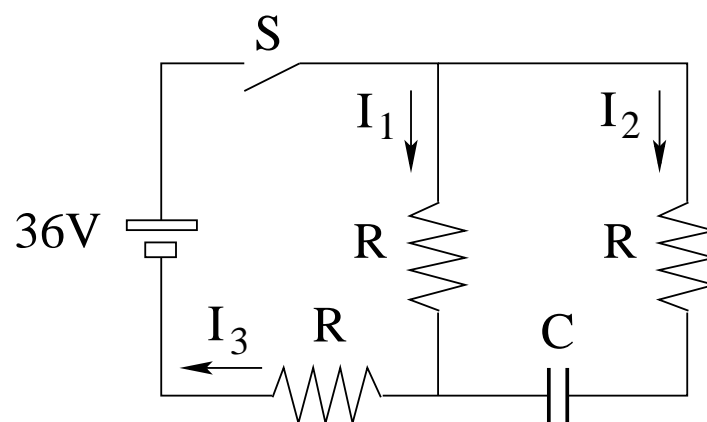


Unit Exam II: Problem #3 (Fall '17)



The switch S of this circuit has been open for a long time. The capacitor has capacitance $C = 6\mu\text{F}$ [$C = 4\mu\text{F}$]. 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



Solution:

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

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

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

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

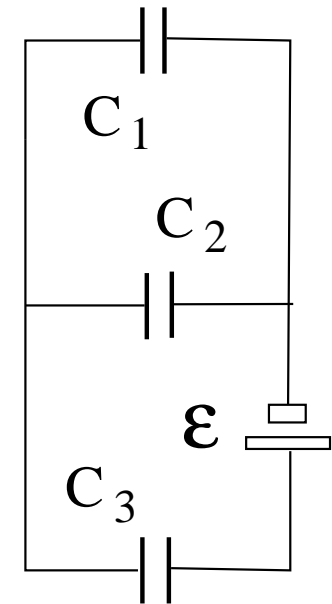
Unit Exam II: Problem #1 (Spring '18)



The circuit shown has reached equilibrium.

The specifications are $\mathcal{E} = 12\text{V}$ [18V], $C_1 = C_2 = C_3 = 5\text{nF}$ [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 $\mathcal{E} = 12\text{V}$ [18V], $C_1 = C_2 = C_3 = 5\text{nF}$ [4nF]

- Find the equivalent capacitance C_{eq} .
- Find the charge Q_2 on capacitor C_2 .
- Find the voltage V_3 across capacitor C_3 .
- Find the total energy U stored in the capacitors.

Solution:

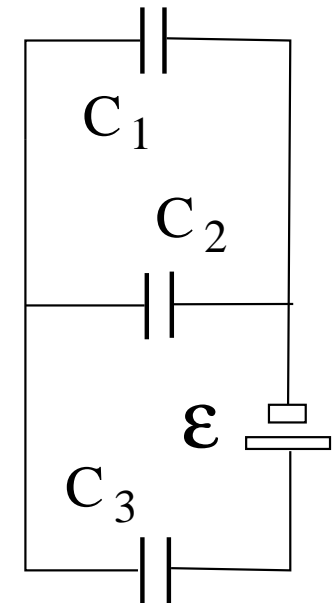
(a) $C_{12} = C_1 + C_2 = 10\text{nF}$ [8nF].

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

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

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

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



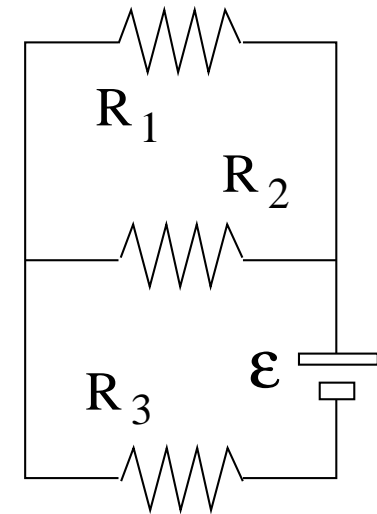
Unit Exam II: Problem #2 (Spring '18)



The circuit shown is in a steady state.

The specifications are $\mathcal{E} = 12\text{V}$ [18V], $R_1 = R_2 = R_3 = 5\Omega$ [4 Ω].

- (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.



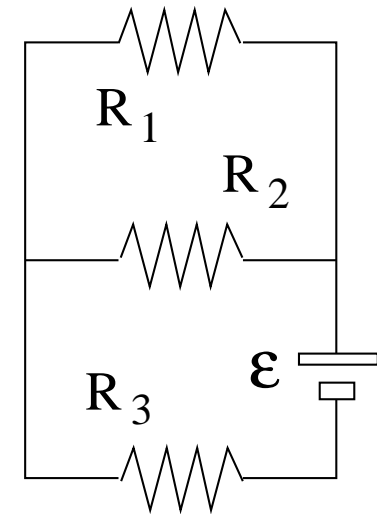
Unit Exam II: Problem #2 (Spring '18)



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].

- Find the equivalent resistance R_{eq} .
- Find the currents I_1 through resistor R_1 .
- Find the voltage V_3 across resistor R_3 .
- Find the power P produced by the battery.



Solution:

$$(a) R_{12} = \left(\frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} = 2.5\Omega [2.0\Omega], \quad R_{eq} = R_{12} + R_3 = 7.5\Omega [6.0\Omega].$$

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

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

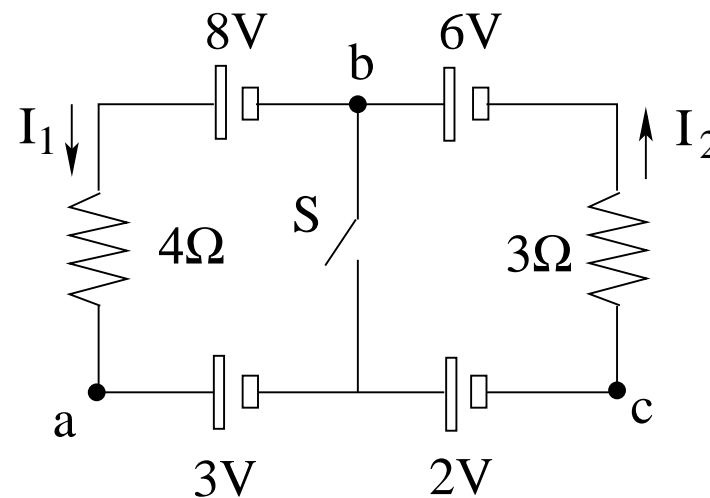
$$(d) P = \frac{\mathcal{E}^2}{R_{eq}} = R_{eq} I_3^2 = 19.2\text{W} [54.0\text{W}].$$

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.

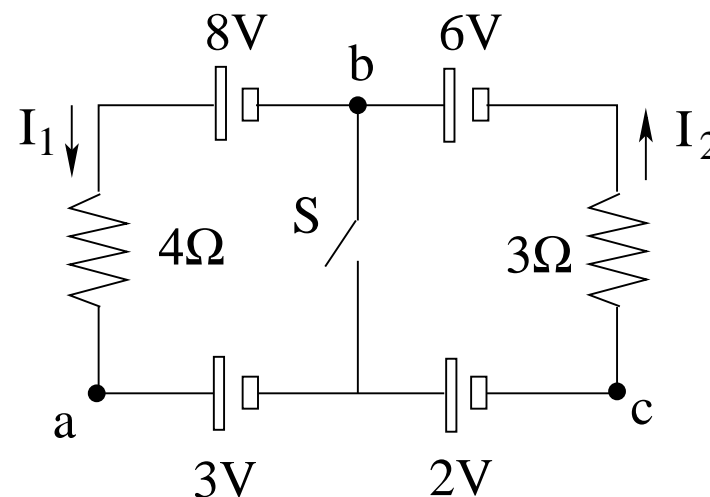


Unit Exam II: Problem #3 (Spring '18)



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:

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

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

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

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

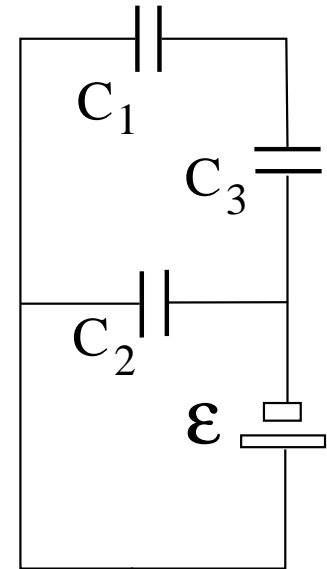
Unit Exam II: Problem #1 (Fall '18)



The circuit shown has reached equilibrium.

The specifications are $\mathcal{E} = 12\text{V}$ [14V], $C_1 = C_2 = C_3 = 7\text{nF}$ [5nF]

- Find the equivalent capacitance C_{eq} .
- Find the charges Q_1, Q_2, Q_3 on capacitors 1, 2, 3, respectively.
- Find the voltages V_1, V_2, V_3 across capacitors 1, 2, 3, respectively.



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



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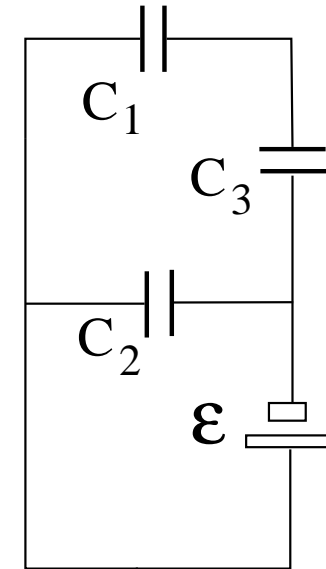
Solution:

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

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

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

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



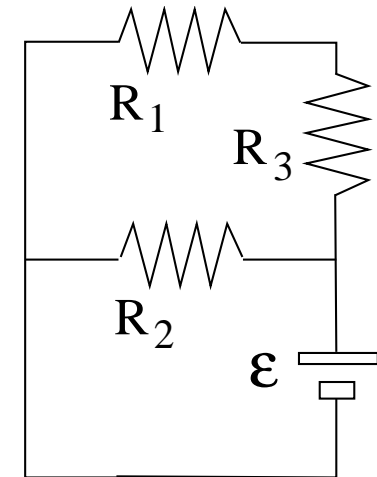
Unit Exam II: Problem #2 (Fall '18)



The circuit shown is in a steady state.

The specifications are $\mathcal{E} = 12\text{V}$ [14V], $R_1 = R_2 = R_3 = 7\Omega$ [5 Ω].

- Find the equivalent resistance R_{eq} .
- Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.
- Find the voltages V_1, V_2, V_3 across resistors 1, 2, 3, respectively.



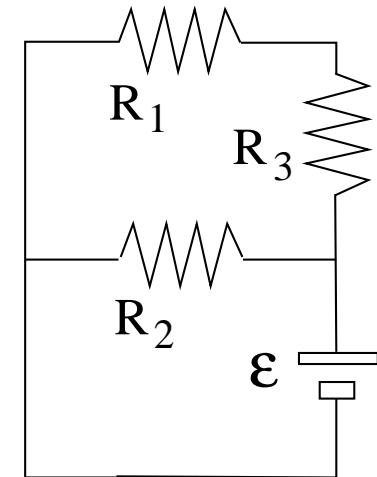
Unit Exam II: Problem #2 (Fall '18)



The circuit shown is in a steady state.

The specifications are $\mathcal{E} = 12\text{V}$ [14V], $R_1 = R_2 = R_3 = 7\Omega$ [5 Ω].

- Find the equivalent resistance R_{eq} .
- Find the currents I_1, I_2, I_3 through resistors 1, 2, 3, respectively.
- Find the voltages V_1, V_2, V_3 across resistors 1, 2, 3, respectively.



Solution:

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

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

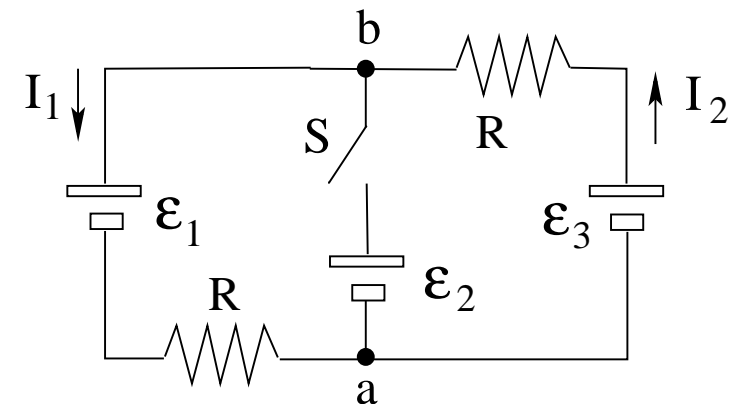
(c) $V_1 = R_1 I_1 = 6\text{V}$ [7V], $V_2 = R_2 I_2 = 12\text{V}$ [14V], $V_3 = R_3 I_3 = 6\text{V}$ [7V].

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



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

- (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.

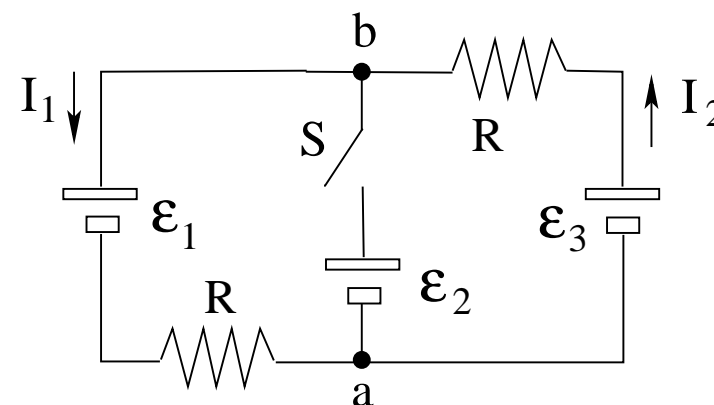


Unit Exam II: Problem #3 (Fall '18)



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

- Find the currents I_1 and I_2 when the switch is open.
- Find the currents I_1 and I_2 when the switch is closed.
- Find the voltages $V_b - V_a$ when the switch is open.
- Find the voltages $V_b - V_a$ when the switch is closed.



Solution:

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

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

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

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

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

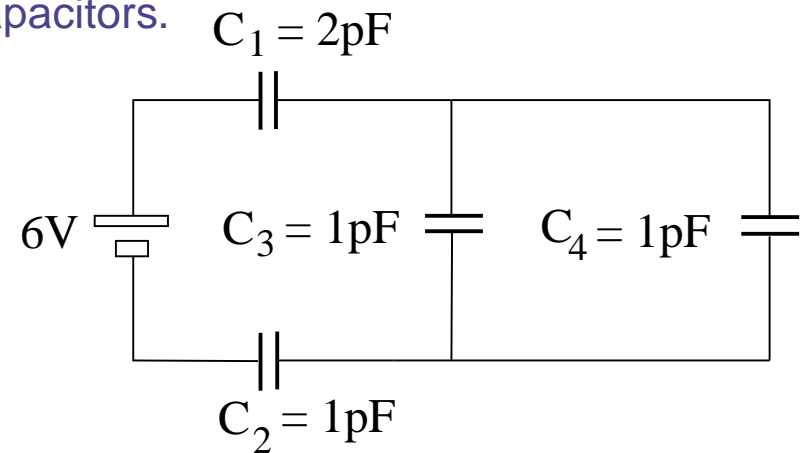
$$(d) \quad V_b - V_a = 6V \quad [V_b - V_a = 7V]$$

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.

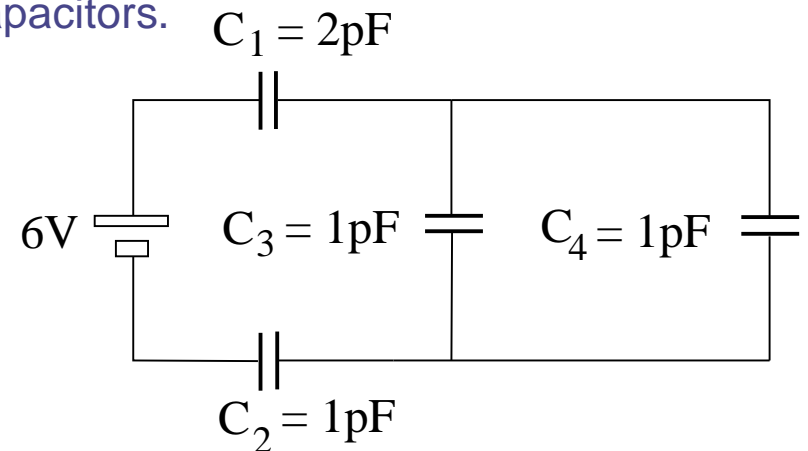


Unit Exam II: Problem #1 (Spring '19)



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:

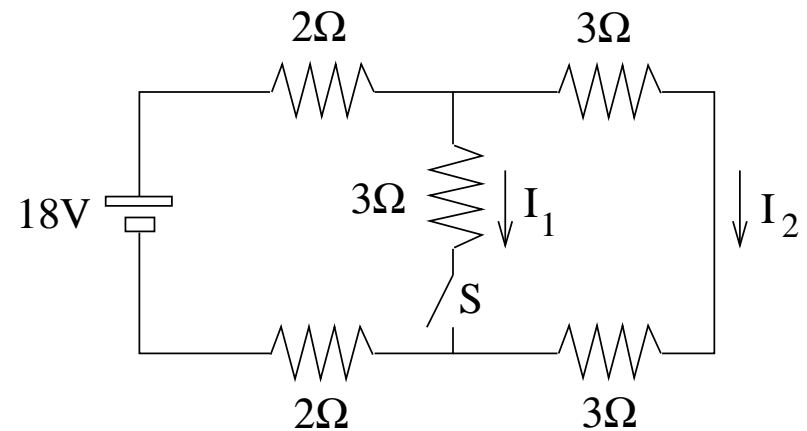
- (a) $C_{34} = C_3 + C_4 = 2\text{pF}$, $C_{eq} = \left(\frac{1}{C_1} + \frac{1}{C_{34}} + \frac{1}{C_2} \right)^{-1} = \frac{1}{2}\text{pF}$.
- (b) $Q_1 = Q_2 = Q_{34} = C_{eq}(6\text{V}) = 3\text{pC}$, $Q_3 = Q_4 = \frac{1}{2}Q_{34} = 1.5\text{pC}$.
- (c) $V_1 = \frac{Q_1}{C_1} = 1.5\text{V}$, $V_2 = \frac{Q_2}{C_2} = 3\text{V}$, $V_3 = \frac{Q_3}{C_3} = 1.5\text{V}$, $V_4 = \frac{Q_4}{C_4} = 1.5\text{V}$.

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.

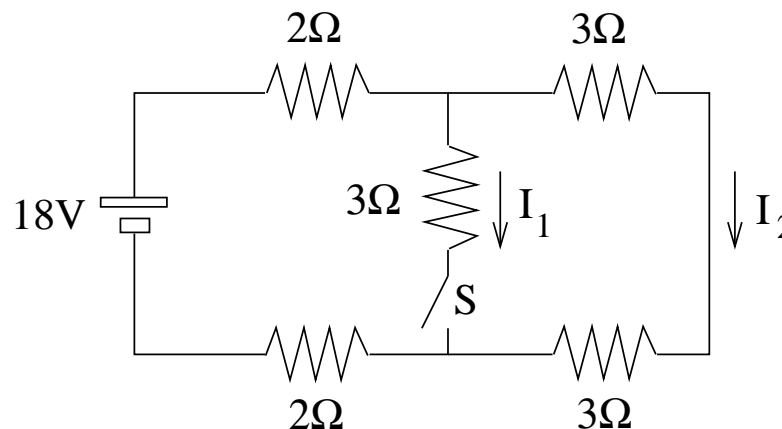
Solution:

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

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

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

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

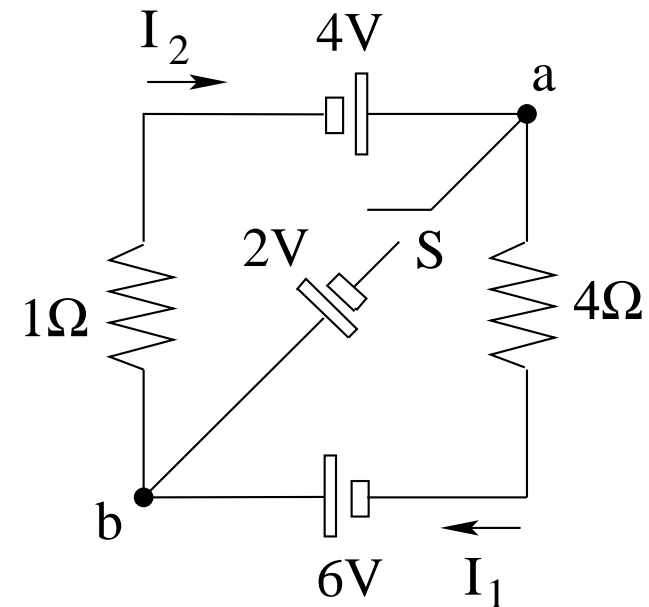


Unit Exam II: Problem #3 (Spring '19)



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.

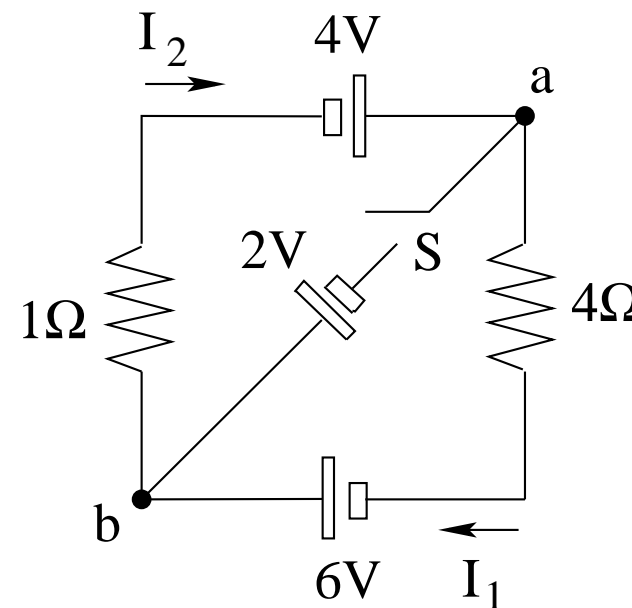


Unit Exam II: Problem #3 (Spring '19)



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.



Solution:

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

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

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

(d) $V_a - V_b = -2V.$