ECE3 Fall 2020 Name HO | Nhat
Family (Last) Name Given (First) Name

Final Exam UID 105 355 311

DO NOT OPEN UNTIL INSTRUCTED TO DO SO.

- We will copy some graded exam papers for archival purposes!
- Put your name in the blank on EVERY page.
- Show your setup.
- Circle your answers.
- Add notes to help the graders determine your intentions.

Problem	Value	Score	Problem	Value	Score
1	5		7	7	
2	4		8	7	
3	5		9	7	
4	5		10	18	
5	5		11	10	
6	7		12	20	
			TOTAL	100	

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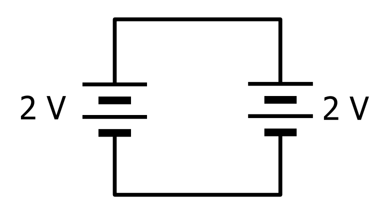
1 If you double the current through an ideal battery, is the potential difference across the battery doubled?

a. Yes, because Ohm's Law says that V = IR
b. Yes, because as you increase the resistance, you increase the potential difference
c. No, because as you double the current, you halve the potential difference
d. No, because the potential difference is a property of the battery
e. No, because the potential difference is a property of everything in the circuit

2 In the world of EE3, is this a legal circuit?



a. Yes, because the batteries are exchanging power.
b. Yes, because the batteries are in series.
c. No, because the batteries oppose each other.
d. No, because the currents cancel each other out.

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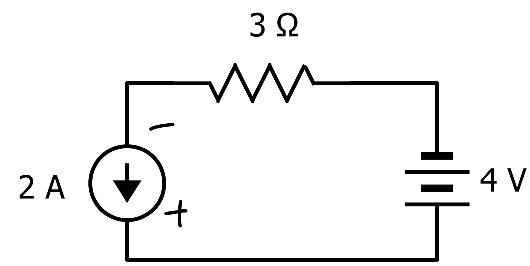

3 Is the 2 A current source providing or absorbing power?

Because in this case, the current is leaving the positive end, so the 2A current source is a

providing power

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It is usually good for a battery to have a low output impedance because:

a. The voltage output is usually lower, and so requires less power to operate.
b. The load has less effect on the battery's output voltage.
c. Ideal battery voltages are affected by the load.
d. High output impedance means that the battery can drive only low-resistance loads.

5

Ideal voltmeters have infinite input impedance.

a. True, because low input impedance means that the voltmeter draws less power.
b. True, because high input impedance adds no load to the circuit.
c. False, because infinite input impedance voltmeters are unaffected by the circuit.
d. False, because infinite input impedance is a sign of a non-functioning circuit.

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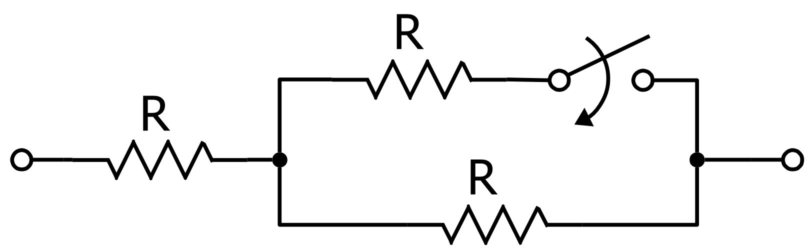
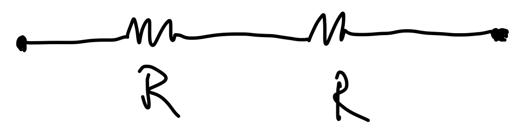


6 How does the resistance between the endpoints change when the switch is closed?

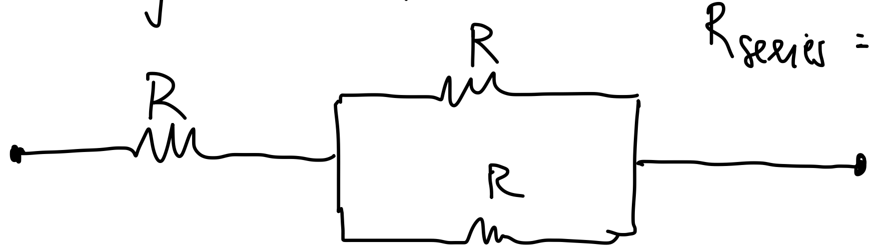
a. It increases
b. It decreases
c. It does not change

Before closing the switch:



$\Rightarrow R_{total} = R + R = 2R \ (\Omega)$

After closing the switch:



$R_{series} = \frac{1}{\frac{1}{R} + \frac{1}{R}} = \frac{R}{2}$

$\Rightarrow$ R series $(R // R) \Rightarrow R_{total} = R + \frac{R}{2} = \frac{3R}{2}$

Because $\frac{3R}{2} = 1.5R < 2R$

$\boxed{\Rightarrow \text{the resistance between the end point is decrease}}$

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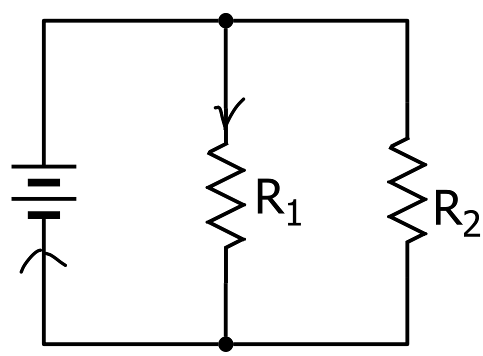
In this circuit, $R_1 < R_2$. Which resistor dissipates the most power?

a. Neither; they dissipate the same power.
b. R_1
c. R_2



We have $V_{R_1} = V_{R_2}$

Also, $P_{R_1} = \frac{V_{R_1}^2}{R_1}$, $P_{R_2} = \frac{V_{R_2}^2}{R_2}$

because $R_1 < R_2$ & $V_{R_1} = V_{R_2} \Leftrightarrow V_{R_1}^2 = V_{R_2}^2$

$$\Rightarrow \frac{V_{R_1}^2}{R_1} > \frac{V_{R_1}^2}{R_2} = \frac{V_{R_2}^2}{R_2}$$

$$\Rightarrow P_{R_1} > P_{R_2}$$

$\Rightarrow$ $\boxed{R_1 \text{ dissipates the most power}}$

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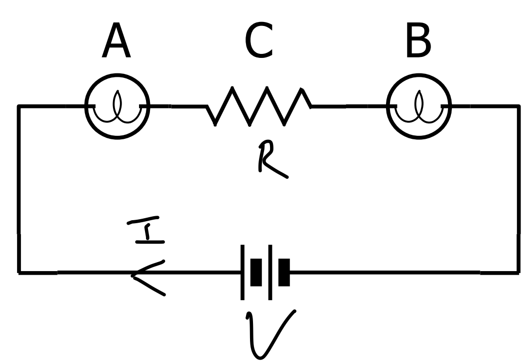
For the question on this page, assume that the lamp brightness increases with increasing current. Also, assume that all lamps are equal, and all batteries are equal. Select the ONE BEST answer.

8 If you increase the resistance of C, what happens to the brightness of lamps A and B?



a. A stays the same, B decreases
b. A decreases, B stays the same
c. A and B increase
d. A and B decrease
e. A and B stay the same

We have $I = \frac{V}{R}$ => if R is increased

=> I has to be decrease (V is const)

=> current goes through the lamps A & B is decreased => the brightness of lamps A & B are decreased.

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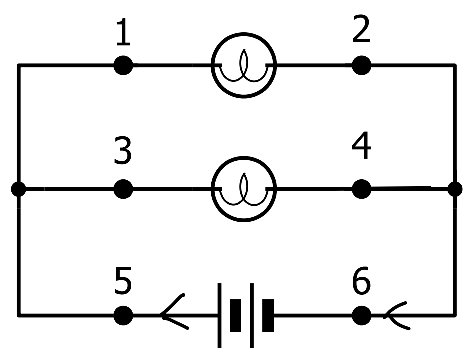
For the question on this page, assume that the lamp brightness increases with increasing current. Also, assume that all lamps are equal, and all batteries are equal. Select the ONE BEST answer.

9

Rank the currents at points 1, 2, 3, 4, 5, and 6 from highest to lowest.

a. 5,1,3,2,4,6
b. 5,3,1,4,2,6
c. 5 = 6, 3 = 4, 1 = 2
d. 5 = 6, 1 = 2 = 3 = 4
e. 1 = 2 = 3 = 4 = 5 = 6



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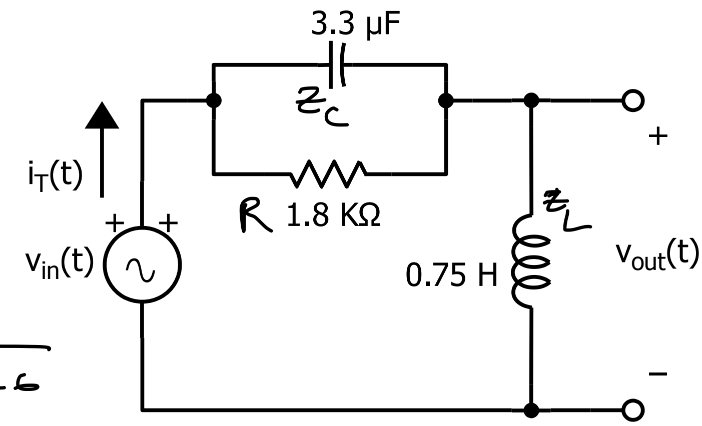
10 If $v_{in}(t) = 10\cos(1000t+40°)$, compute $i_T(t)$.



$\Rightarrow \omega = 1000$ (Rad/s)

$Z_C = \frac{-j}{\omega C} = \frac{-j}{1000 \times 3.3\times10^{-6}}$

$\Rightarrow Z_C = -303.03j\ (\Omega)$; $Z_L = j\omega L = j\,1000 \times 0.75H = 750j\,(\Omega)$

Because $Z_C \parallel R\,(1.8K\Omega) \Rightarrow R_{\parallel} = \frac{1}{\frac{1}{Z_C} + \frac{1}{R}}$

$= \frac{1}{\frac{1}{-303.03j\,\Omega} + \frac{1}{1.8\times10^3\,\Omega}} = 49.61 - 294.68j\ (\Omega)$

$\Rightarrow R_{total} = R_{\parallel} + Z_L = 49.61 - 294.68j + 750j =$

$= 49.61 + 455.32j\ (\Omega)$

$\Rightarrow i_T(t) = \frac{V_{in}(t)}{R_{total}} = \frac{10\cos(1000t + 40°)}{49.61 + 455.32j\,(\Omega)} = \frac{10\angle 40°}{458\angle 83.78°}$

$\Rightarrow i_T(t) = 0.01576 - 0.0151j = 0.0218\angle{-43.78°}$ (A)

$\Rightarrow \boxed{i_T(t) = 0.0218\cos(1000t - 43.78°)\ (A)}$

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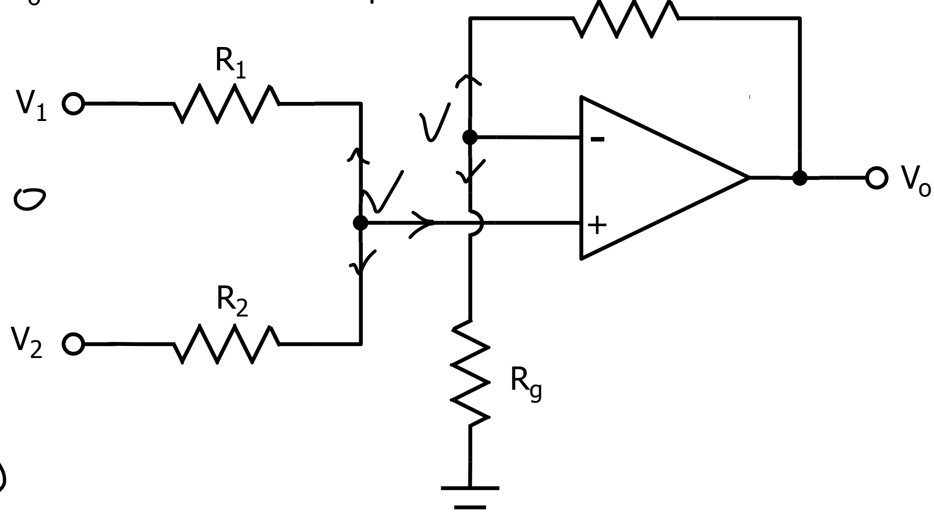
11 Find an expression for V_o when all the R's are equal.



$$\frac{V-V_1}{R_1} + \frac{V-V_2}{R_2} = 0$$

$\Rightarrow V - V_1 + V - V_2 = 0$

(Because $R_1 = R_2$)

$\Rightarrow 2V - V_1 - V_2 = 0 \Leftrightarrow 2V = V_1 + V_2$ (1)

Also: $$\frac{V - V_o}{R_f} + \frac{V - 0}{R_g} = 0 \quad (R_f = R_g)$$

$\Rightarrow V - V_o + V = 0 \Rightarrow V_o = 2V$ (2)

From (1) & (2) $\Rightarrow$ $\boxed{V_1 + V_2 = V_o}$

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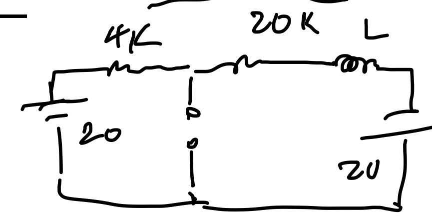
at $t \to 0^-$:



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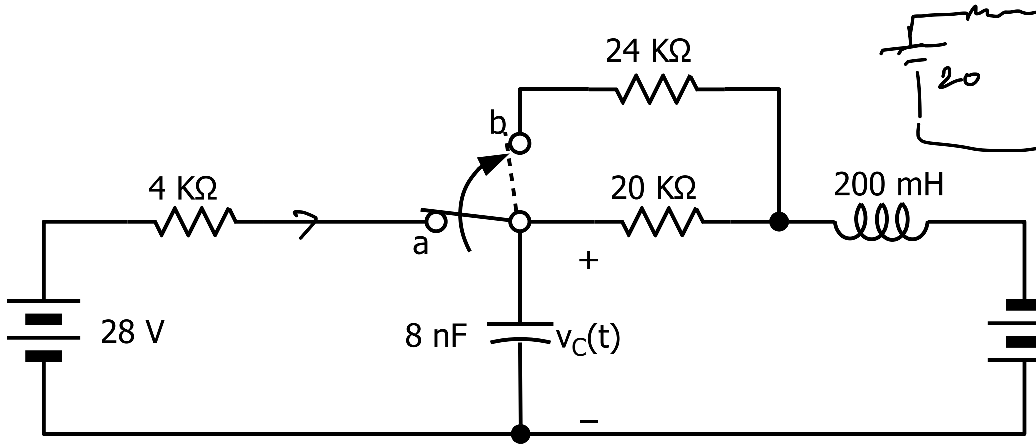

The switch has been in position a for a <u>long time</u>. All transients have died out. At t = 0, the switch moves instantaneously to position b.

a. At $t=0^+$ (the first instant that the switch is in position b), what is the current through the inductor? We have: at $t \to 0^-$ $\Leftrightarrow$ switch has been in position a for a long time, $i_L(0^-) = \frac{28V + 20V}{4K + 20K} = \frac{48V}{24000\Omega}$ ✓

$\Rightarrow i_L(0^-) = 0.002(A) = 2(mA)$.

Since the inductor current can not changed instantaneously

$\boxed{\rightarrow i_L(0^+) = i_L(0^-) = 2(mA)}$

b. At $t=0^-$ (the last instant that the switch is in position a), what is the direction of the current through the 4KΩ resistor? Circle one: left to right.

- Left to Right
- Right to Left

c. At $t=0^+$ (the first instant that the switch is in position b), what is the voltage across the capacitor? Note the assumed polarity of the capacitor voltage!

At $t \to 0^-$, we have: $-28 + 4k.i_L(0^-) + V_c = 0$ (KVL)

$\Rightarrow V_C(0^-) = 28 - 4k.i_L(0^-) = 28 - 4000\Omega \times 0.002A$

$\Rightarrow V_C(0^-) = 20(V)$. Since the voltage of capacitor can not changed instantaneously, $\rightarrow \boxed{V_C(0^-) = V_C(0^+) = 20(V)}$