

Print your name **neatly**:

Last name: 

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First name: 

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*Sign* your name: \_\_\_\_\_

Please fill in your Student ID number (UIN): \_\_\_\_\_-\_\_\_\_\_-\_\_\_\_\_

## IMPORTANT

Read these directions carefully:

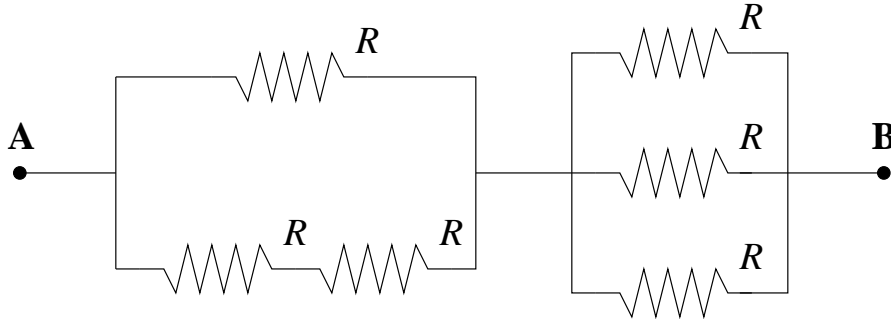
- There are 7 problems totalling 100 points. Check your exam to make sure you have all the pages. Work each problem on the page the problem is on. You may use the back. If you need extra pages, I have plenty up front.
- **Indicate what you are doing!** We cannot give full credit for merely writing down the answer. **Neatness counts!** I will give generous partial credit **if** I can tell that you are on the right track. This means you must be *neat* and organized.
- Each problem with its associated figure is self explanatory. If you *must* ask a question, then come to the front, being as discrete as possible so as not to disturb others.
- Put your name on each page it is asked for. You will lose credit if you fail to print your name on each page it is asked for.

Print your name: \_\_\_\_\_

Physics 208: Electricity and Magnetism, Exam 2

Problem 1. 15 points.

(a) In the resistor network shown, all the individual resistors have the same resistance  $R$ . Calculate the resistance between points **A** and **B**. Express your answer in terms of  $R$  and numerical quantities.



(b) Suppose you have been handed four capacitors, whose capacitances are exactly  $3.0 \mu\text{F}$ ,  $5.0 \mu\text{F}$ ,  $6.0 \mu\text{F}$ , and  $8.0 \mu\text{F}$ . Show a way to obtain an equivalent capacitance of exactly  $7.0 \mu\text{F}$  using some or all of these capacitors.

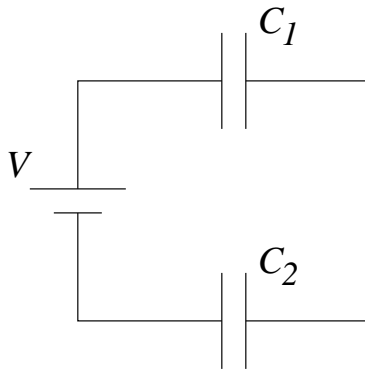
Be **neat**. Neatness helps. Work *neatly*.

Print your name: \_\_\_\_\_

Physics 208: Electricity and Magnetism, Exam 2

Problem 2. 15 points.

A battery with EMF given by  $V$  is connected to two capacitors  $C_1$  and  $C_2$  as shown.



- (a) Calculate the charge on each capacitor.
- (b) Calculate the potential difference across each capacitor.
- (c) Calculate the total energy stored in the two capacitors.

Express all your answers in terms of  $V$ ,  $C_1$ ,  $C_2$ , and numerical factors.

If you work **neatly** I will find more partial credit for you!

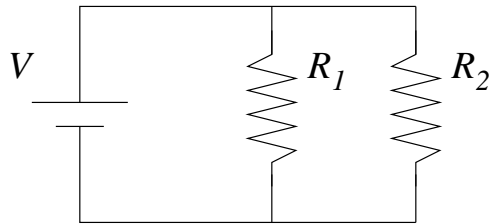
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Physics 208: Electricity and Magnetism, Exam 2

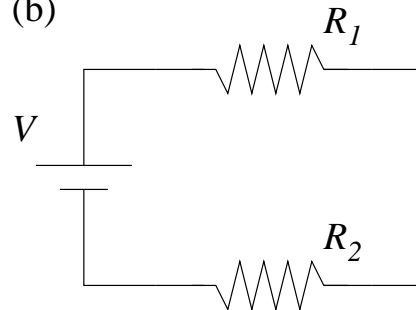
Problem 3. 10 points.

A battery with EMF given by  $V$  is connected to two resistors  $R_1$  and  $R_2$  in two ways as shown in the two figures.

(a)



(b)



Calculate the total power dissipated in the resistors for each of the two cases (a) and (b). Indicate which one is larger.

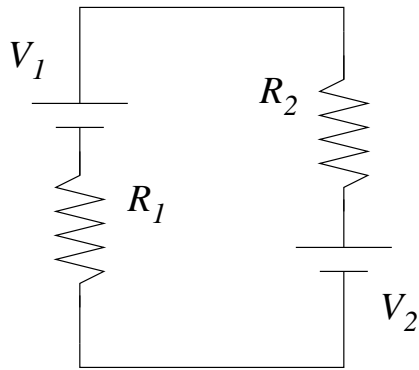
Make sure you are being neat. Working neatly will help you get it right.

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Problem 4. (10 points)

Two batteries with EMF given by  $V_1$  and  $V_2$  are connected with two resistors  $R_1$  and  $R_2$  as shown in the Figure.



(a) Derive an expression for the current that is flowing in this circuit. Express your answer in terms of  $V_1$ ,  $V_2$ ,  $R_1$ ,  $R_2$ , and numerical factors.

(b) Suppose that  $V_1 = 10$  V,  $V_2 = 20$  V,  $R_1 = 10$   $\Omega$ , and  $R_2 = 10$   $\Omega$ . Calculate the current in Amperes, and indicate if it is clockwise or anticlockwise.

Work neatly! If you are neat, I can read what you did.

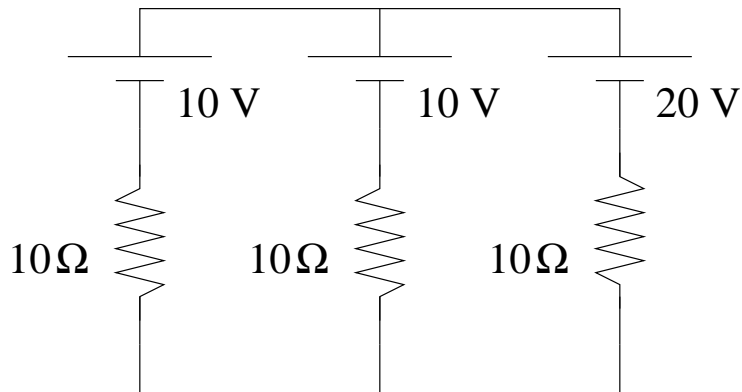
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Physics 208: Electricity and Magnetism, Exam 2

Problem 5. (20 points)

In the circuit shown below, there are three batteries and three resistors. Two of the batteries have EMF equal to 10 V and the third is 20 V. All of the resistors have the same resistance of  $10\ \Omega$ .

Calculate the current in each resistor. **Make sure you make it clear which is which!** For example, you could say which is right, center, and left. Similarly, you could call them 1, 2, and 3, but you must clearly indicate which is which. You must also make it clear which *direction the current is flowing* in each case.



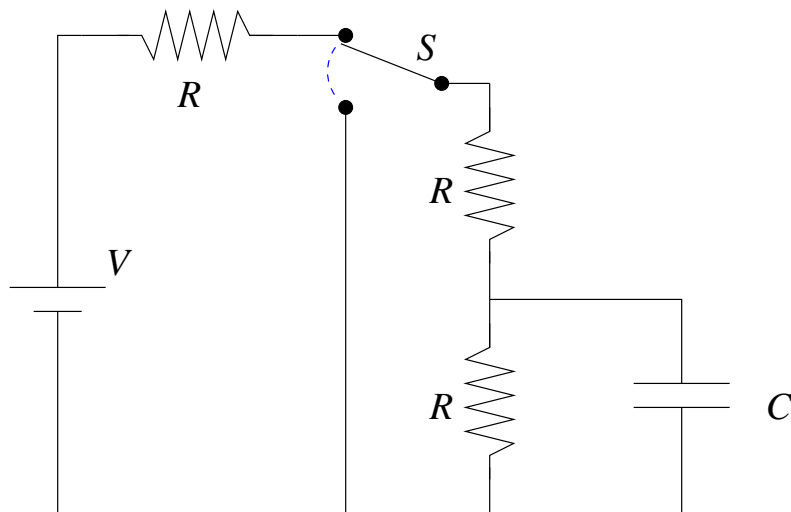
**IMPORTANT:** You must write your equations neatly! I will not give full credit unless your equations and answers are neat and organized.

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Problem 6. (15 points)

Consider the circuit shown below. The battery has EMF given by  $V$ , the capacitor has capacitance  $C$ , and all three of the resistors have the same resistance  $R$ .



(a) Suppose that the switch  $S$  is in the position shown above for a long time. Calculate the charge on the capacitor. Express your answer in terms of  $V$ ,  $C$ ,  $R$ , and numerical factors.

(b) Suppose that after the charge on the capacitor has equilibrated at the value you just calculated, the switch  $S$  is flipped to the opposite position shown. We will call the time that the switch is flipped  $t = 0$ .

Give an expression for the charge  $q(t)$  on the capacitor as a function of time. Express the function in terms of  $V$ ,  $C$ ,  $R$ , numerical factors, and, of course,  $t$ .

NOTE: I don't expect you to solve any integration, but you must indicate your thinking, and how you got your result.

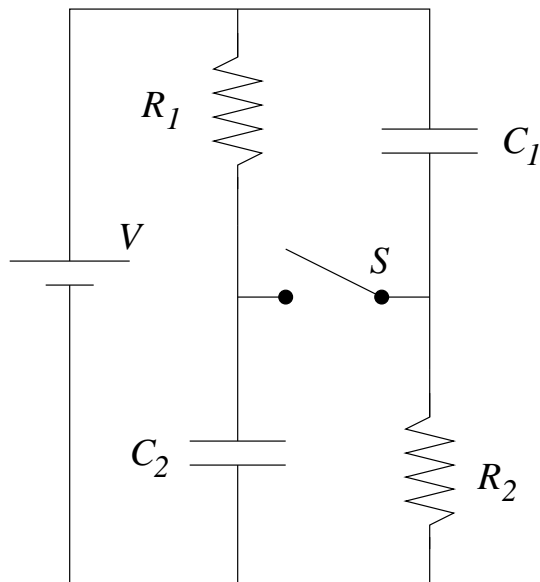
You should be neat. You are more likely to get it right if you work neatly.

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Problem 7. (15 points)

Consider the circuit shown below consisting of a battery with EMF given by  $V$ , two resistors  $R_1$  and  $R_2$ , and two capacitors  $C_1$  and  $C_2$ .



(a) Suppose the switch  $S$  is open as shown, for a long time. Calculate the charge on each of the two capacitors.

(b) Suppose the switch is closed for a long time. Now calculate the charge on each of the two capacitors.

In all cases, express your answers in terms of  $V$ ,  $R_1$ ,  $R_2$ ,  $C_1$ ,  $C_2$ , and numerical factors.

Working *neatly* will help you think about what you are doing.