Physics 112 Sample Test 3

NAME _____

Please complete this page and turn it in. Then you will receive the rest of the exam with an equation sheet.

Please write down the following relationships.

Current Density in terms of conductivity	
Current Density in terms of resistivity	
Resistance in terms of resistivity	
Ohm's Law	
Power Law	
Capacitance	
Voltage of Discharging Capacitor	
Voltage of Charging Capacitor	
Power stored in a capacitor (3 versions)	

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By writing my name above, I affirm that this test represents my work only, without aid from outside sources. In all aspects of this course I perform with honor and integrity.

SHOW YOUR WORK ON ALL OF THE PROBLEMS. YOUR APPROACH TO THE PROBLEM IS AS IMPORTANT AS, IF NOT MORE IMPORTANT THAN, YOUR ANSWER. DRAW **CLEAR AND NEAT PICTURES** SHOWING COORDINATE SYSTEMS AND ALL OF THE RELEVANT PROBLEM VARIABLES. ALSO, **EXPLICITLY** SHOW THE **BASIC EQUATIONS** YOU ARE USING. BE NEAT AND THOROUGH. THE EASIER IT IS FOR ME TO UNDERSTAND WHAT YOU ARE DOING, THE BETTER YOUR GRADE WILL BE.

Current Density in terms of conductivity	$J = \sigma E$
Current Density in terms of resistivity	$J = \frac{E}{\rho}$
Resistance in terms of resistivity	$R = \frac{\rho d}{A}$
Ohm's Law	$V = IR$
Power Law	$P = IV$
Capacitance	$C = \frac{\lvert Q \rvert}{\lvert \Delta V \rvert}$
Voltage of Discharging Capacitor	$V = V_0 e^{-t/RC}$
Voltage of Charging Capacitor	$V = V_0(1 - e^{-t/RC})$
Power stored in a capacitor (3 versions)	$U = \frac{1}{2}CV^2,\ U = \frac{1}{2}QV,\ U = \frac{1}{2}\frac{Q^2}{C}$

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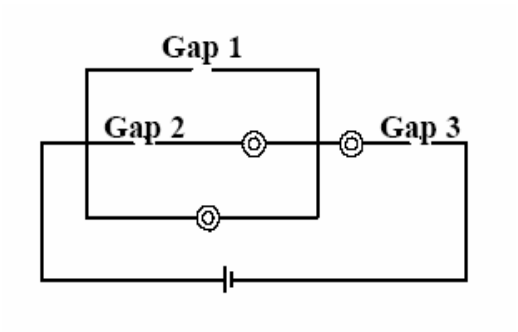
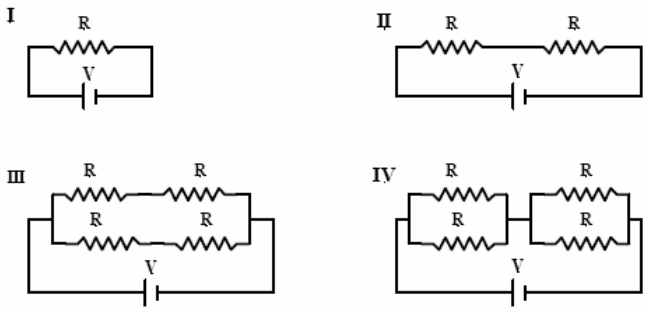
1.1) This circuit contains a battery and three light bulbs (indicated by concentric circles). There are also three gaps in the circuit. You want to close all three gaps, but you have the option of closing them either with other light bulbs or with small pieces of wire. Which gaps should be closed with bulbs if you want the circuit to emit the maximum amount of light? Assumptions: all bulbs are identical; gaps not closed with bulbs are instead closed with wires and vice versa.

(a) Gap 1, only
(b) Gap 2, only
(c) Gap 3, only
(d) Gaps 1 & 2, only
(e) Gaps 1, 2, & 3



1.2) The batteries and resistors in these circuits are identical. For which circuit will the total current flowing from the battery be V/R?

(a) I, only
(b) I and III, only
(c) I and IV, only
(d) I, III, and IV, only
(e) I, II, III, and IV



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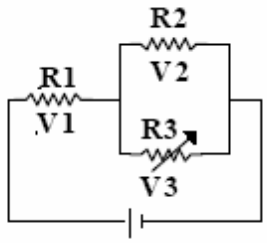
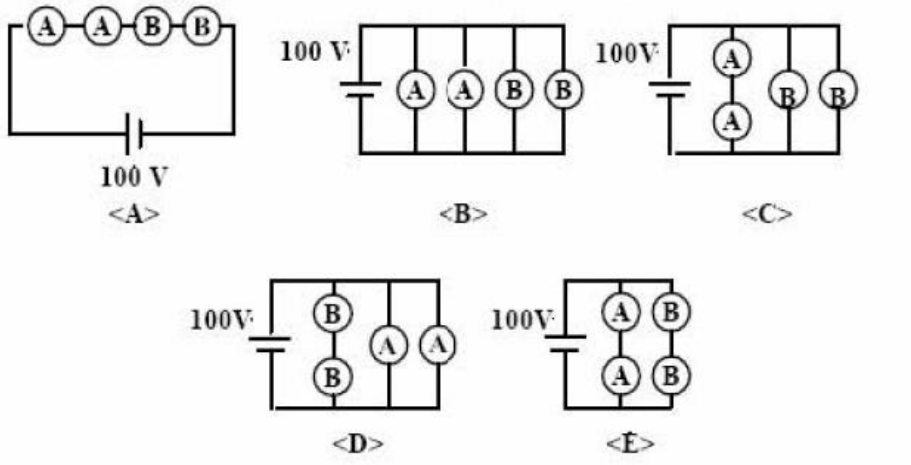
1.3) This circuit consists of a battery, two fixed resistors (R1 and R2), and an adjustable resistor (R3). The voltages across the three resistors are V1, V2, and V3. If the resistance R3 were to be increased, which of the voltages would also increase?

(a) V1, only
(b) V3, only
(c) V1 and V3, only
(d) V2 and V3, only
(e) V1, V2, and V3



1.4) Type A light bulbs can be wired across a potential difference of up to 100 volts without burning out. Type B bulbs can only be wired across a potential difference of up to 50 volts without burning out. Which of the circuits here would emit the most amount of light without burning out a bulb? (Ignore changes in bulb properties with temperature.)



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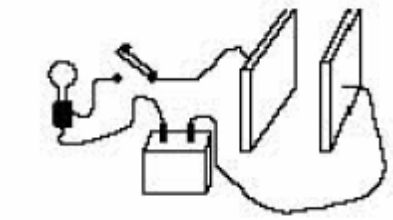
1.5) The picture here shows a circuit with a battery, a light bulb, a parallel plate capacitor, and a switch. If the battery were connected to the light bulb by itself, it would cause the bulb to emit a noticeable amount of light.



Which of the following best describes the intensity of the bulb's light if the switch were closed?

(a) The bulb would not light.
(b) The bulb would initially emit a bright light that subsequently get dimmer.
(c) The buld would initially emit a dim light that subsequently get bright.
(d) The bulb would emit a steady amount of light equally a bright as if just the bulb and battery were wired together.
(e) The bulb would emit a steady amount of light, but an amount that is substantially dimmer than if just the bulb and battery were wired together.

1.6) After the switch has been closed for a very long time, a certain amount of charge will have built up on each plate. Which of the following changes to the apparatus would have caused the charge magnitude on each plate to be larger? (circle all that are correct)

(a) Increasing the voltage of the battery
(b) Increasing the surface area of the metal plates
(c) Increasing the resistance of the light bulb

2) A wire with resistance R is drawn out through a die so that its new length is three times its original length. Find the resistance of the new wire, R_N, in terms of R assuming that neither its resistivity nor density changed.

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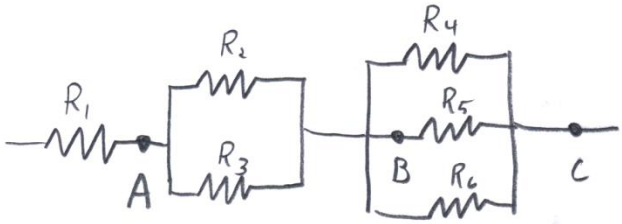
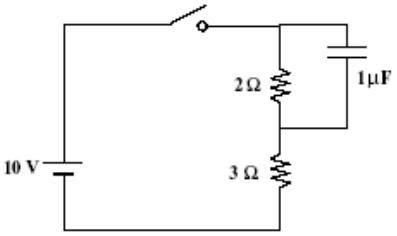
3. A current of I_B flows through point *B*. All resistors have resistance R.



   a) What is the magnitude of the potential difference between points *A* and *C*, V_{AC}, in terms of I_B and *R*?
   b) What is the current in R_2, in terms of I_B and *R*?

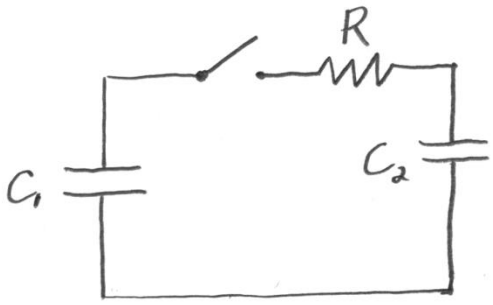
4. Consider the circuit shown at the right.



(a) If the switch is closed, and you wait sufficiently long that the currents in the circuit reach their steady-state values, what is (i) the rate at which energy leaves the battery and (ii) the charge on the capacitor? ("The rate at which energy leaves" is also called the power dissipation.)

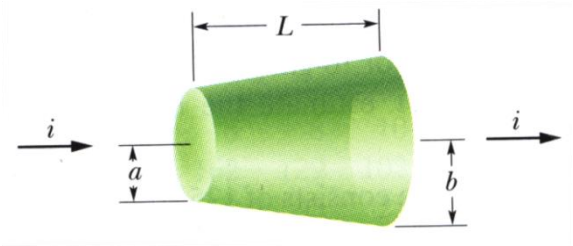
(b) If the switch is then opened, how long does it take for the capacitor's charge to drop by 50%?

5. In the figure at the right, C_1 is initially charged to V_0 and C_2 is initially uncharged. The switch is then closed. Find the total energy dissipated in the resistor as the circuit comes to equilibrium. (HINT: Charge is conserved.)



Super Fun Bonus Problem!

In the figure at the right, current flows through a truncated right circular cone of resistivity ρ, left radius a, right radius b, and length L. Assume that the current density is uniform across any cross section taken perpendicular to the length. What is the resistance of the cone?



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