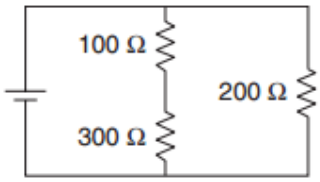
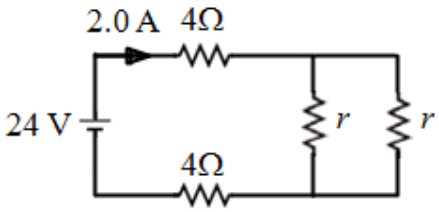
AP Physics C Name: _____

Unit 4 Test: Circuits Period: _____

Part 1: Multiple Choice - Choose the answers that best answers the questions below. If an exact answer is not present, chose the closest available answer. (3 points each)

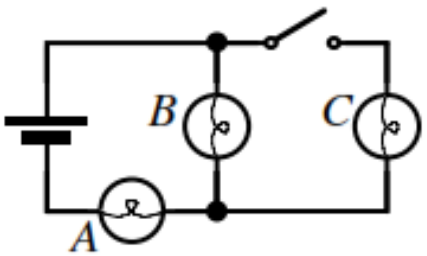


1. The figure above shows 3 resistors connected in a circuit with a battery. If the battery shown in the circuit supplies 12 V, voltage dropped in the 300 Ω resistor?
   A) 8 V B) 6 V C) 12 V D) 3 V E) 9 V



2. In the circuit shown on the right, the value of *r* is
   A) 0 Ω B) 1 Ω C) 2 Ω D) 3 Ω E) 8 Ω

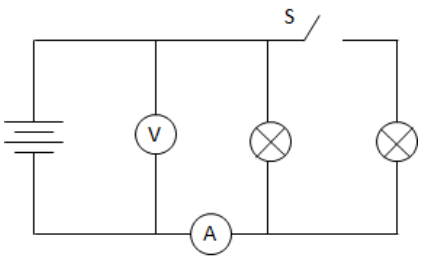
3. Three light bulbs are wired in a circuit as shown on the right. The switch is initially open. When the switch is closed, what will happen to bulbs A and B?



   A) A and B both get brighter.
   B) A gets dimmer; B gets brighter
   C) A gets brighter, B gets dimmer
   D) A stays the same, B gets brighter
   E) A gets brighter, B goes out

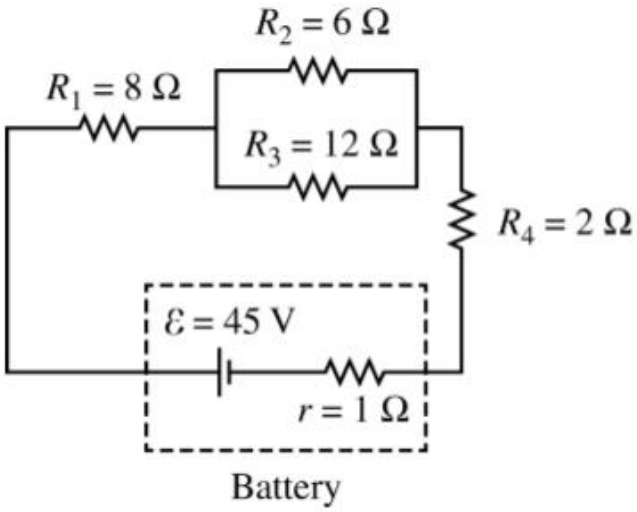
4. When two identical resistors are connected is series to a battery, the total power dissipated is P. When the two resistors are connected in parallel to the same battery, the total power:
   A) P B) 2P C) 4P D) $P/2$ E) $P/4$

5. A lamp, a voltmeter *V*, an ammeter *A*, and a battery with zero internal resistance are connected as shown right. The switch is initially open. What happens when the switch closes?



   A) The voltmeter reading will decrease.
   B) The ammeter reading will increase.
   C) The ammeter reading will decrease.
   D) The voltmeter reading will increase.
   E) None of the above.

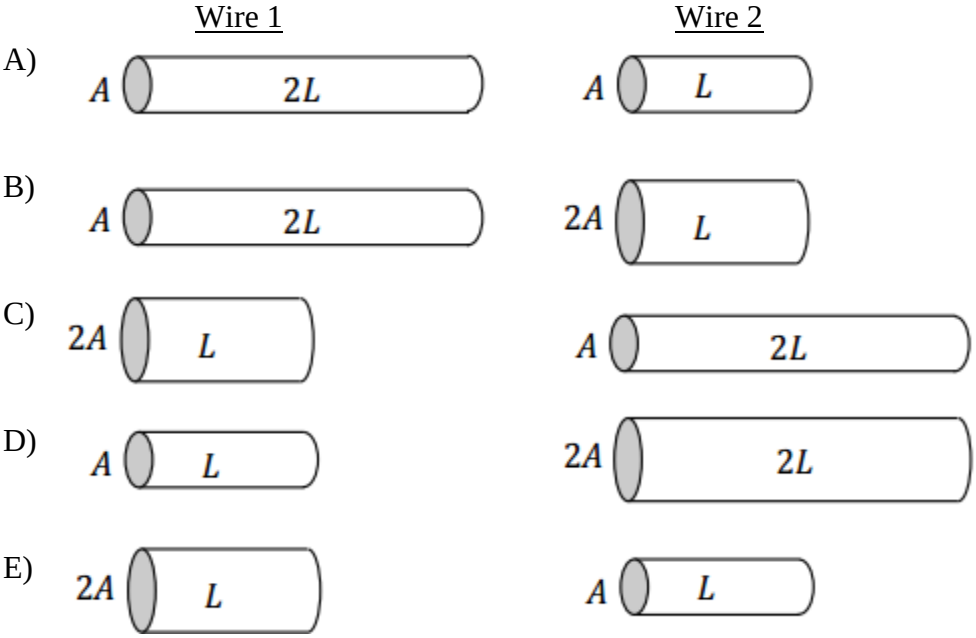
(6-7) The circuit represented in the figure below contains four resistors and a battery. The 45 V battery has an internal resistance of 1 Ω.



6. Which of the following ranks the absolute values of the potential differences ΔV across the resistors from highest to lowest?
   A) $\Delta V_4 > (\Delta V_2 = \Delta V_3) > \Delta V_1$
   B) $\Delta V_1 > \Delta V_4 > \Delta V_2 > \Delta V_3$
   C) $\Delta V_3 > \Delta V_1 > \Delta V_2 > \Delta V_4$
   D) $\Delta V_4 > \Delta V_2 > \Delta V_1 > \Delta V_3$
   E) $\Delta V_1 > (\Delta V_2 = \Delta V_3) > \Delta V_4$

7. How much energy is dissipated by the battery's internal resistance in 60 s?
   A) 9 J B) 180 J C) 540 J D) 900 J E) 8100 J

8. Two conducting wires, W_1 and W_2, are made of two different materials. The first wire W_2 has a resistivity equal to half of the resistivity of W_2 ($\rho_1 = \frac{\rho_2}{2}$. Which of the following pairs of cylindrical wires, with indicated cross sectional area and length, will have equal resistances?



9. A small bulb is rated at 7.5 W when operated at 125 V. The tungsten filament has a temperature coefficient of resistivity $\alpha = .0045/℃$. When the filament is hot and glowing, its temperature is seven times room temperature 140 ℃. What is the resistance of the filament at room temperature (20℃)?

A) 1280 B) 1350 C) 1911 D) 4530 E) 5630

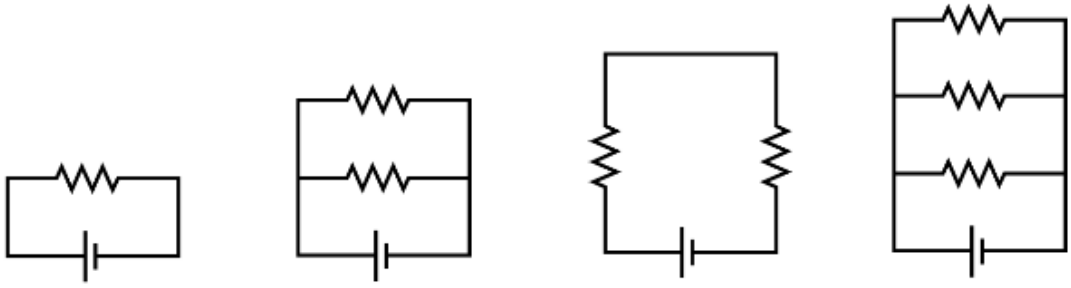
10. A computer is connected to a 120 V power source and is left on for 10 hours while it runs the original Half-Life and plays "I Ran" by A Flock of Seagulls at full blast. If the total cost to run the computer is $0.25 and electricity costs $0.10 per kW-hr, what is the approximate current that runs through the computer?

A) 0.5 A B) 1.0 A C) 1.5 A D) 2.0 A E) 2.5 A

11. How many electrons pass through a 20 Ω resistor in 10 min if there is a potential drop of 30 volts across it?

A) $5.6x10^{21}$ B) $1.1x10^{21}$ C) $7.5x10^{21}$ D) $3.8x10^{21}$ E) $9.4x10^{21}$

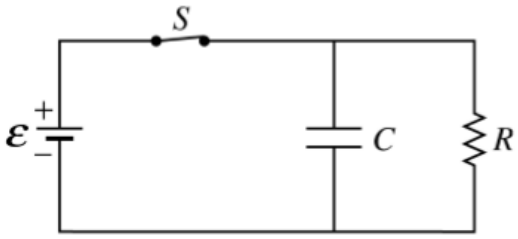
12. The circuits below are each constructed of identical resistors connected as shown to an ideal battery.



Which circuit dissipates the most power?

A) I B) II C) III D) IV E) ┌(ಠ_ಠ)┘

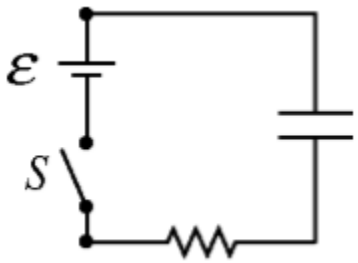
13. Refer to the diagram on the right. Suppose the resistor has been closed for a long time. Which of the following is the correct expression for the current in the resistor?

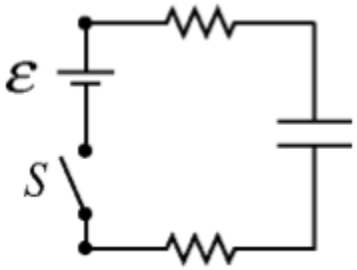


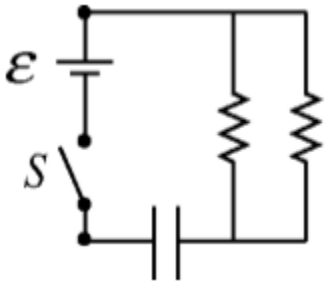
A) Zero B) $\frac{C\varepsilon}{R}$ C) $\frac{\varepsilon}{RC}$

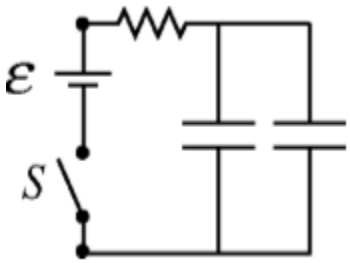
D) $C\varepsilon$ E) $\frac{\varepsilon}{R}$

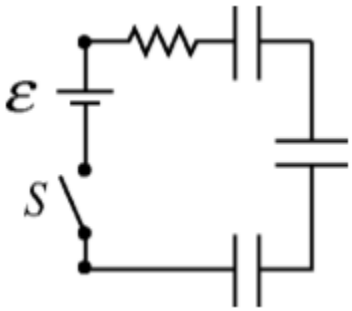
14. Identical resistors and identical uncharged capacitors are connected to identical ideal batteries of a fixed emf shown in the circuits given. Each circuit has a switch S in the open position. In which circuit will the capacitors charge in the least amount of time when switch S is closed?

A) 

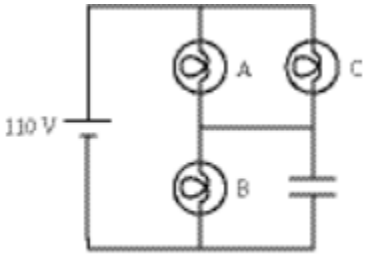
B) 

C) 

D) 

E) 

15. The circuit below contains three light bulbs and a capacitor. The battery has 110 V and the capacitor is fully charged. Which light bulb(s) is (are) brightest?

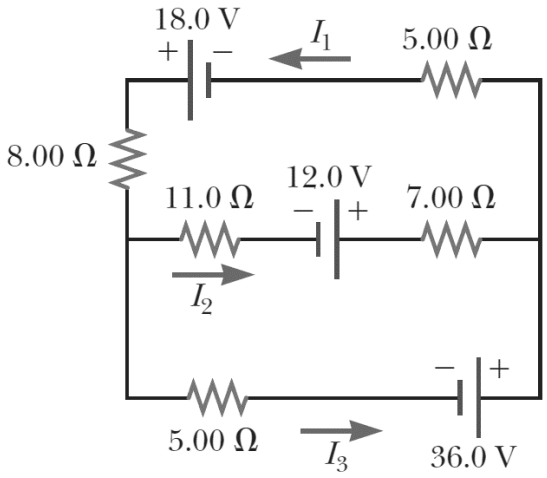


A) A B) B C) C D) A & B E) A & C

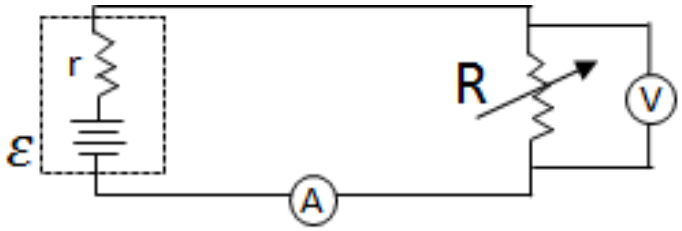
(☞ﾟヮﾟ)☞

Part 2: Free Response. You must show all steps required to arrive at the correct answer for the problem below, including any diagrams. **All answers must be given with correct units.**

16. (10 points) Solve for the values for the 3 currents in the circuit shown.



16. Mr. Kozlow tasks an underling to test the internal resistance of an Amazon Basics battery. The underling connects the battery in series to a variable resistor with a voltmeter across it as shown in the figure below. The battery has an emf of ε and an internal resistance of r. The resistor has variable resitance R.



a) Two voltmeters are available to use, one with a high resistance and with a low resistance. Which voltmeter will provide the most accurate reading (high resistance meter/low resistance meter)? Justify your answer.

b) Derive an expression for the measured voltage, V, in terms of ε, r, and R.

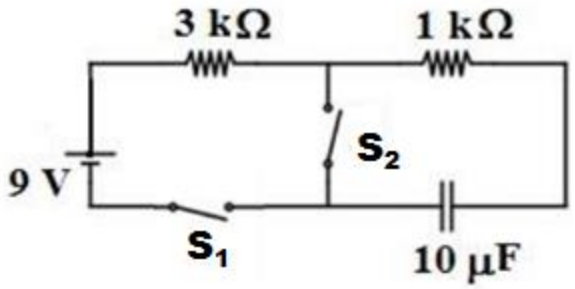
c) The following data is measured in 5 trials.

Trial #	1	2	3	4	5
R (Ω)	1.0	2.0	3.0	5.0	10.0
Meter Voltage (V)	7.8	9.5	10.3	10.8	12.0

i. What is the value of the battery's internal resistance?

ii. Using your value from i., what is the maximum current the battery can provide?

17. A circuit with a 9 V battery of negligible internal resistance is set up with 2 resistors in series with a 10 μF capacitor. Two switches exist in the circuit.



a) For part a), S_1 is closed at time t = 0 s. S_2 is kept open.

i. Set up a differential equation that could be solve to give the charge in the capacitor over time. You can use V_0 for the battery voltage, R_{eq} for the equivalent reistance and C for the capactitance to simplify.

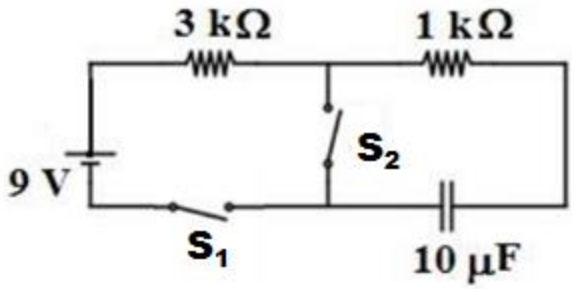
ii. Solve the differential equation to derive an expression for the charge in the capacitor vs. time starting at t = 0 s. Again, you can use the symbols above.

iii. Calculate the time it would take the capacitor to reach a potential differenct of 6 V.

(This question continues on the next page->)

b) Once the capactior is fully charged, S_2 is closed. S_1 remains closed.

i. What is the current in each resistor a long time after switch S_2 is closed?



ii. What is energy stored in the capacitor a long time after the switch is closed?

18. Take some time to do the things you've never had and find the current leaving the battery in the following circuit. It's nothing that hundred men or more could ever do.