AP Physics C Name: _____

Unit 4 Test: Circuits

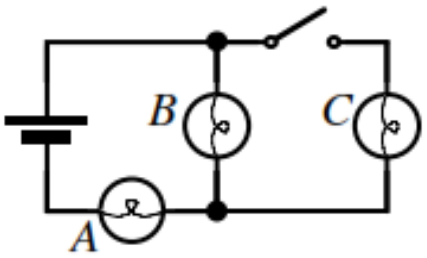
Part 1: Free Response. **You must show all steps** required to arrive at the correct answer for the problem below, including any diagrams. **All answers must be given with correct units.**

1. 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

2. 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) 2.5 A B) 2.0 A C) 1.5 A D) 1.0 A E) 0.5 A

3. How many electrons pass through a 20 Ω resistor in 10 min if there is a potential drop of 30 volts across it?
   A) $1.1x10^{21}$ B) $3.8x10^{21}$ C) $5.6x10^{21}$ D) $7.5x10^{21}$ E) $9.4x10^{21}$

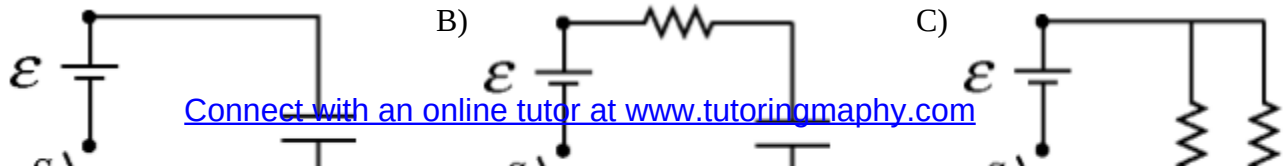
4. Three light bulbs are wired in a circuit as shown on the right. The switch is initially open. When the switch is closed, what will happen to bulbs A and B?



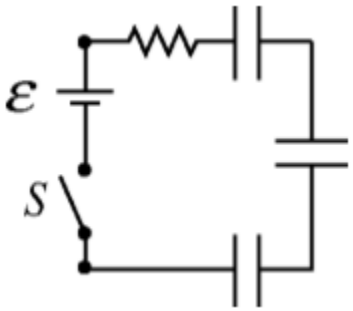
   A) A and B both get brighter.
   B) A gets brighter; B gets dimmer
   C) A gets dimmer B gets brighter
   D) A stays the same, B gets brighter
   E) A gets brighter, B goes out

5. 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) 2P B) 4P C) 4P D) $P/4$ E) $P/2$

6. 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)



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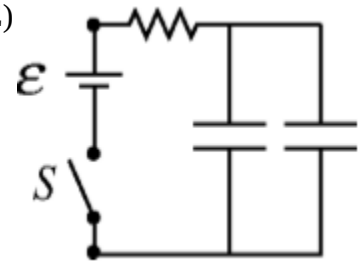
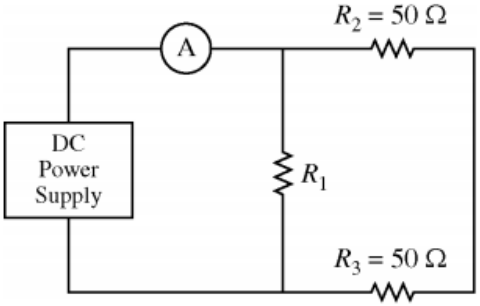


1. (24 points) In the circuit shown, an ideal DC power supply is connected to an ammeter and three resistors. The resistances of two of the resistors are known and labeled, but R_1 is unknown.



a) Outline why the ammeter is wired in series.

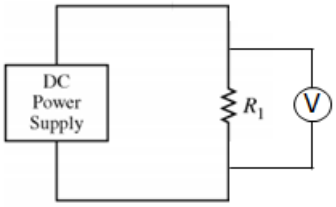
b) Data is collected on the potential difference across the power supply and the current measured by the ammeter. The data is given in the charge below. Using the data from the chart, calculate the value of R_1..

Potential Difference (V)		2	4	6	8	10
Current (mA)		40	55	97	138	155

Using the data from the chart, calculate the value of R_1.

c) The power supply is now fixed at 12 V. Calculate the amount of energy dissipated in R_2 in one minute.

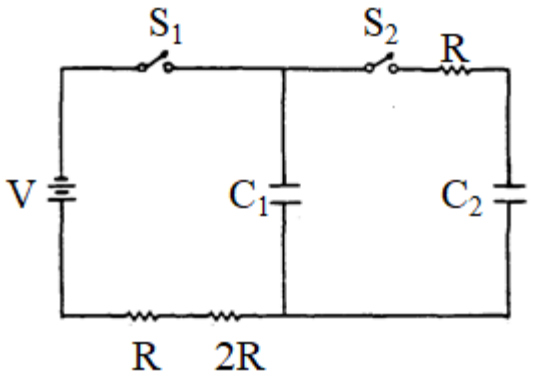
d) The system is now fixed as shown. The power supply is fixed at 12 V, but is non-ideal. Resistors R_3 and R_2 are removed and an ideal voltmeter is wired in parallel with R_1. The voltmeter measures 11 V.



i. Outline why the voltmeter is wired in parallel.

ii. Calculate the internal resistance of the power supply.

2. (26 points) In the given diagram, V = 100 volts; C_1 = 12 microfarads; C_2 = 24 microfarads; R = 100 ohms. Initially, C_1 and C_2 are uncharged, and all switches are open.



a) First, switch S_1 is closed.

i. Set up, but do not solve, a differential equation that could be used to calculate the charge on C_1 over time after the switch is closed.

ii. Solve the differential equation above to determine an expression for Q(t) on C_1 after the switch is closed.

i. Calculate the time it takes the potential difference across C_1 to reach 88 V.

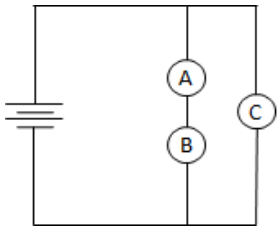
b) Next S_1 is opened and afterward S_2 is closed.

i. Determine the charge on C_1 when equilibrium is again reached.

ii. Calculate the energy dissipated while the 2 capacitors are reaching a steady state.

Part 2: Multiple Choice - Choose the answers that best answers the questions below. If an exact answer is not present, chose the closest available answer. (5 points each)

3. _____Three identical lightbulbs, labeled A, B, and C, are wired as shown in the diagram. If lightbulb A burns out, what will happen to lightbulbs B and C?

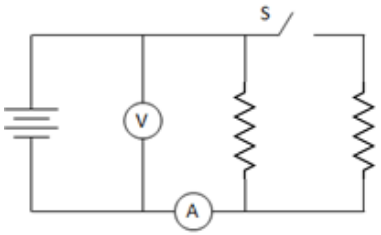


A) B – gets brighter; C – gets dimmer
B) B – goes out; C – gets dimmer
C) B – goes out; C – gets brighter
D) B – goes out; C – stays the same
E) B – gets brighter; C – goes out

4. _____While on Tatooine at 58.0°C, Luke finds that a voltage applied to a copper wire ($\alpha = .00393\ /°C$) produces a current of 1.00 A. Luke then travels to Hoth and applies the same voltage to the wire. What current does he register there if the temperature is 288.0°C? The wire stays the same shape and size.

A) 0.73 A B) 1.90 A C) 0.92 A D) 1.11 A E) 0.52 A

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?

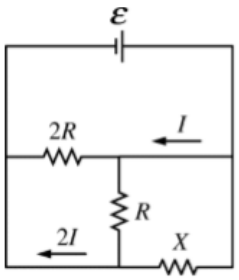


A) The voltmeter reading will increase.
B) The ammeter reading will decrease.
C) The ammeter reading will increase.
D) The voltmeter reading will decrease.
E) Whether the readings increase or decrease depend on the ratio of the resistances of the resistors.

6. _____A copper wire of length L and diameter D dissipates energy at a rate of P when the current in the wire is 10 A. A second copper wire of length L and diameter $2D$. What current in the second wire would dissipate energy at a rate of P?

A) 2.5 A B) 5.0 A C) 10 A D) 20 A E) 40 A

7. _____Three resistors are connected to an ideal battery, as shown in the figure. The battery has an emf ε. Two of the resistors have known resistances R and 2R. The third resistor has unknown resistance X. The current in two of the branches is shown. What is the value of the unknown resistance X ?



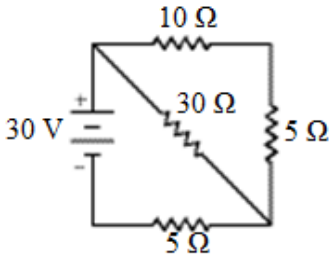
A) R/5 B) R/4 C) R/2 D) R E) 2R

8. _____ How many electrons pass through a point conductor from t = 0 s to = 5.0 s if the current is given by $I(t) = 0.5\sin(0.1t)$?

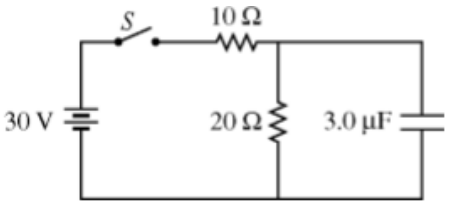
A) $3.8x10^{18}$ B) $7.6x10^{18}$ C) $7.6x10^{16}$ D) $9.6x10^{18}$ E) $1.2x10^{16}$

9. _____ At what rate is thermal energy generated in the 30 Ω resistor?

A) 20 W B) 27 W C) 60 W D) 13 W E) 30 W

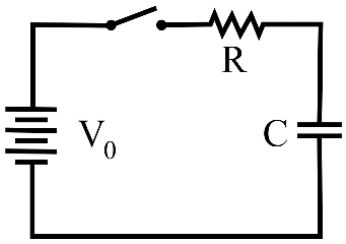


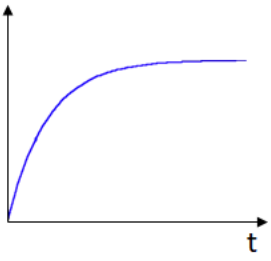
10. _____An uncharged 3.0 μF capacitor is placed in a circuit with an ideal battery, two resistors, and an open switch S, as shown in the figure above. The switch is then closed. What is the current in the 20 Ω resistor a long time after the switch is closed?

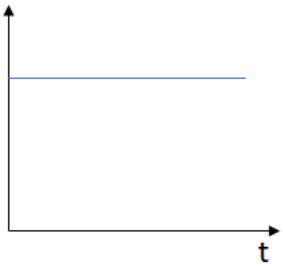


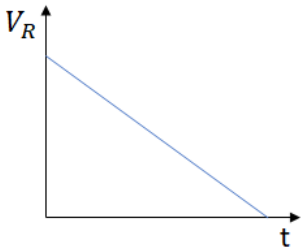
A) Zero B) 1.0 A C) 1.5 A
D) 3.0 A E) 10 A

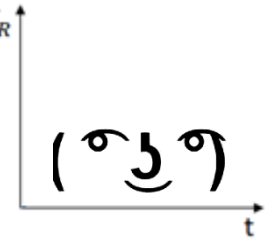
11. _____ For the circuit show on the right, which of the following graphs shows the voltage in the resistor, V_R, as a function of time, t?

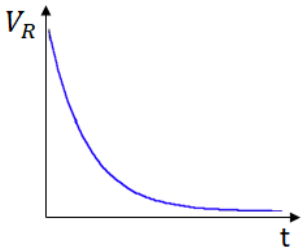


A) 

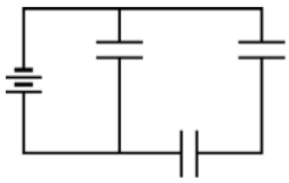
B) 

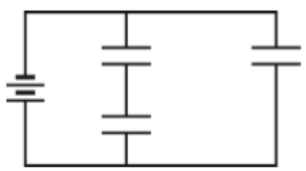
C) 

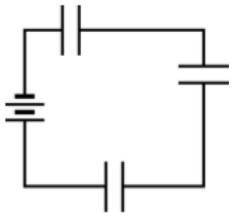
D) 

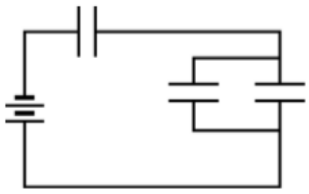
E) 

12. _____Each of the following figures shows three identical capacitors connected to a battery. Which circuit shown takes the longest time to reach a steady-state?

A) 

B) 

C) 

D) 

E)