AP Physics Study Guide Chapter 18 19 Current and Circuits Name_____

USE CORRECT CIRCUIT SYMBOLS FOR ALL CIRCUITS DRAWN IN THE STUDY GUIDE.

Circle the vector quantities below and underline the scalar quantities below

electric current voltage power electric energy

Write the equation that defines each quantity, **INCLUDE UNITS FOR ALL QUANTITIES**

Electric current Electrical resistance (Ohm's Law) Resistance of a wire Capacitance

Power – 3 different expressions using I, V, R Efficiency of an electrical device

List the 3 things necessary to have electric current flowing at a useable rate

1)

2)

3)

Write the definition of conventional electric current using words.

Write the definition of electric resistance using words and an equation

Why does resistance not depend on voltage and current?

List the three characteristics of a conductor that determine its electric resistance.

1) 2) 3)

Write the 3 forms of Ohm's Law that enable you to calculate current, resistance and voltage.

1) 2) 3)

What happens when current flows through a resistor?

Draw an electric circuit which includes a battery, connecting wires, one resistor, an ammeter to measure the current through the circuit and a voltmeter to measure the voltage drop across the resistor. ALSO draw and label the direction of the electric current.

Explain how a real battery differs from an ideal battery. Use the terms "internal resistance" "emf" and "terminal voltage" in your explanation.

Write the definition of what the equivalent resistance of a circuit containing multiple resistors. (do not use an equation)

Draw a circuit containing 2 resistors wired in series with each other and an ideal battery. Write the equation that allows you to calculate the equivalent resistance of the circuit.

Draw a circuit containing 2 resistors wired in parallel with each other and an ideal battery. Write the equation that allows you to calculate the equivalent resistance of the circuit.

For a series circuit containing 2 resistors the current through each resistor _____ and the voltage drops _____ to the total voltage supplied by the battery. For a parallel circuit containing 2 resistors the current through each resistor _____ to the total current flowing out of the battery and the voltage drops across each resistor _____.

Write Kirchoff's Junction Rule:

Write Kirchoff's Loof Rule:

Ammeters must be connected in a circuit in _____ where the current is to be measured and voltmeters must be connected in a circuit in _____ where the voltage is to be measured.

Write the definition of equivalent capacitance for a circuit containing multiple capacitors (not an equation).

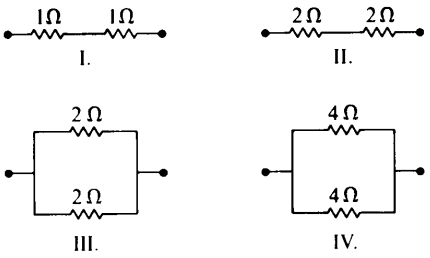
Draw a circuit containing 2 capacitors wired in series with each other and an ideal battery. Write the equation that allows you to calculate the equivalent capacitance of the circuit.

Draw a circuit containing 2 capacitors wired in parallel with each other and an ideal battery. Write the equation that allows you to calculate the equivalent capacitance of the circuit.

For a series circuit containing 2 capacitors the charge on each capacitor _____ and the voltage drops _____ to the total voltage supplied by the battery. For a parallel circuit containing 2 capacitors the charge on each capacitor _____ to the total charge flowing out of the battery and the voltage drops across each capacitor _____.

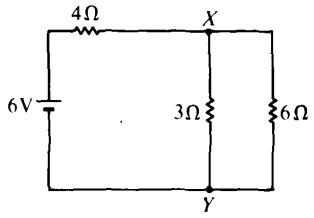
Draw an RC circuit containing a battery in series with a resistor and a capacitor.

No process is required for these multiple choice questions



1. Which two arrangements of resistors shown above have the same resistance between the terminals?
   (A) I and II (B) I and IV (C) II and III (D) II and IV (E) III and IV

1)_____



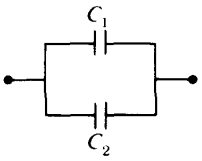
2. In the circuit shown above, what is the value of the potential difference between points X and Y if the 6-volt battery has no internal resistance?

(A) 1 V (B) 2 V (C) 3 V (D) 4 V (E) 6V 2)_____

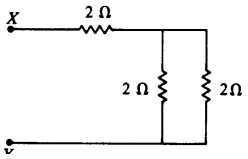
3) A certain coffeepot draws 4.0 A of current when it is operated on 120 V household lines. If electrical energy costs 10 cents per kilowatt-hour, how much does it cost to operate the coffeepot for 2 hours?

(A) 2.4 cents (B) 4.8 cents (C) 8.0 cents (D) 9.6 cents (E) 16 cents

3)_____



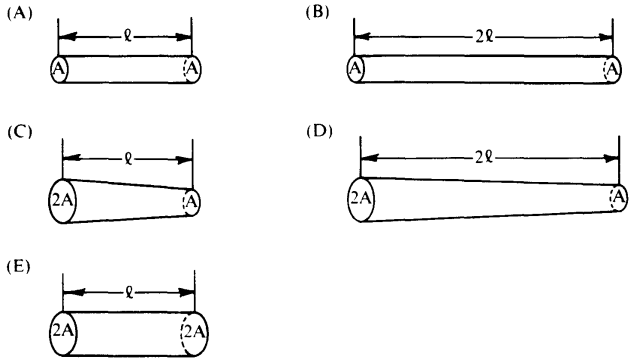
4. Two capacitors are connected in parallel as shown above. A voltage V is applied to the pair. What is the ratio of charge stored on C_1 to the charge stored on C_2, when $C_1 = 1.5C_2$?
   (A) 4/9 (B) 2/3 (C) 1 (D) 3/2 (E) 9/4 4)_____

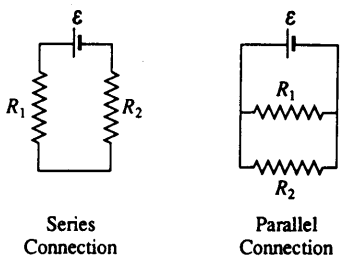


5. The equivalent resistance between points X and Y in the circuit shown above is
   (A) 3 Ω (B) 4 Ω (C) 5 Ω (D) 6 Ω (E) 7 Ω 5)_____

6. An immersion heater of resistance R converts electrical energy into thermal energy that is transferred to the liquid in which the heater is immersed. If the current in the heater is I, the thermal energy transferred to the liquid in time t is
   (A) Irt (B) I^2Rt (C) IR^2t (D) IRt^2 (E) IR/t 6)_____

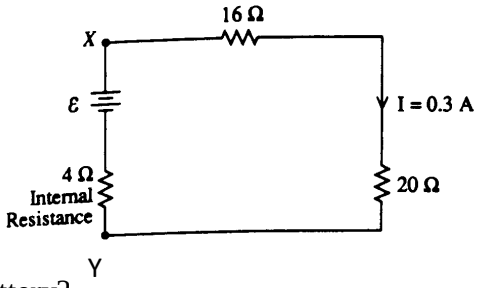
7. The five resistors shown below have the lengths and cross-sectional areas indicated and are made of material with the same resistivity. Which resistor has the least resistance? 7)_____





8. In the diagrams above, resistors R_1 and R_2 are shown in two different connections to the same source of emf ε that has no internal resistance. How does the power dissipated by the resistors in these two cases compare?
   (A) It is greater for the series connection.
   (B) It is greater for the parallel connection. 8)_____
   (C) It is the same for both connections.
   (D) It is different for each connection, but one must know the values of R_1 and R_2 to know which is greater.
   (E) It is different for each connection, but one must know the value of ε to know which is greater.

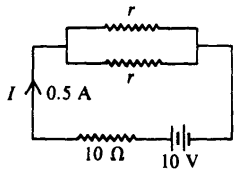
Questions 9 – 11 relate to the following circuit diagram which shows a battery with an internal resistance of 4.0 ohms connected to a 16-ohm and a 20-ohm resistor in series. The current in the 20-ohm resistor is 0.3 amperes



9. What is the emf of the battery? 9)_____
   (A) 1..2 V (B) 6.0 V (C) 10.8 V (D) 12.0 V (E) 13.2 V

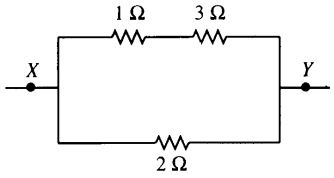
10. What is the potential difference across the terminals X and Y of the battery? 10)_____
    (A) 1.2 V (B) 6.0 V (C) 10.8 V (D) 12.0 V (E) 13.2 V

11. What power is dissipated by the 4-ohm internal resistance of the battery? 11)_____
    (A) 0.36 W (B) 1.2 W (C) 3.2 W (D) 3.6 W (E) 4.8 W



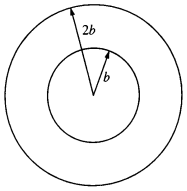
12. In the circuit shown above, the value of r for which the current I is 0.5 ampere is
(A) 0 Ω (B) 1 Ω (C) 5 Ω (D) 10 Ω (E) 20 Ω 12)_____

Questions 13 – 14 refer to the following diagram that shows part of a closed electrical circuit.



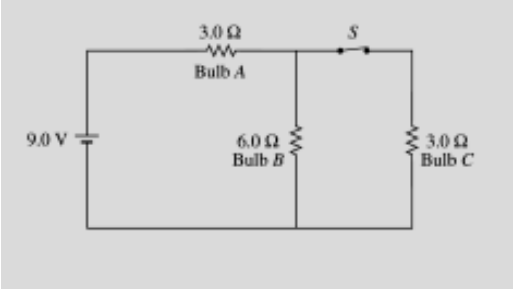
13. The equivalent electrical resistance of the part of the circuit shown between point X and point Y is
a. 4/3 Ω b. 2 Ω c. 2.75 Ω d. 4 Ω e. 6 Ω
13)_____

14. When there is a steady current in the circuit, the amount of charge passing a point per unit of time is
a. the same everywhere in the circuit
b. greater at point X than at point Y
c. greater in the 1 Ω resistor than in the 2 Ω resistor
d. greater in the 1 Ω resistor than in the 3 Ω resistor
e. greater in the 2 Ω resistor than in the 3 Ω resistor 14)_____



Two concentric circular loops of radii *b* and *2b*, made of the same type of wire, lie in the plane of the page, as shown above.

15) The total resistance of the wire loop of radius *b* is *R*. What is the resistance of the wire loop of radius *2b* ?
a. *R/4* b. *R/2* c. *R* d. *2R* e. *4R* 15)_____



1) Lightbulbs of fixed resistance 3Ω and 6Ω, a 9.0 V battery, and a switch S are connected as shown in the schematic diagram above. The switch S is closed.

a) calculate the current in bulb A a)_____

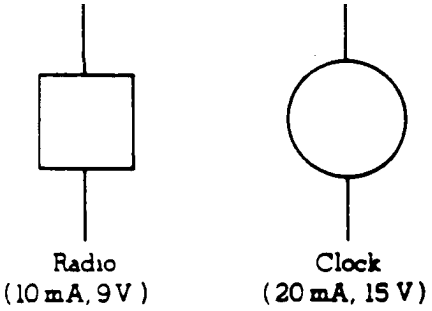
b) Which lightbulb is brightest? Justify your answer b)_____

c) Switch S is then opened. by checking the appropriate spaces below, indicate whether the brightness of each lightbulb increases, decreases or remains the same. Explain your reasoning for each bulb.

i. Bulb A: The brightness _____increases _____decreases _____remains the same
Explain

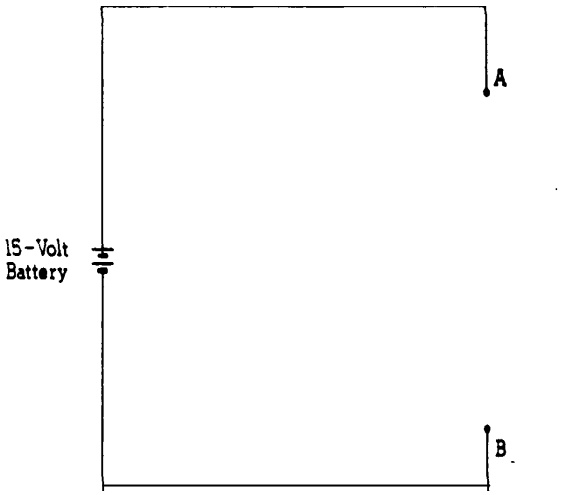
ii. Bulb B: : The brightness _____increases _____decreases _____remains the same
Explain

ii. Bulb C: : The brightness _____increases _____decreases _____remains the same
Explain



2) A cabin contains only two small electrical appliances: a radio that requires 10 milliamperes of current at 9 volts, and a clock that requires 20 milliamperes at 15 volts. A 15-volt battery with negligible internal resistance supplies the electrical energy to operate the radio and the clock.

a. Complete the diagram below to show how the radio, the clock, and a single resistor R can be connected between points A and B so that the correct potential difference is applied across each appliance. Use the symbols in the diagram above to indicate the radio and the clock.

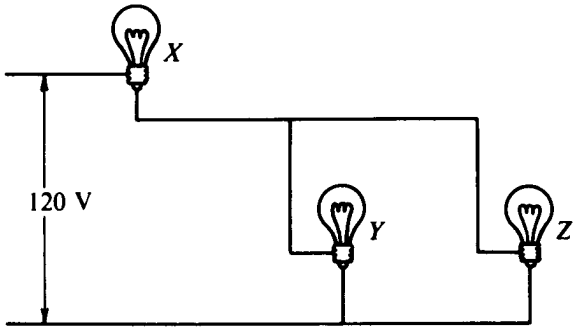


b. Calculate the resistance of R.

b)_____

c. Calculate the electrical energy that must be supplied by the battery to operate the circuits for 1 minute.

c)_____



3) In the circuit shown above, X, Y. and Z represent three light bulbs, each rated at 60 watts, 120 volts. Assume that the resistances of the bulbs are constant and do not depend on the current.

a. What is the resistance of each bulb?

a)_____

b. What is the equivalent resistance of the three light bulbs when arranged as shown?

b)_____

c. What is the total power dissipation of this combination when connected to a 120-volt source as shown?

c)_____

d. What is the current in bulb X ?

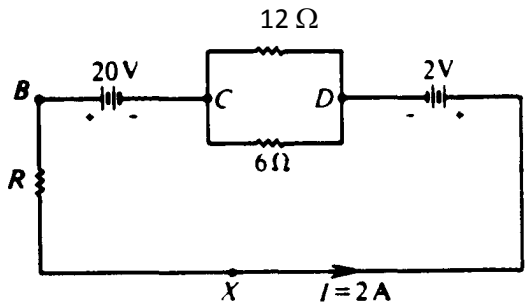
d)_____

e. What is the potential difference across bulb X ?

e)_____

f. What is the potential difference across bulb Z ?

f)_____



4) The circuit shown above is constructed with two batteries and three resistors. The connecting wires may be considered to have negligible resistance. The current I is 2 amperes.

a. Calculate the resistance R.

a)_____

b. Calculate the current in the
   i. 6-ohm resistor

i)_____

   ii. 12-ohm resistor

ii)_____

c. The potential at point X is 0 volts. Calculate the electric potential at points B. C, and D in the circuit.

_____

_____

_____

d. Calculate the power supplied by the 20-volt battery.

d)_____

5) A certain light bulb is designed to dissipate 6 watts when it is connected to a 12-volt source.

a. Calculate the resistance of the light bulb.

a)_____

b. i. If the light bulb functions as designed and is lit continuously for 30 days, how much energy is delivered to the bulb? Be sure to indicate the units in your answer.

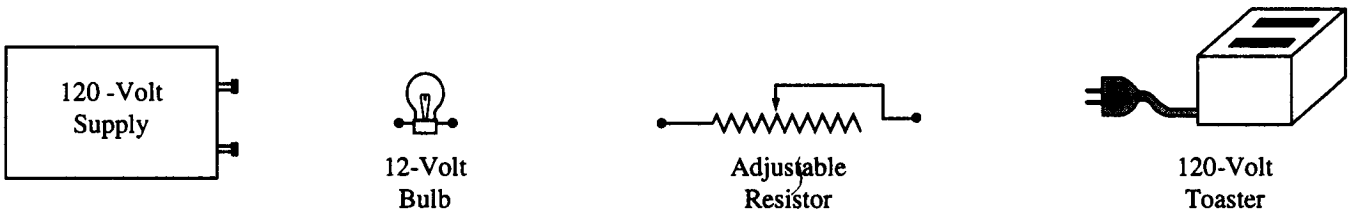
i.)_____

ii. assuming that the bulb gives off 8 MJ of light and heat energy in the 30 days calculate the efficiency of the light bulb

ii)_____

The 6-watt, 12-volt bulb is connected in a circuit with a 1,500-watt, 120-volt toaster; an adjustable resistor; and a 120-volt power supply. The circuit is designed such that the bulb and the toaster operate at the given values and, if the light bulb fails, the toaster will still function at these values.

c. On the diagram below, draw in wires connecting the components shown to make a complete circuit that will function as described above.



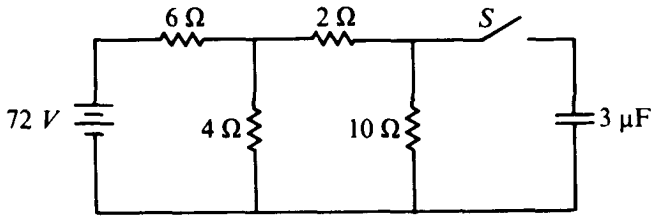
d. Determine the value of the adjustable resistor that must be used in order for the circuit to work as designed.

d)_____

e. If the resistance of the adjustable resistor is increased, what will happen to the following?

i. The brightness of the bulb. _____
Briefly explain your reasoning.

ii. The power dissipated by the toaster. _____
Briefly explain your reasoning.



6) The circuit shown above includes a switch S, which can be closed to connect the 3-microfarad capacitor in parallel with the 10-ohm resistor or opened to disconnect the capacitor from the circuit.

Case 1: Switch S is open. The capacitor is not connected. Under these conditions determine:

a. the current in the battery a)_____

b. the current in the 10-ohm resistor b)_____

c. the potential difference across the 10-ohm resistor c)_____

Case II: Switch S is closed. The capacitor is connected. After some time, the currents reach constant values. Under these conditions determine:

d. the charge on the capacitor

d)_____

e. the energy stored in the capacitor

e)_____