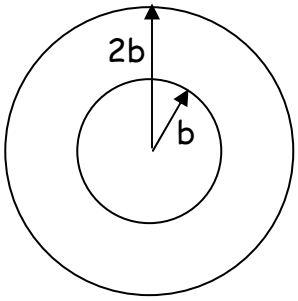
A.P. Physics – C

Unit 9 Test Review

Electric Circuits: Chapters 26-27

Multiple Choice Review: On this portion of the test, you will not be allowed to use your calculator or AP formula sheet. (You may, however, use your AP table of information.) Approximate $g=10 m/s^2$ for simplicity of calculations. No partial credit will be given.

1. 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. If the total resistance of the b-radius loop is R, what is the resistance of the 2b-radius loop?



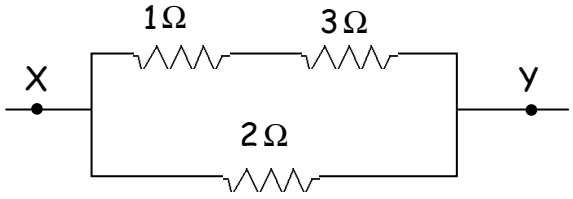
a. R/4
b. R/2
c. R
d. 2R
e. 4R

2. How much does it cost to operate a 60W light bulb for 600 minutes, if energy costs 10 cents per kilowatt-hour?

a. 6 cents
b. 10 cents
c. 36 cents
d. 60 cents
e. $3.60

3. Three resistors are connected as shown in the diagram. What is the electrical resistance of the part of the circuit shown?

a. $4/3\,\Omega$
b. $2\,\Omega$
c. $2\,\frac{3}{4}\,\Omega$
d. $4\,\Omega$
e. $6\,\Omega$



4. If the group of resistors in the previous problem is attached to a source of emf, the amount of charge passing a point per unit of time is…

a. the same everywhere in the whole circuit.
b. greater at point X than at point Y.
c. greater in the $1\,\Omega$ resistor than in the $2\,\Omega$ resistor.
d. greater in the $1\,\Omega$ resistor than in the $3\,\Omega$ resistor.
e. greater in the $2\,\Omega$ resistor than in the $3\,\Omega$ resistor.

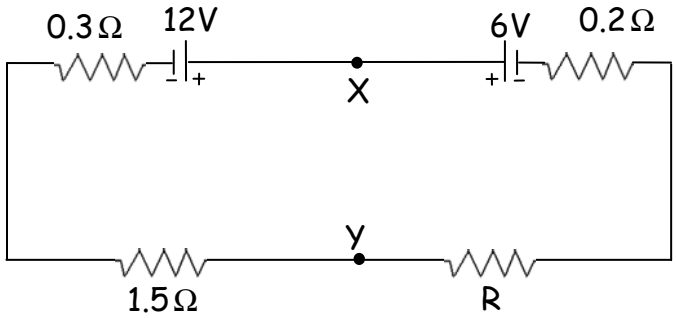
5. A wire of length L and radius r has a resistance R. What is the resistance of a second wire made from the same material that has length L/2 and radius r/2?

a. 4R **b.** 2R **c.** R **d.** R/2 **e.** R/4

6. Which of the following is NOT true about a circuit (containing a battery) with a 100W light bulb (resistor) connected in series with a 60W light bulb?

a. If one bulb burns out, they'll both go out.
b. The voltage across each bulb is different.
c. The equivalent resistance of the circuit is less than that of either bulb.
d. The current in each bulb is the same.
e. The 60W bulb is brighter than the 100W bulb.

Questions #7-9: In the circuit shown below, the emf's and the resistances have the values shown. The current I in the circuit is 2 amperes.



7. The resistance R is…

a. 1Ω **b.** 2Ω **c.** 3Ω **d.** 4Ω **e.** 6Ω

8. The potential difference between points X and Y is…

a. 1.2 V **b.** 6.0 V **c.** 8.4 V **d.** 10.8 V **e.** 12.2 V

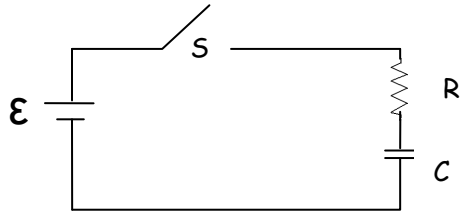
9. How much energy is dissipated by the 1.5-ohm resistor in 60 seconds?

a. 6 J **b.** 180 J **c.** 360 J **d.** 720 J **e.** 1440 J

10. A certain battery has an emf of 12V and internal resistance of 2Ω. If this battery is connected to a circuit in such a way that a current of 0.3A flows through the circuit, what is the terminal voltage of the battery?

a. 11.4V **b.** 11.7V **c.** 12V **d.** 12.3V **e.** 12.6V

11. In the circuit shown to the right, the capacitor is initially uncharged. At time t=0, switch S is closed. The natural logarithmic base is e. Which of the following is true at time t=RC?



a. The current is $\mathcal{E}/eR$.

b. The current is $\mathcal{E}/R$.

c. The voltage across the capacitor is $\mathcal{E}$.

d. The voltage across the capacitor is $\mathcal{E}/e$.

e. The voltages across the capacitor and resistor are equal.

Problem Review: On this portion of the test, you may use your calculator, AP formula sheet, and AP table of information. Partial credit will be given on these problems.

12. A current of 15 A exists in a wire. How many seconds does it take for 8.0×10^{20} electrons to flow through a given cross section of the wire?

13a. How much resistance is present in a 240V generator dissipating 120 kW of power?

b. How much energy is dissipated by the resistance in the generator over the course of 4 minutes?

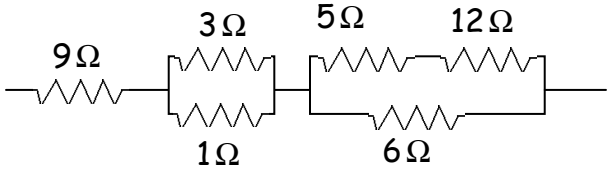
14a. Calculate the cross-sectional area of a 2.00cm length of tungsten filament in a small lightbulb if a potential difference of 120V sets up a current in it of 0.24A. (Tungsten's resistivity is $5.6 \times 10^{-8}\ \Omega m$.)

b. Calculate the current density in the filament.

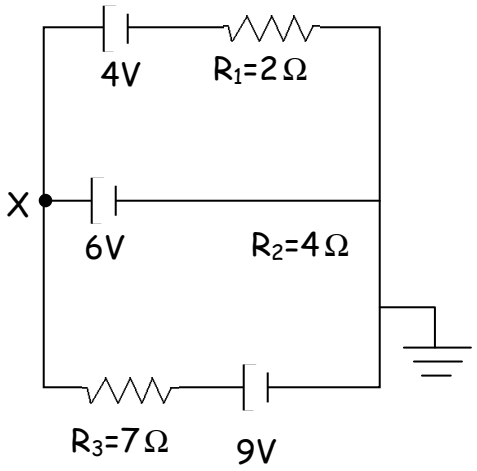
c. Calculate the strength of the electric field in the filament.

15. A 0.52A current exists in a copper wire whose diameter is 2.9mm. If the number of charge carriers per unit volume is $8.49 \times 10^{28}\ m^{-3}$, calculate the drift velocity of the electrons in the copper wire.

16. Use the rules for resistors connected in parallel and series (not Kirchoff's rules) to calculate the current through the 5Ω resistor in the figure, when the complex circuit is attached to a 12V battery.



17. Use Kirchoff's rules to find the size and direction of the current through R_1, and also the potential at point X.



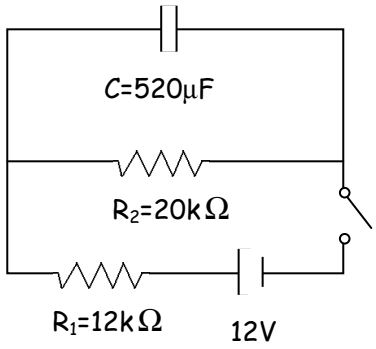
18. A 35nF capacitor is initially uncharged when it is placed in series with a 200MΩ resistor.

a. When the resistor-capacitor combination is connected across a 12V battery, how much time is required for the potential difference across the capacitor to reach 9V?

b. How much charge is stored in the capacitor at that time?

c. The capacitor is allowed to charge fully, and then the battery is removed at time t=0. What is the charge stored by the capacitor at time t=4.2s?

19. The circuit in the given figure is constructed with C initially uncharged. The switch is closed at time t=0.



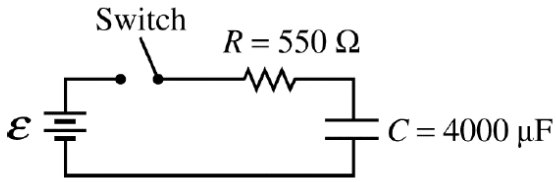
a. At time t=0, find the current through both resistors.

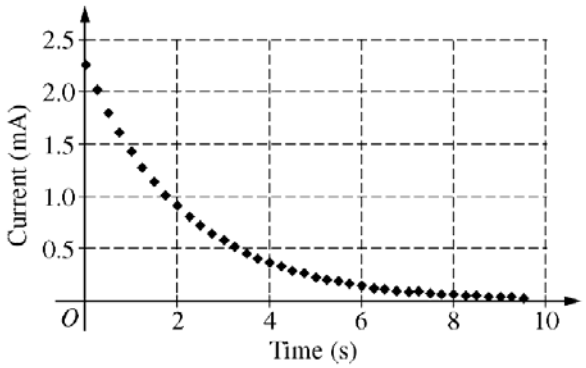
b. At time t=∞, find the current through both resistors.

c. At time t=∞, find the charge on the capacitor.

20. Actual A.P. Physics C Free-Response Question (2007):

A student sets up the circuit shown to the right during a lab experiment. The values of the resistance and capacitance are as shown, but the constant voltage **ℰ** delivered by the ideal battery is unknown. At time t=0, the capacitor is uncharged and the student closes the switch. The current as a function of time is measured using a computer system, and the following graph is obtained.





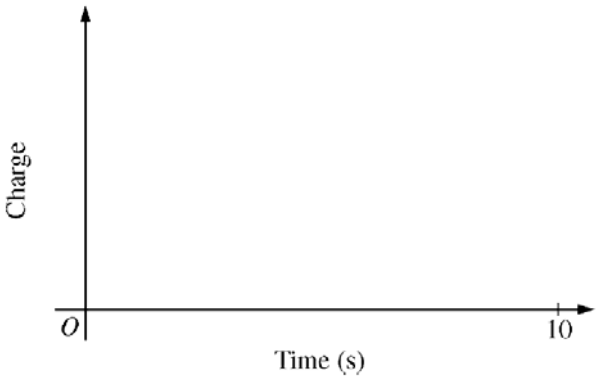
a. Using the data above, calculate the battery voltage **ℰ**.

b. Calculate the voltage across the capacitor at time t=4.0 s.

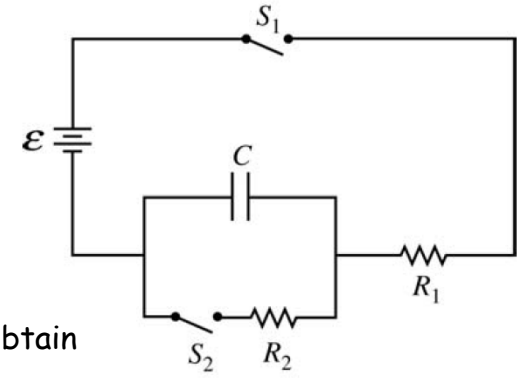
c. Calculate the charge on the capacitor at time t=4.0 s.

d. On the axes to the right, sketch a graph of the charge on the capacitor as a function of time.

e. Calculate the power being dissipated as heat in the resistor at time t=4.0s.



21. Actual A.P. Physics C Free-Response Question (2006):



The circuit shown to the right contains a capacitor of capacitance C, a power supply of emf $\mathcal{E}$, two resistors of resistances R_1 and R_2, and two switches, S_1 and S_2. Initially, the capacitor is uncharged and both switches are open. Switch S_1 then gets closed at time t=0.

a. Write a differential equation that can be solved to obtain the charge on the capacitor as a function of time t.

b. Solve the differential equation in part a to determine the charge on the capacitor as a function of time t.

c. Numerical values for the components are given as follows:

$\mathcal{E}$ = 12V C = 0.06F $R_1 = R_2$ = 4700Ω

Determine the time at which the capacitor has a voltage 4.0 V across it.

d. After switch S_1 has been closed for a long time, switch S_2 gets closed at a new time t=0. On the axes below, sketch graphs of the current, I_1 in R_1 versus time and of the current I_2 in R_2 versus time, beginning when switch S_2 is closed at new time t=0. Clearly label which graph is I_1 and which is I_2.