**Electrostatics and Circuits**

Electrostatics in AP Physics 1 covers charging by conduction and induction, polarization, conservation of charge, and the coulomb force.

The conservation of charge does not state that charge is never created or destroyed, but that the net charge of a closed system does not change. The conservation of charge states that a net charge can neither be created nor destroyed. Charges are created or destroyed in nuclear reactions involving the weak force and in antimatter interactions. In normal situations of "charging" objects, charge is neither created nor destroyed, just moved from one object to another. The charges that move in these situations are always electrons--protons are in the nucleus and moving them would require a nuclear reaction.

Circuits for AP Physics 1 are basic resistor circuits--series, parallel and combinations of the two. A lot of questions on the exam are "what would happen to other parts of the circuit if bulb x were removed."

The best way to approach these is by looking at what happens to the total resistance in part of a circuit when another element is added in parallel. The resistance of that part of the circuit decreases, the resistance of the entire circuit decreases, and the total current increases or becomes series (that part of the circuit increases in resistance, the total resistance increases, and the total current decreases). Any circuit element that is in series with the battery will receive the full current of the circuit.

**Multiple Choice:**

1. Two small spheres have equal charges q and are separated by a distance d. The force exerted on each sphere by the other has magnitude F. If the charge on each sphere is doubled and d is halved, the force on each sphere has magnitude
2. F
3. 2F
4. 8F
5. 16F
6. A person rubs a neutral comb through their hair and the comb becomes negatively charged. Which of the following is the best explanation for this phenomenon?
7. The hair gains protons from the comb.
8. The hair gains protons from the comb while giving electrons to the comb.
9. The hair loses electrons to the comb.
10. The comb loses protons to the person’s hand while also gaining electrons from the hair.

Questions 3-4: A negatively charged PVC pipe is held near a neutral aluminum can that is at rest on a level surface but doesn’t touch it.

1. Which diagram best shows the distribution of charge inside the aluminum can?

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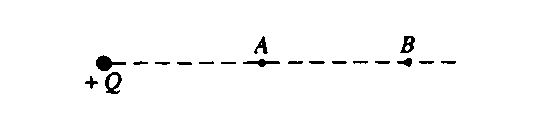
a)

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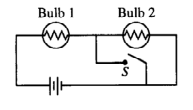
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1. If the can were free to move, which direction would it move?
2. it would not move
3. towards the charged PVC pipe
4. away from the charged PVC pipe
5. more information is needed
6. Which of the following regarding the property of an object called charge is true?
7. charge cannot be created
8. there is only one type of charge
9. there are infinite types of charge
10. the net charge of a closed system is constant

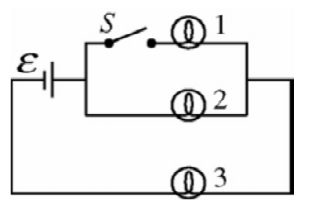


1. The diagram provided shows an isolated, positive charge, Q. Point B is twice as far away from Q as point A. A small positive test charge, +q, is placed first at A and then at B. The ratio of the electric force strength at A to the electric force strength at B is
2. Field at B = ¼ Field at A
3. Field at B = ½ Field at A
4. Field at B = 2 Field at A
5. Field at B = 4 Field at A
6. When two resistors with resistance R1 and R2 are connected in parallel, the equivalent resistance of the combination is 5 Ω. Which of the following statements about the resistances is correct?
7. One of the resistances is greater than 5 Ω, and one of the resistances is less than 5 Ω.
8. Both R1 and R2 are greater than 5 Ω.
9. Both R1 and R2 are less than 5 Ω.
10. Both R1 and R2 are equal to 5 Ω.
11. The circuit in the figure shown contains two identical lightbulbs in series with a battery. At first, both bulbs glow with equal brightness. When switch S is closed, which of the following occurs to the bulbs?



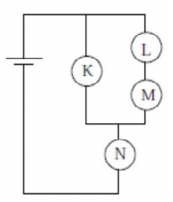
*Bulb 1 Bulb 2*

1. Goes out Gets brighter
2. Gets brighter Goes out
3. Gets brighter Gets slightly dimmer
4. Gets slightly dimmer Gets brighter



1. The three light bulbs in the circuit shown are identical, and the battery has zero internal resistance. When switch S is closed to cause Bulb 1 to light, which of the other two bulbs increase in brightness?
2. Both Bulb 2 and Bulb 3
3. Bulb 3 only
4. Bulb 2 only
5. Neither bulb

Questions 10-12 refer to the following circuit:



1. Four identical light bulbs K, L, M, and N are connected in the electrical circuit as shown. Rank the current through the bulbs from greatest to least.
2. N > L = M > K
3. N > K > L = M
4. L = M > K = N
5. L > M > K > N
6. Bulb K burns out. Which of the following statements is true?
7. Bulb N becomes dimmer but does not go out.
8. The brightness of bulb N remains the same.
9. Bulb N becomes brighter.
10. All the bulbs go out.
11. Bulb M burns out. Which of the following statements is true?
12. Bulb N goes out but at least one other bulb remains lit.
13. The brightness of bulb N remains the same.
14. Bulb N becomes dimmer but does not go out.
15. All the bulbs go out.
16. A positively charged conductor attracts a second object. Which of the following statements could be true? Select two answers.
17. The second object is a conductor with positive net charge.
18. The second object is a conductor with zero net charge.
19. The second object is an insulator with zero net charge.
20. The second object is an insulator with positive net charge

**Free Response:**

1. Some students want to know what gets used up in an incandescent light bulb when it is in series with a resistor: current, energy, or both. They come up with the following two questions.

(1) In one second, do fewer electrons leave the bulb than enter the bulb?

(2) Does the electric potential energy of electrons change while inside the bulb?

The students have an adjustable power source, insulated wire, light bulbs, resistors, switches, voltmeters, ammeters, and other standard lab equipment. Assume that the power supply and voltmeters are marked in 0.1 V increments and the ammeters are marked in 0.01 A increments.

1. Describe an experimental procedure that could be used to answer questions (1) and (2) above. In your description, state the measurements you would make and how you would use the equipment to make them. Include a neat, labeled diagram of your setup.

b)

1. Explain how data from the experiment you described can be used to answer question (1) above.
2. Explain how data from the experiment you described can be used to answer question (2) above.

A light bulb is nonohmic if its resistance changes as a function of current. Your setup from part (a) is to be used or modified to determine whether the light bulb is nonohmic.

c)

1. How, if at all, does the setup need to be modified?
2. What additional data, if any, would need to be collected?
3. How would you analyze the data to determine whether the bulb is nonohmic? Include a discussion of how the uncertainties in the voltmeters and ammeters would affect your argument for concluding whether the resistor is nonohmic.