Batteries and Circuit Elements
Challenge Problems

Problem 1:

(a) If charges flow very slowly through a metal, why does it not require several hours for light to come on when you throw a switch?

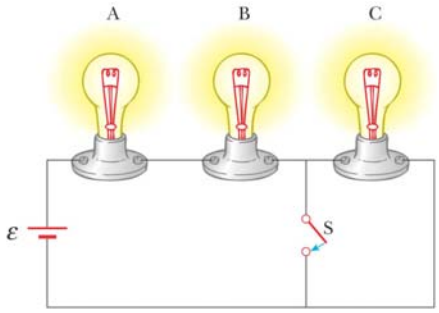
(b) What advantage does 120-V operation offer over 240 V? What are the disadvantages?

(c) Why is it possible for a bird to stand on a high-voltage wire without getting electrocuted?

(d) If your car's headlights are on when you start the ignition, why do they dim while the car is starting?

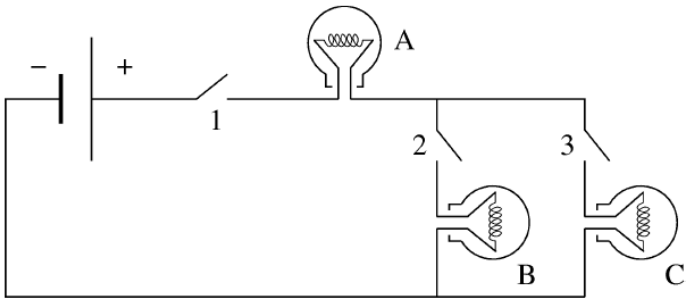
(e) Suppose a person falling from a building on the way down grabs a high-voltage wire. If the wire supports him as he hangs from it, will he be electrocuted? If the wire then breaks, should he continue to hold onto the end of the wire as he falls?

(f) A series circuit consists of three identical lamps connected to a battery as shown in the figure below. When the switch S is closed, what happens to the brightness of the light bulbs? Explain your answer.



Problem 2:

The circuit below consists of a battery (with negligible internal resistance), three incandescent light bulbs (A, B & C) each with exactly the same resistance, and three switches (1, 2, & 3). In what follows, you may assume that, regardless of how much current flows through a given light bulb, its resistance remains unchanged. Assume that when current flows through a light bulb that it glows. The higher the current, the brighter the light will be.



In each situation (a, b, c) as described below, we want to know which light bulbs are glowing (and which are not) and how bright they are (relative to each other). *Always briefly discuss your reasoning.*

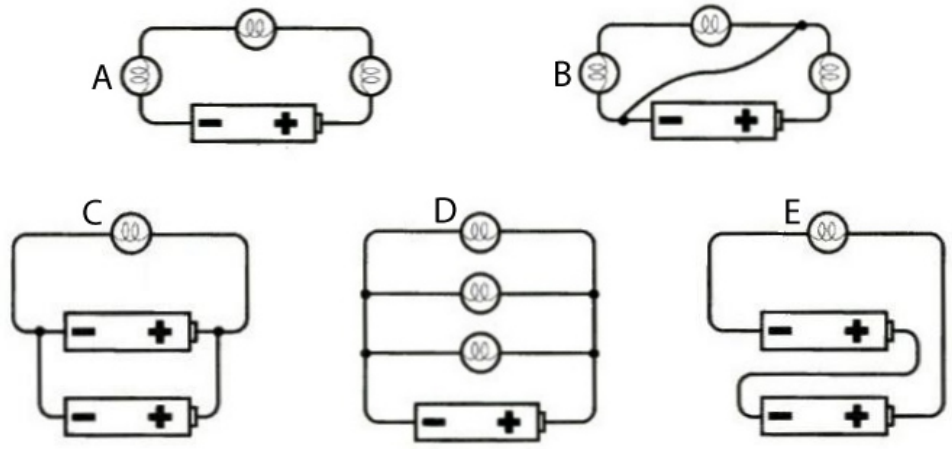
a. Switch #1 is closed; the others are open.
b. Switches #1 & #2 are closed; #3 is open
c. All three switches are closed
d. Now compare situations a, b & c. Which bulb is brightest of all, and which is faintest of all (bulbs which are off don't count).

Now replace bulb A by a wire of negligible resistance. We still have three switches and now two light bulbs (B & C).

e. Answer the questions b through d again for this situation.

Problem 3:

What is the correct order for the *total power* dissipated in the following circuits, from least to greatest? Assume all bulbs and all batteries are identical. Ignore any internal resistance of the batteries.



a) A < B = C < D < E

b) D < C < B = E < A

c) D < B < E < A < C

d) A = B < D < C < E

e) B < A < C = D < E

8.02SC Physics II: Electricity and Magnetism

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