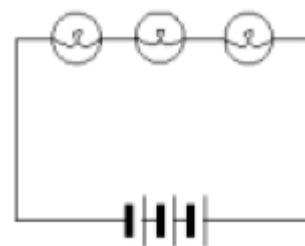


Here's a circuit for you to consider, and I'm going to ask you to try to think about it in several ways. Each of the batteries is a 1.5 V battery, and the bulbs are all identical. (These both depict the same circuit. The overall question here is this: Which bulb, if any, would be the brightest? But I want you to answer it from three different ways of thinking about electricity.



a) Sometimes people think the reason there are two connections to the batteries is because a positive current flows out of one end and a negative current flows out of the other. It's when they hit each other that you get light. (Ampere had an idea just like that, in the early 1800s, known as Ampere's model of clashing currents.) How would someone thinking in this way answer the question?

b) In lecture we talked about an analogy to pulling a rope: Charge is like rope, moving charge is like moving rope, a battery is like someone pulling the rope to try to make it move, and a bulb is like something the rope rubs as it passes. How would someone using that analogy answer the question?

c) We also talked about an analogy to flowing air: Charge is like air, moving charge is like moving air, a battery is like an air pump with a high pressure output and low pressure input, and a bulb is like a whistle that constricts the flow of air a little. How would someone using that analogy answer the question?

d) Now consider the model we discussed in class: metal consists of a fixed array of positive ions with an equal density of loose electrons so the overall metal is neutral. When an electric force is exerted on the material, the electrons flow in the metal like an incompressible fluid (something like water in a pipe). How would someone using this model answer the question?

e) When you were asked a similar question in tutorial (part II) with two bulbs, what was your intuition? Did you think one or the other of the bulbs would be brighter? Did your intuition correspond to one of the four models above or to something else? If something else, describe your reasoning. (If you didn't get to this part of the tutorial, read it over now and see what your intuition tells you.)

f) Were you surprised when you saw that the bulbs were of equal brightness? (If you didn't get to this part of the tutorial, if the bulbs are indeed identical, they will be of equal brightness when connected in series.) If so, were you able to reconcile your intuition with what you saw? Explain how or why not.