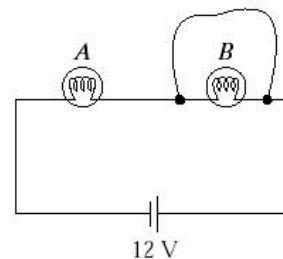


Physics 122, section 5 – Mini quiz 2 - Feb 27 Solution  
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In all of these questions we use the fact that battery brightness is related to current.

- 1) Two light bulbs  $A$  and  $B$  are connected in series to a battery that maintains a constant voltage. When a wire is connected across  $B$  as shown, bulb  $A$

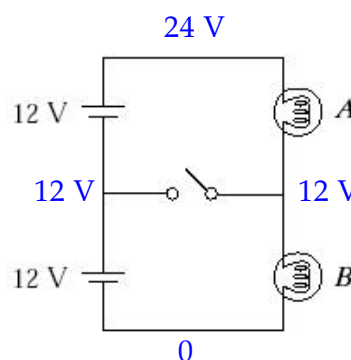
- a) burns more brightly.
- b) burns as brightly.
- c) burns more dimly.
- d) goes out.



Initially, the sum of the voltage drops across the two bulbs must equal  $12\text{ V}$  by Kirchoff's rule and by our understanding of how pressure differences are necessary for current to flow through a resistor. When the wire is added across  $B$ , it goes out since there can be no pressure/voltage drop in a wire. Now the full  $12\text{V}$  voltage drop is happening at  $A$ , so it must now have a higher current and thus be brighter. If the bulbs are identical, the voltage drops across the two are identical ( $6\text{V}$  each), so that with the wire, the voltage drop across  $A$  doubles, as does the current. It's like suddenly I only have one straw instead of two in series, so I get more current.

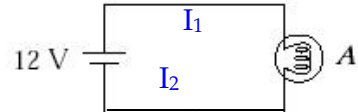
- 2) The light bulbs in the circuit are identical. When the switch is closed,

- a) both bulbs increase in brightness.
- b)  $A$  gets brighter,  $B$  dimmer.
- c)  $B$  gets brighter,  $A$  dimmer.
- d) both bulbs get dimmer or go out.
- e) nothing changes.



Before we close the switch, we could approach this problem by letting the bottom wire have zero voltage. This means between the two batteries there has been a rise of  $12\text{ V}$  to  $12\text{ V}$ . Crossing the second battery to the top wire gives another  $12\text{ V}$  rise to  $24\text{ V}$ . We know by Kirchoff's rule (come back to where we started) that crossing both batteries has to get us back down to zero, so the drops must be equal across the two, or  $-12\text{ V}$  each. This makes the wire between the two batteries at  $12\text{ V}$ . Thus, when you close the switch, no current needs to flow. Remember, the batteries aren't sources of current. They're just little systems that try to maintain a voltage difference across them. They CAN provide current to do this if necessary, but won't if they don't need to.

You could also figure this out by doing Kirchoff's loop rules with the switch closed. Looking at the top loop, with one battery and one bulb, we see that summing voltage changes around the loop,  $+12\text{ V} - \Delta V_A = 0$ , which tells us that the voltage drop across A is still  $12\text{ V}$ , the same as before. The same is true for B. This means the currents through A and B are the same, so by Kirchoff's junction rule (currents in = currents out) that  $I_2$  is 0.



- 3) If all the bulbs are identical, then you'd expect
- a) bulb B would be the brightest, A and C would be equal and next brightest, and D would be the dimmest.
  - b) bulbs A and C would be equal and brighter than B and D, which would be equal.
  - c) bulbs B and D would be equal and brighter than A and C, which would be equal.
  - d) bulb B would be the brightest, and A, C, and D would all be equally bright.
  - e) all bulbs would be equally bright

We know that B and D must be the same since the current that flows through D must flow through the battery and through B without change (continuity - think of rope...) A and C must have less current than B and D because they have to share what B and D have (the current splits at the junction.)

