Lecture S5 Muddiest Points

General Comments

Today, we finished up one PRS question (the first one on light bulbs), and did another similar one. The point of these questions is to get you to think about circuits in terms of potentials. Many students found these questions challenging, which is good — I need to challenge you preconceptions in order to change them.

Responses to Muddiest-Part-of-the-Lecture Cards

(45 cards)

1. ***How do we know if a battery is absorbing or supplying power? (1) How does the 12 V battery in the PRS question absorb power? (1)*** For any circuit element with current i and voltage v, the element is dissipating or absorbing power if $iv > 0$; the element is supplying power if $iv < 0$. But to make this work, you *must* use the passive sign convention, which requires that you label i as going into the + terminal (or out the − terminal).

2. ***I can't do the KVL equation for complex loops. (1)*** There is plenty of practice on the homework. Please see me at office hours if there is a problem.

3. ***In the PRS question, you sad that the battery* forces *the node voltage to be 12 V. What do you mena by "force"? (1)*** The constitutive law of the battery (a voltage source, really) is that the voltage across its terminals must be exactly the source strength, in this case 12 V. Since the − terminal is at ground, the + terminal is at exactly 12 V. When the switch is closed, the middle node is at the same potential as the + terminal, so it must be at 12 V. Using the word "force" is a bit of colorful language to make this point.

4. ***Muddy point: How to deal with split currents in KVL in the last concept question. (1)*** Not sure I understand the question — please ask again, or see me at office hours or recitation.

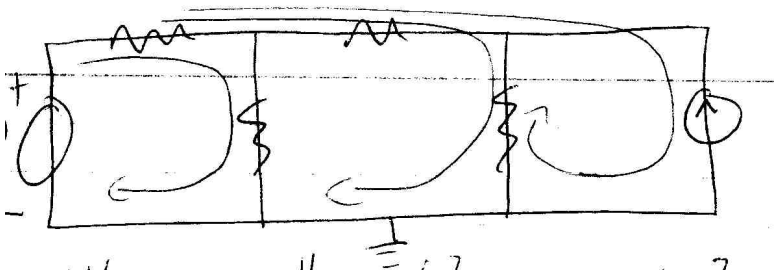
5. ***In the first PRS question, how do you apply KCL at the junction between the two bulbs? (1)*** The sum of currents out of the node sum to zero. Since the current into the node through bulb A is the same as the current out of the node through bulb B, KCL is satisfied only if there is no current through the switch and battery.

6. ***In the PRS question, wouldn't the 12 V battery explode with such a large back current applied to it? (1)*** But you don't know how large the current is, since I didn't tell you the constitutive law of the bulbs! It would also depend on the type of battery — is it rechargable or not. So it might or might not "explode," depending on the actual circumstances.

7. ***In the PRS question, how do you know that the current coming into B and C is less than that through A? (1)*** Before the switch is closed, the currents are the same (as

required by KCL). After the switch is closed, the current through B and C decrease, because the voltage across them is decreased, and they act a little like resistors — less voltage implies less current. Also after the switch is closed, the voltage across A increases, so the current through A increases.

8. ***Is this allowed [when using the loop method]:***



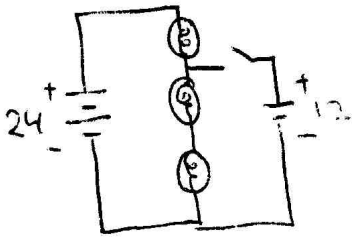
(1 person) No. Each loop current in the loop method must be a loop. Each loop must begin and end at the same place, like an "O". Your loop currents here look more like a "6" than an "O."

9. ***What is the most complex circuit we will get? (1)*** Hard to say. It would be impractical, say, to solve a 5×5 problem on a quiz by hand. But you could set up such a problem.

10. ***How can i_1 go in one direction if i_2 goes in the other direction (refering to the diagram on the board)? (1)*** I assume you mean in the case when element 1 and element 2 are in series? We can label i_1 as being out of a node, and i_2 as being out of the same node. KCL then requires one be negative, and the other be positive. You have to distinguish the labeling (which is largely arbitrary) from the physical currents.

11. ***Do voltages from batteries or voltage sources alwaays take precedence in a circuit, as in the PRS question? (1)*** Yes, in the following sense: The voltage across a voltage source is always exactly the source strength. That's what the constitutive law of a voltage source says it does. So in that sense, it takes precedence.

12. ***In this circuit, what would happen if you flipped the 12 V battery? Where would ground be?***



(1 person) Ground is any node you define to be the ground node. I would pick the bottom node, because (1) it is the only node common to both batteries; (2) it's at the bottom — sometimes this is helpful; and (3) why not?

13. ***Guess I'm having a hard time understanding how bulb A gets brighter* and *the battery absorbs power. (1) I'm unclear how power is transferred in a circuit. How would you explain the power transfer in the second concept question using equations? (1)*** Bulb A gets brighter (dissipates power) and the 12 V battery absorbs power. This would violate the first law if this is all that happened, but it isn't. The 24 V battery supplies more power, and bulbs B and C dissipate less power than before the switch is closed. The net change in power dissipation / absorption is zero.

    As to the second question, the power absorbed or dissipated by any element in the circuit is iv. It can be shown fairly easily that for any circuit which obeys Kirchhoff's laws,

$$\sum_n i_n v_n = 0 \tag{5}$$

    This result is known as *Tellegen's theorem*. The point is this: In order for the sum to be zero, any dissipation or power absorbtion ($iv > 0$) in the circuit must be balanced against other elements supplying power ($iv < 0$).

14. ***What is the symbol that is a circle with an arrow in the middle? (1)*** It is a *current source*. Its constitutive law is that $i = I$ for all v. (I is the source strength, usually labelled right next to the arrow.)

15. ***Don't understand how you determined that there were 4 nodes in the 3 loop circuit. (1)*** A node (or junction) is a point in the circuit where two or more circuit elements are joined. I just looked for all those points, and counted. I will discuss again in class tomorrow, for clarity.

16. ***Could you please go over the basic assumptions one more time, i.e., moving from + to − is a negative/positive current, etc. (1)*** Please see the Lecture S2 muddy points.

17. ***In 8.02, we had to worry about bigger loops crossing over nodes. Can we still use bigger loops in the more complex circuits? (1)*** If I understand you question correctly, the answer is yes. The loop method works for any circuit. It is sometimes a little more diffiuclt to apply for largere circuits with crossovers.

18. ***Please explain the reasoning behind today's last PRS question. (1)*** Within a day or so, I will have the PRS question part of my web site up.

19. ***I don't understand the loop method. (1)*** We will discuss again in the next lecture.

20. ***Loop method is out of control! (1)*** What does this mean?

21. ***No mud. (25)*** Good! I think that the second light bulb question may have cleared a lot up today. There were some comments: ***"I think we are putting too much emphasis on concept questions per lecture. We only need to do a question once and explain it, not several times. We can do more on our own time."*** That was balanced somewhat by ***"Good speed today; Great PRS questions."*** Also, there was this: ***"What was helpful was the extra concept test to help understand the circuit."*** On balance, I think that it is more important to use my time in class where it adds the most value, and that is often helping with conceptual problems. Last year, I did just the light bulb concept test with the two light bulbs. On the test, I asked the concept question

with the three light bulbs, and the results were very poor. So this year, I asked two concept questions in class. I hope that this year's quiz results will prove this to be the right decision!

Also, there was this: ***Could you please not put one board on the bottom? The first few rows can't see it.*** It's a bad room for blackboards, isn't it? I'll try to keep the most recent board on top, and put the "stale" board on the bottom.