DC Circuits -- Conceptual Questions

1.) What is the difference between voltage and current?

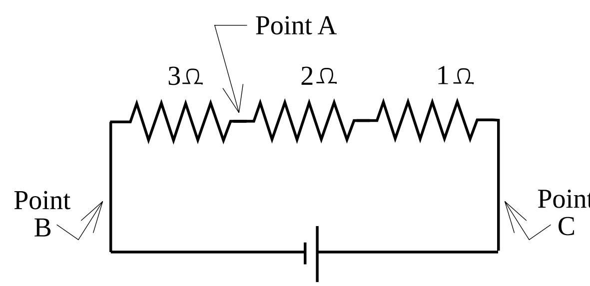
2.) A 12 ohm resistor has 2 amps of current passing through it. How much work does the resistor do on an electron moving through the resistor?

3.) There are 3 amps of current being drawn from a power supply. The circuit is comprised of three resistors as shown.

a.) In what direction will current flow in this circuit?

b.) In what direction will electrons flow in this circuit?

c.) Some might suggest that there is an apparent discrepancy between the answers to *Part a* and *b*. What is the problem, and why is this not really a discrepancy?



d.) What is the voltage across the power supply?

e.) What is the current at *Point A*?

f.) What is the voltage drop across the 2 ohm resistor?

g.) What is the net voltage across the 1 ohm and 2 ohm resistors (combined)?

h.) How would the readings differ if you put an ammeter at *Point B* versus an ammeter at *Point C*?

i.) If this were, in fact, an actual circuit you had built, what might you do if you wanted to rearrange things so that the current drawn from the power supply doubled?

4.) Your friend has built a circuit. She says that when she removes one resistor in the circuit, the current drawn from the power supply goes up.

a.) What evidently happened to the effective resistance of the circuit when the resistor was removed?

b.) Was the circuit a series or parallel combination?

5.) Your friend has built a circuit. He says that when he adds one resistor in the circuit, the current drawn from the power supply goes up.

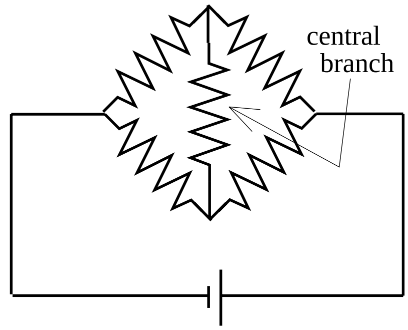
a.) What evidently happened to the effective resistance of the circuit when the resistor was removed?

b.) Was the circuit a series or parallel combination?

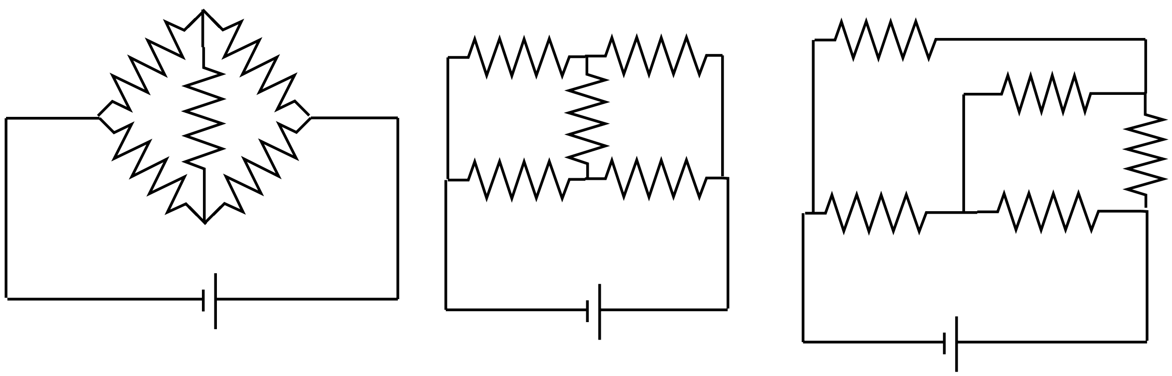
6.) What is common in series connections?

7.) What is common in parallel connections?

8.) You find that the current through the central branch of the circuit to the right is *zero*. What *must* be true of the circuit for this to be the case?



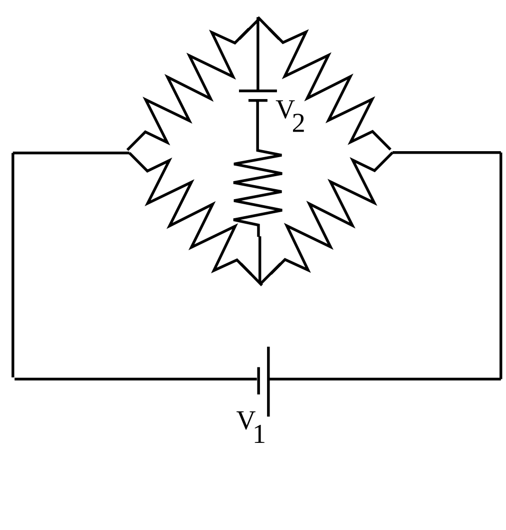
9.) If you had to determine the current being drawn from the power supply in at least one of the circuits shown below, which circuit would you pick?



10.) Charge carriers don't move very fast through electrical circuits. For instance, in a car's electrical system, charge moves at an incredibly slow 100 seconds per centimeter (that's a velocity of .01 cm/sec). So why do car lights illuminate immediately when you turn them on?

11.) You measure the resistance in a wire and find it to be R_1. You measure the resistance in a second wire that is twice as long and twice as thick (it's made of the same material) and find it to be R_2. Which resistance is larger, and by how much?

12.) For the circuit shown to the right:
- a.) How many nodes exist in the circuit?
- b.) How many branches exist in the circuit?
- c.) How many loops exist in the circuit?

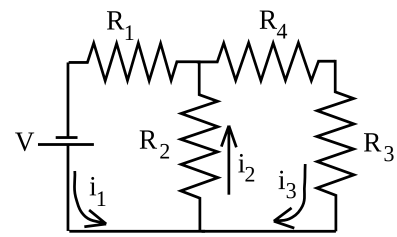


d.) How many equations would a rookie need to determine the current being drawn from the power supply V_1?

e.) What clever thing could you do that would halve the number of equations identified in *Part d*?

f.) There are two constraints placed on the equations you would need to solve for the current drawn from the power supply V_1. What are these constraints?

13.) Consider the circuit shown to the right.



a.) How many nodes are there in this circuit?

b.) How many independent node equations can you write for this circuit?

c.) Why would you expect the number in *Part a* and the number in *Part b* to be different?

d.) There are three loops available in the circuit. If you wrote out loop equations for all three loops and tried to solve them simultaneously for the current i_2, you would get *zero* as a result. This makes no sense. What's wrong? That is, why are you calculating *zero current* in a section you *know* has current flowing through it?

e.) Are R_1 and R_2 in series? Justify.

f.) Are there *any* series combinations in the circuit?

g.) Are there *any* parallel combinations in the circuit?

h.) Is there anything wrong with the circuit as it is set up? That is, have I forgotten and/or mislabeled anything? Explain.

i.) Assume all the resistors have the same resistance, say, 10 ohms, except R_4, which is twice as large. Assume you don't know V, but you do know the voltage across R_2 is 60 volts. What is the *easiest* way to determine the voltage across R_4? In fact, for the humor of it, do that calculation.

14.) The system of units generally in use in the U.S. is called *the English system of units*. What that means is that you grew up using measures like pounds, feet and inches as your standards. There are two units of measure in the world of electrical systems that you have grown up with that aren't a part of the English system of units. What are they?

15.) Without changing anything else, you double the current through a resistor. How will that affect the power being dissipated by the resistor?

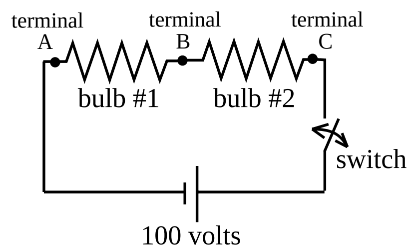
16.) You have a resistor attached to a power supply. You halve the resistance of the resistor. How will that affect the power being dissipated by the resistor?

17.) You have a resistor attached to a power supply. You halve the voltage of the power supply.

a.) How will that affect the power being provided by the power supply?

b.) How will that affect the power being dissipated by the resistor?

18.) You have a 10 watt light bulb and a 20 watt light bulb hooked in series in a circuit. Which bulb would you expect to have the greater resistance?



19.) Two light bulbs are hooked in series to a particular power supply (assume the resistance of a light bulb is *not* temperature dependent).

a.) *Bulb #1* is taken out of the circuit by putting a wire across terminals A and B. The switch is closed, and it is observed that *bulb #2* dissipates 40 watts of power.

i.) How much current is being drawn from the power supply in this situation?

ii.) What is the resistance of *bulb #2*?

b.) Removing the wire across terminals *A* and *B* and placing it across terminals *B* and *C*. The switch is closed and it is observed that *bulb #1* dissipates 10 watts of power.

i.) How much current is being drawn from the power supply in this situation?

ii.) What is the resistance of *bulb #1*?

c.) Both bulbs are placed in series across the power supply and the switch is thrown.

i.) What is the current in this circuit?

ii.) What will happen in the circuit? That is, will both bulbs light up? If not, which one won't . . . and why won't it?

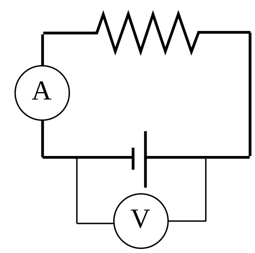
d.) Using the terminals available in the sketch, can you add lines (i.e., wires) to make the original bulb configuration into a parallel combination without disconnecting any of the wires already there? If you can, draw the circuit. If you can't, explain what's stopping you.

e.) Let's say you did whatever was appropriate to make the bulb configuration into a parallel combination.

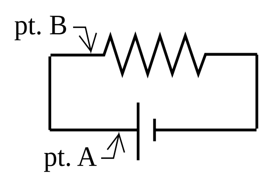
i.) How will the current in the circuit change from what it was as a series combination? Think about this conceptually before trying to do it mathematically.

ii.) Is more power dissipated in the series or the parallel combination? Again, think about this conceptually.

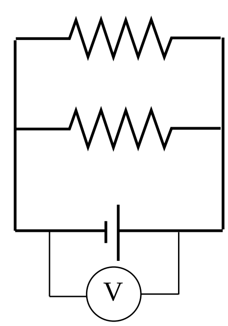
iii.) What is the ratio of power between the two kinds of circuits?



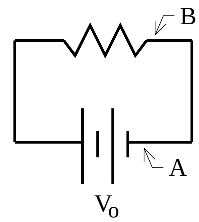
20.) The theory is simple. Attach a power supply to a resistor. Put a voltmeter across the power supply to measure the supply's voltage and put an ammeter into the circuit measure the current through the resistor. According to Ohm's Law, if you double the voltage, the current should double. So, our hapless teacher takes a light bulb and attaches it to a variable DC power supply (see sketch). She uses the voltmeter to set the power supply voltage (hence the voltage across the bulb) at 40 volts. At this setting the ammeter reads .45 amps. She doubles the voltage to 80 volts expecting to see the current double to .9 amps. What she sees instead is that the current has risen to only .65 amps. So there she sits before a classroom full of students looking like Jacqueline the idiot, with no explanation to be had. Is Ohm's Law working here? In any case, why is the circuit acting the way it is?



21.) Why is the voltage at *point A* the same as the voltage at *point B*? In theory, assuming ideal components, how would things change is we put an ammeter into the circuit between those two points?



22.) Once again, the theory is simple. Attach a power supply to two resistors connected in parallel. The voltage across each will be the same and will equal, to a very good approximation, the voltage across the power supply. In theory, nothing will happen to the current through either of the resistors if the other resistors is removed. Why? Because the voltage will not change across the remaining resistor, so the current should still be V_R/R. So, our hapless teacher (this time a male) takes two light bulbs, hooks them in parallel across a DC power supply, connects a voltmeter across the power supply and uses the meter to set the voltage at 80 volts. He then unscrews one of the lightbulbs expecting to find that the brightness of the second bulb does not change. What he finds is that it gets brighter. So there he sits before a classroom full of students looking like Jack the idiot, with no explanation to be had. Is Ohm's Law working here? In any case, why is the circuit acting the way it is?



23.) You hook up the simple circuit shown to the right. Assume you make the resistance of the resistor really big. You muse about the circuit's inner workings. You realize that an electron leaving the battery has a certain amount of energy. You acknowledge that the voltage at *A* and the voltage at *B* are essentially the same, so you accept that only a little bit of the electron's energy will be lost as it moves through the wire. In fact, almost all of its energy will be lost as the electron passes through the resistor. It all makes sense . . . until.

Being perverse, you remove the larger resistor and replace it with a resistor of smaller resistance. You muse. Your guinea pig electron still has the same amount of energy as it leaves the battery, and it still loses the same amount of energy as it passes through the wire, but now it has to get rid of almost all of its energy through a much smaller resistance. How does that work? How can the size of the resistor not matter when it comes to energy loss?