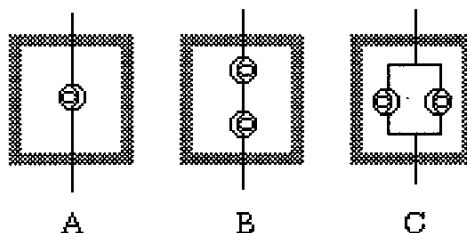


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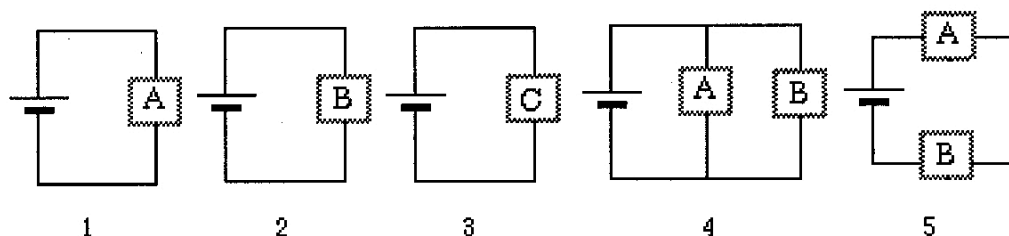
## HOMEWORK FOR UNIT 22 #2

### DIRECT CIRCUITS

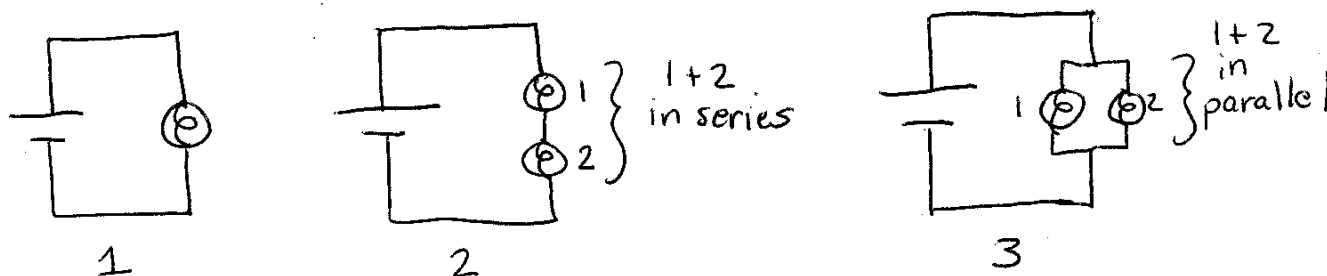
1. Suppose you had three boxes, labeled A, B, and C, each having two terminals. We put the arrangement of bulbs in the boxes shown below



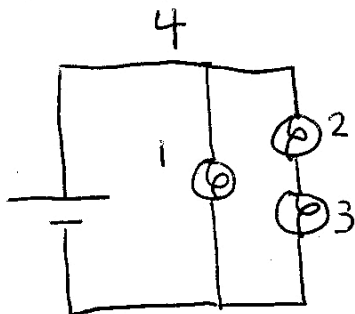
Consider the five circuits shown below in completing the following problems.



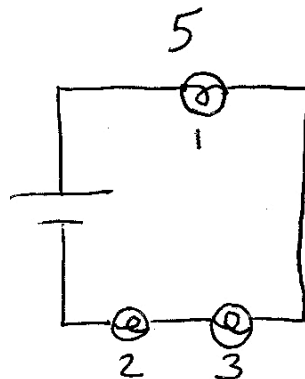
- a) For each of the circuits 1 through 5, sketch below a standard circuit diagram showing all the bulbs in the circuit. In each diagram number the bulbs and describe which bulbs or combination of bulbs are in series and parallel connections with each other.



a) (continued)



2+3 in series  
1 in parallel with 2+3



1+2+3 in series

b) Rank the networks A, B, and C by their resistances. Which has the most resistance? The least resistance?

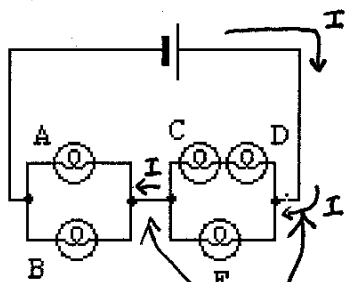
$B > A > C$  by resistance  
most least

(c) Rank each of the circuits according to the total current through the battery. Explain your reasoning!

$3 > 4 > 1 > 2 > 5$  by current

The battery current will be greatest for the lowest total resistance. 3 has the lowest resistance due to having 2 paths of one bulb each. 4 is next lowest, etc....

2. Predict the relative brightness of each of the bulbs shown in the following figure. Explain the reasons for your rankings.



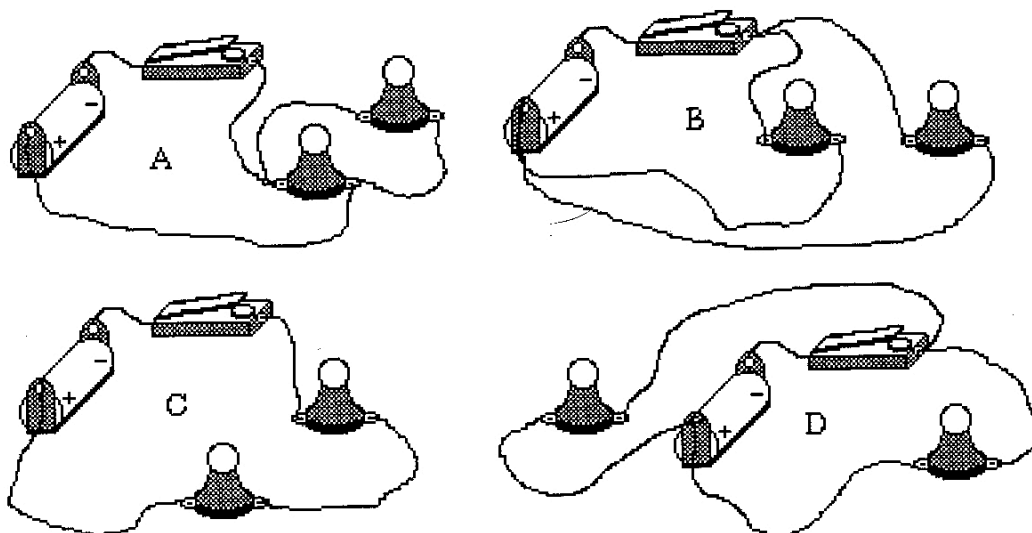
$E > A = B > C = D$

Brightness depends on the amount of current. E has the most current because it is a single bulb with the largest voltage drop. A and B have a smaller  $V$  because the parallel combination of A and B is less resistive than the combination of C+D. C and D have half the voltage drop of E so and E. half the current!

Note:

The same total current  $I$  enters each parallel combination. In the first  $E$  gets more than  $I/2$  and C+D get less than  $I/2$ , in the second both A+B get  $I/2$ .

3. One of the most confusing things about wiring circuits and figuring out what you've done is that many arrangements are electrically equivalent. Unless you have unusual powers of visualization it is often hard to recognize this. For example, three of the circuits shown below are electrically equivalent and one is not.



- (a) Which circuit is not like the others? Explain why it's different.

C is different. In C, there are no junctions in the circuit. The 4 circuit elements are in series with each other. In the other three circuits the two bulbs are in parallel so that the total current splits at a junction and flows thru

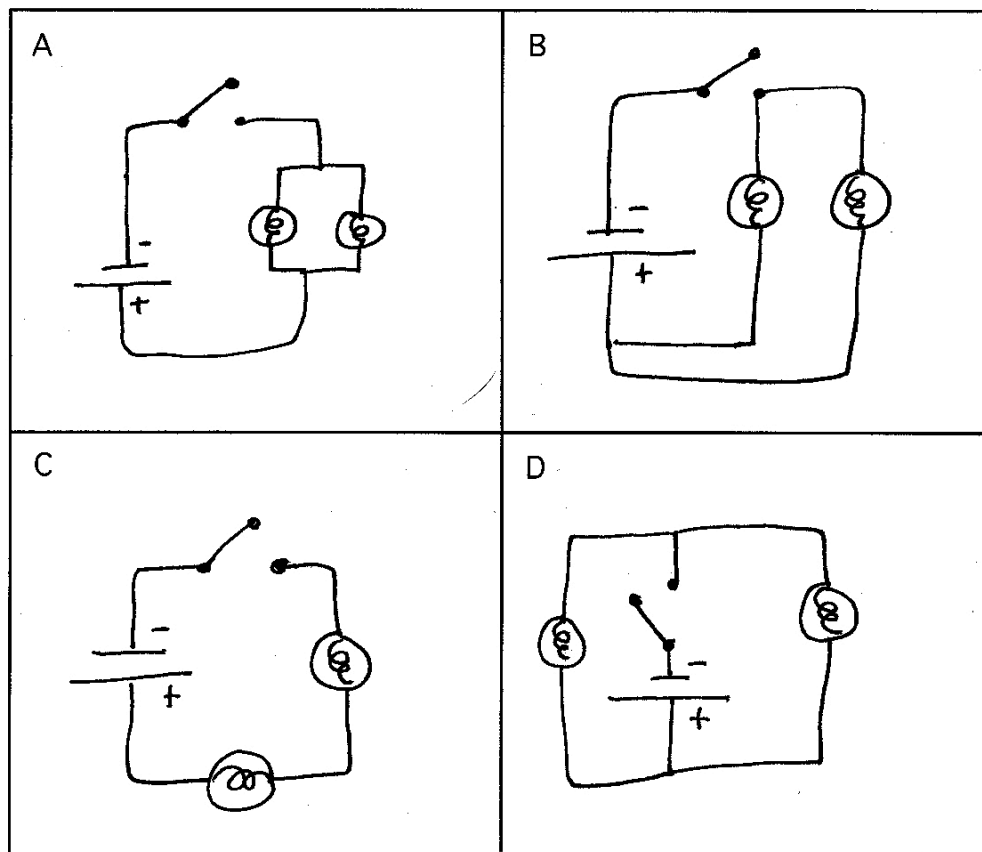
- (b) Which circuits represent parallel arrangements for the bulbs? Which represent series the arrangements?

A, B, D parallel

C series

two  
bulbs  
separately

(c) Draw circuit diagrams for each of the arrangements below.

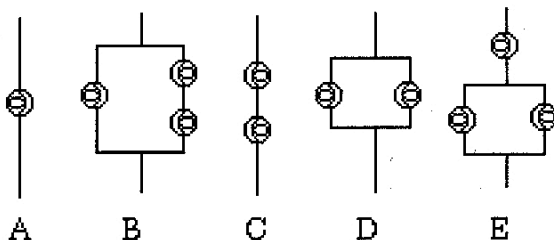


(d) Examine your diagrams. Is it possible for neat circuit diagrams which look superficially different to represent the same set of electrical connections?

Yes it is. There are many ways to draw the same electrical connections. It does not matter to the result how long you draw a wire or how it bends.

4. Use the model for electric current to rank the networks shown below in order by resistance.  
Explain your reasoning.

Adding parallel paths  
decreases resistance.  
Adding bulbs in  
series ~~decreases~~ increases  
resistance.



one bulb (less than 2 in series)

$C > E > A > B > D$

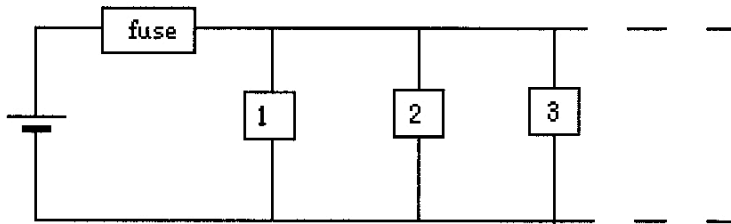
2 in series (most resistance) → C  
1 in series w/ (2 in parallel) (which is less resistive than 2) → E  
1 in parallel w/ (2 in series) (which is less resistive than one bulb alone) → A  
two paths of one bulb each is the lowest resistance, less than one bulb alone → B  
D

5. If a battery were connected to each of the circuits in Problem 4, in which case would the current through the battery be the largest? The smallest? Explain your reasoning.

Largest Current → Smallest Resistance → D  
Smallest Current → Largest Resistance → C

6. The diagram below shows a typical household circuit. The appliances (lights, television, toaster, etc.) are represented by boxes labeling 1, 2, 3, and so on. The fuse, or circuit breaker, shown in the diagram is a switch intended to shut off the circuit automatically if the wires become too hot because too much current is flowing in the circuit.

**Note:** Although houses in Canada use alternating current which differs in some ways from the direct current we have been studying, you can use the model you developed for this problem.



- a. What happens to the current through the fuse when more appliances are added to the circuit?

*The current will increase.*

- b. Does the current through element #1 change when elements #2 and #3 are added to the circuit?

*No, it does not. 1 still has the same voltage across it.*

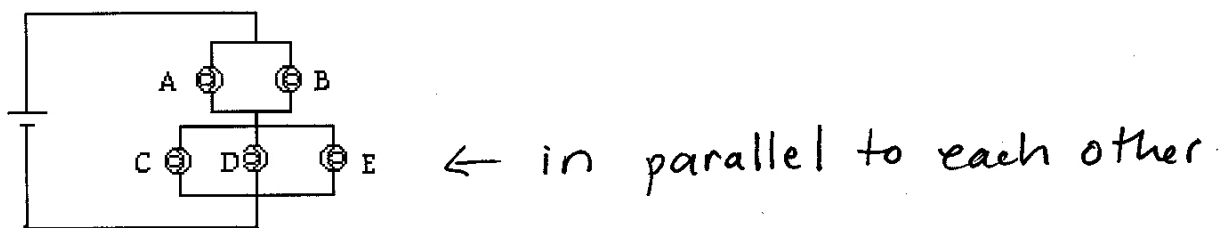
- c. Is this model consistent with your observations of everyday household electricity? For example, what happens to the brightness of a light bulb in a room when a second one is turned on?

*Yes this is consistent. A bulb brightness does not change when a second bulb is turned on.*

- d. What may happen to the fuse if too many appliances are added to the circuit? Why?

The fuse will blow (or shut off) if too many appliances are added because the current will get too large.

7. Are the bulbs C, D and E in the circuit below connected in series, parallel, or neither?



8. Rank the bulbs in the circuit above in order of brightness. Use the symbols "=", "<" and ">". Explain your ranking.

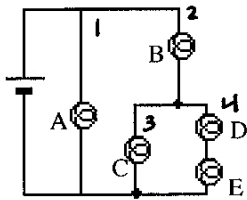
$$A = B > C = D = E$$

A and B split the total current ~~into~~ two ways,  
C, D and E split the same total current  
three ways and so have less current each.

9. How will the brightness of bulbs A and B change if bulb C is unscrewed? Will the result be different if bulb D or E is unscrewed instead? Explain.

If C is unscrewed, the total resistance of the circuit will increase so the total current will decrease which means the currents thru A and B will decrease so A+B will get dimmer. The result will be the same if D or E is unscrewed.

10. Rank the brightness of the bulbs in the circuit below. Use the symbols "=", "<" and ">". Explain your ranking.



$$A > B > C > D = E$$

The current in the parallel path (1) with bulb A is larger than in the other path (2) because the other path has a resistance larger than one bulb.

Bulb B has more current than C, D or E because it has the total current for path #2. C has less than B, but more current than D+E because its path (3) has less resistance than the path (4) of D+E.