Patricia A. McCarrin
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Electric Circuits Paper Assignment

Part 1 – Outline of important elements of the current model for the behavior of electric circuits.

The elements that are important to consider for a current model are the type of circuit, the brightness of the bulbs in a circuit and the amount of resistance in the circuit.

There are basic things to consider in thinking about a circuit: the conductors, resistors and the paths available for the current to pass through.

1. Conductors are needed in order for current to be able to move through a circuit. Materials that conduct current are mostly metal although other substances can be conductors if they have high electron mobility. Conductors are things that allow bulbs to light.

2. A complete circuit must have a path of conductors that is continuous with no breaks so the current can flow from one terminal of the power source to the other without interruption. Another term that could be used in place of complete circuit is closed circuit. A circuit that has an interruption is called an open circuit and can be obtained with the use of a switch or break in the wire. Experiment 1.9 page 385. If a wire is connected such that it interrupts the path between the bulb and power source then the bulb will not light. This results in what is known as a short circuit. Experiment 1.11 page 386

Proof: In our initial experiments we found that several things were necessary to get a bulb to light in a single bulb circuit. It was necessary for the wire in the bulb that was touching the screw thread to touch one end of the battery terminal, while the other wire that touched the rivet needed to be touching the opposite terminal of the battery. This connection was found to be needed in all subsequent experiments. If a switch was included and the switch was open then the bulb would not light. If the wire was disconnected the bulb would not light. If the connection was broken in any way then the bulb would not light. We also found that a circuit could be shorted if a wire was connected that would bypass the bulb. However we did not prove that no current at all branched off to the bulb, just that the bulb did not light. Through inference we are deducing that the current bypasses the bulb and travels the path of least resistance, the one without the bulb. Bulbs indicate resistance. Additional experiments that confirmed this theory are 1.12, page 388. 1.3, page 494.

3. A circuit can be a single circuit which would contain one bulb, a light source and a power source, a series circuit, a parallel circuit or a combination circuit. Bulb brightness in each circuit is an indicator of the amount of current in each circuit. Currently we still do not know if current flows in a particular direction.

Single Bulb – This consists of a circuit which contains one bulb, a battery and one path for the current to travel. The bulb in this circuit receives all of the current from the battery. The circuit is closed. Each part of the circuit must be touched in order for the bulb to light. The brightness of the bulb is equal to bulbs in simple parallel circuits. If the circuit is broken than the bulb will go out.

Series Circuit – There is still only one path for the current to travel but there are two or more bulbs along the single path which the current flows. More resistance occurs as additional bulbs are added and less current is released with each succeeding bulb. Evidence of this was shown in class and home experiments. A single bulb was always brighter than bulbs in series. Each additional bulb caused the bulbs to get dimmer. We determined that less current was generated from the battery because there was only one path for the current to follow. If there was equal current generated then all of the bulbs would have the same brightness as the single bulb. Since this was not the case we came to the conclusion that less current was being generated from the battery. Through class experiments we found that when one bulb is disconnected or broken in the series then the whole series is affected. All of the lights in the series will go out.

Parallel Circuit – There are two or more branches in a parallel circuit. The current flowing to each branch is equal. The brightness of two bulbs in a parallel with one bulb in each branch indicates that the current through each is the same and the same as through a single bulb circuit. The current in a parallel circuit is divided equally among the branches. This was proved when we built parallel circuits. The power source remained the same but each bulb had the same brightness as a bulb in a single circuit. The amount of branches did not make a difference. In order for this to occur, more power had to be generated from the power source with each additional branch. Through class discussion we determined that more branches offered less resistance because there were more paths that the current could follow. In a parallel circuit one branch can be disconnected or broken and this will not affect the rest of the bulbs in the circuit.

Parallel Circuit Combination – The bulb brightness is determined by the arrangement of the bulbs in each branch. The bulb brightness yields results which concur with the above mentioned circuits. The arrangement of the bulbs influences the brightness of the bulbs. A branch that has a single bulb and an element with some bulbs in series will be less bright than a branch with a single bulb.

Ranking in order of brightness is as follows:

Parallel Circuit = Single Bulb Circuit > Series Circuit

Combinations stand alone in terms of brightness because it depends on the arrangement of the bulbs in the branches and the elements that are in the branches. They cannot be neatly categorized.

Experiments 2.1 page 295, 3.3 page 497, 3.4 page 497 (part a and b), 2.3 page 496, 3.3 page 497, 3.4 page 497 parts a and b, 3.5 page 498, homework 3, problems 4,5, and 6, all homework 4.

Both single circuit bulbs and parallel circuit bulbs will have equal brightness even when branches are added to the parallel circuit.

Series circuits bulbs are dimmer than a single circuit or a parallel circuit. Bulbs become dimmer as more bulbs are added. This indicates that there is less current coming from the battery. This leads to the conclusion that a series circuit has more resistance.

The bulb in branch 1 will be brighter than the bulbs in branch 2 which leads us to infer that less current is flowing through branch 2. Because of the resistance in branch 2, less current must be coming from the power source than in a parallel circuit with the two branches having a single bulb or in the single bulb circuit because the single bulb circuit is the same brightness as the parallel circuit with single bulbs in each branch.

A short will occur when a current can find a path that is complete and bypasses the paths with bulbs because we have found through experimentation that a current will take the path of least resistance.

4. A circuit experiences different resistance depending on its type. As resistance increases, current decreases and so does brightness. More bulbs in certain circuits can offer more resistance or less depending on how they are added. If more bulbs are added to a parallel circuit, then more paths are available and there is less resistance. As more bulbs are added to a series circuit more resistance is incurred. The current that passes through the battery depends on the amount of resistance. We have not yet determined if the type of bulb (wattage) will make a difference. Thus far we have used all the same type of bulb. In addition we have found that if a wire is connected so that the current can travel in a path that bypasses the bulb/s then the bulbs will not light. We believe that this is because the current will take the path of least resistance because of experiment 7 in homework 4 and Exercise 4.3 number 5 and one other experiment I can't find which caused the bulb to not light when a wire was placed in a position that would allow the current to bypass the bulb.

Proof: Single Series Circuit

We determined this by conducting the following experiment. When we had one bulb in a single series circuit it had a particular brightness. Each time a bulb was added the brightness of the bulbs changed. Because of this result we determined that the output from the battery must be less because each bulb must receive the same amount of current output from the power source. Since the brightness changed then the current flowing from the power source must be different. This scenario leads us to the conclusion that more resistance is caused when bulbs are added because the bulbs are dimmer with each addition.

Parallel series

We also built a parallel series. The bulb in each branch had the same brightness as a bulb in a single bulb series. Because of this result the inference is that the current coming from the battery must increase to make the bulbs equally bright in the parallel circuit as in the single circuit. To make each bulb in the parallel circuit equally bright then the current from the power source must increase. Through class discussion we determined that the more paths that the current has to flow the less resistance it incurs. In a parallel circuit the bulbs have equal brightness.

Combination circuits

In a combination circuit there can be a variety of branches and depending on the combinations, the brightness of the bulbs vary. But the results follow the pattern we found in previous experiments. In homework 3 and 4 we found that the brightness of the bulbs in the individual branches was determined by the set up of the bulbs in each branch and the elements in the branch. Per class discussion the conclusion drawn is that bulbs in series have more resistance. When bulbs are in series they will follow the rules we have previously established. Less current will flow from the power source to a particular bulb, depending on its position in the circuit. This is indicated by brightness of the bulb. (Experiment 2.1, page 495), (3.4, page 497), (homework 3, problem 7), (3.5, page 398), (homework 4, problem 6 and 7).

Part II

In order to determine the brightness of the bulbs we have to look at the circuit to see the flow of the current. In problem 1 we can see that the current will come from the battery and reach a junction. At the first junction there are two branches. The current will not divide equally at this point because branch A has a single bulb and branch B/C is in series. Class and home experiments have shown this to be true. The current divides at the junction according to how much resistance is in each branch. More power, although we don't really know how much, will go to branch (A) because it has less resistance than branch (B/C). At the base of these branches the current will come together again. At this point it will come to another junction but this time the current will split equally because both branches have a single bulb and have the same resistance.

In order of brightness we will see **A > D = E > B = C**

Circuit 2 contains both parallel and series elements. When the current leaves the battery and comes to the first junction the power will split. We know that Branch F/G will receive less power because it is in series. Through home and class experimentation we have repeatedly proved that this results in more resistance and less brightness in the bulbs. A larger portion of the power will go to H/I/J because this branch has three bulbs but multiple paths so there will be less resistance. All of the current will go to H causing this to be the brightest of the bulbs because of its position in the branch. The current will pass through H and then come to a junction where it will split equally. This is because the bulbs are in parallel with one another and there is only one bulb in each branch. According to Kathy Tait, "I and J receive ½ of the more current causing them to be dimmer than bulbs f and g which are receiving all of the less current with bulb h being the brightest." In terms of brightness we will have the following:

H > F = G > I = J