Physics II - Quiz #1
October 20, 2007

Name

1. On the basis of your observations so far, answer the following questions about circuits I and II shown below. (Bulbs 1, 2 and 3 are identical, and the batteries are identical.)

   a. In circuit I, how does the current through the battery compare to that through bulb 1, point a, and point b? Explain your reasoning.

   The current through the battery at points a and b are equal because there is a continuous flow of electricity in a circular path from +battery → a → b → battery.

   b. In circuit II, how does the current through the battery compare to that through bulb 2, bulb 3, and the labeled points (x – z)? Explain your reasoning.

   In circuit II, the current through the battery is in equal at points x, y, and z. This is because the circuit is flowing in a circular path, the evidence would be that the brightness of bulbs 2 and 3 are equal to each other.

   c. Which bulb has more current flowing through it: bulb 1 (in circuit I) or bulb 2 (in circuit II)? Explain your reasoning.

   If you increase the resistance or number of obstacles, then you reduce the current flow. Bulb 1 in circuit I has more current flow than bulb 2 in circuit II because there is more resistance in circuit #2. Circuit #2 has more resistance therefore the current is reduced. Bulb #1 will be brighter than bulb #2.

   d. Which has more current flowing through it, the battery in circuit I or the battery in circuit II? Explain your reasoning.

   The battery in circuit #1 has more current flowing through it and will result in a brighter bulb #1 because it has less resistance. The addition of another bulb in circuit #2 has increased the resistance and therefore decreased the current flow resulting in bulbs 2 + 3 being dimmer than bulb #1.
Consider the three circuits shown below. Each circuit has 4 identical bulbs and an ideal battery. The batteries in each circuit are identical. (You may assume that if current is flowing through a bulb that it will light.)

1. **Rank the bulbs in each circuit (not between circuits) according to brightness.** (That is, rank the four A bulbs to each other, but not to the B or the C bulbs; then do the same for the B bulbs and the C bulbs.) Explain your reasoning – how you determined your rankings.

   a. In circuit diagram A, bulbs A1 and A4 have equal brightness, while bulbs A2 and A3 have equal brightness, however they are connected. The bulbs A1 and A4.

   b. This diagram is of a series circuit with A1, component A2A3, and A4 in a continuous path. The same amount of current flows through each obstacle; however, component A2A3 shares the current.

2. **Rank the currents through the three batteries (A-C) from greatest to least.** Explain how you made your ranking.

   2. Battery B will have the greatest electric current flow because it has the greatest number of paths and the least resistance. In a parallel circuit, increasing the number of branches (paths) actually reduces the

3. **For each circuit, specify what fraction of the current through the battery each bulb receives.** (For example, you might say “Bulb A1 gets half of battery A current, while bulb A2 gets…”). Briefly explain how you know.

   Circuit A: Bulbs A1 and A4, and component A2A3 share an equal amount of electric current. If you were to remove one of the bulbs in component A2A3, all three of the

   Circuit B: Bulbs B1, B2, B3 & B4 share equally the same amount of current because they are parallel. The bulbs would be equally bright. If you were to turn off one of the bulbs, reducing the # of pathways would reduce the total amount of current.
14. Battery. Each bulb will have equal brightness because the electric current has four separate and equal pathways.

16. In circuit diagram C, bulb C4 will be brighter than bulbs C1, C2, and C3 because bulb C4 receives all of the electric current from the battery. Bulbs C1, C2 and C3 make up a component with parallel paths and therefore will be equally bright, but dimmer than C4 because they share the same current flow.

2. Cont amount of resistance and increase the amount of electric current flow across the battery.

Battery C would have the 2nd greatest electric current flow. The bulbs in C are arranged in a series current with the battery. As a result, increasing the number of obstacles increases the amount of resistance, thus decreasing the amount of electric current from the battery.

Battery A will have the least electric current flow. It is also in a series, however, it has one less path than C. As a result, reducing the pathways increase the amount of resistance which reduces the amount of electric current flow.

3. Cont Circuit A — Bulb C1 left would have the same brightness.

Circuit C — Bulb C4 and component C1, C2, C3 share an equal amount of electric current. If you remove two of the bulbs in the component, bulb C4 and the remaining light bulb would be equal brightness.
Consider the circuit diagram at right. The bulbs are identical and the battery is ideal. (You may assume that if current is flowing through a bulb that it will light.)

A. Rank the bulbs A-E according to brightness. Explain your reasoning – how you determined your ranking.

B. Suppose a bulb F were added in parallel to bulb B. For bulbs A, D and E only, state whether the brightness of that bulb will increase, decrease, or remain the same in response to this addition. Explain your reasoning in each case.

1. The brightness of bulb A will increase because adding a bulb parallel to B will decrease the overall resistance on that branch, which will increase the amount of current. Bulb A will be the brightest on this branch because it receives all the current flow.

2. The brightness of bulb D will also increase because the flow of electric current to this branch has increased. It still will be equally as bright as C, but brighter than before, because it is dependent.

3. The brightness of bulb E will remain the same because it is an independent parallel branch across the battery and is not affected by changes to other branches.

Continued on reverse.........
C. Consider the original circuit shown at right. Suppose instead a bulb G were added in series with bulb C.

Will the brightness of bulb D change or remain the same in response to this addition? Explain your reasoning.

Adding bulb G in series with bulb C will not affect the brightness of bulb D because bulbs C and D is a network with 2 equal parallel branches. The addition of bulb G will affect the brightness of bulb C because they are in a series.

D. Consider the original circuit shown above. Suppose instead a piece of connecting wire were added in parallel to with bulb C.

Will the brightness of bulb D change or remain the same in response to this addition? Explain your reasoning.

Adding a wire in parallel to bulb C would prevent bulbs C and D from lighting. By adding a wire in parallel to bulb C you add an alternate path in the CD network that has no resistance to the flow of electricity. The current will take the path of the wire and not go through bulbs C or D.
1. In the circuit at right, assume that the battery is ideal, all bulbs are identical and all pieces of Nichrome wire are the same length.

A. A student has measured the current through two of the elements in the circuit with these results:

Current through Bulb C: 0.25 A
Current through Wire E: 0.90 A

Fill in the current values for the remaining circuit elements (A, B, D, Battery). Explain your reasoning in each case.

B. Wire F is now added to the circuit as shown at right.

Find the current through the circuit element specified below. If you cannot determine the current with the information given, state so explicitly. In either case, explain your answer and/or reasoning.

i. Wire E

Adding wire F to the circuit will not affect A, B, C or D because they are on a separate independent branch across the battery. However, adding F on the same branch with E will increase the resistance on that branch. When you double the resistance, you half the current. So, \( \frac{1}{2} \times 0.45 \text{ A} = 0.225 \text{ A} \) for each F.

ii. Bulb C

Adding F will not affect bulb C because it is on an independent branch across the battery.

iii. The Battery

Adding wire F, will increase the total amount of resistance, to the flow of electric current. When you increase resistance, it will decrease the current flow from the battery.
C. Wire G is added to the original circuit as shown at right.

i. What is the current through wire G? Explain how you know. If you cannot determine the current with the information given, state so explicitly. In either case, explain your answer and/or reasoning.

By adding wire G parallel to the battery, you have created another path for the current to flow and reduced the total resistance to the flow of electricity. Thus, you can expect the current to flow through wire G, but because of the reduced resistance, the battery was increased flow — but G is the same as E!

ii. [5] Does the current though any of the other circuit elements (including the battery) change? If so, specify which ones change and the new current value for that (those) element(s). If no other currents change, state that explicitly. In either case, explain your reasoning.

By adding wire G, the current through the battery increased because the overall resistance of the circuit has decreased. Because G is added to a parallel pathway, the total resistance is decreased, and thus the current flow will increase. The current flow in each branch is increased.

\[ \frac{R}{N} = \frac{R}{1} = \frac{R}{2} = \frac{R}{3} \] (overall resistance is reduced).
The circuit at right contains three identical bulbs (F, G, and H), two pieces of nichrome wire (not necessarily identical), and a battery. The switch S is open, as shown in the diagram.

With switch S open, the measurements shown in the table below have been made. Complete the table by deducing the remaining quantities. Explain how you figured out what the remaining quantities should be.

First, redraw the circuit diagram.

The circuit diagram contains bulb H in series with a network that contains multiple elements. With the switch S open, resistor R₂ will not receive any electrical current or voltage because it is an open circuit. In a series network, the voltage across the battery is equal to the voltage across the battery. In a parallel network, the voltage across each branch is equal to the voltage across the battery regardless of the amount of resistance in any branch. As, the voltage across a parallel network is equal to the voltage across the battery. If $V_e = 1.80V$ then $V_g + V_r$ must also be $1.80V$.

The voltage across bulb G is 1.05V so the $V_r$ must be equal 0.75V. The total amount of current going into a node has to equal the amount of current coming out, so if $I_e = I_H + (\text{network F, G, R})$. There is less resistance in the network, so it should have a higher current flow.

$\frac{V}{V} = 0.95 \text{ A}$

$0.75 = I_H$

**Actually, this should be**

$\frac{V}{V} = 0.95 \text{ A}$

**Written**

$I_H = (\text{network F, G, R})$

You don't want it to show up twice in the equation.
2. For each of the quantities in the table above (both given and deduced), indicate if the quantity would increase, decrease or remain the same when the switch is closed. Explain your reasoning.

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb F</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td>Bulb G</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td>Bulb H</td>
<td>reduce</td>
<td>reduce</td>
</tr>
<tr>
<td>Resistor $R_1$</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td>Resistor $R_2$</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td>Battery</td>
<td>increase</td>
<td>same</td>
</tr>
</tbody>
</table>

Closing the switch $S$, reduces the resistance on the whole circuit. Reducing the overall resistance in the circuit will increase the current flow. Therefore, bulb $H$ will increase because it will receive all of the increase. Bulb $F$ will also increase because the total current split has it increase and it receive the full share. The current through $R_2$ will increase because it is now a closed system. The current through $R_1$ will decrease because the resistance in this branch has decreased. The voltage across the battery will remain the same.