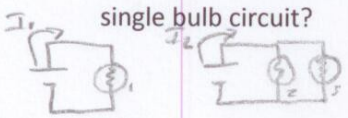
Physics 221

Circuits ILD

Name: Solution

1. How does the brightness of each bulb in the two bulb parallel circuit compare to that of a bulb in a single bulb circuit?



$P_1 = P_2 = P_3$

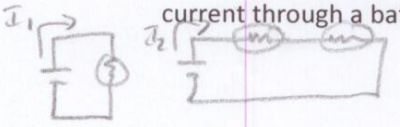
The brightness is equal for all three bulbs. The voltage is equal to the battery voltage for the single bulb. Since the two bulbs are in parallel, the are each directly attached to the battery so also have the same voltage as the battery.

2. How does the amount of current through a battery connected to a single bulb compare to the current through a battery connected to a two bulb parallel circuit?

The current in the 1 bulb circuit is $I = V/R$ The current in the 2 bulb circuit is more because the total resistance is less. $\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2}$

$I_2 > I_1$

3. How does the amount of current through a battery connected to a single bulb compare to the current through a battery connected to a two bulb series circuit?



The total resistance in the 2 bulb series circuit is more $R_1 + R_2 = R_{TOT}$ so the current in the 2 bulb series circuit is less. $I_2 < I_1$

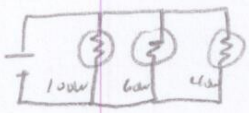
4. Consider a circuit consisting of three different light bulbs, a 40 Watt, a 60 Watt and a 100 Watt bulb, that are connected in parallel and plugged into the wall.
   a) Rank the relative brightness of the three bulbs from brightest to dimmest.

   100W > 60W > 40W

   b) What will happen if one bulb is removed?

   The other two stay exactly the same brightness

   c) Draw a schematic for this circuit.



2. Consider a circuit consisting of the same three light bulbs but connected in series this time and plugged into the wall.
   a) Rank the relative brightness of the three bulbs from brightest to dimmest.

   40W > 60W > 100W

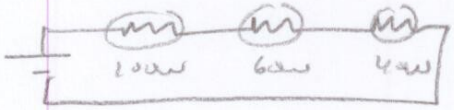
$\Delta V = IR$ $\quad I = \Delta Q/\Delta t$ $\quad \boldsymbol{P = I\Delta V} = (\Delta V)^2/R = I^2R$

$R_{eq} = R_1 + R_2 + R_3 + \ldots$ $\quad 1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$

b) what will happen if one bulb is removed?

They all go out!

c) Draw a schematic for this circuit.



3. What happens if the order of the bulbs is changed in

a) the parallel circuit

Nothing

Consider the chain of electrons like a bicycle chain. They keep going around even after they push the freewheel.

b) the series circuit

Nothing

Notice that $V=IR$ & $P=I\Delta V$ have nothing to do with order!

5. Calculate the resistances of the three bulbs. Remember that the Power ratings on the bulbs are for bulbs placed in a household circuit. This means each bulb must be supplied 120V to produce the rated power. $P=\Delta V^2/R$ $R=\Delta V^2/P$

$\frac{120V^2}{100W}=$ 144Ω $\quad \frac{120V^2}{60W}=$ 240Ω $\quad \frac{120V^2}{40W}=$ 360Ω

6. Using the resistance for each bulb, explain your observations for the parallel circuit

Power is brightness -> energy/second so look at P. ΔV is equal in a parallel circuit. So $P=\Delta V^2/R$ is easiest to consider when ΔV is constant P is inversely proportional to the resistance. 100W has smallest R so largest Power

7. Using the resistance of each bulb, explain your observations of the series circuit.

In series it's the current that is the same in each bulb so $P=I^2R$ is the most useful to consider. If I is the same in each bulb, then P is directly proportional to R. 40W has the largest resistance so it is brightest. Also think of friction. Each bulb has the same current but the one with the most resistance has the most friction and produces the most heat and light.

$\Delta V = IR$ $\quad I = \Delta Q/\Delta t$ $\quad P = I\Delta V = (\Delta V)^2/R = I^2R$

$R_{eq} = R_1 + R_2 + R_3 + \ldots$ $\quad 1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$