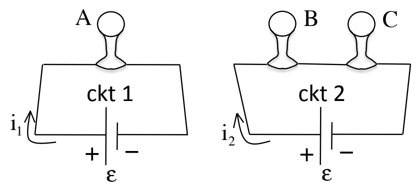
Problem 28.8

All resistances are "R." Neglecting internal resistance of the batteries:



a.) currents?

ckt 1

$$i_1 = \frac{\varepsilon}{R}$$

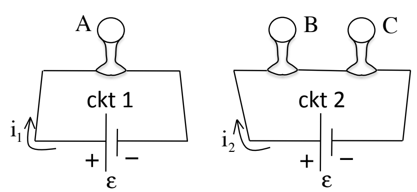
ckt 2

$$i_2 = \frac{\varepsilon}{R+R} = \frac{\varepsilon}{2R} = \frac{1}{2} i_1$$

b.) As the current is the same through each element in the series combination (circuit 2), the obvious response is that the brightness of bulbs B and C will be the same.

Short answer: More current through bulb A suggests a brighter bulb.

For the intellectually curious: It is not unreasonable to wonder "how much more?" To understand the answer to that, we need to look at the math.



"Power dissipated" by a light bulb generates brightness. As power dissipation, hence brightness, is governed by the amount of current passing through a resistor (light bulb), we need the power relationship for a resistor. That is:

$$P_R = i^2 R$$

In other words, the power dissipated by the single resistor (A) in circuit 1 is:

$$P_A = i_1^2 R$$

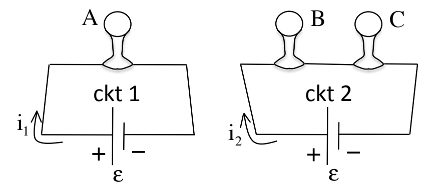
and the power dissipated by a single resistor (say B) in circuit 2 is:

$$P_B = i_2^2 \; R$$

from *Part a*

$$= \left(\frac{i_1}{2}\right)^2 R = \left(\frac{1}{4}\right)\left(i_1^2 R\right) = \frac{P_A}{4}$$

According to the math, the power dissipated by B will be a quarter that dissipated by A, hence B must be a quarter as bright as A.



Looking at this a little differently: The power provided to a circuit by a battery is $P = \varepsilon i$. Each of our circuits has a battery voltage of ε. As the current through *circuit 2* is half of that through *circuit 1*, the total power provided to *circuit 2* is half that provided to *circuit 1*. Half of *circuit 2's* power, or a *quarter of circuit's 1's* power, is dissipated by each of circuit *circuit 2's* two resistors.

$$P_{ckt-1} = \varepsilon \, i_1 \text{ and } P_{ckt-2} = \varepsilon \, i_2$$

$$\Rightarrow \frac{P_{ckt-2}}{P_{ckt-1}} = \frac{\varepsilon \, i_2}{\varepsilon \, i_1} = \frac{i_2}{i_1}$$

$$\Rightarrow \frac{P_{ckt-2}}{P_{ckt-1}} = \frac{i_2}{i_1} = \frac{i_2}{2 i_2}$$

$$\Rightarrow P_{ckt-2} = \frac{1}{2} P_{ckt-1}$$

Bottom line: Bulbs B and C should be a *quarter* as bright as bulb A.