PHY 240: Basic Electronics
Homework Problem H2

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1. Voltages and Currents in Eight Simple Circuits.
   (a) You are given a battery and three identical light bulbs (incandescent bulbs). Provide a schematic for a circuit containing these four elements in which the current through Bulb 1, I_1, is twice that through Bulb 2, I_2. Neither of these currents can be zero. Use appropriate schematic symbols for your circuit elements, and be sure to label your bulbs 1, 2, and 3

   (b) Now provide a schematic for a circuit containing these four elements in which the voltage across Bulb 1, V_1, is twice that across Bulb 2, V_2. Neither of these voltages can be zero. Use appropriate schematic symbols and label your bulbs 1, 2, and 3.

   (c) Redraw your circuit from part (a) with an ammeter included in a config- uration that will allow the ammeter to measure the current flowing through Bulb 2. Use the appropriate schematic symbol for an ideal ammeter.

   (d) Redraw your circuit from part (b) with a voltmeter included in a config- uration that will allow the voltmeter to measure the voltage across Bulb 2. Use the appropriate schematic symbol for an ideal voltmeter.

   (e) Draw the schematic for a circuit in which a 10 V battery, a 100 Ω resistor, and a 220Ω resistor are all in series with one another. Determine the voltage across each resistor and the current flowing through each resistor.

   (f) Draw the schematic for a circuit in which a 10 V battery, a 100 Ω resistor, and a 220Ω resistor are all in parallel with one another. Determine the voltage across each resistor and the current flowing through each resistor.

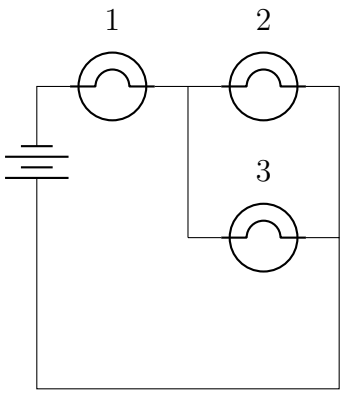
   (g) Draw the schematic for a circuit in which a 100 mA current source, a 100 Ω resistor, and a 220 Ω resistor are all in series with one another. Determine the voltage across each resistor and the current flowing through each resistor. Use an appropriate schematic symbol for an ideal current source.

   (h) Draw the schematic for a circuit in which a 100 mA current source, a 100 Ω resistor, and a 220 Ω resistor are all in parallel with one another. Determine the voltage across each resistor and the current flowing through each resistor.

Solution:

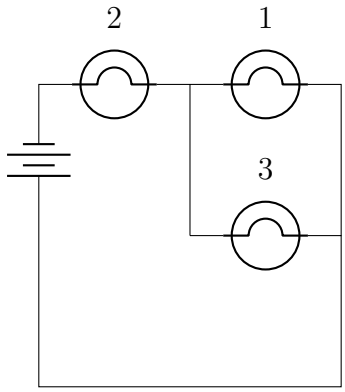
(a)

$$I_1 = 2I_2$$



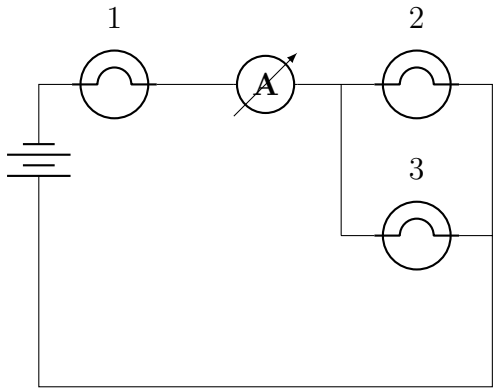
(b)

$V_1 = 2V_2$



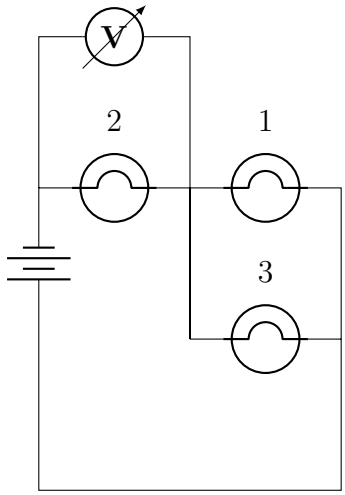
(c)

$I_1 = 2I_2$



(d)

$V_1 = 2V_2$



(e)

$$V = IR$$

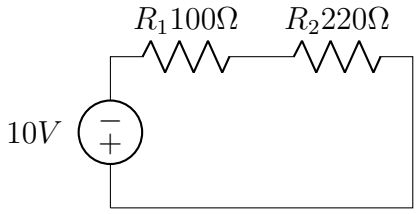
$$10V = I320\Omega$$

$$I = 0.03125A$$

Since this circuit is in series, the current must be constant everywhere.

$$V_1 = (0.03125A)(100\Omega) = 3.125V$$

$$V_2 = (0.03125A)(220\Omega) = 6.875V$$



(f)

$$V = IR$$

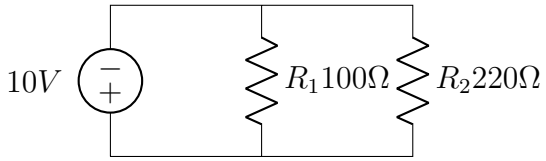
$$10V = I(68.75\Omega)$$

$$I \approx 0.145A$$

Since this circuit is in parallel, the voltage must be constant everywhere.

$$I_1 = \frac{10V}{100\Omega} = 0.1A$$

$$I_2 = \frac{10V}{220\Omega} \approx 0.045A$$



(g)

$$V = IR$$

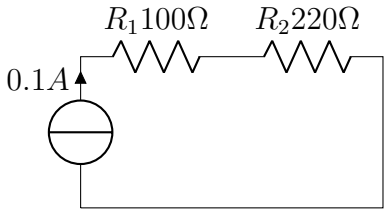
$$V = (0.1A)320\Omega$$

$$V = 32V$$

Since this circuit is in series, the current must be constant everywhere.

$$V_1 = (0.1A)(100\Omega) = 10V$$

$$V_2 = (0.1A)(220\Omega) = 22V$$



(h)

$$V = IR$$

$$V = 0.1A(68.75\Omega)$$

$$V = 6.875V$$

Since this circuit is in parallel, the voltage must be constant everywhere.

$$I_1 = \frac{6.875V}{100\Omega} = 0.06875A$$

$$I_2 = \frac{6.875V}{220\Omega} \approx 0.03A$$