Name:____________________ UIN: | | | | | | | | | | Section AB/BB: | |

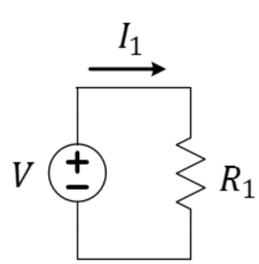
PRE-LAB #3: Switched-Resistor Speed-Control

Please use the Notes margin on the right for both notes to yourself about the experiment as well as for feedback to your TA on the quality or clarity of the lab procedure. Thanks!

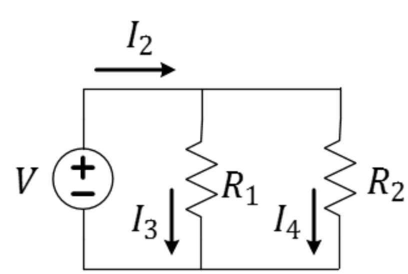
The Interpretation of Basic Circuit Laws

In 1845, Gustav Kirchhoff, partially working from Ohm's discovery, formulated two more mathematical theories. These are known as **Kirchhoff's Laws** and they drastically aid our understanding of circuits. As we begin our own exploration of electronics, we will re-investigate these fundamental laws of circuit theory ourselves.

Ohm's law may be used to describe a very simple circuit with only a single source and a single resistor. When two resistances are connected across the same voltage drop (such as the second schematic of Figure 1), there are, in fact, *two* paths for the current to flow from the positive terminal of the source to the negative terminal. In this configuration, the two resistances are said to be connected in **parallel**. It is sometimes beneficial to think of resistors as water pipes. The narrower the pipe, the larger the resistance to current flow. Having two resistances in parallel is similar to adding an extra pipe for the water to follow compared to the single resistor configuration. In the analogy, water would flow through both pipes, but more water would flow through the wider pipe as it offers less resistance to flow.



(a)



(b)

Notes:

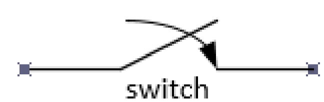
Figure 1: Two circuit schematics used to explore current in parallel resistive elements. In (a), the current has one path back to the source. In (b), the current has two *parallel* paths back to the source. The parallel combination will have less resistance to current flow than R_1 alone.

Question 1: Assume R_1 is the same value in both Figure 2 (a) and (b). Then the current I_2 will be larger than I_1. Explain this fact using both Ohm's law and the water-pipe analogy.

Question 2: If you are given that $R_1 = R_2$, how do I_3 and I_4 relate to one another? Is one greater than the other? How do they each relate to I_1? Explain your reasoning using Ohm's Law.

Question 3: In lab 3, we will add fine-tuned speed control to the car. To do this, we will be using a switch to add two $47 - \Omega$ resistors in parallel with each network of $100 - \Omega$ resistors. Complete the circuit schematic for the physical diagram of Figure 3 (a). HINT: You will be adding two motors and ten resistors to complete the circuit schematic of Figure 3 (b).

The symbol for a Normally Open switch looks like this:



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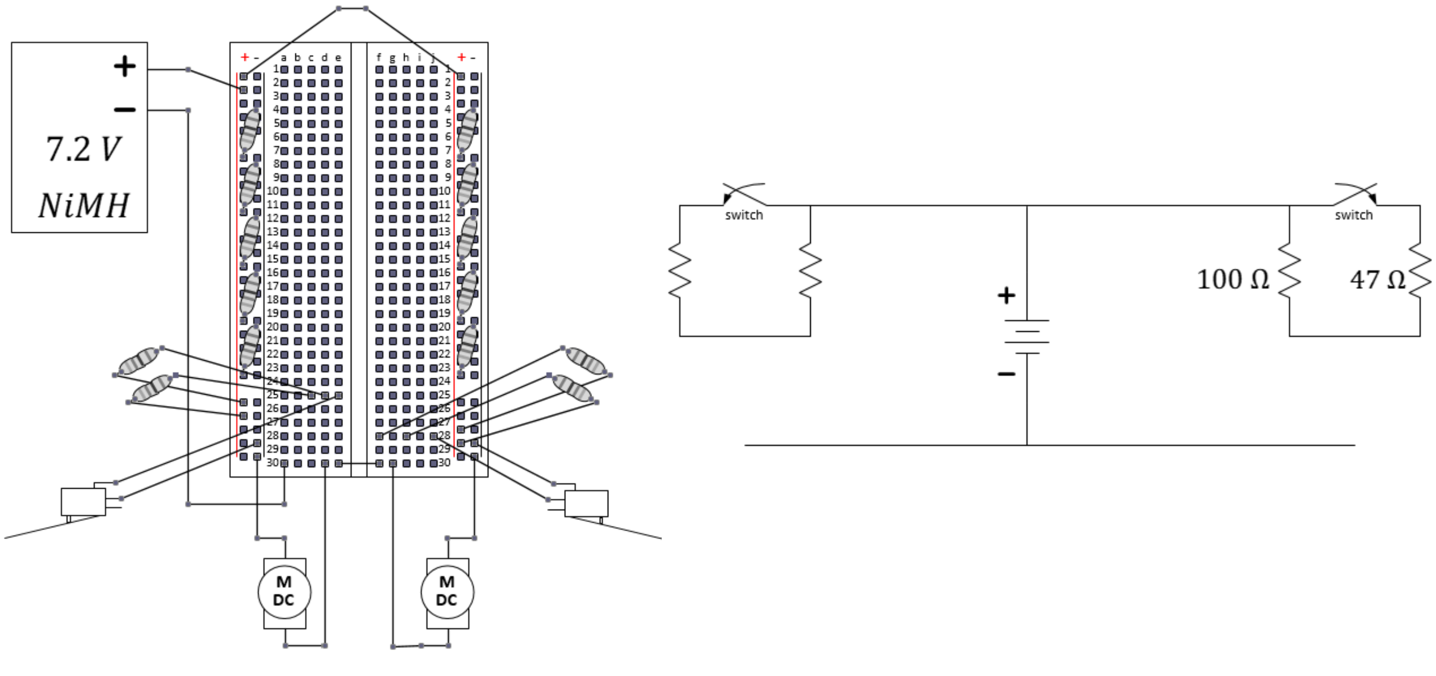

(a) (b)

Figure 3: A physical diagram (a) and the circuit schematic **to be completed by the student** (b) for the same circuit.

Question 4: Build the **resistive network** exactly as show in Figure 3 (a) (but with shorter wires for the four $47 - \Omega$ resistors and be ready for the first breakout session in Lab 3. Remember, a neatly-planned board is much easier to interpret and troubleshoot! Be ready to add the switches, motors, and battery during the Experiment 3 Breakout Session.

Notes:

Reflection…

Think about how this circuit accomplishes these goals:

1. The fastest design would have the car run straight with *no* control action by the operator.
2. Since the car is likely to not perform as expected, some fine-tuning by the operator may be needed.
3. Fine tuning may involve using the snap-action switches not to stop/start the vehicle, but rather to alter the resistive network to change the wheel speeds by small amounts.
4. A resistive network might be allowed to run above its power limit ***only*** in short, occasional bursts.

Question 5: Comment briefly on the power limit of the resistive network. Which resistors are dissipating the most power?

Question 6: Watch the instructional video and read through the Experiment 3 procedures. Doing this in advance will save you a lot of time in the lab, especially this week! (No, there is nothing to answer in the space below ☺)