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(circle one)

PRE-LAB #4: Kirchhoff's Circuit Laws

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!

An Application 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 expand our own exploration of electronics, we again consider these fundamental "laws" of circuit theory.

Last time, we discussed series and parallel paths. Now we introduce an example where the parallel paths might be leveraged to achieve a specific goal.

Think about this...

Even a small current might cause maximum deflection of a **galvanometer**. A better **ammeter** can be constructed by using a sensitive galvanometer plus a "shunt" resistor (a resistor in parallel with the galvanometer). A well-chosen shunt resistor can carry a majority of the current to be measured (think Current Divider Rule) while the galvanometer accurately measures the smaller current. That small current has a known mathematical relationship to the "undivided" current.
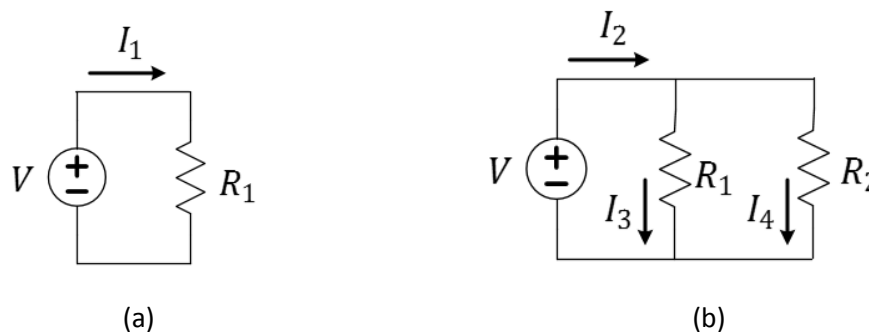

(a)   (b)

Figure 1: An Ammeter might provide two parallel paths for current such that a galvanometer is kept within its natural operating bounds.

Question 1: Try to model this and find a mathematical equation for I_2 in terms of I_3, R_1, and R_2 of Figure 1 (b). State your assumptions. For example, which resistor represents the galvanometer?

Background and Terminology

Within a circuit schematic, we will find junctions, nodes, and loops. We need to understand these definitions as we analyze our circuits. A **junction** is *the connecting point of two or more "wires" in a circuit schematic and, for three or more wires, might be shown as a solid dot*. A **node** is *the equal-potential (constant-voltage) point joining two or more circuit elements*. A node is a concept, not a physical point in a circuit. A node can be larger than a single junction, therefore a junction is merely a subset of a node. The "circle" in the figure below encloses a node. The solid dots are junctions.
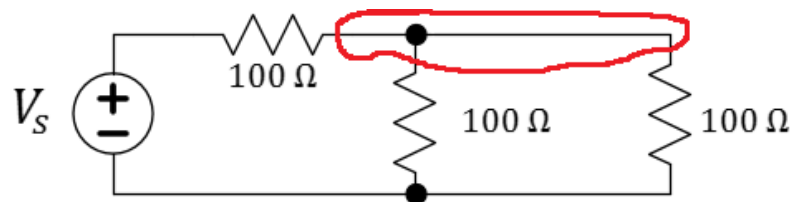

Figure 2: Node example.

Question 2: The circuit schematic in Figure 2 contains three nodes total. One has been circled. Circle the other two.

A **loop** is *a path through a circuit that starts and ends at the same node never crossing through the same circuit element more than once*. The loop in the figure below goes through two different resistors before returning to the same node.
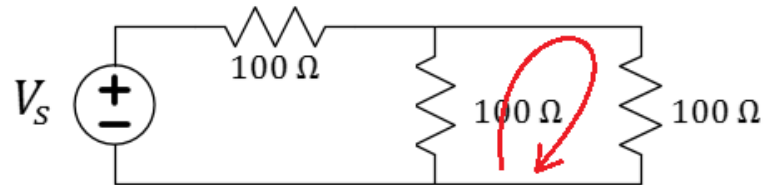

Figure 3: A circuit with a loop labeled.

In the previous lab we learned best practices in taking measurements, plotting graphs, and drawing basic circuit schematics. In this lab we will be employing these skills when we take measurements on some basic *direct-current* (**DC**) circuits. Although the term "direct current" is commonly used in reference to systems with electric charge flowing in a single uniform direction, it is often achieved by supplying the circuit with a constant voltage. Such a supply is often called a *DC-voltage supply* or, more commonly, a *DC-power supply*.

Question 3:   The circuit schematic in Figure 3 contains three possible loop choices. One has been labeled. Label the other two using hand-drawn arrows. HINT: Each of the remaining two loops in this example will pass through the voltage source.

Question 4:   **Build** the circuit of Figure 3 on your breadboard. Do not insert a voltage source, but rather just use the "power rails" for those two terminals so that a voltage source can be easily added during lab. Your TA will check your circuit at the beginning of the lab period and sign below.

☐ TA signature: _____