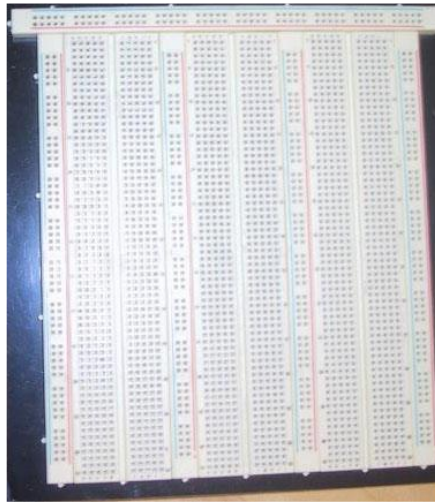


## Appendix F

### Breadboards

In order to implement a circuit in the lab, we are generally going to have to use a breadboard. For now, let's focus on making connections in the center of the board.



**Figure F.1:** Breadboard top view.

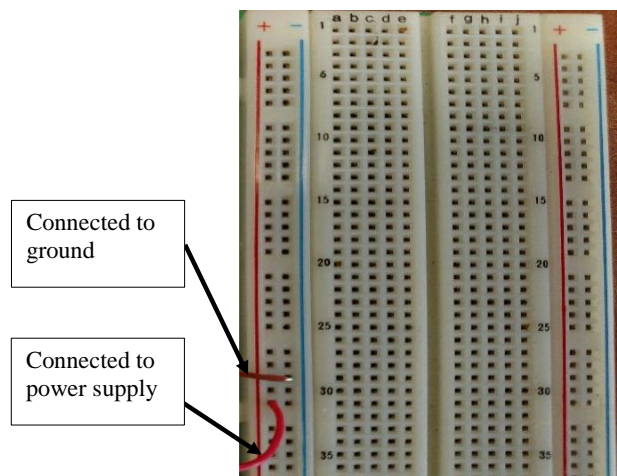
When we consider a circuit, we know we have elements and nodes in the drawing. There are two types of nodes on the breadboard. The first are the nodes created with the horizontal holes. For each row, the holes labeled ABCDE across the top are electrically connected and therefore form one node. FGHIJ on the same line form a DIFFERENT node. See Figure F.2 for details.



**Figure F.2:** Details of the 5 Hole Nodes.

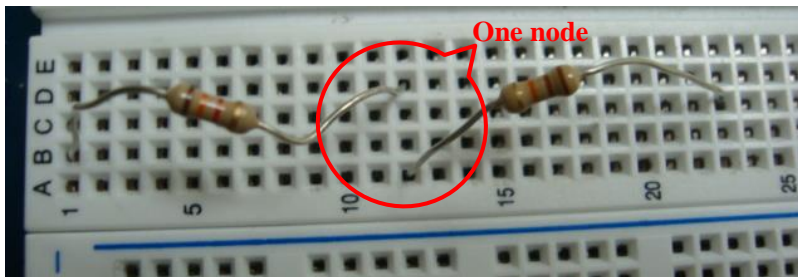
If two elements should be connected to the same node, they could connect to any two of the holes A, B, C, D or E of the same row. The two ends of one element should not be connected in the same node on a breadboard, nor should you try to connect two elements to the same hole in a breadboard.

A second type of node is created with the holes that run in vertical lines. We usually use the vertical nodes for our power sources (+) or as our grounds (-). All the holes in each vertical line are electrically connected to one another. In the breadboard shown in Figure F.3, a voltage source is connected to the (+, red) strip and the ground is connected to the (-, blue) strip. In this case, all of the holes along the red line (on the left of the breadboard) are now connected to the voltage source, and all of the holes along the blue line are grounded. This makes it easy to connect several circuit elements to the voltage source (or to ground). Note, the vertical strips on the right of the breadboard are separate from the ones on the left. That way, if we want to connect a few different voltage sources to the breadboard, we can.



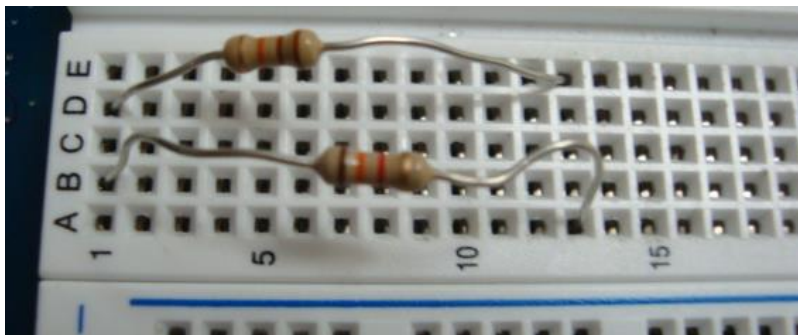
**Figure F.3:** Power and Ground connected to the breadboard.

To connect two elements in series, we make sure the elements share only one node in common as shown in Figure F.4 below.



**Figure F.4:** Two resistors connected in series.

To connect two elements in parallel, we connect one side of each element to the same nodes as shown in Figure F.5 below.



**Figure F.5:** Two resistors connected in parallel.