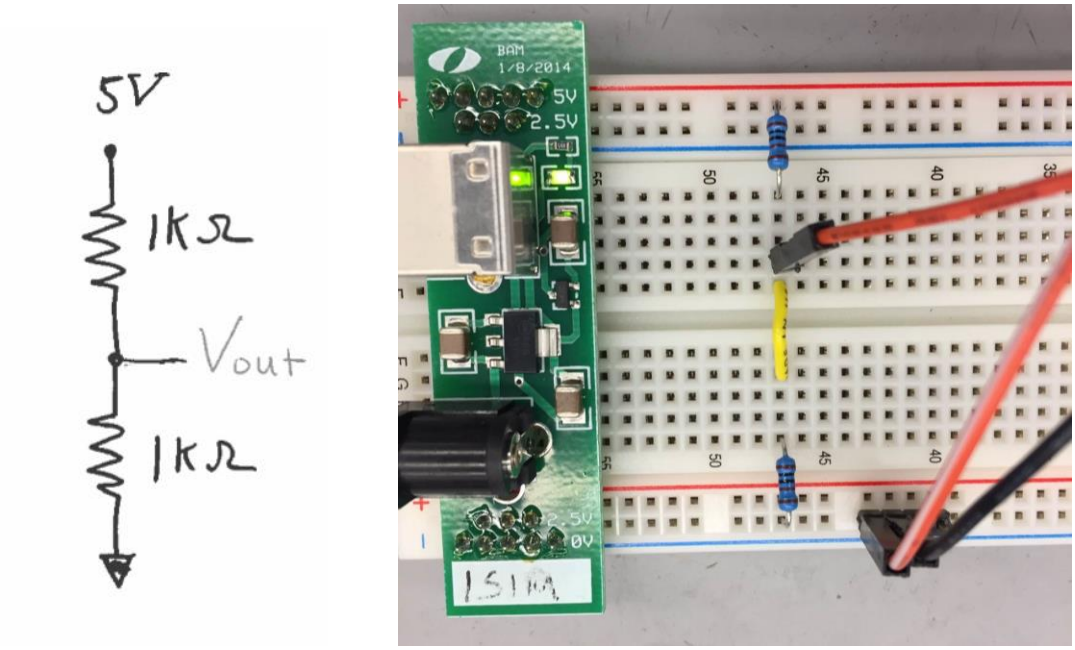
# Resistors in series and parallel

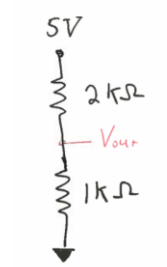
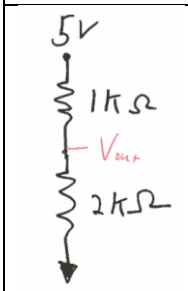
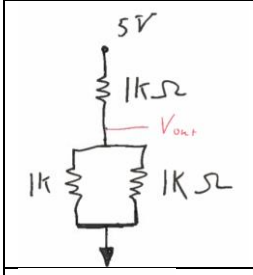
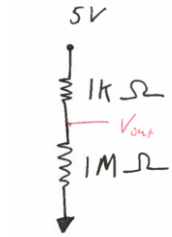
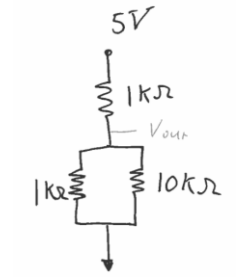
To get started this week, let's use our breadboard and conduct a few very simple experiments with resistors. You should have watched the tutorial video on using the solderless breadboard that helped explain how some the basic connections work. But watching a video is no substitute for doing. If you have never worked with a breadboard, it will take some time and practice to get used to it.

To get you familiar with the breadboard, below we show two equal resistors in series across 5 volts. The measurement, $V_{out}$, is at the midpoint of the resistors and is being done with channel 1 of the Analog Discovery. Below, we show the schematic and an actual implementation on the breadboard. In this case we are using your brand new power supply to provide the constant 5 V.




Your first test will be to create the circuit above, and confirm that with two 1 K resistors in series, that you in fact measure 2.5 volts at $V_{out}$. Depending on how carefully you look at your experiment, you will notice that you don't measure exactly 2.5 volts. One source of error is that you are not supplying exactly 5 volts. You can measure what the actual supply voltage (I measure 5.09 V on my setup) is and take half of that number and see if your measurement is closer to expectation. Another source of error is that the resistors are only specified to within 1% of their target value.

Now that you have the basic idea, analyze and construct each circuit in Table 1 and record the measured and expected voltage in the Table. Fill out the table and include in your lab report for the week.

| Circuit | Expected voltage (include a short calculation) | Measured voltage |
|---|---|---|
|  | | |
|  | | |
|  | | |
|  | | |
|  | | |

Once you have the table complete, construct the following three voltage dividers. All are the same basic circuit and in theory should give the same measured voltage - only the overall value of the resistor is changing. Notice that while you might expect that all circuits would have the same voltage between the two resistors, this is not what you measure. The reason for the departure is that the measurement device has an input impedance (see section 2.4 for an explanation). Make the three measurements below and see if you can infer the value of the Analog Discovery's input impedance. Include your calculation and measurements.

In your lab report, explain your results and compare your analysis and experiments. What value of input impedance for the Analog Discovery best explains your data?