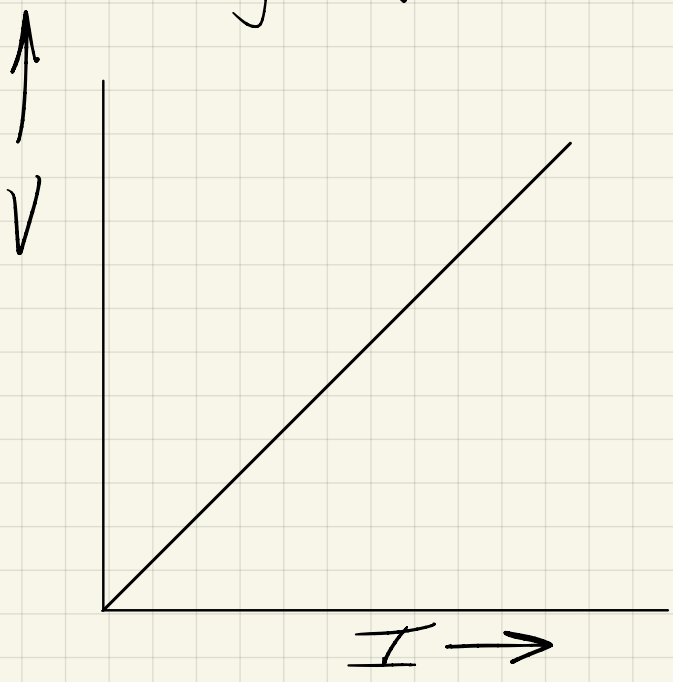
Notes from September 7

Resistors and Batteries

You have various parts in your Arduino kit that have two electrical leads. As examples, you have resistors and diodes. Other parts (synonyms are "components" or "circuit elements") can have three or more leads. If a circuit element has a current flowing through it, there is also some amount of voltage that is causing that current to flow. We can put the current I on one axis and the voltage V on the other axis, and you get an I-V curve:

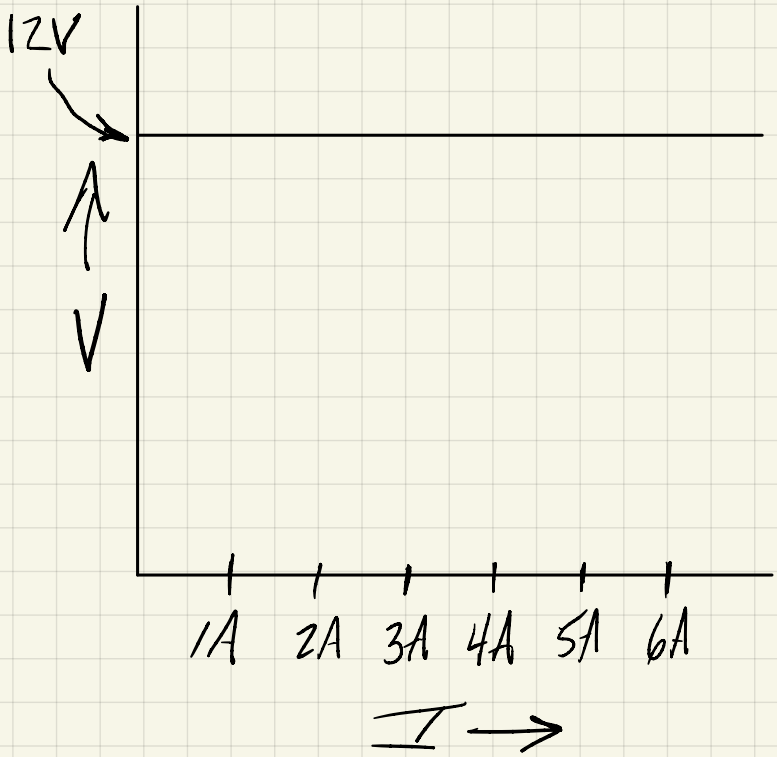


Two important notes:

(1) My example on the left is the simplest I-V curve: a straight line. More on that coming shortly.

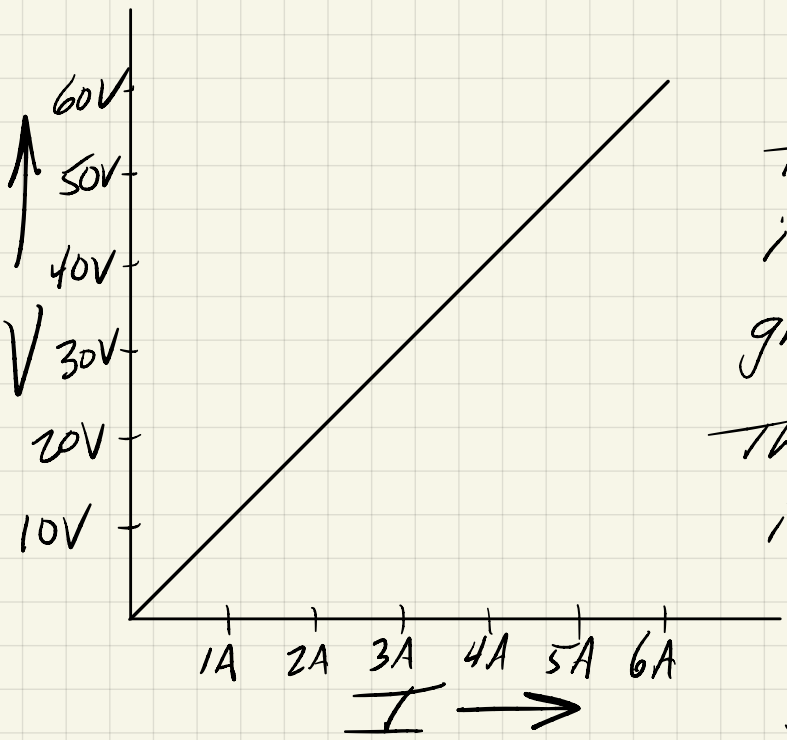
(2) Capital 'V' is the abbreviation for the unit Volts. It is <u>also</u> the variable usually used for an amount of electrical potential or "voltage." You just have to deal with it the same way as in mechanics you have to deal with M sometimes meaning meters and sometimes being the variable for mass.

Here's another I-V curve:

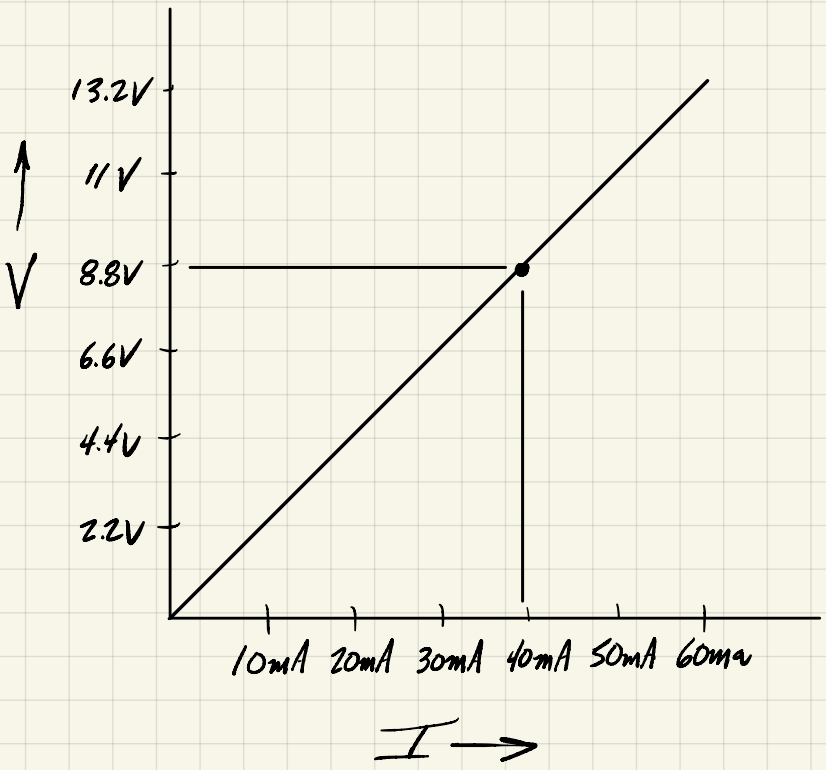


That is the I-V curve for an ideal 12V battery. Why "ideal"? Because a real 12V battery, even a big 12V car battery, actually drops in voltage slightly the more current you draw from it.

Let's go back to the first example:



A straight line passing through the origin is the I-V graph of a resistor. The slope of the line is the resistance. In this example the slope is $10 \frac{V}{A}$



Estimate the slope of that I-V graph

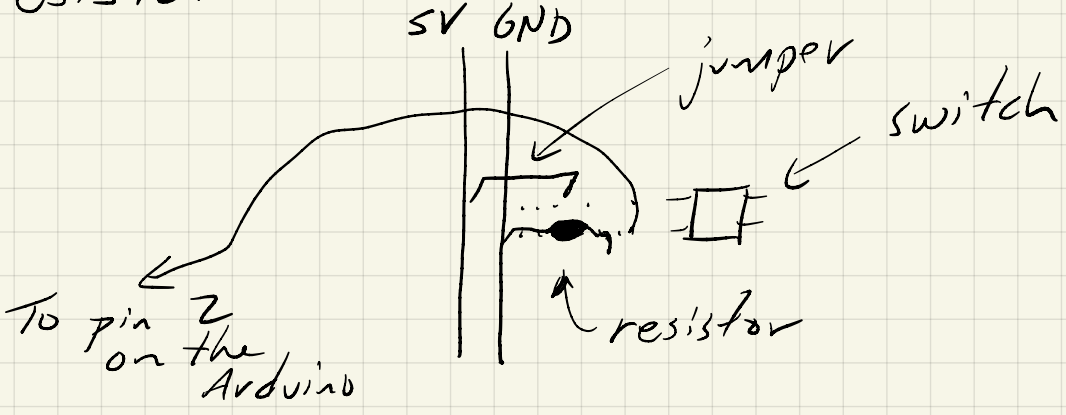
$$\frac{8.8\,V}{40\,mA} = \frac{8.8\,V}{0.04\,A}$$

$$= 220\,\frac{V}{A}$$

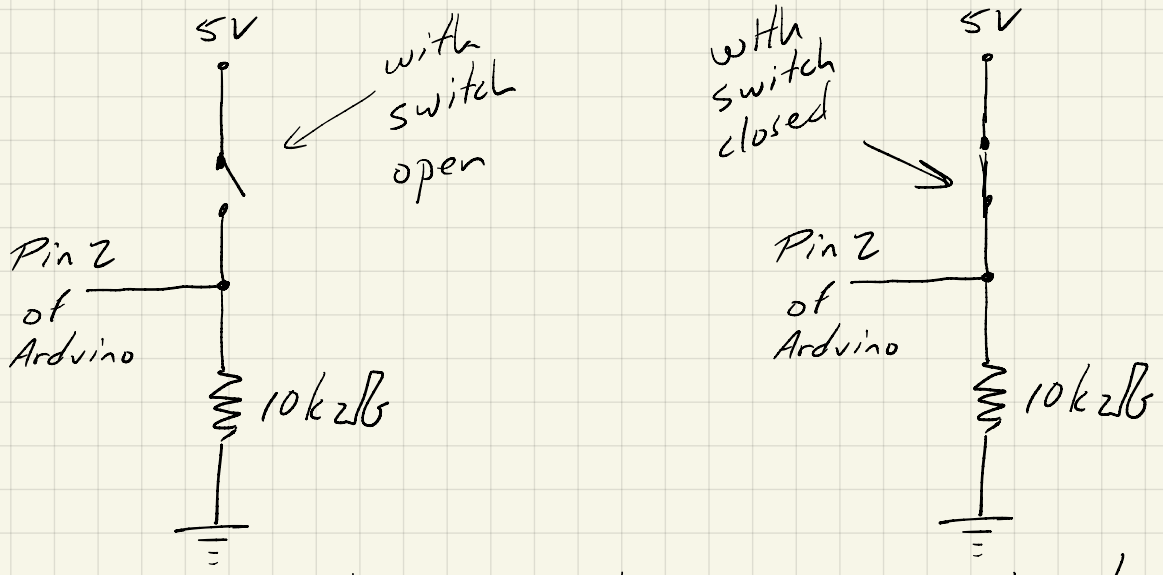
The combination $\frac{V}{A}$ is so common it has a name, the Ohm, abbreviated Ω.

So that is the I-V graph of a 220Ω resistor!

In the spaceship interface there was a switch and a 10kΩ resistor:



The schematic for that part of the circuit looks like this:



If the switch is closed, then clearly Pin 2 of the Arduino is at 5V (pin is "HIGH"). If the switch is open, the 10kΩ resistor is connecting Pin 2 to ground. To be LOW an Arduino pin must be connected to ground through a resistor that is at <u>maximum</u> 10kΩ. This is called a "pull-down" resistor, because it "pulls" pin 2 "down to ground" when the switch is open.

Questions for you: (1) How much current is flowing through the pull-down resistor when the switch is closed? (2) How much power is being wasted by the pull-down resistor when the switch is closed?