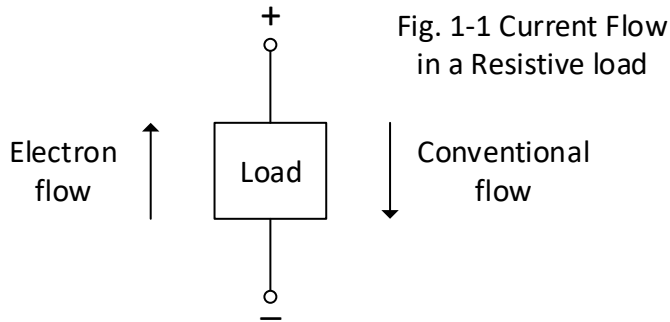


1 Electric Circuits:

Current flow in a resistive load flows either from (-) to (+) which is labeled below as Electron flow or the Conventional flow from (+) to (-). We will use conventional flow in this text. Most texts use Conventional flow as the standard reference for current flow



Loads:

A Load references any device connected to a source of energy. A good example of an energy source would be a battery. Another example would be a power supply or wall outlet. Another would be a solar panel. An example of a load might be a light bulb, a resistor, a motor or a computer. Anything plugged into a source would be a load. The flow of electrons flow from negative to positive but we refer to the current flow from positive to negative and label this current as a positive current. Ben Franklin was responsible for the mix-up and we have lived with the mistake ever since.

The Relation of the Voltage and Current => Resistance:

What all loads have is a property called resistance. Resistance of a load opposes the flow of electrons. A low resistance occurs if a great deal of current flows while a high resistance occurs if only a little current flows through the load. Included in the formula also is the energy or voltage across the load. The definition of resistance is stated below:

$$R = \frac{V}{I}$$

Where R = resistance

V = voltage

I = current

The definition can also be written as $V = I \cdot R$. We relate this equation to the familiar equation $y = mx + b$ where $b = 0$. With $b = 0$, the intersect of the graph is at (0,0). The y value is the dependent variable and the x value the independent variable. The graph is a straight line graph in both the positive and negative direction.

The equation can also be written $I = (1/R) \cdot V$. This equation resembles much more the $y = mx + b$ equation since we usually vary the V value (independent variable) and record the value of I (dependent variable).

For the value of V (Voltage) = 12 V and I (Current) = 2A, find R:

$$R = \frac{V}{I} = \frac{12 \text{ V}}{2 \text{ A}} = 6 \text{ V/A}$$

Changing V to 18 V and current to 6 A gives the value of Resistance:

$$R = \frac{V}{I} = \frac{18 \text{ V}}{6 \text{ A}} = 3 \text{ V/A}$$

Units for Voltage is volts (V). Units for Current is amps (A). Units for resistance is ohms (Ω).

The linear relationship of the equation is equal to the standard equation discussed above. There are many linear resistances or loads. One is the resistor found in the lab kit for the course and shown in Fig. 1-2a below. Other devices such as the diode in the kit are not linear. The graph of the diode is shown below in Fig. 1-2b and displays a non-linear voltage/current relationship. What resistor in the lab kit is the one referenced in Fig. 1-2a?

Figure 1-2 a
Linear Resistance

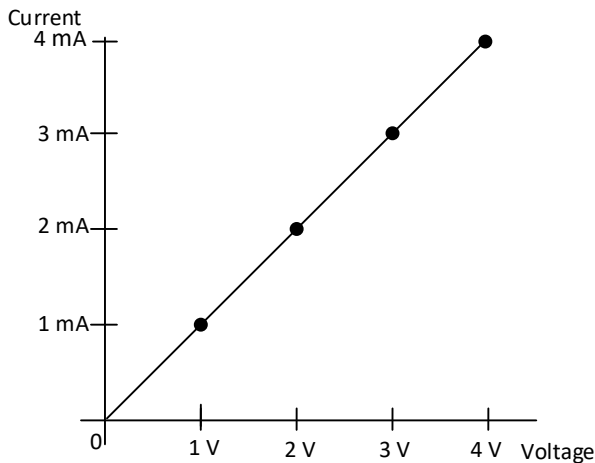
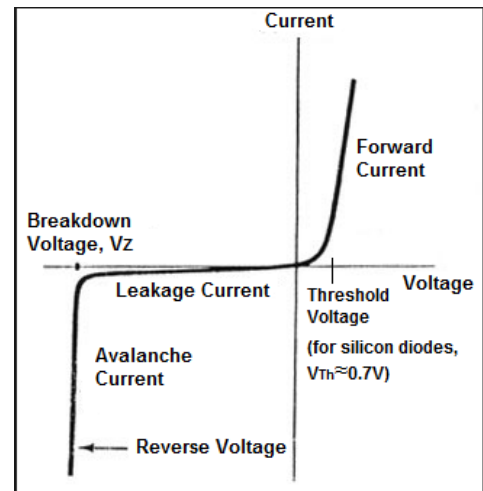


Figure 1-2 b
Non-Linear Resistance



Different equations for Ohm's law are:

$$R = \frac{V}{I}$$

$$V = R \cdot I$$

$$I = \frac{V}{R}$$

For V=10, I=2 mA, R = ?

$$R = \frac{V}{I} = \frac{10}{0.002} = 5000 \Omega = 5 \text{ k}\Omega$$

R is the value of resistance for the two values of V and I. If a graph is given, then 1/R is the slope. The value of the slope is equal to:

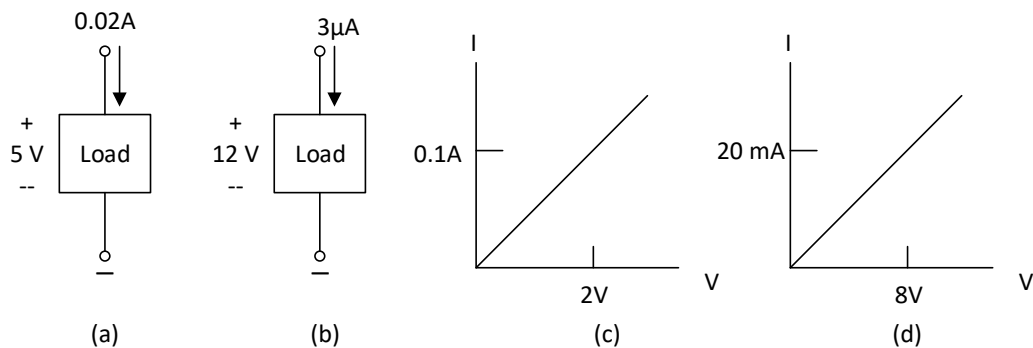
$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

and since the resistance cuts through (0,0), $y_1 = 0$ and $x_1 = 0$ we can write:

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{y_2}{x_2} = \frac{1}{R}$$

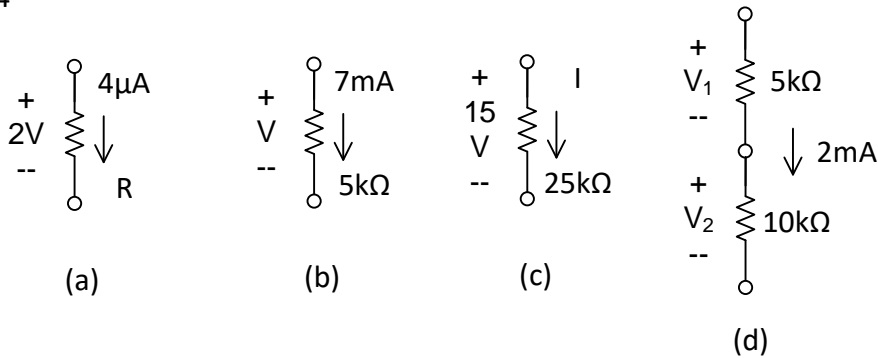
Homework 1

Fig. 1-3



- 1-1 For the load of Fig. 1-3a, find the resistance.
- 1-2 For the load of Fig. 1-3b, find the resistance.
- 1-3 For a typical household voltage of 110 V from which 12 A of current flows, what is the load (resistance).
- 1-4 For a dc electric motor of 90 V with 7 A running through it, what is the load (resistance) of the motor?
- 1-5 For the graph of current vs voltage in Fig. 1-3c, find the current when voltage = 4 V, 8 V.
- 1-6 For the graph of current vs voltage in Fig. 1-3d, find the current when voltage = 15 V.
- 1-7 For the graph of current vs voltage in Fig. 1-3c, find the voltage across the load when current = .3 A. What is the resistance of this load?
- 1-8 For the graph of current vs voltage in Fig. 1-3d, find the voltage across the load when current = 35 mA. What is the resistance of this load?

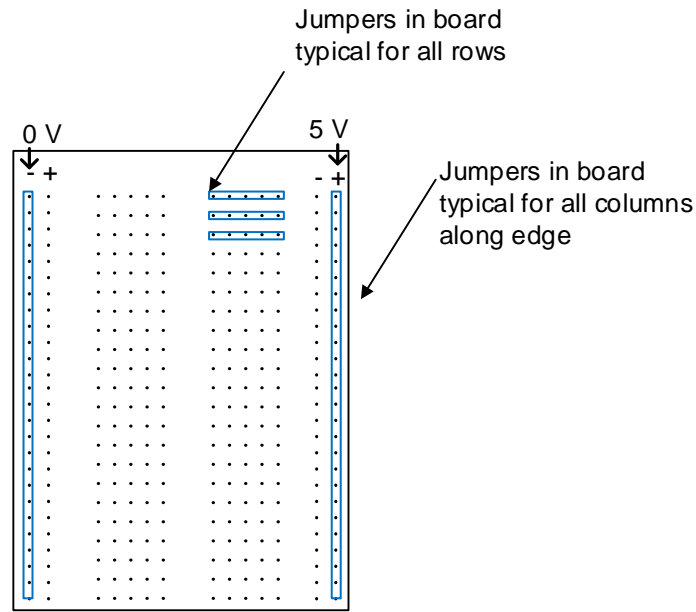
Fig. 1-4



- 1-9 Find the resistance of Fig. 1-4a:
- 1-10 Find the voltage across the resistance of Fig. 1-4b:
- 1-11 Find the current across the load of Fig. 1-4c:
- 1-12 Find the voltages V_1 and V_2 in Fig. 1-4d:
- 1-13 After finding the resistance of Fig. 1-4a, calculate the current if the voltage is changed to 14 V.
- 1-14 If the current of Fig. 1-4b is 21 mA, what is the voltage?
- 1-15 If the voltage of Fig. 1-4c, is 45 V, what is the new current?
- 1-16 If the current of Fig. 1-4d is changed to 5 mA, what are the new values of V_1 and V_2 :
- 1-17 If one amp equals 1 coulomb per second ($Q=It$) and one coulomb equals $6.24159 \cdot 10^{19}$ electrons, find the number of electrons flowing in each of the circuits of Fig. 1-4 above.
- 1-18 For the diode graph of Fig. 1-2b, identify areas of high and low resistance.

Pre-Lab General Skills:

For breadboards used in this course, we find the following jumpers under the board's holes:



For a circuit to be completed, jumper wires are used. A typical set-up would be similar to:

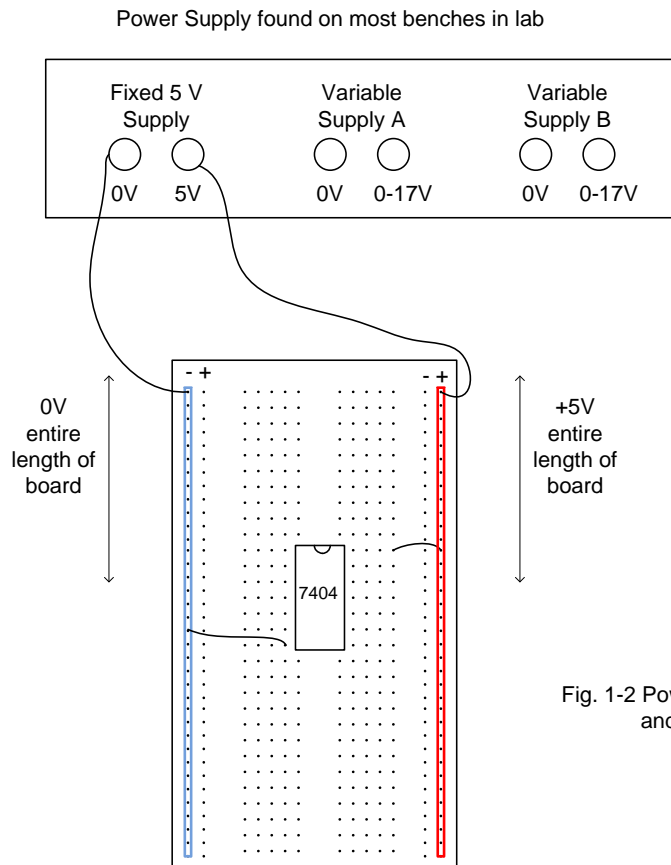
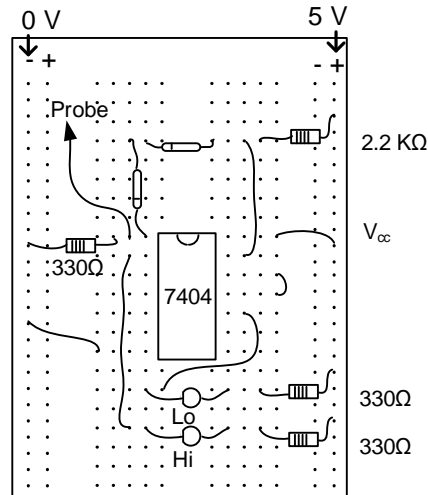


Fig. 1-2 Power to Breadboard and 7404 Chip

Completion of the circuit would resemble:



Color	Digit	Multiplier
BLACK	0	
BROWN	1	$\times 10^0$
RED	2	$\times 10^2$
ORANGE	3	$\times 10^4$
YELLOW	4	$\times 10^6$
GREEN	5	$\times 10^8$
BLUE	6	$\times 10^{10}$
VIOLET	7	
GRAY	8	
WHITE	9	

EXAMPLE: 47,000 Ohms or 47-K Ω .
 1st Digit - 4
 2nd Digit - 7
 Multiplier - 0.000
 Tolerance - 2% - Red
 5% - Gold
 10% - Silver

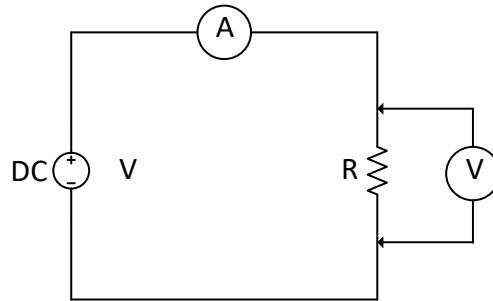
Resistor Color code

When reading voltage, current and resistance, use the Keysight Multimeter. To measure ohms (resistance), turn on the Multimeter, push the Ohms button and connect an unknown value of resistance to the inputs using connectors in the lab as shown below:

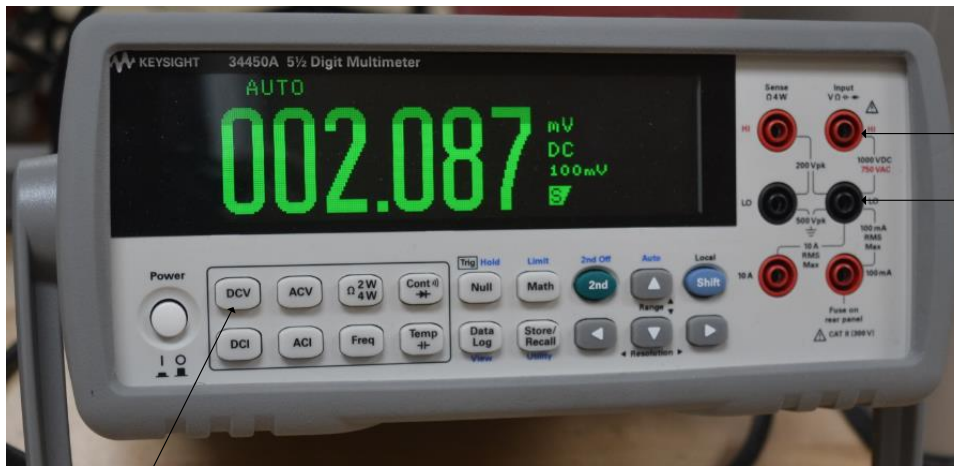


Set to Ohms

For measuring voltage and current, the following must be followed. For voltage, measure across the resistor. For current, break the circuit and make the current run through the meter before or after the resistor.



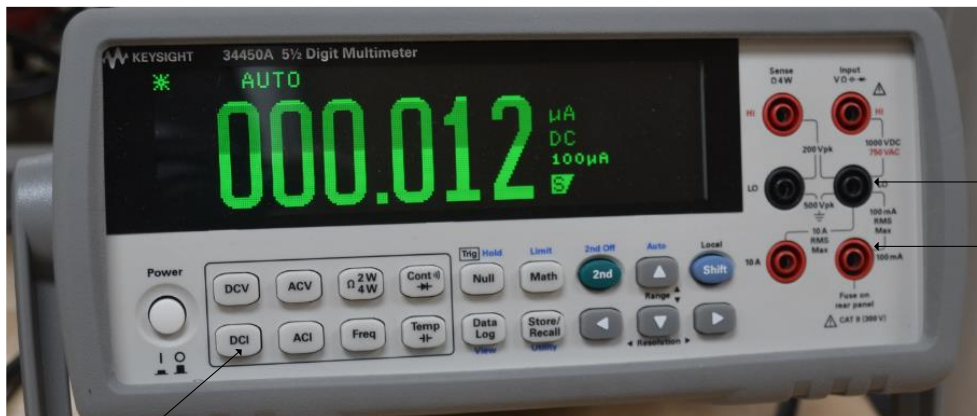
For the voltage reading, be sure to set the multimeter to DCV. Also use the terminals shown:



Use these two terminals for leads:

Set to DCV

For the current reading, be sure to set the multimeter to DCI. Also use the terminals shown and remember to 'break' the circuit as shown above:



Use these two terminals for leads:

Set to DCI