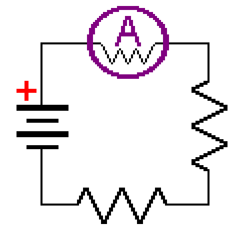
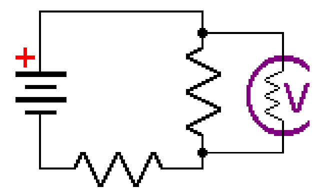
Lab - The Resistivity of Play-Doh

About Voltmeters and Ammeters

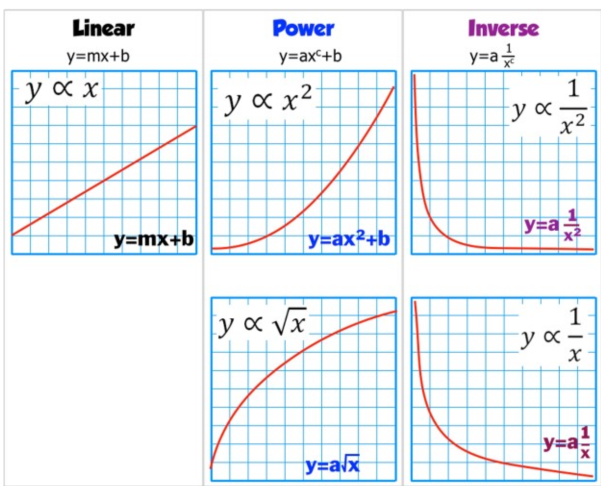


An ammeter measures current *through* a circuit element; therefore **it must be connected in series** with it. **An ammeter should have a much lower resistance** than the other elements in the circuit; otherwise current may change significantly.

A voltmeter measures voltage *across* a circuit element; therefore **it must be connected in parallel** with it. **A voltmeter should have a much higher resistance** than the element in parallel; otherwise voltage will change significantly.



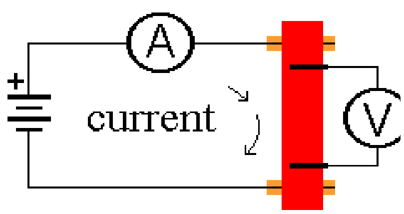
Graphs, Proportionalities and Relationships

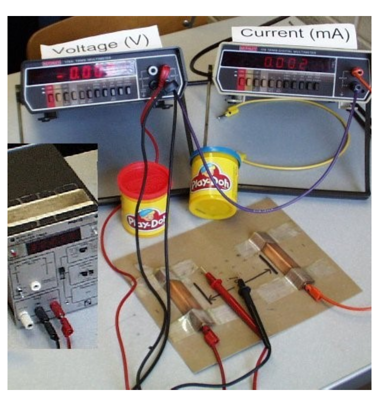


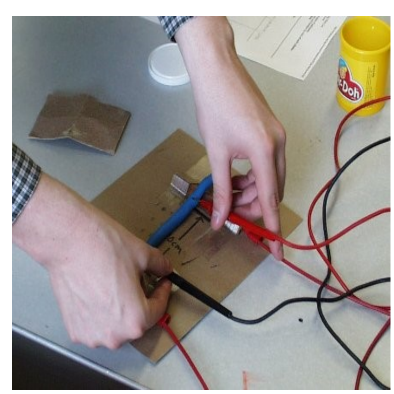
The graphs shown to the left represent y quantity is proportional to x quantity or $y \propto x$ (linear relationship). y quantity is proportional to x quantity squared, cubed, square root of x etc. or $y \propto x^2$ for example, (power relationships) and y quantity is inversely proportional to x quantity or x quantity squared (inverse and inverse square relationships). For example, "The gravitational force varies as the inverse square of the distance separating the centres of mass" could be written as the relationship $F_g \propto \frac{1}{r^2}$. Linear, power and inverse relationships are often seen when scientific data is graphed.

Measuring Resistance Using the Play-Doh Circuit

A power supply is used to drive a current through various cylinders of Play-Doh. By using an ammeter and voltmeter as shown, the resistance of a given length of Play-Doh can be determined. This configuration is used rather than a simple ohmmeter to avoid problems with contact resistance -- the Play-Doh tends to "break down" at the one contact!







Play-Doh: Length Dependence of Resistance:

The resulting values of voltage across various lengths of a Play-Doh cylinder are given below. Note that the values of current through the Play-Doh are constant. Corresponding values of resistance are calculated using Ohm's law.

Length (cm)	**Voltage (V)**	**Current (A)**	**Calculated Resistance (Ω)**
2.0			
4.0			
6.0			
8.0			
10.0			
12.0			
14.0			

Construct the Resistance vs. Length graph below. Is resistance proportional to length? ________
Explain.

Part II: The Dependence of Resistance on Cross-sectional Area of a Resistor

Procedure:

- Roll 10 cm long cylinders of as many **diameters** as material and time permits (see table below). Cooperate with the other groups.
- Write an algebraic expression for resistivity in terms of resistance, length and area.

- Cover the full range; that is, make cylinders numbers 9, 7, 5, 3, and then 1. Fill in the intermediate values next. Make each cylinder about 12 in long; it will be necessary to measure the larger cylinders before fabricating the smaller ones.
- The quality of the experimental results will depend strongly on the uniformity of the cylinders.
    - Same diameter over the entire length
    - No cracks or voids, **knead thoroughly** before rolling

Cylinder	**Diameter**	**Area**	**Current**	**Voltage**	**Resistance**	**Resistivity**
	(m)	(x 10^{-5} m^2)	(A)	(V)	(Ω)	(Ω·m)
1	0.008	5.0				
2	0.009	6.4				
3	0.010	7.85				
4	0.011	9.5				
5	0.013	13.3				
6	0.016	20.1				
7	0.020	31.4				
8	0.024	45.2				
9	0.026	53.1				
Mean Resistivity						

    - Record voltage across 10 cm of material.
    - Record current through cylinder.
    - The two measurements above should be made simultaneously!
- For each cylinder:
    - Calculate its resistance using Ohm's law.
    - Calculate its cross-sectional area.
    - Report the colour of the Play-Doh sample here: _____________________.

Construct the Resistance vs. Cross-sectional Area graph below.

Construct the Resistance vs. the Reciprocal of Cross-sectional Area graph below.

Is resistance inversely proportional to cross-sectional area? ______________ . Explain.