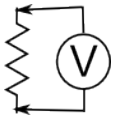
Voltmeters and ammeters

An ammeter is used to measure current flowing through any point (on one end of a resistor, for example, which would also be the current at any point within the resistor). To use it, you must place the ammeter in the path of the current, so that all the current at the point of interest also passes through the ammeter. Like this:

Traditionally, ammeters were made from a device called a galvanometer, which basically consists of a wire coil, a magnet, and a needle. When current passes through the coil, the magnetic field exerts a force on the coil, which causes the needle to deflect. The amount the needle deflects (its angle) depends on the current.

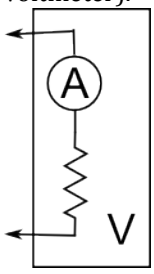
Ideally, since you are inserting an ammeter into the circuit in series (replacing a wire), it is important that the resistance be as *low* as possible so that the potential drop across the ammeter is small enough that it doesn't affect the voltage across other elements in the circuit.

A voltmeter is used to measure the potential difference between any two points, for example, between the two ends of a resistor or between your hand and your friend's hand. To use it, you place a probe at each of the two points between which you want to measure the potential difference. Like this:



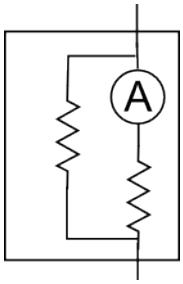
Since you are placing a voltmeter in parallel with other circuit elements, it is important that the current through the voltmeter be very small, so that it doesn't affect the voltage at any other point in the circuit. The resistance of a voltmeter, therefore should be very *high*.

Now, if I have an ammeter, I can make a voltmeter, like this (the thing in the black box is now a voltmeter).



You can change the sensitivity of the voltmeter by adding resistors.

Finally, if I have an ammeter but I want to measure currents that are larger than the maximum reading, I can build circuit that bleeds off just a portion of the current, like this:



Problem:

1. You have an ammeter that has a full-scale reading of 250 mA and an internal resistance of 1.0 Ω.
    a. Design a voltmeter that has a full-scale reading of 10.0 V.
    b. Design an ammeter that has a full-scale reading of 2.5 A.