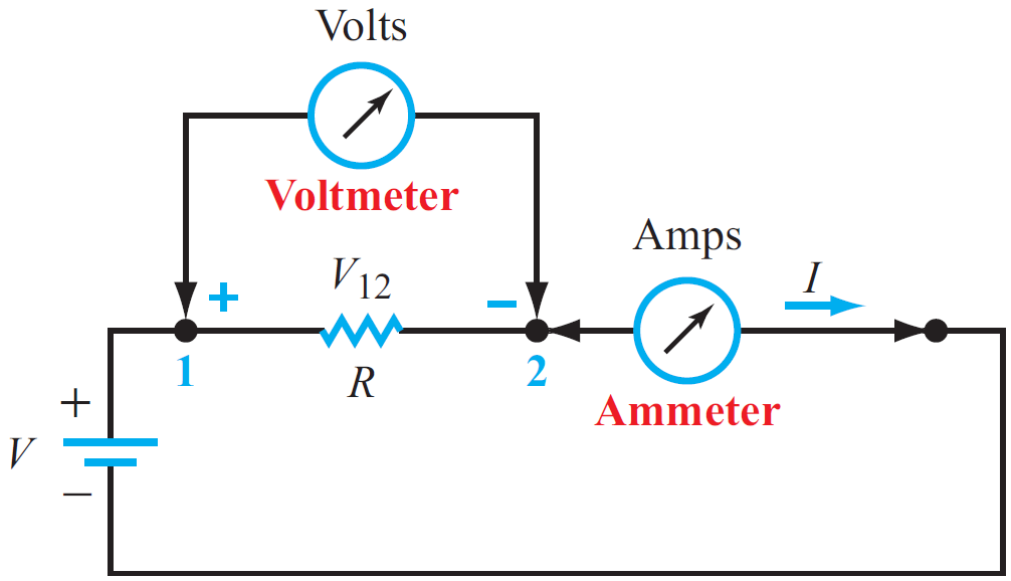
Measuring Voltages and Currents

The **voltmeter** is the standard instrument used to measure the voltage difference between two points in a circuit. To measure V_{12} in the circuit below, we connect the (+) terminal of the voltmeter to terminal 1 and the (−) terminal to terminal 2. Connecting the voltmeter to the circuit does not require any changes to the circuit.

In an ideal case, the voltmeter will not draw any current through itself. This is equivalent to stating that **an ideal voltmeter looks like an open circuit** (i.e. the resistance across it is infinite). This is because if it did draw current, it would change the values of the currents and voltages across what it is measuring (R, in this case).

In reality, the voltmeter has to extract some current from the circuit in order to perform the voltage measurement, but the voltmeter is designed such that the amount of extracted current is so small as to have a negligible effect on the circuit. This is equivalent to stating that **any instrument acting like a voltmeter should have a very large equivalent resistance** relative to what it is measuring (we return to this idea when we discuss amplifiers).



The **ammeter** is the standard instrument used to measure the current flowing between two points in a circuit. To measure I in the circuit above, we insert the ammeter into the current path.

In an ideal case, the ammeter will not produce a voltage across itself. This is equivalent to stating that **an ideal ammeter looks like a short circuit** (i.e. the resistance across it is zero). This is because if it did develop a voltage, it would change the values of the currents and voltages across what it is measuring (the loop current, in this case).

In reality, the ammeter will develop some voltage across itself in order to perform the current measurement, but the ammeter is designed such that the amount of voltage developed is so small as to have a negligible effect on the circuit. This is equivalent to stating that **any instrument acting like a ammeter should have a very small equivalent resistance** relative to what it is measuring (we return to this idea when we discuss amplifiers).