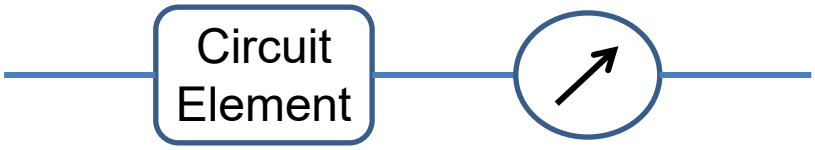
Wheatstone Bridge

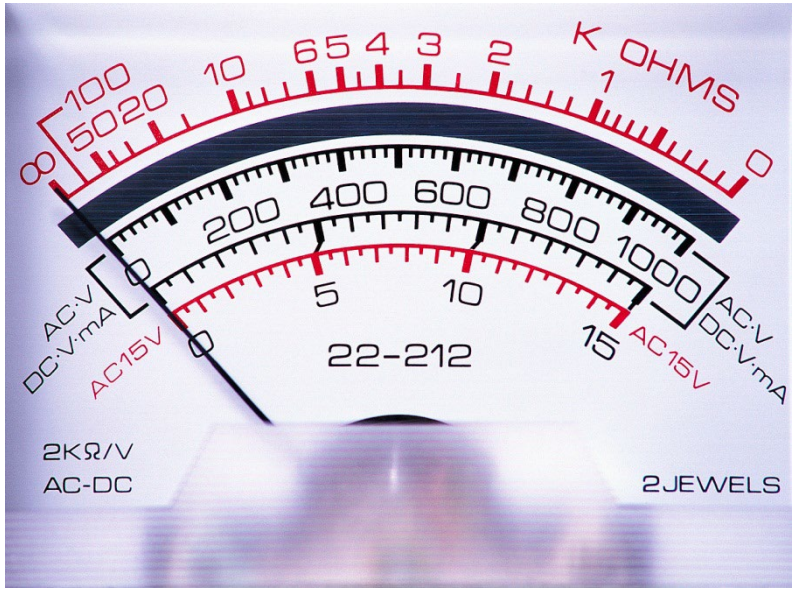
An ammeter is a device which measures the current flowing through it. If we wanted to measure the current through a circuit element, we would place an ammeter in series with that element.



Ammeter

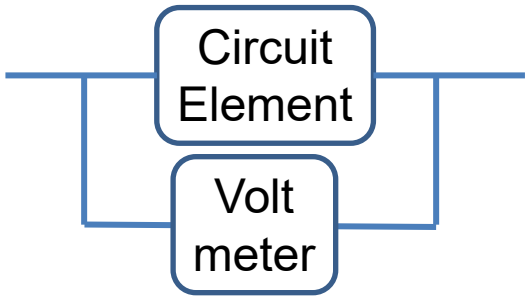
In order to make a proper current measurement, it is important that placing the ammeter in series with the circuit element does not alter the current flowing through the element.

Q: What kind of internal resistance would we want an ideal ammeter to have to insure that it does not alter the flow of current?



Wheatstone Bridge

An voltmeter is a device which measures the voltage across its terminals. If we wanted to measure the voltage through a circuit element, we would place an voltmeter in parallel with that element (place the terminals of the voltmeter across the terminals of the circuit element).

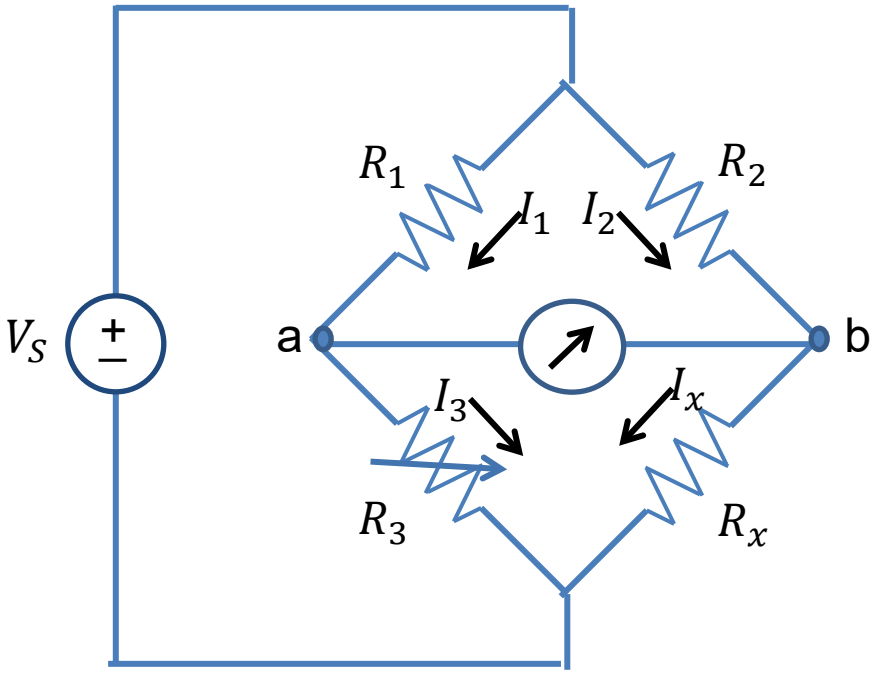


In order to make a proper voltage measurement, it is important that placing the voltmeter in parallel with the circuit element does not alter the voltage across the element.

Q: What kind of internal resistance would we want an ideal voltmeter to have to insure that it does not alter the voltage across the circuit element?

Wheatstone Bridge

A Wheatstone Bridge is a circuit whose purpose is to measure the value of an unknown resistor, R_x.



The resistance of the potentiometer is varied until the ammeter shows no current flowing between nodes a and b. There will also be no voltage drop (why?). In that case we have:

$$I_1 = I_3 \qquad I_2 = I_x$$
$$R_1 I_1 = R_2 I_2 \qquad R_3 I_3 = R_x I_x$$

Using these relationships, we deduce that:

$$R_x = R_3 \frac{I_3}{I_x} = R_3 \frac{I_1}{I_2} = \frac{R_3 R_2}{R_1}$$

Example

The bridge circuit is balanced when $R_1 = 100\Omega, R_2 = 1000\Omega$, and $R_3 = 150\Omega$.
a) What is the value of R_x?
b) Suppose each resistor is capable of dissipating 250mW. Can the bridge be left in the balanced state without damaging the circuit?