

Multimeter Loading Effects

Objectives:

Describe the circuit loading effect of multimeters.

Describe how the multimeter loading is reduced.

Describe the Ohms per volt rating of analog multimeters.

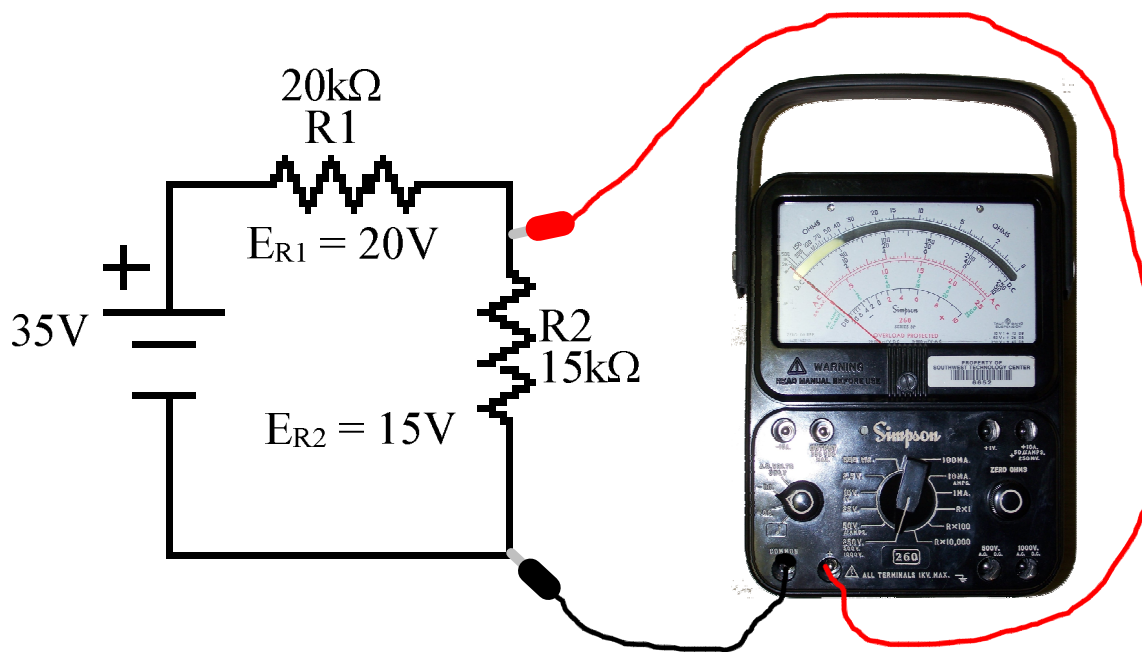
Measure circuit voltages using an analog and digital multimeter.

Observe the loading effect of an analog multimeter.

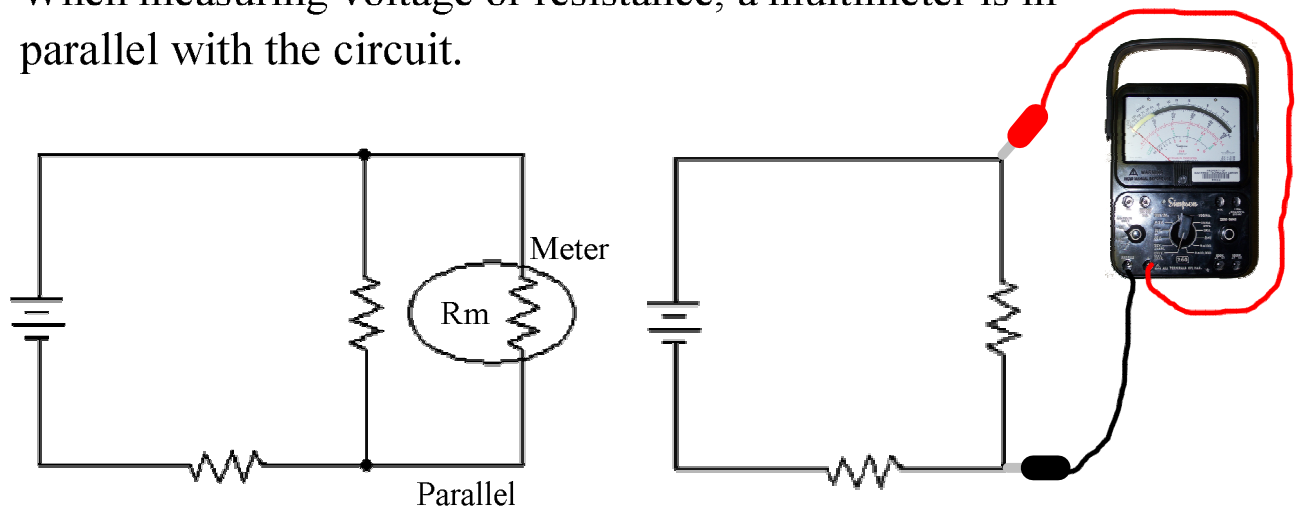
Multimeter loading effects

Multimeters measure at least three quantities: Voltage, Current & Resistance.

Multimeters have an internal resistance: R_M



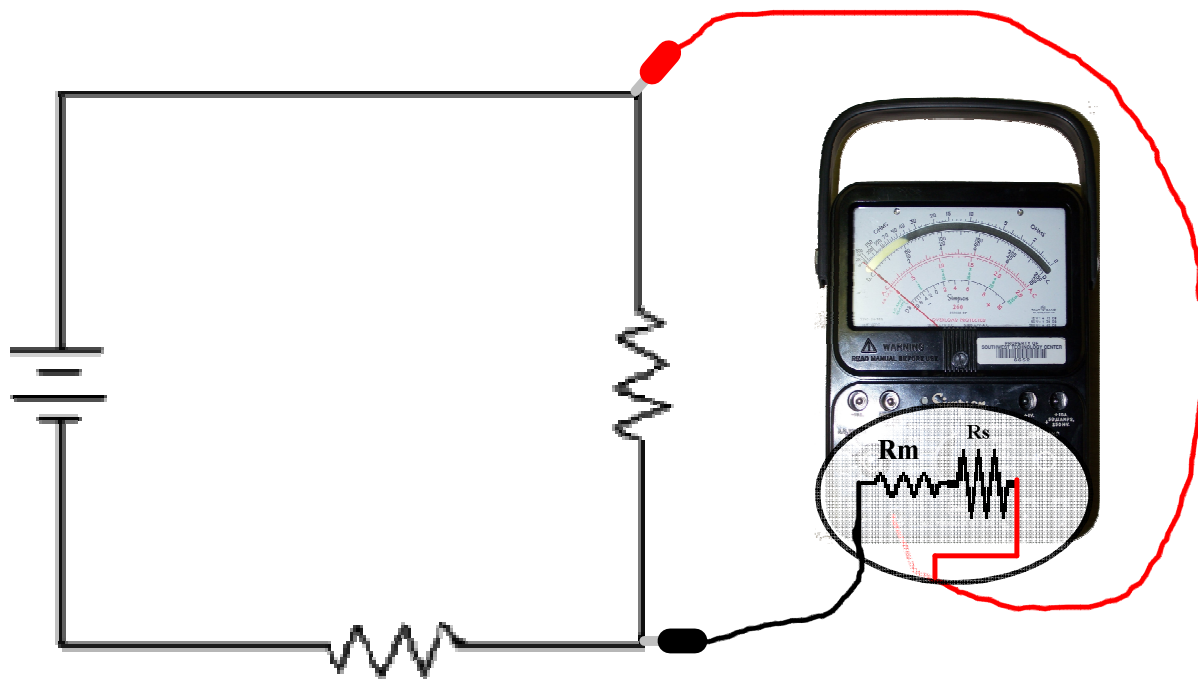
When measuring voltage or resistance, a multimeter is in parallel with the circuit.



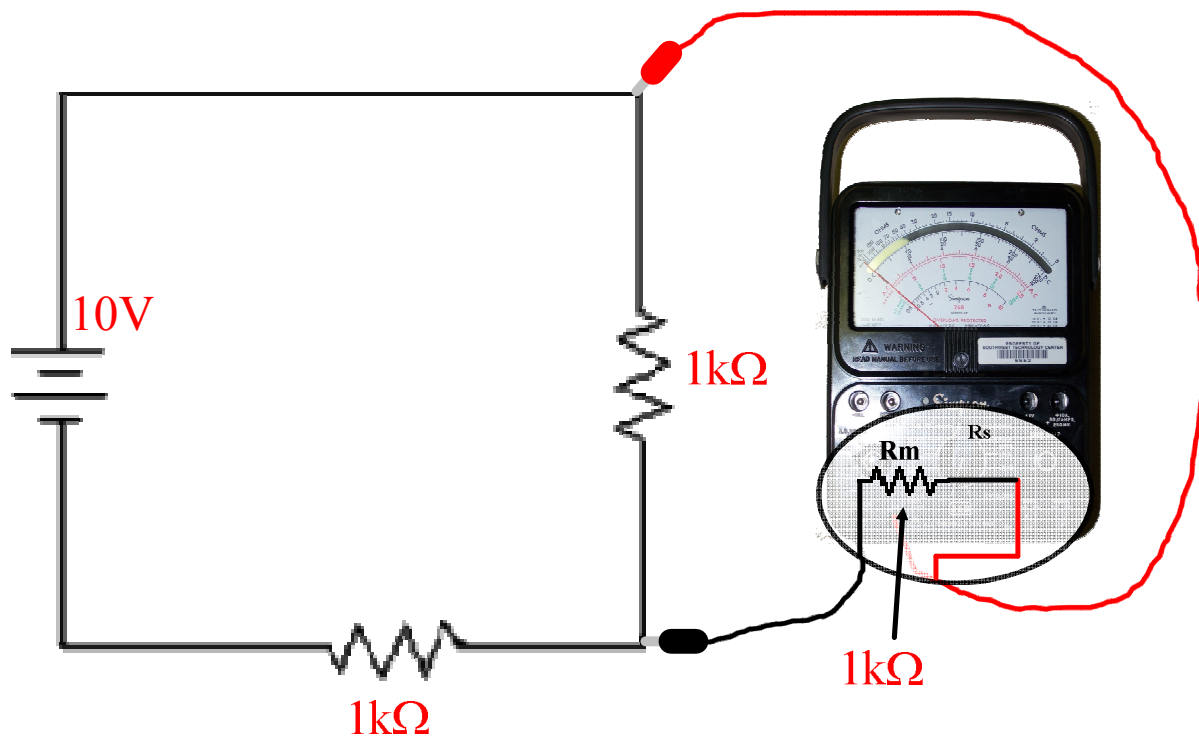
Total resistance decreases, specifically the component being measured.

Current increases because total circuit resistance decreased.

When measuring voltage, the loading effect is reduced by adding a big series resistance (R_s).

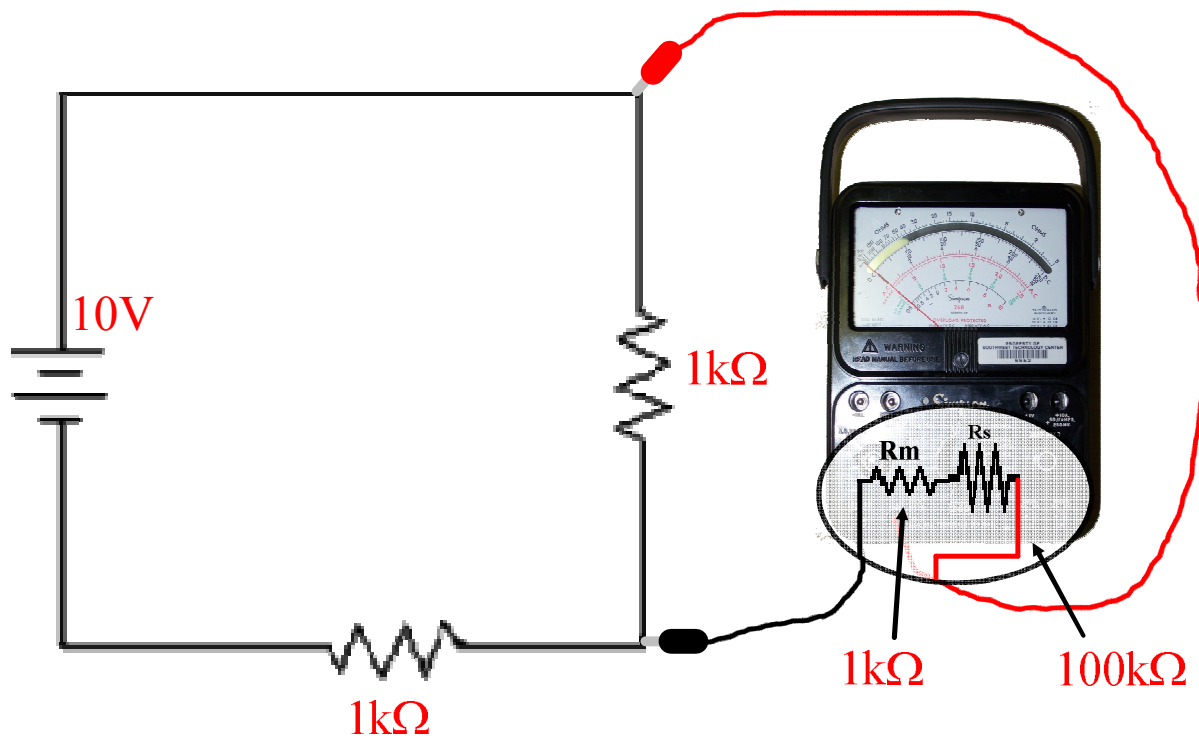


R_m with big series resistance (R_s) added.



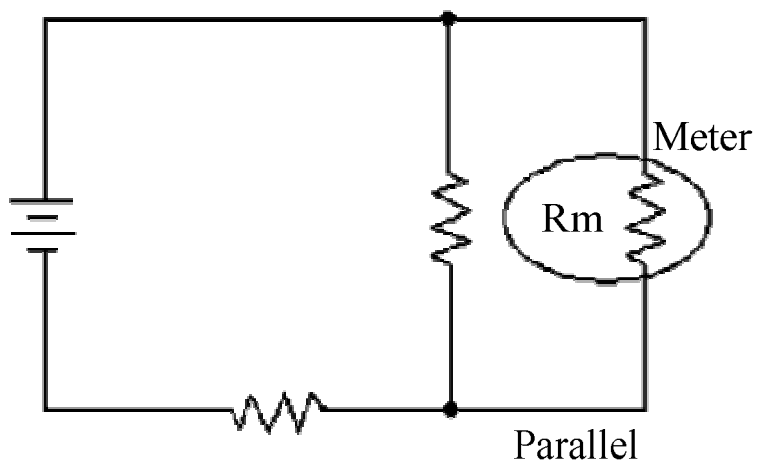
Measured value = $\frac{\text{Measured value}}{\text{Measured value} + R_s} \times 10$

R_m with big series resistance (R_s) added.



Percent error: $\frac{R_m}{R_s + R_m} \times 100\%$
Measured value: $V_m = \frac{R_s}{R_s + R_m} \times V_s$

Analog meters have an Ohm's per volt (Ω/ V) rating.

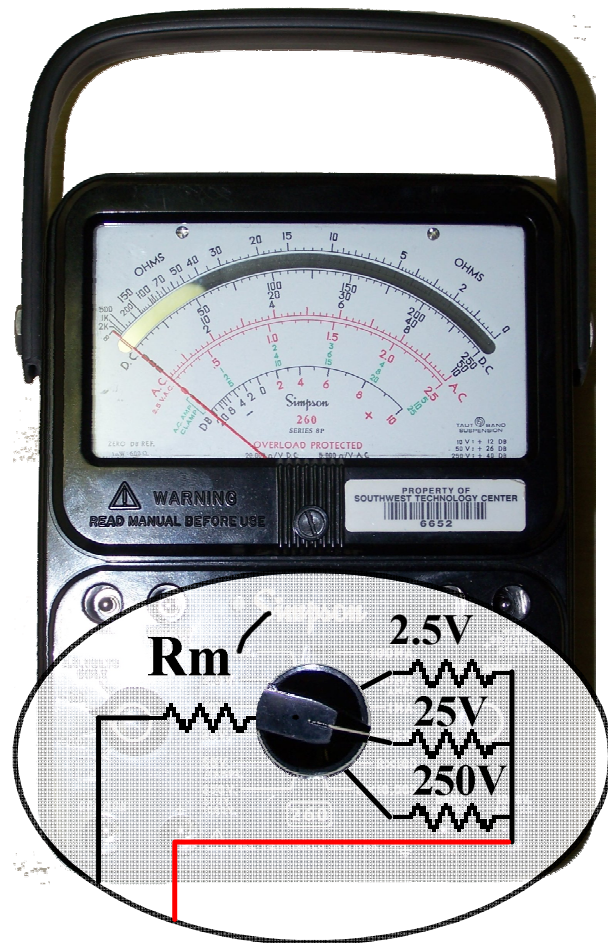


If a multimeter had a $20,000 \Omega/ V$ rating, what would be the resistance of the multimeter if it was set at $25V$?

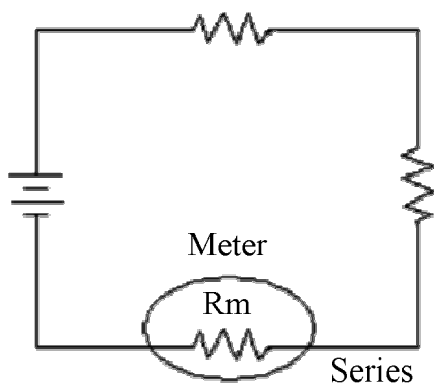
If a multimeter had a 20,000 Ω/V rating, what would be the resistance of the multimeter if it was set at 25V?

What would be the resistance if the multimeter was set at 250V?

What would be the resistance if the multimeter was set at 2.5V?



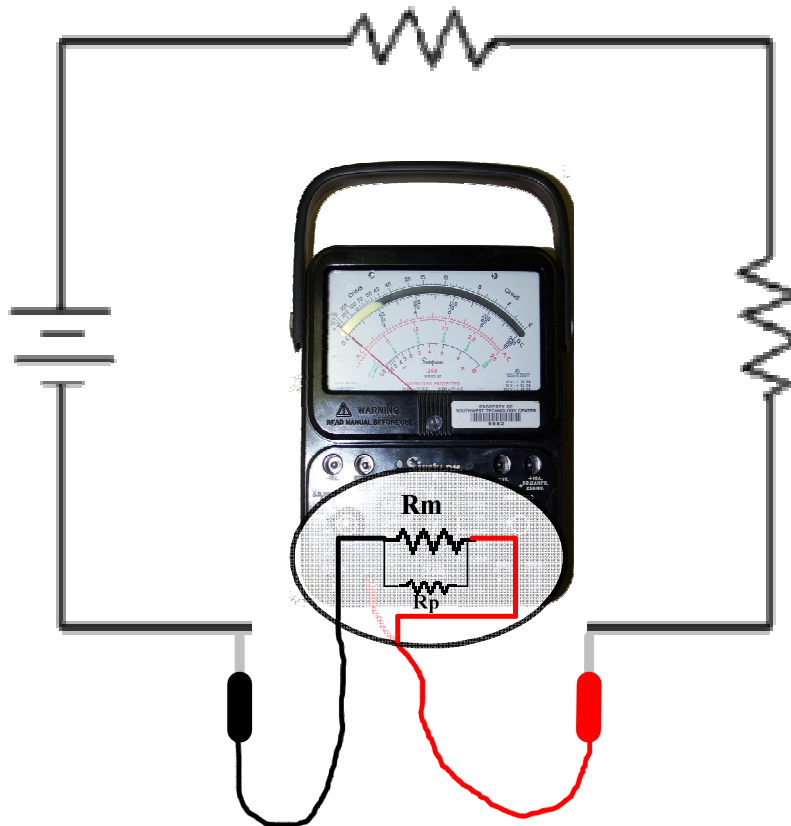
When measuring current, a multimeter is in series with the circuit.



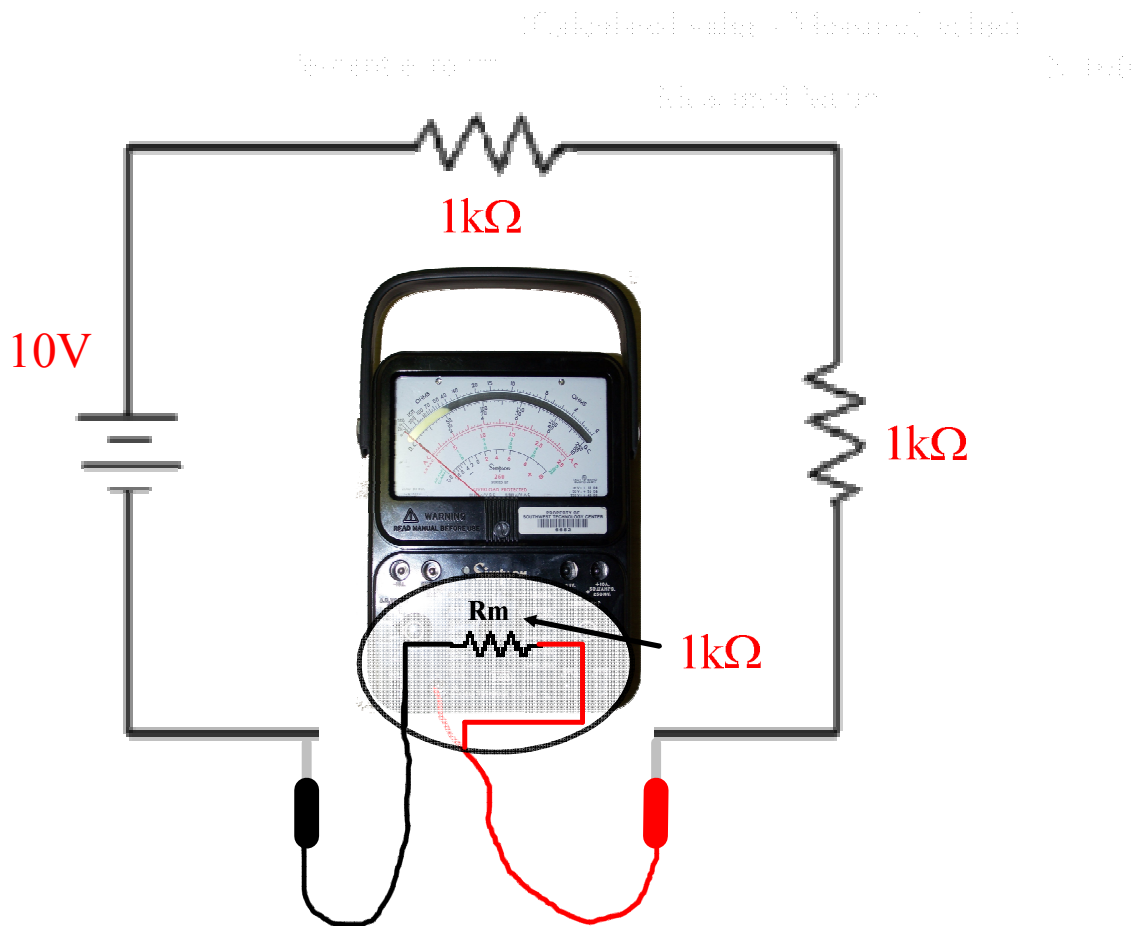
Total resistance increases.

Current decreases because resistance increased.

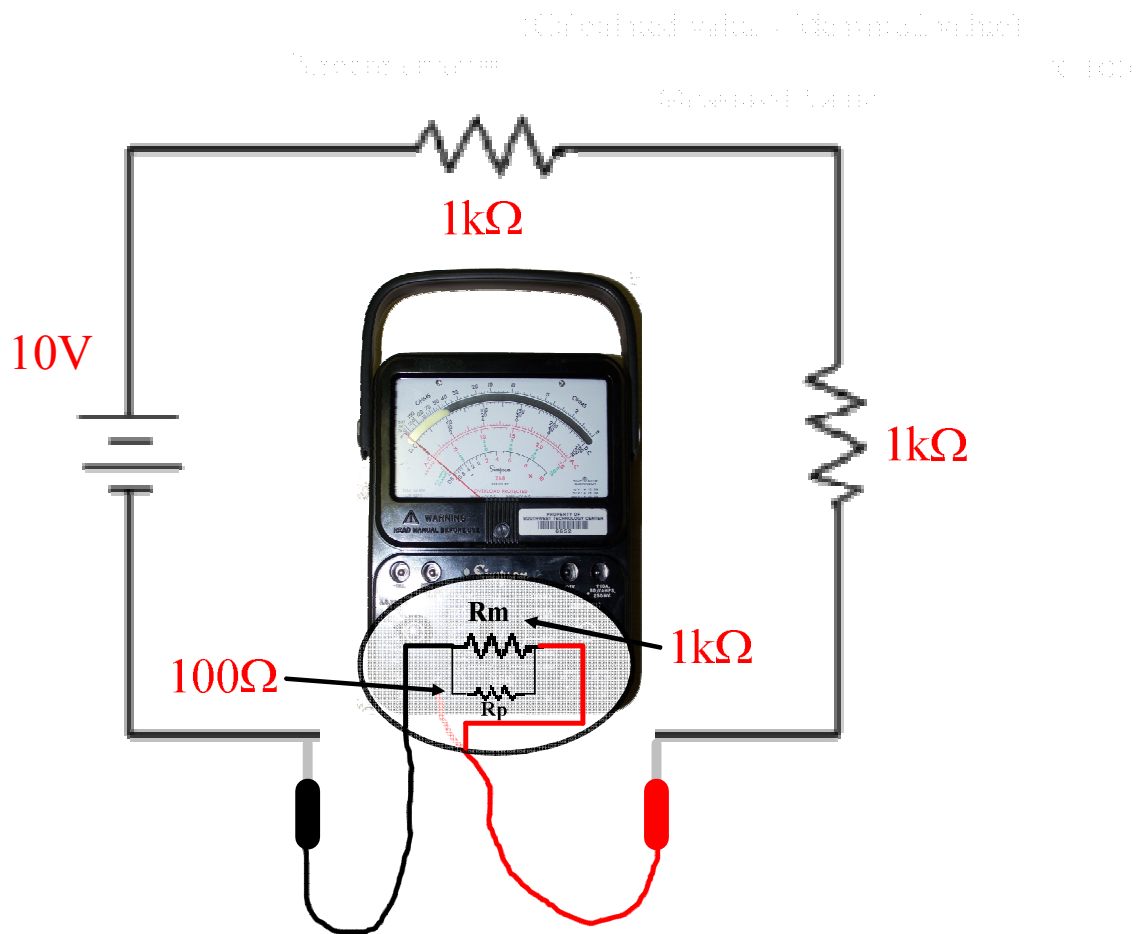
When measuring current, the loading effect is reduced by adding a small parallel resistance (R_p).



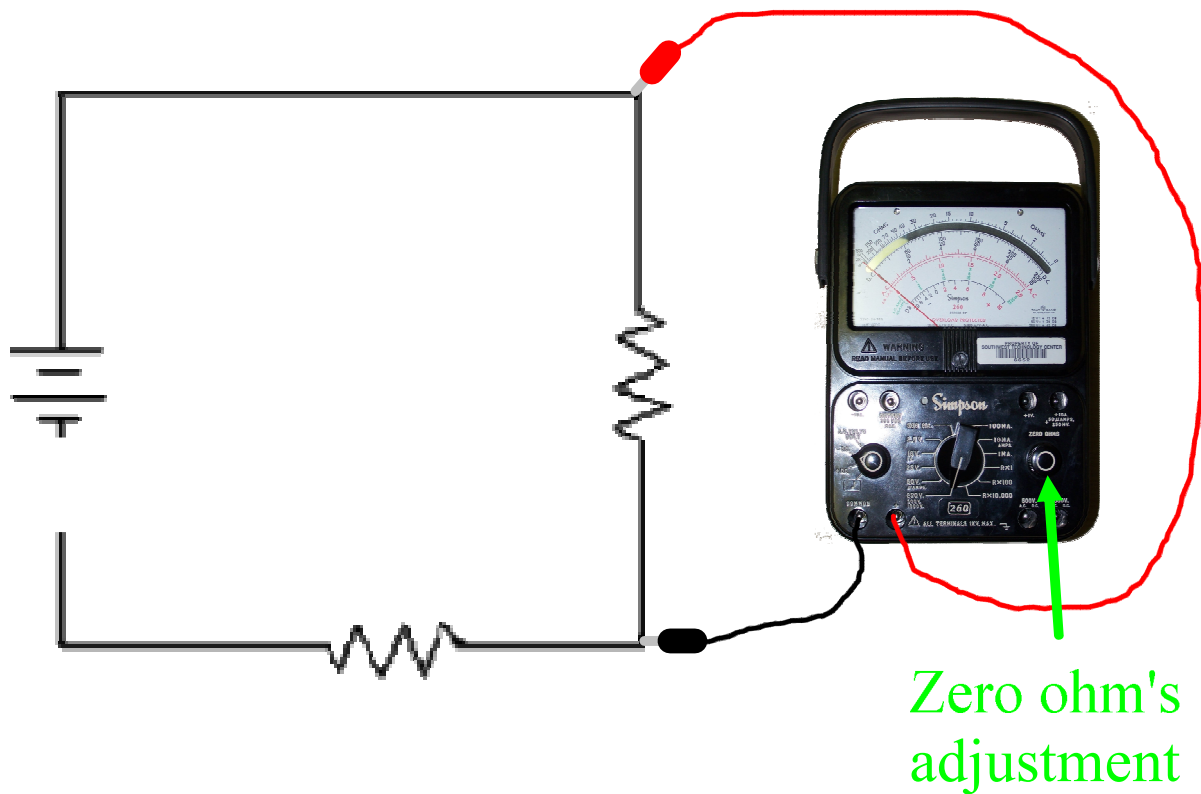
R_m without small parallel resistance (R_p) added.



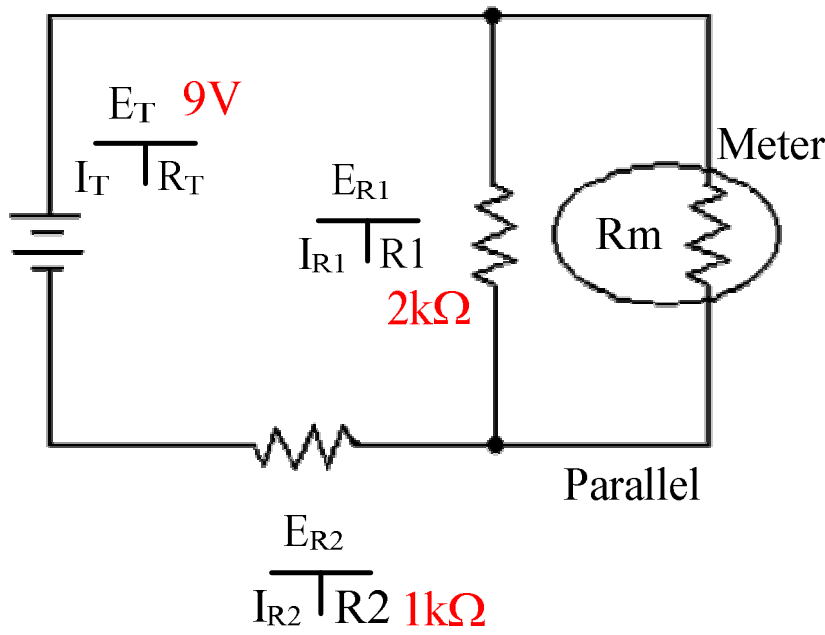
R_m with small parallel resistance (R_p) added.



When measuring resistance with an analog meter, the loading effect is reduced by making meter adjustments.



Problem 1.



Ohms/ Volt Rating:

30,000Ω/ V

Volt Setting:

10V

$R_M =$ _____

$R_{EQ} =$ _____

$R_T =$ _____

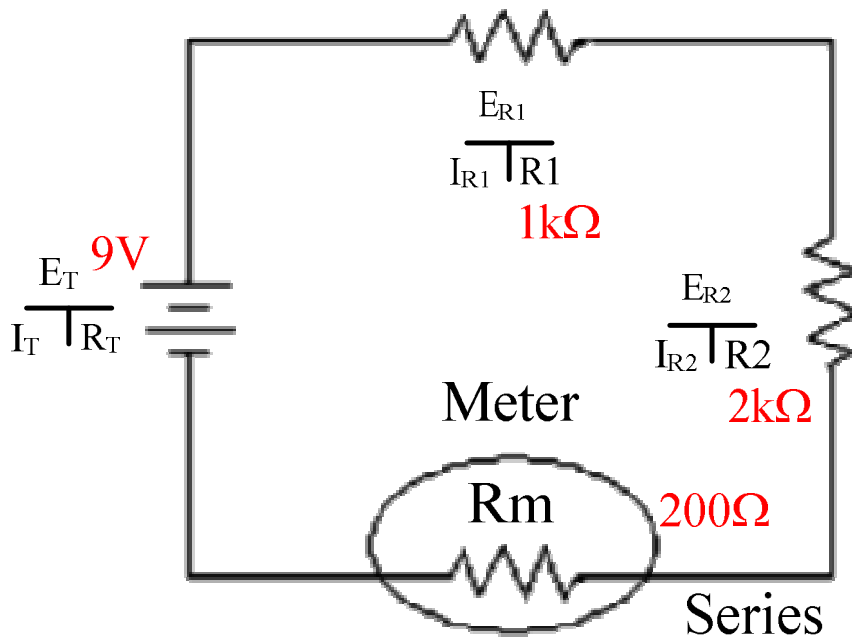
$I_T =$ _____

$V_M =$ _____

$\%_{error} =$ _____

$$\text{Percent error} = \frac{(\text{Calculated value} - \text{Measured value})}{\text{Measured Value}} \times 100$$

Problem 2.



$R_T =$ _____

$I_M =$ _____

$\%_{\text{error}} =$ _____

$$\text{Percent error} = \frac{(\text{Calculated value} - \text{Measured value})}{\text{Measured Value}} \times 100$$