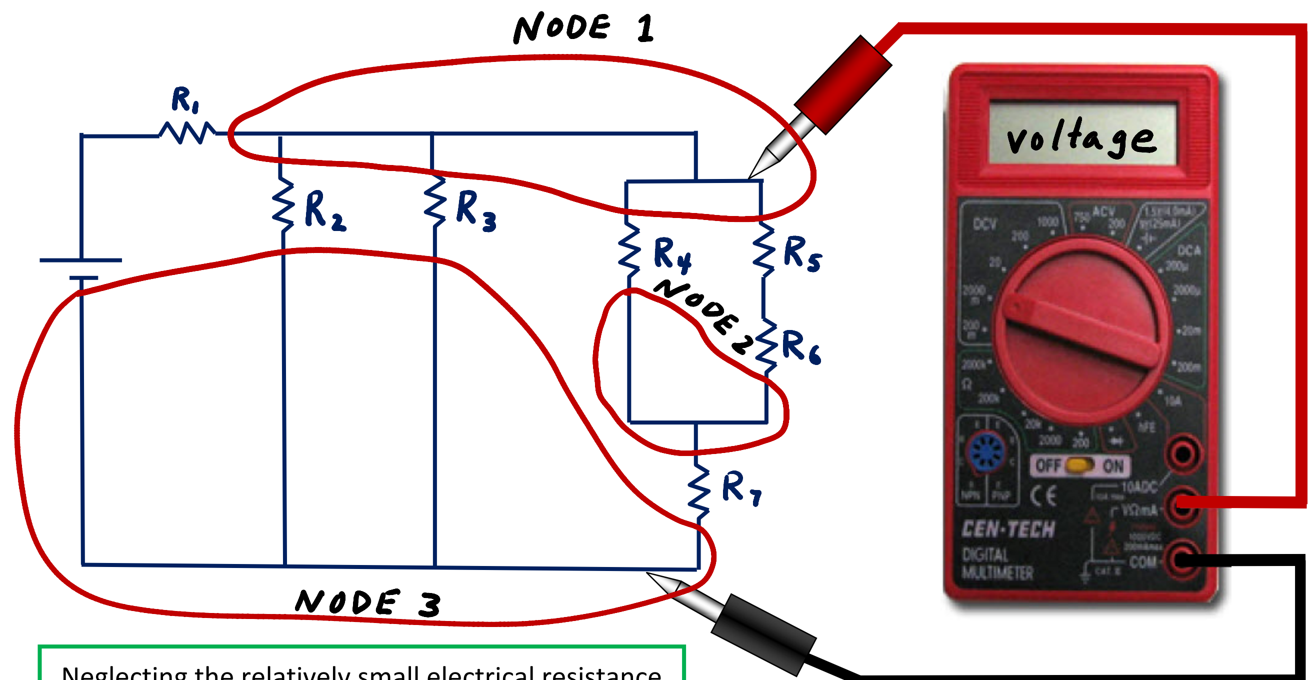
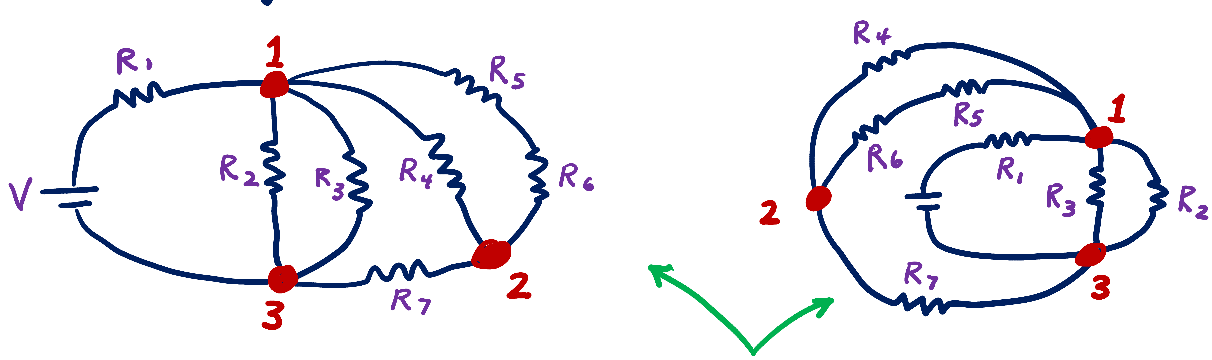
Implications of Kirchoff's Voltage Law (KVL):



Neglecting the relatively small electrical resistance of the "wires," the areas inside the circles can be considered "nodes."

Moving the multimeter probe to any part of the wire within a given red circle will not significantly influence the measured voltage.

We can redraw the circuit in various ways...



R_3 is between nodes 1 and 3

R_7 is between nodes 2 and 3

Due to KVL, sets of circuit elements between two nodes are in **PARALLEL** and have **EQUAL** voltage drops:

$$\Delta V_{R3} = \Delta V_{R2} \quad \text{and} \quad \Delta V_{R4} = \Delta V_{R5} + \Delta V_{R6}$$

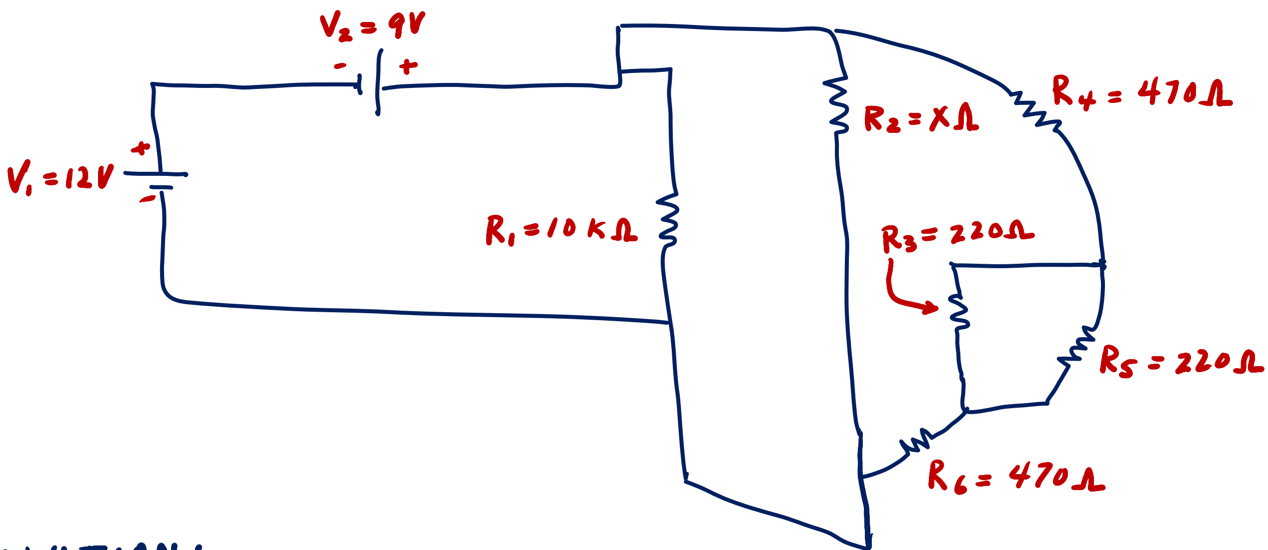
between nodes 1 and 3   between nodes 1 and 2

$$\Delta V_{R5} + \Delta V_{R6} + \Delta V_{R7} = \Delta V_{R2}$$

between nodes 1 and 3

CLASS PROBLEM: Consider the circuit below where R_2 is a variable resistor (a resistor whose value can be changed by turning a knob). We would like to understand the variation of the total current leaving the power sources as a function of R_2.

a. Redraw the circuit so it is easier to tell which resistors are in parallel.
b. Develop a function for the current I in terms of the resistance R_2, and embed this function into Mathcad.
c. Plot the current versus the value of R_2, where R_2 varies from 100 Ω to 10,000 Ω.
d. Find the current when R_2 is equal to 220 Ω, 470 Ω, 1 kΩ, and 10 kΩ.



SOLUTION:

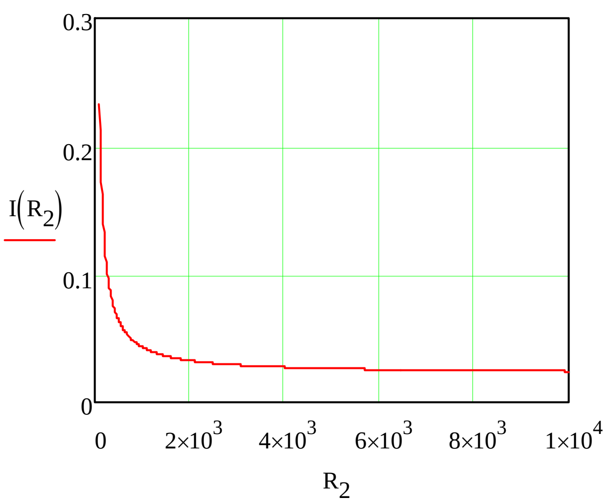
Mathcad Example of Functions and Plots:

	Keystrokes
$R_1 := 10000\,\Omega$	R.1 : 10000* <enter>
$R_3 := 220\cdot\Omega$	R.3 : 220* <enter>
$R_4 := 470\cdot\Omega$	R.4 : 470* <enter>
$R_5 := 220\cdot\Omega$	R.5 : 470* <enter>
$R_6 := 470\cdot\Omega$	R.6 : 470* <enter>
$V_1 := 12\cdot V$	V.1 : 12*V <enter>
$V_2 := 9\cdot V$	V.2 : 9*V <enter>
$V_3 := V_1 + V_2$	V.3 : V.1 + V.2
$R_{eq1} := \dfrac{1}{\dfrac{1}{R_3} + \dfrac{1}{R_5}}$	R.eq1 : 1 / 1 / R.3 <space> + 1 / R.5 <enter>
$R_{eq2} := R_4 + R_{eq1} + R_6$	R.eq2 : R.4 + R.eq1 + R.6
$R_{eq3}(R_2) := \dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_2\cdot\Omega} + \dfrac{1}{R_{eq2}}}$	R.eq3(R.2) : 1 / 1 / R.1 <space> + 1 / R.2* <space> + 1 / R.eq2 <enter>
$I(R_2) := \dfrac{V_3}{R_{eq3}(R_2)}$	I(R.2) : V.3 / R.eq3(R.2) <enter>
$R_2 := 100, 110 .. 10000$	R.2 : 100 , 110 ; 10000 <enter>

To insert the plot:

Insert > Graph > XY Plot

Type in R.2 and I(R.2) in the placeholders



	Keystrokes
$I(220) = 0.118A$	I(220) =
$I(470) = 0.067A$	I(470) =
$I(1000) = 0.043A$	I(1000) =
$I(10000) = 0.024A$	I(10000) =