Name: _____ Section: _____ Date: _____

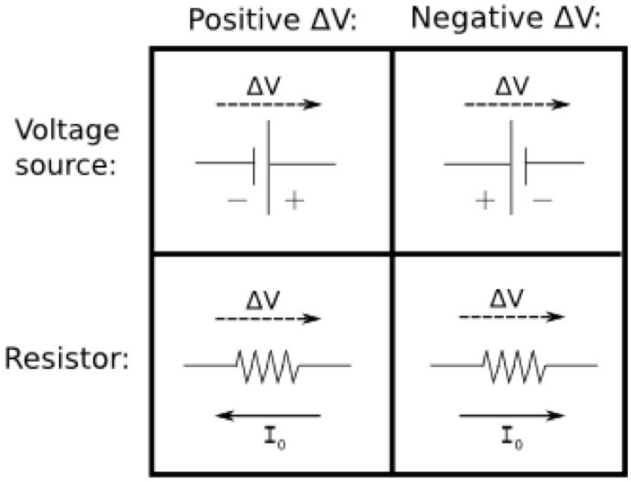
Worksheet - Exp 17: Kirchhoff's Laws for Circuits

Objective: This experiment applies Kirchhoff's laws for circuits to a two-loop circuit to determine the currents and voltage differences around each loop.

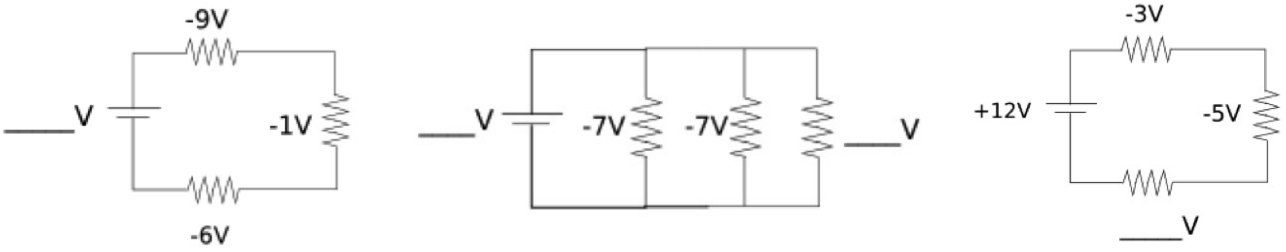
Theory: The two basic laws that are most useful in analyzing circuits are Kirchoff's laws for current and voltage.

- *Kirchoff's Current Law* (The Junction Rule) states that at any junction of a circuit, the sum of currents entering the junction equals the sum of currents leaving the junction. This follows from the principle of charge conservation. $\Sigma I_{in} = \Sigma I_{out}$
- *Kirchoff's Voltage Law* (The Loop Rule) states that around any closed loop in a circuit, the algebraic sum of all potential differences is equal to zero. $\Sigma V_i = 0$

The following sign convention is observed when adding together potential differences:



1. Use Kirchhoff's Voltage Law to find the missing voltage differences in the following circuits. For these circuits, current flows clockwise and potential difference is measured clockwise. (4 pts)



2. Below are two nodes in different circuits. Each has four currents flowing either in or out of it. For each, use Kirchhoff's Current Law to fill in the value of the missing current. [Note each sign (+/−) and direction] (4 pts)

Procedure:

Part 1: Loop Method - Calculations

3. Determine the nominal resistance and tolerance of each resistor by reading its color code. They should have the following approximate resistances: (5 pts)

$R_1 = 10\ \Omega$ $R_2 = 12\ \Omega$ $R_3 = 15\ \Omega$

$R_4 = 18\ \Omega$ $R_5 = 22\ \Omega$

4. Measure the resistance of each resistor using an ohmmeter. (5 pts)

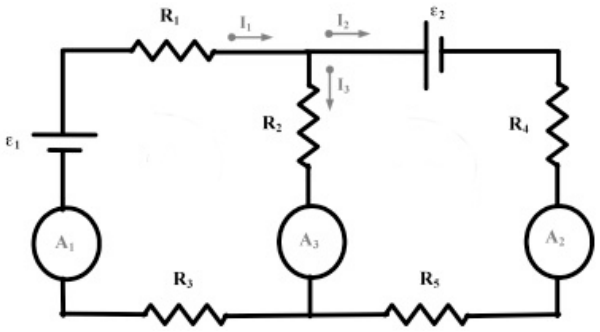
5. Measure ϵ of the two batteries using a voltmeter. They should be at least 1.1V.

6. Construct the circuit shown. Do not connect the ammeter.

7. Using your knowledge of the loop and junction rules, write three equations relating currents in the circuit. (12 pts)

8. Record these equations on the last page. You must solve them by hand, but may use a calculator to verify.

	Nominal	Measured
R_1		
R_2		
R_3		
R_4		
R_5		



Color	**Number**	**Multiplier**
Black	0	10^0
Brown	1	10^1
Red	2	10^2
Orange	3	10^3
Yellow	4	10^4
Green	5	10^5
Blue	6	10^6
Violet	7	10^7
Grey	8	10^8
White	9	10^9

Tolerance	
Gold	5%
Silver	10%
(No Band)	20%

Part 2: Current & Voltage Laws Applied

9. Connect the batteries to the circuit.
10. Measure the current in each of the three branches of the circuit. Refer to the image to the right for proper ammeter connection technique. Disconnect the batteries and turn off the DMM after measurement. (6 pts)

Current	Theoretical	Measured	%Diff.
I_1 (A_1)			
I_2 (A_2)			
I_3 (A_3)			

11. Compare the measured values of current with the calculated values. If they are not approximately equal, check your calculations or retest the circuit. (6 pts)
12. Reconnect the batteries and measure the electric potential across each element of the circuit. Record your answers in the table. V_1 is the voltage across R_1, and so on. Sign and direction are crucial; measure based on the hypothetical directions of current you chose at the beginning. Refer to the diagram in the prelab material and follow your TAs guidance. (14 pts)
13. Do the currents measured verify Kirchhoff's Current Law? How? If not, what could have caused the discrepancy? (10 pts)
14. Do the voltages measured verify Kirchhoff's Voltage Law? How? Explain possible causes for any non-zero loop sums. (10 pts)

Left Loop:	
ε_1	
V_1	
V_2	
V_3	
ΣV	
Right Loop:	
ε_2	
V_4	
V_5	
V_2	
ΣV	
Perimeter Loop:	
ε_1	
V_1	
ε_2	
V_4	
V_5	
V_3	
ΣV	

Record the equations from step 7 here. Solve them by hand. (24 pts)