Contents

LAB REPORT 1
Ohm’s law

Date of Experiment: ....

Date of Report: ....

Members:

1. ....
2. ....
3. ....
4. ....
5. ....

1.1 Circuits Experiment Board

1. Use the wires to make connections between the springs on one light bulb to the springs on the D-cell in such a way that the light will glow, sketch the wires connections, use the symbols from the first page of this lab guide.

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2. Reverse the two wires at the light. Does this have any effect on the operation? Reverse the two wires at the cell. Does this have any effect on the operation? Explain.

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1.2 Lights in Circuits

PART A

3. Connect the second light bulbs into the circuit in such a way that both of them are lighted. Draw your circuit diagram. Is your original light the same brightness, or was it brighter or dimmer than it was during step 1? Can you explain any differences in the brightness, or why it is the same?

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4. Design a circuit that will allow you **to light all three lights**, with **each one being equally bright**. Draw the circuit diagram. If you could characterize the circuit as being a series or parallel circuit, which would it be? What happens if you unscrew one of the bulbs? Explain.

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5. Devise a circuit which will **light two bulbs at the same intensity**, but **the third at a different intensity**. Draw the circuit diagram. What happens if you unscrew one of the bulbs? Explain.

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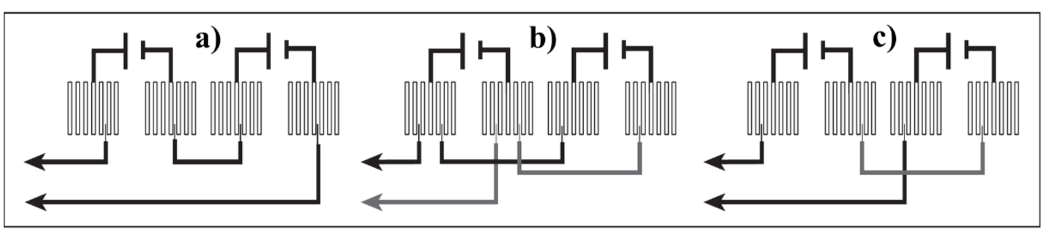
PART B



6. Connect the two D-cells into the circuit as shown in a). What is the effect on the brightness of the light compared to only one D-cells case?

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7. Connect the second D-cell as in b). What is the effect on the brightness?

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8. Connect the second D-cell as in c). What is the effect on the brightness?

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9. Determine the nature of the connections between the D-cells you made in question 6-8. Which of these was most useful in making the light brighter? Which was least useful? Can you determine a reason why each behaved as it did?

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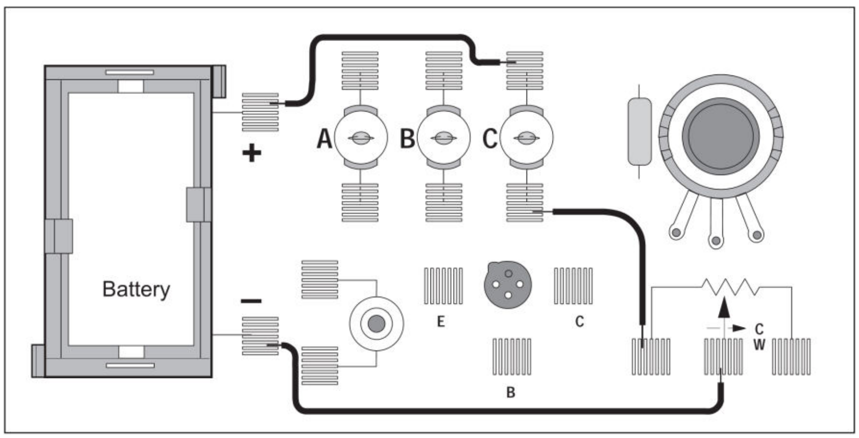
PART C



10. Connect the circuit shown in the figure above. What is the effect of rotating the knob on the device that is identified as a "Potentiometer?"

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1.3 Ohm's Law

No	Resistance, ohm		Current, amp	Voltage, volt	Voltage/ Resistance	%Error
	Average value of R	The tolerance limit of R				
1						
2						
3						
4						
5						

11. Construct a graph of Current (vertical axis) vs. Resistance

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12. From your graph, what is the mathematical relationship between Current and Resistance?

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13. Ohm's Law states that current is given by the ratio of voltage/resistance. Does your data concur with this? Use your data to prove your conclusion

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14. What were possible sources of experimental error in this lab? Would you expect each to make your results larger or to make them smaller?

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LAB REPORT 2:

Resistances – Voltages – Currents in Circuits

Date of Experiment: ....

Date of Report: ....

Members:

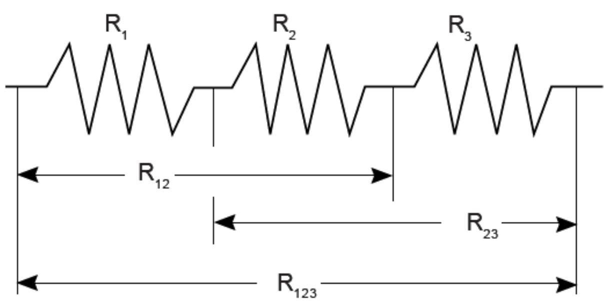
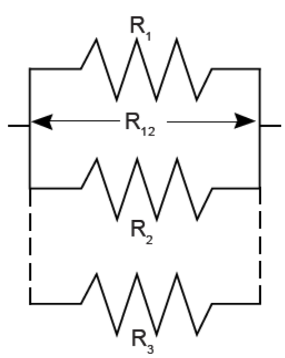
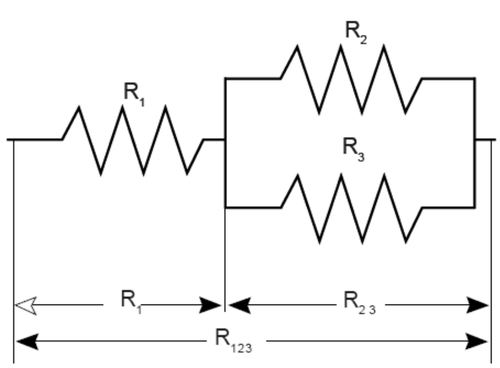
1. ....
2. ....
3. ....
4. ....
5. ....

A. SAME RESISTORS

Experimental data:

	Colors 1st 2nd 3rd 4th	Coded Resistance	Measured Resistance	% Error	Tolerance
#1					
#2					
#3					

1. **Resistances in Circuits**

Circuits	Values
 **Series**	R_{12}= ______________ R_{23}= ______________ R_{123}= ______________
 **Parallel**	R_{12}= ______________ R_{23}= ______________ R_{123}= ______________
 **Combination**	R_1= ______________ R_{23}= ______________ R_{123}= ______________

Questions:

1. How does the % error compare to the coded tolerance for your resistors?

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2. What is the apparent rule for combining **equal resistances** in series circuits? In parallel circuits? In combination circuits? Cite evidence from your data to support your conclusions.

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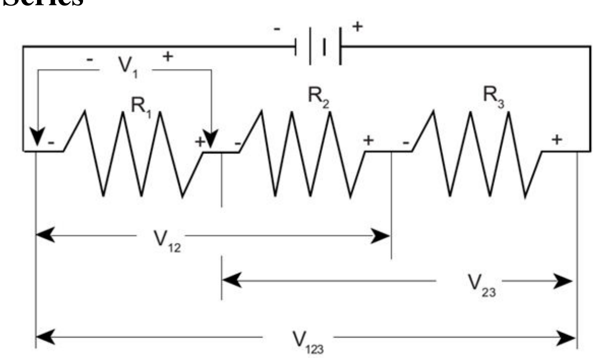
2. Voltages in Circuits

<table>
<tr><th>Circuits</th><th>Values</th></tr>
<tr><td>

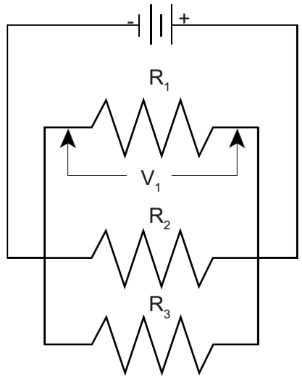
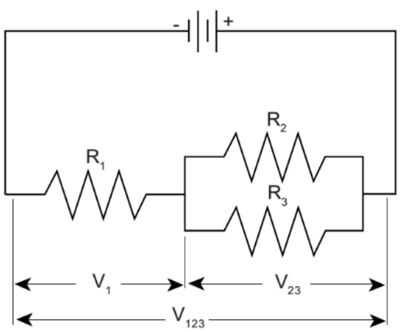
Series



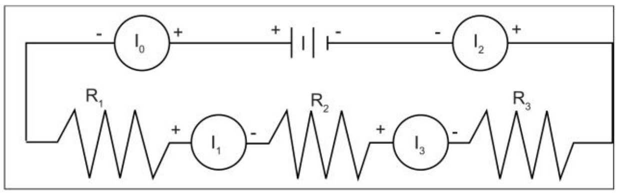
</td><td>

R_1 = ____________ V_1 = ____________
R_2 = ____________ V_2 = ____________
R_3 = ____________ V_3 = ____________
R_{12} = ____________ V_{12} = ____________
R_{23} = ____________ V_{23} = ____________
R_{123}= ____________ V_{123}= ____________

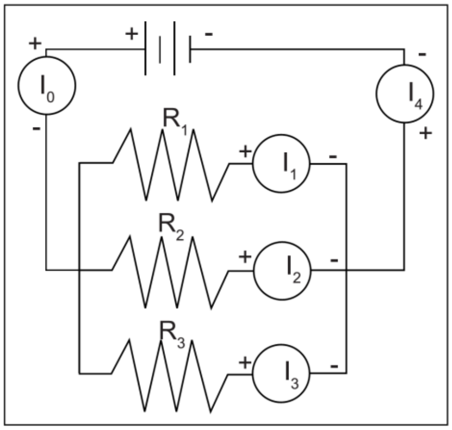
</td></tr>
</table>

Parallel 	R_1 = ________ V_1 = ________ R_2 = ________ V_2 = ________ R_3 = ________ V_3 = ________ R_{123}= ________ V_{123}= ________
Combination 	R_1 = ________ V_1 = ________ R_{23} = ________ V_{23} = ________ R_{123} = ________ V_{123} = ________

3. **Currents in Circuits**

Circuits	**Values**
Series 	R_1 = ________ I_0 = ________ R_2 = ________ I_1 = ________ R_3 = ________ I_2 = ________ R_{12} = ________ I_3 = ________ R_{23} = ________ R_{123}= ________

Parallel



R_1 = ____________ I_0 = ____________

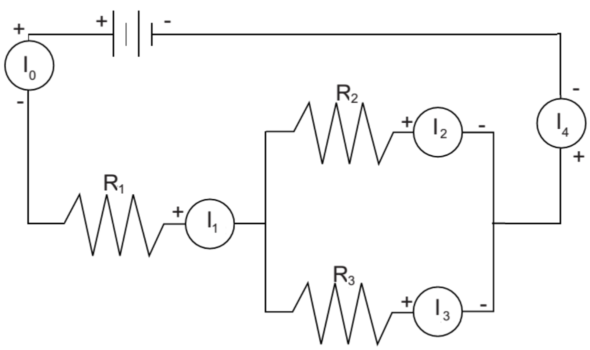
R_2 = ____________ I_1 = ____________

R_3 = ____________ I_2 = ____________

R_{123} = ____________ I_3 = ____________

I_4 = ____________

Combination



R_1 = ____________ I_0 = ____________

R_2 = ____________ I_1 = ____________

R_3 = ____________ I_2 = ____________

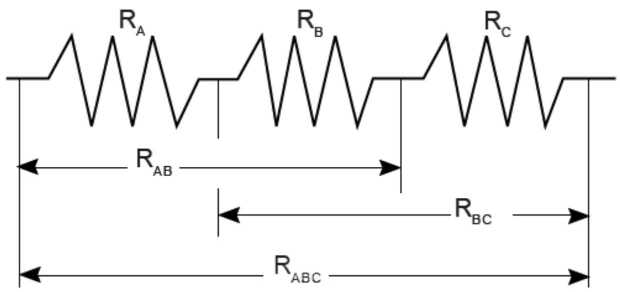
R_{123} = ____________ I_3 = ____________

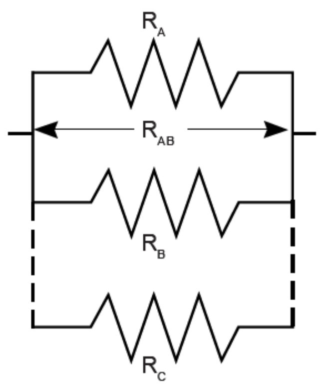
I_4 = ____________

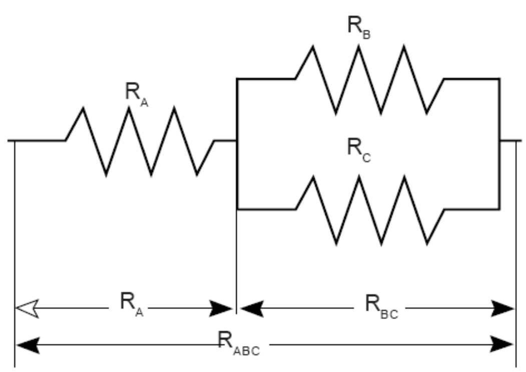
B. DIFFERENT RESISTORS

	Colors 1st 2nd 3rd 4th	Coded Resistance	Measured Resistance	% Error	Tolerance
A					
B					
C					

4. Resistances in Circuits

<table>
<tr><th>Circuits</th><th>Values</th></tr>
<tr><td>


Series</td><td>R_{AB}= ______________
R_{BC}= ______________
R_{ABC}= ______________</td></tr>
<tr><td>


Parallel</td><td>R_{AB}= ______________
R_{BC}= ______________
R_{ABC}= ______________</td></tr>
<tr><td>


Combination</td><td>R_A= ______________
R_{BC}= ______________
R_{ABC}= ______________</td></tr>
</table>

3. What is the apparent rule for combining **unequal resistances** in series circuits? In parallel circuits? In combination circuits? Cite evidence from your data to support your conclusions.

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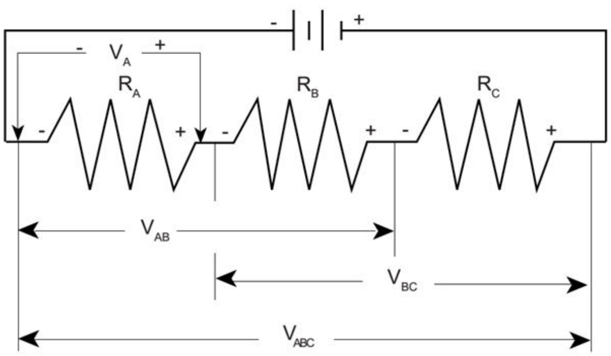
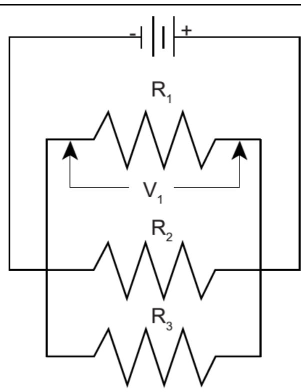
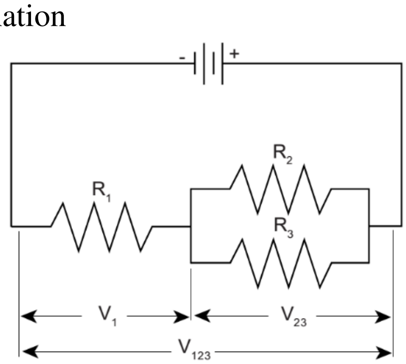
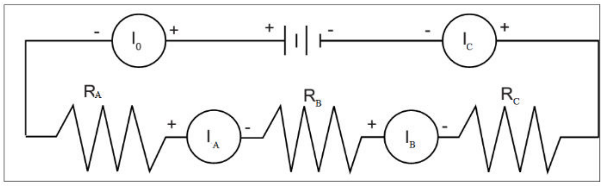
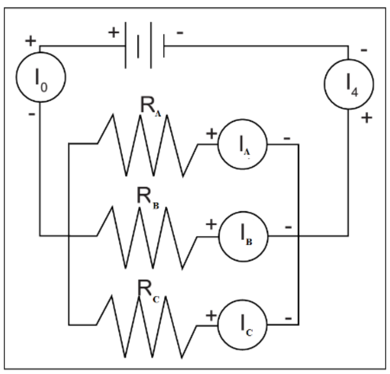
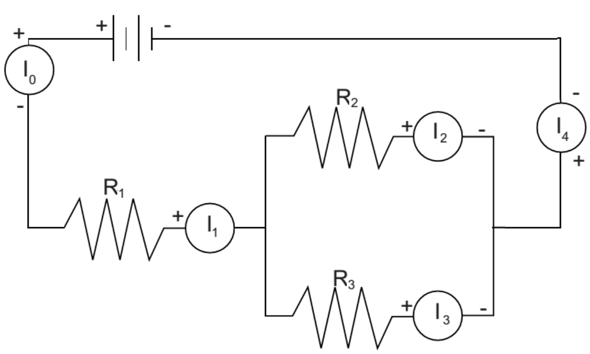
5. <u>Voltages in Circuits</u>

<table>
<tr><th>Circuits</th><th>Values</th></tr>
<tr><td>Series

</td><td>R_A = ________ V_A = ________
R_B = ________ V_B = ________
R_C = ________ V_C = ________
R_{AB} = ________ V_{AB} = ________
R_{BC} = ________ V_{BC} = ________
R_{ABC}= ________ V_{ABC}= ________</td></tr>
<tr><td>Parallel

</td><td>R_1 = ________ V_1 = ________
R_2 = ________ V_2 = ________
R_3 = ________ V_3 = ________
R_{123}= ________ V_{123}= ________</td></tr>
<tr><td>Combination

</td><td>R_1 = ________ V_1 = ________
R_{23} = ________ V_{23} = ________
R_{123} = ________ V_{123} = ________</td></tr>
</table>

6. Currents in Circuits

Circuits	Values
Series 	R_A = ______ I_0 = ______ R_B = ______ I_A = ______ R_C = ______ I_B = ______ R_{ABC} = ______ I_C = ______ I_4 = ______
Parallel 	R_A = ______ I_0 = ______ R_B = ______ I_A = ______ R_C = ______ I_B = ______ R_{ABC} = ______ I_C = ______ I_4 = ______
Combination 	R_1 = ______ I_0 = ______ R_2 = ______ I_1 = ______ R_3 = ______ I_2 = ______ R_{123} = ______ I_3 = ______ I_4 = ______

LAB REPORT 3
LRC Circuits

Date of Experiment: ....

Date of Report: ....

Members:

1. ....
2. ....
3. ....
4. ....
5. ....

1. LC Oscillations

Theoretical values:

Inductance: ....

Capacitance: ....

Angular frequency (theory): ....

Experimental data:

Time at max/min current: ....

Time at next max/min current: ....

Time difference: ....

Period: ....

Linear frequency: ....

Angular frequency (experiment): ....

Compare the angular frequencies between theory and experiment:...

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2. Resistive Circuit

Resistance: ....

Period of the AC voltage: ....

Time at max/min current: ....

Time at max/min voltage: ....

Time difference: ....

Phase difference: ....

Compare the phase difference with the value predicted by theory: ....

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3. Capacitive Circuit

Capacitance: ....

Period of the AC voltage: ....

Time at max/min current: ....

Time at max/min voltage: ....

Time difference: ....

Phase difference: ....

Compare the phase difference with the value predicted by theory: ....

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4. Inductive Circuit

Inductance: ....

Period of the AC voltage: ....

Time at max/min current: ....

Time at max/min voltage: ....

Time difference: ....

Phase difference: ....

Compare the phase difference with the value predicted by theory: ....

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5. LRC Circuit

a. Inductance: ....

Resistance: ....

Capacitance: ....

Frequency at which current reaches its max: ....

b. Inductance: ....

Resistance: ....

Capacitance: ....

Frequency at which current reaches its max: ....

Compare the angular frequency in LRC circuit with the one in LC Oscillations. Does the frequency change when the resistance changes?

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Does the resistance affect the high of the peak? If yes, show your experimental data and explain.

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LAB REPORT 4

Kirchhoff's Laws

Date of Experiment:..

Date of Report:..

Members:

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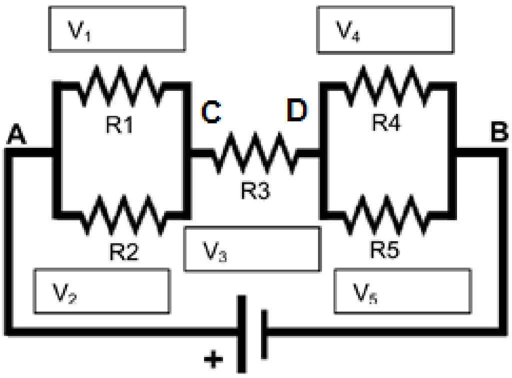

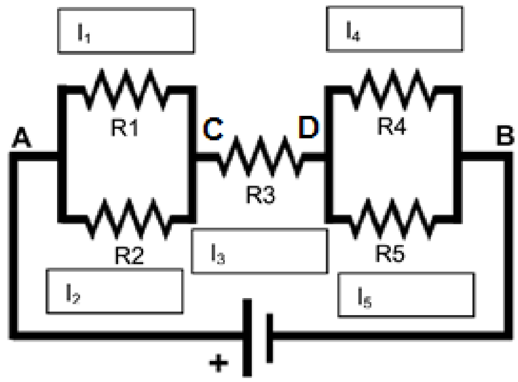

Experimental Data:

Table 4.1

Resistance (Ω)		Voltage (V)		Current (mA)	
R_1		V_1		I_1	
R_2		V_2		I_2	
R_3		V_3		I_3	
R_4		V_4		I_4	
R_5		V_5		I_5	
R_{Total}		V_{Total}		I_{Total}	

Using the schematic of the circuit, calculate the total resistance of the circuit. Record the value in the Table. 4.1. Based on the calculated resistance and the voltage across A and B, calculate the theoretical value of the current using Ohm's Law.

Current (theoretical) = ___________ A

Calculate the percent difference between the theoretical current and the measured current:

$$\%diff = \frac{theoretical\text{-}measured}{theoretical} \times 100\%$$

Write down the Kirchhoff's current law at the junctions A, B, C, and D into the table below. Use the experimental data above to find the net current flowing into (or out of) the junctions.

Junction	Kirchhoff's current law	Current (mA, calculation)		Current (mA, measure)	
A		I_{Total}		I_{Total}	
B		I_{Total}		I_{Total}	
C		I_1		I_1	

D		I_3		I_3	

Compare the currents calculated from Kirchhoff's current law and those measured from experiment. Does the Kirchhoff's current law hold true in the experiment?

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Write down the Kirchhoff's voltage law for 4 different loops. For each loop, use the experimental data above to find the potential difference between a chosen component.

Loop	**Kirchhoff's voltage law**	**Voltage (V, calculation)**		**Voltage (V, measure)**	
$VR_1R_3R_4$		V_1		V_1	
$VR_2R_3R_5$		V_3		V_3	
$VR_1R_3R_5$		V_1		V_1	
$VR_2R_3R_4$		V_2		V_2	

Compare the voltages calculated and those measured from experiment. Does the Kirchhoff's voltage law hold true in the experiment?

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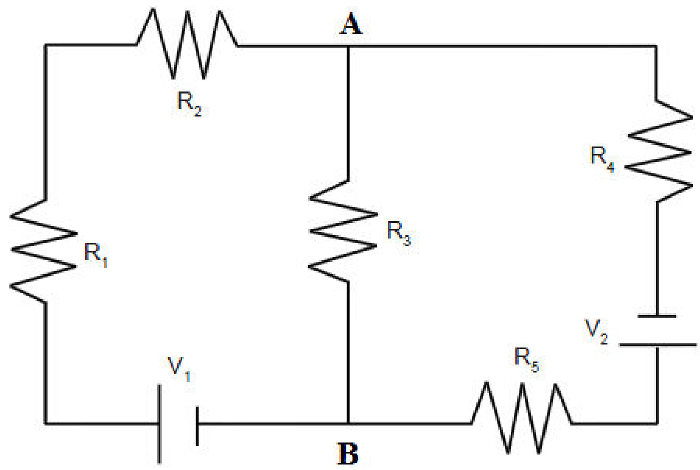

Experimental Data:

Resistance (Ω)		Voltage (V)		Current (mA)	
R_1		V_1		I_1	
R_2		V_2		I_2	
R_3		V_3		I_3	
R_4		V_4		I_4	
R_5		V_5		I_5	
		V_{01}		I_{01}	
		V_{02}		I_{02}	

Write down the Kirchhoff's current law at the junctions A and B into the table below. Use the experimental data above to find the net current flowing into (or out of) the junctions.

Junction	Kirchhoff's current law	Current (mA, calculation)		Current (mA, measure)	
A		I_2		I_2	
B		I_5		I_5	

Compare the currents calculated from Kirchhoff's current law and those measured from experiment. Does the Kirchhoff's current law hold true in the experiment?

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Write down the Kirchhoff's voltage law for 3 different loops. For each loop, use the experimental data above to find the potential difference between a chosen component.

Loop	Kirchhoff's voltage law	Voltage (V, calculation)		Voltage (V, measure)	
$V_1R_1R_2R_3$		V_1		V_1	
$V_2R_5R_3R_4$		V_3		V_3	
$V_1R_1R_2R_4V_2R_5$		V_4		V_4	

Compare the voltages calculated and those measured from experiment. Does the Kirchhoff's voltage law hold true in the experiment?

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LAB REPORT 5
RC Circuit

Date of Experiment:...

Date of Report:...

Members:

1. ....
2. ....
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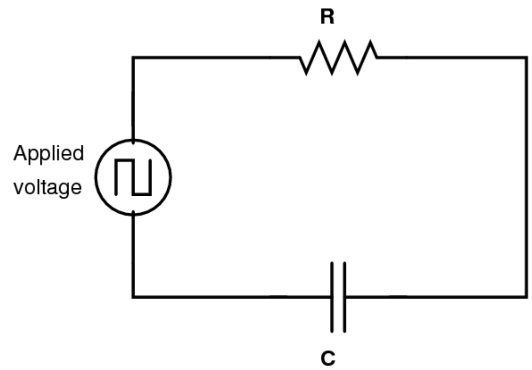
4. ....
5. ....

PROCEDURE A:

Charging the Capacitor

	Theoretical			Experimental Determinations of the Time Constant				
				1	2		3	
	R	C	τ_{theo}	$\tau_{\exp}$ (time to 63% V_{max})	$t_{1/2}$ (time to 50% V_{max})	$\tau_{\exp} = \frac{t_{1/2}}{\ln 2}$	t_{full}	$\tau_{\exp} \approx \frac{t_{\text{full}}}{9}$
Case 1								
			% errors:					
Case 2								
			% errors:					
Case 3								
			% errors:					

PROCEDURE B:
Discharging the Capacitor



	Theoretical			Discharging Process			Half Life $t_{1/2}$	Time constant τ_{exp}	Time constant τ_{exp}
	R	C	$\tau = RC$	Started at t_o	50% max $t_{50\%}$	37% max $t_{37\%}$	$t_{50\%} - t_o$	$= \frac{t_{1/2}}{\ln 2}$	$t_{37\%} - t_o$
Case 1									
							% Errors:		

$f =$

Case 2									
							% Errors:		

$f =$

Case 3									
							% Errors:		

$f =$

QUESTIONS PROCEDURE A:

Charging the Capacitor

1. Compare the time constants of the three circuits: When was $\tau_{\exp}$ longer, when R was high or when R was low?

2. Compare the times to fully charge. When was t_{full} longer, when $\tau_{\exp}$ was long or when $\tau_{\exp}$ was short?

3. Given that $q = CV$, what was the maximum current stored in the capacitor in each case? Show the calculations here:

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4. What are some factors that could account for the difference between the theoretical and experimental values? Which experimental value of time constant, if any, has the largest uncertainty? Explain.

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QUESTIONS PROCEDURE B:

Discharging the Capacitor

1. Was the half-life for charging the same as the half-life for discharging?

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2. Which circuit discharges faster, the one with higher τ or the one with lower τ ?

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LAB REPORT 6

LR Circuit

Date of Experiment:..

Date of Report:...

Members:

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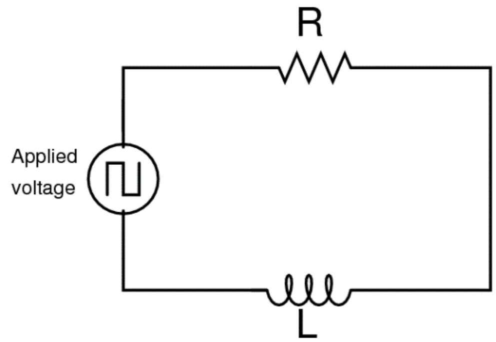

Experimental data:

a.

Item	Value
Inductor resistance	
Resistor resistance	
Total resistance	
Time at peak voltage	
Time at half-maximum voltage	
Time to reach half-maximum	
$\tau = \frac{t_{1/2}}{\ln 2}$	
$\tau = \frac{L}{R}$	

b.

Item	Value
Inductor resistance	
Resistor resistance	
Total resistance	
Time at peak voltage	
Time at half-maximum voltage	
Time to reach half-maximum	
$\tau = \frac{t_{1/2}}{\ln 2}$	
$\tau = \frac{L}{R}$	

Questions:

1. How does the inductive time constant found in this experiment compare to the theoretical value given by $\tau = \frac{L}{R}$? (Remember that R is the total resistance of the circuit and therefore must include the resistance of the coil as well as the resistance of the resistor.)

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2. Does Kirchhoff's Loop Rule hold at all times? Use the graphs to check it for at least three different times. Does the sum of the voltages across the resistor and the inductor equal the source voltage at any given time?

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3. How does the value of the resistor effect to the inductive time constant τ?

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Extension

Item	**Value**
Time at peak voltage	
Time at half-maximum voltage	
Time to reach half-maximum	
$\tau = \frac{t_{1/2}}{\ln 2}$	

From the table above, calculate the new value of inductance. How does the iron core affect to the value of the inductance?

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LAB REPORT 7
Magnetic Fields of Coils

Date of Experiment:..

Date of Report:..

Members:

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5. ....

1. What is the purpose of the experiment?

2. Briefly describe the experiment in your own words?

3. **Magnetic fields of a single coil** (attach the graph describing the magnetic field strength along the axis perpendicular to the coil plane and through the center of the coil in the report): Base on your graph, does the theoretical line fit the experimental data everywhere? Explain.

4. **Magnetic fields of two coils** (attach the graphs describing the magnetic field strength along the axis perpendicular to the coil planes and through the center of the coils in three cases $d = 5.25cm$, $d = 10.5cm$, and $d = 15.75cm$ in the report): Base on your graphs, do the theoretical lines fit the experimental data everywhere? Explain.

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5. **Magnetic fields of a solenoid** (attach the graph describing the magnetic field strength as a function of location in the report): Calculate the magnetic field strength inside the solenoid. Compare with the value found from your experimental data.

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LAB REPORT 8

The e/m Experiment

Date of Experiment: ....

Date of Report: ....

Members:

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2. ....
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5. ....

1. What is the purpose of the experiment?

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2. Describe briefly in your own words how the electron's charge to mass ratio is determined.

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3. Base on your experimental results, how does the radius of electron's path change when
   a. the accelerating potential increase/decrease? Explain.

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b. the current in the Helmholtz coils increase/decrease? Explain.

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4. Base on your experimental data, calculate the average e/m ratio.

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5. Compare your average e/m ratio with the standard value? Explain factors in the experiment that can affect the result.