Experiments-1 Name: Verification of Ohm's Law

Objectives:

- Find the resistance of a resistor from its colour code.
- Measure voltage, current and resistance values using a digital multimeter.
- Verify the validity of Ohm's Law.
- Test the voltage divider rule in a series circuit.

Apparatus:

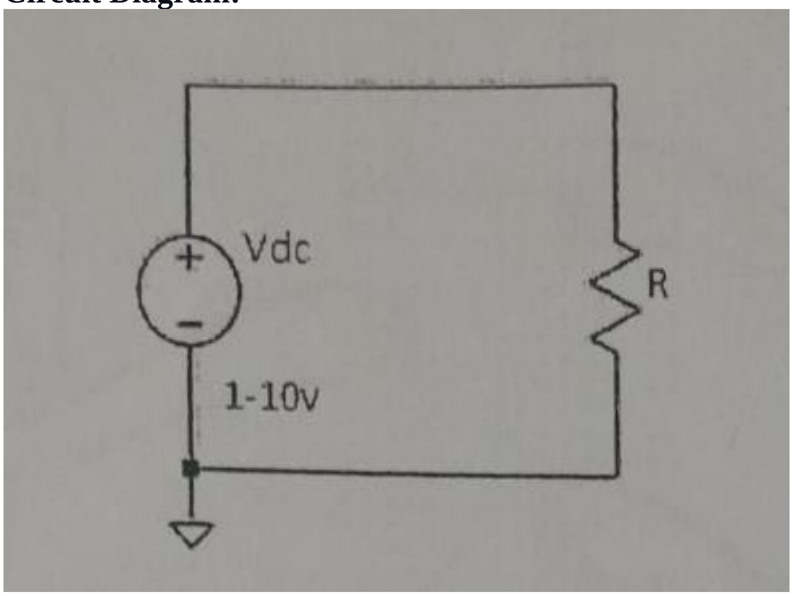
- Breadboard
- Resistors (3.3k Ω, 5.6k Ω)
- Digital Multimeter (DMM)
- Digital Power Supply
- Wires

PRECAUTION

To avoid damage to the DMM:

- Keep it switched off while not in use.
- Before connecting the DMM, the measurement mode must be selected, and its meter range should be placed to its highest value.
- The red probe must connect to the correct terminal.

Circuit Diagram:



Data Table:

Table 1:

Resistance using colour coding					kΩ	
Band 1	Band 2	Band 3	Band 4	Resistance ± tol kΩ	Resistance using DMM	% Error
Orange (3)	Orange (3)	Red (2)	Gold (±5%)	3.135 – 3.465	3.24	1.82
Green (5)	Blue (6)	Red (2)	Gold (±5%)	5.32 – 5.88	5.49	1.96

Table 2:

Table 2:

3.3 KΩ	Experimental readings		
Voltage	Current, I	Voltage, I R	Power, I^2R
2 1.95	0.62	2.046	~~6.752~~ 1.269
4 4.01	1.24	4.092	~~13.504~~ 5.074
6 6.02	1.85	6.105	~~20.147~~ 11.294
8 7.95	2.48	8.184	~~27.007~~ 20.296
10 10.00	3.10	10.23	~~33.759~~ 31.713

Table 3

5.6 KΩ	Experimental readings		
Voltage	Current, I	Voltage, I R	Power, I^2R
2 1.97	0.36	2.016	0.726
4 4.02	0.72	4.032	2.903
6 5.94	1.09	6.104	6.653
8 7.96	1.46	8.176	11.936
10 10.02	1.82	10.192	18.549

Graph:
Attached.

Result Analysis:
From this experiment, we learn about the colour code of resistors. And it's matching with the assigned resistance of this resistor.
From the graph, we found a straight line, and it's continuously increasing. That means the larger the voltage applied, the bigger the current becomes. Ohm's Law also declares that. In short, our experiment completely follows Ohm's Law.

Questions and Answers:

01. Ohm's Law: Ohm's law states that electrical current in a resistive circuit is directly proportional to the applied voltage and inversely proportional to its resistance, provided all physical conditions and temperatures remain constant.

$$I = \frac{V}{R} \qquad \text{in amperes (A)}$$

Where V is the applied voltage in volts (V).
R is the resistance in ohms (Ω).
I is the current in amperes (A).

The larger the applied voltage is, the larger the current becomes. The larger the resistance is, the smaller the current becomes.

02. Graph Attached

03. Yes, our experiment circuit follows ohm's law. According to Ohm's Law, The larger the applied voltage, the larger the current. From the graph V vs I, we found an increasing straight line. Whenever we increase the voltage in our circuit, the current also increases. From the graph, we can say our experiment completely follows Ohm's Law.

04. ..

4

From the graph of R_1.

point-1 : $(4.5, 1.4)$

point-2 : $(5.45, 1.7)$

$\therefore$ Slope, $m_1 = \frac{1.7-1.4}{5.45-4.5} = \frac{6}{19}$

$\therefore$ inverse of slope,

$m_1^{-1} = r_1 = \frac{19}{6} = 3.17\ k\Omega$

From DMM,

$R_1 = 3.24\ k\Omega$

$\therefore$ Error $= \left|\frac{3.24-3.17}{3.24}\right| \times 100\%$

$= 2.16\%$

From the graph of R_2

Point - 1: $(3.3, 0.6)$

Point - 2: $(5.46, 1)$

$\therefore$ Slope, $m_2 = \frac{1-0.6}{5.46-3.3} = \frac{5}{27}$

∴ inverse of slope,

$$m_2^{-1} = R_2 = \frac{27}{5} = 5.4\ k\Omega$$

From DMM,

$$R_2 = 5.49\ k\Omega$$

$$\therefore \text{Error} = \left| \frac{5.49 - 5.4}{5.49} \right| \times 100\%$$

$$= 1.64\%$$

~~These error~~

This error happens because we draw the graph according to the best feed line.

Discussion:

In this experiment, we don't face any difficulties. We need to take care of the red jack when measuring the current. First, one of our group mates experimented alone then each member practiced it under his observation. From this experiment, we learn how to measure the voltage and current and use DMM and Digital Power Supply.

Attachment:

1. **Graph of V vs I.**
2. **Simulation using Multisim.**
3. **Signed Data Table**

Experiments-2 Name: KVL and Voltage Divider Rule using Series Circuit.

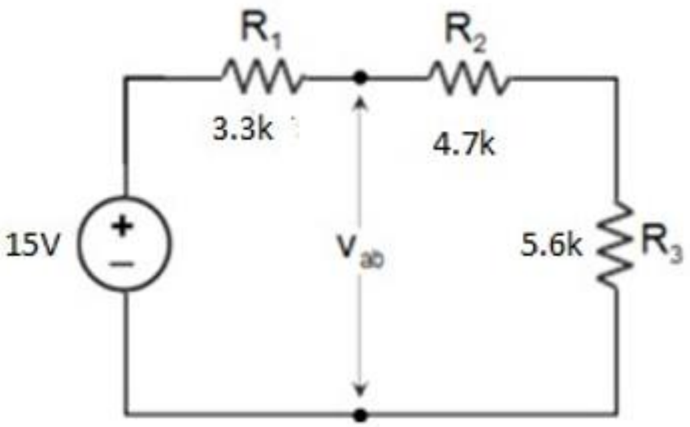
Objectives:

- Learn how to connect a series circuit on a breadboard.
- Validate the voltage divider rules.
- Verify Kirchhoff's voltage law.

Apparatus:

- Bread board
- Resistors (3.3k Ω, 4.7k Ω, 5.6k Ω)
- DC Power Supply
- Digital Multimeter (DMM)
- Connecting Wires

Circuit Diagram:



Circuit 2

Data Table:

Table 1:

	Resistance using colour coding					(kΩ)	
	Band 1	Band 2	Band 3	Band 4	Resistance ± tol kΩ	Resistance using DMM	% Error
R_1	Orange (3)	Orange (3)	Red (2)	Gold (±5%)	3·135 – 3·465	3·24 kΩ	1·82
R_2	Yellow (4)	Violet (7)	Red (2)	Gold (±5%)	4·465 – 4·935	4·64 kΩ	1·28
R_3	Green (5)	Blue (6)	Red (2)	Gold (±5%)	5·32 – 5·88	5·51 kΩ	1·61

Table 2:

Experimental readings				Theoretical values			
V_S	V_{R1}	V_{R2}	V_{R3}	V_S	V_{R1}	V_{R2}	V_{R3}
15.10	~~3.39~~ 3.63	~~5.16~~ 5.22	6.20	15.10	3.65	5.23	6.21

% Error			
V_S	V_{R1}	V_{R2}	V_{R3}
0	0.55%	0.19%	0.16%

Table 3:

Potential rise V_S	15.10	Are the voltage rises and drops equal?
Potential drops ($V_{R1} + V_{R1} + V_{R3}$)	15.05	Approximately Equal

Table 4

Experimental readings		Theoretical values	
V_{ab}	R_{eq}	V_{ab}	R_{eq}
11.42	13.37	11.45	13.39

% Error	
V_{ab}	R_{eq}
0.26%	0.15%

Graph:

N/A

Result Analysis:

According to Kirchhoff's voltage law, in a circuit loop, voltage rise, and drops are equal. The data table-3 shows that the voltage rise was 15.10 V, and the voltage drop was 15.05 V. So, the voltage drop was approximately equal to the rise. Data table-4 also showed that it follows the voltage divider rule. In short, we can say that our experiment follows Kirchhoff's voltage law.

Questions and Answers:

01. Voltage division rule:

the voltage across a resistor in a series circuit is equal to the value of that resistor times the total applied voltage divided by the total resistance of the series configuration.

$$\boxed{V_x = R_x \frac{E}{R_T}}$$

02. Kirchhoff's voltage law (KVL).

the algebraic sum of the potential rises and drops around a closed path (or closed loop) is zero.

In symbolic form it can be written as

$$\boxed{\Sigma_{\circlearrowright} V = 0} \qquad \text{(Kirchhoff's voltage law in symbolic form) (}$$

03. ...

3)

Calculation of theoretical values:

$$V_{R_1} = \frac{3.24}{3.24+4.64+5.51} \times 15.10$$

$$= \frac{3.24}{13.39} \times 15.10$$

$$= 3.65\ V$$

$$V_{R_2} = \frac{4.64}{13.39} \times 15.10$$

$$= 5.23\ V$$

$$V_{R_3} = \frac{5.51}{13.39} \times 15.10$$

$$= 6.21\ V$$

Error Calculation:

$$V_{R_1} = \left| \frac{3.65 - 3.63}{3.65} \right| \times 100\%$$

$$= 0.55\%$$

$$V_{R_2} = \left| \frac{5.23 - 5.22}{5.23} \right| \times 100\%$$

$$= 0.19\%$$

$$V_{R_3} = \left| \frac{6.21 - 6.20}{6.21} \right| \times 100\%$$

$$= 0.16\%$$

Here,

Potential rise, $V_s = 15.10\ V$

Potential drops, $V_T = (3.63 + 5.22 + 6.20)$

$= 15.05\ V$

Here, potential drops is approximately equal to the voltage rise. So, we can say that, our circuit follows KVL.

04. ...

4|

Calculation of theoretical values of V_{ab}:

$$V_{ab} = \frac{4.64 + 5.51}{3.24 + 4.64 + 5.51} \times 15.10$$

$$= 11.45 \text{ V}$$

experimenta value of V_{ab}: 11.42V

$$\therefore \text{Error} = \left| \frac{11.45 - 11.42}{11.45} \right| \times 100\%$$

$$= 0.26\%$$

Here, theoretical value and experimental value approximately equal. So, we can say that.

~~our circuit~~

~~at the point a-b~~

our circuit follows voltage divider rules.

05. ...

5.

Theoretical value of $R_{eq} = 3.24 + 4.64 + 5.51$

$= 13.39\ k\Omega$

experimental value of $R_{eq} = 13.37\ k\Omega$

$$\therefore \text{Error} = \left|\frac{13.39 - 13.37}{13.39}\right| \times 100\%$$

$$= 0.15\%$$

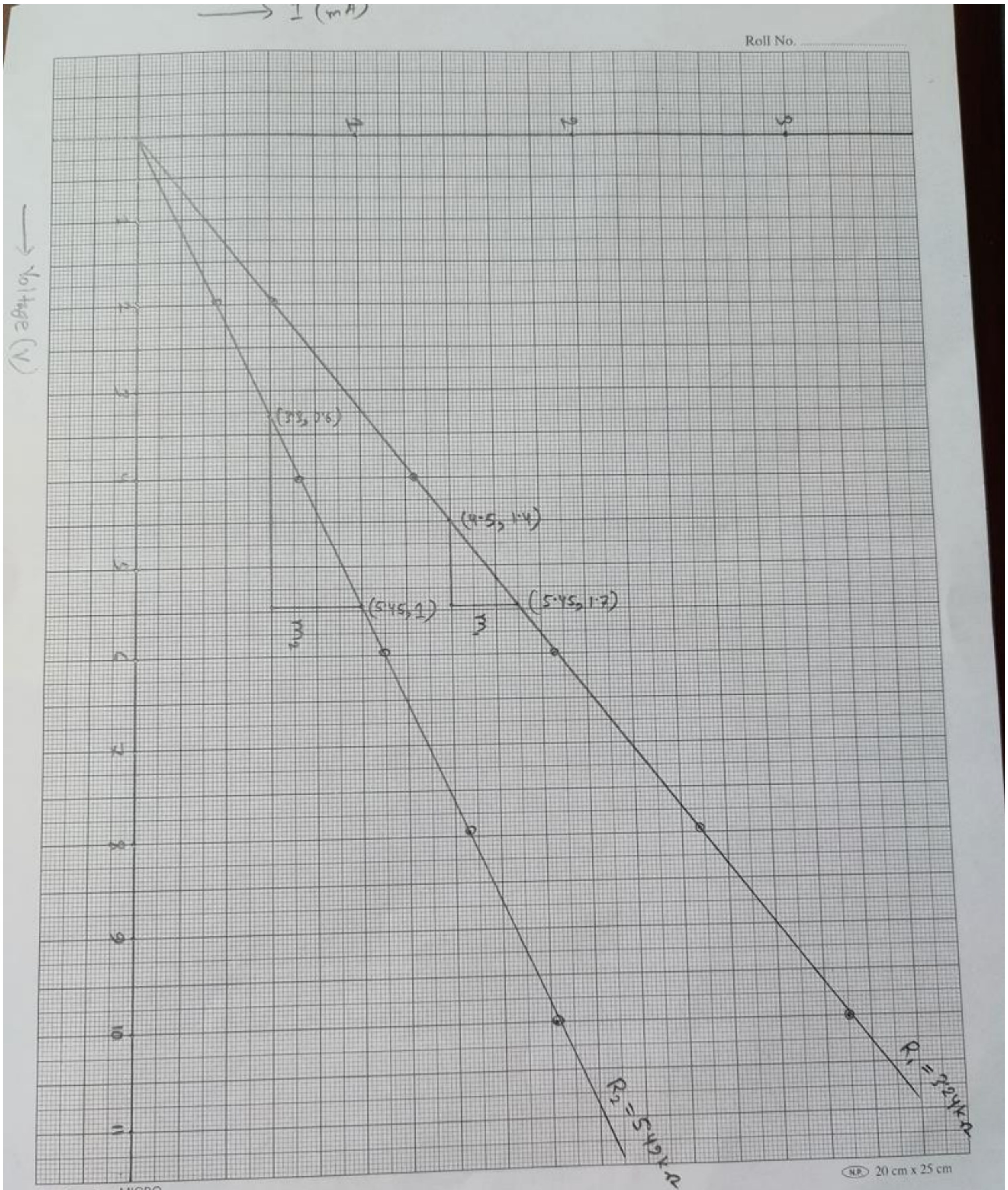
Discussion:

In this experiment, we learn how to make a series circuit using some resistors in a breadboard. Also, we verify Kirchhoff's voltage law and voltage divider rules. While we measured the voltage of R1, we faced some problems; DMM not giving us any stable output. It was slowly increasing. Then Lab Instructor helped us and taught about how to hold the jack of DMM. Then we get a stable result. Then we complete the rest of the experiment together, and we learn a lot.

Attachment:

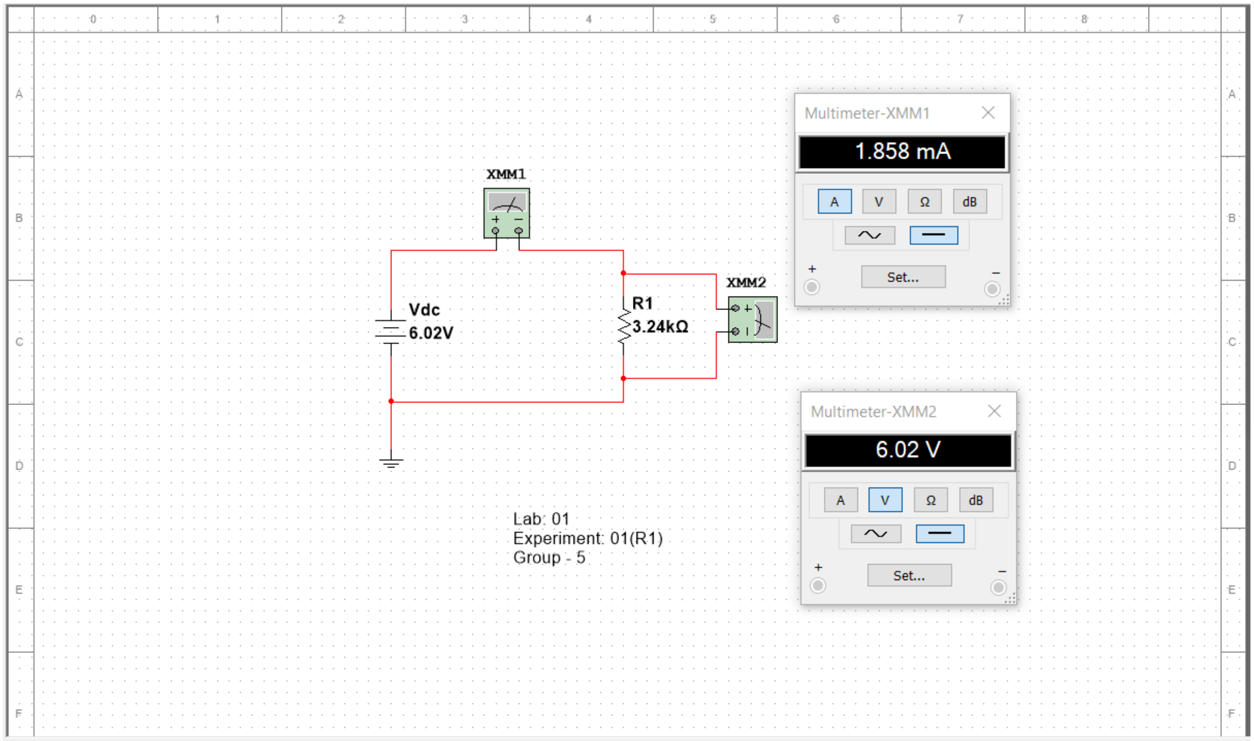
  01. Simulation using Multisim.
  02. Signed Data Table

Roll No. ....

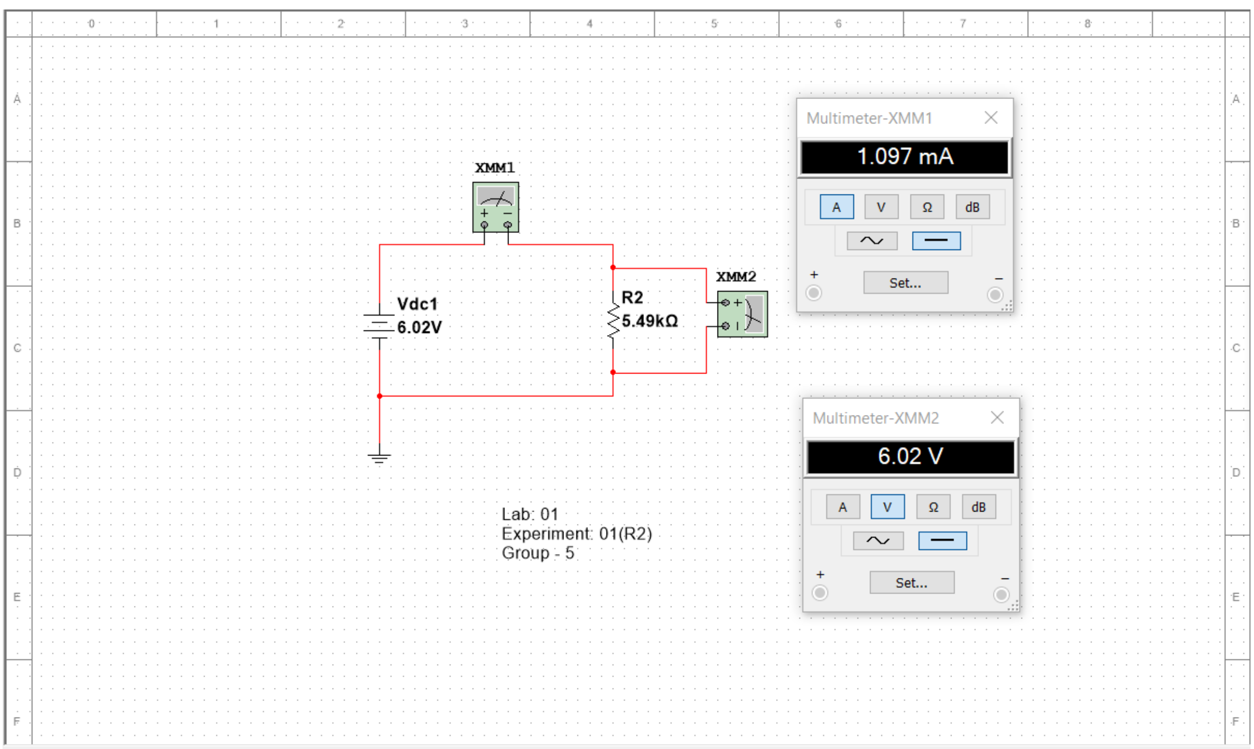


MICRO

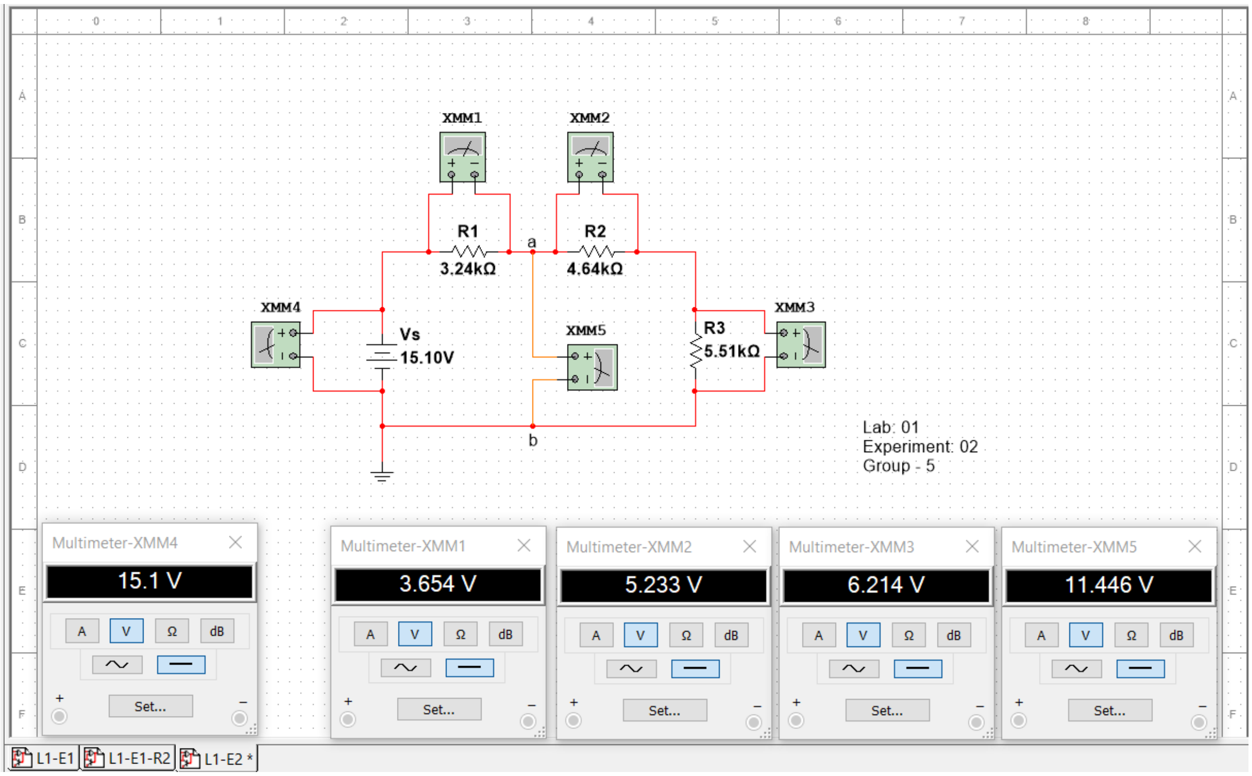
20 cm x 25 cm



Multimeter-XMM1
1.858 mA
XMM1
XMM2
Vdc
6.02V
R1
3.24kΩ
Multimeter-XMM2
6.02 V
Lab: 01
Experiment: 01(R1)
Group - 5



Multimeter-XMM1
1.097 mA
XMM1
XMM2
Vdc1
6.02V
R2
5.49kΩ
Multimeter-XMM2
6.02 V
Lab: 01
Experiment: 01(R2)
Group - 5


XMM1
XMM2
R1
3.24kΩ
a
R2
4.64kΩ
XMM4
Vs
15.10V
XMM5
R3
5.51kΩ
XMM3
b
Lab: 01
Experiment: 02
Group - 5
Multimeter-XMM4
15.1 V
Multimeter-XMM1
3.654 V
Multimeter-XMM2
5.233 V
Multimeter-XMM3
6.214 V
Multimeter-XMM5
11.446 V
L1-E1
L1-E1-R2
L1-E2 *