23W-EC ENGR-11L-LEC-1 Module 1: Analog Discovery and Kirchhoff's Laws

SANJIT SARDA

TOTAL POINTS

90 / 90

QUESTION 1

Ohm's Law and Measuring Voltage and Current 20 pts

1.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Wrong Setup

- 1 pts No Setup Image

1.2 Impedance Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 2 pts One Wrong Impedance Value

- 5 pts Multiple Wrong Impedance values

- 1 pts Error of one resistance is higher than usual

- 3 pts Practical Impedance values not shown

Good Job on giving the error percentage as well

1.3 Voltage and Current Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 4 pts Incorrect Voltage and Current Values, Voltage values should be same for all the resistors. Constant Voltage mode hasn't been selected.

- 1 pts One incorrect current value

1.4 Discussion 1 **3 / 3**

✓ **- 0 pts** *Correct*

- 1 pts Error is high

1.5 Discussion 2 **3 / 3**

✓ **- 0 pts** *Correct*

- 3 pts Wrong answer

1.6 Discussion 3 **3 / 3**

✓ **- 0 pts** *Correct*

- 3 pts Wrong Explanation

- 1 pts "Voltage Divider" Concept missing

QUESTION 2

Equivalent Resistance 25 pts

2.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image missing

2.2 Impedance Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 2 pts Slightly higher error

- 5 pts Impedance measurement missing

2.3 Equivalent Resistance **8 / 8**

✓ **- 0 pts** *Correct*

- 2 pts Theoretical Req must be done using theoretical resistance values

- 1 pts Slightly high error

- 4 pts High error in experimental value

- 4 pts Wrong theoretical value

- 8 pts No theoretical and practical values

2.4 Skin Depth **8 / 8**

✓ **- 0 pts** *Correct*

- 4 pts Deduce skin resistance from equivalent resistance

- 4 pts Skin resistance is in parallel, the equation is wrong.

- 5 pts No Calculations shown

- 2 pts No Calculations shown

2.5 Discussion 1 **3 / 3**

✓ **- 0 pts** *Correct*

QUESTION 3

Voltage and Current Dividers 25 pts

3.1 Test Image Setup 1 **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image Missing

3.2 Voltage Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 2 pts Major Mistake

- 5 pts Missing

3.3 Test Image Setup 2 **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image Missing

3.4 Current Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 2 pts Major Mistake

- 5 pts Missing

- 3 pts Two of three values wrong

3.5 Test Image Setup 3 **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image Missing

3.6 Sensor Circuit **6 / 6**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 2 pts Minor Mistake

- 3 pts Major Mistake

- 6 pts Missing

3.7 Discussion 1 **3 / 3**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 3 pts Missing

3.8 Discussion 2 **3 / 3**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 3 pts Missing

QUESTION 4

Kirchhoff's Laws Analysis of Circuits

20 pts

4.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Click here to replace this description.*

- 1 pts Missing

4.2 Voltage and Current Measurement **16 / 16**

✓ **- 0 pts** *Click here to replace this description.*

- 1 pts Minor Mistake

- 2 pts Minor Mistake

- 4 pts Major Mistake

- 8 pts Major Mistake

- 16 pts Missing

4.3 Discussion 2 **3 / 3**

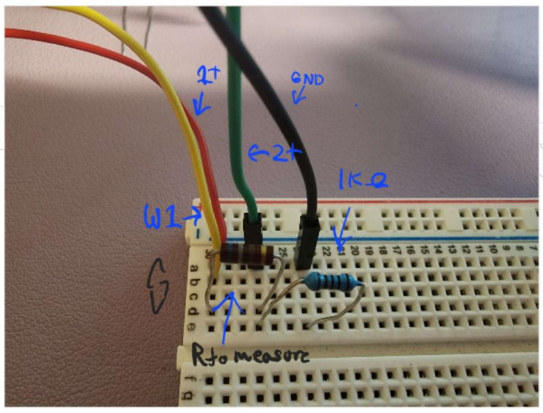
✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 3 pts Missing

Lab

1. Ohm's Law and Measuring Voltage and Current



$$\frac{|\text{Measured} - \text{Expected}|}{\text{Measured}}$$

From Impedance Measurement:

Theoretical Resistance (Ω)	Measured Resistance (Ω)	% Error
680 Ω	679.5 Ω	0.07%
1 kΩ	999.6 Ω	0.04%
2.2 kΩ	2204 Ω	0.18%

From Voltage and Current Measurement:

Resistance (Ω)	Voltage (V)	Current (mA)
680 Ω	1.001 V	1.472 mA
1 kΩ	0.996 V	0.997 mA
2.2 kΩ	0.998 V	0.453 mA

1.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Wrong Setup

- 1 pts No Setup Image

Lab

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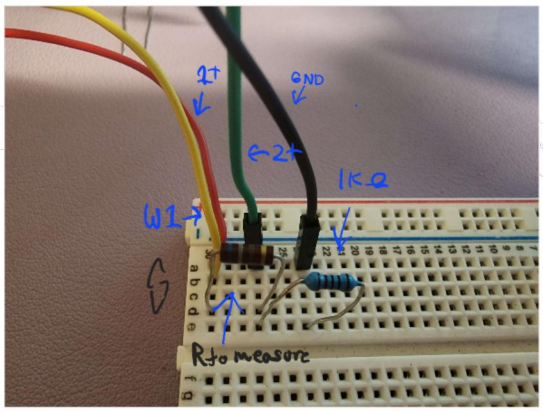

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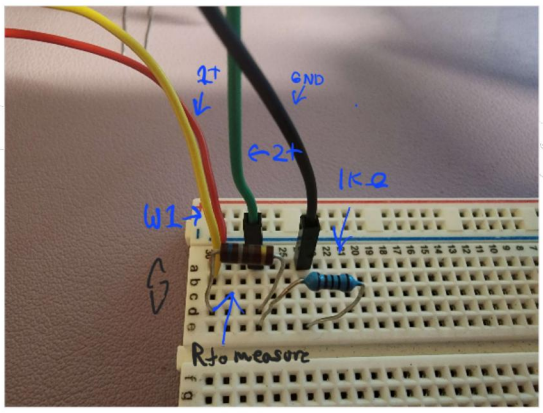

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✓ **- 0 pts** *Correct*

- 4 pts Incorrect Voltage and Current Values, Voltage values should be same for all the resistors. Constant Voltage mode hasn't been selected.

- 1 pts One incorrect current value

Discussion

- How did the values of resistance vary from their given values based on color code? Were they within the given variance?

All the % Error < 1%, which made them within the gold – Brown Tolerances.

- How does Ohm's Law hold for your experimental results?

Yes, when you compute $V = IR$, you get very close to the measured Voltage values ∴ Ohms law holds

- AD2 cannot measure the current directly. Based on your observation, how does AD2 impedance analyzer produce the values for the current and resistors?

2 of my guesses are:

1) They use the voltage Divider formula & compute the impedance.

2) They use another resistor in series to compute the current.

Option 1 is more likely since #2 is redundant

1.4 Discussion 1 **3 / 3**

✓ **- 0 pts** *Correct*

- 1 pts Error is high

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1.5 Discussion 2 **3 / 3**

✓ **- 0 pts** *Correct*

- 3 pts Wrong answer

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1.6 Discussion 3 **3 / 3**

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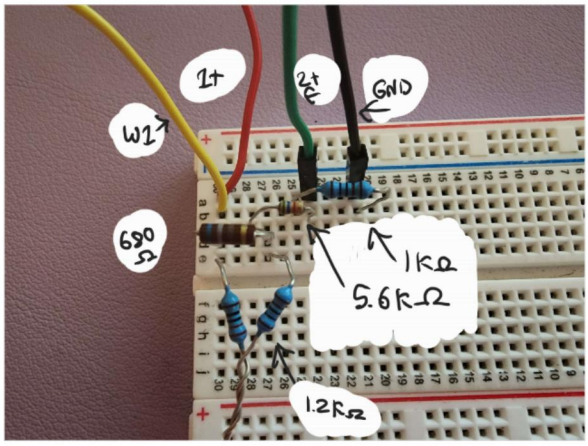
- 3 pts Wrong Explanation

- 1 pts "Voltage Divider" Concept missing

2. Equivalent Resistance



Note I could not find a 1.2kΩ so I used a 1kΩ + 220Ω. When I measured the $R_{eq} = 1.223 k\Omega$ %E = 1.8% which falls within Red Band of tolerance.

Theoretical Resistance (Ω)	Measured Resistance (Ω)
680 Ω	672.1Ω
1.2 kΩ	1223 Ω
5.6 kΩ	5574 Ω

- What is the equivalent resistance from nodes A and B?

$$\%E = \frac{6034 - 5959}{5959} \approx 1.26\%$$

From Theoretical Calculation: 6034Ω

From Impedance Analyzer: 5959Ω

  - Do they agree? Why not?

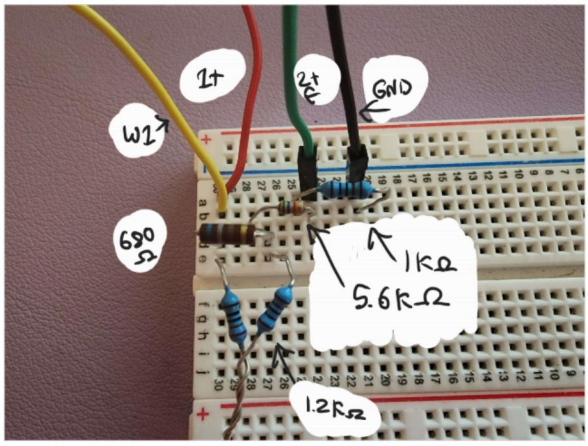
They do agree, since 1.26% < 5% which would make it within the Gold Band.

2.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image missing

2. Equivalent Resistance



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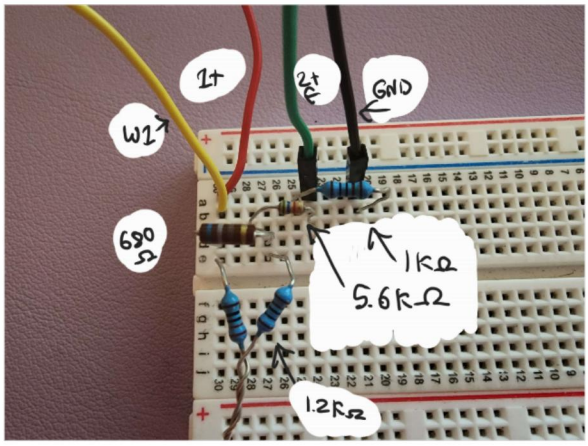
2.2 Impedance Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 2 pts Slightly higher error

- 5 pts Impedance measurement missing

2. Equivalent Resistance



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2.3 Equivalent Resistance **8 / 8**

✓ **- 0 pts** *Correct*

- 2 pts Theoretical Req must be done using theoretical resistance values

- 1 pts Slightly high error

- 4 pts High error in experimental value

- 4 pts Wrong theoretical value

- 8 pts No theoretical and practical values

- Calculate the skin resistance and mark the answer clearly

$R_{ref} = 1M\Omega \longrightarrow 1.02M\Omega = 1020k\Omega$

(1MΩ: Theoretical; 1.02MΩ: Measured)

With Skin

$R_{eq} = 366.8k\Omega = \left(R_{skin}^{-1} + R_{measured}^{-1}\right)^{-1}$

$\therefore R_{skin} = \frac{R_{measured} R_{eq}}{R_m - R_e} = 572.8k\Omega$

Discussion

- Voltages of about 50V can cause an electric shock (assuming contact with dry hands, as in this experiment). Based on your experimental results, how much current would be going through your body with such a voltage?

$V = I \cdot R_{skin} \quad \therefore I = \frac{50V}{572.8k\Omega} = 0.000087A$

From this we can see that currents as low as 0.087A can be dangerous at high enough voltages.

2.4 Skin Depth **8 / 8**

✓ **- 0 pts** *Correct*

- 4 pts Deduce skin resistance from equivalent resistance

- 4 pts Skin resistance is in parallel, the equation is wrong.

- 5 pts No Calculations shown

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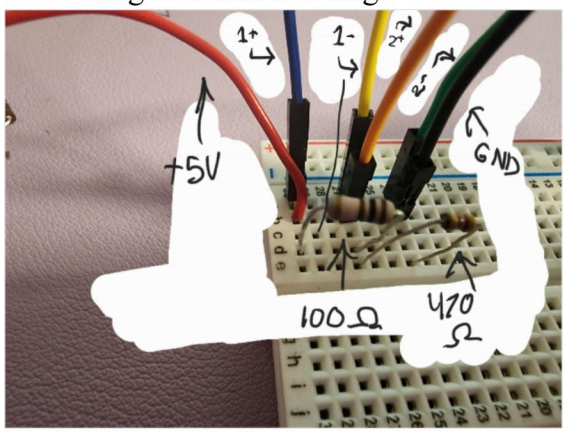
2.5 Discussion 1 **3 / 3**

✓ **- 0 pts** *Correct*

3. Voltage and Current Dividers

- Voltage Divider Readings.



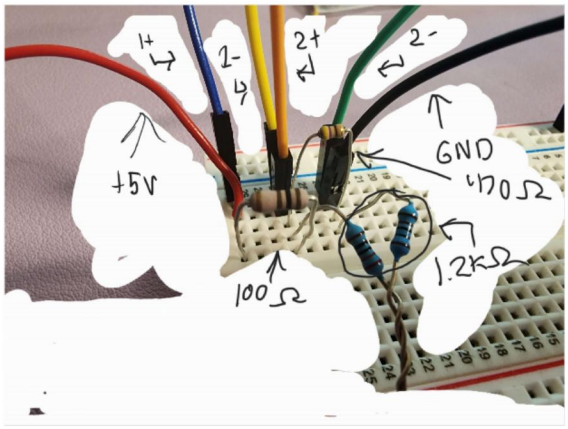
$R_{eq} = 570\,\Omega$

$5 = 570i$

$i = 0.00877\,A$

	Theoretical Voltage (V)	Measured Voltage (V)	%E
Across R1 = 100 Ω	0.877V	0.886V	1.016%
Across R2 = 470 Ω	4.123V	4.106V	0.56%

- Current Divider Readings.



	Measured Voltage Across Resistor (V)	Branch Current (mA)
R1 = 100 Ω	1.144V	11.4mA
R2 = 470 Ω	3.86V	8.213mA
R3 = 1.2 kΩ	3.86V	3.217mA

3.1 Test Image Setup 1 **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image Missing

3. Voltage and Current Dividers

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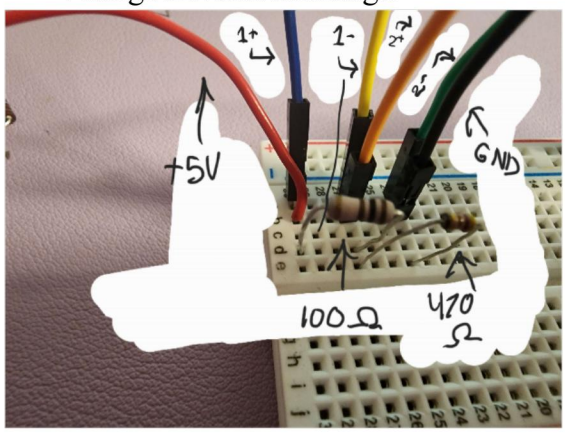

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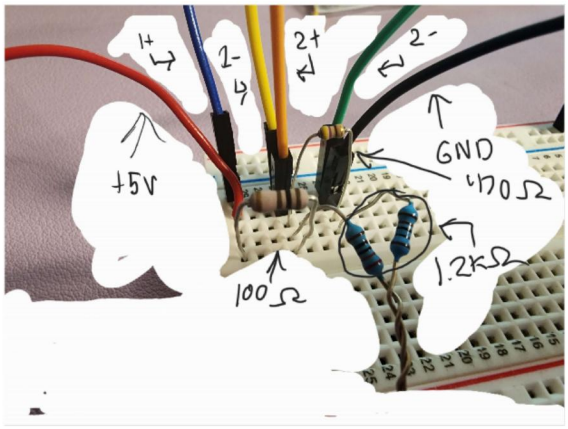

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3.2 Voltage Measurement **5 / 5**

✓ **- 0 pts** *Correct*

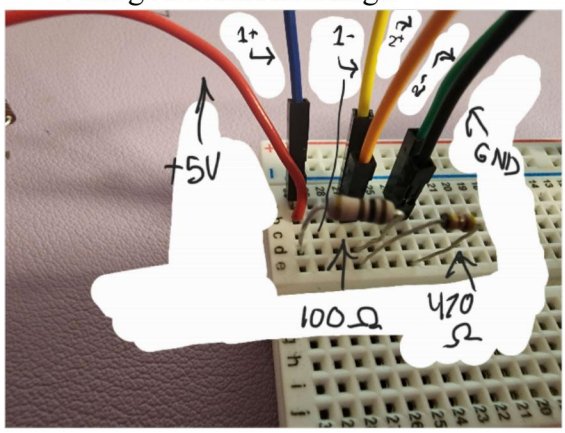
- 1 pts Minor Mistake

- 2 pts Major Mistake

- 5 pts Missing

3. Voltage and Current Dividers

- Voltage Divider Readings.



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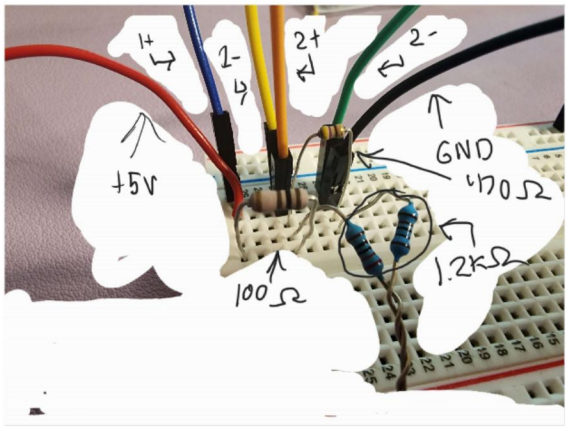

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3.3 Test Image Setup 2 **1 / 1**

✓ **- 0 pts** *Correct*

- 1 pts Image Missing

3. Voltage and Current Dividers

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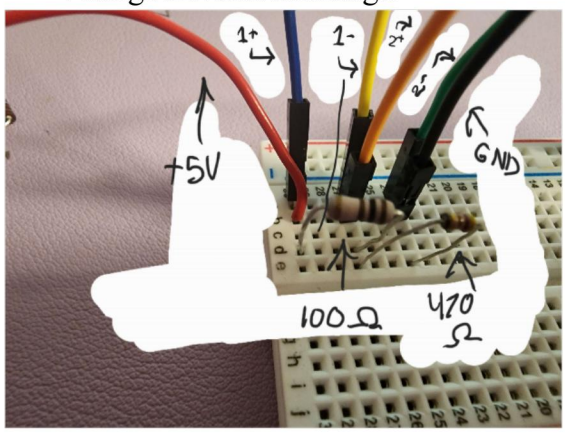

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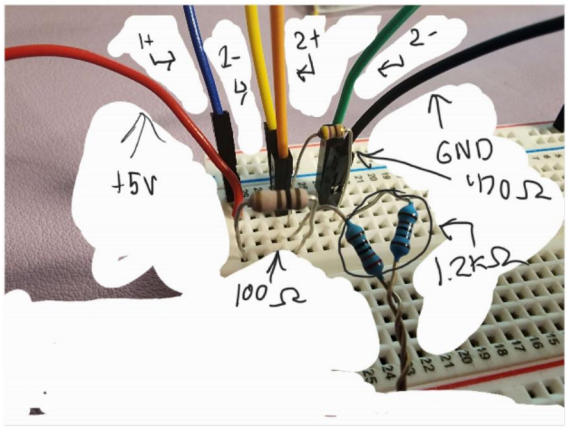

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3.4 Current Measurement **5 / 5**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 2 pts Major Mistake

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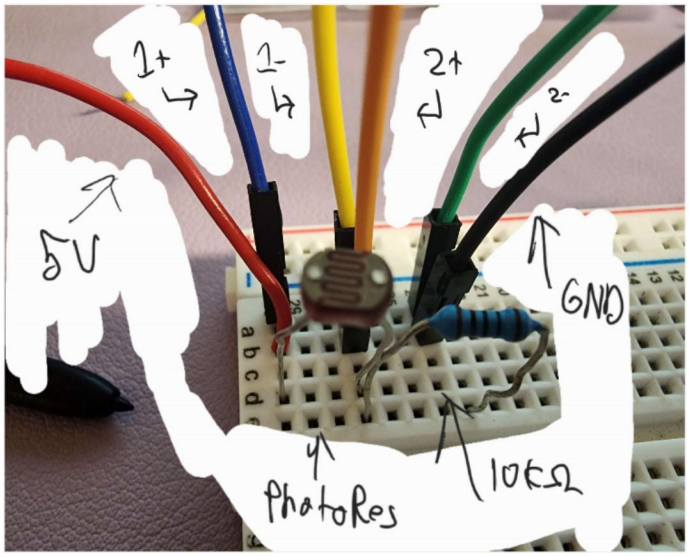
- 3 pts Two of three values wrong

Sensor-Circuit

<Insert One Sample Image of Test-Setup>



- What is the value of R_1 chosen for implementing the sensor circuit?

R_1 = 10kΩ

Voltage output in Normal Lighting (V)	Voltage output in Darkness (V)
2.43V	4.66V

Discussion

- How did the voltage and current divider compare with theoretical expectations?

% Error was within 2% for both the voltage & current dividers, this is consistent with theoretical expectations & shows KCL & KVL hold

- How does the resistance of the photoresistor change as you alter the level of light?

Resistance was inversely proportional to light level i.e when Low light = R↑ & high light = R↓

3.5 Test Image Setup 3 **1 / 1**

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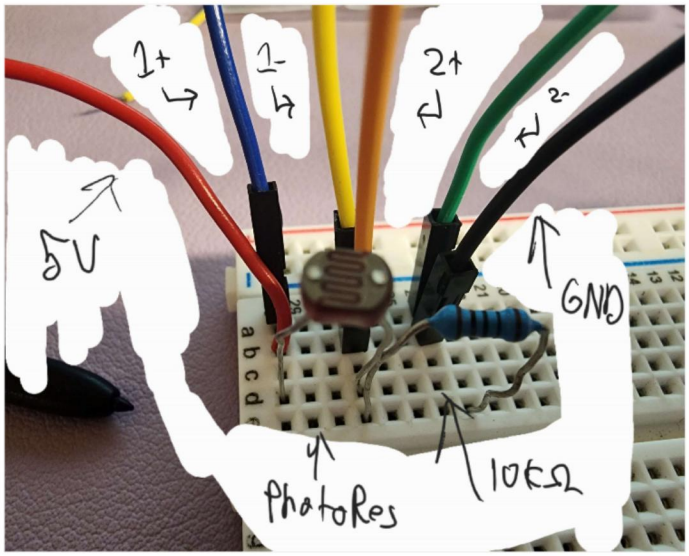
- 1 pts Image Missing

Sensor-Circuit

<Insert One Sample Image of Test-Setup>



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3.6 Sensor Circuit **6 / 6**

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- 6 pts Missing

Sensor-Circuit

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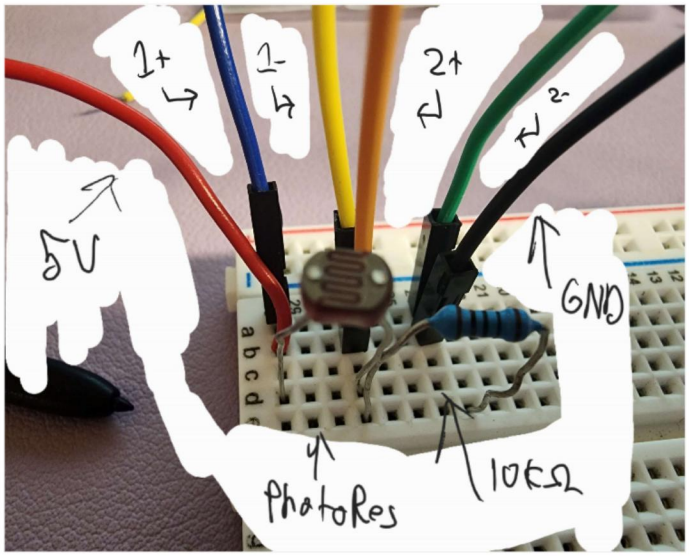

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3.7 Discussion 1 **3 / 3**

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- 1 pts Minor Mistake

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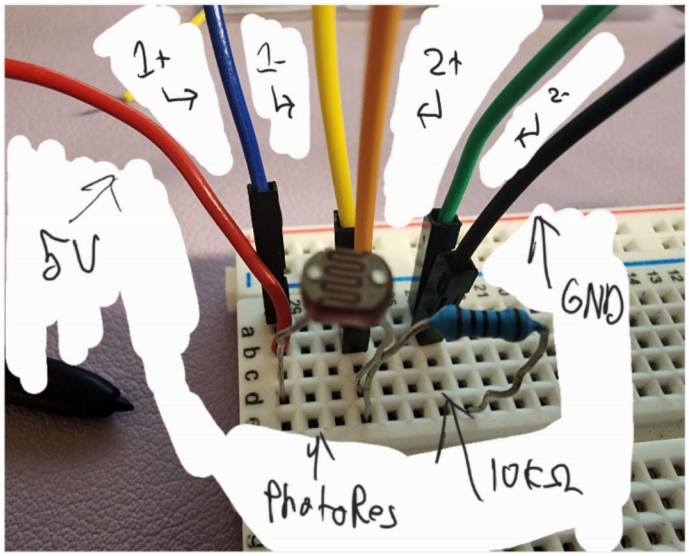
Sensor-Circuit

<Insert One Sample Image of Test-Setup>



- What is the value of R_1 chosen for implementing the sensor circuit?

R_1 = 10kΩ

Voltage output in Normal Lighting (V)	Voltage output in Darkness (V)
2.43V	4.66V

Discussion

- How did the voltage and current divider compare with theoretical expectations?

% Error was within 2% for both the voltage & current dividers, this is consistent with theoretical expectations & shows KCL & KVL hold

- How does the resistance of the photoresistor change as you alter the level of light?

Resistance was inversely proportional to light level i.e when Low light = R↑ & high light = R↓

3.8 Discussion 2 **3 / 3**

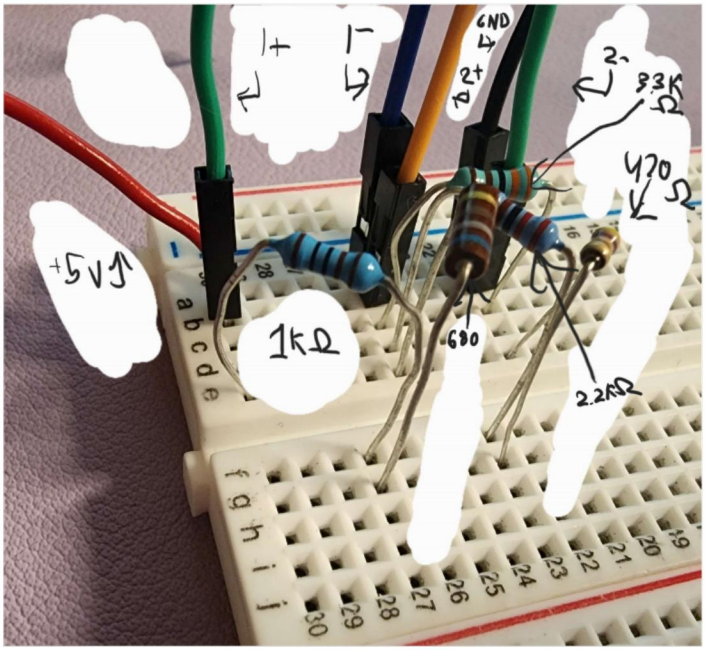
✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 3 pts Missing

4. Kirchhoff's Laws Analysis of Circuits

<Insert One Sample Image of Test-Setup>



	Theoretical		Measured	
	Voltage Across Resistor (V)	**Branch Current (mA)**	**Voltage Across Resistor (V)**	**Branch Current (mA)**
R1 = 1 kΩ	1.58V	1.6mA	1.582V	1.582mA
R2 = 680 Ω	1.077V	1.6mA	1.072V	1.513mA
R3 = 3.3 kΩ	2.343V	0.71mA	2.336V	0.711mA
R4 = 2.2 kΩ	1.914V	0.87mA	1.928V	0.83mA
R5 = 470 Ω	0.408V	0.87mA	0.406V	0.83mA

Discussion

- Does your experimental results obey Kirchhoff's Laws?

<Answer in 1-2 lines.>

Yes The % Errors seem to be less than 5% just by eyeballing. Upon calculating they are less than 1%. Therefore the experiment obeys Kirchoff's Laws.

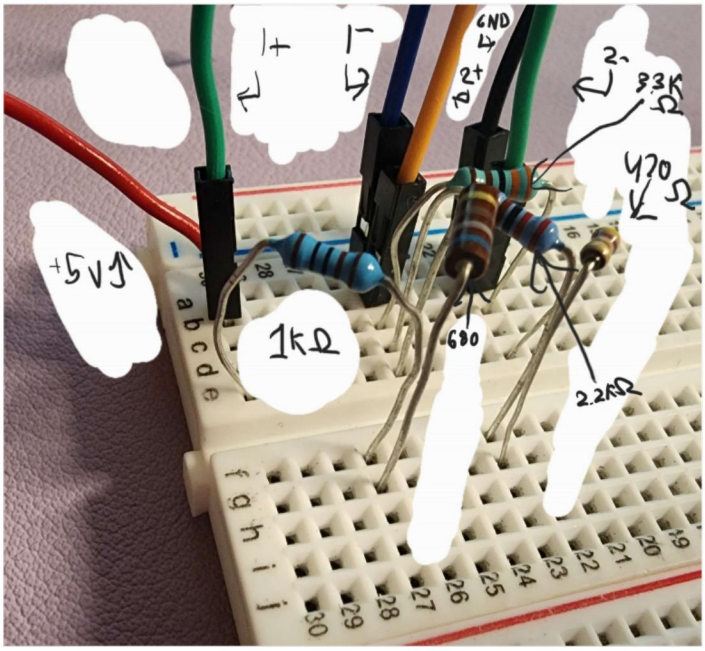
4.1 Test Image Setup **1 / 1**

✓ **- 0 pts** *Click here to replace this description.*

- 1 pts Missing

4. Kirchhoff's Laws Analysis of Circuits

<Insert One Sample Image of Test-Setup>



	Theoretical		Measured	
	Voltage Across Resistor (V)	**Branch Current (mA)**	**Voltage Across Resistor (V)**	**Branch Current (mA)**
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Discussion

- Does your experimental results obey Kirchhoff's Laws?

<Answer in 1-2 lines.>

Yes The % Errors seem to be less than 5% just by eyeballing. Upon calculating they are less than 1%. Therefore the experiment obeys Kirchoff's Laws.

4.2 Voltage and Current Measurement **16 / 16**

✓ **- 0 pts** *Click here to replace this description.*

- 1 pts Minor Mistake

- 2 pts Minor Mistake

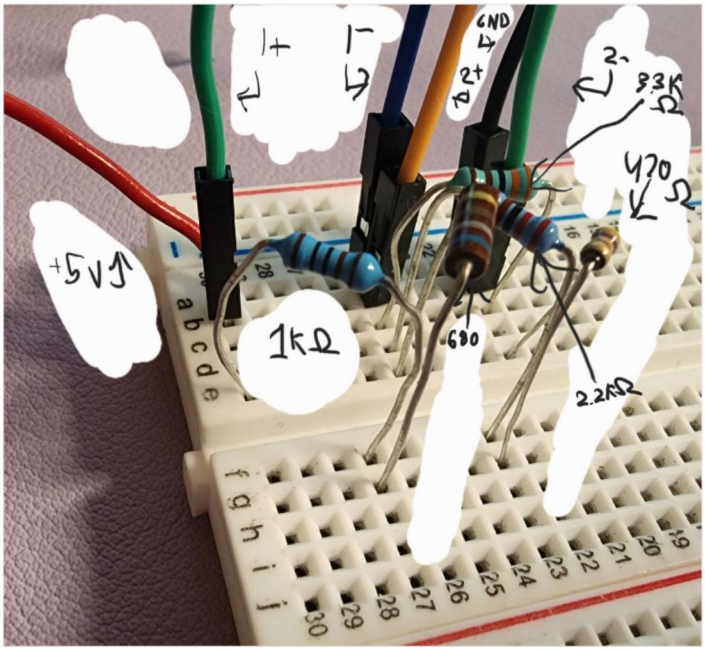
- 4 pts Major Mistake

- 8 pts Major Mistake

- 16 pts Missing

4. Kirchhoff's Laws Analysis of Circuits

<Insert One Sample Image of Test-Setup>



	Theoretical		Measured	
	Voltage Across Resistor (V)	**Branch Current (mA)**	**Voltage Across Resistor (V)**	**Branch Current (mA)**
R1 = 1 kΩ	1.58V	1.6mA	1.582V	1.582mA
R2 = 680 Ω	1.077V	1.6mA	1.072V	1.513mA
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R5 = 470 Ω	0.408V	0.87mA	0.406V	0.83mA

Discussion

- Does your experimental results obey Kirchhoff's Laws?

<Answer in 1-2 lines.>

Yes The % Errors seem to be less than 5% just by eyeballing. Upon calculating they are less than 1%. Therefore the experiment obeys Kirchoff's Laws.

4.3 Discussion 2 **3 / 3**

✓ **- 0 pts** *Correct*

- 1 pts Minor Mistake

- 3 pts Missing

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ECE11L Lab

Instructor: Sudhakar Pamarti