Objective:

To learn the basic measurement and calculation techniques in electronics,

1. **How to measure voltage**
2. **How to measure current**
3. **How to find resistance by using Ohm's Law**
4. **How to find power by using the formula $P = I.V$**
5. **How to find the Energy consumed.**

1. How to measure Voltage: (15 Points)

Voltage in a circuit is always measured 'ACROSS' a component or it is measured between 'TWO POINTS' in a circuit.

Procedure:

1. Construct the circuit given in Figure-1 on the breadboard. Do not connect the positive terminal of DC power source to the circuit. Set the voltage on channel 1 of the power supply to 10V.
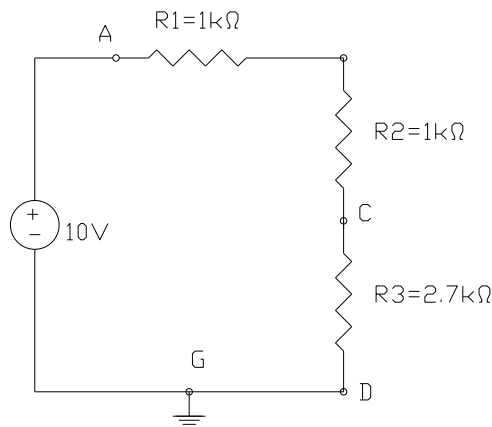

Figure 1

2. After carefully checking all the connections, connect the positive terminal of the DC power source.

3. Use digital multi-meter to measure the voltage drop between the points specified in Table-1 and record them to the corresponding cells in Column A of Table-1,

4. Remove R_3 from the circuit and measure the specified voltages and record them to the corresponding cells in Column B of Table-1,

Table- 1

	Between Points		(Column A) Circuit shown in Figure-1	(Column B) R_3 Removed
	Black Lead	**Red Lead**		
1	G	A		
2	G	B		
3	G	C		
4	C	A		
5	C	B		
6	C	D		
7	C	G		
8	A	B		
9	A	C		
10	A	D		
11	A	G		
12	B	A		
13	A	B		
14	B	C		

Questions:

1. **What happens when the leads of the multi-meter are interchanged?**

2. **Explain what happened to the voltages across the other resistors when R_3 is removed from the circuit?**

2. How to measure Current: (15 Points)

Current in a circuit is always measured in 'SERIES' with the circuit. Wherever the current is to be measured the ammeter is inserted in series in the circuit by braking the circuit between 'TWO POINTS'.

Procedure:

1. Construct the circuit given in Figure-2a on the bread board. Connect the positive terminal of DC power source to the circuit. Set the voltage on channel 1 of the power supply to 10V.
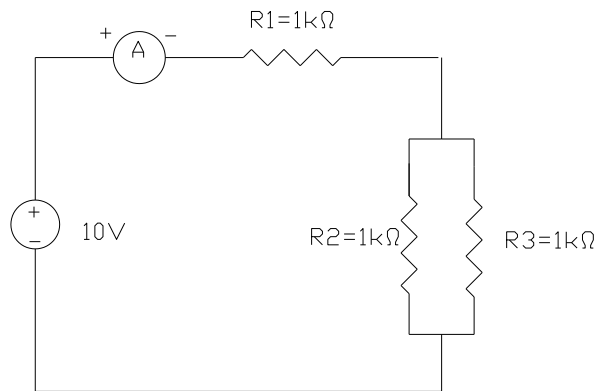

Figure 2a

2. After carefully checking all the connections, connect the positive terminal of the DC power source.
3. Use digital multi-meter to measure the current flow through R_1.
4. Remove the positive terminal of the DC power source (removing power) and reverse the connection of digital multi-meter, connect battery and measure the current flow through R_1 again.
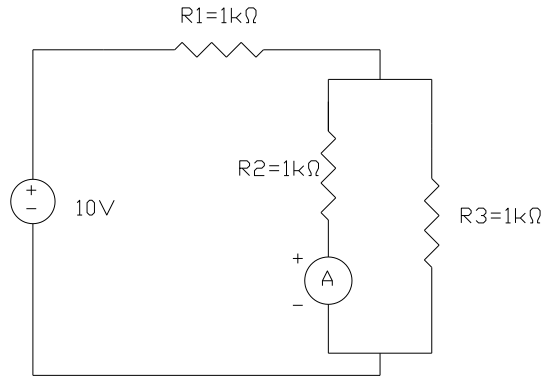5. Remove the power and replace the multi-meter as shown in Figure-2b.

Figure 2b

6. Connect power and measure the current flow through R_2.

7. Remove power reverse the connections of digital multi-meter and connect power.

8. Measure the current flow through R_2 once more.

9. Repeat the same procedure to measure the current flow through R_3.

10. Change the value of R_3 to **10 kΩ** and repeat steps 3-9.

11. Record all your measurements on Table-2.

Table- 2

Resistance Value	Measured Element	Meter Connection	Current
	R_1	Normal	
	R_1	Reverse	
	R_2	Normal	
	R_2	Reverse	
	R_3	Normal	
	R_3	Reverse	
	R_1	Normal	
	R_1	Reverse	
	R_2	Normal	
	R_2	Reverse	
	R_3	Normal	
	R_3	Reverse	

Questions:

1. What happens when the leads of the multi-meter are interchanged?

2. Explain the difference in the current values from steps 3-9 to step 10.

3. How to measure Resistance: (15 Points)

For the most accurate measurement, test the resistance of a component individually. Remove the component from the circuit or test it before you install it. Testing the component while still in the circuit can cause inaccurate readings from other components. If you are testing a circuit or even just removing a component, be sure that all power to the circuit is turned off before proceeding.

Procedure:

1. Construct the circuit given in Figure-3a on the breadboard. Do not connect any power. Fill up Table 3 (Rows 1-6), according to the resistance measurement configurations.
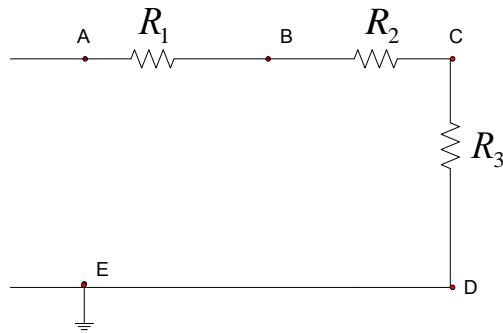

Figure 3a

The resistor values are: $R_1 = 1$ kΩ, $R_2 = 10$ kΩ, $R_3 = 2.2$ kΩ

2. After carefully checking all the connections, connect the positive terminal of the DC voltage source as in Figure-3b between nodes A and E. Measure the resistance value between nodes D and C and fill up Table-3 (Rows 7 and 8)
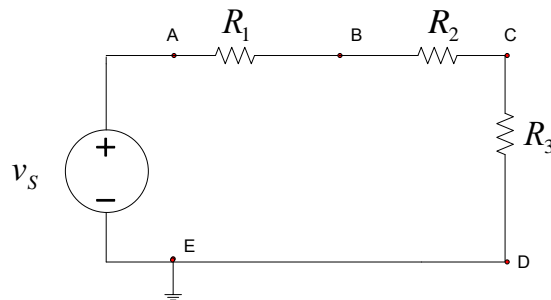
Figure 3b

3. Use digital multi-meter to measure the voltage drop between the points specified in Table-1 and record them to the corresponding cells in Column A of Table-1,

4. Remove R_3 from the circuit and measure the specified voltages and record them to the corresponding cells in Column B of Table-1,

Table- 3

Measurements	Nodes (points)		Resistances
	Black probe	Red probe	Digital Multimeter
1	D	C	
2	C	D	
3	A	B	
4	B	A	
5	B	C	
6	C	B	
7	D (power on)	C (power on)	
8	C (power on)	D (power on)	

Questions:

1. **What happens when the leads of the multi-meter are interchanged?**

2. **What happens to the reading when power is applied at points A and E?**

3. **Can resistance be measured is the circuit is connected to a power supply?**

4. **In the experiment up to step 6 no power was applied, how the pointer of the multi meter moved without a voltage source?**

4. How to find the resistance by using Ohm's Law: (15 Points)

Ohm's low states that, the voltage versus current characteristics is a linear relation for a linear time invariant resistor and the ratio of the voltage to the current value for this reason is constant and it is called as the resistance. Hence Ohm's law is given by the formula,

$$R = \frac{V}{I} \qquad (1)$$

where 'V' is the voltage measured in Volts across the resistor in Volts, 'I' is the current measured through the resistor in Amperes and 'R' is the resistance in Ohms (Ω).

Procedure:

1. Construct the circuit given in Figure-4 on the breadboard. Use digital multi meter to measure the voltage and current. (You will be given 2 different resistors: R=1kΩ and 10kΩ)
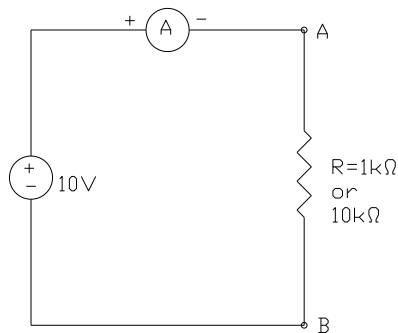

Figure 4

2. Change resistor to a different one and repeat the voltage and current measurements, fill up Table-4 with these measurements and calculated values of Resistors, Power and Energy for each case.

Table- 4

	R (Read)	Voltage	Current	R (Calculated)	Power (calculated)	Energy (Calculated)
1						
2						