SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR – 603 203

LABORATORY MANUAL

GE3221– ENGINEERING SCIENCES LABORATORY(PHYSICS)

(R-2023)

(Second semester B.E/B.Tech. students for the Academic Year 2024-2025)

Prepared by

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(Private circulation only)

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DEPARTMENT OF PHYSICS

Instructions to the students

The following instructions must be followed by the students in their laboratory classes.

1. Students are expected to be punctual to the lab classes. If they are late, they will be considered absent for that particular session.
2. Students should strictly maintain the dress code.
3. Students must bring their observation note, record note (completed with previous experiment) and the calculator to every lab class without fail.
4. Students are advised to come with full preparation for their lab sessions by
   - Reading the detailed procedure of the experiment from the laboratory manual.
   - Completion of observation note book (i.e.) Aim, Apparatus required, Formula (with description), least count calculation, diagrams and the tabular column should be written in the observation note before entering into the laboratory.
5. Data entry in the observation note book must be by pen only.
6. Students must get attestations immediately for their observed readings.
7. Students should complete their calculations for their experiments and get it corrected on the same day of that experiment.
8. Students who miss observation, record note they have to do the experiment once again and get it corrected.
9. Class assessment marks for each experiment is based only on their performance in the laboratory.
10. Record note has to be completed then and there and get corrected when the students are coming for the next lab class.
11. Students must strictly maintain silence during lab classes.
12. If any of the students is absent for the lab class for genuine reasons, he/she will be permitted to do the experiment during the repetition class only.
13. Students are advised to perform their experiments utmost care.

CONTENTS

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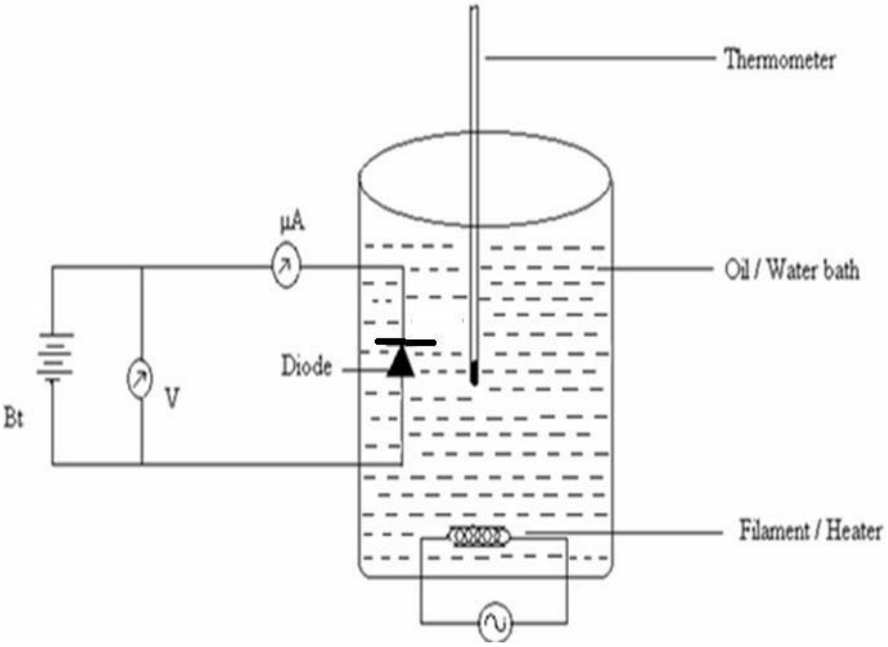

Figure. 1.1. Circuit for band gap determination

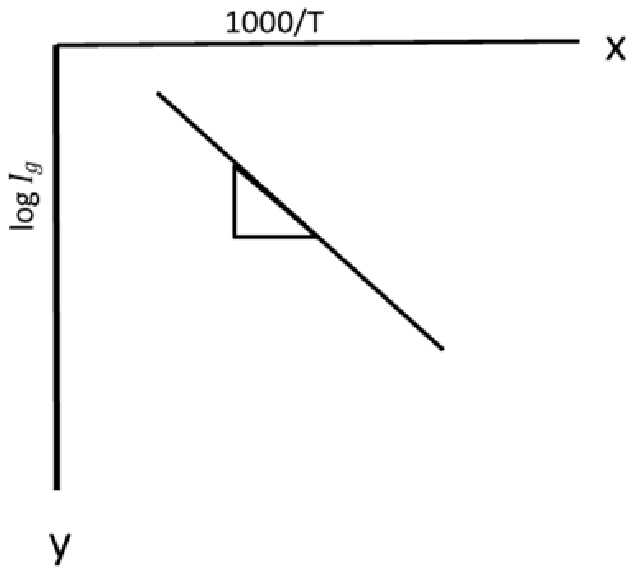

Figure. 1.2. Variation of current with temperature

1. DETERMINATION OF BAND GAP OF A SEMICONDUCTOR

AIM

To determine the band gap energy of a semiconductor by varying the temperature

APPARATUS REQUIRED

Semiconductor diode, Heating arrangement to heat the diode, Ammeter, Voltmeter, thermometer.

FORMULA

Band gap energy $E_g = 0.198 \times \text{Slope eV}$

$$\text{Slope} = \log I_s / (1000/T)$$

SYMBOL	EXPLANATION	UNIT
I_s	Reverse saturation current	A
T	Absolute temperature	kelvin

PROCEDURE

- The circuit connections are as shown in Figure. (1.1). The semiconductor diode and the thermometer are immersed in the water or oil bath, in such a way that the thermometer is kept nearby the diode.
- The power supply is kept constant (2 Volts). The heating mantle is switched ON and the oil bath is heated up to 70° C. Now the heating mantle is switched OFF and the oil bath is allowed to cool slowly. For every one degree fall of temperature the micro ammeter the reading I_s is noted.
- A graph is plotted taking 1000/T along X axis and log I_s along negative Y axis, (Since I_s in the order of micro-ampere, log I_s value will come in negative). A straight line obtained as shown in model graph (Figure.1.2). By finding the slope of the straight line, the band gap energy can be calculated using the given formula.

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To determine the saturation current

S.No	Temperature	Temperature	1000 /T	I_s	log I_s
unit	°C	K	K^{-1}	$\times 10^{-6}$ A	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

R

CALCULATION

$$E_g = 0.198 \times \text{Slope} \qquad \text{eV}$$

$$E_g = 0.198 \times \left(\frac{\log I_s}{\left(\frac{1000}{T}\right)} \right) \text{eV}$$

E_g = -------------- eV

RESULT

The band gap energy of the given diode is E_g = eV.

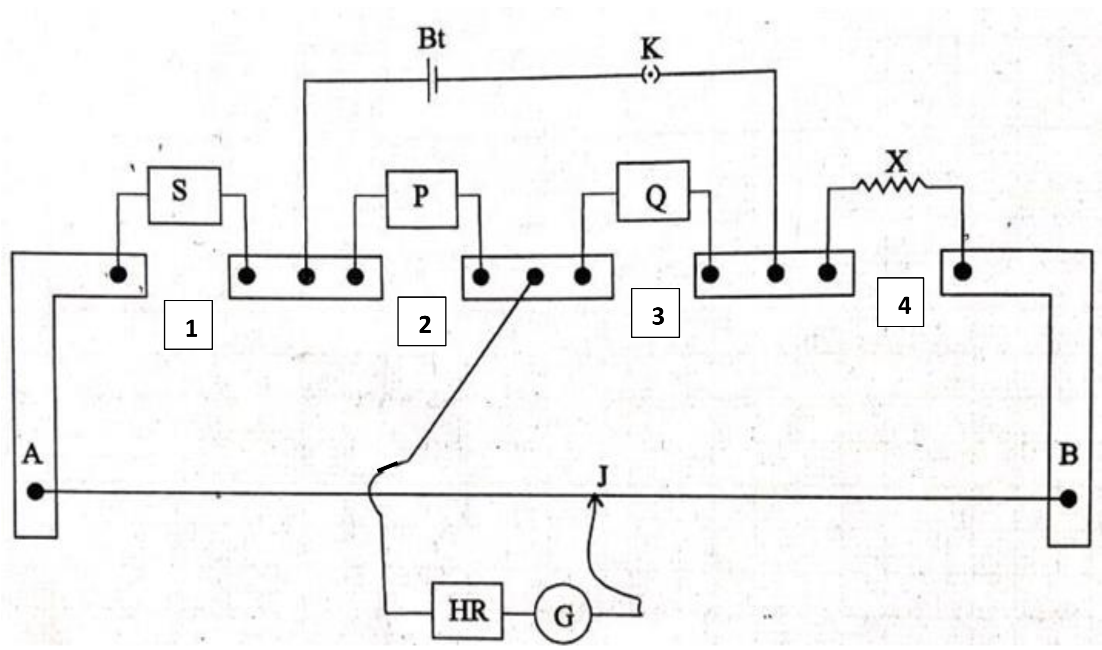

Figure 2.1 Experimental setup for Carey Foster Bridge

To find the resistance of the bridge wire per meter

S.No	Resistance box in S	Balancing length		$l_1 \sim l_2$,	Resistance of the wire per meter $\rho = \frac{S}{l_1 \sim l_2}$
		Before interchanging l_1,	After interchanging l_2,		
	ohm	m	m	m	ohm/m

Mean $\rho =$ ohm/m

2. DETERMINATION OF ELECTRICAL RESISTIVITY OF METAL AND ALLOY – CAREY FOSTER BRIDGE

AIM

To determination of the specific resistance or resistivity of the material of the given wire

APPARATUS REQUIRED

Bridge wire resistance coil, Battery, 4 & 2 dial resistance boxes, copper strips, galvanometer, High resistance, key, Jockey, etc.,

FORMULA

Specific resistance of the wire $= \frac{X \pi r^2}{l}$ ohm metre

Unknown resistance = $X = S + \rho\,(l_2 - l_1)$ ohm

EXPLANATION

SYMBOL	EXPLANATION	UNIT
X	Resistance of the wire	Ohm
r	Radius of the wire	metre
l	Length of the wire	metre
l_1, l_2	Balancing length	metre
ρ	Resistance of the wire per meter	ohm/metre

PROCEDURE

- The circuit connections are as shown in the Figure. 2.1 the two equal resistance P and Q are connected in the inner gaps 2 and 3. A known low resistance S is connected in the gap 4.
- The unknown resistance is connected to the in the gap 1. A battery and a galvanometer are connected as shown in the Figure. 2.1 the circuit is closed by a key.
- The jockey is pressed near one end A of the bridge wire and then end B. The connections are correct only when the deflections are in opposite direction. The balancing length (l_1) is measured by pressing the jockey along the bridge wire for null deflection in the galvanometer.

L

To determine the resistance of the coil (X)

S. No	Resistance box in S	Balancing length		$l_1 \sim l_2$	Unknown resistance $X = S + \rho\,(l_2 - l_1)$
		Before interchanging l_1	After interchanging l_2		
	ohm	m	m	m	m

Mean $X =$ ohm

CALCULATION

Radius of the wire r = …………………………. metre

Length of the wire l = ……………………………metre

Resistance of the wire X = ……………………. ohm

Specific resistance of the wire $= \frac{X\pi r^2}{l}$

- The second balancing length is found by interchanging X for S. For different values of S, $l1$ and $l2$ are found. The readings are tabulated, and using the formula $X = S + \rho\,(l_2 - l_1)$ the unknown resistance value is found. To find ρ, a thick copper strip of zero resistance is connected instead of X. the balancing lengths l_1, and l_2, are determined.

- The experiment is repeated with different values of S and the mean value ρ is taken. The specific resistance of the wire is found using the formula by measuring r the radius of the wire and length l of the wire.

RESULT

Resistance of the given wire = …………………………………. ohm.

Specific resistance of the given wire = ………………………ohm. metre.

L

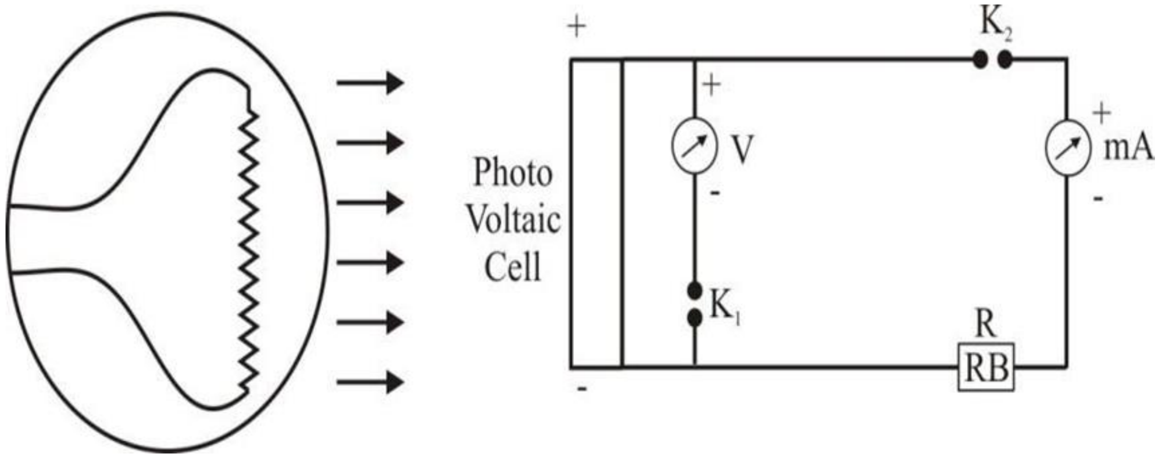

Figure 3.1 Circuit diagram of solar cell

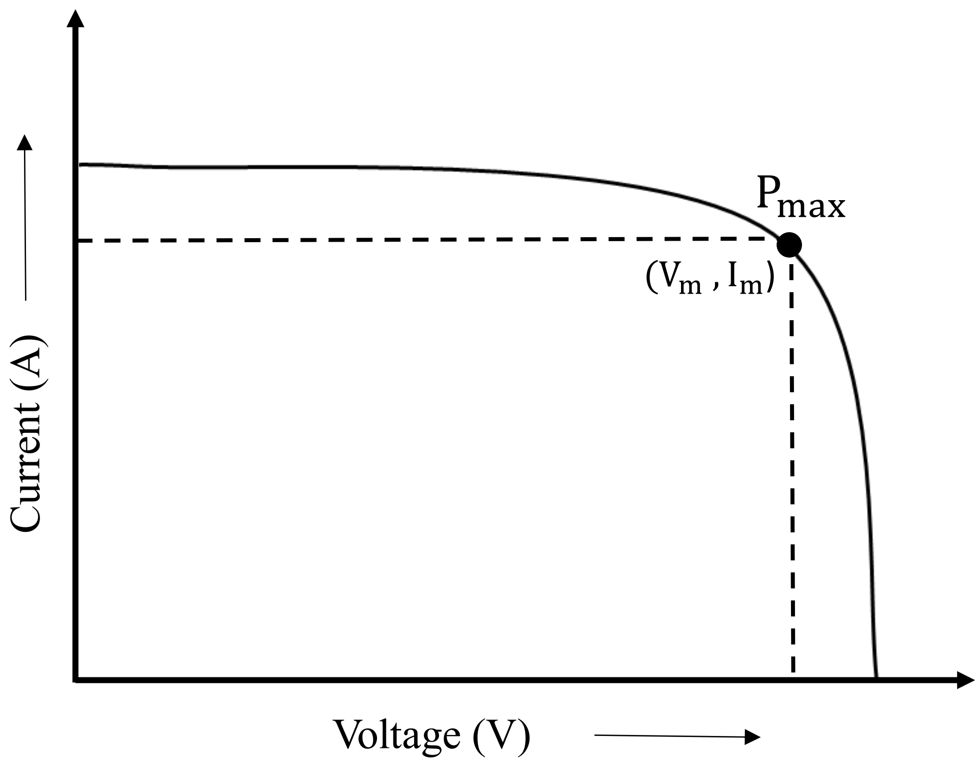

Figure 3.2. Model Graph for I-V characteristics

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3. STUDY OF I-V CHARACTERISTICS OF SOLAR CELL AND DETERMINATION OF ITS EFFICIENCY

AIM

To study the I-V Characteristics of a solar cell illuminated by an incandescent lamp and to determine its efficiency.

APPARATUS REQUIRED

Solar cell, voltmeter, mill ammeter, a dial type resistance box, Keys, illuminating lamps, connecting wires etc.

FORMULA

Efficiency of the solar cell $\eta = \frac{P_{max}}{AI_o} \times 100$

Where, $P_{max} = V_m \times I_m$ watt

$$I_0 = \frac{P}{4\pi d^2} \text{ watt/m}^2$$

EXPLANATION

SYMBOL	EXPLANATION	UNIT
V_m	Maximum voltage point	volts
Im	Maximum current point	ampere
A	Area of the solar panel	m^2
P	Power of light	watt
I_0	Intensity of light	Wm^{-2}

PROCEDURE

- The connections of the solar cell are as shown in the Figure 3.1. The resistance is set at the minimum. the incandescent lamp is connected with its power supply.
- The lamp is switched on and adjusted to illuminate the maximum area of the solar cell. the distance between the lamp and the solar cell is noted. As the resistance is varied, the current and voltage values are noted.
- The graph between Voltage and current is drawn for measured distance (d) The maximum power output at the turning points on the curves are determined. (Figure 3.2)

L

To find the I-V characteristics

Distance between the solar panel and the bulb (d) = cm

Intensity of light I_0 = Wm^{-2}

S.No.	Resistance (ohm)	Voltage (V)	Current (mA)

CALCULATION

$P_{max} = V_{mp} \times I_{mp}$ watt

R

$$I_0 = \frac{P}{4\pi d^2} \text{ watt/m}^2$$

Efficiency of the solar cell

$$\eta = \frac{P_{max}}{AI_o} \times 100$$

Result

The efficiency of the solar cell η =

L

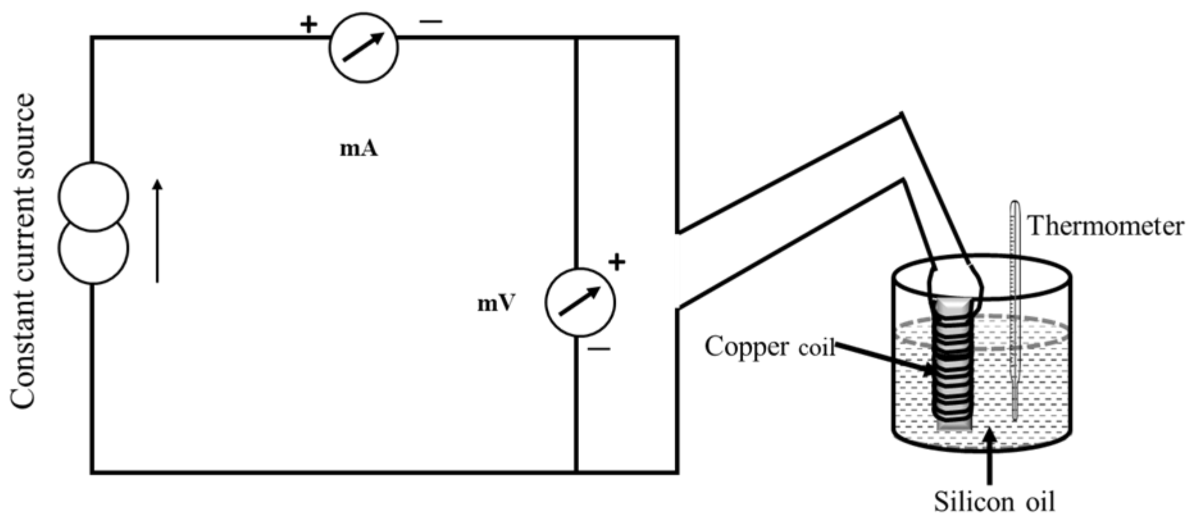

Figure 4.1. Experimental setup for determination of Fermi Energy

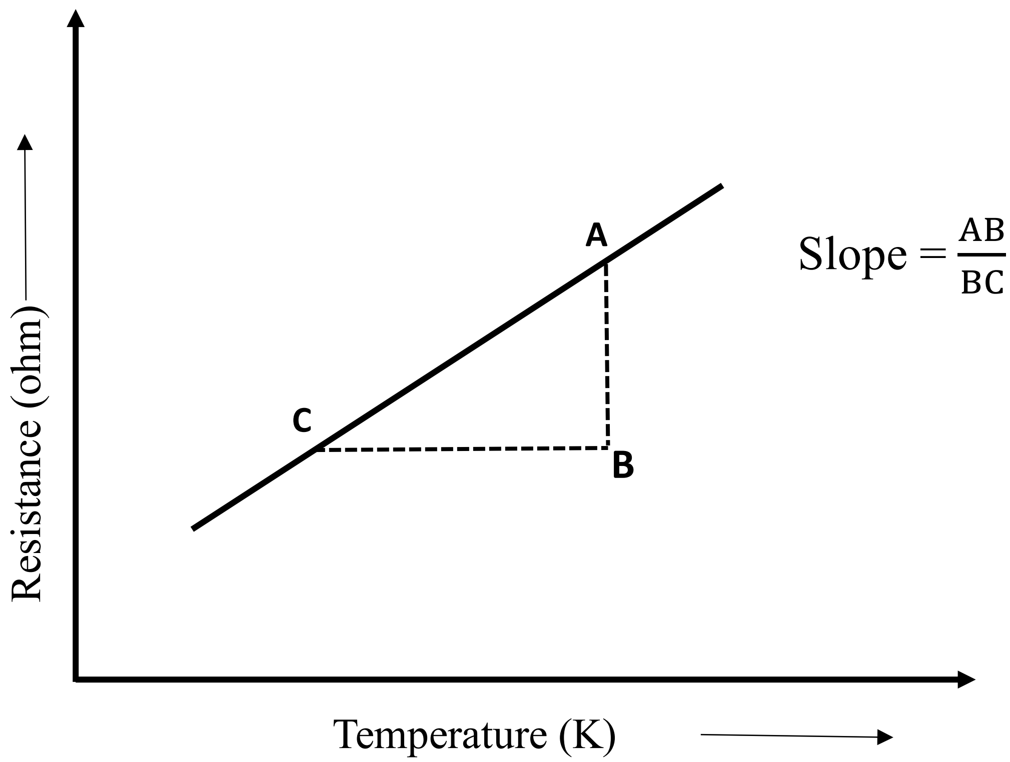

Figure 4.2 Model graph Resistance vs Temperature

4. DETERMINATION OF FERMI ENERGY

AIM

To determine the Fermi Energy of Copper

APPARATUS

DC regulated power supply, copper coil, connecting wire, thermometer, oven, beaker and silicon oil.

FORMULA

The Fermi Energy of copper

$$E_f = \frac{1.36 \times 10^{-15}}{1.6 \times 10^{-19}} \times \sqrt{\left(\frac{\rho AS}{L}\right)} \quad \text{eV}$$

EXPLANATION

SYMBOL	EXPLANATION	UNIT
E_f	Fermi energy of Copper	eV
ρ	Density of copper (8940 kg/m^3)	ampere
A	Area of the cross section ($0.64 \times 10^{-6} m^2$)	m^2
L	Length of copper wire	watt

PROCEDURE

- The red connector of the copper coil (on the red wire) is connected to +I, and the black connector (on the white wire) is connected to +V (Figure 4.1). Similarly, the red connector of the copper coil (on the other red wire) is connected to -I and the black connector (on the black wire) to -V of the main unit.

- The copper coil is placed in a beaker with silicon oil and kept in an oven. The heater is switched on. The silicon oil is heated to 80. The heater is switched off, the temperature rises to a minimum, and the deceleration occurs. The resistance of every 5 °C fall in temperature is noted and tabulated.

- The graph (Figure 4.1) between resistance and temperature is drawn, and the slope S is calculated. By substituting the values in the given formula, the Fermi energy of copper is measured.

L

To determine the resistance

Trail .No	Temperature	Temperature	Resistance R
unit	°C	K	Ω
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

CALCULATION

$$E_f = \frac{1.36 \times 10^{-15}}{1.6 \times 10^{-19}} \times \sqrt{\left(\frac{\rho AS}{L}\right)}$$

RESULT

The Fermi Energy of Copper $E_f =$ eV

L

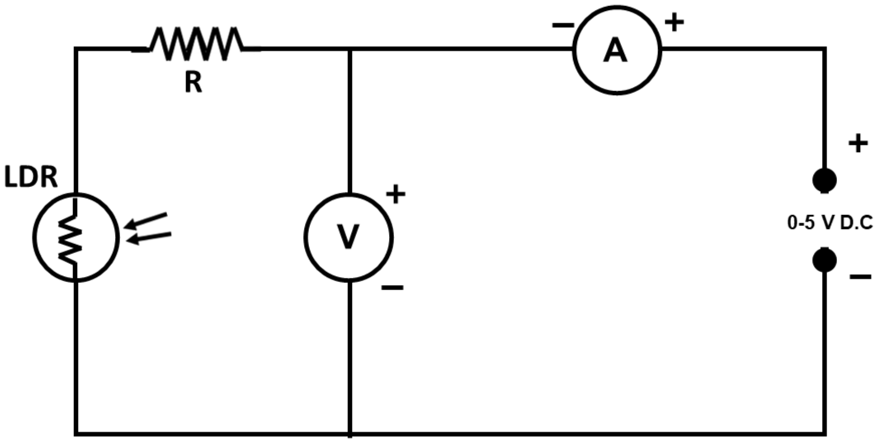

Figure 5.1. Circuit of LDR set up

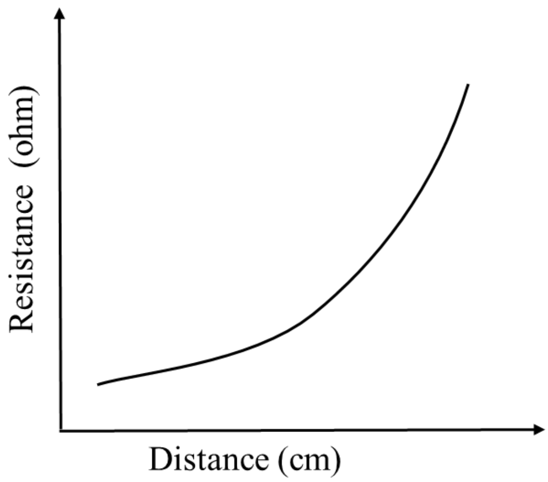

Figure 5.2. Model graph Resistance R Vs Distance

5. DETERMINATION OF THE DARK RESISTANCE OF LIGHT DETECTIVE RESISTER

AIM

To study the V-1 Characteristics of Light Detective Resister (LDR)

APPARATUS

LDR , light source, Regulated power supply, Ammeter, Voltmeter and connecting wires.

FORMULA

Resistance $R = \frac{V}{I}$ ohm

EXPLANATION

SYMBOL	EXPLANATION	UNIT
R	Resistance of LDR	ohm
V	voltage	volts
I	current	ampere

PROCEDURE

- Connection are given as shown in Figure 5. 1.
- The light source is kept at a distance and switch it ON, so that it falls on the LDR
- The current and voltage readings are noted in ammeter and voltmeter.
- The current and voltage readings for various distance of the light source are noted.
- The graph between R as calculated from observed V and I and distance of light source is drawn. (Figure 5. 1)

L

To find the resistance of LDR

S. No	Distance cm	Voltage (V)	Current (mA)	Resistance (ohm)

CALCULATION

Resistance $R = \frac{V}{I}$ ohm

RESULT

The characteristics of LDR are studied and verified