Explore a portable display system using renewable energy source.

Objective:

To determine I-V characteristics and the suitability of the solar cell in electric power generation for electronic devices.

Apparatus:

Solar cell characteristic kit, light source, LEDs.

Theory:

Principle of solar cell:

The principle of power generation behind the solar cells consists of the utilization of the photovoltaic effect of semiconductors. When such a cell is exposed to light, electron-hole pairs are generated in proportion to the intensity of the light. Solar cells are made by bonding together p-type and n-type semiconductors. The negatively charged electrons move to the n-type semiconductor while the positively charged holes move to the p-type semiconductor. They are collected at electrodes to form a potential. When the two electrodes are connected by a wire, a current flows and the electric power thus generated can be transferred to an outside application.

Formula Used:

Short circuit current flows with zero external resistance and it is the maximum current delivered by the solar cell at any illumination level. Similarly the open circuit voltage, V_{oc}, is the potential which develops at the terminals of the solar cell when the external load resistance is very large. The power delivered to the load is zero at both extremes and reaches a maximum (P_{max} or MPP) at a finite load resistance value.

The maximum power (P_{max} or MPP) delivered to the solar cell is the area of the largest rectangle under the I-V curve. It is given by the product of maximum current (I_m) and maximum voltage (V_m)

$$(P_{max}) = I_m \times V_m \text{ (Watts)}$$

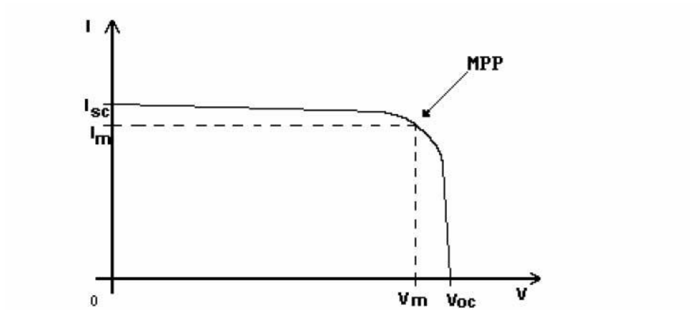

Fig1: I-V Characteristics of Solar cell

A commonly used parameter that characterizes the solar cell is called the **Fill Factor** (FF). It is defined as the ratio of the P_{max} to the area of the rectangle formed by V_{oc} and I_{sc}

$$FF = (P_{max} / (V_{oc}) \times (I_{sc})) \text{ (No Unit)}$$

The **Efficiency** of the solar cell is the ratio of the electrical power it delivers to the load by the optical power incident on the cell. Maximum efficiency is when power delivered to solar cell is $P_{max.}$

$$\eta = (P_{max} / (A \times I_0)) \times 100\ \%$$

where A is the area of the solar cell in m^2 and I_0 intensity of solar light radiation (Watts/m^2).

Procedure:

Solar cell characterization

I. To Find the I-V Characteristics of solar cell

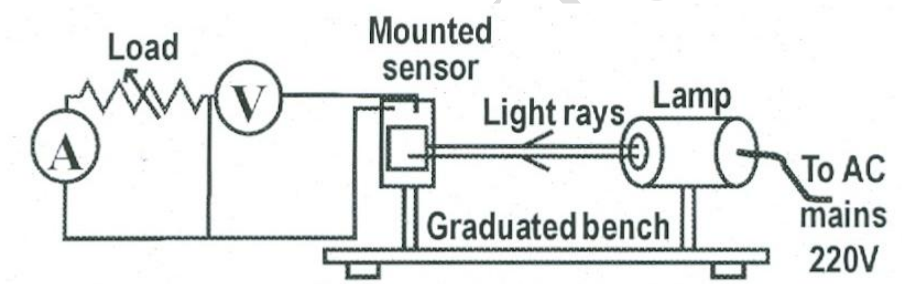

Fig:2 Schematic wiring circuit diagram

1. Make the connections as shown in figure .Then place the source at a distance (x = 10cm) from the solar cell
2. Note the open circuit voltage V_{oc} indicated by the millivoltmeter by opening the connecting wire joining negative of the milliammeter to the load.
3. Bring load selector switch to Sc position to short circuit the solar cell and note the reading in the milliammeter. If meter shows out of scale then decrease the light intensity by increasing the distance. Note down the maximum current I_{sc}
4. Now introduce the load resistance in the circuit (start from low value of resistance) and note down the milliammeter and millivoltmeter readings.
5. Plot the graph of voltage along X axis and current along Y-axis.
6. Plot Power Vs Voltage in the same graph and find the value of P_{max}.

7. Then calculate the values of fill factor and efficiency.
8. **Repeat the experiment for another distance (15 cm) between solar cell and source of light**.

Suitability of the given solar cell for display device using LED lighting:

1. Connect the output of the solar cell to the bread board containing the LEDs
2. Find out the suitable distances to light up LEDs with full glow

Precautions:

You suggest

Observation

Table I: I-V Characteristics of Solar cell

Short circuit current (I_{sc}) = Open circuit voltage (V_{oc}) =

Distance= 10 cm $A = 6\times10^{-4}\ m^2$ $I_0 = 11.49\ W/m^2$

Sl. No	Resistance (**Ω**)	Current (mA)	Voltage (V)	Power = Watts
1	300			
2	400			
3	500			
4	600			
5	900			
6	1000			

Table II: I-V Characteristics of Solar cell

Short circuit current (I_{sc}) = Open circuit voltage (V_{oc}) =

Distance= 15 cm $A = 6\times10^{-4}\ m^{2}$ $I_0 = 6.12\ W/m^{2}$

Sl. No	Resistance (**Ω**)	Current (mA)	Voltage (V)	Power = Watts
1	300			
2	400			
3	500			
4	600			
5	900			
6	1000			

Calculations and results: Follow the formulas

Conclusion & Inference:

For example,

Why some LEDs did not glow? Some applications…………