Hands on Activity 3 – Photovoltaic Cells

This HoA is an individual e-learning activity and is worth a total of 3% of the Physical World grade. This activity is based on: (1) answers to this worksheet, graded out of 20 points due on 23 April 2020 Thursday at 6 pm; and (2) an individual 4-minutes online MCQ assessment, graded out of 10 points.

Learning Objective and Outcomes

Students should be able to

- determine the short circuit current (I_{sc}), the open circuit voltage (V_{oc}) and the fill factor (FF) of the solar cell through experimental technique
- analyze how and why V_{oc} changes with operating temperature
- describe the effect of intensity of light on the current and voltage of the solar cell

There are three parts to this HoA 3:

I) Construct an IV plot of the solar cell at constant intensity by varying load resistors

II) Determine the effect of light intensity, by varying the LED at different heights, on the short circuit current for LEDs

III) Complete an individual 4 minutes online MCQ

Part I: Construct an IV plot of the solar cell at constant intensity by varying load resistors

Materials used:

1) 1 load measurement box
2) 1 power adaptor for the load measurement box
3) 1 black and 1 red wire with alligator clips
4) 1 halogen lamp
5) Power connector for the halogen lamp
6) 1 solar cell
7) 1 retort stand

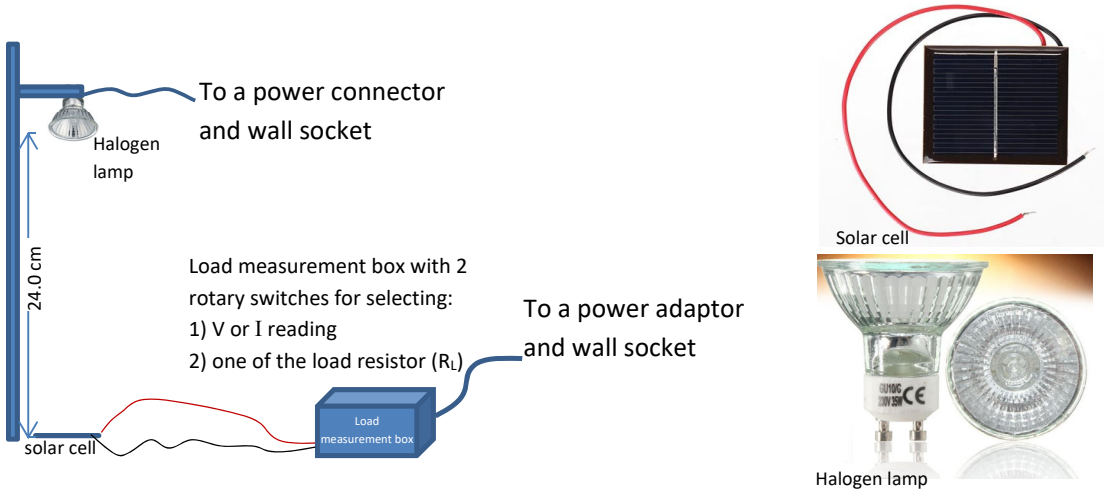

Figure 1: Setup for measuring current (I) and voltage (V) at different load resistor (R_L)

Data Collection (done by instructors)

i. The solar cell was connected to the load measurement box and the halogen lamp was connected to the power source using an adaptor as shown in figure 1.

ii. The halogen lamp was fixed at a vertical position of 24.0 cm directly above the solar cell using a ruler and retort stand. Figure 2 shows the Circuit diagram of the measurement box connected to the solar cell and R_L.

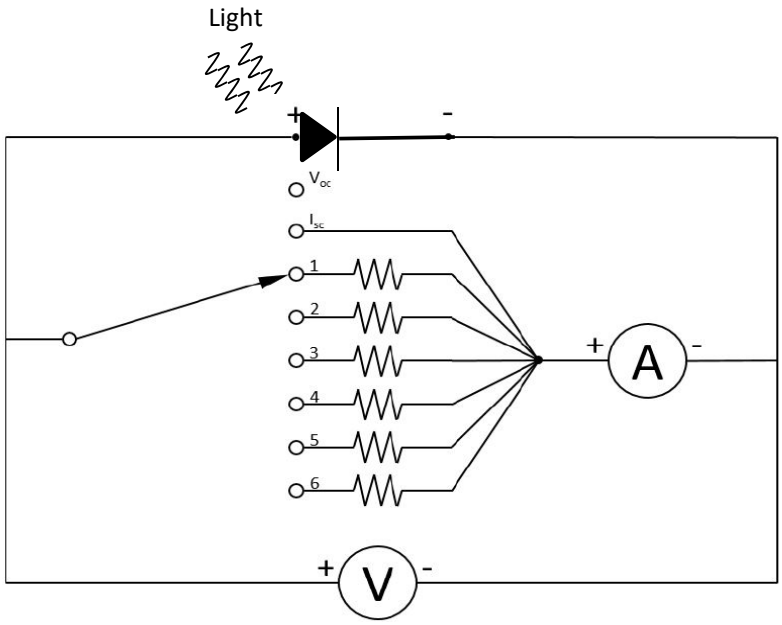

Figure 2: FYI - Circuit Diagram of the measurement box with solar cell

iii. The measurements (V_{OC} and the corresponding I, and Isc) at various R_L were taken using the following steps and are shown in table 1 in the worksheet.

a. Turn the rotary switch of the load measurement box to V_{OC}. The current should be zero, but a reading may be observed on the voltmeter even without the lamp on.

b. Switch on the lamp. Record the open circuit voltage (V_{OC}) and the corresponding I.

c. Turn the rotary switch to the Isc position. Record the short circuit current, and the corresponding V.

d. Turn the rotary switch to the first load resistor that was installed on the measurement box. Record the V and the corresponding I.

e. Repeat d for all 6 load resistors on the measurement box.

f. Turn the rotary switch back to V_{OC}, and leave the halogen lamp on. Record the V_{OC} again after 10 min.

g. Measure the dimensions of the solar cell

Part II: Determine the effect of light intensity, by varying the LED at different heights, on the short circuit current for LEDs

Materials Required

1) 1 digital multimeter
2) 1 black and 1 red wire with alligator clips
3) 1 LED lamp
4) Power connector for the LED
5) 1 solar cell
6) 1 retort stand

Instructions

i. The solar cell was connected to the digital multimeter ((μA·mA channel) and the red LED lamp was connected to the power source using an adaptor as shown in figure 3.

ii. The LED lamp was fixed at a vertical position of 17.0 cm directly above the solar cell using a ruler and retort stand.

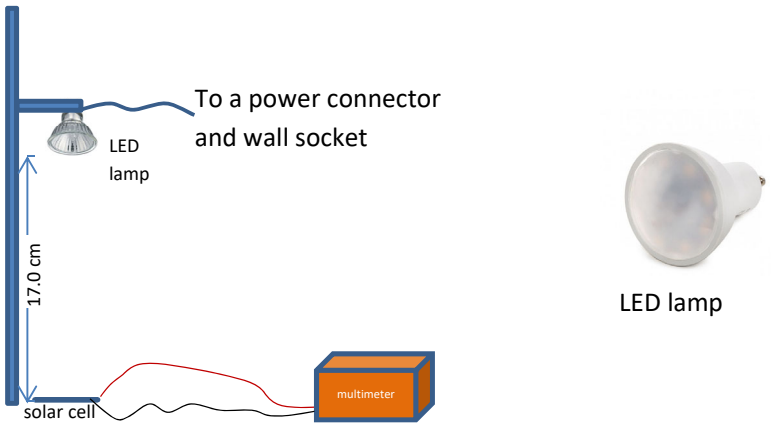

Figure 3: Determining effect of intensity on current produced

iii. The knob on the digital multimeter was turned to μA.
iv. Switch on the LED lamp.
v. The short circuit current I_{SC} generated can be found in Table 2 of the worksheet.
vi. The height of the LED lamp was varied at 3 different values ranging from 6.0 – 17.0 cm and the Isc recorded in table 2.
vii. The experiment was repeated with green and blue LED lamps.
viii. For your data analysis, please use the following wavelengths for the color of LED lamps.

Color of LEDs	Wavelength (nm)
RED	633
GREEN	524
BLUE	460