Cohort class: ______ ID: ___________ Name: _________________

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:

Complete the table below (2 points)

Table 1: V_{OC}, V and the corresponding I, and Isc

I (~~A or~~ mA)	**V (V)**	**Resistance (mΩ) (Calculated from V and I)**	**Power (mW)**
0	0.535		
6.78	0.516		
20.6	0.467		
26	0.407		
28.5	0.315		
29.3	0.236		
29.7	0.112		
I_{sc} = 29.9	0.031		

Dimensions of the solar cell: Length = 4 cm Width = 2 cm

V_{oc} after 10 min = 0.513 V

Data Analysis

1) Plot the IV curve of the solar cell in Excel. Attach the graph to this worksheet. (2 points)

Cohort class: ______ ID: ___________ Name: _________________

2) From the graph, determine the

a. Fill Factor (FF) of the solar cell. (1 point)

b. Considering the efficiency of the solar cell to be 18.9%, calculate the intensity of the light that is received by the solar cell assuming that the efficiency of the halogen lamp is similar to the solar spectrum and the efficiency does not change with the light intensity. (2 points)

c. Is the V_{oc} after 10 min the same as the one measured at the beginning? If not, suggest a possible reason for a change in the value for V_{oc}. (1 point)

3) The solar cell has to be placed flat directly below the light source. Why? (1 point)

4) Why is it possible that there was a reading on the voltmeter in iii a. even without turning on the lamp? (1 point)

Cohort class: ______ ID: ___________ Name: _________________

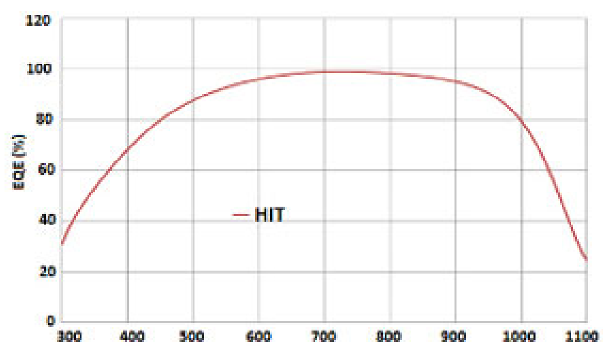
Part II:

1) Complete the following table (6 points)

Table 2a: Data from varying height of red LED lamp

Height (cm)	**I_{SC} (μA)**	**No. of electrons/ s cm^2**	**No. of photons/ s cm^2**	**Quantum Efficiency**	**Intensity (mW/cm^2)**
6.5	3228				
9.0	1900				
12.0	970				
17.0	500				

Show a sample calculation on how you arrived at No. of electrons/ s cm^2, No. of photons/ s cm^2 and Intensity (mW/cm^2). You may use the following graph to estimate the quantum efficiency of the solar cell. (2 point)



Wavelength (nm)

http://www.enli.com.tw/s/2/product-144288/DSSC-Solar-Cell-Quantum-Efficiency-Measurement-System-QE-mini.html

Cohort class: ______ ID: ___________ Name: _________________

Table 2b: Data from varying height of green LED lamp

Height (cm)	I_{SC} (μA)	No. of electrons/ s cm^2	No. of photons/ s cm^2	Quantum Efficiency	Intensity (mW/cm^2)
6.5	1250				
9.0	814				
12.0	515				
17.0	278				

Table 2c: Data from varying height of blue LED lamp

Height (cm)	I_{SC} (μA)	No. of electrons/ s cm^2	No. of photons/ s cm^2	Quantum Efficiency	Intensity (mW/cm^2)
6.5	2440				
9.0	1250				
12.0	970				
17.0	470				

2) Is the relationship between intensity and height reasonable? Comment. (1 point)

3) Is the result for the different LEDs reasonable? Why? (1 point)