Contents

Pset4

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Problem 1

Two types of solar cells are:

1. Monocrystalline

   Advantage: They are the most efficient solar panels, with an efficiency of about (15% - 20%)

   Disadvantage: They are quite expensive

2. Polycrystalline

   Advantage: They are cheaper and easier to produce than monocrystalline solar panels

   Disadvantage: Their efficiency is lower than that of monocrystalline cells (13% - 16%)

Problem 2

It is known that I_o (the reverse saturation current) is directly proportional to the intensity of light incident on the solar panel.

Also note that:

$$I_{sc} = I_o(e^{\frac{eV}{k_BT}} - 1)$$

$$V_{oc} = \frac{K_BT}{e} ln\left(\frac{I_{sc}}{I_o} + 1\right)$$

From the first formula, we note that I_{sc} is proportional to the I_o which implies that it is also proportional to the intensity of light incident on the solar panel.

Hence, when the light intensity is doubled, we get the new $I_{sc} = 300mA$

Using the first formula in the second formula, we can write:

$$I_{sc} = I_o(e^{\frac{qV}{k_BT}} - 1)$$

$$\frac{I_{sc}}{I_o} = e^{\frac{qV}{k_BT}} - 1$$

For $500W/m^2$, we have:

$$\frac{0.15}{I_o} = e^{\frac{e0.53}{k_BT}} - 1$$

For $1000W/m^2$, we have:

$$\frac{0.3}{I_o} = e^{\frac{qV_{oc}}{k_BT}} - 1$$

Dividing the two equations:

$$\frac{1}{2} = \frac{e^{\frac{q0.53}{k_BT}} - 1}{e^{\frac{qV_{oc}}{k_BT}} - 1}$$

$$e^{\frac{qV_{oc}}{k_BT}} - 1 = 2 \times e^{\frac{q0.53}{k_BT}} - 2$$

$$e^{\frac{qV_{oc}}{k_BT}} = 2 \times e^{\frac{q0.53}{k_BT}} - 1$$

Log on both sides:

$$\frac{qV_{oc}}{k_BT} = ln\left(2 \times e^{\frac{q0.53}{k_BT}} - 1\right)$$

we know that $q = 1.6 \times 10^{-19}C$ and $K_BT = 4.149 \times 10^{-21}J$. Using these values, we calculate and simplify the above expression to:

$38.56V_{oc} = 21.13$

$V_{oc} = 0.548V$

$I_{sc} = 300mA$

Problem 3

i)

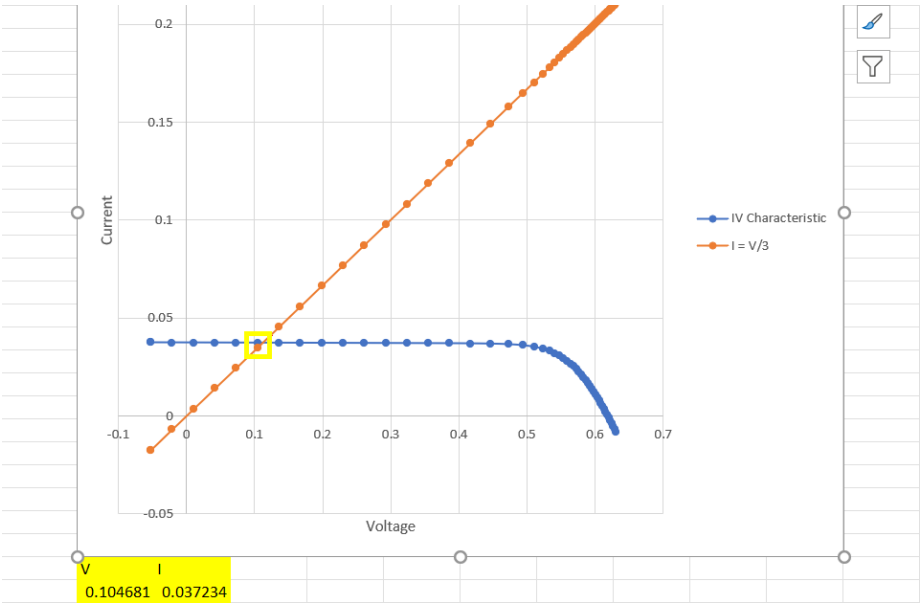

Figure 1: Finding out the Voltage and Current used by the load

From the graph above,

$V = 0.104681V \;\; I = 0.037234A$

ii)

$P = 0.104681 \times 0.037234W$

$P = 0.0039W$

iii)

$$\%Conversion = \frac{P_{delivered}}{P_{incident}} \times 100\% = \frac{0.0039}{1000 \times 10^{-4}} \times 100\%$$

$\%Conversion = 3.9\%$

iv)

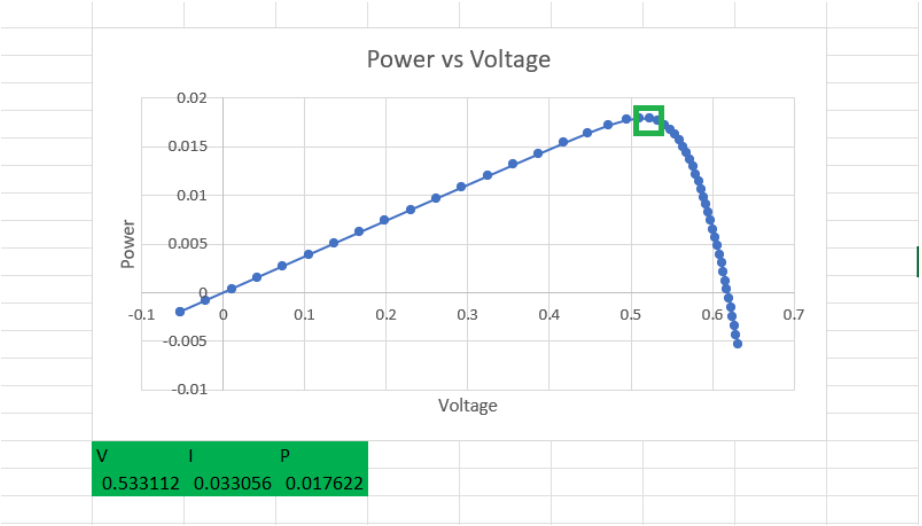

Figure 2: Finding out the max Power by graph

From the graph above,

$P_{max} = 0.0176W$

v)

$V_{oc} = 0.62V$

$I_{sc} = 0.037A$

$$FF = \frac{P_{max}}{V_{oc}I_{sc}} = \frac{0.0176}{0.62 \times 0.037}$$

$FF = 0.767$

vi)

$$\eta = \frac{P_{max}}{P_{in}} = 0.01760.1$$

$\eta = 0.176$