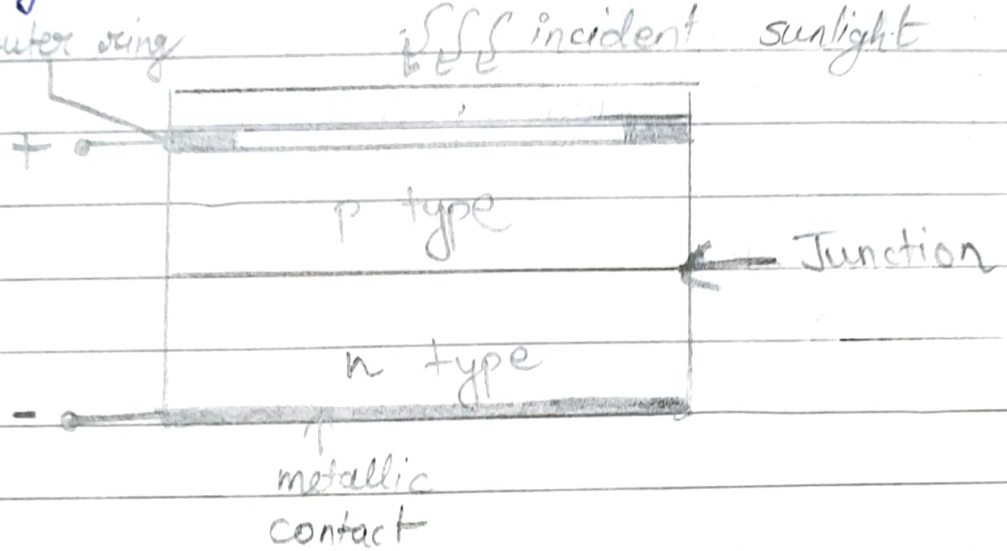
3.

d) What is photovoltaic effect? Draw I-V characteristics of solar cell and define fill factor.

→ ① Photovoltaic's effect is direct conversion of light into electricity at the atomic level.

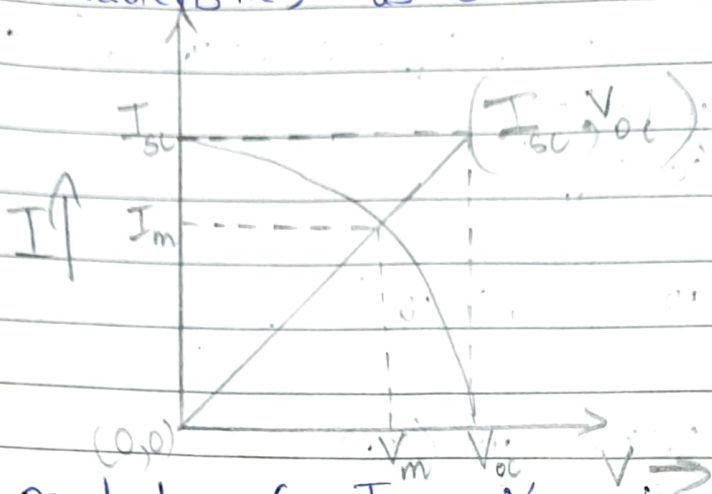


② When light falls on a p-n junction produces a potential difference across it.

③ This potential difference is capable of driving a current through an external circuit, producing useful work.

I-V Characteristics of solar cell

(4) When the solar cell exposed to the light it IV characteristics as shown is below diagram



(5) The product of $I_{sc} \times V_{oc}$ gives the theoretical maximum power output from the solar cell.

(6) However, the actual maximum power is less than this and is given by the product $I_m \times V_m$

(7) The fill factor is defined as ratio of actual maximum power to ideal power i.e

$$FF = \frac{I_m \times V_m}{I_{sc} \times V_{oc}}$$

$$\eta = \frac{I_m \times V_m}{I_{sc} \times V_{oc}} \times 100$$

Explain Hall effect. Derive the equation of Hall voltage and Hall coefficient.

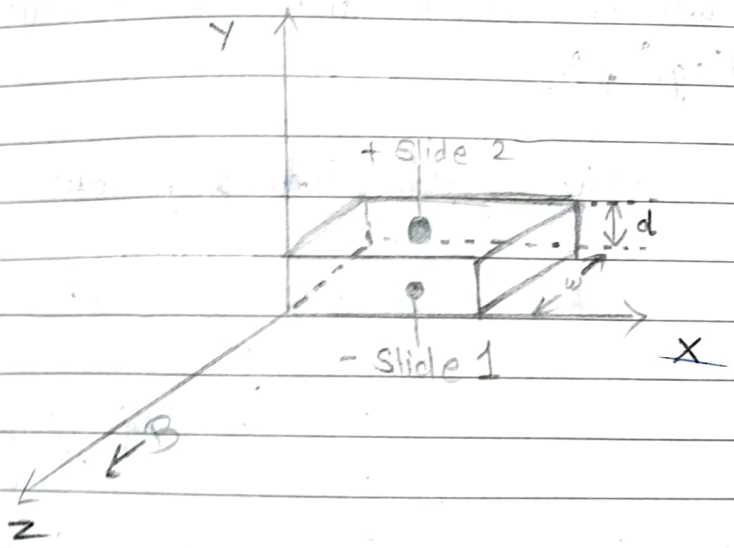
→ ① Hall observed, when strip of semiconductor carrying current is placed in a transverse magnetic field potential difference was developed across strip.

② The direction of electric field developed because of induced potential depends on whether the current is due to electrons or holes.

③ In order to understand Hall effect consider a rectangular strip of n-type semi-conductor material.

④ Under the application of some potential difference, let current I flow through it along positive x-direction.

⑤ Let the magnetic field B act along the positive z-direction as shown in diagram.



⑥ As the magnetic field is applied, the magnetic force acts along negative Y-direction.

⑦ As the semiconductor is n-type, the charge carriers are electrons

⑧ Magnitude of force is given by

$F = B.e.v$ ——— (1)

v = drift velocity.

e = charge on electron.

(9) Thus due to this force the electrons are forced to move in negative Y-direction and ~~electrons~~ soon obstructed by the walls of specimen

(10) If the side 2 is negative w.r.t side 1 then the charge carriers are holes i.e the semiconductor is p-type.
and get accumulated there.

(10) Because of charge accumulation towards side 1 it becomes negatively charged w.r.t side 2.

(11) directed along negative Y-direction,

(11) This electric field opposes further movement of electrons towards side 1.

(12) In equilibrium condition the force due to electric field is balanced to the force due to magnetic field and the current flows in the positive X-direction only.

(13) At this stage a steady potential difference is produced between side 1 and side 2 called as 'Hall Voltage', V_H

Let ϵ be electric field ~~intensity~~ due to V_H

$$F_2 = eE \quad \text{——— (2)}$$

$eE = BeV$ — [From eq^n (1) & (2)]

$E = B.V$ ——— (3)

But $\epsilon = \frac{V_H}{d}$ ——— (4)

$\frac{V_H}{d} = B.V$

$V_H = B.V.d$ ——— (5)

We know $I = nevA$ ——— (6)

$V = \frac{I}{neA}$

Put (6) in (5) we get

$$V_H = B\left(\frac{I}{neA}\right)d = \frac{1}{ne}\frac{BId}{A}$$

$$\boxed{V_H = \frac{1}{ne}\frac{BI}{w}} \quad \text{——} \quad (6)$$

$$\boxed{\frac{d}{A} = \frac{1}{w}}$$

The quantity $\frac{1}{ne}$ is property of material of specimen and is called Hall coefficient

$$\boxed{R_H = \frac{1}{ne}} \quad \text{——} \quad (7)$$

$$\therefore V_H = R_H \frac{BI}{w}$$

Put (7) in (6)

S15

b) State measures to improve efficiency of solar cell.

1) Concentration of light - By using Parabolic light concentrator, the intensity of light of solar cell can be improved which increases efficiency of solar cell.

2) Solar tracker - Solar tracker is rotation of panel / array of solar cells so they always face the sun, this helps to increase maximum energy output.

3) Reflection - Solar cell efficiency can be improved by minimizing amount of light reflected

4) Fill Factor - Fill factor refers to the utilization of available surface area and it ranges from 70 - 90 %. Round / moon shaped solar cells have lower FF whereas square cells have more Fill Factor.

Conductivity of Semiconductor (intrinsic extrinsic)

(1) In SC, I is due 2 holes & e^-

(2) I due 2 holes

$$I_h = n_h e A v_h$$

I due 2 e^-

(3) $$I_e = n_e e A v_e$$

(4) Total $$I = I_e + I_h$$

$$I = eA (n_e v_e + n_h v_h)$$

$$\frac{I}{A} = J$$

$$J = e (n_e v_e + n_h v_h)$$

But $J = \sigma \epsilon$

$$\sigma \epsilon = e (n_e v_e + n_h v_h)$$

$$\sigma = e \left(n_e \frac{v_e}{\epsilon} + n_h \frac{v_h}{\epsilon}\right)$$

$$\sigma = e (n_e \mu_e + n_h \mu_h)$$

For intrinsic $n_e = n_h = n_i$

$$\therefore \sigma = e n_i (\mu_e + \mu_h)$$

N Type $n_e >>> n_h$

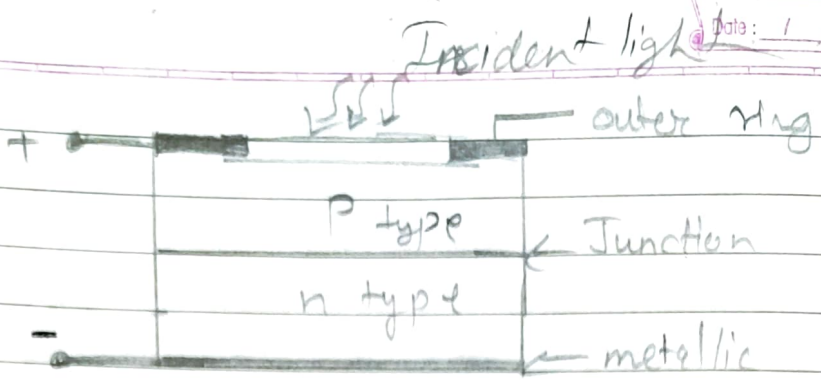
$$\sigma = e (n_e) \mu_e$$

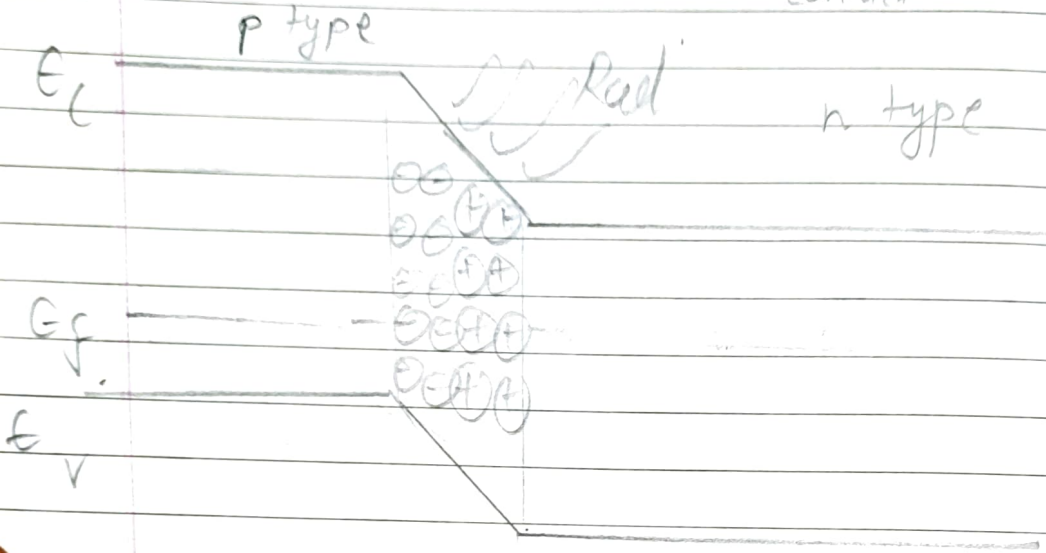
P type $n_h >> n_e$

$$\sigma = e n_h \mu_h$$

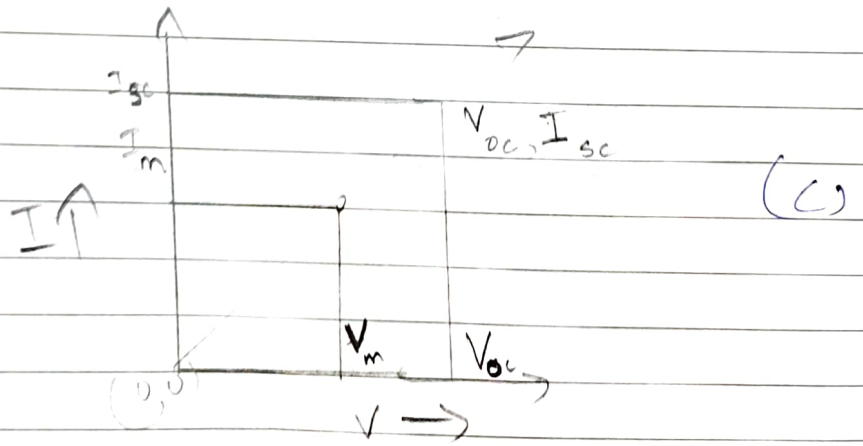
Solar Cell (S.C)

Name :
Date : / /





(1) Photovoltaic effect is direct conversion of light → electricity.
(2) When light fall on P-N Jun^n it generates V
(3) This V is capabale of deriving I through external circuit



$P = VI$

Name:
Date: / /

(4) I-V characteristics in figure (c)
(5) Product of $I_{sc} \times V_{oc}$ give theoretical max of power o/p of S.C - I.P
(6) Actual Power is less than this
n is given by $I_m \times V_m$ - A.P
(7) FF is ratio of A.P to I.P

$$FF = \frac{I_m V_m}{I_{sc} V_{oc}}$$

$$\eta = \frac{A}{I} \times 100$$

Ways 2 improve Efficiency of S.C
(1) S.C efficiency can be improved by minimising reflected light.
(2) FF refers to utilization of available surface area. 2 rangs frm 70-90%. Round / moon shape S.C have ↓ FF whereas square shaped have greater FF.
(3) Solar tracker is rotation of panel/array of S.C so they always face ☀ this helps 2 ↑ese max energy output.
(4) By using parabolic light concentrator the intensity of light can be improved which ↑ese η of S.C.

Applications
(1) S.C can be used for street lighting
(2) In Dry areas with abundant sunlight, Solar powered Drip Irrigation provides minimal usage of H_2O.
(3) Solar panels are only source of power 4 satellites
(4) Solar Home System is effective way of capturing sunlight & storing the produced electricity and later using it for household purposes.

Name :
Date : / /

Adv	Dis
Available in ample quantity	Space Consumption is more
Free energy which can be trapped easily	Installation + Initial cost high
Clean way 2 produce electricity.	Production is ↓ during winter.
Helps to achieve sustainable development	Disposal of battery is difficult