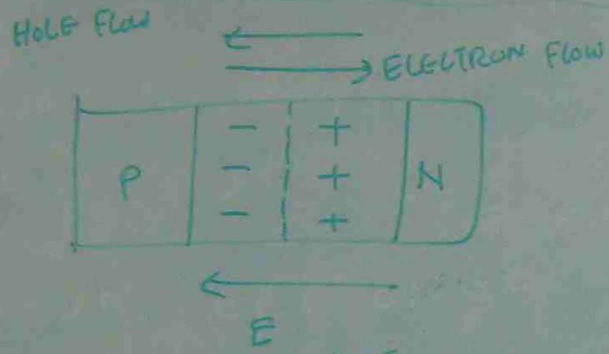
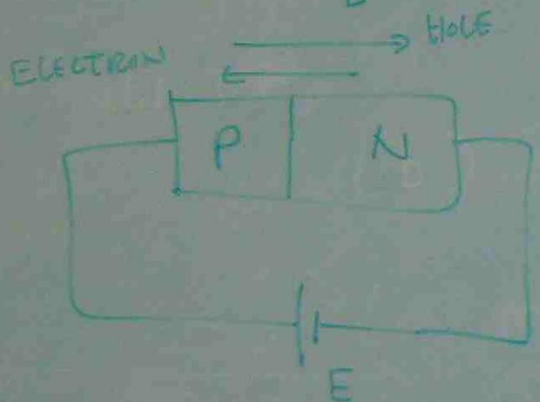
SOLAR CELL SEMI CONDUCTOR DARK & ILLUMINATED CURRENT





$$I = I_0 \left\{ e^{\frac{qV}{nkT}} - 1 \right\}$$

I_0 = DARK SATURATION CURRENT

DIODE LEAKAGE CURRENT

q = ABSOLUTE VALUE OF ELECTRONIC CHARGE

k = BOLTZMANN'S CONSTANT

T = ABSOLUTE TEMPERATURE

V = APPLIED VOLTAGE

1 }

RRENT

RRENT

ELECTRONIC
CHARGE

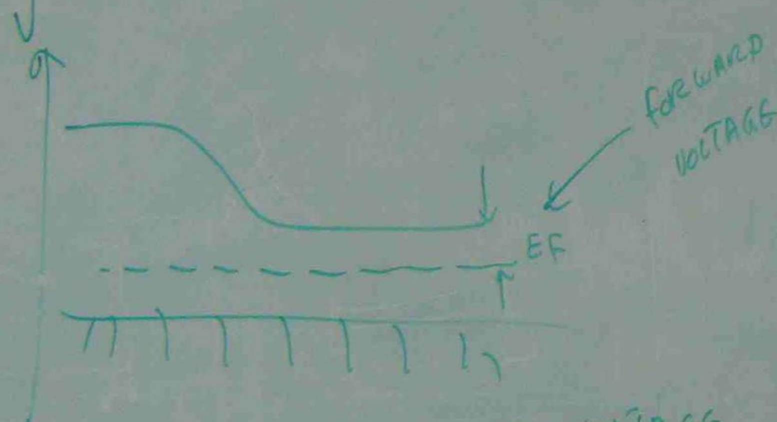
NT

URE

E

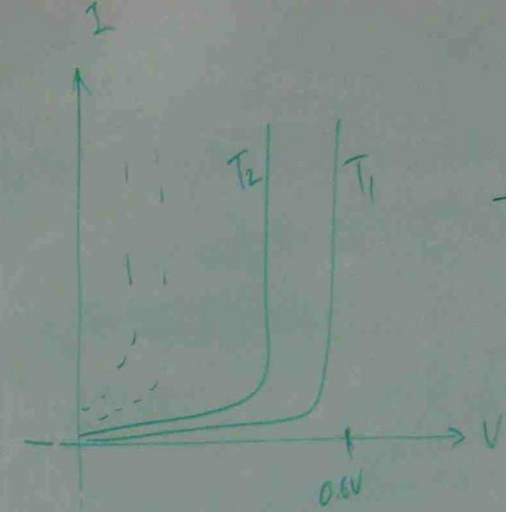
n = NUMBER OF ELECTRONS IN CONDUCTION BOND

$$n = N_C \, e^{\frac{E_F - E_C}{kT}}$$

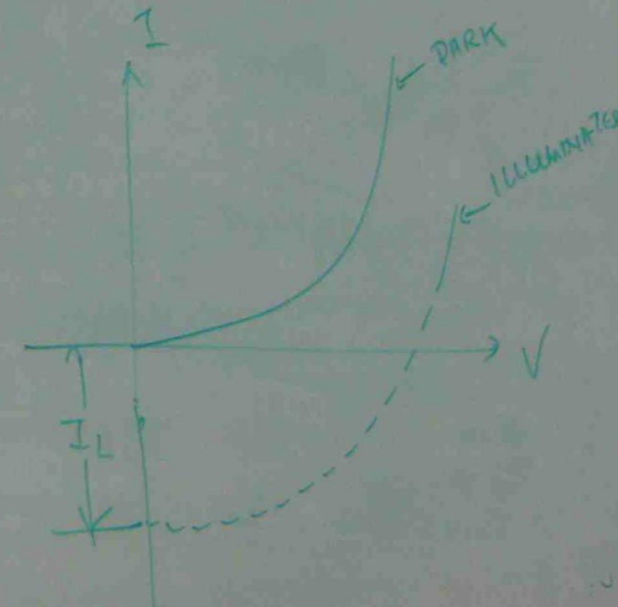


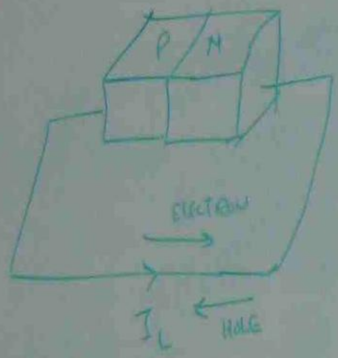
E_C = CONDUCTION VOLTAGE

I = ILLUMINATED CURRENT

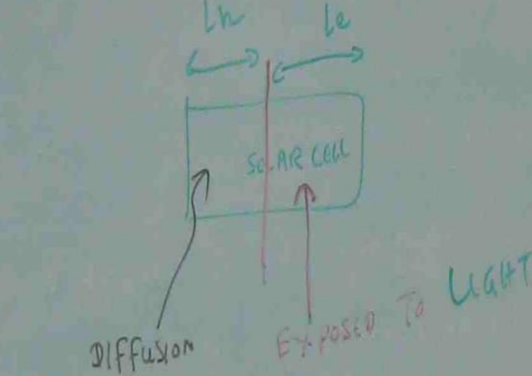


$T_2 > T_1$





DARK & ILLUMINATED CURRENT EQUATIONS



$$I_0 = A\left[\frac{q\,D_e\,n_i^2}{L_e\,N_A} + \frac{q\,D_h\,n_i^2}{L_h\,N_D}\right]$$

q = ELECTRONIC CHARGE

D_e = EXPOSED DENSITY

D_h = DIFFUSION DENSITY

A = CROSS SECTIONAL AREA OF DIODE

L_e = EXPOSED LENGTH

L_h = DIFFUSION LENGTH

N_A = NO. OF ACCEPTOR ELECTRONS

N_D = NO. OF DONOR ELECTRONS.

I_0 = DARK CURRENT

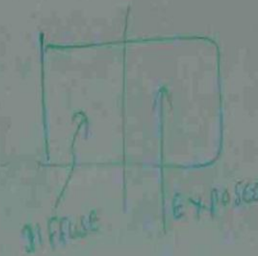
n_i = NO. OF ELECTRONS IN CONDUCTION BAND

ILLUMINATED CURRENT

$I_L = q$

ILLUMINATED CURRENT EQUATION

$$I_L = q A G \left(L_e + W + L_h \right)$$

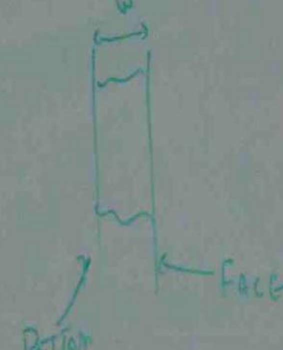


q = ELECTRON CHARGE

A = C.S.A OF DIODE

G = IRRADIANCE

W = PLATE SEPARATION



I_L = CURRENT PRODUCED BY SOLAR CELL (ILLUMINATED CURRENT)

$$\frac{q D_h n_i^2}{L_h N_D}$$

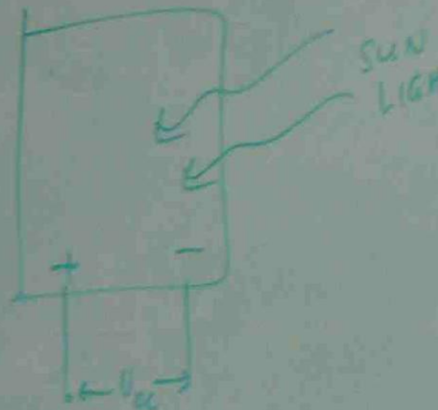
N_A = NO. OF ACCEPTOR ELECTRONS

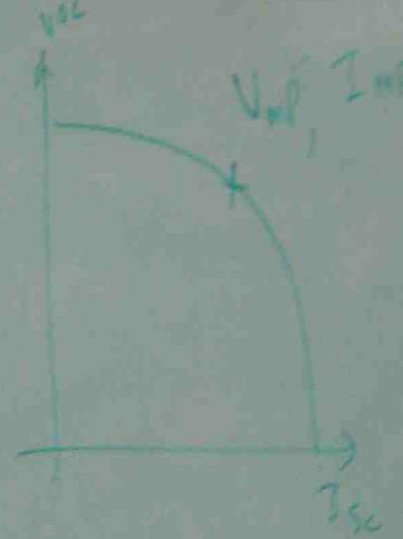
N_D = NO. OF DONOR ELECTRONS.

n_i = NO. OF ELECTRONS IN CONDUCTION BAND.

I_0 = DARK CURRENT

SOLAR CELL OUTPUT PARAMETERS





V_{mp} = MA

I_{mp} = MA

V_{oc} = OPEN CIRCUIT VOLTAGE

F_F = F

F_F =

$$\boxed{V_{oc} = \frac{kT}{q} \ln\left\{\frac{I_L}{I_0} + 1\right\}}$$

q = ELECTRON CHARGE

F_F =

I_L - ILLUMINATED CURRENT

I_0 = DARK CURRENT

T = ABSOLUTE TEMPERATURE

k = BOLTZMAN'S CONSTANT

ENERGY CONVERSI EFFICI

ARAMETERS

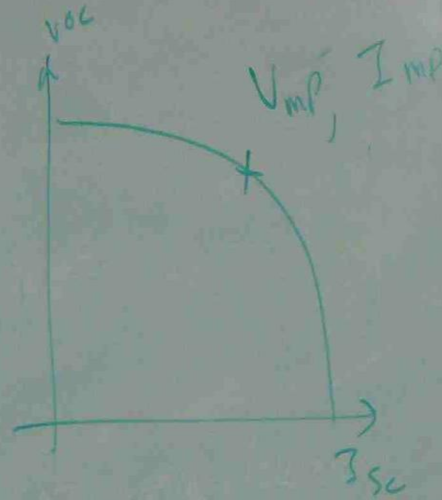
SUN
LIGHT

T VOLTAGE

$$\boxed{\frac{I_L}{I_0} + 1 \}}$$

ERATURE

NSTANT



q = ELECTRON CHARGE

I_L - ILLUMINATED CURRENT

I_0 = DARK CURRENT

V_{mp} = MAXIMUM POWER POINT VOLTAGE

I_{mp} = MAXIMUM POWER POINT CURRENT

F_F = FILL FACTOR

$$F_F = \frac{V_{mp} \times I_{mp}}{V_{oc} \times I_{sc}}$$

$$F_F = \frac{V_{oc} - \ln(V_{oc} + 0.72)}{V_{oc} + 1}$$

$$\text{ENERGY CONVERSION EFFICIENCY} = \frac{V_{mp} \times I_{mp}}{\text{INPUT SUN POWER}}$$

STANDARD

1 R

2 F
G

3 C
G
S

...OWER POINT VOLTAGE

... POWER POINT CARRENT

...R

... I_{mp}

... I_{sc}

... $Ln\,(V_{oc} + 0.72)$

...$_{oc} + 1$

$V_{mp} \times I_{mp}$

INPUT SUN POWER

PRODUCTION OF SOLAR CELL

STANDARD SILICON SOLAR CELL TECHNOLOGY

STANDARD TECHNOLOGY FOR MAKING SOLAR CELLS

1. REDUCTION OF SAND TO METALLURIGICAL GRADE SILICON
2. PURIFICATION OF METALLURGICAL GRADE SILICON TO SEMI CONDUCTOR GRADE SILICON
3. CONVERSION OF SEMI CONDUCTOR GRADE SILICON TO SINGLE CRYSTAL SILICON WAFERS.
4. PROCESSING OF SINGLE CRY...
5. SOLAR CELL EN CAPSULATIO...

(1) SAND = SiO_2 (SILICON...

$SiO_2 + 2C = Si + 2CO$

SAND SiO_2 IS REDUCED IN...

(2) METALLURGICAL GRADE SIL...

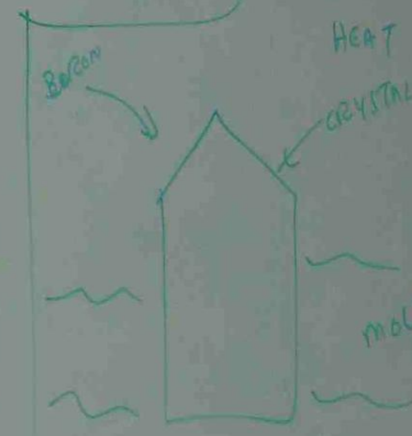
$Si + 3HCl \longrightarrow$ ...

$SiHCl_3 + H_2 \longrightarrow$ ...

(4) PROCESSING OF SINGLE CRYSTAL SILICON WAFERS INTO SOLAR CELLS

(5) SOLAR CELL ENCAPSULATION INTO WEATHER PROOF SOLAR CELL MODULE

(3) SILICON IS DEPO
POLY CRYSTALLINE
HEAT SILICON ROD.



(1) SAND = SiO_2 (SILICON DIOXIDE)

$SiO_2 + 2C = Si + 2CO$

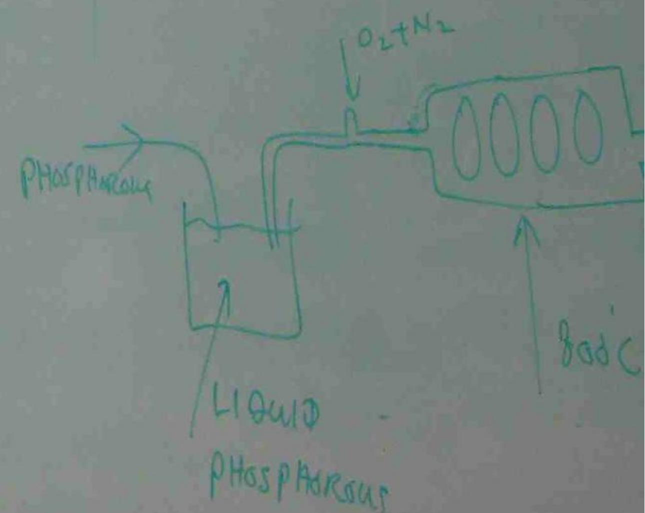
SAND SiO_2 IS REDUCED IN LARGE FURNACE BY CARBON

METALLURGICAL GRADE SILICON ⟶ SEMI CONDUCTOR GRADE SILICON

(2) METALLURGICAL

$Si + 3HCl \longrightarrow SiHCl_3 + H_2$

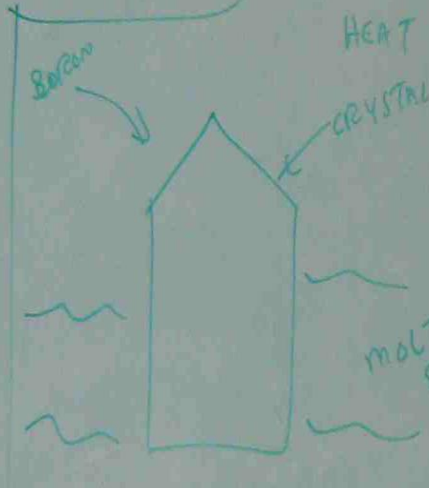
$SiHCl_3 + H_2 \longrightarrow Si + 3HCl$



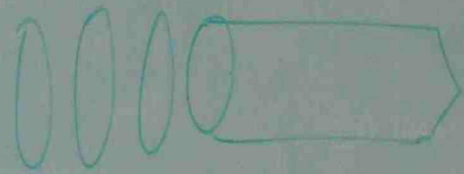
INTO SOLAR CELLS

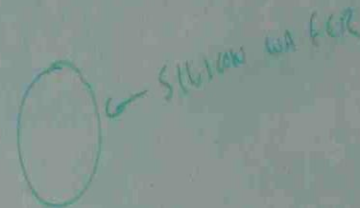
roof SOLAR CELL MODULE

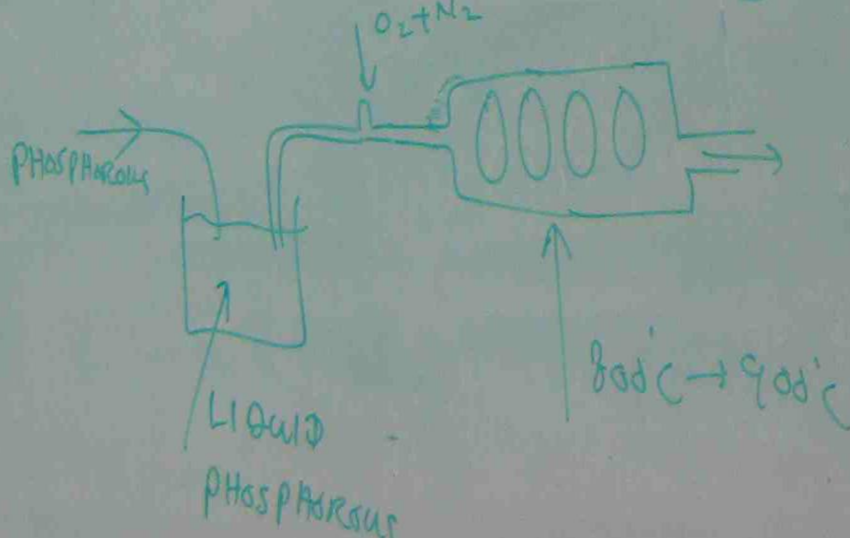
CARBON

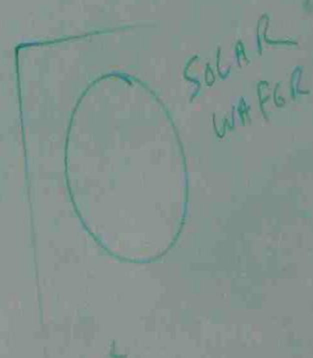


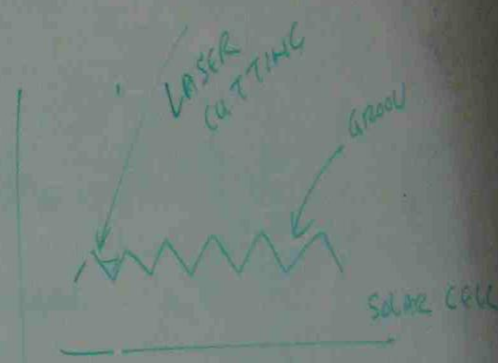
③ SILICON IS DEPOSITED IN A FINE GRAINED POLYCRYSTALLINE FORM ON TO ELECTRICALLY HEAT SILICON ROD.





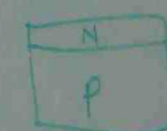






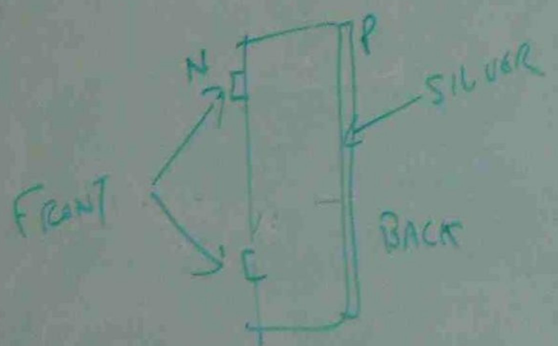
PHOSPHOROUS IMPURITIES + SILICON → N TYPE SEMI CONDUCTOR

BORON IMPURITIES + SILICON → P TYPE SEMICONDUCTOR



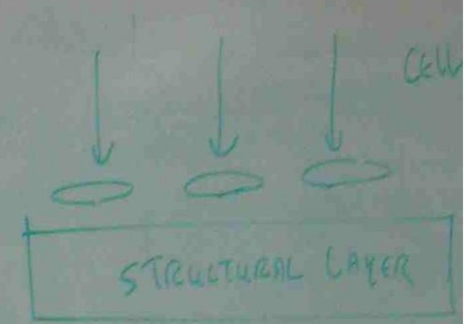
THEN SOLAR CELL SURFACE IS GROOVED BY LASER

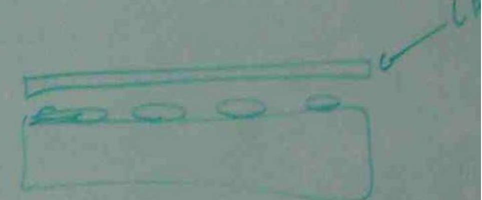
- METAL CONTACTS ARE THEN ATTACHED TO BOTH P TYPE AND N TYPE REGION
- BACK CONTACT IS NORMALLY DEPOSITED OVER THE ENTIRE BACK SURFACE
- THE TOP CONTACT IS PUT IN THE FORM OF GRID

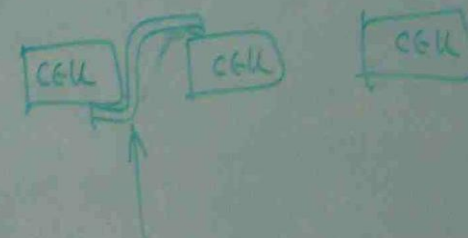


DEPOSIT THE SILVER CONTACT

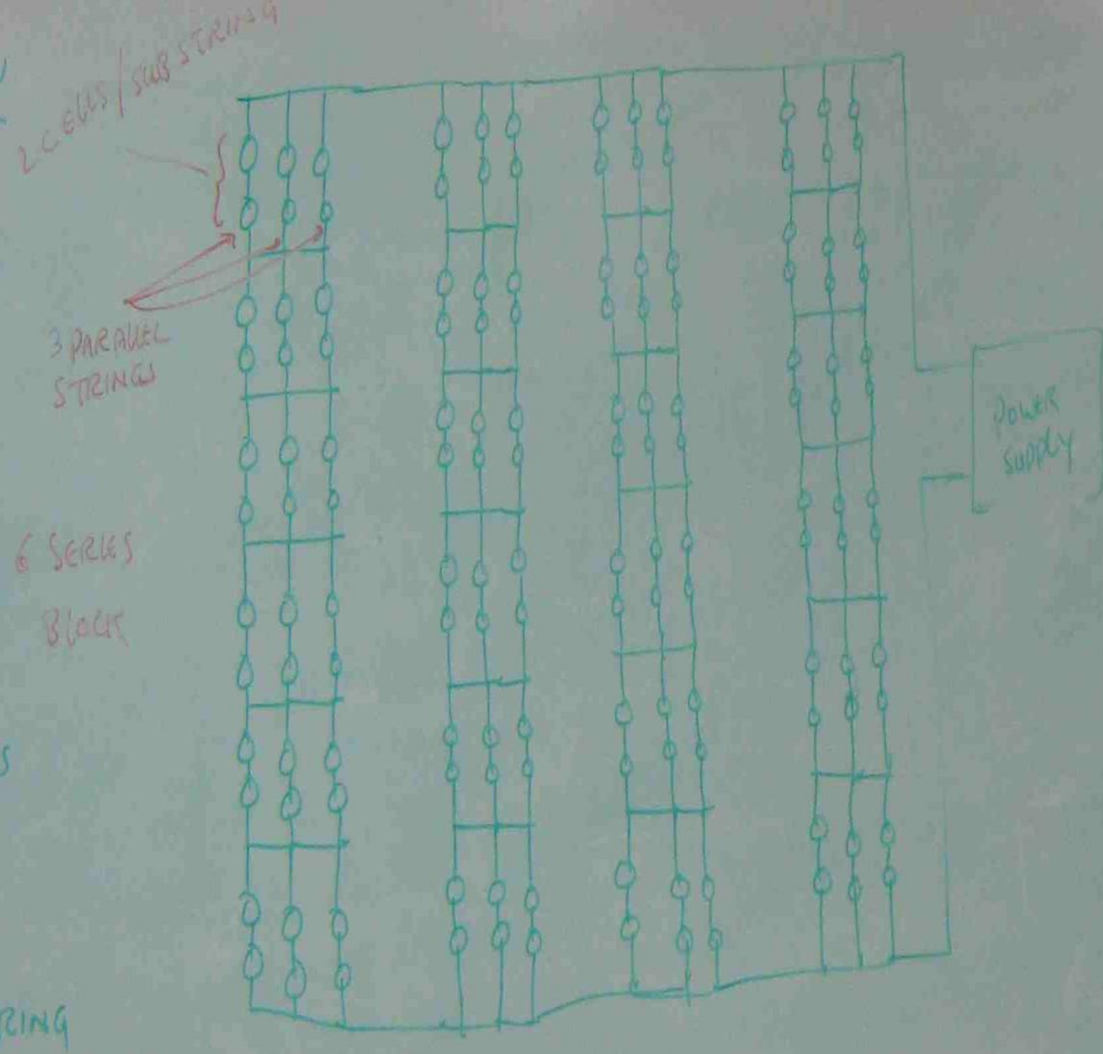
HEAT 500C → 600C







INTERCONNECTION BETWEEN CELLS.



COST OF ELECTRICITY BY USING SOLAR CELL

$$CoE = \frac{C_m + C_b}{\text{Efficiency}} \left(\frac{1+i}{S}\right)^{FCR} + 0.016$$

CoE = COST OF ELECTRICITY \$/kWh

C_m = P.V MODULE COST / UNIT AREA

C_b = BALANCE OF SYSTEM COST (BATTERY, INVERTER, CONTROL) PER UNIT AREA

FCR = FIXED CHARGE RATE

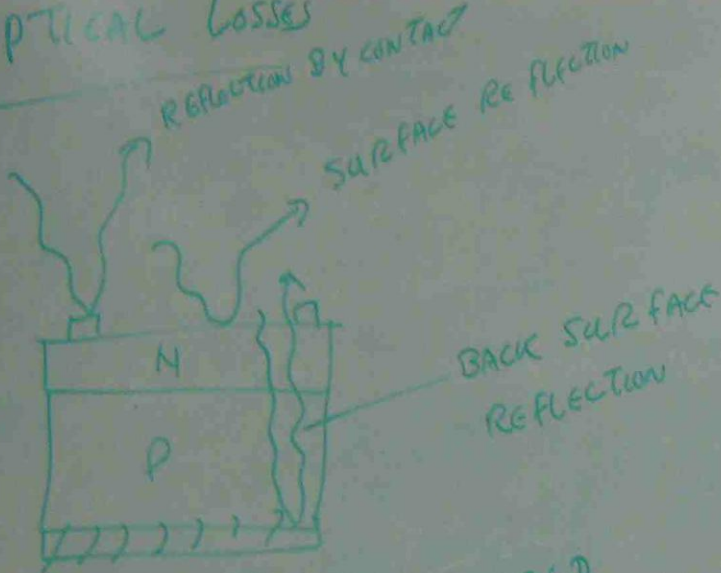
S = ANNUAL INCIDENT ENERGY

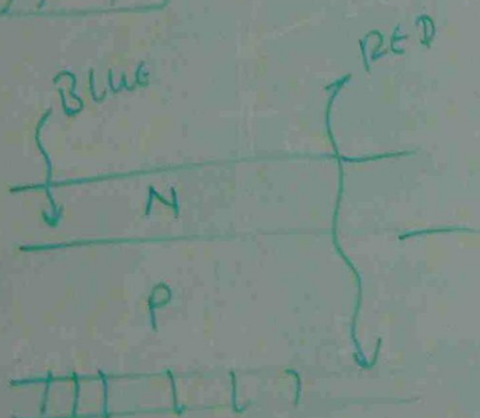
0.016 = POWER CONDITIONING, OPERATING AND MAINTENANCE COST

i = INTEREST RATE

\$/kWh

OPTICAL LOSSES





$$R_b = \rho \frac{l}{A} = \rho \frac{W}{A}$$

BULK RESISTANCE of CONTACT

l = LENGTH OF CONTACT

W = WIDTH OF BULK REGION

A = CELL AREA

ρ = RESISTIVITY