Solutions

1.

a)

$$\eta = \frac{FF \cdot V_{OC} \cdot I_{SC}}{P \cdot A}$$

With:

$$P_X = X \cdot P_0$$
$$\Rightarrow I_{SC,X} = X \cdot I_{SC,0}$$

How is U_{OC} changing?

$$I(U_{OC}) = 0 = I_0\left(\exp\left(\frac{eU_{OC}}{mkT}\right) - 1\right) - I_{SC}$$
$$\rightarrow U_{OC,X} = \frac{mkT}{e}\ln\left(X\frac{I_{SC}}{I_0}\right), I_{SC} \gg I_0$$
$$= U_{OC} + \frac{mkT}{e}\ln(X)$$

Efficiency:

$$\eta = \frac{FF \cdot I_{SC,X} \cdot U_{OC,X}}{P_X \cdot A}$$
$$= \eta\left(1 + \frac{mkT}{eU_{OC}}\ln(X)\right)$$

b)

1. Losses are proportional to I^2
2. There will be a heat increase, which again leads to higher losses
3. The production of those are quite cumbersome

2.

a)

Must be thicker than the absorption length of the light (α)

But at the same time thinner than the diffusion length

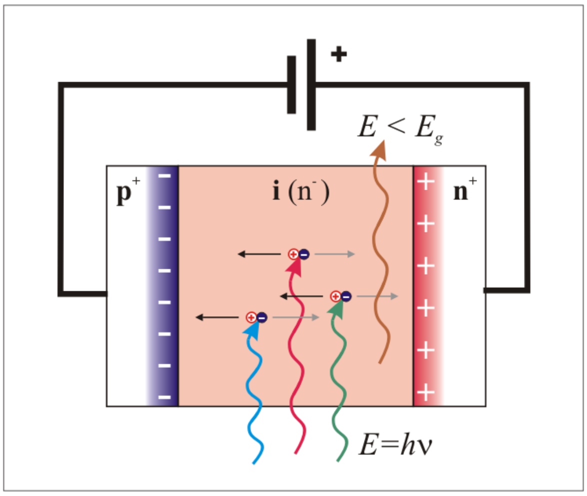
b)

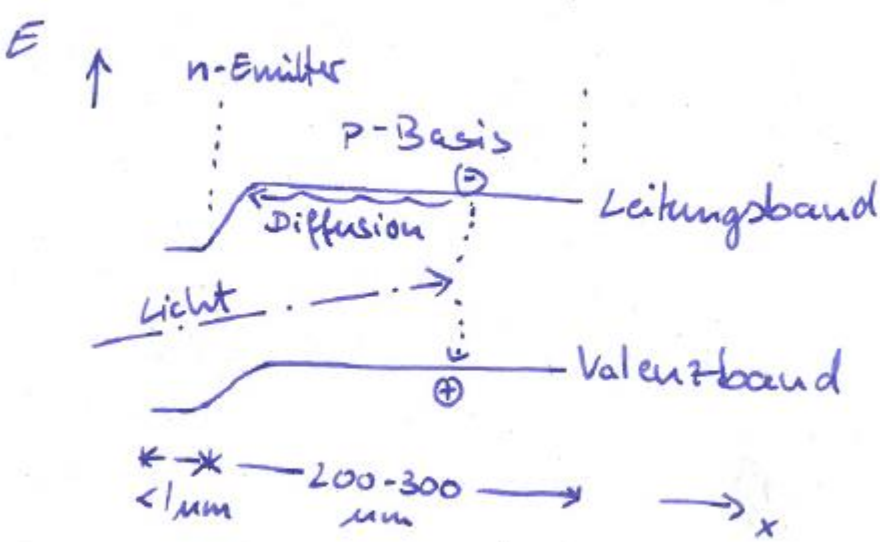
1. Low material consumption (cost, energy consumption, weight)

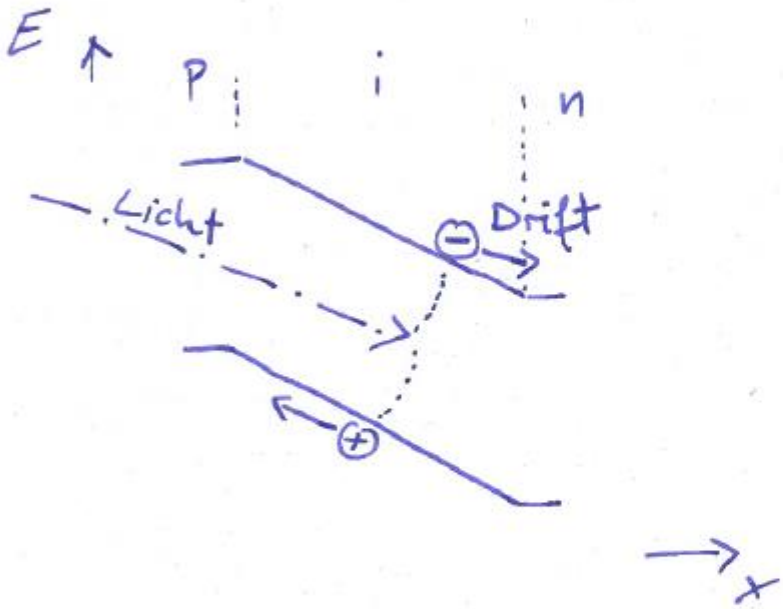
2. Less material errors

3. Do not need to be flat

c) In an usual solar cell the creation of charge carriers happens in the p-layer of the pn-junction. The diffusion length of electrons is around several 100 µm. However, in a-Si the diffusion length is only up to 100 nm. So, the pn-junction gets replaced by a pin-junction with an additional intrinsic layer. Here, the electron hole pair gets apart by the electric field (drift dominated).







a)

$$P_{loss} = \int I^2 dR = \int_0^{\frac{S}{2}} \frac{J^2 b^2 y^2 \rho_S}{b} dy = \frac{J^2 b \rho_S S^3}{24}$$

$$P_{mp} = V_{mp} J_{mp} b \frac{S}{2}$$

$$p = \frac{P_{Loss}}{P_{mp}} = \frac{\rho_S S^2 J_{mp}}{12 V_{mp}}$$

b)

$$P_{SH} = V_{mp} J_{mp}\, b \frac{S}{2}$$

$$P_{mp} = V_{mp} J_{mp}\, b \frac{(S+x)}{2}$$

$$p = \frac{S}{S+x}$$

$$p_{total} = \frac{\rho_S J_{mp}}{12 V_{mp}} S^2 + \frac{S}{S+x}$$

$$p' = \frac{\rho_S J_{mp}}{6 V_{mp}} S + \frac{x}{(S+x)^2} = 0$$

However, this is not simple. I thought it would be a quadratic equation.