1. prvo B $E_1 = 75\,keV$ $Q_1 = 2\cdot10^{12}\,cm^{-2}$ $R_{p1} = 225\,nm$ $\Delta R_{p1} = 77\,nm$
potom As $E_2 = 110\,keV$ $Q_2 = 7\cdot10^{12}\,cm^{-2}$ $R_{p2} = 60\,nm$ $\Delta R_{p2} = 28\,nm$
} R_p i ΔR_p iz priručnika tablica 11, odnosno 12

silicij P a) $N_D = 5\cdot10^{16}\,cm^{-3}$, b) $N_D = 9\cdot10^{16}\,cm^{-3}$, c) $N_D = 6\cdot10^{17}\,cm^{-3}$, d) $N_D = 2\cdot10^{18}$

- najveća koncentracija prilikom implantacije:

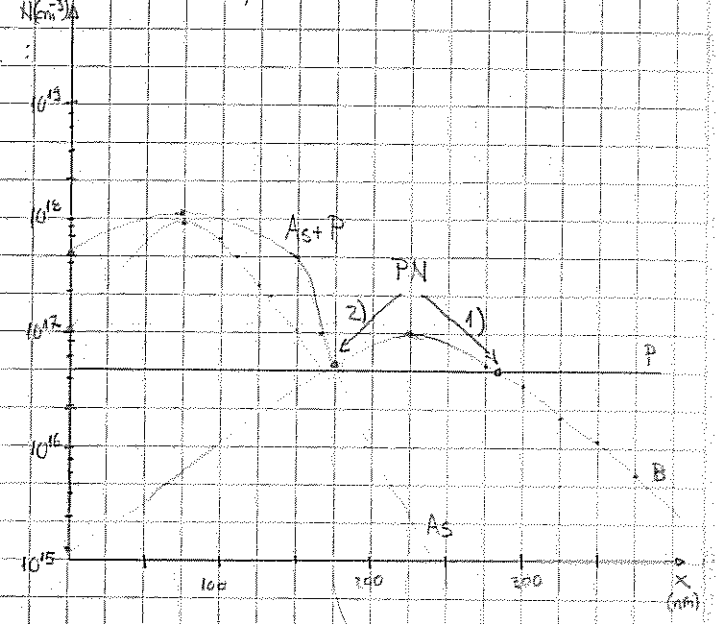
$$N_{p1} = \frac{Q_1}{\Delta R_{p1}\sqrt{2\pi}} = 10.36\cdot10^{16}\,cm^{-3}$$

$$N_{p2} = \frac{Q_2}{\Delta R_{p2}\sqrt{2\pi}} = 99.73\cdot10^{16}\,cm^{-3}$$

- koncentracija na površini

$$N_{A1}(0) = N_{p1}\exp\left(-\frac{R_{p1}^2}{2\Delta R_{p1}^2}\right) = 1.45\cdot10^{15}\,cm^{-3}$$

$$N_{D2}(0) = N_{p2}\exp\left(-\frac{R_{p2}^2}{2\Delta R_{p2}^2}\right) = 10.04\cdot10^{16}\,cm^{-3}$$



1) izjednačiti $N_{A1}(x) = N_D$ i proračunati x_1 i x_2

2) izjednačiti $N_{A1}(x) = N_D + N_{D2}(x)$ —"—

3) Usporediti x iz 1) i x iz 2), i odrediti stvarne PN spojeve

1) $N_{A1}(x) = N_{p1}\exp\left(-\frac{(x-R_{p1})^2}{2\Delta R_{p1}^2}\right) = N_D$

$$\frac{N_D}{N_{p1}} = \exp\left(-\frac{(x-R_{p1})^2}{2\Delta R_{p1}^2}\right) \;/\ln$$

$$\ln\frac{N_{p1}}{N_D} = \frac{(x-R_{p1})^2}{2\Delta R_{p1}^2}$$

$$x_{1,2} = R_{p1} \pm \Delta R_{p1}\sqrt{2\ln\frac{N_{p1}}{N_D}} = 225\cdot10^{-9} \pm 77\cdot10^{-9}\sqrt{2\ln\frac{10.36\cdot10^{16}}{N_D}} =$$

a) $N_D = 5\cdot10^{16}\,cm^{-3}$ $x_1 = 317\,nm$ $x_2 = 132\,nm$

b) $N_D = 9\cdot10^{16}\,cm^{-3}$ $x_1 = 265\,nm$ $x_2 = 184\,nm$

c) $N_D = 6\cdot10^{17}\,cm^{-3}$, d) $N_D = 2\cdot10^{18}\,cm^{-3}$ } $N_D > N_{p1}$ ⇒ krivulje se ne sijeku, dobivamo $\sqrt{-}$ nepostoji PN spoj

2) $N_{A1}(x) = N_D + N_{D2}(x)$

$$N_{p1}\exp\left(-\frac{(x-R_{p1})^2}{2\Delta R_{p1}^2}\right) = N_D + N_{p2}\exp\left(-\frac{(x-R_{p2})^2}{2\Delta R_{p2}^2}\right) \;/:N_{p1}$$

$$\exp\left(-\frac{(x-R_{p1})^2}{2\Delta R_{p1}^2}\right) = \frac{N_D}{N_{p1}} + \frac{N_{p2}}{N_{p1}}\exp\left(-\frac{(x-R_{p2})^2}{2\Delta R_{p2}^2}\right) \;/\ln$$

$$-\frac{(x-R_{p1})^2}{2\Delta R_{p1}^2} = \ln\left(\frac{N_D}{N_{p1}} + \frac{N_{p2}}{N_{p1}}\exp\left(-\frac{(x-R_{p2})^2}{2\Delta R_{p2}^2}\right)\right)^{-1}$$

$$(x-R_{p1})^2 = 2\Delta R_{p1}^2\ln\left(\frac{N_D}{N_{p1}} + \frac{N_{p2}}{N_{p1}}\exp\left(-\frac{(x-R_{p2})^2}{2\Delta R_{p2}^2}\right)\right)^{-1}$$

$$x = R_{p1} \pm \Delta R_{p1}\sqrt{2\ln\left(\frac{N_D}{N_{p1}} + \frac{N_{p2}}{N_{p1}}\exp\left(-\frac{(x-R_{p2})^2}{2\Delta R_{p2}^2}\right)\right)^{-1}}$$

$$x = R_{P1} \pm \Delta R_{P1} \sqrt{2 \ln\left(\frac{N_D}{N_{P1}} + \frac{N_{P2}}{N_{P1}} \exp\left(-\frac{(x-R_{P2})^2}{2\Delta R_{P2}^2}\right)\right)^{-1}}$$

a) $N_D = 5 \cdot 10^{16}\ cm^{-3}$

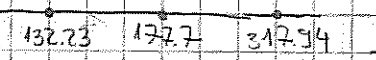
$$x = 225 \pm 77 \sqrt{2 \ln\left(\frac{5}{10.36} + \frac{99.73}{10.36} \exp\left(-\frac{(x-60)^2}{2 \cdot 28^2}\right)\right)^{-1}}$$ iteracija

(-) x_1

rezultat	uvrstio
132.1	200
178.4	132.1
132.23	178.4
177.7	132.23

(+) x_2

rezultat	uvrstio
317.9	200
317.94	317.9



2 PN spoja jedan $x_1 = 317.94 nm$

$x_2 = 177.7 nm$, prvo sjecište $N_{A1}(x) = N_D + N_{D1}(x)$

$x_3 = 132.23 nm$ odbacujemo, ovo rješenje smo pokupili iz 1) $N_{A1}(x) = N_D$

b) $N_D = 9 \cdot 10^{16}\ cm^{-3}$

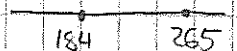
$$x = 225 \pm 77 \sqrt{2 \ln\left(\frac{9}{10.36} + \frac{99.73}{10.36} \exp\left(-\frac{(x-60)^2}{2 \cdot 28^2}\right)\right)^{-1}}$$

(-) x_1

rezultat	uvrstio
184.7	200
184.2	184.2

(+) x_2

rezultat	uvrstio
265.84	200
265.85	265.84



2 PN spoja $x_1 = 184 nm$, $x_2 = 265 nm$

c) $N_D = 6 \cdot 10^{17}\ cm^{-3}$

d) $N_D = 2 \cdot 10^{18}\ cm^{-3}$

$N_D > N_{P1} \Rightarrow$ ne postoje PN spojevi

2. $R = 0.38\,\mu m$ $DOF = \pm 0.37\,\mu m$ $n = 1.66$ $k_1 = 0.62$ $k_2 = 0.52$

$$\lambda = k_2 \frac{R^2}{k_1^2 DOF} = 0.52 \cdot \frac{(0.38 \cdot 10^{-6})^2}{0.62^2 \cdot 0.37 \cdot 10^{-6}} = 527.9\,nm$$

$$\boxed{\lambda = 528\,nm}$$

Poboljšanje rezolucije ⇒ dodajemo materijal koji će izazvati fazni pomak za $180°$.

$$d = \frac{\lambda}{2(n-1)} = \frac{528 \cdot 10^{-9}}{2(1.66-1)} = 400\,nm$$

$$\boxed{d = 400\,nm}$$ debljina materijala