solution fys9n4310 500- 2 (5.2 from Stephen Campbells textbook)

```
> restart;
```

Si, substrate concentration 1e15 cm^-3; B implant, Require peak at 0.3 µm with peak concentration 1e17 cm^-3,
Determine
a) Energy
b) Dose
c) The as-implanted junction depth

a)

Fig 5.9 B gives for *R*p=3000 Å ***E*=85 keV** (and ΔRp=70 nm),

b)

We assume a Gaussian distribution , define function *N*(*x*)

```
> N:=x-> Phi/sqrt(2*Pi)/delRp*exp(-(x-Rp)^2/2/delRp^2);
```

$$N := x \rightarrow \frac{\Phi\, e^{-\frac{1}{2}\frac{(x-Rp)^2}{delRp^2}}}{\sqrt{2\,\pi}\ delRp}$$

All calculations are done with units cm and eV
We put the numerical values given (and found) into the set called 'pars' with units cm, eV.

```
> pars:={delRp=700e-8,Rp=3000e-8,Eo=85e3,Npeak=1e17,Nbulk=1e15};
```

$$pars := \{Eo = 8.50 \times 10^{4},\ Nbulk = 1.00 \times 10^{15},\ Npeak = 1.00 \times 10^{17},\ Rp = 3.00 \times 10^{-5},\ delRp = 7.00 \times 10^{-6}\}$$

We have given that the concentration at the peak, Rp, should be a certain value, Npeak. That gives us the following equation

```
> eq1:=N(Rp)=Npeak;
```

$$eq1 := \frac{1}{2}\ \frac{\Phi\sqrt{2}}{\sqrt{\pi}\ delRp} = Npeak$$

So we solve this equation with respect to phi

```
> eq2:=Phi=solve(eq1,Phi);
```

$$eq2 := \Phi = Npeak\sqrt{\pi}\ delRp\sqrt{2}$$

```
> answer_b:=evalf(subs(pars,eq2),3);
```

$$answer\_b := \Phi = 1.75\ 10^{12}$$

So we have our answer dos=1.75e12 cm^-2
We put the value into the set 'consts'

```
> pars2:=pars union {answer_b} ;
```

$$pars2 := \{Eo = 8.50 \times 10^{4}, Nbulk = 1.00 \times 10^{15}, Npeak = 1.00 \times 10^{17}, \Phi = 1.75 \times 10^{12}, Rp = 3.00 \times 10^{-5}, delRp = 7.00 \times 10^{-6}\}$$

c)

We need to find when N(x)=Nbulk;

```
> eq3:=N(x)=Nbulk;
```

$$eq3 := \frac{1}{2}\,\frac{\Phi\sqrt{2}\,e^{-\frac{1}{2}\frac{(x-Rp)^2}{delRp^2}}}{\sqrt{\pi}\,delRp} = Nbulk$$

```
> answer_c:=solve(eq3,x);
```

$$answer\_c := Rp + delRp\sqrt{-\ln\left(\frac{2\,\pi\,Nbulk^2\,delRp^2}{\Phi^2}\right)}, Rp - delRp\sqrt{-\ln\left(\frac{2\,\pi\,Nbulk^2\,delRp^2}{\Phi^2}\right)}$$

```
> answer_c2:=solve(subs(pars2,eq3),x);
```

$$answer\_c2 := 8.76 \times 10^{-6}, 5.12 \times 10^{-5}$$

So we have two solutions!

We want to plot the concentration profile together with the bulk concentration

```
> with(plots):
> plot1:=logplot(subs(pars2,N(x)),x=0..6100e-8):
> plot2:=logplot([[0,1e15],[6100e-8,1e15]],color=green):#The bulk
  concentration is constant, so we plot a line
> display([plot1,plot2]);
```