```
> restart;
```

#FYS9n4310 solution problem 200-18

Problem:

A Czochralski growth process is begun by inserting 1000 moles of pure Si and 0.01 mole of pure As in the crucible. For this boule the maximum permissible doping concentration is $11x0^{18}$ cm^{-3}. What fraction, X, of the boule is usable?

Solution

Equation 2.13 in text book

```
> eq2_13:=Cs=k*C0*(1-X)^(k-1);
```

$$eq2\_13 := Cs = k\,C0\,(1 - X)^{k-1}$$

Here Cs is concentration of dopant in Si after a fraction X of the boule is solidified
C0 is the concentration of dopant in the melt at the start and k is the segragation coefficient.

We solve equuation 2_13 with respect to X

```
> eq1A:=X=solve(eq2_13,X);
```

$$eq1A := X = -e^{\frac{\ln\left(\frac{Cs}{C0\,k}\right)}{k-1}} + 1$$

We set in for the parameters and put those in the set called 'nums'

```
> Digits:=3;
```

$$Digits := 3$$

```
> nums:={Cs=1e18/5e22,C0=0.01/1000,k=0.3};
```

$$nums := \{C0 = 0.0000100,\ Cs = 0.0000200,\ k = 0.3\}$$

We put the parameter values into the solution given by eq1A.

```
> eq1:=evalf(subs(nums,eq1A));
```

$$eq1 := X = 0.934$$

So, 93 % of the boule is usable in this case.
And the doping concentration will vary between $3x10^{17}$ cm^{-3} and $1x10^{18}$ cm^{-3}.