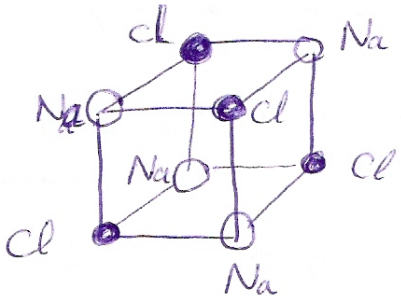
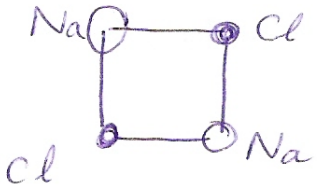
ELEC 321 HW #1

1.



a)



b) The nearest neighbors are assumed to be touching (not expressed in my drawings!)

$r_{Na} = 1\,\text{Å} = 10^{-8}\,\text{cm}$; $r_{Cl} = 1.8\,\text{Å} = 1.8\times10^{-8}\,\text{cm}$

$\Rightarrow \boxed{a = 1\,\text{Å} + 1.8\,\text{Å} = 2.8\times10^{-8}\,\text{cm}}$

c) Volume density of Na or Cl atoms $= \dfrac{4\times\frac{1}{8}}{a^3} \simeq 2.3\times10^{22}\ \text{atoms}/\text{cm}^3$

d) As for this part you have to consider the atomic mass

Atomic mass of Na : 22.989 g/mole

" " " Cl : 35.453 g/mole

mass density of NaCl $= \dfrac{0.5(22.989+35.453)}{6.02\times10^{23}} \times \dfrac{1}{a^3} \simeq 2.2\ \text{g}/\text{cm}^3$

(6.02×10^{23}: Avogadro's number)

2. Effective $r_A = 2.2\times10^{-8}$ cm

" $r_B = 1.8\times10^{-8}$ cm

a) Assuming that atoms are touching:

$a = ?$ As the crystal is a BCC the packing density along the diagonal length of the cubic would be the determining factor to have the above condition met $\Rightarrow \underbrace{\sqrt{3}a}_{\text{length of diag.}} = 2r_A + 2r_B$

$\Rightarrow a \simeq 4.6\times10^{-8}$ cm

b) $\Rightarrow$ Volume density of A atoms $= \dfrac{8\times\frac{1}{8}}{a^3} \simeq 1.03\times10^{22}\ \text{atoms}/\text{cm}^3$

" " B " $= \dfrac{1}{a^3} \simeq 1.03\times10^{22}\ \text{atoms}/\text{cm}^3$

b) No difference c) The two are just the same!

3. (110) plane is considered for surface density

A atoms at the corners:

surface density in (110) of A atoms $= \frac{4 \times \frac{1}{4}}{a \times a\sqrt{2}} = 3.34 \times 10^{14} \frac{\text{atoms}}{\text{cm}^2}$

surface density in (110) of B atoms $= \frac{1}{a \times a\sqrt{2}} = 3.34 \times 10^{14} \frac{\text{atoms}}{\text{cm}^2}$

if B atoms were to be at the corners $\Rightarrow$ no difference!

The two are the same!

4. $\left(\frac{1}{4a}, \frac{1}{2a}, \frac{1}{4a}\right) \xrightarrow{\times 4a} (121)$

5. FCC & surfaces of nearest neighbors are touching.

$r = 2.5 \times 10^{-8}$ cm $\Rightarrow \sqrt{2}a = 4r \Rightarrow a \simeq 7.07$ Å

a) Volume density $= \frac{8 \times \frac{1}{8} + 6 \times \frac{1}{2}}{a^3} \simeq 1.13 \times 10^{22} \frac{\text{At}}{\text{cm}^3}$

b) distance between nearest (110) planes $= \frac{\sqrt{2}a}{2} \simeq 5.0$ Å

c) surface density on (110) plane $= \frac{2 \times \frac{1}{2} + 4 \times \frac{1}{4}}{a \times a\sqrt{2}} \simeq 2.83 \times 10^{14} \frac{\text{atoms}}{\text{cm}^2}$