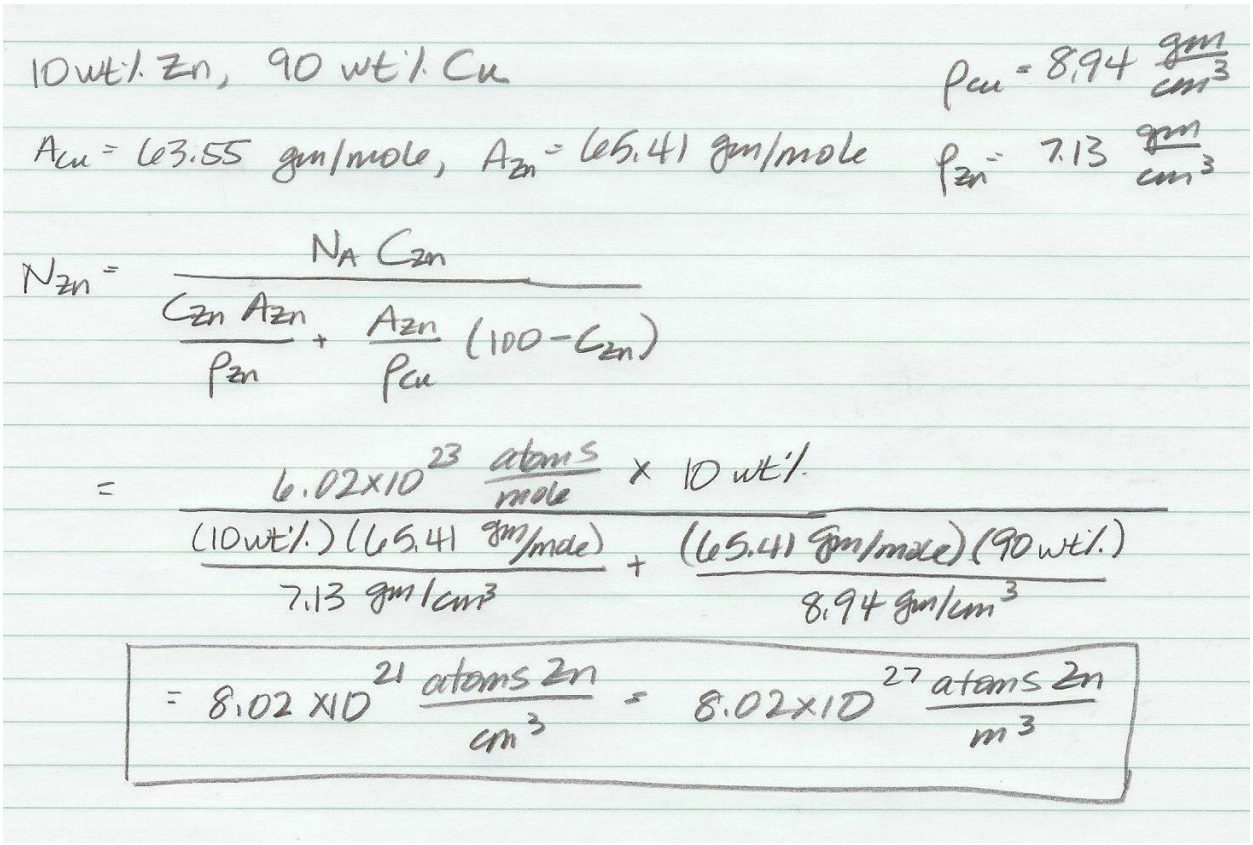
Problem 1
An alloy contains 10 wt.% zinc and 90 wt.% copper. What is the concentration of Zn (in atoms of Zn/m^3) in the alloy?
DATA: A_{Cu} = 63.55 gm/mole, A_{Zn} = 65.41 gm/mole, ρ_{Cu} = 8.94 gm/cm^3, ρ_{Zn} = 7.13 gm/cm^3



Problem 2

Nitrogen from a gaseous phase is to be diffused into pure iron. If the surface concentration is maintained at 0.3 wt.% N, what will be the concentration at 0.5 mm from the surface after 20 hours? The diffusion coefficient for N in Fe is 2.5×10^{-11} m^2/sec.

Tabulation of Error Function Values

z	$erf(z)$	z	$erf(z)$	z	$erf(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

$800°C = 1073K$ $C_s = 0.3$ wt% N $C_o = 0$ $x = 0.5mm$
$C_x = ?$ $t = 20$ hrs

$$\frac{C_x - C_o}{C_s - C_o} = 1 - erf\left(\frac{x}{2\sqrt{Dt}}\right)$$

$$\frac{C_x}{0.3} = 1 - erf\left[\frac{0.5\times10^{-3}\ m}{2\sqrt{2.5\times10^{-11}\ m^2/sec \cdot 20\ hrs \cdot 3600\ \frac{sec}{hr}}}\right]$$

$$\frac{C_x}{0.3} = 1 - erf(0.186)$$

Table

z	$erf(z)$
0.15	0.1680
0.186	x
0.20	0.2227

$$\frac{C_x}{0.3} = 1 - 0.21$$

Interpolation (linear)

$$\frac{x - 0.1680}{0.186 - 0.15} = \frac{0.2227 - 0.1680}{0.2 - 0.15}$$

$x = 0.2074$

$\Rightarrow$ $\boxed{C_x = 0.238 \text{ wt\% N}}$

Problem 3
Tungsten has an atomic radius of 0.137 nm, a density of 19.3 gm/cm^3 and atomic weight, A_W = 183.84 gm/mole. Determine if the structure is FCC or BCC.

$r = 0.137$ nm $\quad \rho = 19.3 \frac{gm}{cm^3} \quad A_W = 183.84 \frac{gm}{mole}$

$\rho = \frac{n A_W}{V_C N_A}$ For FCC $V_{C_{FCC}} = (a_{FCC})^3 = (2r\sqrt{2})^3 \quad n = 4$

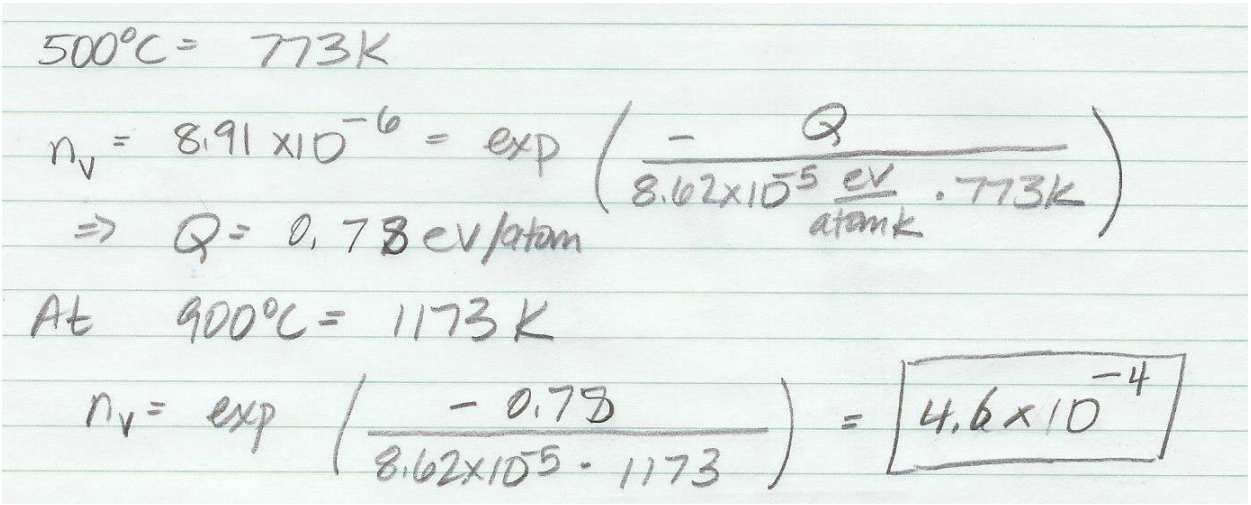
$$\rho_{FCC} = \frac{4 \text{ atoms} \cdot 183.84 \text{ gm/mole}}{(2 \times 0.137 \times 10^{-7} \text{ cm} \sqrt{2})^3 \cdot 6.02 \times 10^{23} \frac{\text{atoms}}{\text{mole}}} = 21 \frac{gm}{cm^3}$$

For BCC $V_{C_{BCC}} = (a_{BCC})^3 = \left(\frac{4}{\sqrt{3}} r\right)^3 \quad n = 2$

$$\rho_{BCC} = \frac{2 \text{ atoms} \cdot 183.84 \text{ gm/mole}}{\left(\frac{4 \times 0.137 \times 10^{-7} \text{ cm}}{\sqrt{3}}\right)^3 \cdot 6.02 \times 10^{23} \frac{\text{atoms}}{\text{mole}}} = 19.3 \frac{gm}{cm^3} \checkmark$$

Then it is **BCC**

Problem 4
The fraction of vacancies in a metal at 500˚C is 8.91 x 10^{-6}. What is the fraction of vacancies at 900˚C?



Problem 5
Put your answer in the boxes to the right.

	(answer)
The grain size of a material can be determined by: (a) the density (b) x-ray diffraction (c) optical microscopy (d) all of the above	c
T/F Steady state diffusion occurs when the concentration gradient changes with the distance.	F
A close packed plane in the FCC structure is the: (a) (101) (b) $(\bar{1}\bar{1}1)$ (c) (001) (d) none of the above	b
An x-ray diffraction pattern from a BCC crystal has a peak at $2\theta = 35^\circ$ that is indexed to the (110) plane. What is the lattice parameter? The x-ray wavelength = 0.154 nm. (a) 0.190 nm (b) 0.256 nm (c) 0.362 nm (d) none of the above	c
An covalent bond forms by the: (a) formation of an electron cloud surrounding the atoms (b) sharing of electrons between the atoms (c) transfer of an electron from one atom to the other (d) none of the above	b

$$2d_{hjl}\sin\theta_{hkl} = n\lambda \qquad n = 1$$

$$d_{hjl} = \frac{a}{\sqrt{h^2 + k^2 + \ell^2}}$$

$$\frac{2a}{\sqrt{1^2 + 1^2}}\sin(17.5^\circ) = 0.154\ nm$$

$$a = 0.362\ nm$$