Due 9/10/08

Homework # 1

1) Draw representative lattices for

a) Honeycomb (hexagonal)

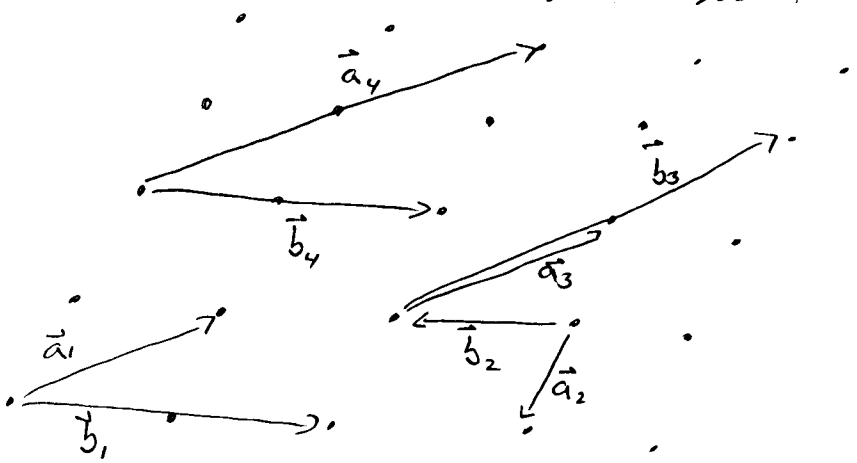
b) Hexagonal close-packed

c) Body-centered cubic

d) Simple cubic

Lattices. Explain whether each is a Bravais lattice. Why or why not?

2) Given the following sets of vectors, explain whether they are primitive vectors, why or why not?

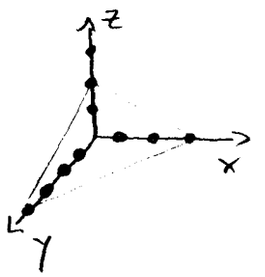


4) GIVE THE COORDINATION NUMBERS FOR FCC, BCC, HONEYCOMB and SIMPLE CUBIC CRYSTAL STRUCTURES

5) GIVE THE PRIMITIVE VECTORS FOR THE PRIMITIVE CELL OF THE BCC LATTICE STRUCTURE WITH A LATTICE CONSTANT OF 5.65 Å FOR THE SIMPLE CUBIC LATTICE. WHAT ARE THE RECIPROCAL LATTICE VECTORS FOR THESE PRIMITIVE VECTORS? WHAT TYPE OF LATTICE DO THE REC. LATT. VECTORS SPAN?

6) WRITE THE FCC LATTICE AS A CUBIC (SIMPLE CUBIC) WITH A BASIS

7) GIVE THE MILLER INDICES FOR THE FOLLOWING PLANES:

a) 

b) THE YZ PLANE

c) THE PLANE DEFINED BY (1,0,0), (0,1,0) AND (2,2,1)

8) Assume $K_d = 0.3$ for P in Si.

Explain what effect zone refining will have on a heavily Phosphorus-doped Si ingot.

9) What are the advantages / disadvantages of crystals grown by MBE vs. Czochralski-pulled x-tals?

10) Derive the average energy of an oscillating mode if mode's energy is given by: $E_n = nh\nu$

Assume energies are discrete, but

$$f_n = C e^{-E_n/KT}$$

1) Normalize to find "C"

- ✡ can't use integral, only sum
- ✡ substitute $x = \frac{E}{KT} = \frac{h\nu}{KT}$

  expand as Taylor series

2) To find average, write $\bar{E} = \sum_{n=0}^{\infty} E_n f_n$

✡ $\sum y^n = (1-y)^{-1}$

11) Au HAS A WORK FUNCTION OF 4.7eV

WHAT IS THE ENERGY OF AN ELECTRON EMITED BY A PHOTON WITH

a) $\lambda = 632\ nm$

b) $\gamma = 2 \times 10^{15}\ Hz$

12) 1) DEBROGLIE SUGGESTED THAT MATTER CAN HAVE A WAVELENGTH

$$\lambda = \frac{h}{p}$$

2) BOHR ARGUED THAT ANGULAR MOMENTUM OF e^-'s AROUND NUCLEUS WAS QUANTIZED $L = n\hbar$

USING 1) + 2) DETERMINE λ FOR AN ELECTRON IN THE FIRST + SECOND STATES OF THE H ATOM

13) DERIVE THE 2D DENSITY OF MODES FOR A SQUARE CAVITY

14) SHOW THAT THE WAVEFUNCTION $\begin{cases} \psi(x) = 0 & x<0,\ x>L \\ \psi(x) = A \sin\frac{2\pi}{L} x, & 0<x<L \end{cases}$ IS A SOLUTION FOR THE SCHRODINGER EQUATION FOR A POTENTIAL GIVEN BY $V(x) = 0 \quad 0<x<L$

$= \infty \quad x<0,\ x>L$

-> HINT: SOLVE S.E FOR $0<x<L$

WHAT IS A?

15) What is the expectation value of x for $|4,0\rangle$ in PROB. 14? WHAT IS THE UNCERTAINTY IN x?