Ministry of Higher Education
The Higher Institute of Engineering and technology
in New Damietta

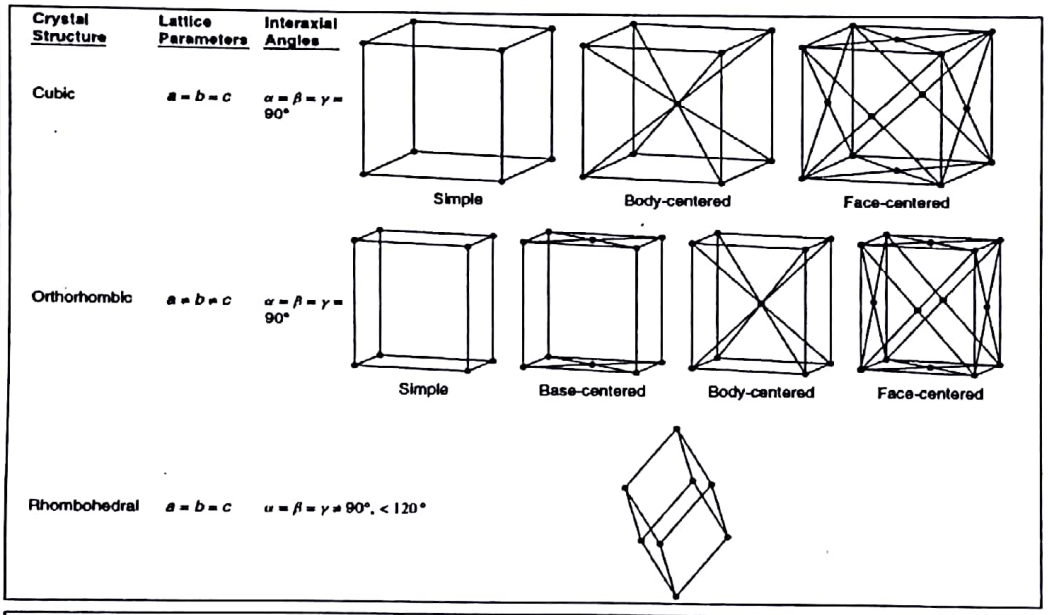
Department: Chemical Engineering
Level: 3th level
Semester: First Semester(mid term exam)
Course title : Metallurgy and material science
Course Code: CHE 302

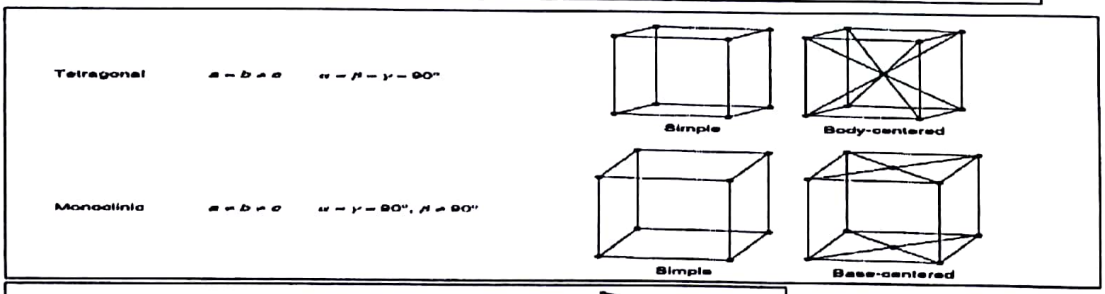
Date: 11/11/2017 **Day:** Saturday
Time allowed: 1.30 hr.
Full marks: 20 marks
No. of pages: 1

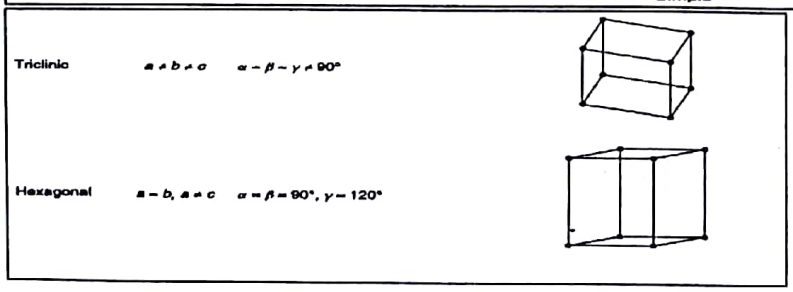
Answer on all questions

Question1 (10 marks)

1- The crystal system divided into 7 groups (**Demonstrate** them). **(3marks)**







2-Consider a metal with an FCC structure and an atomic weight of 95.9. When monochromatic x-radiation having a wavelength of 0.1028 nm is focused on the crystal, the angle of diffraction (3θ) for the (411) set of planes in this metal occurs at 90 degrees. **(3marks)**
(for the first order reflection n=1).

a. Calculate the inter planar spacing for this set of planes.
b. Calculate the lattice parameter for this metal.
c. Calculate the density of the metal (units of g/cm^3)

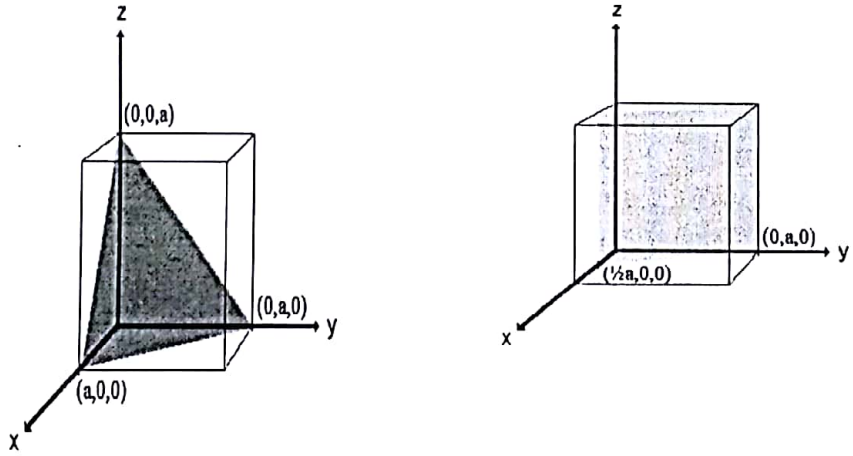
Answer:

a) $d = \frac{\lambda}{2\sin\theta} = \frac{0.1028}{2\sin(71.2/2)} = 0.0883nm$

b) $a = d\sqrt{h^2 + k^2 + l^2} = 0.0883\sqrt{3^2 + 1^2 + 1^2} = 0.293nm$

c) $\rho = \frac{nA}{a^3 N_A} = \frac{4 \cdot 92.9}{(0.293\times10^{-7})^3 \cdot 6.02\times10^{23}} = 24.53\,g/cm^3$

3- Draw the following planes and their directions: **(2marks)**
(211), (111), (101), (220)



4-Compare between the three types of dislocation" line defects"? **(2marks)**

There are three types of dislocations:
edge dislocations,
screw dislocations,
and a combination of these two, termed mixed dislocations

An edge dislocation

occurs when a single atomic plane does not extend completely through the lattice.

The edge dislocation is designated by a perpendicular sign, either ⊥ if the plane is above the dislocation line or T if the plane is below the dislocation line.

the screw dislocation, occurs when the Burger's vector is parallel to the dislocation line.

When a line defect has both an edge and screw dislocation component, a mixed dislocation results. In this case, the Burger's vector is neither parallel nor perpendicular to the dislocation line,.

Dislocation Type	Burger's Vector	Propagation Direction
Edge	⊥ to dislocation line	‖ to dislocation line, ‖ to Burger's vector
Screw	‖ to dislocation line	⊥ to dislocation line, ⊥ to Burger's vector
Mixed	Neither ‖ nor ⊥ to dislocation line	Neither ‖ nor ⊥ to dislocation line, Burger's vector

Question2 (10marks):

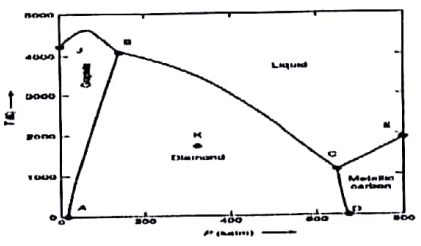
1- Mention the Symmetry Operations that define Twinning ? **(1marks)**

1) Reflection across a mirror plane. The added mirror plane would then be called a twin plane.

(2) Rotation about an axis or line in the crystal. The added rotation axis would then be called a twin axis.

(3) Inversion through a point. The added center of symmetry would then be called a twin center.

2-By using phase rule **explain** this chart: **(3marks)**



F=c-Φ+2

K →F=1-1+2=2

CE, CD, CB, AB, JB→ F=1-2+2=1

C, B → F=1-3+2=0

3-From your study for free energy for alloys **compare** between ideal case and regular case? **(3marks)**

$$G = H - TS$$
$$H = X_A H_A^\circ + X_B H_B^\circ + \Delta H_{mix}$$
$$S = X_A S_A^\circ + X_B S_B^\circ + \Delta S_{mix}$$

$$G = X_A(H_A^\circ - TS_A^\circ) + X_B(H_B^\circ - TS_B^\circ) + \Delta H_{mix} - T\Delta S_{mix}$$
$$G = X_A G_A^\circ + X_B G_B^\circ + \Delta G_{mix}$$

where

$$\Delta G_{mix} = \Delta H_{mix} - T\Delta S_{mix}$$

$$\Delta S_{conf} = \Delta S_{mix} = -R(X_A \ln X_A + X_B \ln X_B)$$

$$\alpha^{ideal} = \Delta H_{mix}^{ideal} = 0$$

$\alpha < 0$, exothermic mixing ($H_{mix} < 0$)

$\alpha > 0$. Endothermic mixing ($H_{mix} > 0$)

$$\Delta H_{mix} = \alpha X_A X_B$$

$$\alpha^{ideal} = \Delta H_{mix}^{ideal} = 0$$
$$\Delta G_{mix} = \alpha X_A X_B + RT(X_A \ln X_A + X_B \ln X_B)$$

$$G^{ideal} = X_A G_A^\circ + X_B G_B^\circ + .RT(X_A \ln X_A + X_B \ln X_B)$$

$$G^{reg} = X_A G_A^\circ + X_B G_B^\circ + \alpha X_A X_B + RT(X_A \ln X_A + X_B \ln X_B)$$

4- Explain Origin of Twinning? **(2marks)**

Growth Twins:

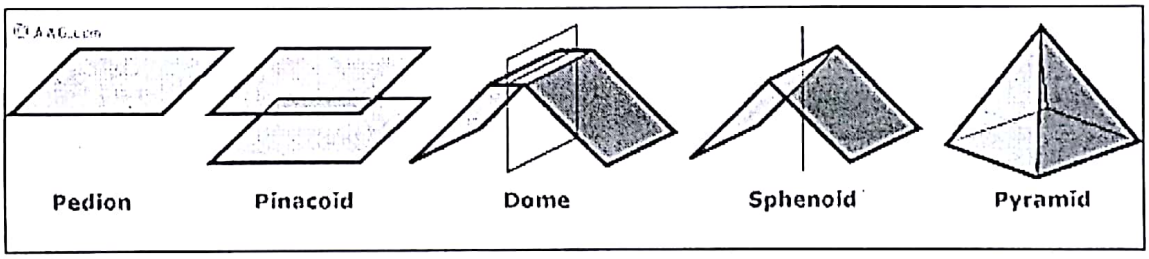
When accidents occur during crystal growth and a new crystal is added to the face of an already existing crystal,

Transformation Twins
Transformation twinning occurs when a preexisting crystal undergoes a transformation due to a change in pressure or temperature.
Deformation (Gliding) Twins
During deformation atoms can be pushed out of place

5-The crystal forms is open forms and closed forms **demonstrate** them by examples. **(1marks**

1- Open Forms

The eighteen open-forms are those facet groupings that are related by symmetry, but do not completely enclose a volume of space.



2. Closed Isometric Forms

These forms include: Hexahedron , Octahedron (*Diamond, Spinel*) , Tetrahedron (*Tetrahedrite*) Dodecahedron (Rhombic - *Garnet*) ,Hexoctahedron (*Diamond*)