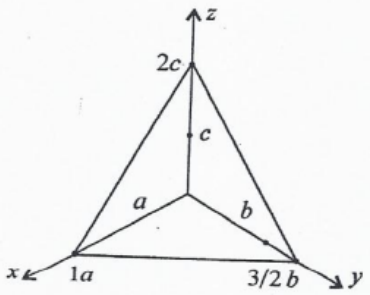
Tutorial 1:

- Crystalline and amorphous structure of matter;
- Different crystal systems, space groups;
- Methods of determination of crystal structure; X-ray diffraction, scanning and transmission electron microscopies

Q1:

(d) ...leads to the formation of (i) proton and (ii) neutron ? 10



A crystal plane is shown in the above figure. Find its Miller indices and interplanar spacing. 10

(e) Draw and explain ...

2013

Q2:

In a cubic unit cell, find the angle between normals to the plane (111) and (121). 10

2014

Q3:

What is the reciprocal lattice and why is it named so ? Derive the relationships for the primitive translation vectors of the reciprocal lattice in terms of those of the direct lattice. 20

2014

Q4:

Show that any arbitrary rotation axis is not permitted in a crystal lattice. 10

2015

Q5:

The primitive translation vectors of a two-dimensional lattice are

$$\mathbf{a} = 2\hat{\mathbf{i}} + \hat{\mathbf{j}}, \quad \mathbf{b} = 2\hat{\mathbf{j}}.$$

Determine the primitive translation vectors of its reciprocal lattice. *10*

2016

Q6:

Obtain Laue's equations for X-ray diffraction by crystals. Show that these are consistent with the Bragg's law. *15+5=20*

2016

Q7:

Calculate Atomic Packing Fraction (APF) for FCC and HCP structures, and show that these are the most closely packed structures. 10

2018

Q8:

Derive Bragg diffraction law for X-ray diffraction. Compare Laue and Debye-Scherrer methods for crystal structure determination. 10

2018

Q9:

Deduce the Miller indices of the close-packed planes of atoms in the f.c.c. lattice. 10

2019

Q10:

The angles between the tetrahedral bonds of diamond are the same as the angles between the body diagonals of a stack of neighbouring cubes having common edges and not faces. Use vector analysis to find the value of the angle. 10

2019

Q11:

Consider a face-centred cubic lattice of side a. Deduce—

(i) the primitive translation vectors;

(ii) the volume of the primitive cell;

(iii) the reciprocal primitive translation vectors;

(iv) the volume of the reciprocal lattice. 20

2019

Q12:

Calculate the Hall coefficient of sodium based on the free electron model. Sodium has BCC structure and the side of the cube is 4·28 Å. 10

2020

Q13:

The potential energy of a diatomic molecule in terms of the interatomic spacing R is given by

$$U(R) = \frac{-A}{R^2} + \frac{B}{R^{10}}$$

where $A = 1{\cdot}44 \times 10^{-39}$ J m^2 and $B = 2{\cdot}19 \times 10^{-115}$ J m^{10}. Calculate the equilibrium spacing, R_e and the dissociation energy. 20

2020

Q14:

The lattice parameter and the atomic mass of a diamond crystal are 3·57 Å and 12, respectively. Calculate the density of the crystal. Given, Avogadro's number, $N = 6{\cdot}023 \times 10^{26}$ (kg mol)$^{-1}$. 10

2020

Q15:

In an almost pure thick aluminium sheet, there are 0·19 atomic percent of copper at the surface and 0·18 atomic percent at a depth of 1·2 mm from the surface. Calculate the flux of the copper atoms from the surface at 550 °C, if the diffusion coefficient of copper in aluminium at this temperature is $5{\cdot}25 \times 10^{-13}$ m^2 s^{-1}. Given, Al FCC with lattice parameter, $a = 4{\cdot}05$ Å. 10

2020

Q16:

An X-ray beam of wavelength (λ_1) undergoes a first order Bragg reflection at a Bragg angle of 30°. X-ray of wavelength 97 nm undergoes 3rd order reflection at a Bragg angle of 60°. Consider that the two beams are reflected from the same set of planes. Find the value of λ_1. 10

2021

Q17:

The wavelength of a prominent X-ray line from a copper target is 0·1512 m. The radiation, when diffracted with (111) plane of a crystal with fcc structure, corresponded to a Bragg angle of 20·2°. If the density of the crystal is 2698 kg/m^3 and atomic weight is 26·98 kg/k mol, calculate the Avogadro number. 15

2022

Q18:

Derive diffraction conditions using reciprocal lattice concept. What are these conditions known as ? 10

2023

Q19.

The spacing between successive (100) planes in sodium chloride is 1·41 Å. X-rays incident on the surface of the crystal are found to give rise to second order Bragg reflections at a glancing angle 10°. Calculate the wavelength of X-ray radiations. *10*

2024

Q20.

Find the radius of the interstitial sphere which can just fit into the void at the body centre of the fcc structure coordinated by the facial atoms. 10

2025

Q21.

In powder diffraction method pattern for lead with radiation of wavelength $\lambda = 1{\cdot}54$ Å, the (220) Bragg reflection angle is $\theta = 32°$. Find the radius of the atom. 10

2025

Q22.

What is X-ray diffraction? How is an XRD pattern used to determine the crystal structure of the material? 15

2025