Page No.
Date

Periodic Test - I

Q.A) MCQ.

1) The number of atoms present in body centred cubic crystal is 2.

2) Amorphous solid have Irregular structure.

3) The smallest portion of the lattice is known as Unit Cell.

4) What is the co-ordination number of simple cubic crystal structure. 6

5) A unit cell that contains lattice points only at the corners is known as Primitive unit cell.

Q.2

A) Calculate the relation between atomic radius and lattice constant for body centred cubic crystal and face centred cubic crystal.

→

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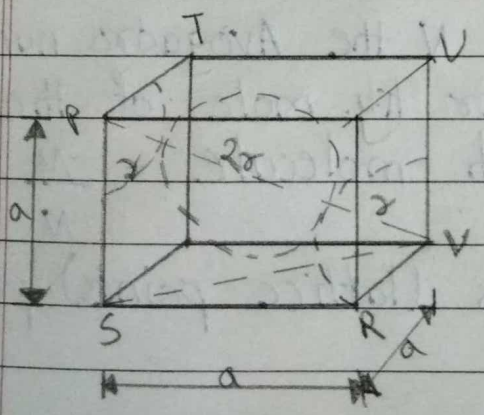


$$(PV)^2 = (PS)^2 + (SV)^2$$

$$= (PS)^2 + (SR)^2 + RV^2)$$

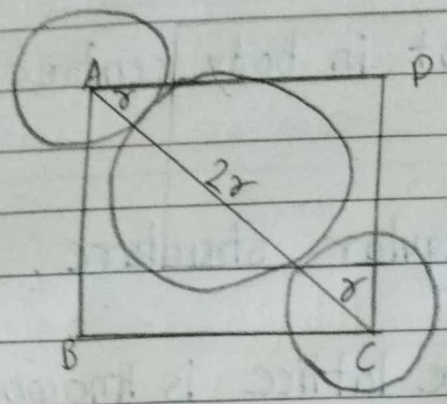
$$(4r)^2 = a^2 + (2a^2) = 3a^2$$

$$16r^2 = 3a^2$$

$$r = \frac{\sqrt{3}}{4} a$$

$$a = \frac{4}{\sqrt{3}} r$$

FCC:



$$AC^2 = AB^2 + BC^2$$
$$(4r)^2 = a^2 + a^2$$
$$16r^2 = 2a^2$$
$$4r = a\sqrt{2}$$
$$r = \frac{a\sqrt{2}}{4} \times \frac{\sqrt{2}}{\sqrt{2}}$$
$$= \frac{a}{2\sqrt{2}}$$

8) Derive the relation between ~~atomic radius~~ lattice parameter and crystal density.
A substance with face centred cubic crystal lattice has density 6250 kg/m^3 and Molecular weight 60.2. Calculate the lattice constant a.

→ Consider a cubic lattice of lattice constant 'a'.
If ρ is the density of the crystal then,
∴ Mass in each unit cell = $a^3\rho$ -①
where a^3 = volume of unit cell.

If M is the molecular weight, N the Avogadro number (the number of molecules per kg. mole of the substance) then mass of each molecule = $\frac{M}{N}$

If n is the no. of molecules (lattice points) per unit cell, then

Mass in each unit cell $= \frac{nM}{N}$ — (ii)

from (i) & (ii)

$$a^3 = \frac{nM}{N\rho}$$

From this relation, the lattice constant 'a' can be calculated.

- $n = 4$, $M = 60.2$ g/mol, $\rho = 6250$ kg/m^3 $= 6.25$ g/cm^3
$N = 6.02 \times 10^{26}$ / kg-mole $= 6.02 \times 10^{23}$ / mole.

$$\therefore a^3 = \frac{4 \times 60.2}{6.02 \times 10^{23} \times 6.25}$$

$$a^3 = 64 \times 10^{-24}$$

$$a = 4 \times 10^{-8} \text{ cm}$$

$$\therefore a = 4 \times 10^{-10} \text{ m} = 4 \text{ A}^\circ$$

Page No.
Date

1) Explain and deduce bragg's law in X-ray diffraction. Calculate the longest wavelength that can be analyzed by a crystal with an interplaner spacing of 3A° in first order.

→ Bragg's law:

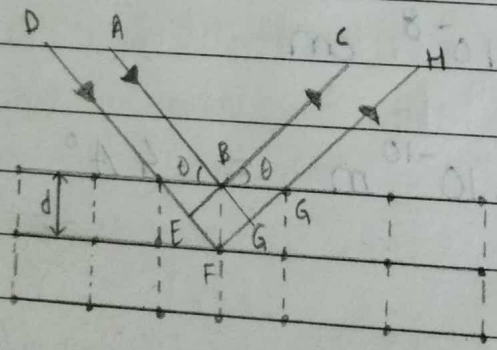
i) Consider a crystal consisting of a set of parallel planes separated by a distance d.

ii) Let a narrow monochromatic beam of X-rays of wavelength λ be incident on this plane at a glancing angle θ.

iii) Consider two parallel rays ABC and DFH which are reflected by two atoms B and F in adjacent layers,

iv) The path difference between them is 'EF + FG'.

v) When the path difference is equal to $n\lambda$, the reflected rays will reinforce each other to produce an intense beam.



∴ Condition for reinforced reflected X-ray beam i.e maxima is

$$EF + FG = n\lambda \quad - (i)$$

$$EF = FG = d\sin\theta \quad - (ii)$$

Substituting (ii) in (i)

$$2d\sin\theta = n\lambda$$

This relation is known as Bragg's law. It indicates that for given values of n, λ and d there is reflection only in a particular direction defined by θ.