University of Calcutta

Semester 5

PHYSICS

Paper: PHS-A-CC-5-12

CRYSTAL STRUCTURE ASSIGNMENTS

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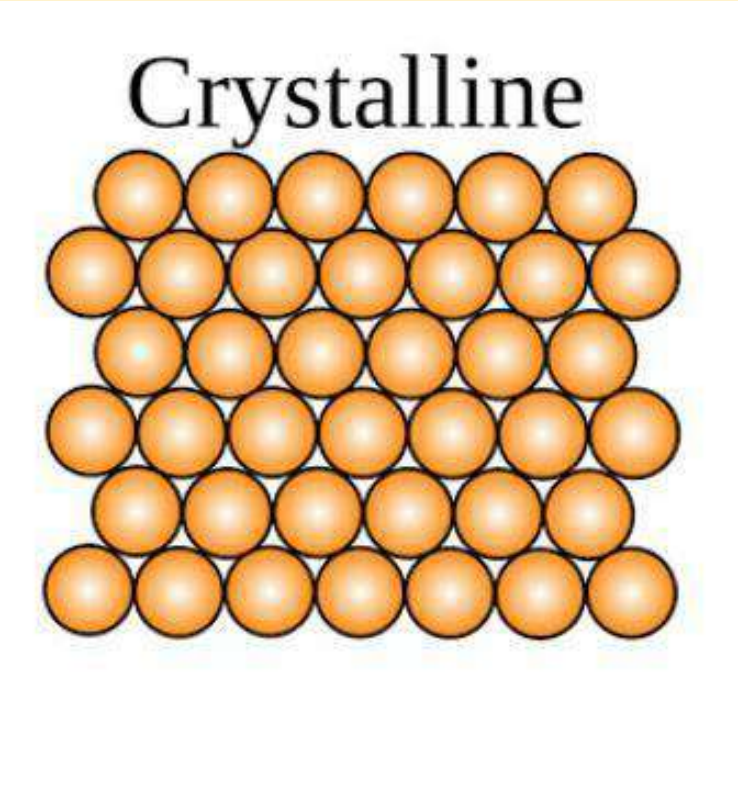
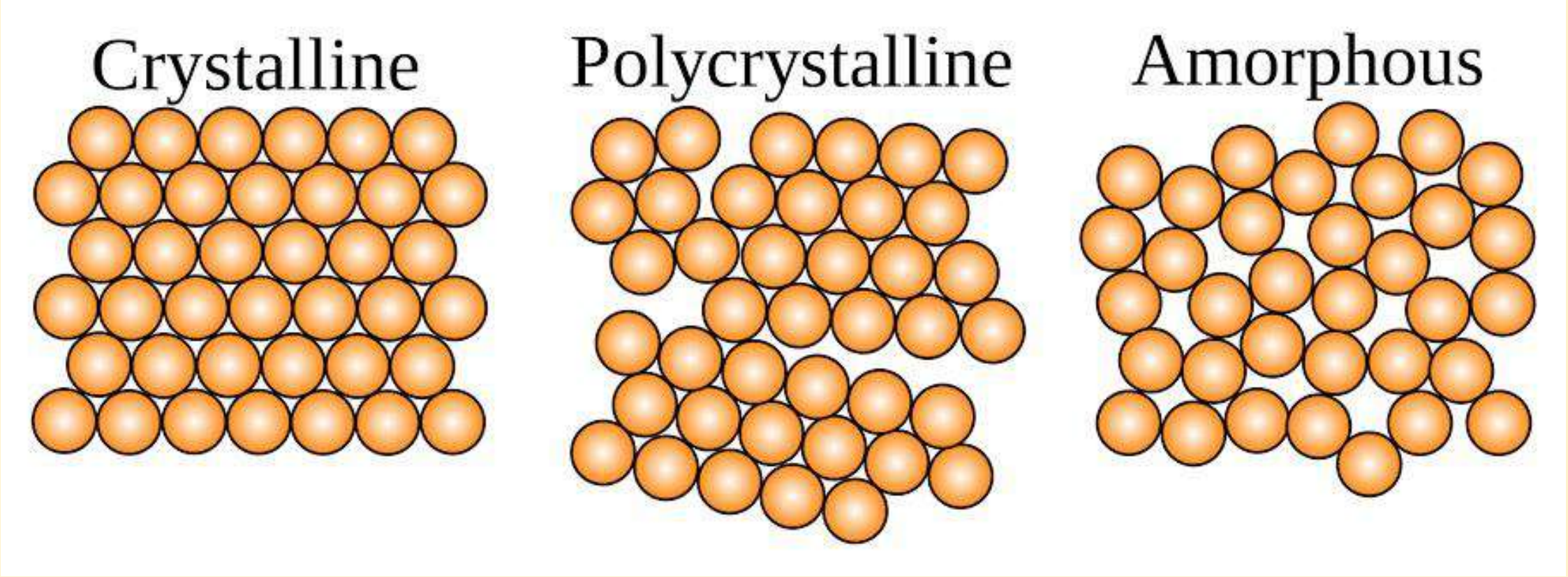
WHAT IS CRYSTAL??

A CRYSTAL is a substance which is formed by regular repetition In three dimensions of identIcal units where a unit may contain one or more atoms

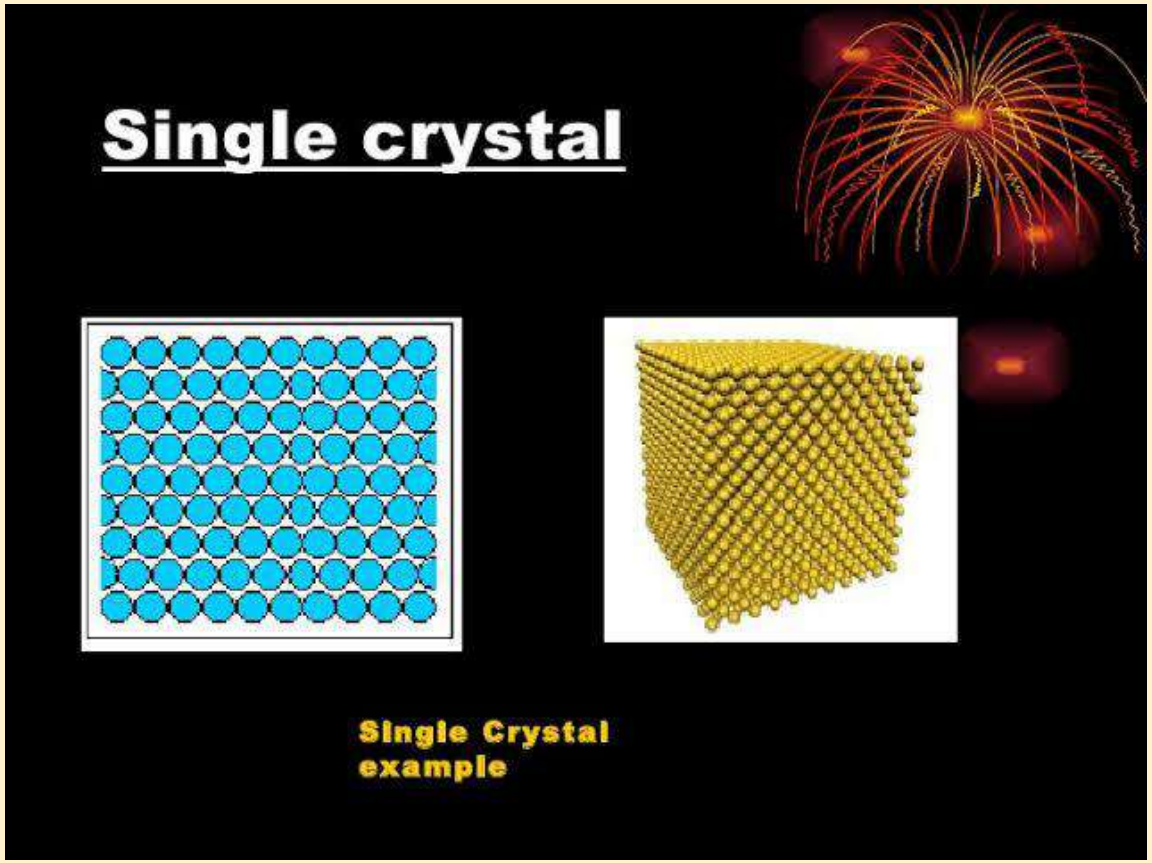


ONE PICTURE .....LOT OF CONCEPTS !!



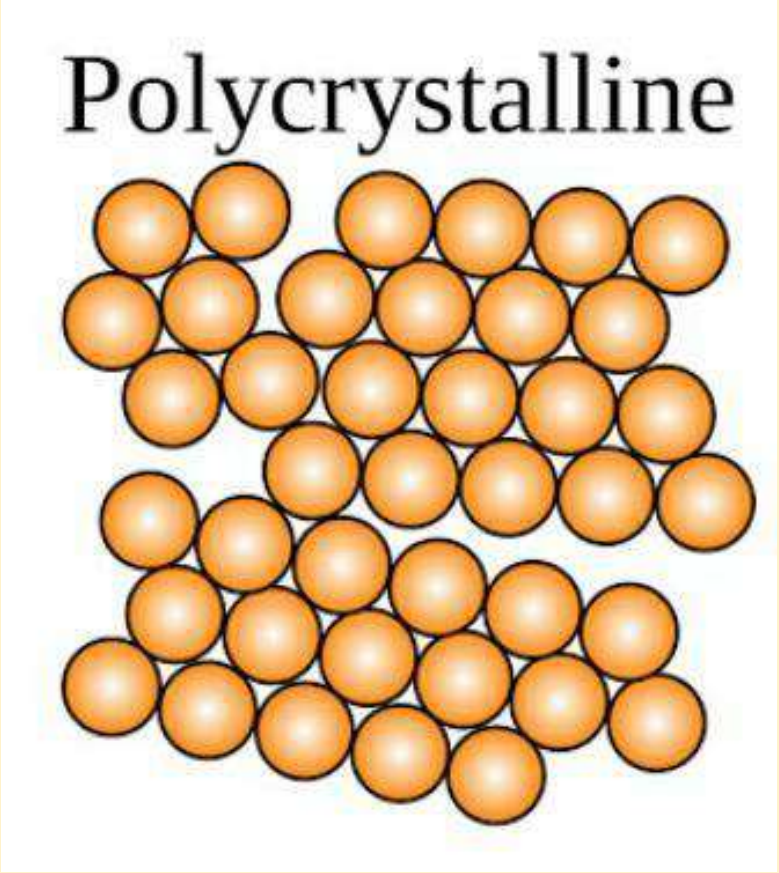
WHAT IS SINGLE CRYSTAL ??

If the atoms are arranged in a regular manner through out the sample of macroscopic size, then the specimen is termed as a SINGLE CRYSTAL



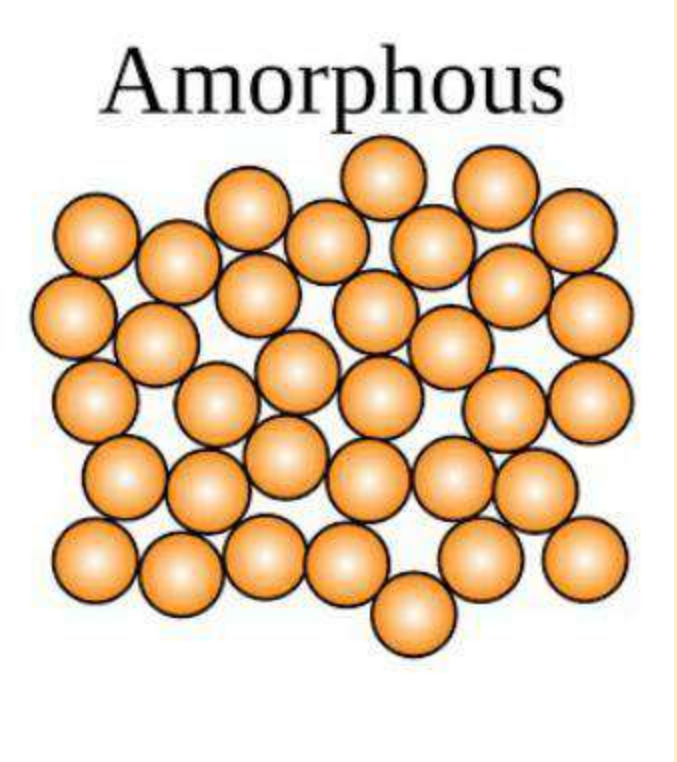
WHAT IS POLYCRYSTALLINE MATERIAL?

- A crystalline solid is composed of an agglomeration of a large number of small crystalline grains.
- These grains are arranged in a more or less random fashion and joined at interfaces referred to as GRAIN BOUNDARIES.
- THE RESULTING SUBSTANCE IS CALLED POLYCRYSTALLINE .



WHAT IS AMORPHOUS MATERIAL ??

- Characterised by RANDOM ARRANGEMENT OF ATOMS OR MOLECULES.
- Constituent atoms take their positions in a regular manner over SHORT DISTANCES OF THE ORDER OF SEVERAL INTERATOMIC SPACINGS.
- No correlation between the positions of the stond occurs over distance es.
- Examples: Glass, Plastics



WHAT IS CRYSTAL LATTICE??

- In a crystal the arrangement of atoms is periodic.
- Each atom can be replaced by a geometrical point at the equilibrium position of the atom.
- The pattern will be formed in the imaginary space points.
- This pattern formed is called LATTICE POINTS.
- IN A LATTICE, ANY ATOM HAS THE SAME ENVIRONMENT AS EVERY OTHET ATOM.

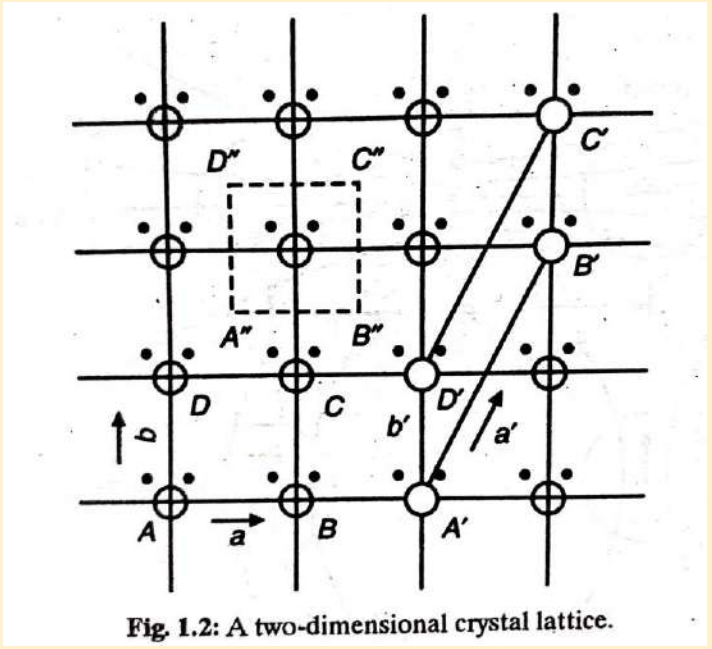


Fig. 1.2: A two-dimensional crystal lattice.

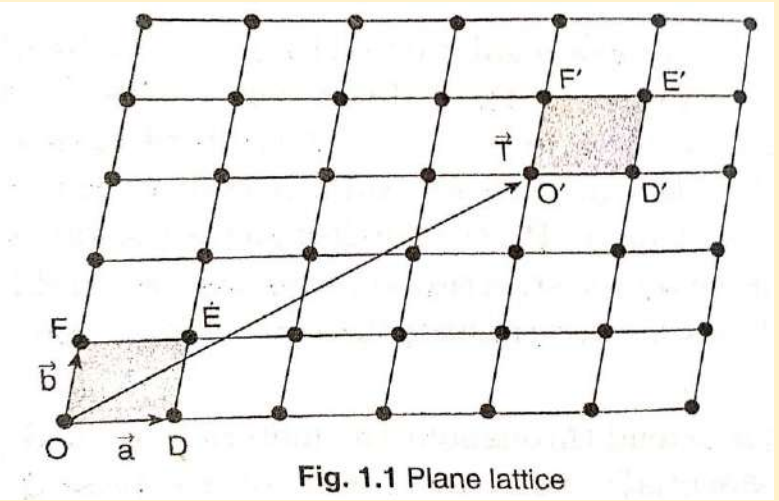


Fig. 1.1 Plane lattice

LATTICE TRANSLATIONAL VECTORS

Let O be any lattice point in a plane lattice (Fig. 1.1). Then, any other lattice point in the lattice can be obtained by repeated translation of vectors $\vec{a}$ and $\vec{b}$. Such vectors as $\vec{a}$ and $\vec{b}$ are called the ***basis vectors***. The position of any lattice point with respect to O (as origin) can be expressed as

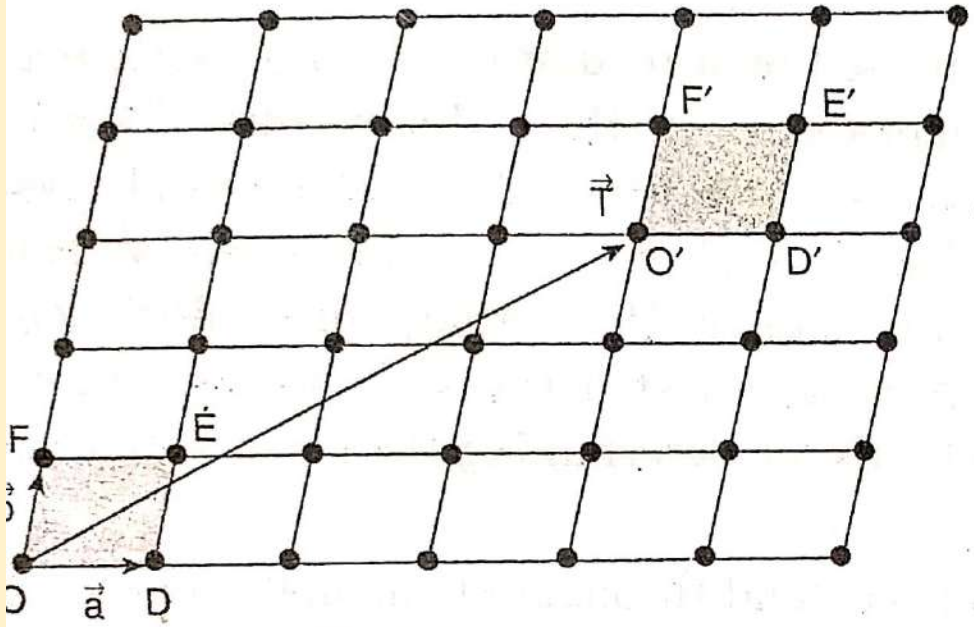


Fig. 1.1 Plane lattice

$$\vec{T} = n_1\vec{a} + n_2\vec{b} \qquad (1.2.1)$$

where n_1 and n_2 are two arbitrary integers. The vector $\vec{T}$ is known as the ***translation vector***.

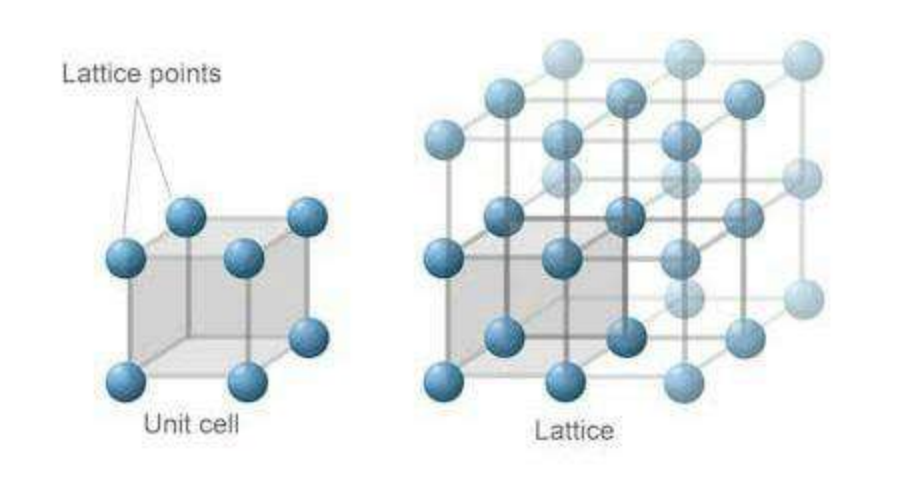
In a similar fashion, one can develop space lattice by employing the basis vectors $\vec{a}, \vec{b}$ and $\vec{c}$ along the directions x, y, z of the crystallographic axis and with respect to any lattice point as origin, the position of any other lattice point may be written as

$$\vec{T} = n_1\vec{a} + n_2\vec{b} + n_3\vec{c} \qquad (1.2.2)$$

where n's are arbitrary integers and $\vec{T}$ the translation vector in three dimensions.

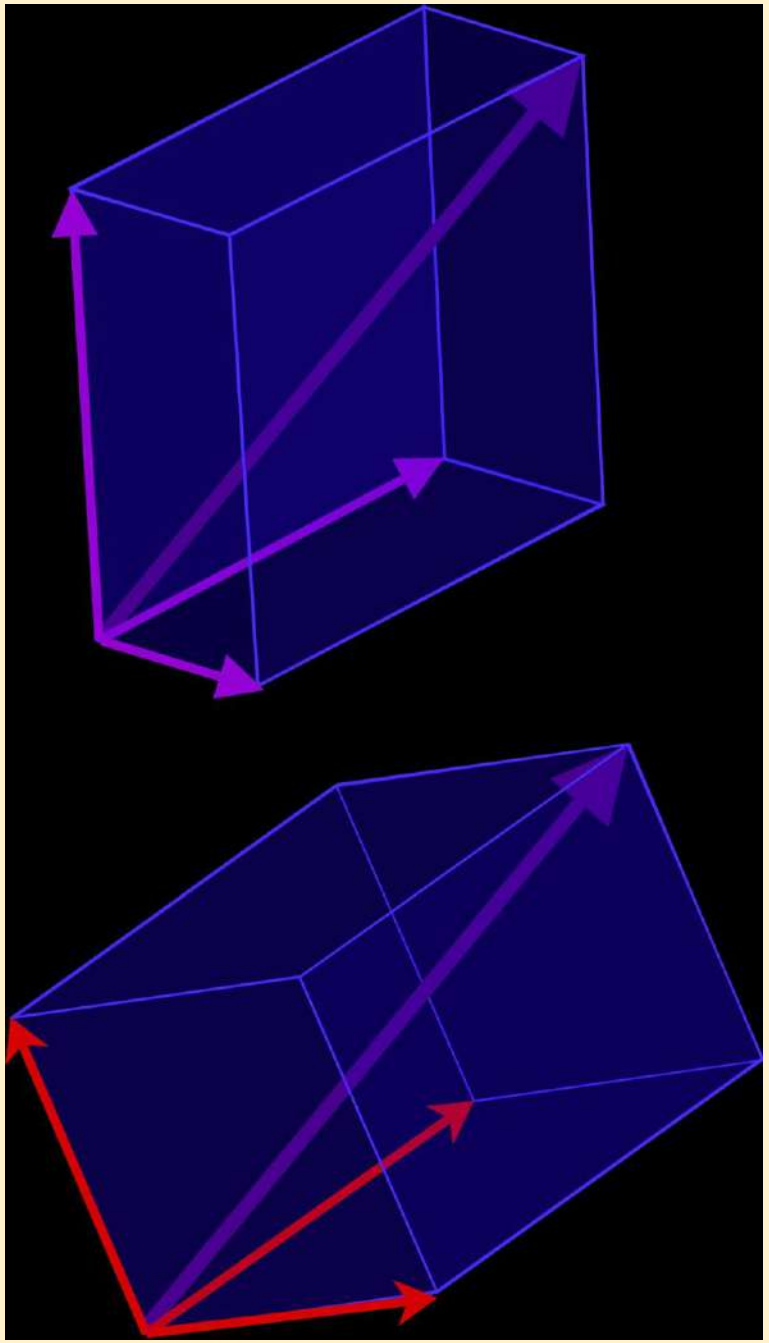
UNIT CELL

This is a region of the crystal defined by the basis vectors **a, b, c** such that a translational of this region by any integral multiple of these vectors will result in a similar region of the crystal



BASIS VECTORS

Three linearly independent vectors **a, b, c** used to defined a unit cell called the basis vectors



EASY WAY TO REMEMBER

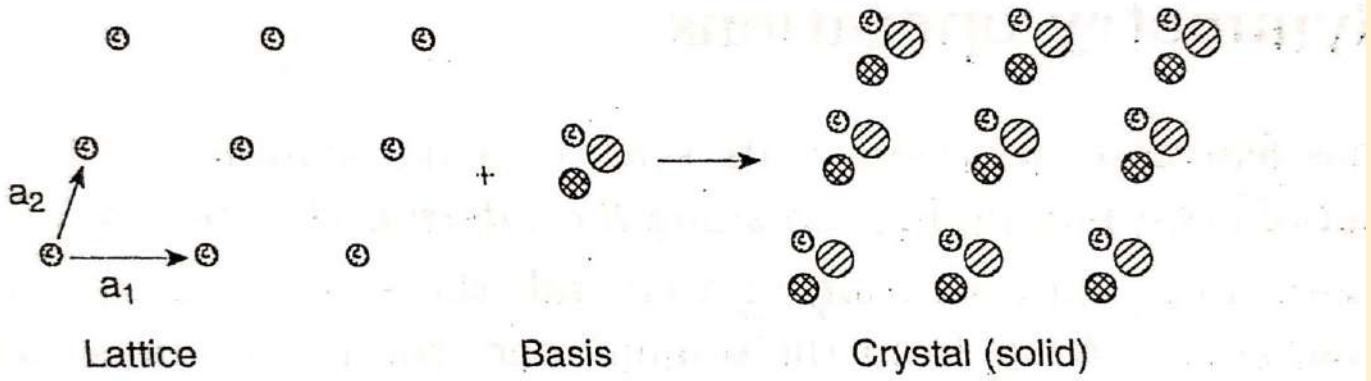


Fig. 1.2 A two-dimensional crystal with a basis of three atoms

$$\therefore \quad Crystal\ structure = Lattice + Basis$$

Crystal=lattice+basis

Lattice:	the underlying periodicity of the crystal,
Basis:	atom or group of atoms associated with each lattice points
Lattice:	how to repeat
Motif:	what to repeat

CLEAR YOUR IDEA MORE

https://youtu.be/BjVTdZ_htu8

https://youtu.be/RjlKTkfQOng

Assignment

1. What is the difference between a crystalline and an amorphous solid?
(Gauhati and Calcutta Hons.)

2. Define the single crystal, Bravais lattice and the unit cell.

3. Define crystal lattice, plane lattice, space lattice, basis, unit cell and translational vectors.
(Guru Nanak and Lucknow Univ.)