

1.4 Crystal Lattices and Unit Cells

The main characteristic of crystalline solids is a regular and repeating pattern of constituent particles. If the three dimensional arrangement of constituent particles in a crystal is represented diagrammatically, in which each particle is depicted as a point, the arrangement is called *crystal lattice*. Thus, a regular three dimensional arrangement of points in space is called a **crystal lattice**. A portion of a crystal lattice is shown in Fig. 1.5.

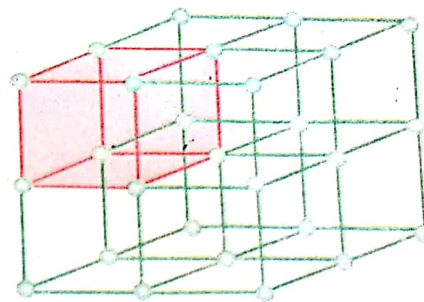


Fig. 1.5: A portion of a three dimensional cubic lattice and its unit cell.

There are only 14 possible three dimensional lattices. These are called **Bravais Lattices** (after the French mathematician who first described them). The following are the characteristics of a crystal lattice:

- Each point in a lattice is called lattice point or lattice site.
- Each point in a crystal lattice represents one constituent particle which may be an atom, a molecule (group of atoms) or an ion.
- Lattice points are joined by straight lines to bring out the geometry of the lattice.

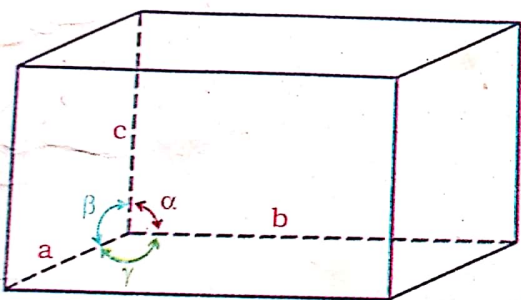


Fig. 1.6: Illustration of parameters of a unit cell

Unit cell is the smallest portion of a crystal lattice which, when repeated in different directions, generates the entire lattice.

A unit cell is characterised by:

- its dimensions along the three edges, a , b and c . These edges may or may not be mutually perpendicular.
- angles between the edges, α (between b and c) β (between a and c) and γ (between a and b). Thus, a unit cell is characterised by six parameters, a , b , c , α , β and γ . These parameters of a typical unit cell are shown in Fig. 1.6.

Unit cells

| 2 Types

Primitive
When constituent particles are present only on the corner positions of a unit cell.

→ Particles present other than corners
| 3 types

Body-centered

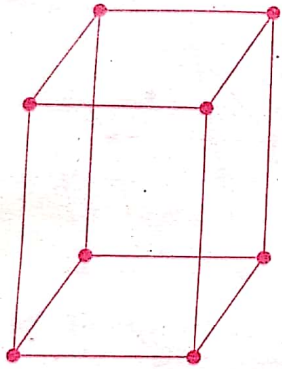
Face centered

Edge centered

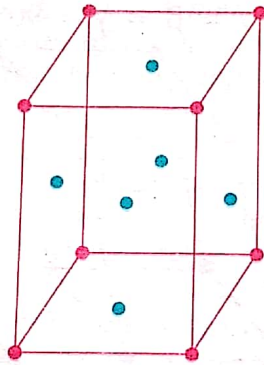
↓
Constituent particles present in corners as well as ~~at~~ one in its body.

↓
Constituent particles present in corners as well as at centre of each face.

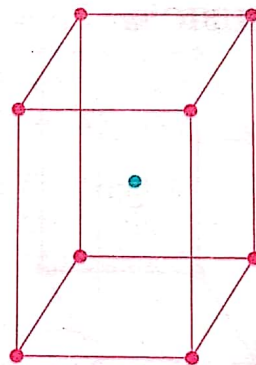
↓
Constituent particles present in corners as well as centre of any two opposite faces.



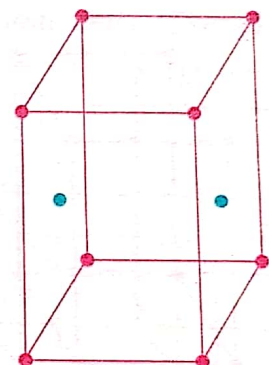
Simple or Primitive
unit cell



Face centred
unit cell



Body centred
unit cell



End centred
unit cell

FIGURE 1.7. Primitive and non-primitive (or centred) unit cells.