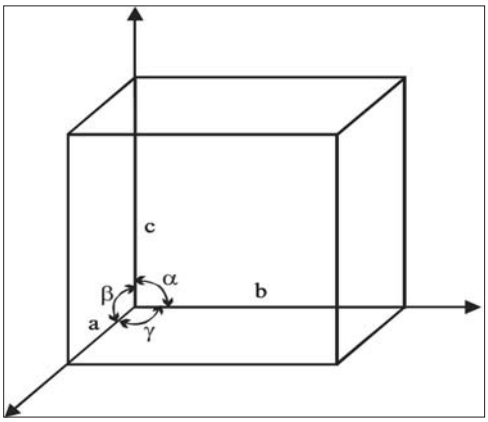
UNIT CELLS AND CRYSTAL LATTICES

Unit Cell (U.C.)

The unit cell of a crystalline substance is described as the smallest repeating unit that exhibits the complete geometry of the crystalline substance, akin to a brick in a wall. It represents the smallest depiction of the entire crystal. A unit cell is distinguished by the edge lengths a, b, and c along the three edges of the unit cell and the angles α, β, and γ between the pairs of edges bc, ca, and ab, respectively.



Characteristics of a Unit Cell

1. Its dimensions extend along the three edges, a, b, and c, which may or may not be perpendicular to each other.
2. The angles between the edges, a (between b and c), b (between a and c), and γ (between a and b).
3. Each unit cell possesses a characteristic relationship between a, b, and c, or a, b, and γ, leading to various types of unit cells

   Thus, a unit cell is characterised by six parameters, a, b, c, a, b, and g. These parameters of a typical unit cell are shown in figure.

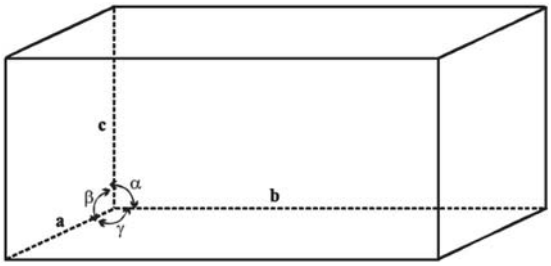


Illustration of parameters of a unit cell

A unit cell can be alternatively described as a three-dimensional arrangement of lattice points in 1D, 2D, or 3D, which generates the entire lattice through repetition or stacking.

Note: Generally, most symmetrical and smallest volume unit cell is selected.

Parallelogram

We can only shift the unit cell parallel not rotate it.

(i) Square unit cell → a = b, g = 90º
(ii) Rectangle unit cell → a ¹ b, g = 90º
(iii) Hexagonal unit cell → a = b, g = 60º
(iv) Rhombic unit cell → a = b, g ¹ 90º & g ¹ 60º
(v) Parallelogram → a ¹ b, g ¹ 90º

Types of Unit Cell

Type of Unit Cell (Bravais Lattice)

The distance between consecutive lattice planes of the same type is referred to as the spacing of planes or the interplanar distance.

The lattices may be divided in following classes:

- Simple/Primitive/Basic Unit cell
- Body centered cubic (b.c.c.) cell
- Face centered cubic (f.c.c.) cell
- End Centered Unit Cell