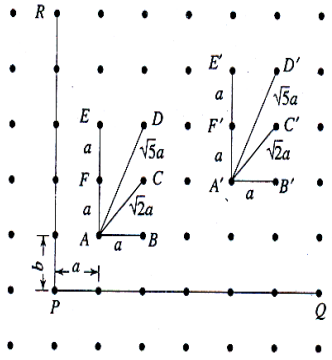
Single Crystals; unit cell, crystal systems

- **SPACE LATTICE**

- A lattice is a regular and periodic arrangement of points in three dimensions.
- It is defined as an infinite array of points in three dimensions in which every point hassurroundings identical to that of every other point in the array.
- The Space lattice is otherwise called the Crystal lattice



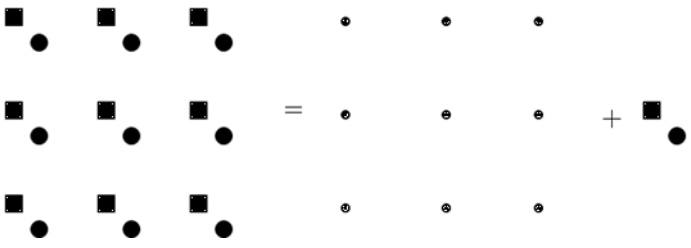
- Consider the points P, Q and R.
- Let us join the points P and Q by a straight line, and the point P and R by anotherstraight line.
- The line PQ is taken as X-axis and the line PR is taken as Y-axis.
- The distance between any two successive lattice points in the X-direction is taken as `a'.
- Similarly, the distance between any two successive lattice points along the Y-direction istaken as 'b'.
- Here a and b are said to be lattice translational vectors. Consider a square lattice inwhich a=b.
- Consider two sets of points A, B, C, D, E, F and A′, B′, C′, D′, E′, F′.
- In these two sets, the surrounding environment looks symmetrical; i.e. the distances ABand A′B′, AC and A′C′, AD and A′D′, AE and A′E′ and AF and A′F′ are equal.
- Therefore, in the arrangement of points, if the surrounding environment looks the samewhen the arrangement is viewed from different lattice points, then that arrangement is said to be a space lattice.

- **BASIS:**

- A crystal structure is formed by associating every lattice point with an unit assembly of atoms or molecules identical in composition, arrangement and orientation. This unitassembly is called the ***`basis'***.

When the basis is repeated with correct periodicity in all directions, it gives the actualcrystal structure. The crystal structure is real, while the lattice is imaginary.

CRYSTAL STRUCTURE



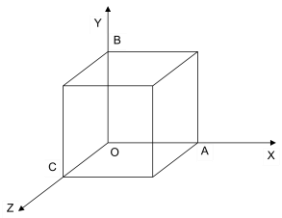
Crystal structure = Lattice + Basis

UNIT CELL

A unit cell is defined as a fundamental building block of a crystal structure, which can generate the complete crystal by repeating its own dimensions in various directions.

CRYSTALLOGRAPHIC AXES:

- Consider a unit cell consisting of three mutually perpendicular edges OA, OB and OC asshown in figure.
- Draw parallel lines along the three edges.
- These lines are taken as crystallographic axes and they are denoted as X, Y and Z axes.



LATTICE PARAMETERS

- Consider the unit cell as shown in figure. Let OA, OB and OC are the intercepts made bythe unit cell along X, Y and Z axes respectively.
- These intercepts are known as ***primitives***. In crystallography the intercepts OA, OB andOC are represented as a, b and c.
- The angle between X and Y axes is represented as γ.
- Similarly the angles between Y and Z and Z and X axes are denoted by ′α′ and ′β′ respectively as shown in the above figure. These anglesα, β and γ are called as interaxial***angles or interfacial angles***.
- To represent a lattice, the three interfacial angles and their corresponding intercepts areessential. These six parameters are said to be ***lattice parameters***.

PRIMITIVE CELL:

- It is the smallest unit cell in volume constructed by primitives. It consists of only one fullatom

A primitive cell is one, which has got the points or atoms only at the corners of the unit cell.If a unit cell consists of more than one atom, then it is not a primitive cell.

Example for primitive cell: Simple Cubic unit cell. Examples for non-primitive cell: BCC and FCC unit cell.

CRYSTALS SYSTEMS:

- A three dimensional space lattice is generated by repeated translation of threetranslational vectors a, b and c.
- Crystals are grouped under seven systems on the basis of the shape of the unit cell.
- The seven crystal systems are distinguished from one another by their lattice parameters.The seven systems are,

1. Cubic 2. Tetragonal 3. Orthorhombic 4.Trigonal (rhombohedral) 5. Hexagonal 6.Monoclinic and 7. Triclinic

The space lattices formed by unit cells are marked by the following

- symbols. Primitive lattice: P → having lattice points only at the corners of the unit cell.
- Body centred lattice: I → having lattice points at the corners as well as at the body centre ofthe unit cell.
- Face centred lattice: F → having lattice points at the corners as well as at the face centres ofthe unit cell.
- Base centred lattice: C → having lattice points at the corners as well as at the top and bottombase centres of the unit cell.