Dr. Madhukarrao Wasnik P.W.S College Of Arts, Commerce And Science, Nagpur

Subject : Physics

B.Sc. – Second Year Semester IV
Paper – I

UNIT - 1

Topic : Crystal Structure

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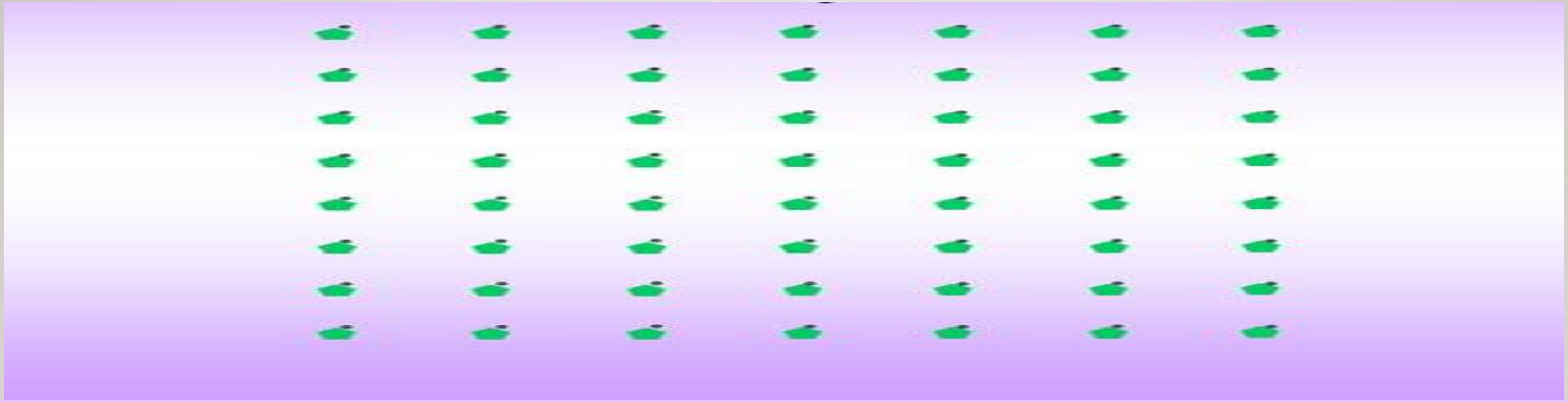
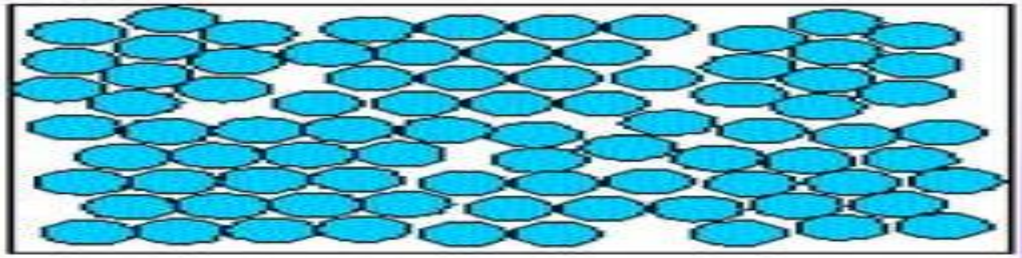
CRYSTAL STRUCTURE



Crystal structure = **Lattice + Basis**

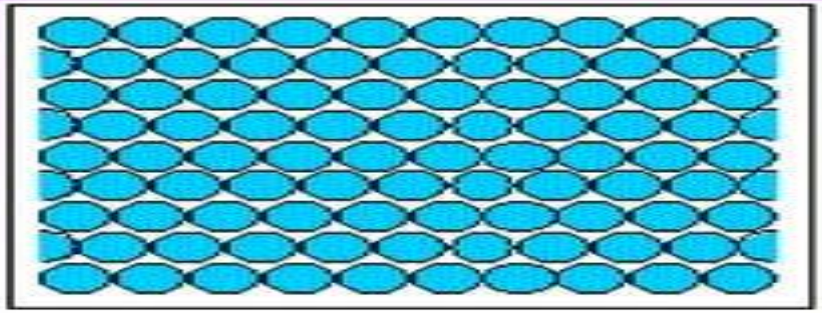
CLASSIFICATION OF CRYSTAL

- Crystals are classified into two types
  1. Poly crystal
  2. Single crystal
- Poly crystal: In this type of crystal periodicity is not maintained throughout the body.



Polycrystal

- Single crystal: In this type of crystal periodicity is maintained throughout the body.



Single crystal

Unit cell:- " Atoms or group of atoms forming a building block of the smallest acceptable size of the whole volume of a crystal is defined as a unit cell ".

Basic Of Crystal Structure

- ***Lattice***:-

  "An infinite periodic array of points in a space "

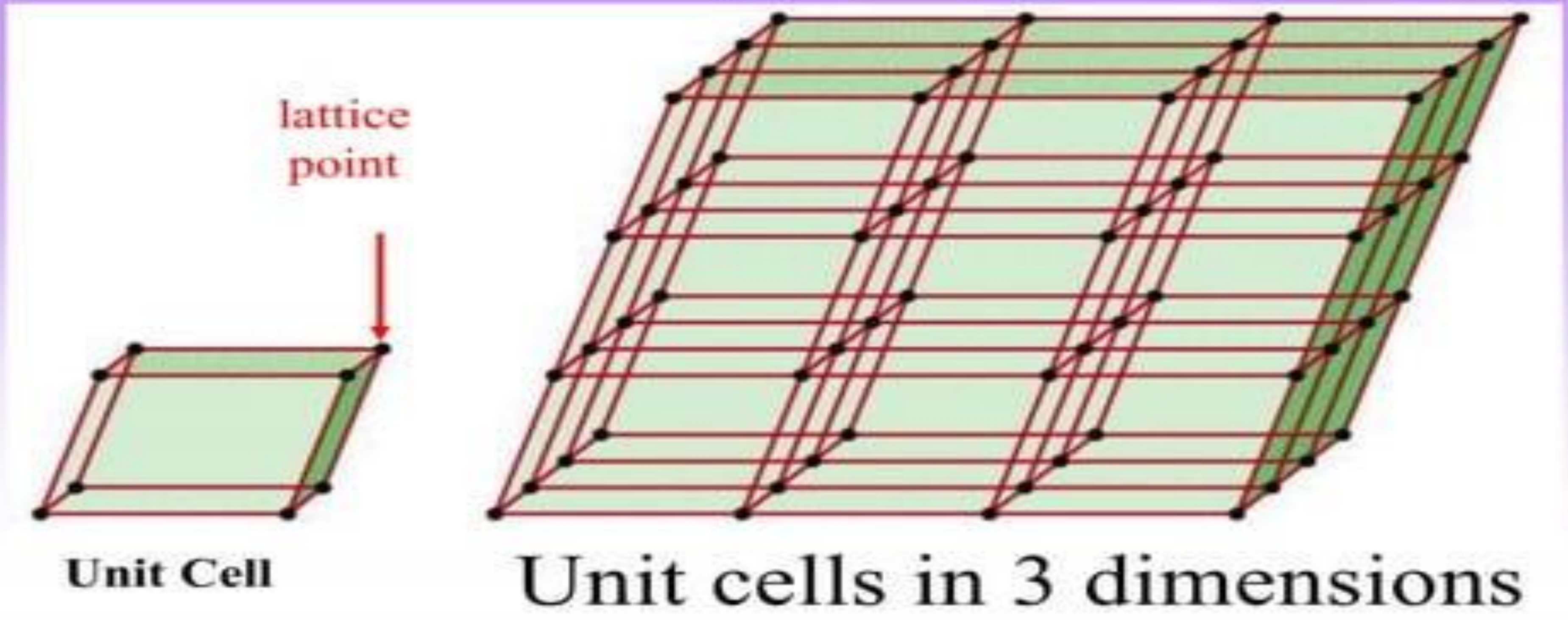
  -The arrangement of points defines the lattice symmetry

  -A lattice may be one, two or three dimensonal

Basis(Motif):-

A group of one or more atoms, located in a particular way with respect to each other and associated with each point, is known as the Motif or Basis.

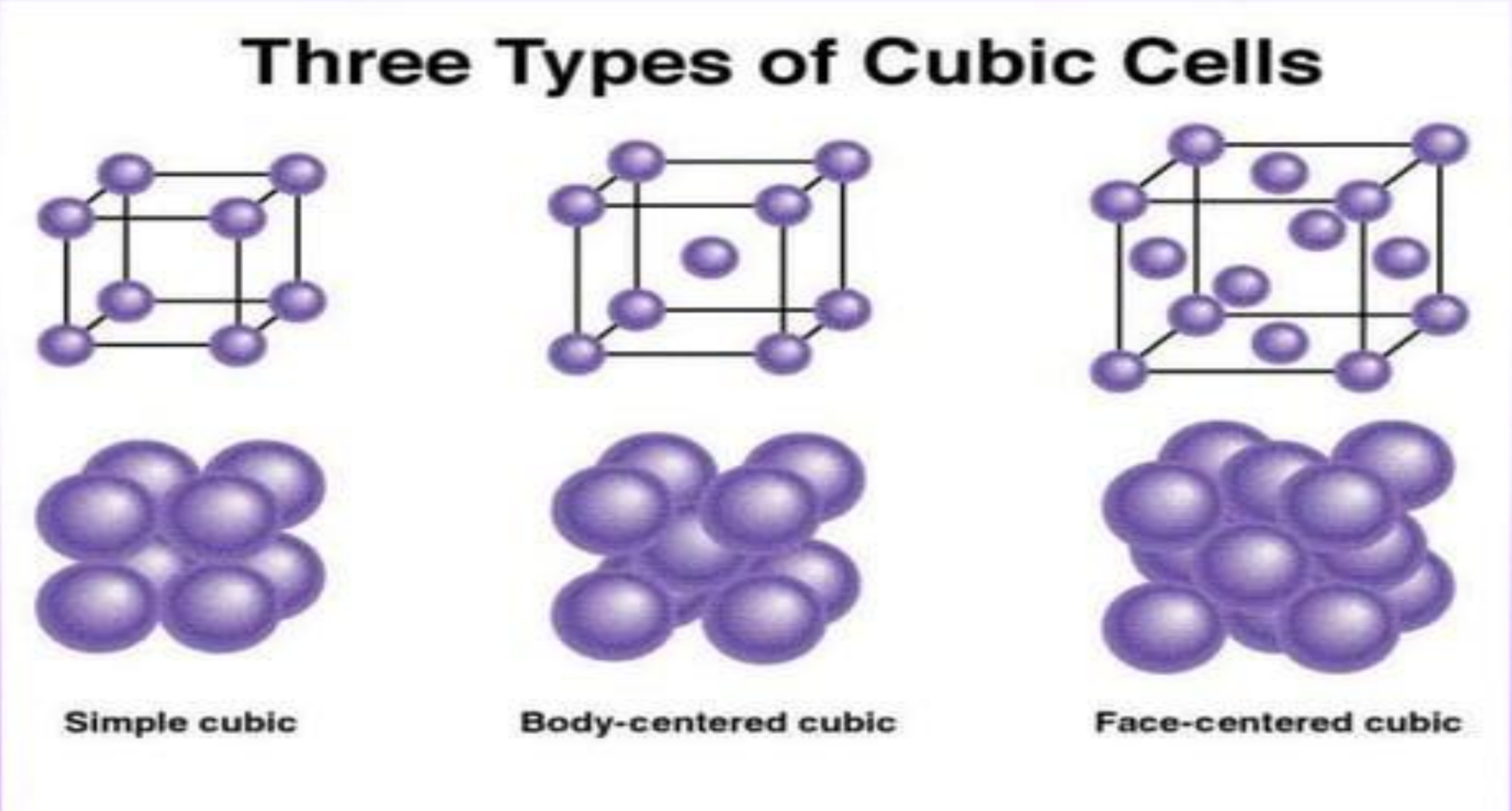
Motif



-By stacking identical unit cells, the entire lattice can be constructed.

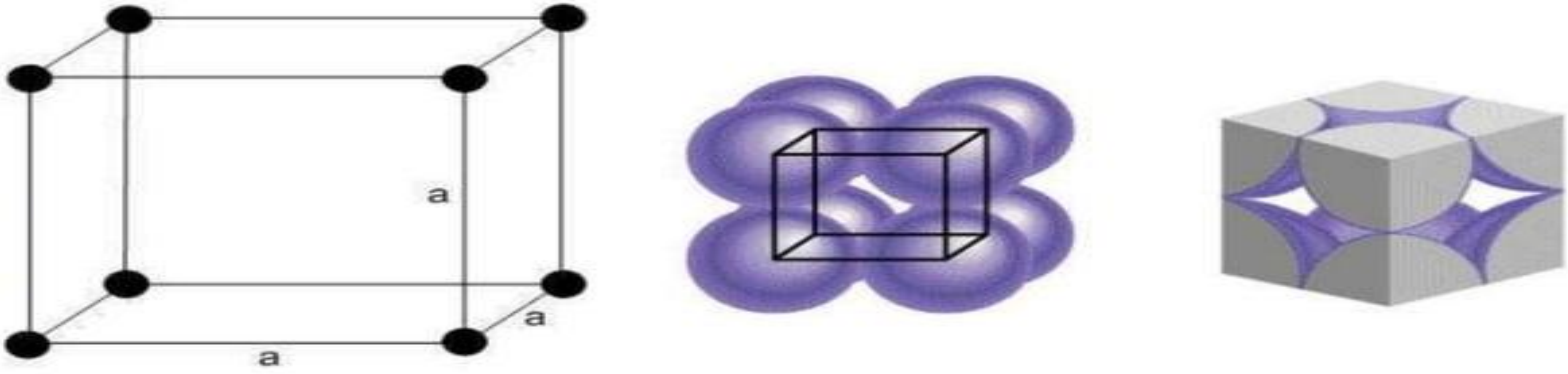
- Lattice points are located at the corner of the unit cell and in some cases, at either faces or the centre of the unit cell.

- Here for the cubic crystal system we have Simple cubic (SC), Face-centred cubic (FCC),and Body-centred cubic(BCC).



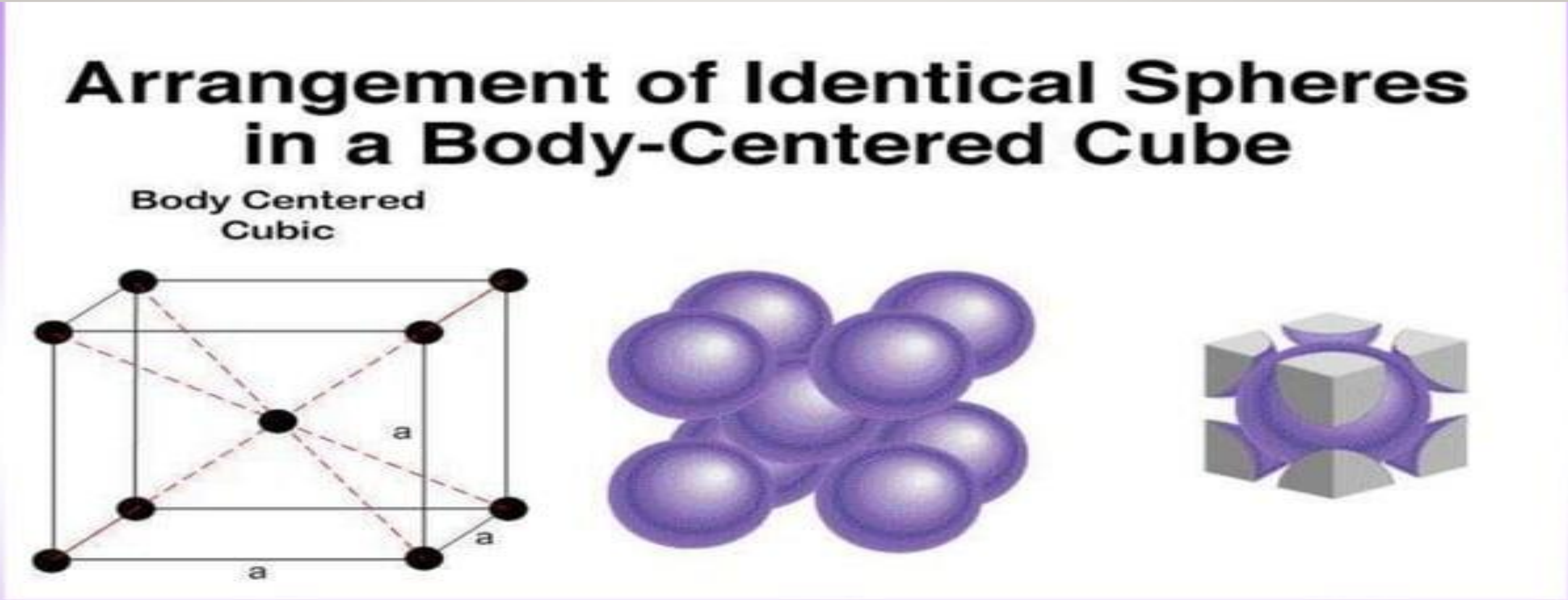
• SIMPLE CUBIC (SC)

Arrangement of Identical Spheres in a simple Cubic Cell



Total no. of atom per simple cubic cell is
$8(1/8) = 1$ atom

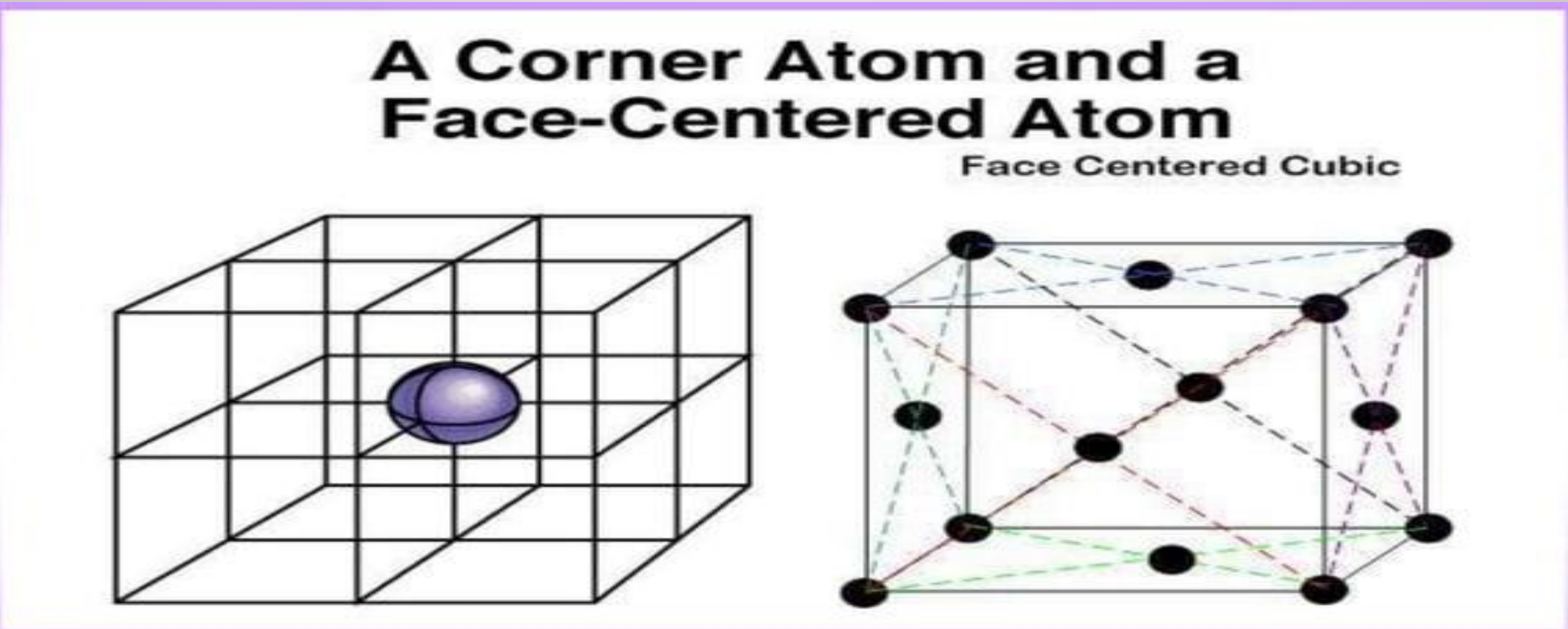
- **BODY CENTERED CUBIC (BCC)**



Total no. of atom per BCC unit cell is

$8(1/8)+1 = 2$ atom

• FACE CENTERED (FCC)

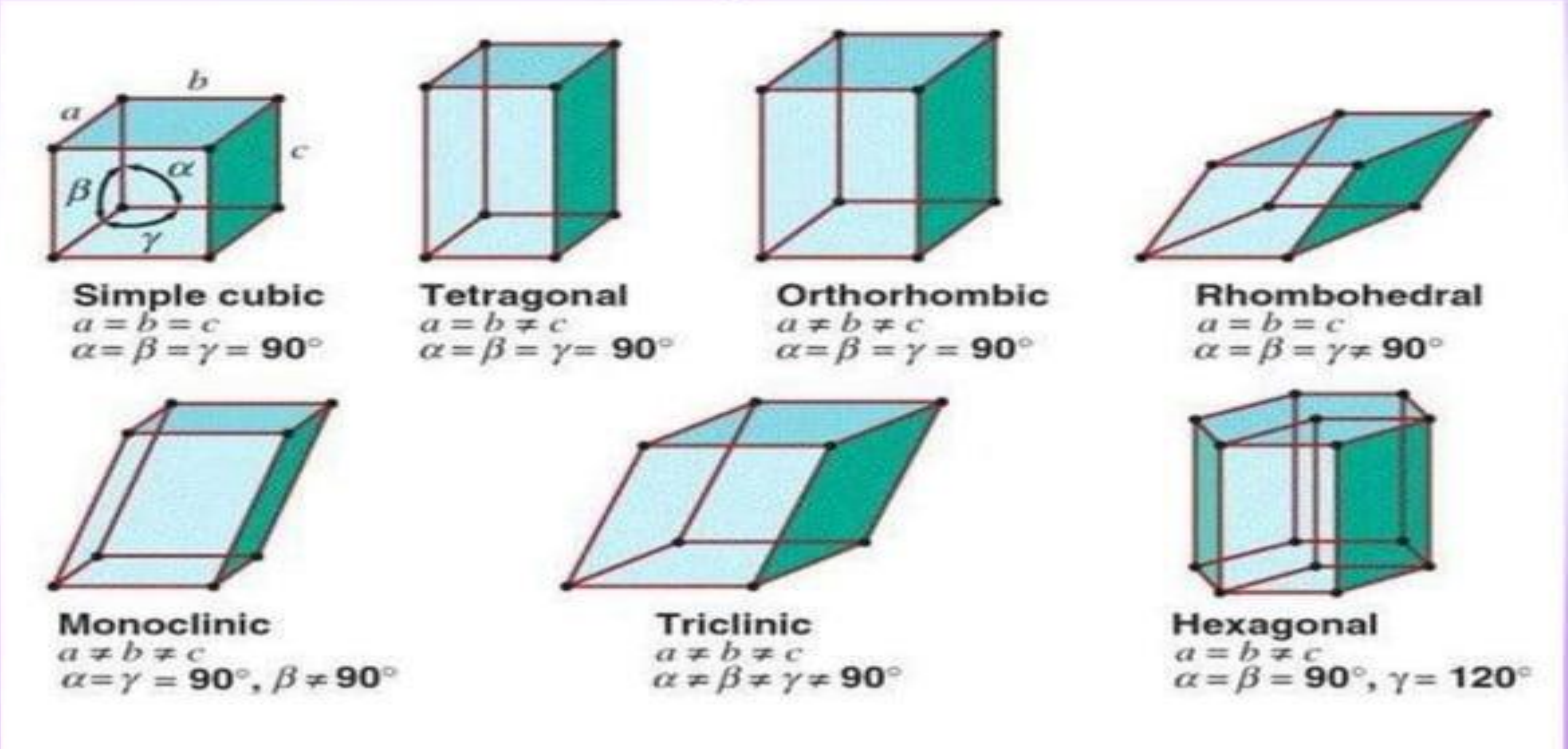


Shared by 8 unit cells

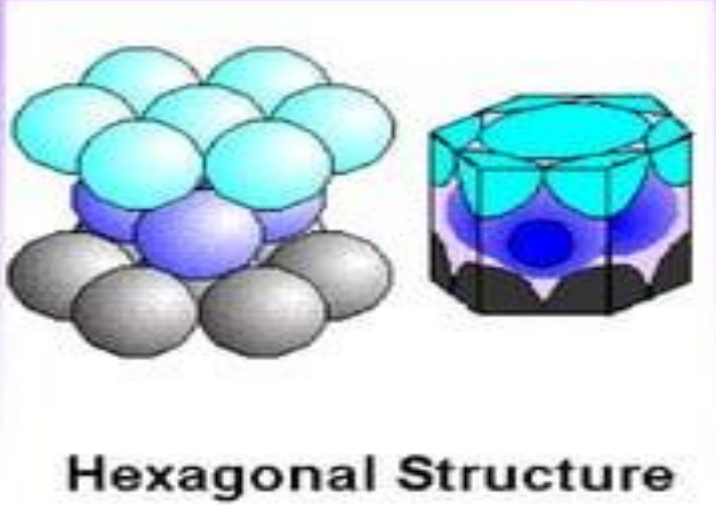
Total no. of atom per FCC unit cell is

$$8(1/8)+6(1/2) = 4 \text{ atom}$$

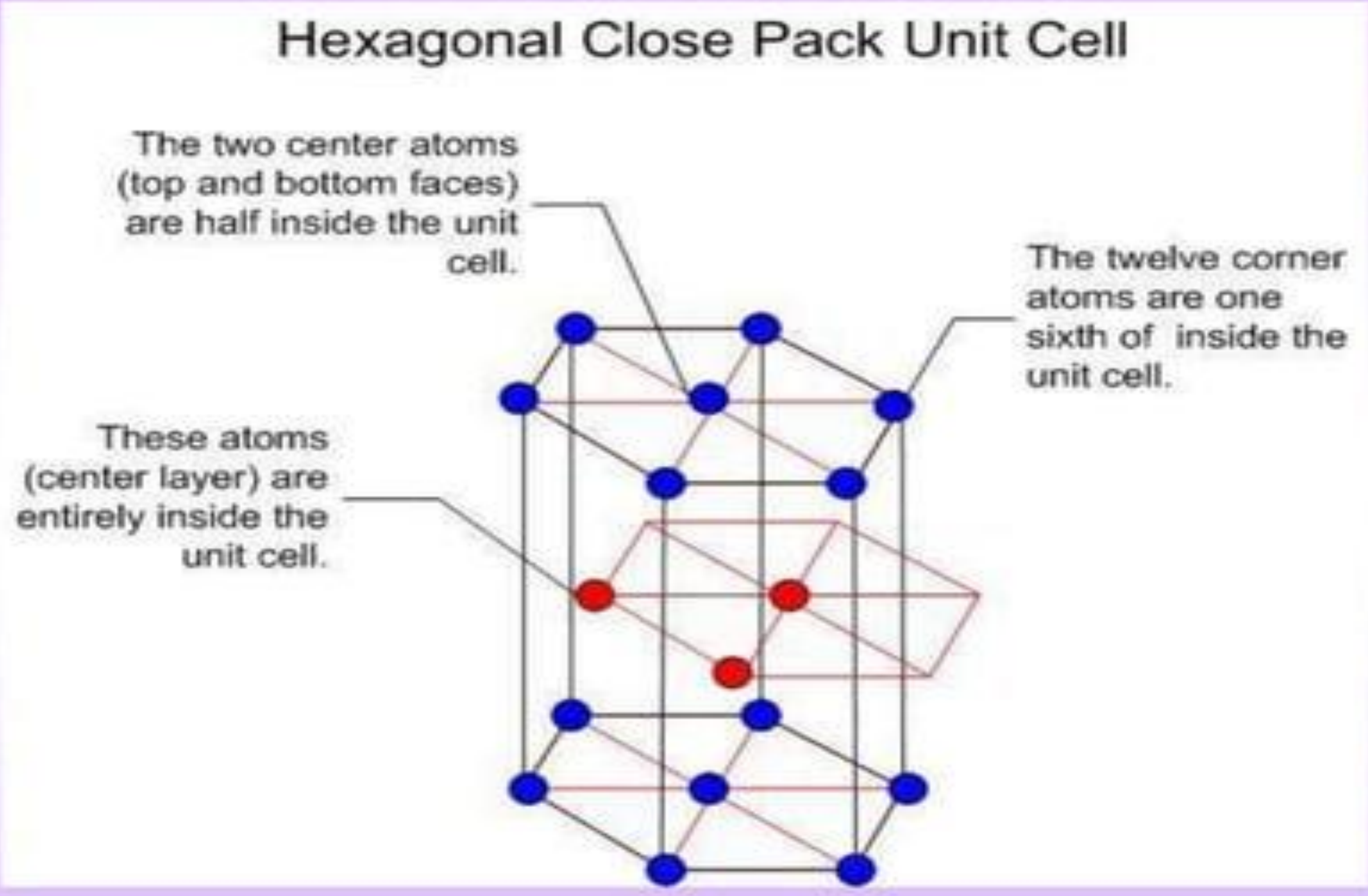
- There are seven unique arrangements ,known as crystal systems, which fill in a three dimensional space.



Hexagonal structure



Quartz is the example of hexagonal close pack solid



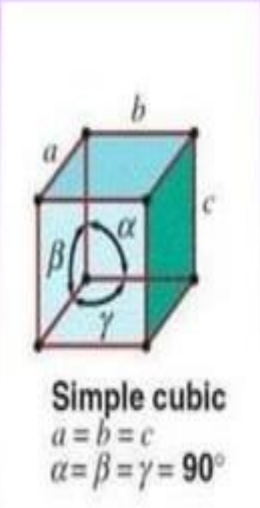
This means that a total of 12(1/6) + 2(1/2) + 3 = 6 atoms are inside the unit cell

THE 7 CRYSTAL SYSTEMS

1. Cubic Crystals

$a = b = c$

$\alpha = \beta = \gamma = 90^o$



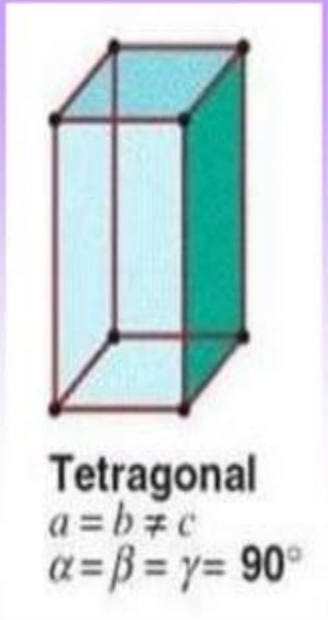
Fluorite
Octahedron

Pyrite
Cube

2. Tetragonal Crystals

$a = b \neq c$

$\alpha = \beta = \gamma = 90^o$

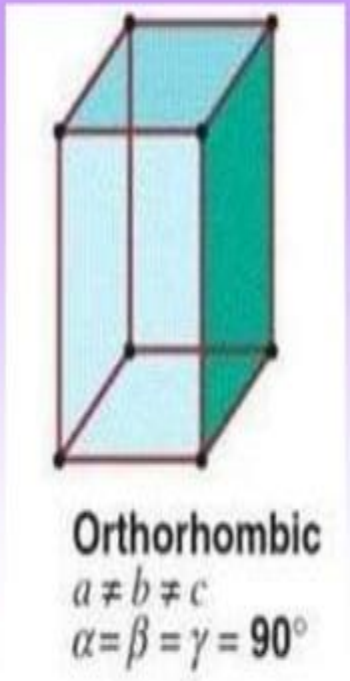


Zircon

3. Orthorhombic Crystals

$a \neq b \neq c$

$\alpha = \beta = \gamma = 90^o$



4. Hexagonal Crystals

$a = b \neq c$

$\alpha = \beta = 90^o \quad \gamma = 120^o$

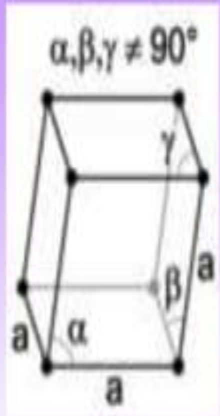
Topaz

Corundum

5. Rhombohedral Crystals

$a = b = c$

$\alpha, \beta, \gamma \neq 90^\circ$

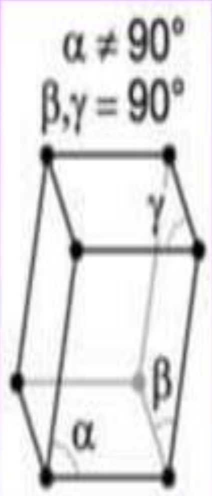



Tourmaline

6. Monoclinic Crystals

$a \neq b \neq c$

$\alpha \neq 90^\circ, \beta, \gamma = 90^\circ$

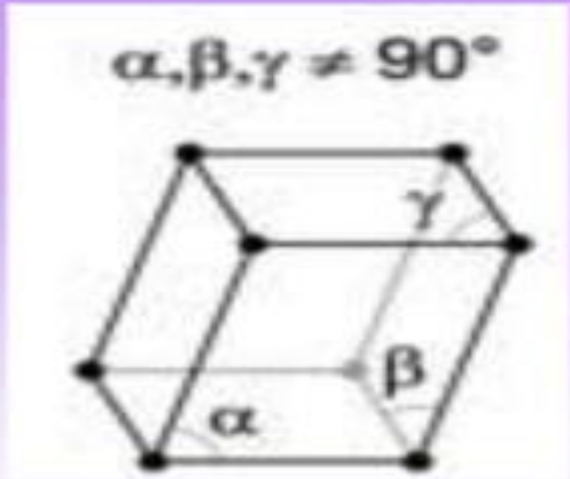


Kunzite

7. Triclinic Crystals

$a \neq b \neq c$

$\alpha \neq \gamma \neq \beta$



Amazonite

No.	Crystal System	Axes	Angles	Examples
1.	Cubic	$a = b = c$	$\alpha = \beta = \gamma = 90^o$	Fe, Cu, NaCl, NaBr, Diamond
2.	Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90^o$	Sn, SnO_2, MnO_2, NH_4Br
3.	Orthorhombic	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^o$	Iodine, KNO_3, Rhombic sulphur
4.	Rhombohedral	$a = b = c$	$\alpha = \beta = \gamma \neq 90^o < 120^o$	Bi, Al_2O_3, $NaNO_3$, KNO_3
5.	Hexagonal	$a = b \neq c$	$\alpha = \beta = 90^o, \gamma = 120^o$	Graphite, ZnO, CdS
6.	Monoclinic	$a \neq b \neq c$	$\alpha = \gamma = 90^o, \beta > 90^o$	Sugar, Sulphur, Borax
7.	Triclinic	$a \neq b \neq c$	$\alpha \neq \beta = \gamma \neq 90^o$	H_3BO_3, $K_2Cr_2O_7$, $CuSO_4.5H_2O$