SNS COLLEGE OF ENGINEERING

Coimbatore-641 107

(An Autonomous Institution)

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Affiliated to Anna University, Chennai

DEPARTMENT OF PHYSICS

COURSE NAME :19PY101-ENGINEERING PHYSICS

I YEAR / I SEMESTER

UNIT 4 – CRYSTAL PHYSICS

TOPIC 2 – BRAVAIS LATTICES, DIRECTIONS AND PLANES IN A CRYSTAL

In a crystal system how to identified bravai’s lattices in different types of crystal system?

Bravai's Lattice

- **Bravai's Lattice** refers to the 14 different 3-dimensional configurations into which atoms can be arranged in crystals.
- There are several ways to describe a lattice.
- The most fundamental description is known as the Bravai's lattice.
- A Bravai's lattice can refer to one of the 14 different types of unit cells that a crystal structure can be made up of.

TYPES OF BRAVAIS LATTICE

- 14 types of Bravais lattices some 7 types of Bravais lattices in three-dimensional space are listed in this subsection.
- Note that the letters a, b, and c have been used to denote the dimensions of the unit cells.
- whereas the letters ***α, β, and γ*** denote the corresponding angles in the unit cells.

1. Cubic Systems

In Bravais lattices with cubic systems, the following relationships can be observed. $a = b = c$, $\boldsymbol{\alpha = \beta = \gamma = 90^{o}}$

The 3 possible types of cubic cells have been illustrated below.

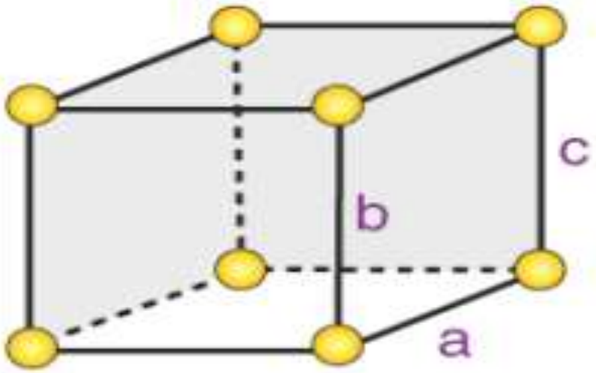
These three possible cubic Bravais lattices are –

Primitive (or Simple) Cubic Cell (P)

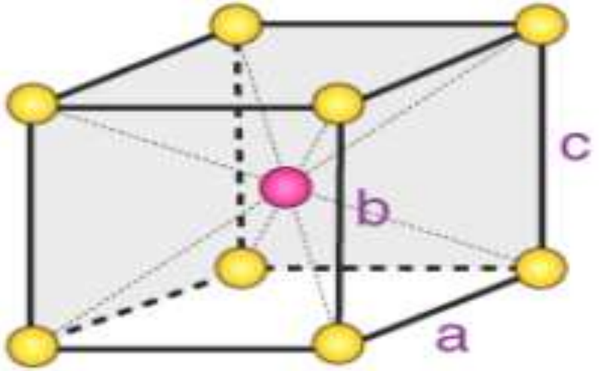
Body-Centered Cubic Cell (I)

Face-Centered Cubic Cell (F)

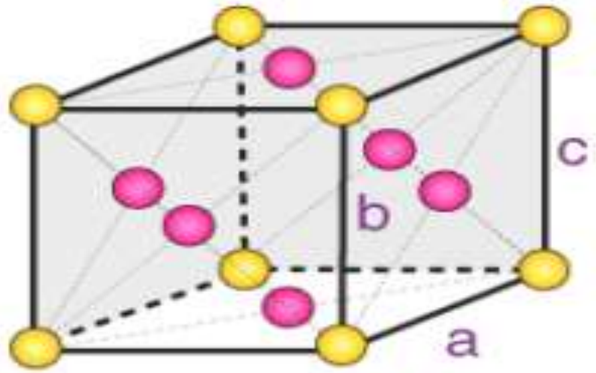
Examples: Polonium has a simple cubic structure, iron has a body-centered cubic structure, and copper has a face-centered cubic structure.



Simple cubic



Body-centred Cubic Unit Cell (BCC)



Face-centred Cubic Unit Cell (FCC)

2. Orthorhombic Systems

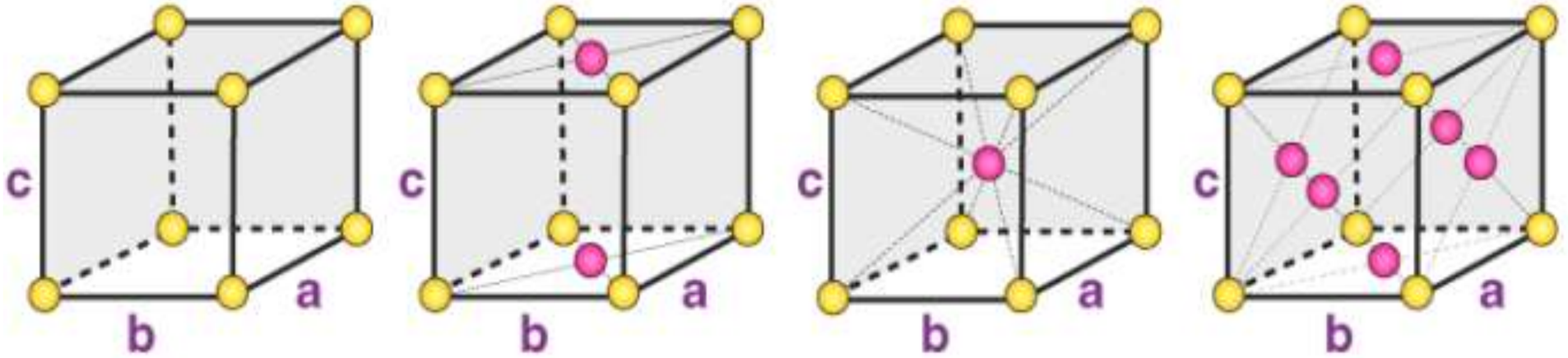
• The Bravais lattices with orthorhombic systems obey the following equations: $a \neq b \neq c$ $\boldsymbol{\alpha = \beta = \gamma = 90^{o}}$

• The four types of orthorhombic systems (***simple, base centered, face-centered, and body-centered orthorhombic cells***)

Examples of Orthorhombic Systems:

• Rhombic Sulphur has a simple orthorhombic structure

• Magnesium sulfate heptahydrate ($MgSO_4.7H_2O$) is made up of a base centred orthorhombic structure.


c
b
a
Simple cubic
Base-centred Cubic Unit Cell
Body-centred Cubic Unit Cell (BCC)
Face-centred Cubic Unit Cell (FCC)

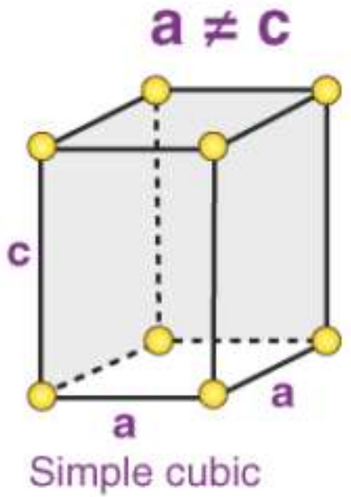
3. Tetragonal Systems

• In tetragonal Bravais lattices, the following relations are observed:

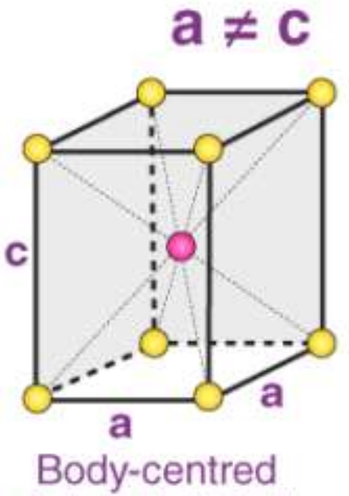
$a = b \neq c \quad \boldsymbol{\alpha = \beta = \gamma = 90^o}$

• The two types of tetragonal systems are ***simple tetragonal cells and body-centered tetragonal cells***,

• Examples of tetragonal Bravais lattices are – stannic oxide (simple tetragonal) and titanium dioxide(body-centered tetragonal)



Simple cubic



Body-centred Cubic Unit Cell

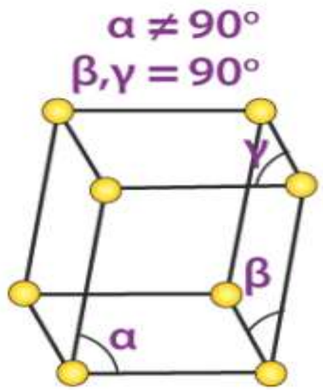
4. Monoclinic Systems

• Bravais lattices having monoclinic systems obey the following relations:

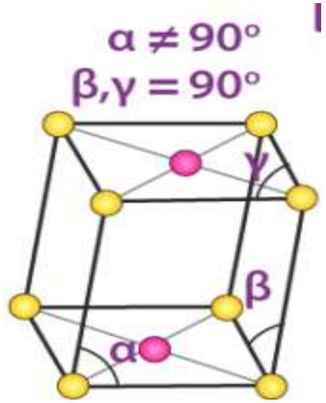
$a \neq b \neq c$ $\quad \boldsymbol{\beta = \gamma = 90^o}$ **and** $\boldsymbol{\alpha \neq 90^o}$

• The two possible types of monoclinic systems are ***primitive and base centered monoclinic cells.***

• Examples: Monoclinic sulphur (simple monoclinic) and sodium sulfate decahydrate (base centered monoclinic)



Centered



Simple

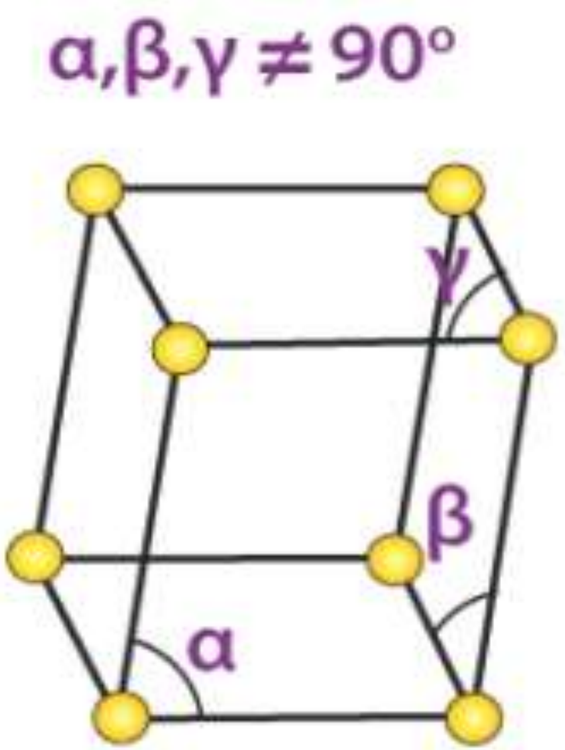
5. Triclinic System

•There exists only one type of triclinic Bravais lattice, which is a ***primitive cell***.

• It obeys the following relationship.

$$a \neq b \neq c \quad \boldsymbol{\alpha \neq \beta \neq \gamma \neq 90^{o}}$$

Example: potassium dichromate

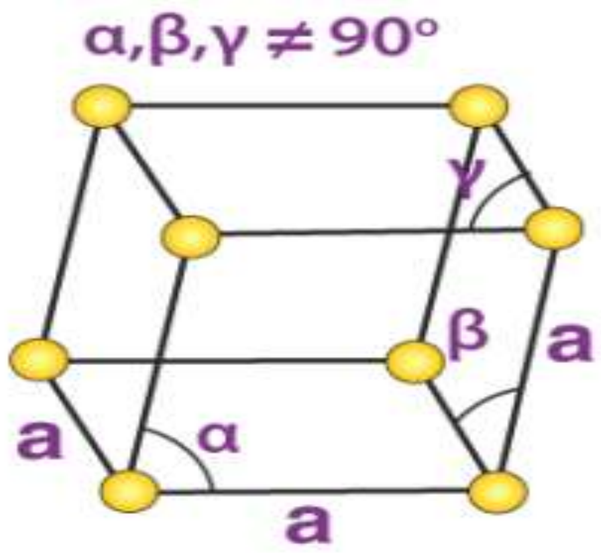


6. Rhombohedral System

• Only the primitive unit cell for a rhombohedral system exists. Its cell relation is given by:

a = b = c $\boldsymbol{\alpha = \beta = \gamma \neq 90^{o}}$

Examples: Calcite and sodium nitrate are made up of simple rhombohedral unit cells.



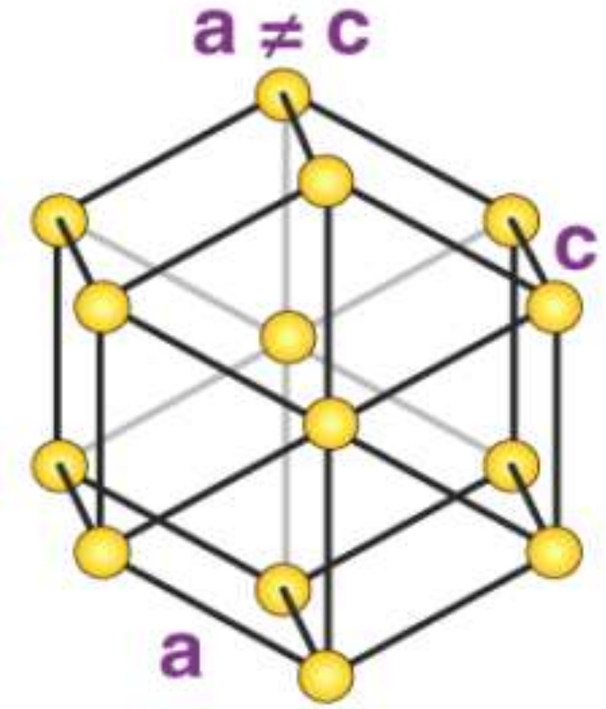
7. Hexagonal System

• The only type of hexagonal Bravais lattice is the ***simple hexagonal cell***.

•It has the following relations between cell sides and angles.

$a = b \neq c$ $\quad \boldsymbol{\alpha = \beta = 90^o \text{ and } \gamma = 120^o}$

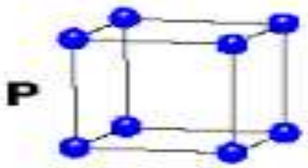
• Examples: Zinc oxide and beryllium oxide are made up o simple hexagonal unit cells.

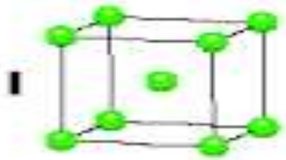


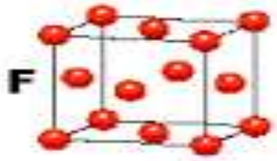
CUBIC

$a = b = c$

$\alpha = \beta = \gamma = 90°$



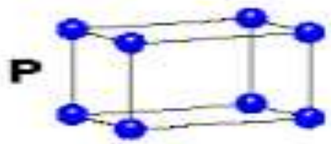


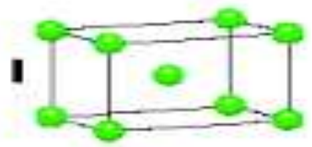


TETRAGONAL

$a = b \neq c$

$\alpha = \beta = \gamma = 90°$

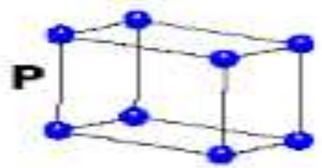


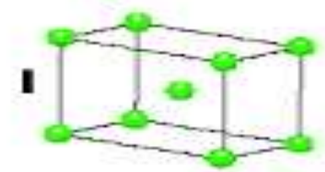


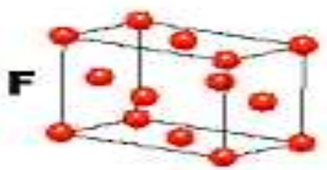
ORTHORHOMBIC

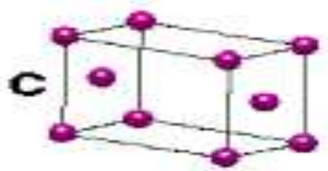
$a \neq b \neq c$

$\alpha = \beta = \gamma = 90°$







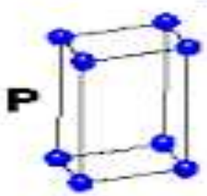


HEXAGONAL

$a = b \neq c$

$\alpha = \beta = 90°$

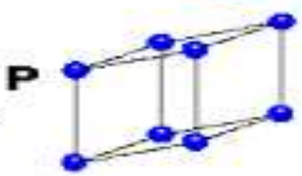
$\gamma = 120°$



TRIGONAL

$a = b = c$

$\alpha = \beta = \gamma \neq 90°$

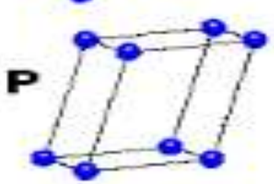


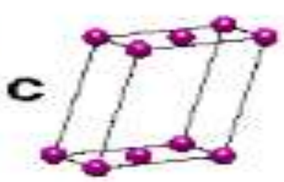
MONOCLINIC

$a \neq b \neq c$

$\alpha = \gamma = 90°$

$\beta \neq 120°$

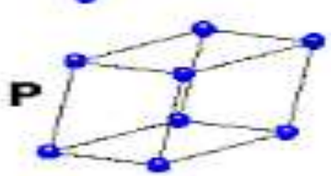




TRICLINIC

$a \neq b \neq c$

$\alpha \neq \beta \neq \gamma \neq 90°$



4 Types of Unit Cell
P = Primitive
I = Body-Centred
F = Face-Centred
C = Side-Centred
+
7 Crystal Classes
→ 14 Bravais Lattices

References

- https://images.app.goo.gl/NrLyFgbjwTcVNcbz7