



# **SNS COLLEGE OF ENGINEERING**

**Coimbatore-641 107**

**( An Autonomous Institution )**

Accredited by NBA & NAAC with 'A' Grade  
Approved by AICTE, New Delhi & Recognized by UGC  
Affiliated to Anna University, Chennai

## **DEPARTMENT OF PHYSICS**

**COURSE NAME :19PY101-ENGINEERING PHYSICS**

**I YEAR / I SEMESTER**

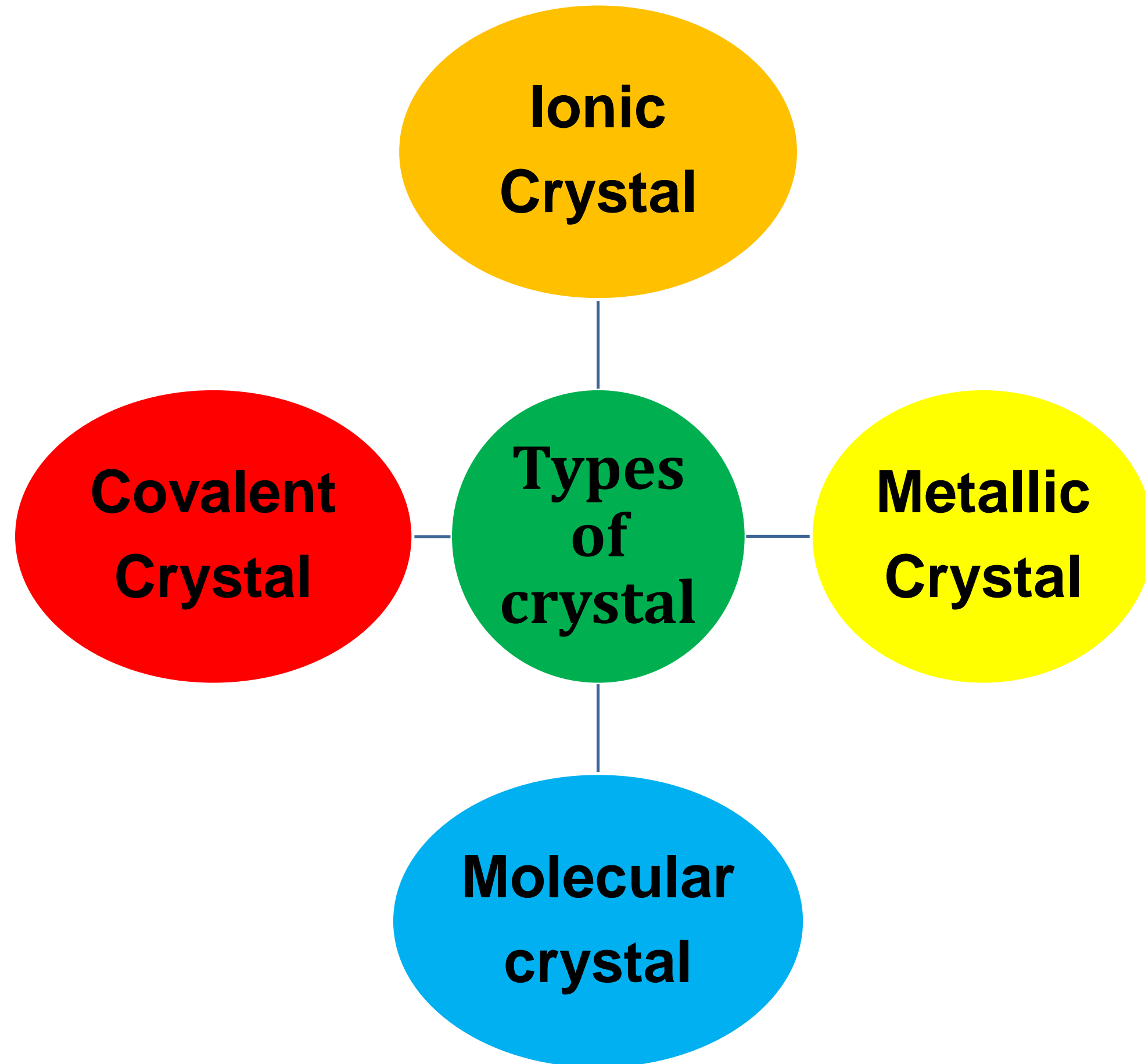
### **UNIT 4 – CRYSTAL PHYSICS**

**TOPIC 1 – INTRODUCTION TO CRYSTALS PHYSICS, SINGLE CRYSTALLINE,  
POLYCRYSTALLINE AND AMORPHOUS MATERIALS,  
SINGLE CRYSTALS: UNIT CELL, CRYSTAL SYSTEMS**



A **crystal** or **crystalline solid** is a solid material whose constituents (such as atoms, molecules, or ions) are arranged in a highly ordered microscopic structure, forming a crystal lattice that extends in all directions.





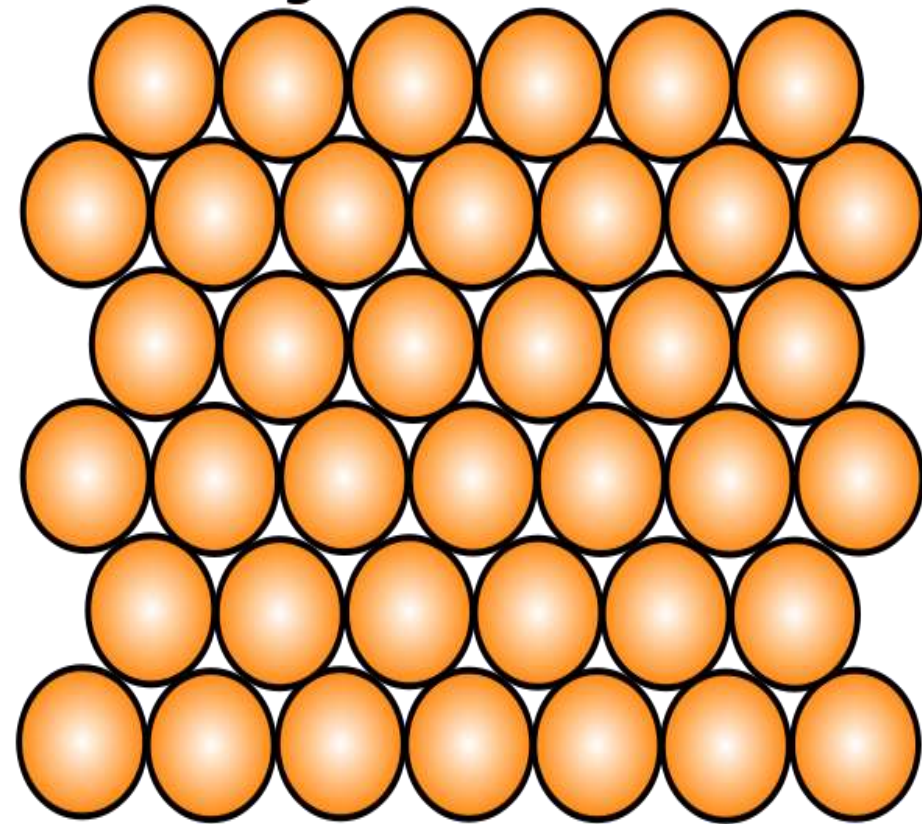


The structures of all crystals can be classified according to the symmetry of the unit cells.

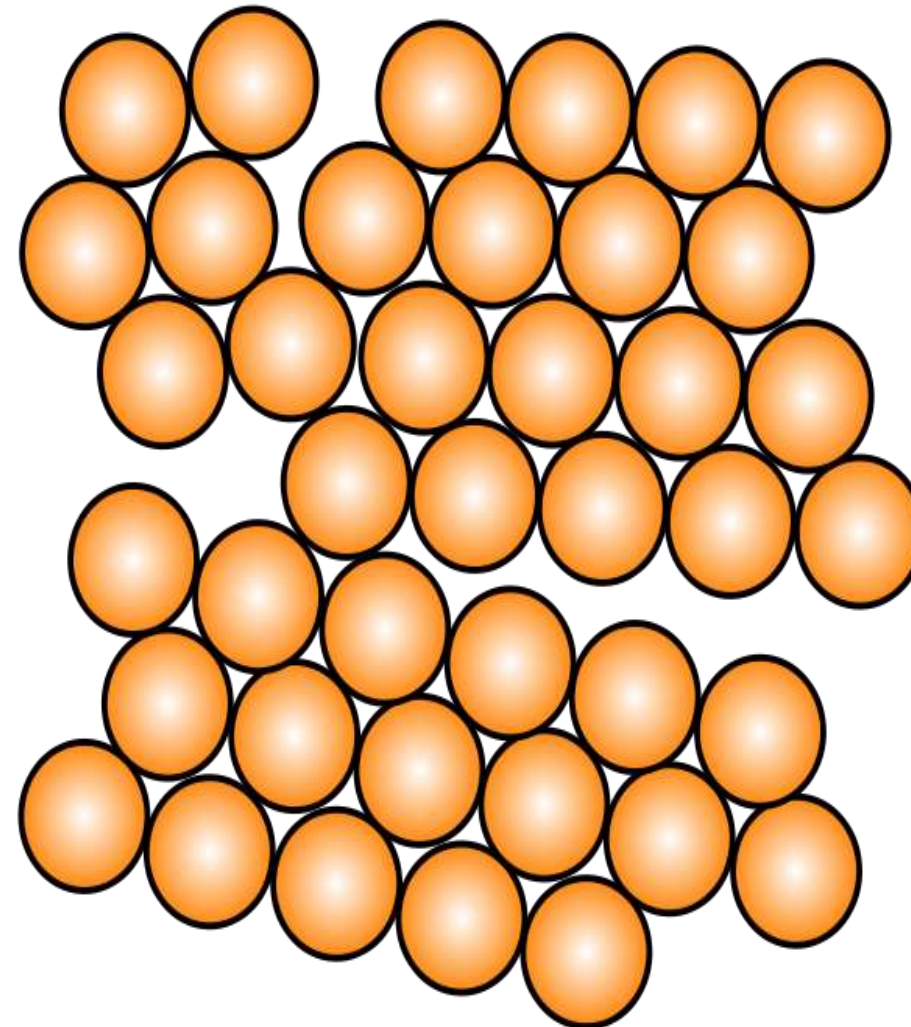
There are in total 7 groups, collectively called Crystal Systems:

1. **Triclinic,**
2. **Monoclinic,**
3. **Orthorhombic,**
4. **Tetragonal,**
5. **Trigonal,**
6. **Hexagonal, and**
7. **Cubic.**

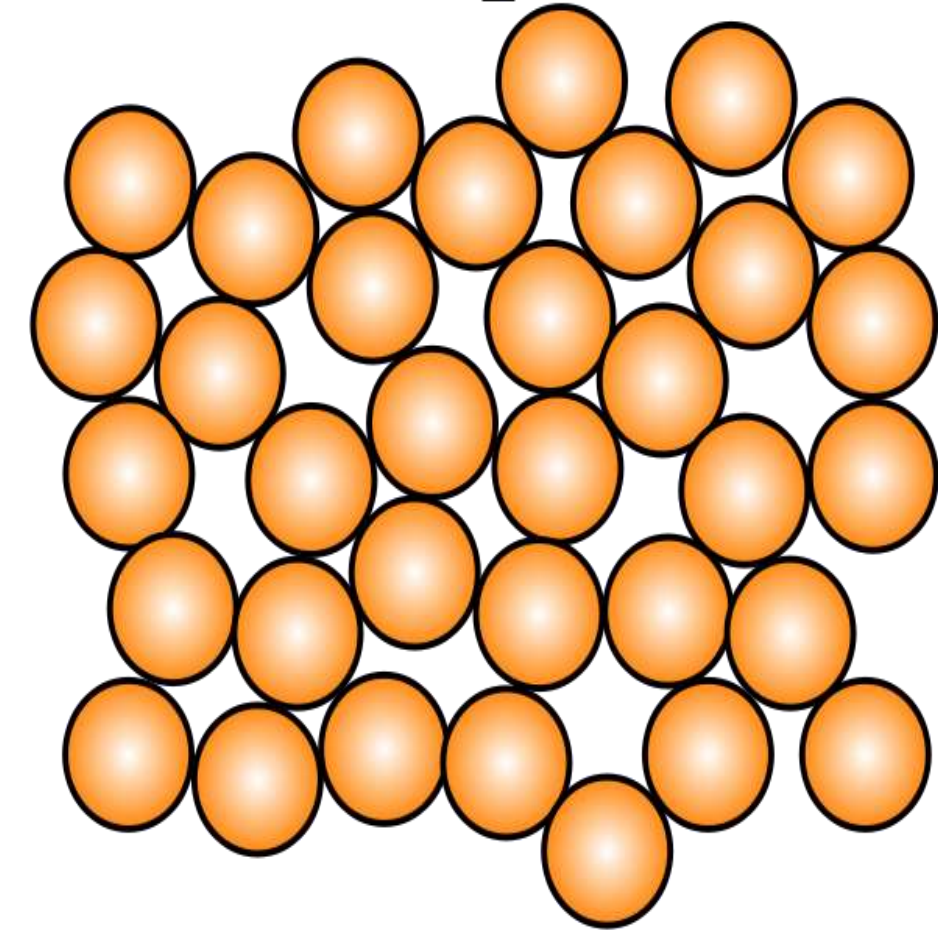
# Crystalline



# Polycrystalline



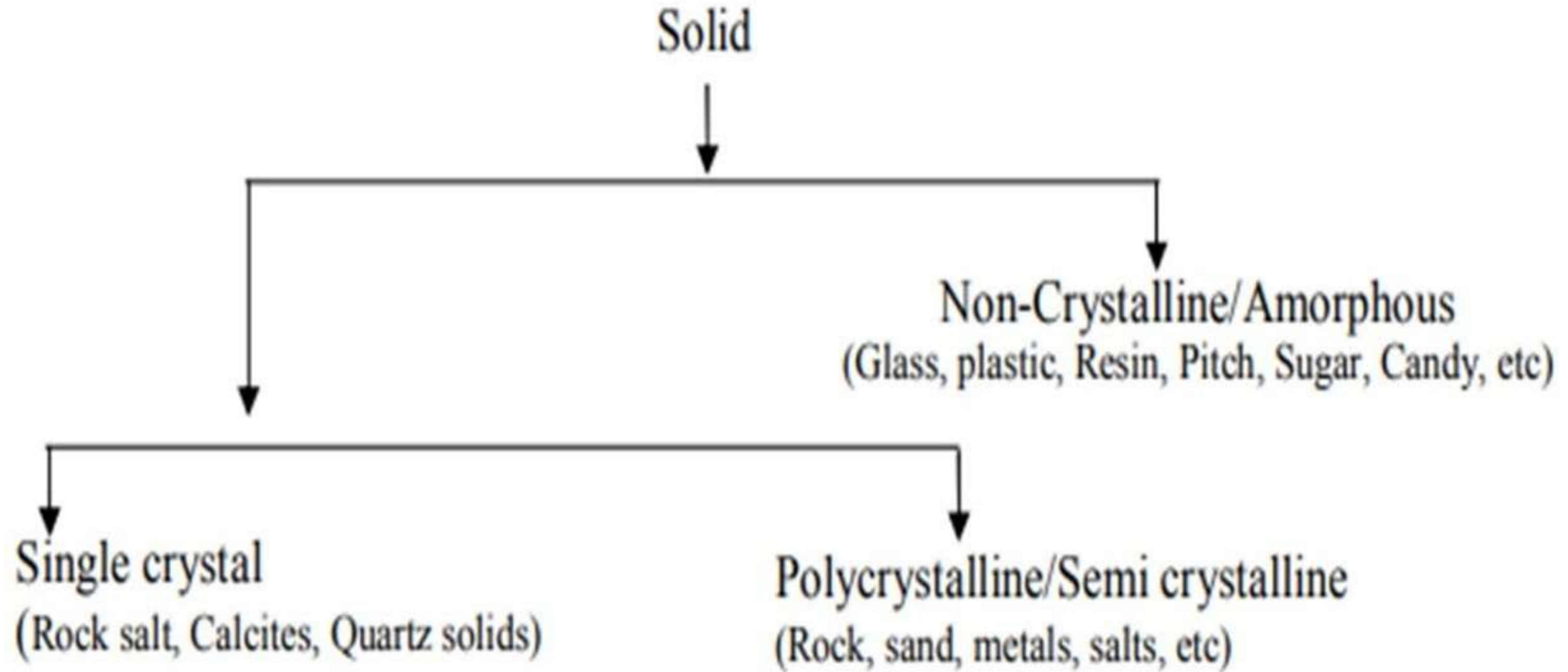
# Amorphous





# Differences between crystalline and non-crystalline solids

Characteristic	Crystalline	Non-crystalline
Atomic arrangements	Regular and orderly manner in all three dimensions	Irregular
Fracture mechanism	Ductile manner. Solids behave elastically up to their yield points	Brittle manner. Solids do not behave elastically
Tensile strength	High	Low
Dislocation defects	Possible	Not possible





# SINGLE CRYSTALS AND POLYCRYSTALLINE MATERIALS



Crystal:

- Single crystal

The whole piece (or body) of material has the same crystal structure and orientation.

- Polycrystalline

made up of a number of crystals (small single) with **identical structures** but **different orientations**.

**grains** : small (single) crystals  $0.5 - 50 \mu\text{m}$ .

**Grain boundaries** : internal surfaces of finite thickness where crystals of different orientations meet.





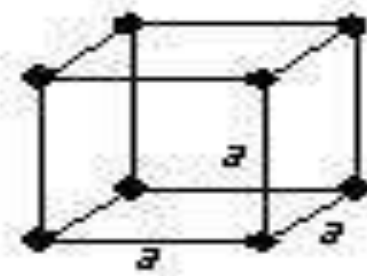
# Assignment



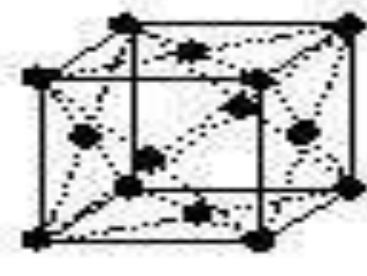
1. What are crystal names?

2. What are common crystals?

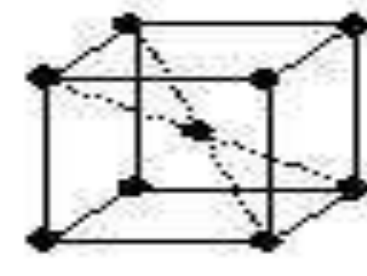




Simple

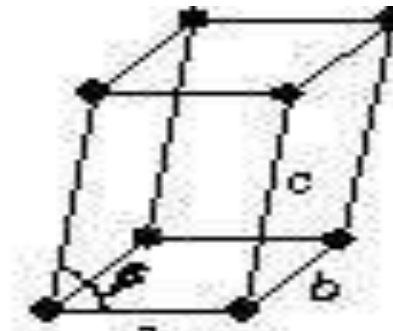


Face-centered

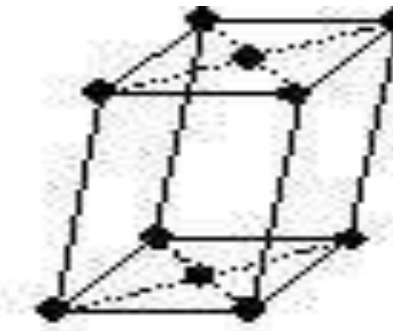


Body-centered

CUBIC

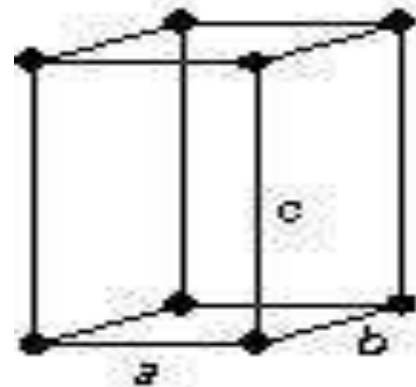


Simple

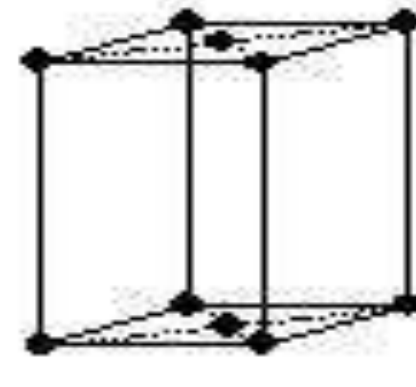


End face-centered

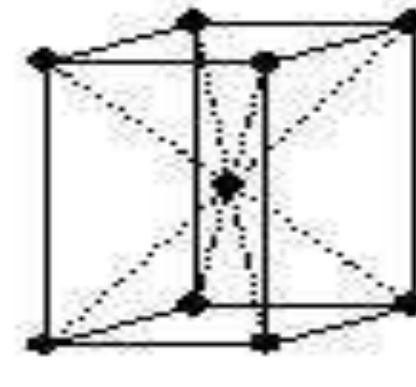
MONOCLINIC



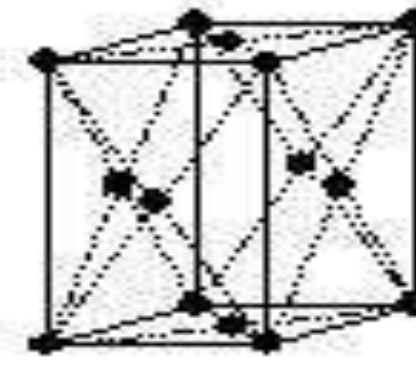
Simple



End face-centered

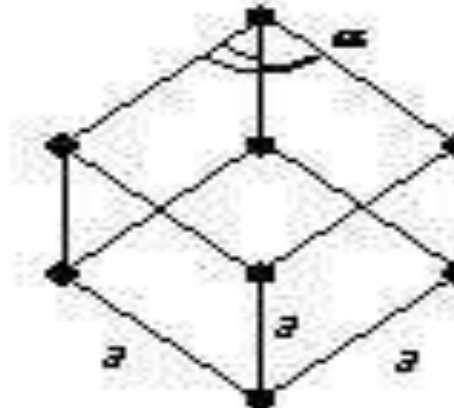


Body-centered

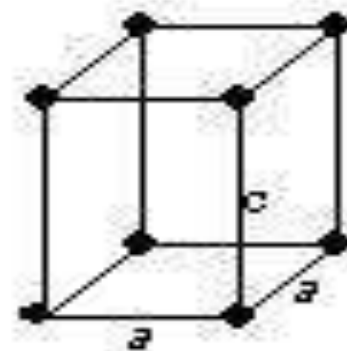


Face-centered

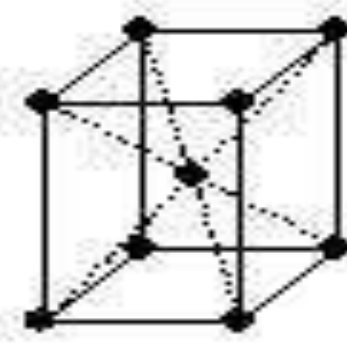
ORTHORHOMBIC



RHOMBOHEDRAL

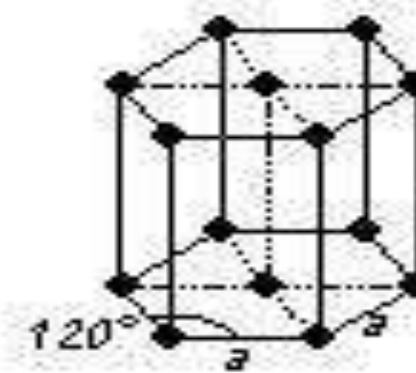


Simple

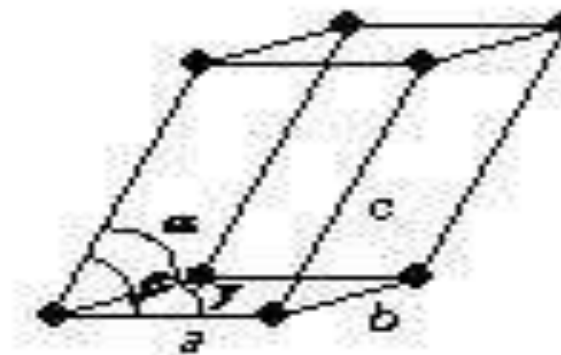


Body-centered

TETRAGONAL



HEXAGONAL



TRICLINIC

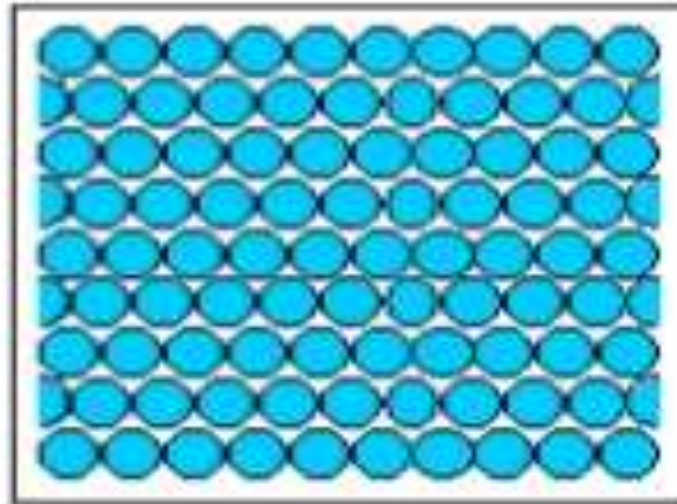


## Think it

1. What is unit cell?
2. How we have changed the crystal system?

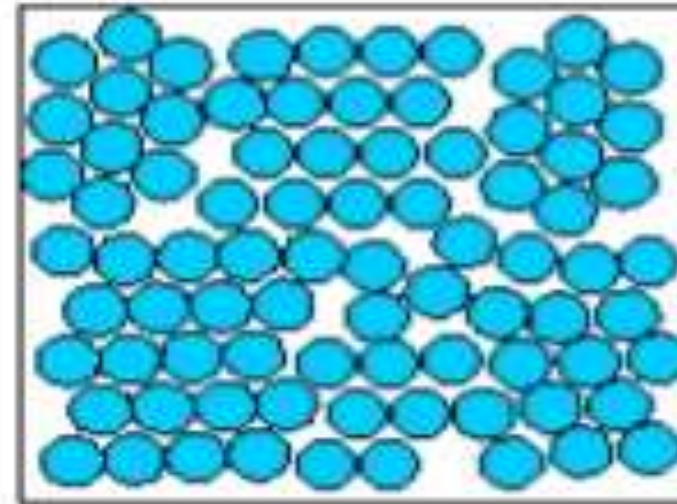


# Single & Polycrystal materials



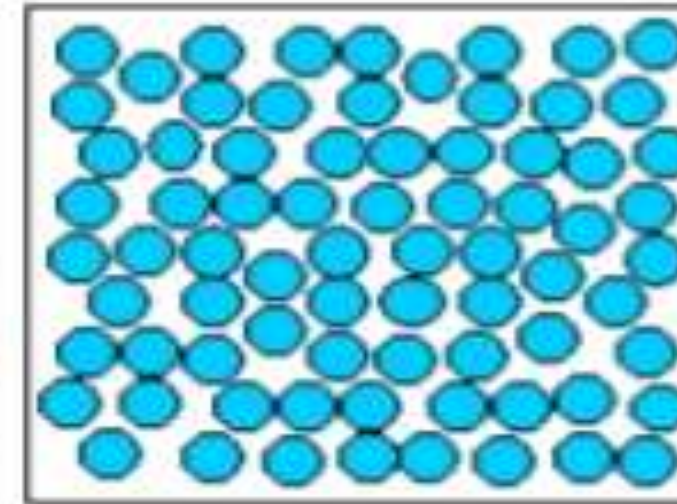
Single crystal

Periodic across the whole volume.



Polycrystal

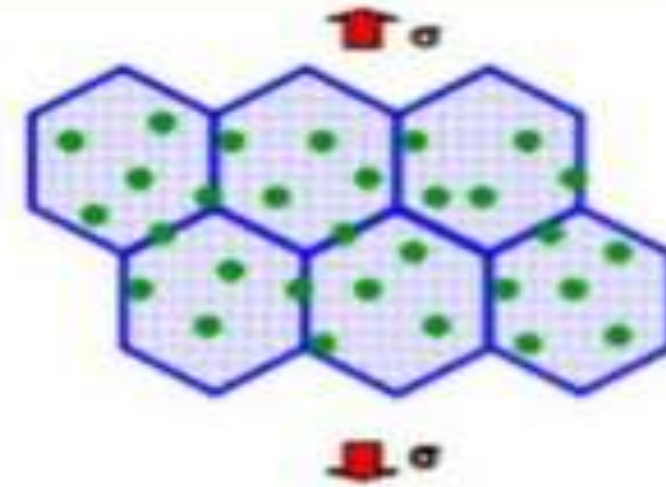
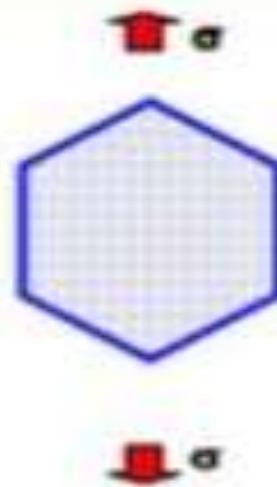
Periodic across each grain.



Amorphous solid

Not periodic.

## Single crystal | Poly crystalline



Polycrystalline: Macroscopically homogeneous, microscopically heterogeneous

Multiple grain boundaries and second phase particles present in polycrystalline materials.

It is easier to study plastic deformation in a single crystal to eliminate the effects of grain boundaries and second phase particles



# SINGLE CRYSTALS UNIT CELL

A **single crystal** is defined as a **crystal** consisting of a non interrupted repetition of the **unit cell** in three dimensions.

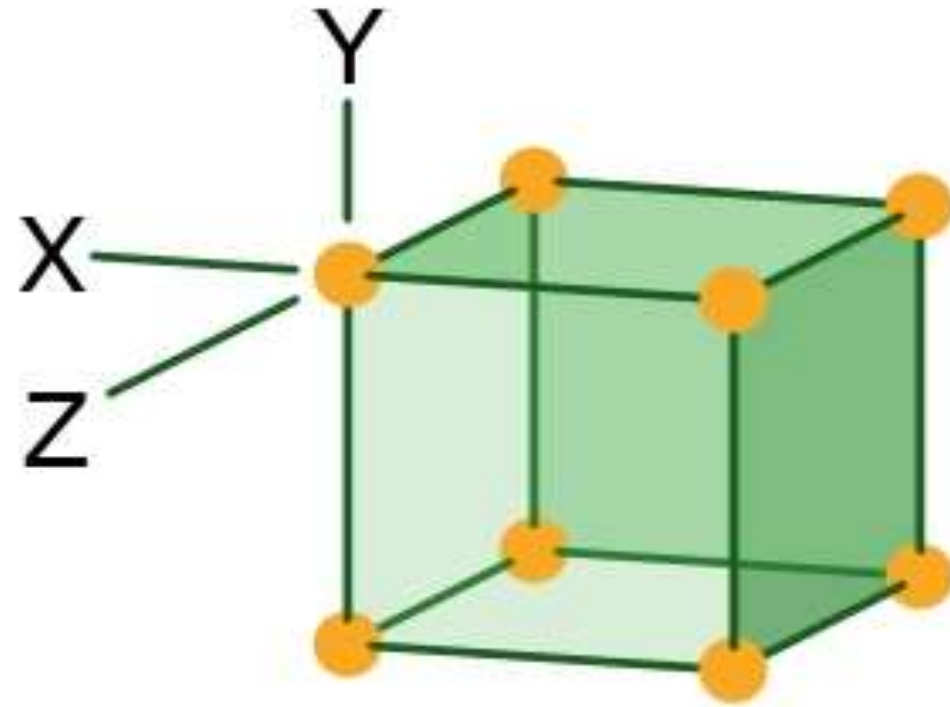
**unit cell**

- The **unit cell** is the smallest group of atoms showing the characteristic lattice structure of a particular metal is a **unit cell**.

**single crystal**

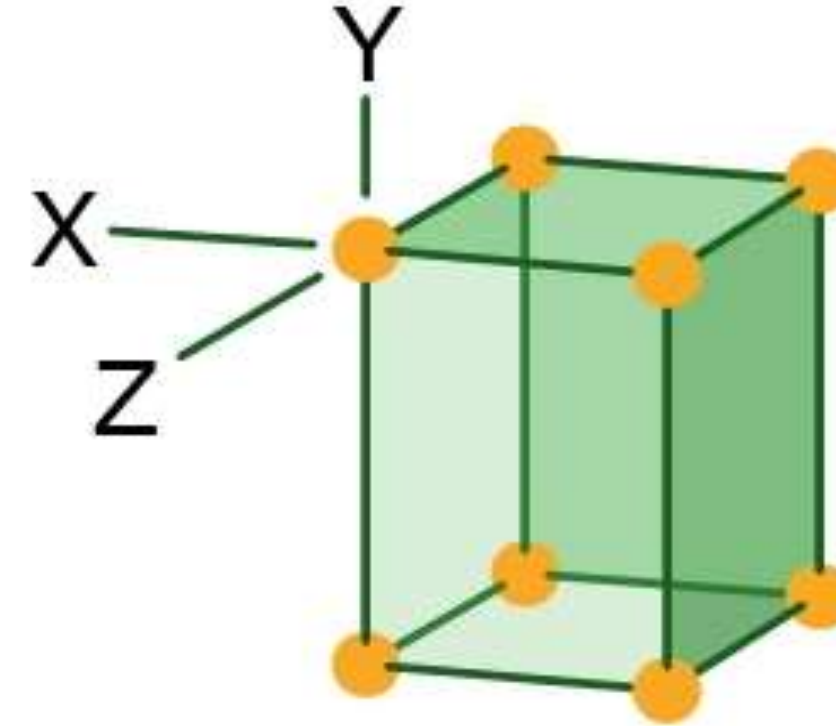
- A **single crystal** can have many **unit** are composed.

# The seven primitive crystal systems



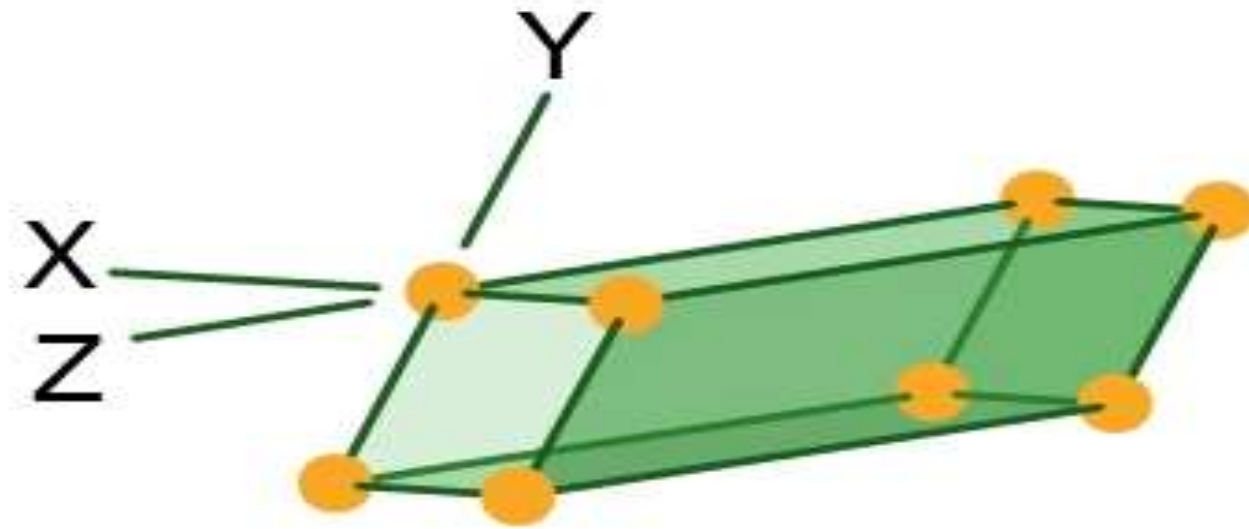
## Isometric (or cubic)

All three axes are equal in length, and all are perpendicular to one another.



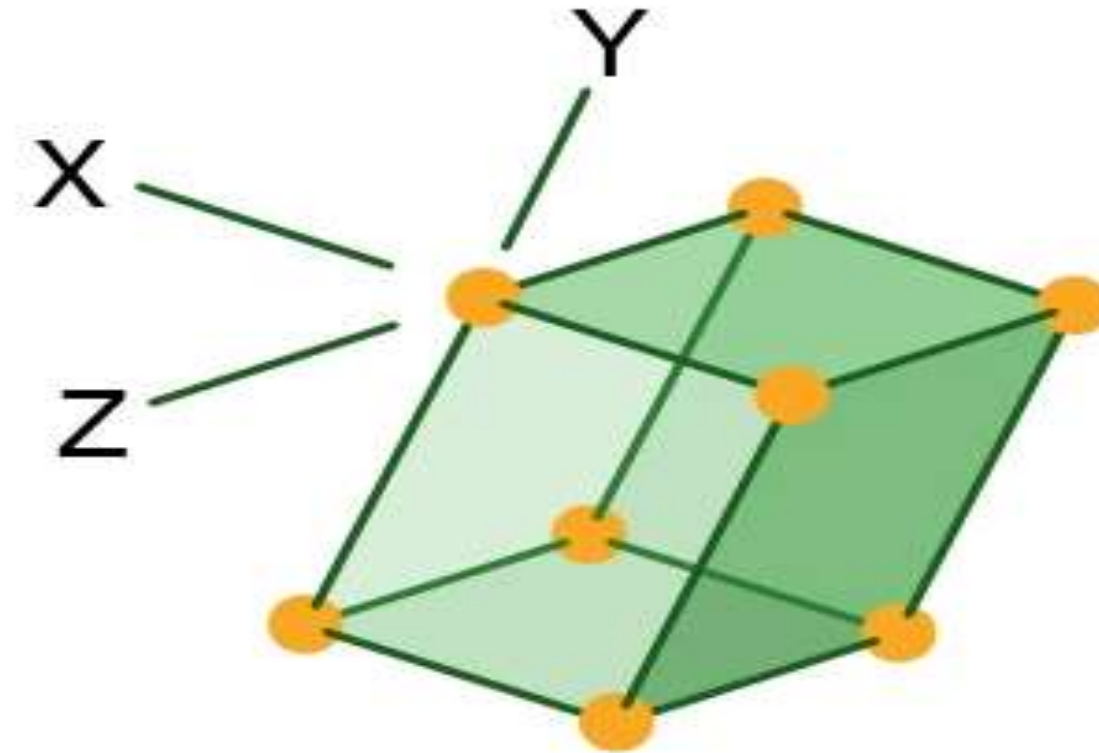
## Tetragonal

Two of the three axes are equal in length, and all three axes are perpendicular to one another.



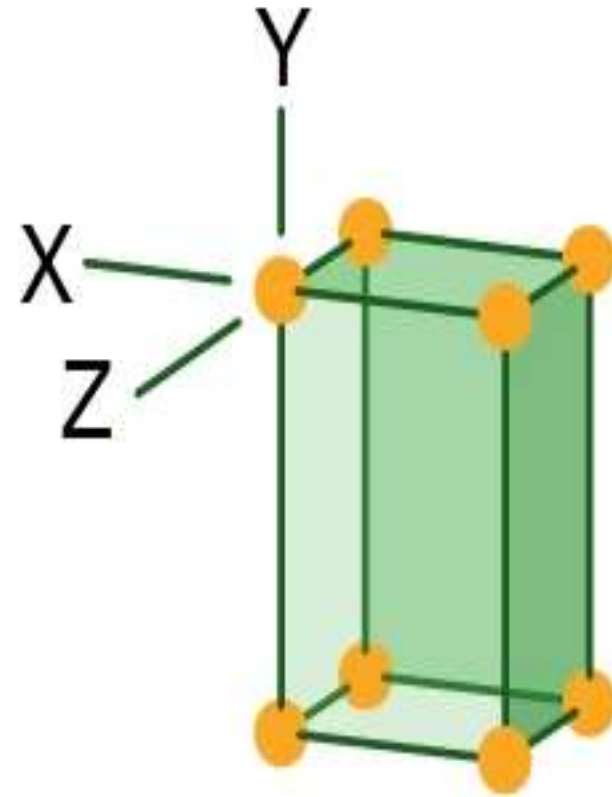
## Triclinic

All three axes are unequal in length, and none is perpendicular to another.



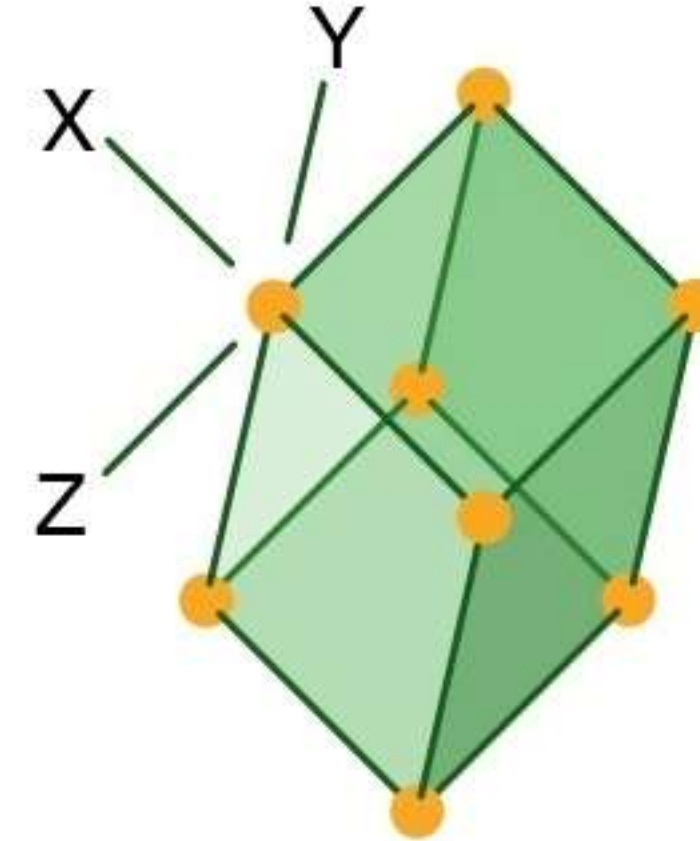
## Monoclinic

All three axes are unequal in length, and two axes are perpendicular to each other.



### Orthorhombic

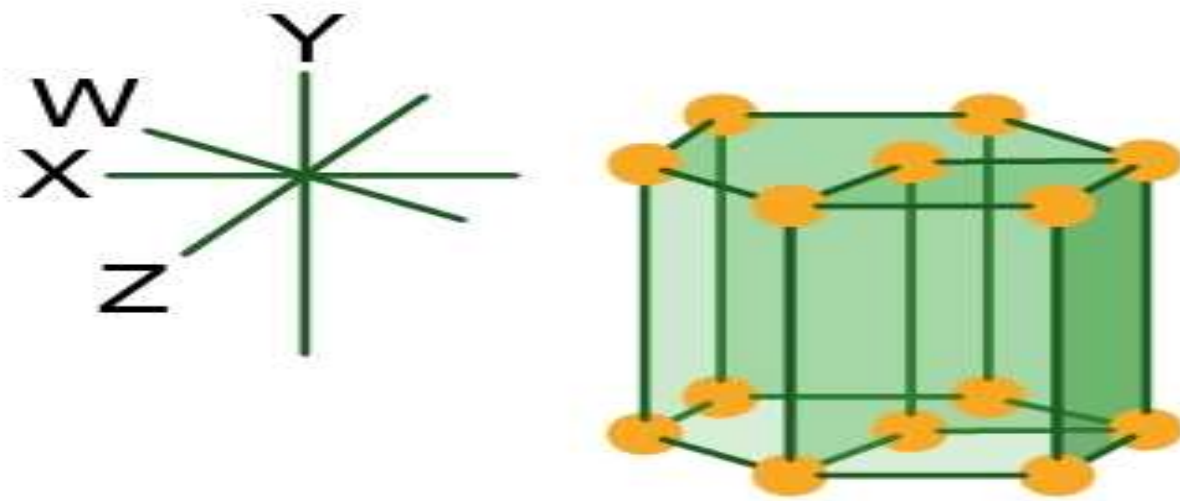
All three axes are unequal in length, and all are perpendicular to one another.



### Rhombohedral (or trigonal)\*

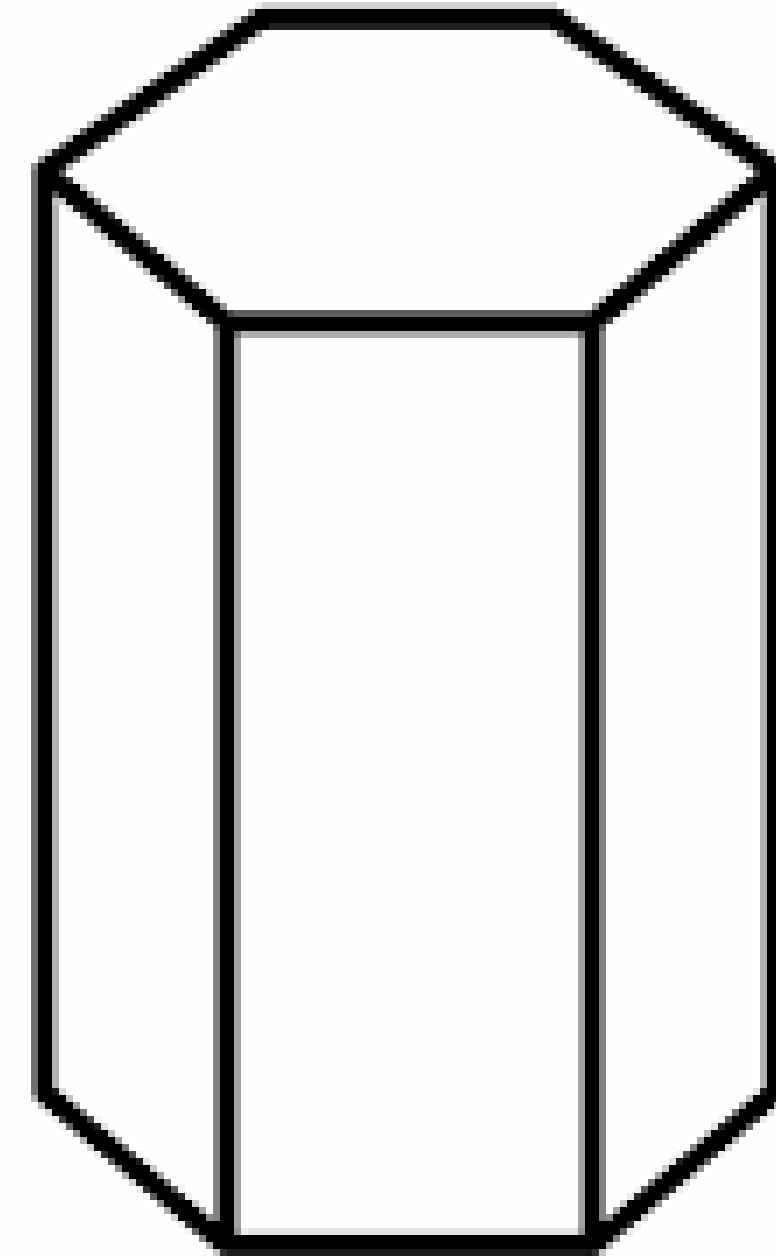
All three axes are of equal length, and none of the axes is perpendicular to another, but the crystal faces all have the same size and shape.





## Hexagonal

Of four axes, three are of equal length, are separated by equal angles, and lie in the same plane. The fourth axis is perpendicular to the plane of the other three axes. Hexagonal cells have lattice points in each of the two six-sided faces.





# References

- <https://images.app.goo.gl/9VYWj3nKCV8kimaw8>
- <https://images.app.goo.gl/ntBFndq5oCytvFJu9>
- <https://images.app.goo.gl/1P7s2GC8oxWCeGdF6>
- <https://images.app.goo.gl/i31nQ1kpSaKZYSJf7>
- <https://images.app.goo.gl/QhvfqUTwnkYS5Yq7B7>

*Thank You*