Crystal Systems

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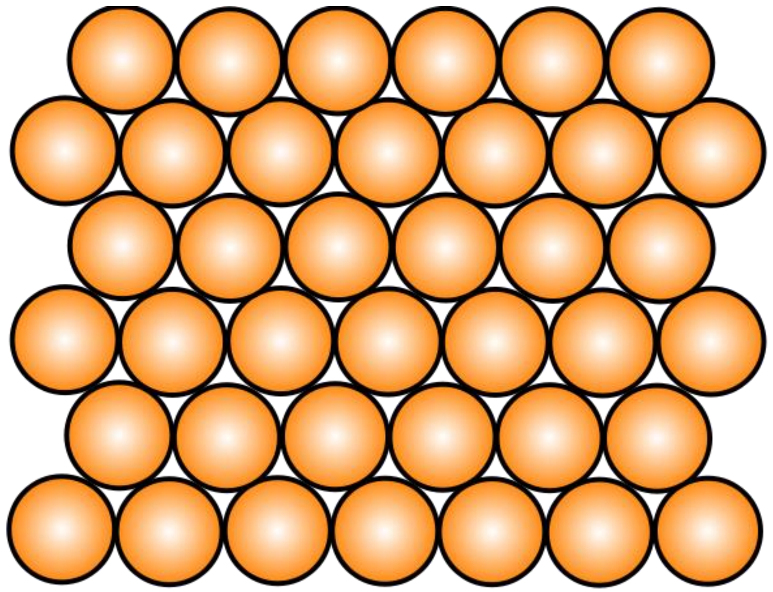
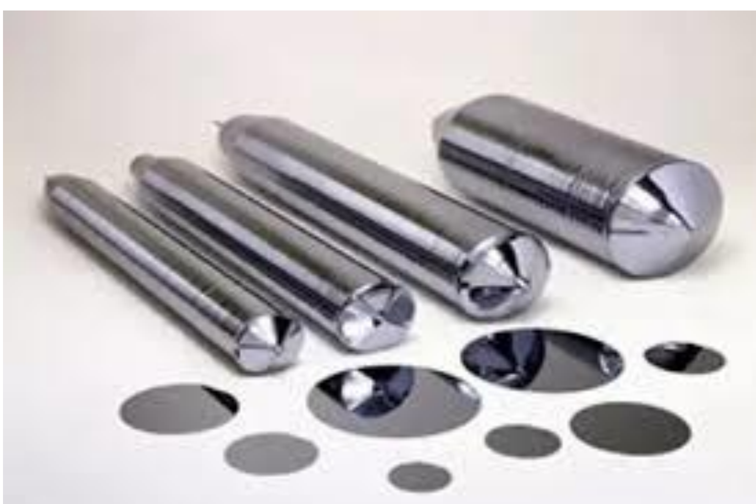
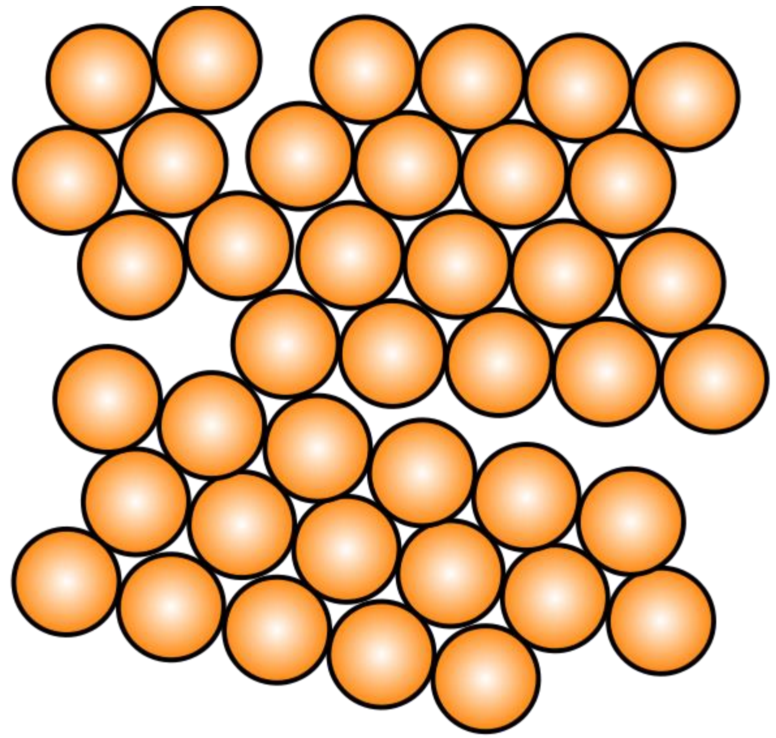
Types of materials

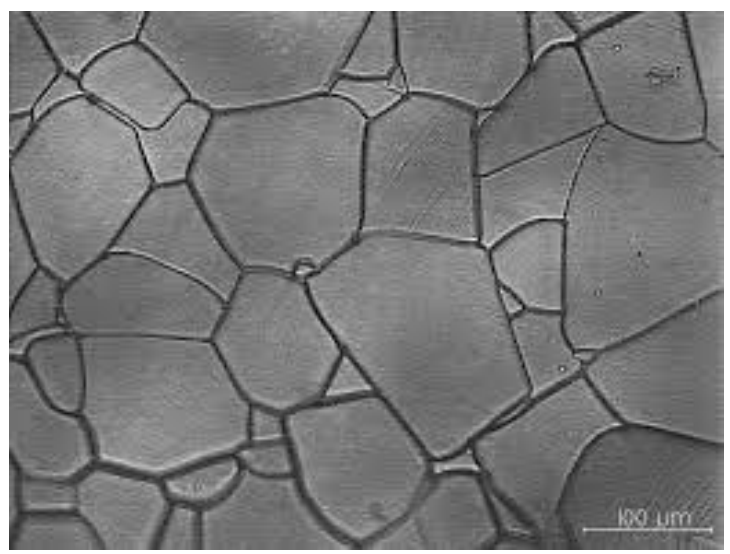
Monocrystalline



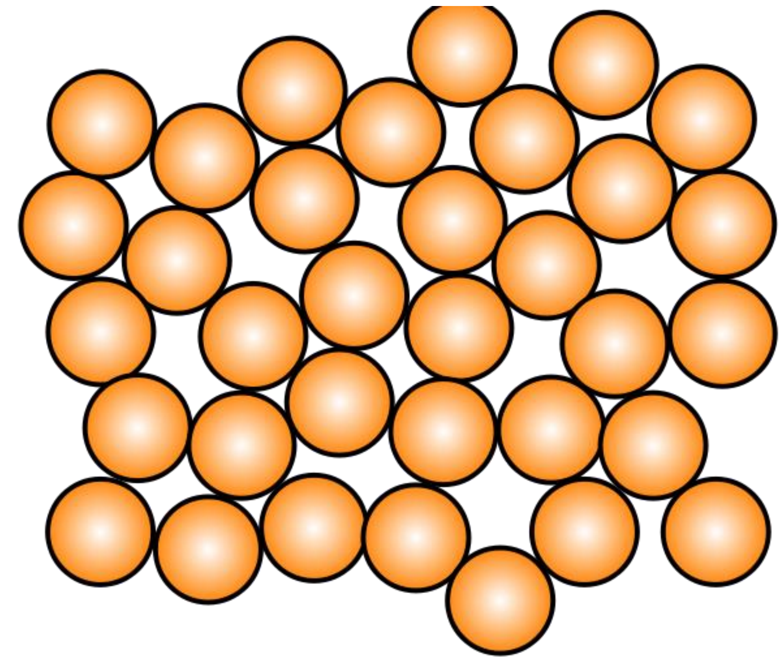


Polycrystalline





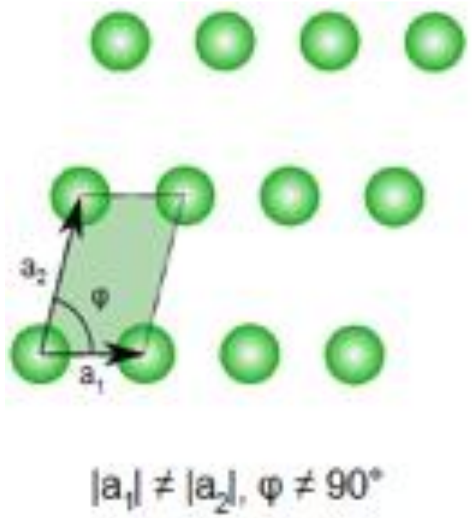
Amorphous



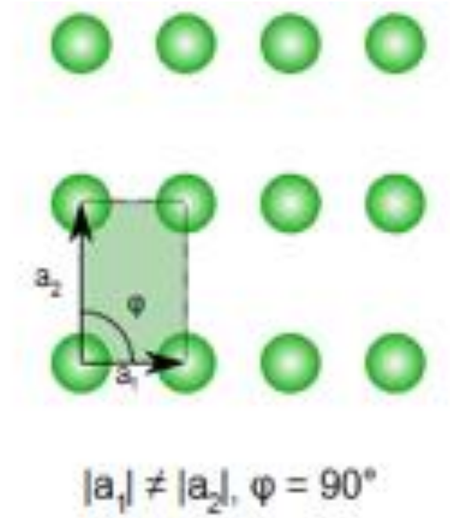
Bravais Lattice

- Crystalline structures can be understood by considering atoms as a hard spheres.
- These hard spheres can be situated at Imaginary point in a space used to describe position of atom/ion/molecule.
- These imaginary points are called as **Lattice Points.**
- The smallest repeating unit of lattices is called as **Unit Cell.**
- A lattice is formed by repeating unit cells.
- 1-D lattice - Linear lattice
- 2-D lattice - Space lattice
- 3-D lattice - Crystal lattice

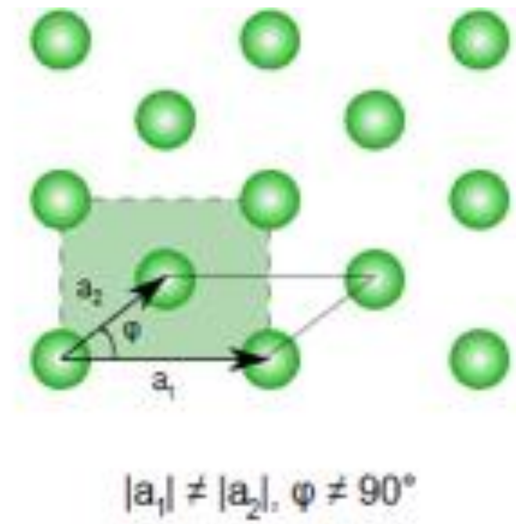
5 Bravais Lattices in 2-D



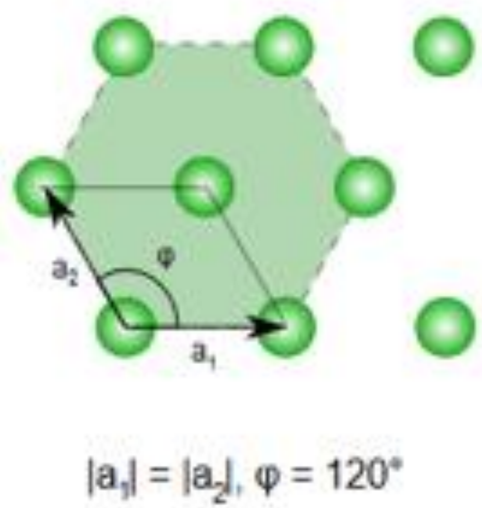
Oblique



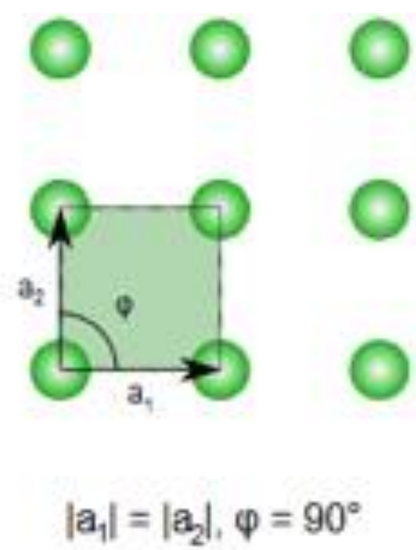
Rectangular



Centered rectangular

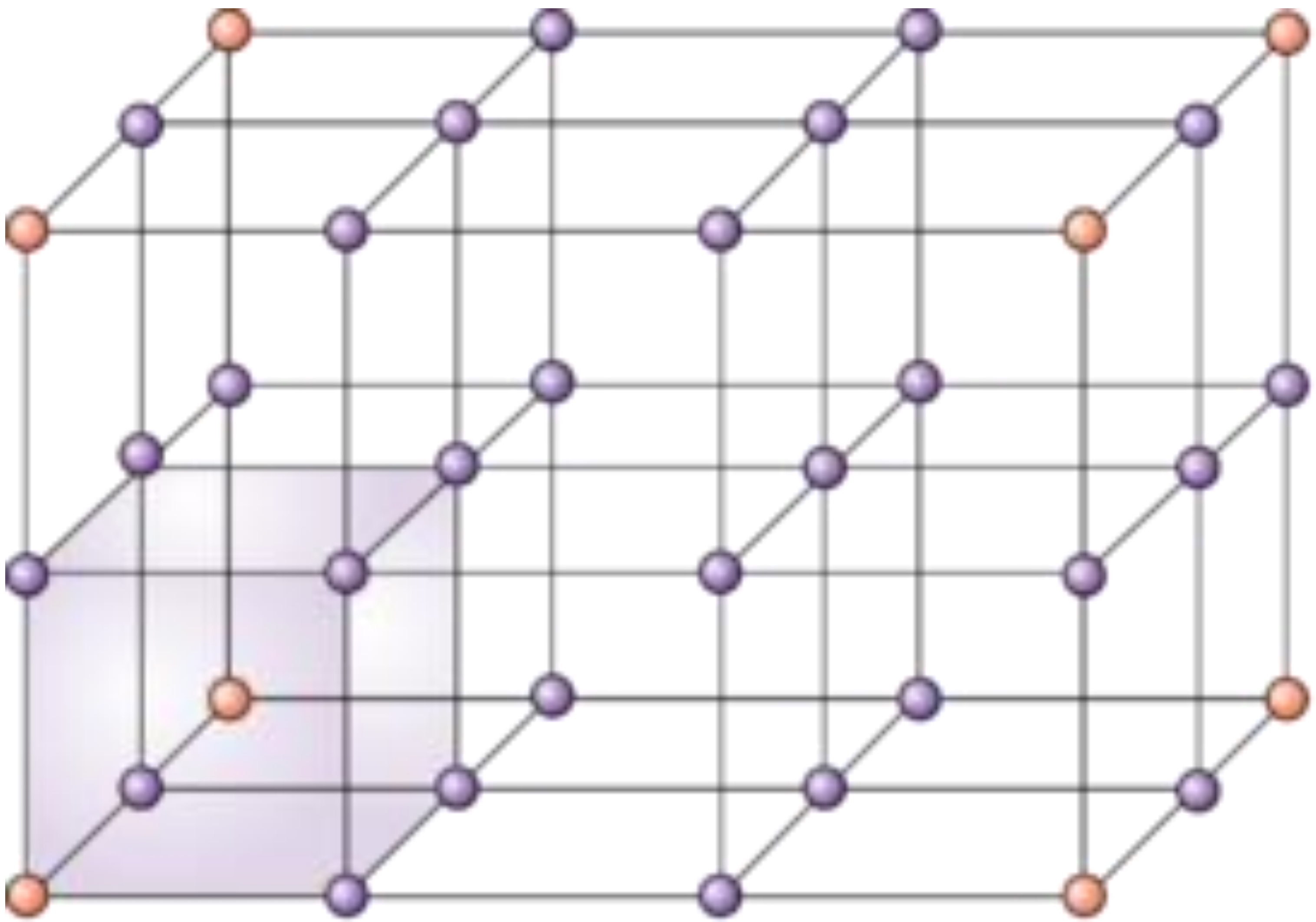


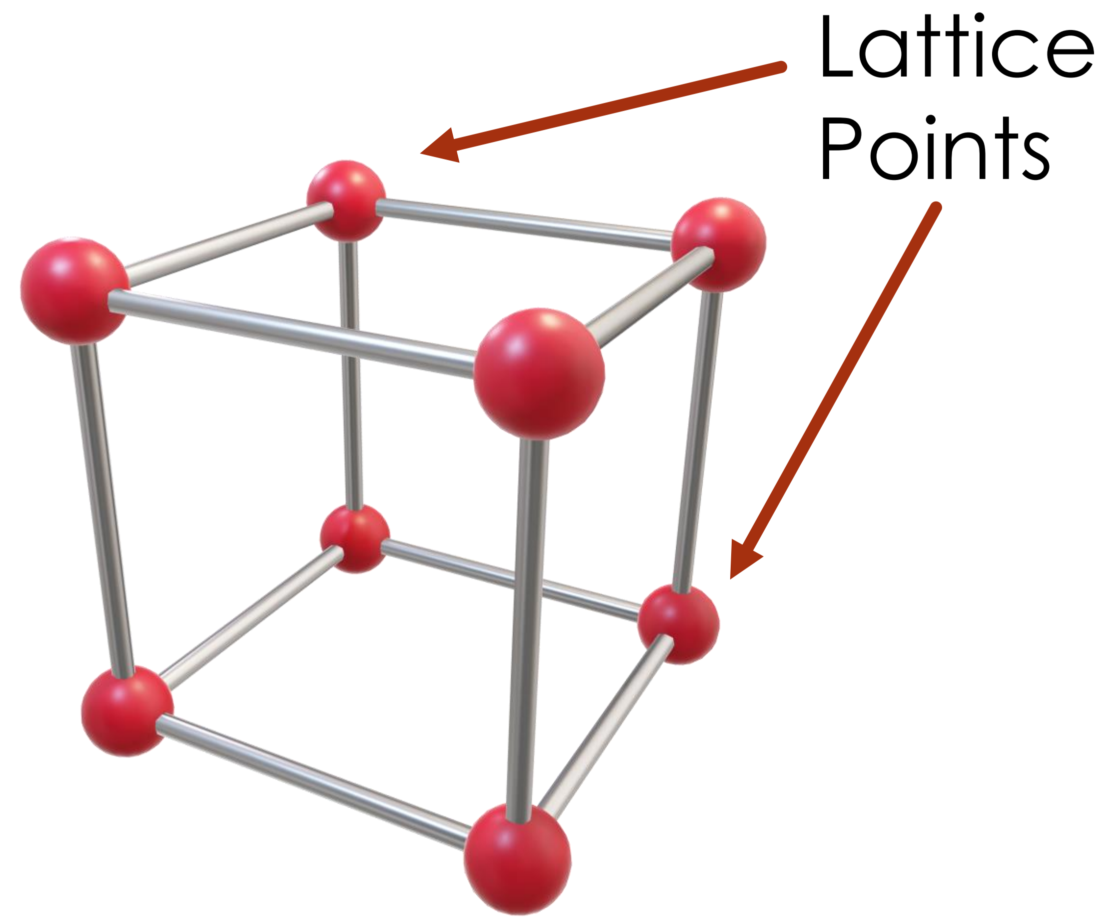
Hexagonal



Square

3-D Lattice

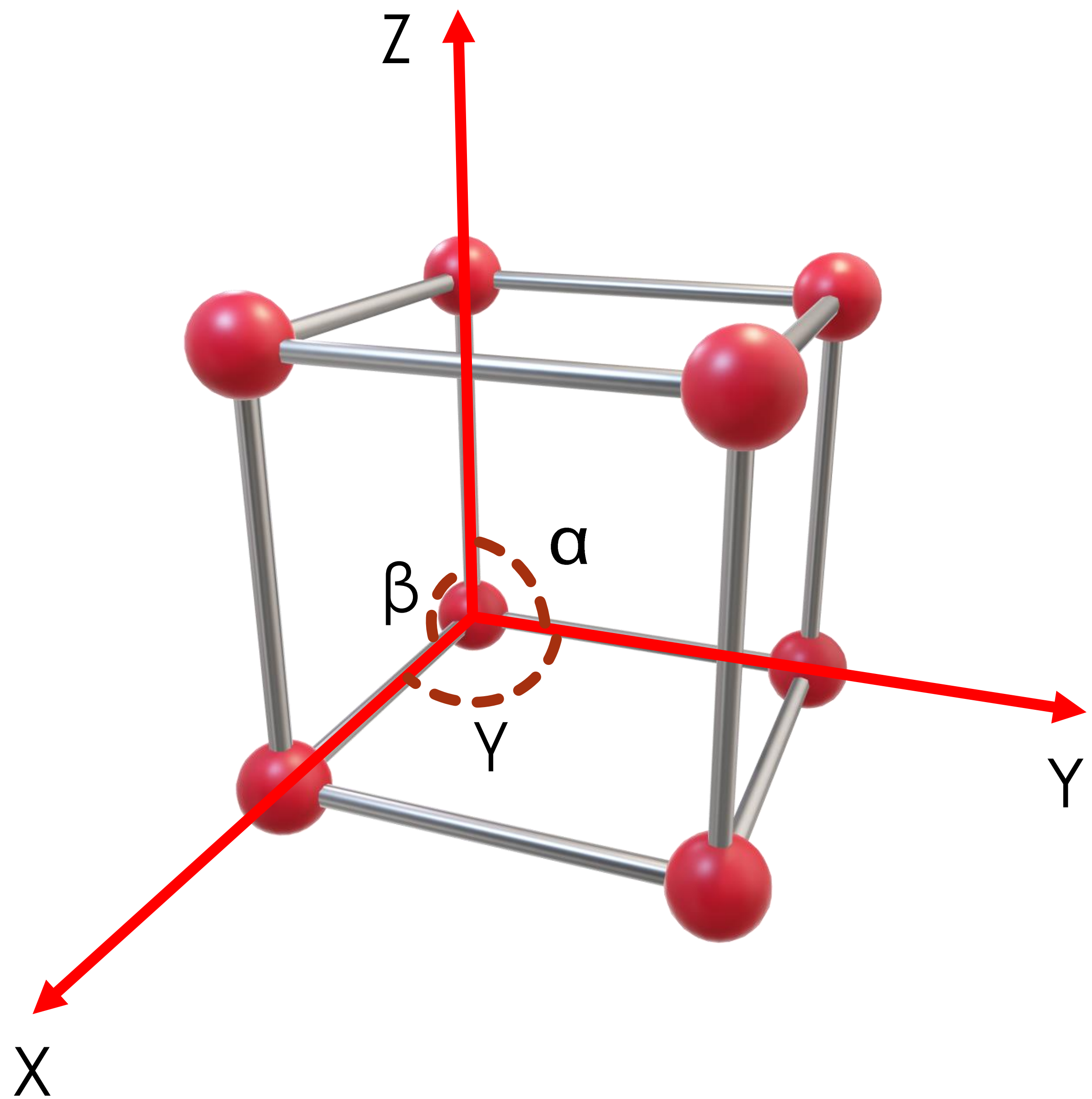




Unit cell

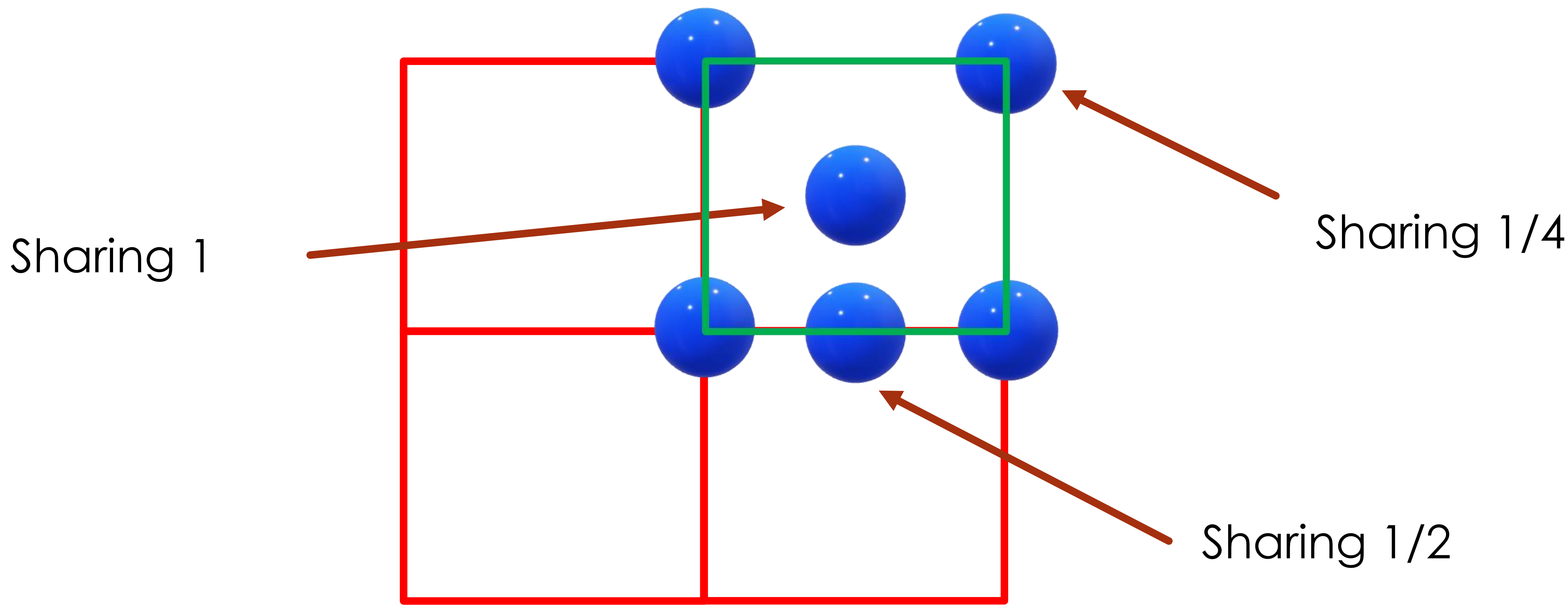
7 Crystal systems

7 Different types of unit cells



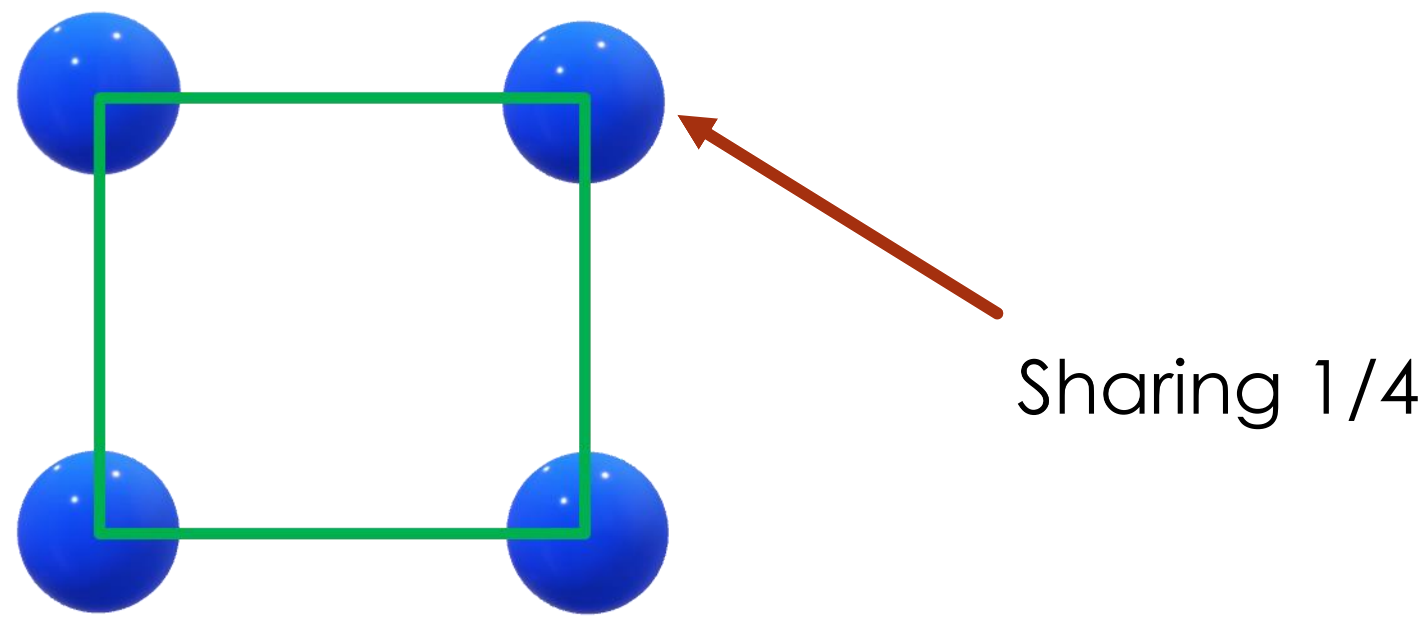
Crystal System	Lengths	Angles
Cubic	a=b=c	α=β=γ=90
Trigonal	a=b=c	α=β=γ<120, ≠90
Hexagonal	a=b≠c	α=β=90, γ=120
Tetragonal	a=b≠c	α=β=γ=90
Orthorhombic	a≠b≠c	α=β=γ=90
Monoclinic	a≠b≠c	α=β=90≠γ
Triclinic	a≠b≠c	α≠β≠γ

Sharing of lattice points in 2-D



Primitive lattice in 2-D

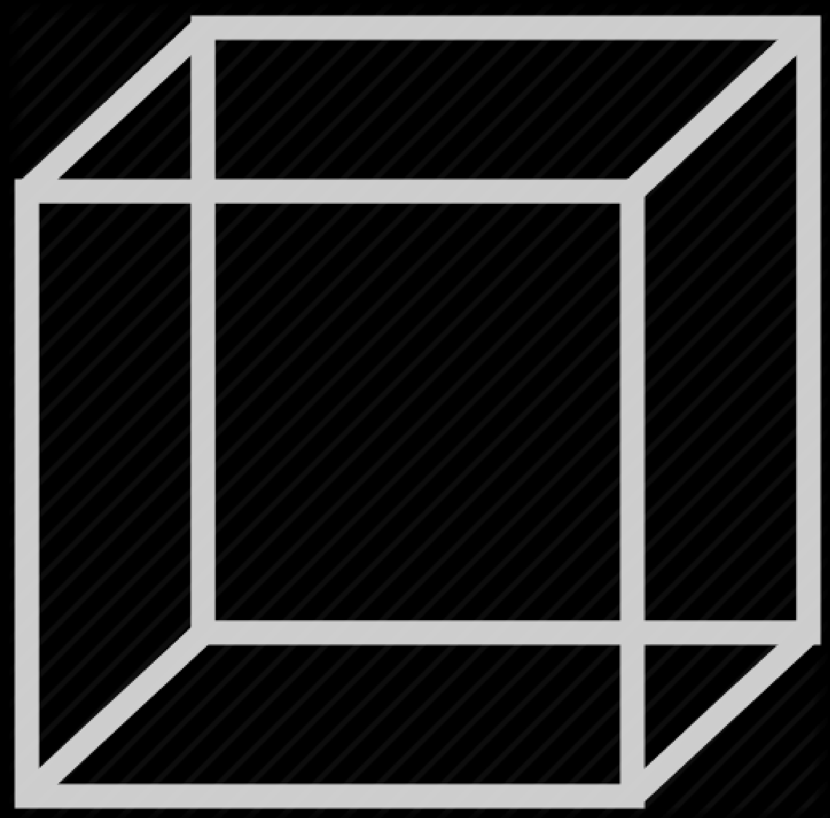
A Lattice with only 1 lattice point



Sharing in a unit cell 1/4 * 4 = 1

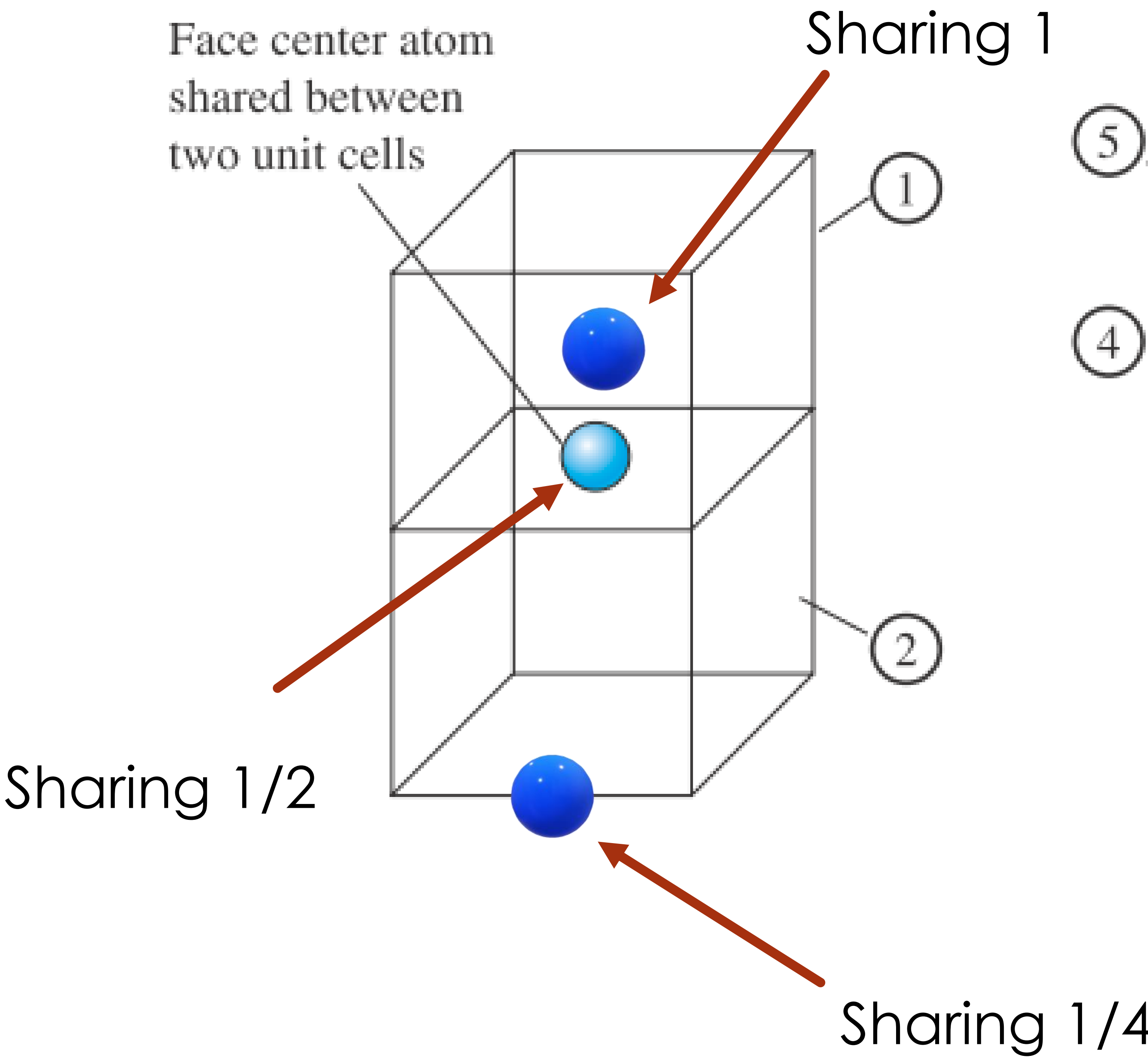
Remember

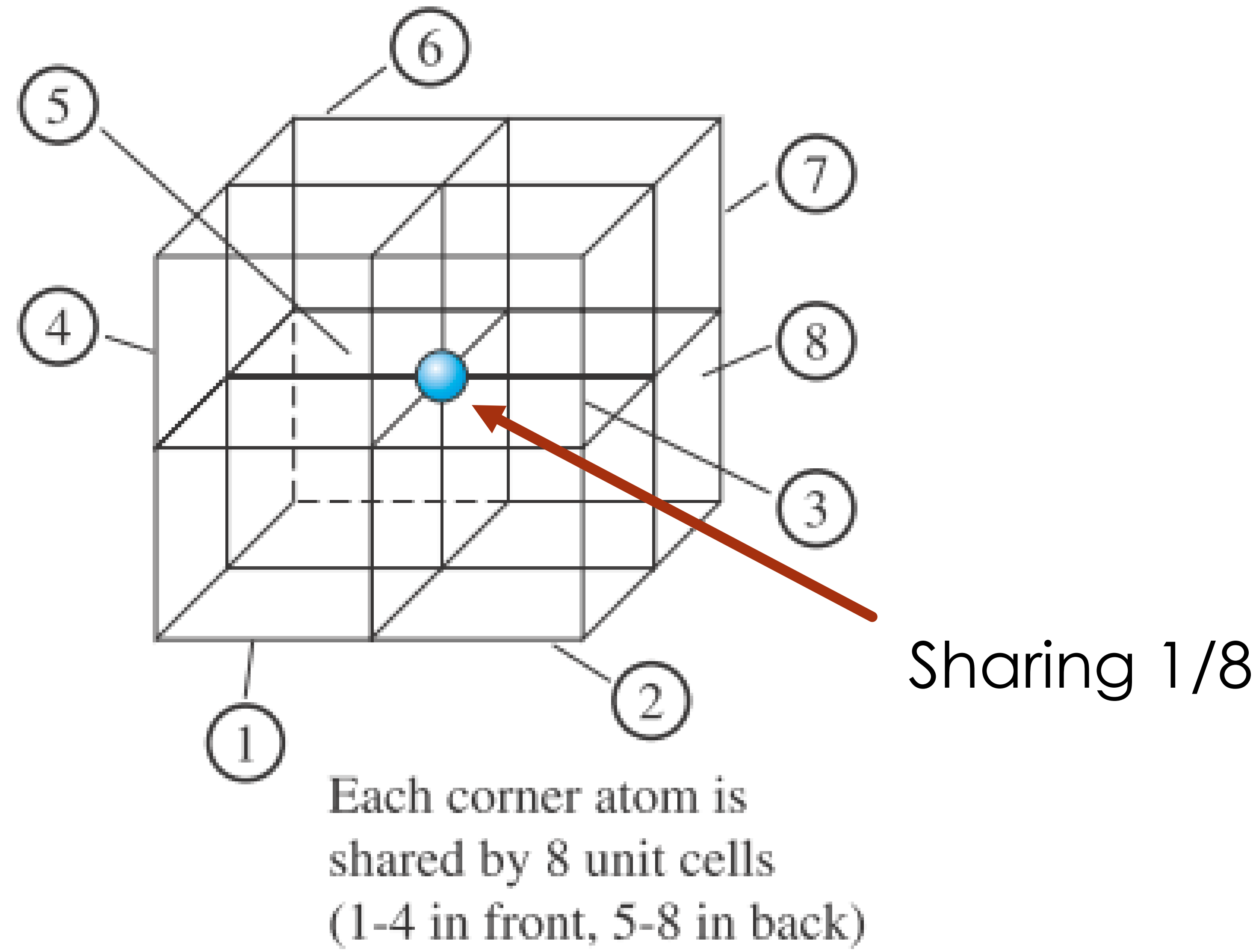
In a cubic unit cell (Try it yourself)



No. of. corners:	8
No. of edges:	12
No. of Faces:	6
No. of Body Diagonals:	4
No. of Face Diagonals:	12

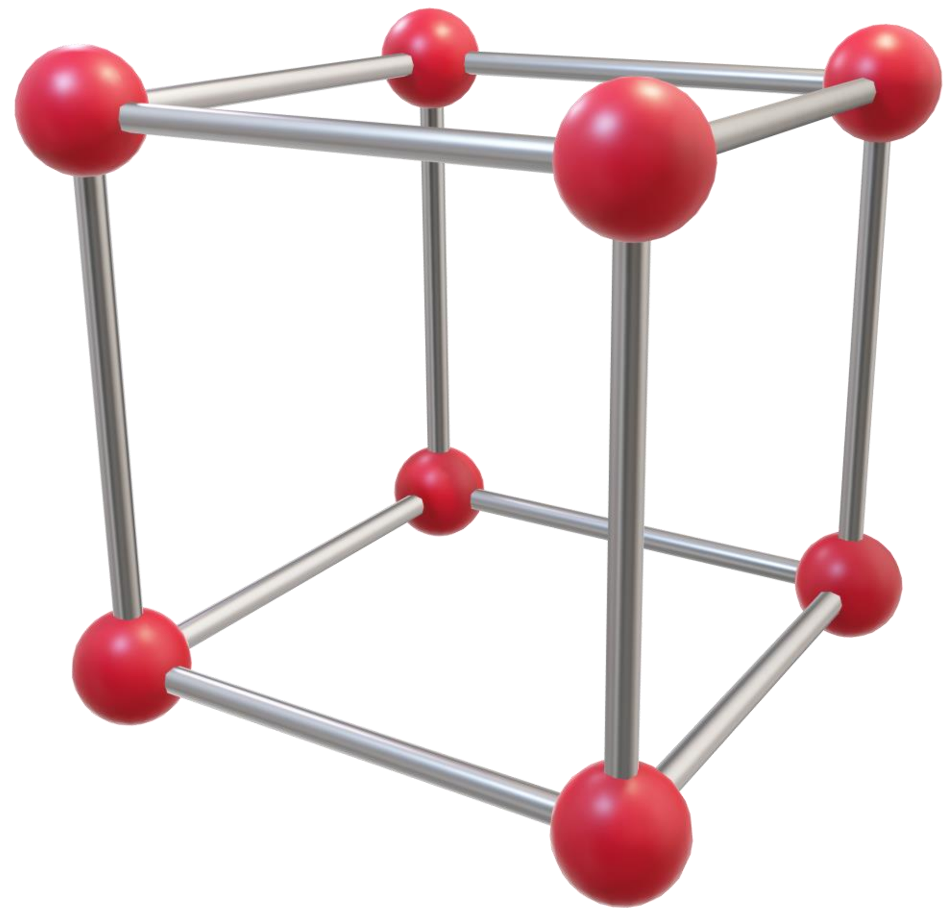
Sharing of lattice points in 3-D





Primitive lattice in 3-D

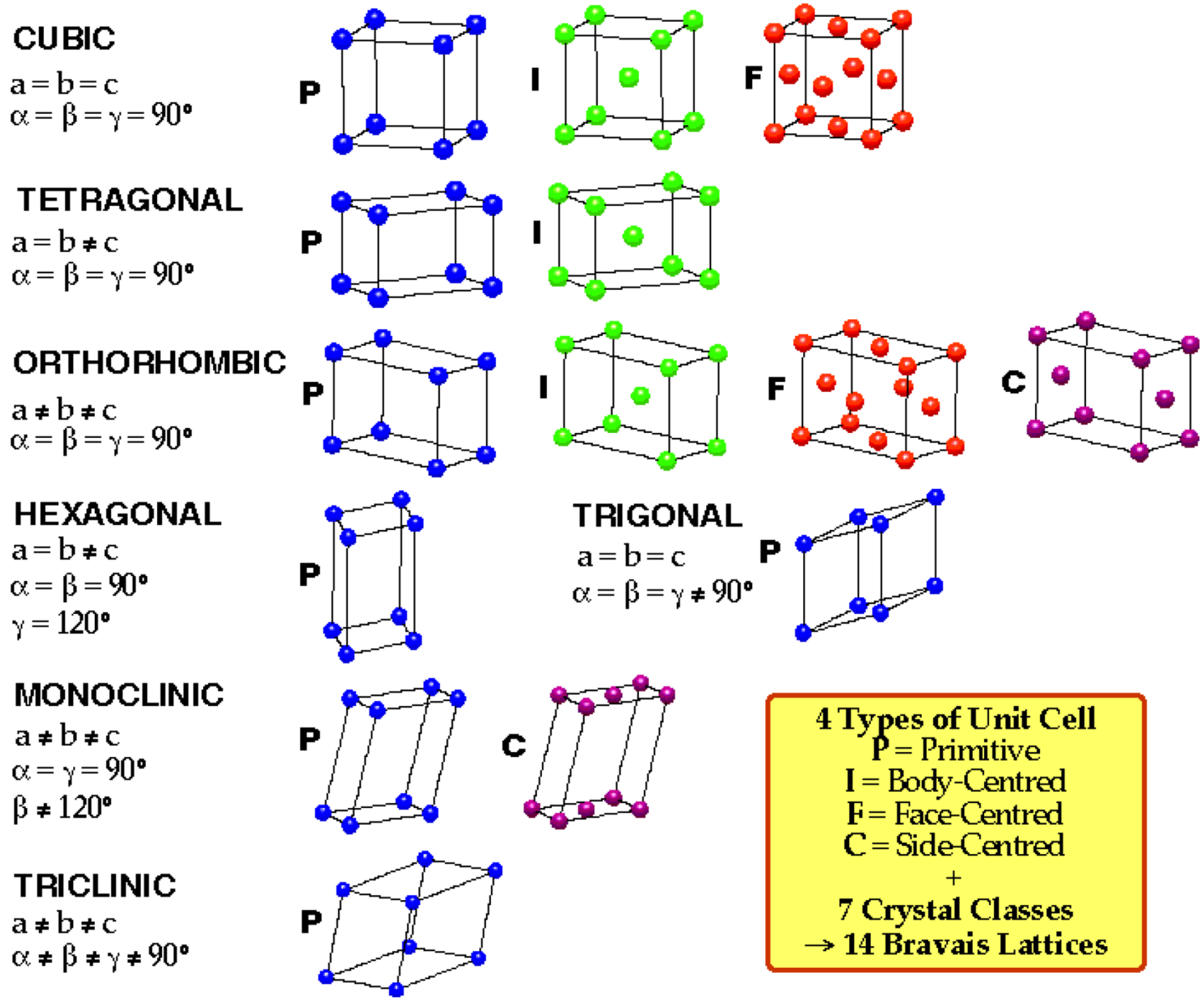
A Lattice with only 1 lattice point



Sharing in a unit cell 1/8 * 8 = 1

14 Bravais Lattices in 3-D

There are only 14 ways of arranging lattice so that environment looks same from each point



Summary

1. Single crystalline or monocrystalline materials have periodic arrangement of atoms throughout.
2. A polycrystalline material consists of many single crystallite with a boundary.
3. Amorphous materials have random arrangement of atoms.
4. There are 7 crystal systems and 14 Bravais lattices.
5. The atom sitting in the unit cell can share different part depending upon its location.
6. A primitive lattice has only one lattice point in the unit cell.

Assignments

1. Why a 2-D pentagon lattice is not possible?
2. Which crystal systems are the least and most symmetric. Explain the reason.
3. Show that FCT does not exist in Bravais Lattice list.
4. Find out the number of lattice points in SC, BCC and FCC lattices.
5. Write down types of bonds present in different materials.
6. Find out 2-D primitive lattices in following pictures.