SOLID STATE

For
B.Sc Chemistry(Part-III)
Physical Chemistry
Paper-V
Lecture-02

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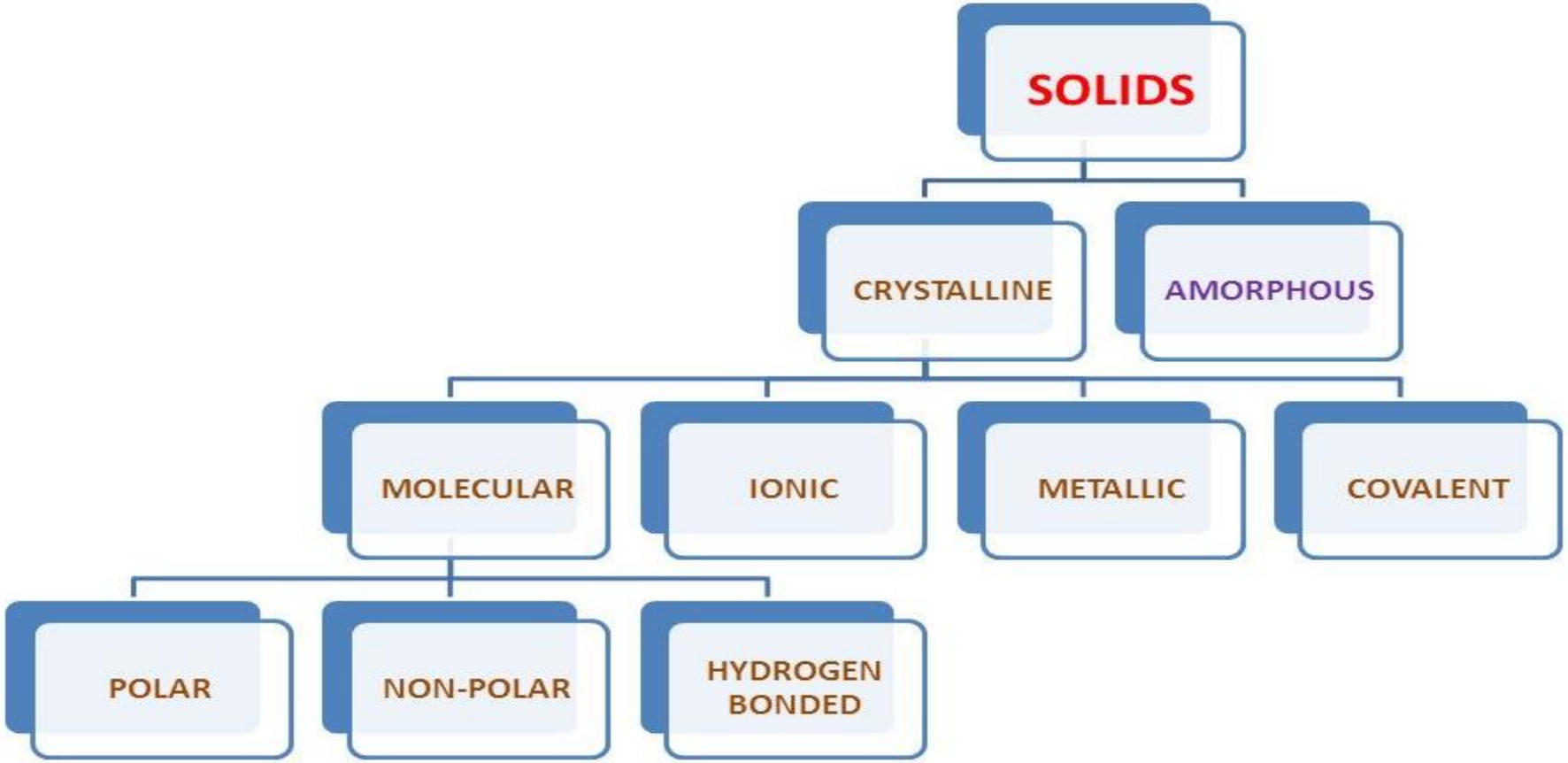
- Crystal forces
- Radius ratio rule
- Co-ordination number of ions

Classification of Solid



Crystal forces

- Crystals is a solid material formed by atoms, ions, and or molecules
- Crystals are pack together in ordered way and they have periodic arrangements.
- Crystal structures holds atoms and molecules together and there is interaction among them.
- Constituents of Crystals are arranged in a highly Weak van der Waals forces help hold together certain crystals, such as crystalline molecular solids, as well as the interlayer bonding in graphite.
- Crystals often form in nature when liquids cool and start to harden

There are four types of crystals:

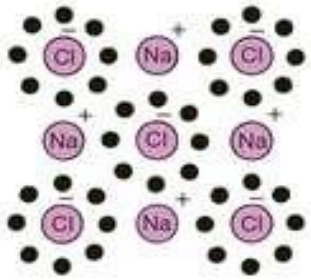
(1) ionic

(2) (2) metallic

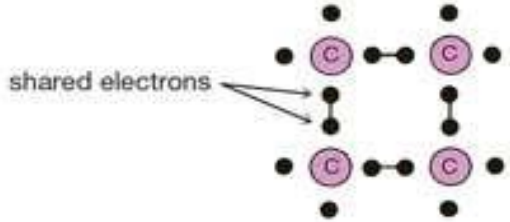
(3) (3) covalent network

(4) (**4**) molecular

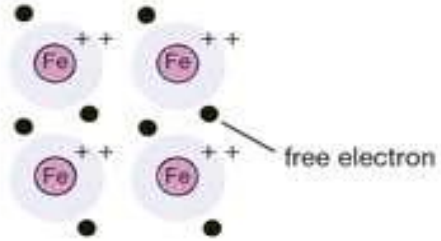
CRYSTAL STRUCTURE



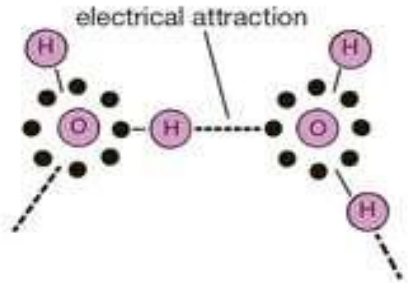
ionic bonding
electron transferred from Na to Cl



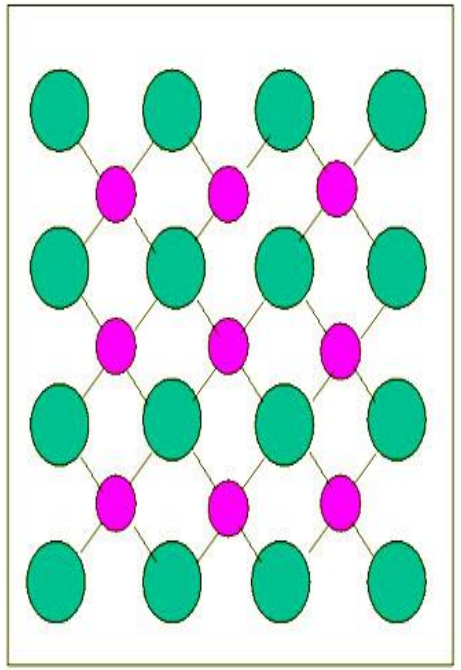
covalent bonding
atoms share electrons



metallic bonding
ions surrounded by free electrons



molecular bonding
weak electrical attraction binds molecules



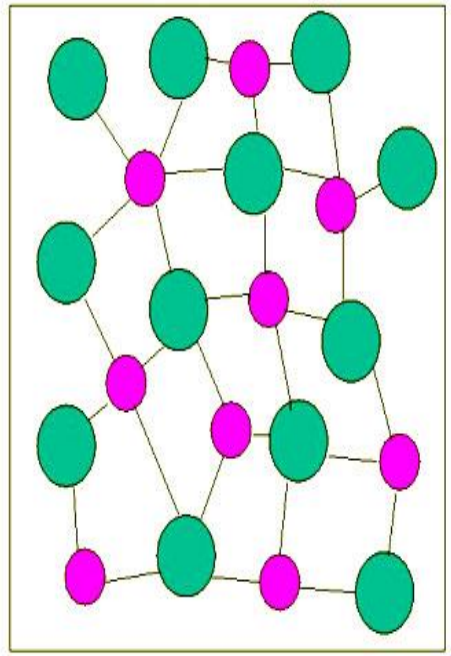


Image taken from google

Radius ratio rule

The **ratio** of the **radius** of cations (r^+) to the **radius** of the anion (r^-) is known as the **radius ratio** of the ionic **solid**.

Relation between the radius,coordiation number ad structural arrangemets of the molecule

Radius ratio = $\mathbf{r^+ / r^-}$

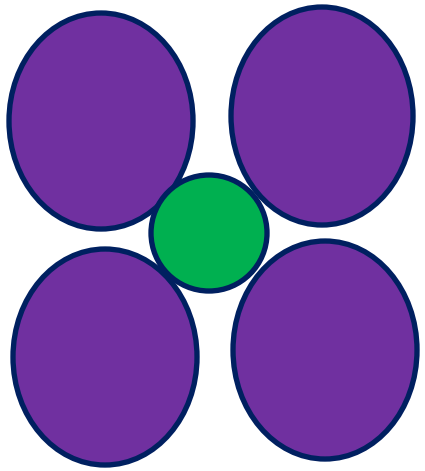
Significance:

It is useful in predicting the structure of ionic **solids**.

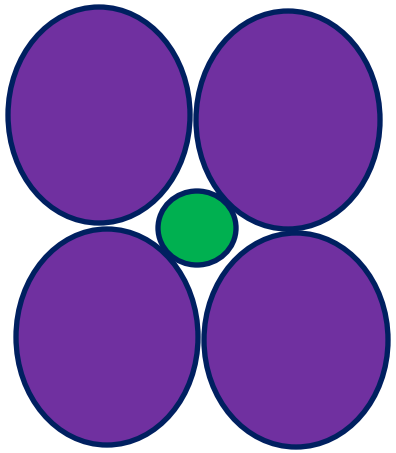
The structure of an ionic compound depends upon stoichiometry and the size of ions.

Greater the radius ratio,larger the size of the cation and hence the coordination number.

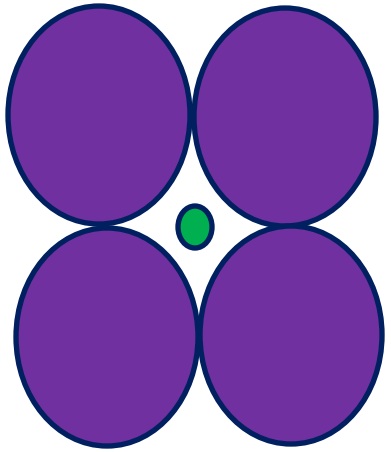
Radius ratio rule



r of cations (r^+)/ **r** of anions (r^-)> Ideal
Stable



r of cations (r^+)/ **r** of anions (r^-)> Ideal
Stable



r of cations (r^+)/ **r** of anions (r^-)<Ideal
unstable

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Limiting radius ratio

It is the minimum allowable value for the **ratio** of ionic **radii** ($\rho = r^+/r^-$) for this structure to be stable.

Here, r^+ is the **radius** of the cation and r^- is the **radius** of the surrounding anions.

The anions are usually larger than cation.

Limiting **radius ratio** is 0.524 , therefore **coordination number** is six and shape is octahedral.

It is proved by X-ray study of NaCl crystal that each Na^+ is surrounded by six Cl^- which are arranged octahedrally

Co-ordination number of ions

Co-ordination number :The number of atoms or ions immediately surrounding a central atom in a complex or crystal.

Radius Ratio	Coordination number	Type of void	Example
< 0.155	2	Linear	
0.155 - 0.225	3	Triangular Planar	B_2O_3
0.225 - 0.414	4	Tetrahedral	ZnS, CuCl
0.414 - 0.732	6	Octahedral	NaCl, MgO
0.732 - 1.000	8	Cubic	CsCl, NH_4Br
1	12	Close packing (ccp and hcp)	metals

Relationship between Radius Ratio and Coordination Number

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Problems for practice:

1. How the crystals are formed?
2. What is radius ratio in solid state?
3. How do you find the coordination number from the radius ratio?
4. What are two types of stoichiometric defects?