

IONIC & METALLIC BONDING

Chapter 7

VALENCE ELECTRONS

- ⦿ Electrons in the highest occupied energy level.
 - Na
 - Al
 - Cl
 - Se
- ⦿ **Lewis (Electron) Dot Diagrams** show valence electrons; inner electrons are represented by the element symbol.

FORMATION OF IONS

◉ Cations lose electrons

- What types of elements form cations?
- What type of cations do alkali metals form?
Alkaline earth metals?
 - Na
 - Al

◉ Anions gain electrons

- What type of element form anions?
- What type of anions do halogens form? Group 6A?
 - Cl

REVIEW QUESTIONS

- How can you determine the number of valence electrons in an atom of a representative element?
- How many valence electrons are in each of the following atoms?
 - Potassium
 - Carbon
 - Magnesium
 - Oxygen
- Draw the electron dot structure for each of the above elements.
- How many electrons will each of the following gain or lose in forming an ion?
 - Calcium
 - Fluorine
 - Aluminum
 - Oxygen

TYPES OF BONDS

All atoms want 8 electrons (octet rule). Bonding occurs to satisfy this need for electrons!

⊙ Ionic Bonds

- Metal/Nonmetal - Electrons are transferred from one atom to another.

⊙ Metallic Bonds

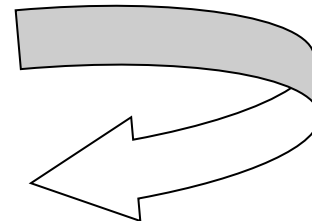
- Metal/Metal - A mixture of metals with delocalized electrons that flow through all atoms' shells.

⊙ Covalent/Molecular Bonds

- Nonmetal/Nonmetal (or metalloid) - Electrons are shared/fought over between atoms.

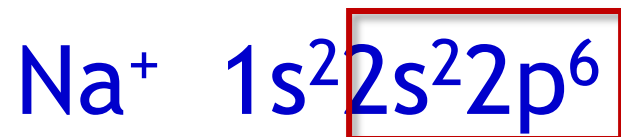
IONIC BONDING: THE FORMATION OF SODIUM CHLORIDE

- ❑ Sodium has 1 valence electron
- ❑ Chlorine has 7 valence electrons
- ❑ An electron transferred gives each an octet



IONIC BONDING: THE FORMATION OF SODIUM CHLORIDE

This transfer forms ions, each with an octet:



IONIC BONDING: **THE FORMATION OF SODIUM CHLORIDE**

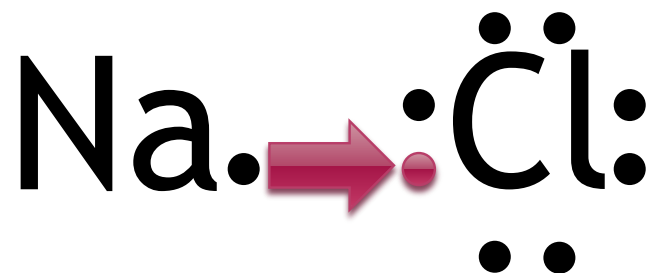
The resulting ions come together
due to electrostatic attraction
(opposites attract):



The net charge on the compound
must equal zero

IONIC BONDING: THE FORMATION OF SODIUM CHLORIDE

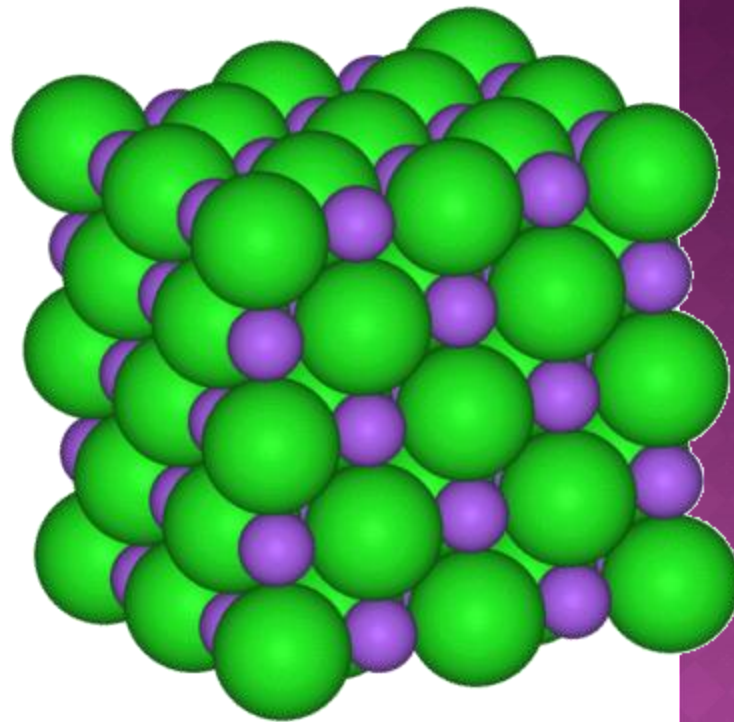
- First, find the chemical formula for the compound.
 - Na likes to form 1+ ions, Cl likes to form 1- ions.*
 - Na⁺ and Cl⁻ balance together in a formula as NaCl.*
- Then, draw the appropriate number of electrons in Lewis Dot form.
- Finally, “transfer” the electrons appropriately.



SODIUM CHLORIDE CRYSTAL LATTICE

Ionic compounds form solid *crystals* at ordinary temperatures.

Ionic compounds organize in a characteristic crystal lattice of alternating positive and negative ions.



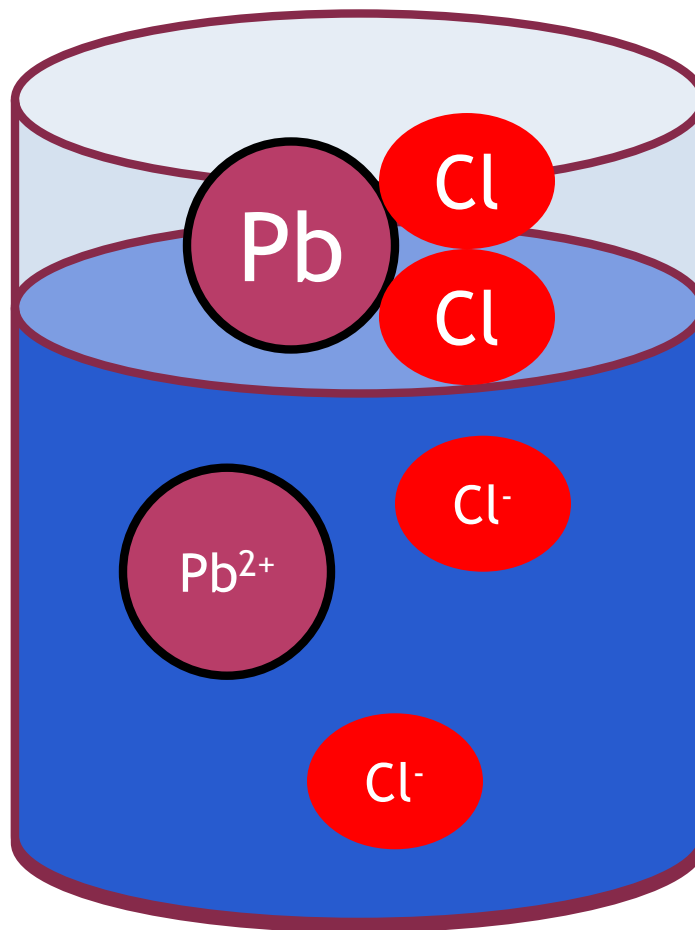
All salts are ionic compounds and form crystals.

PROPERTIES OF IONIC COMPOUNDS

- ◉ Crystalline solids at room temperature
 - Think table salt.
- ◉ High melting points
 - Takes a lot of heat/energy to melt them.
- ◉ Conduct electricity when melted or dissolved
- ◉ Soluble in water

DISSOCIATION

- ◉ In water, ionic compounds sometimes break up into the ions of which they're composed.
 - This is a process called dissociation.



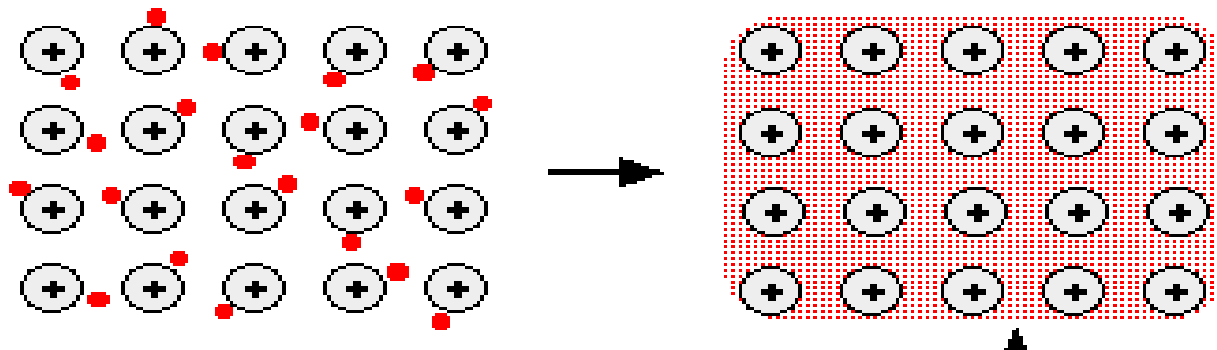
METALLIC BONDING



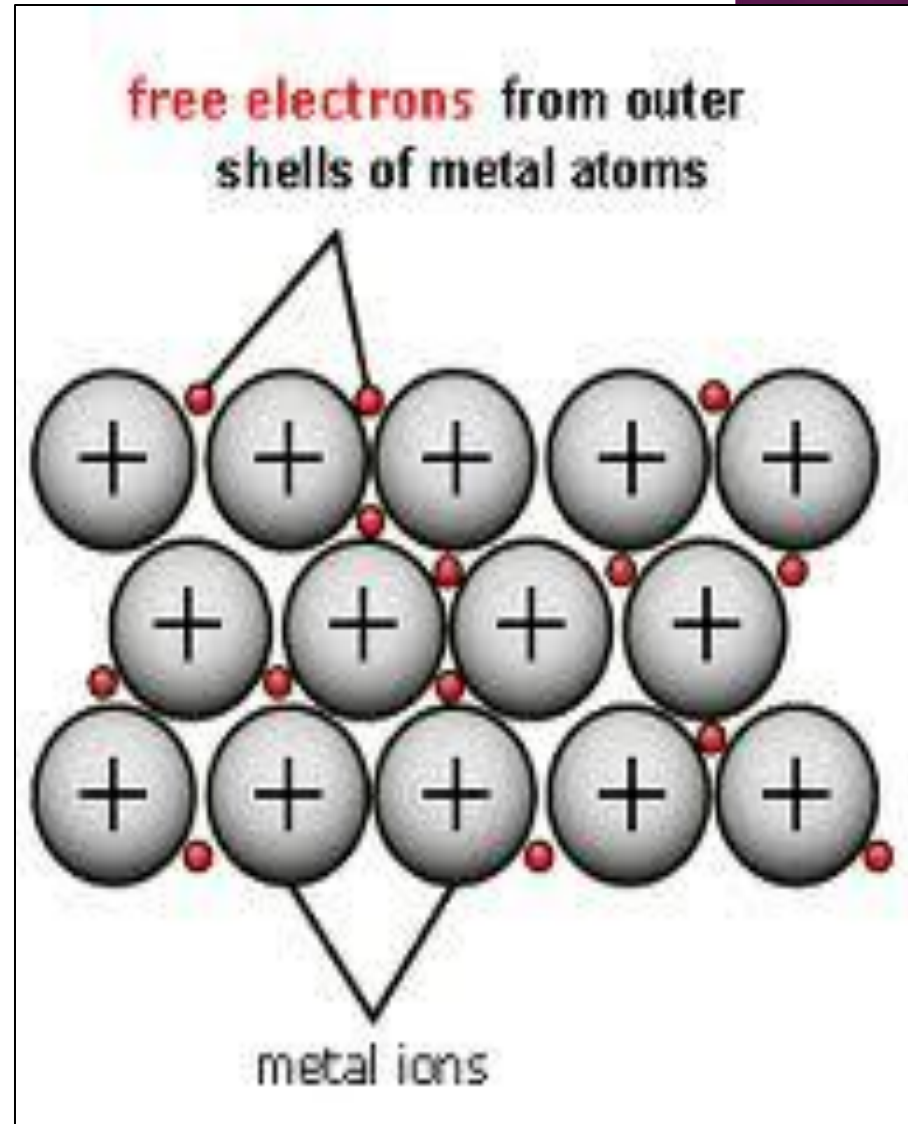
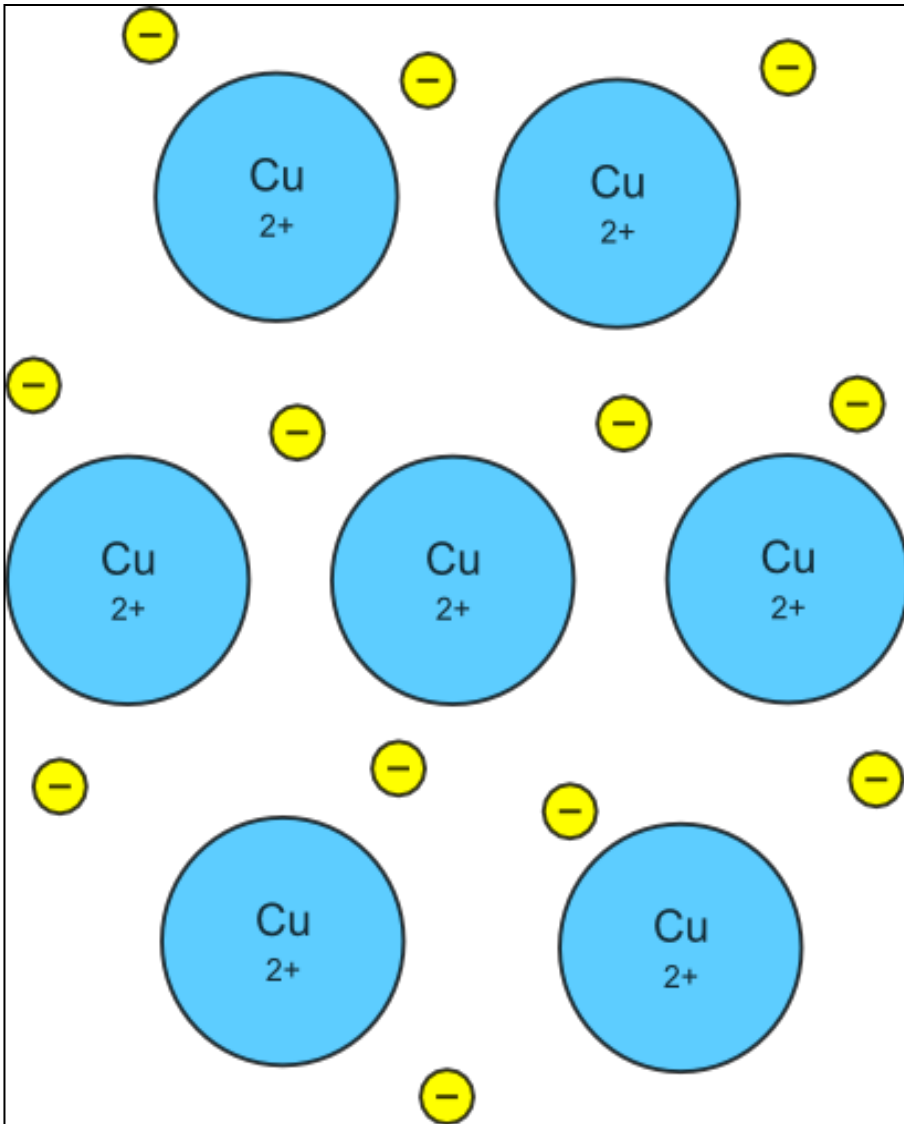
Strong forces of attraction are responsible for the high melting point of most metals.

METALLIC BONDS

- ◉ In metallic bonds, all the cations are packed closely together.
- ◉ The valence electrons, rather than hanging out near their atoms' nuclei, exist in a sea of delocalized electrons.
- ◉ There is still an attraction between the free floating electrons (-) and metal cations (+).

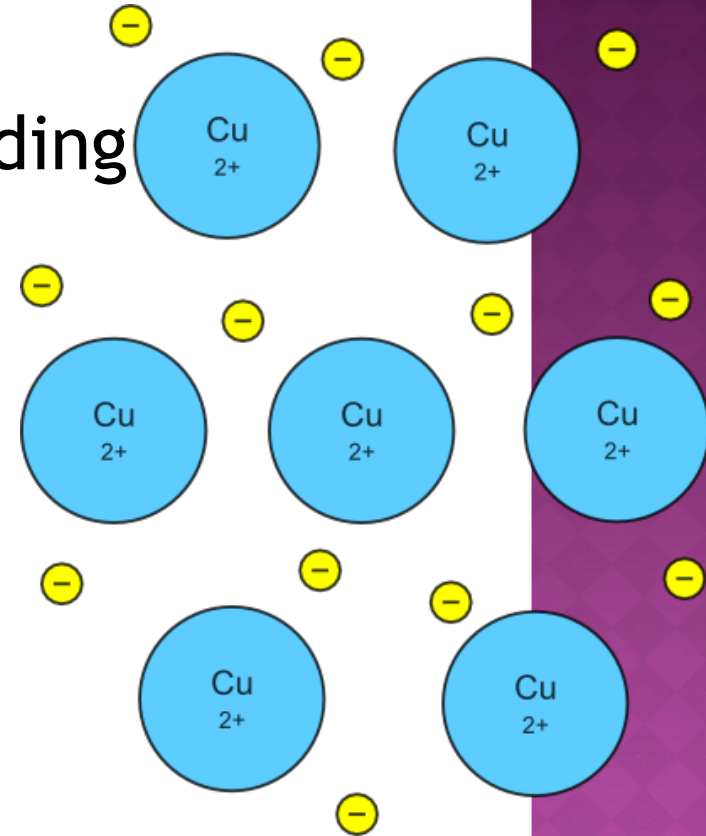


METALLIC BONDING



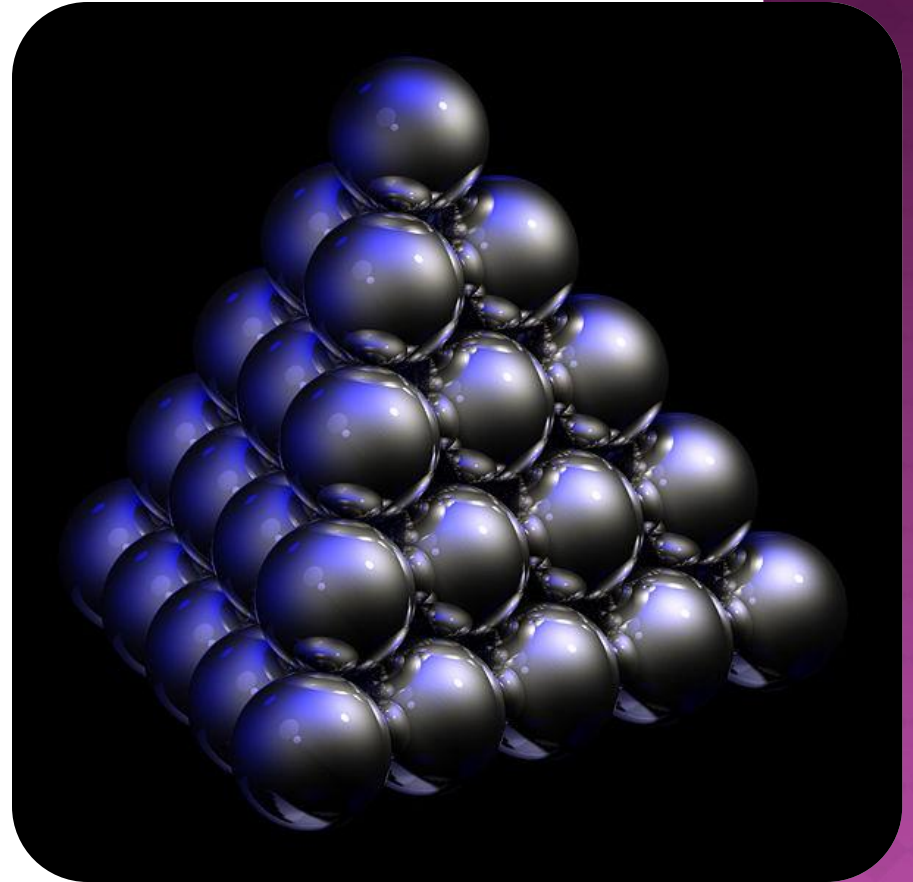
METALLIC BONDING

- ❑ The chemical bonding that results from the attraction between metal cations and the surrounding sea of electrons
- ❑ Vacant *p* and *d* orbitals in metal's outer energy levels overlap, and allow outer electrons to move freely throughout the metal
- ❑ Valence electrons do not belong to any one atom



PACKING IN METALS

Model: Packing uniform, hard spheres to best use available space. This is called *closest packing*. Each atom has 12 nearest neighbors.



PROPERTIES OF METALS

- ☐ Metals are good conductors of heat and electricity
- ☐ Metals are malleable
- ☐ Metals are ductile
- ☐ Metals have high tensile strength
- ☐ Metals have luster
- ☐ Insoluble in water

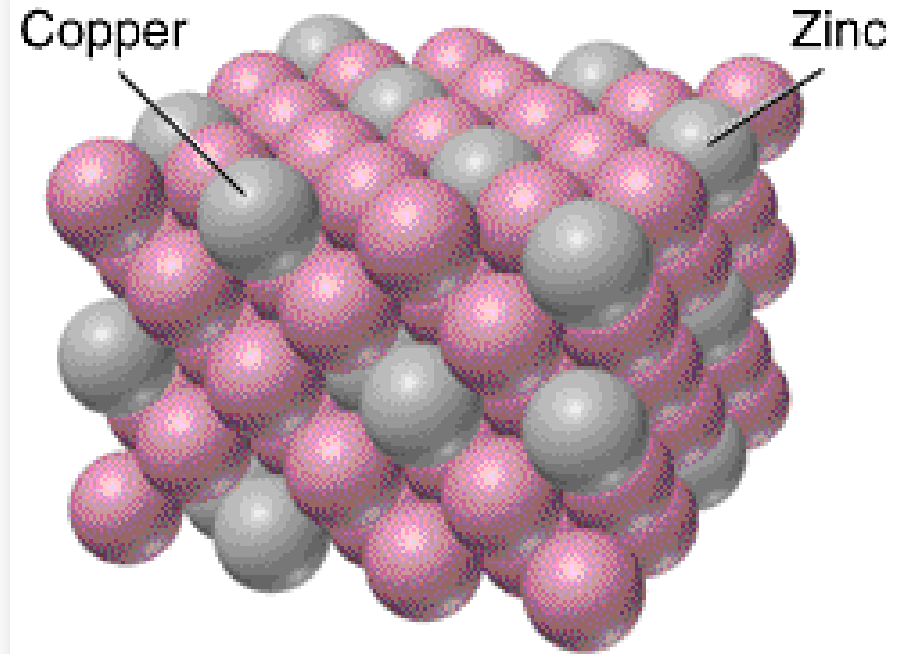


ALLOYS

- ⦿ A mixture of 2 or more metals that have superior properties to their components
 - Brass, bronze, steel are alloys

METAL ALLOYS

❖ **Substitutional Alloy:** some metal atoms replaced by others of similar size.

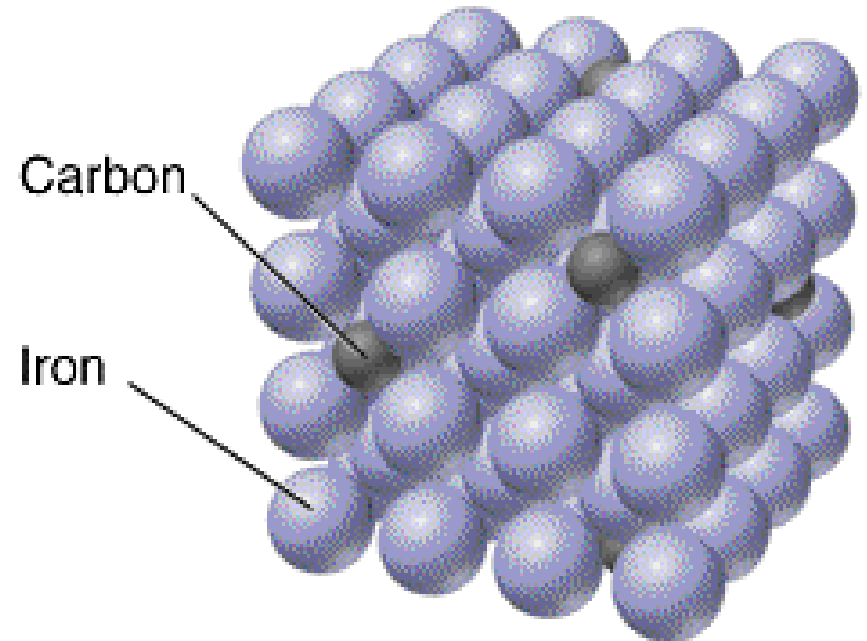


A Brass, a substitutional alloy

METAL ALLOYS

❖ Interstitial Alloy:

Interstices (holes) in closest packed metal structure are occupied by small atoms.



B Carbon steel, an interstitial alloy