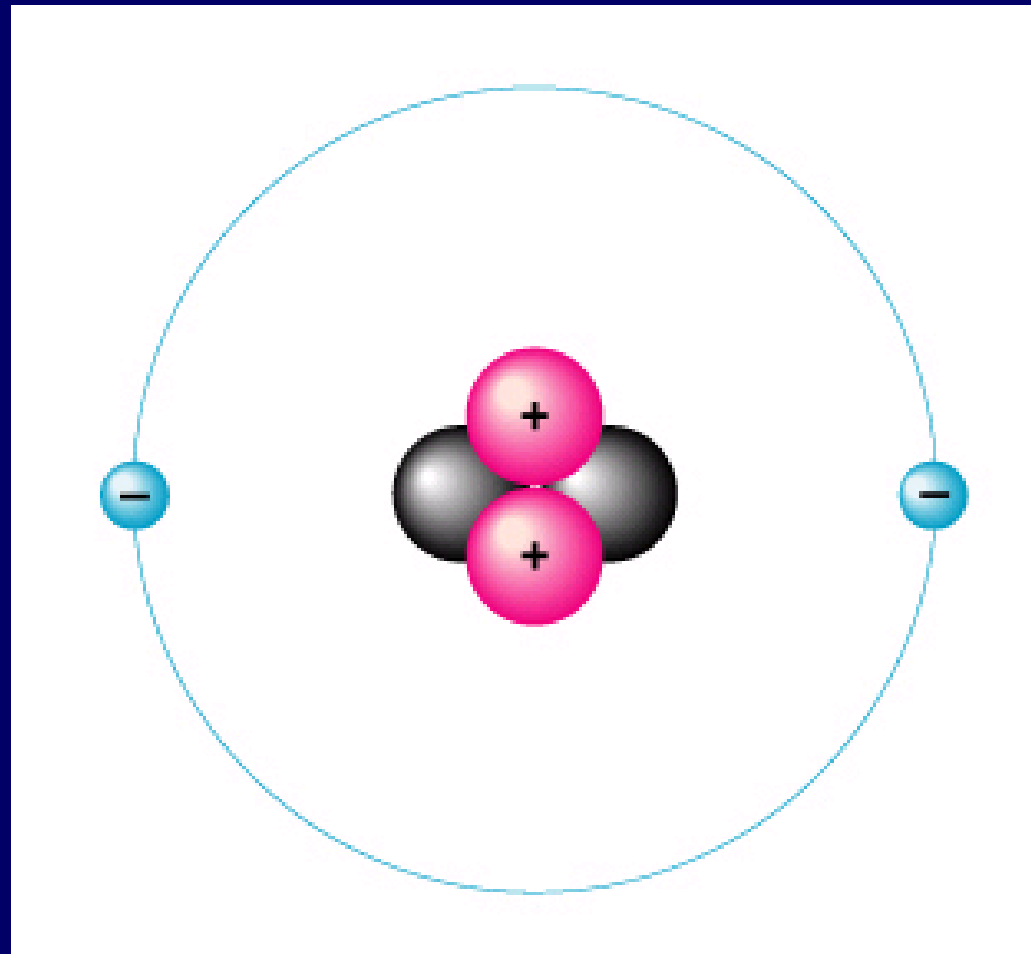


Atom – the smallest unit of matter “indivisible”



Helium
atom

electron shells

- a) Atomic number = number of Electrons
- b) Electrons vary in the amount of energy they possess, and they occur at certain energy levels or **electron shells**.
- c) Electron shells determine how an atom behaves when it encounters other atoms

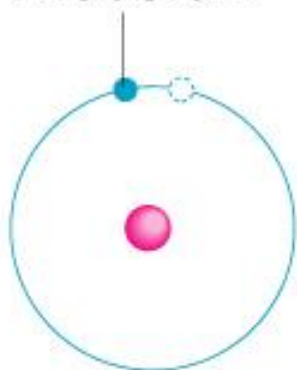
Electrons are placed in shells according to rules:

- 1) The 1st shell can hold up to two electrons, and each shell thereafter can hold up to 8 electrons.

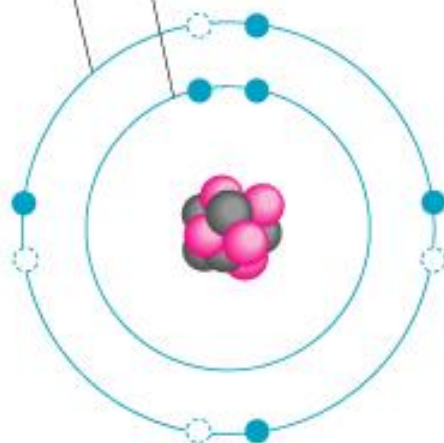
Outermost electron shell (can hold 8 electrons)

First electron shell (can hold 2 electrons)

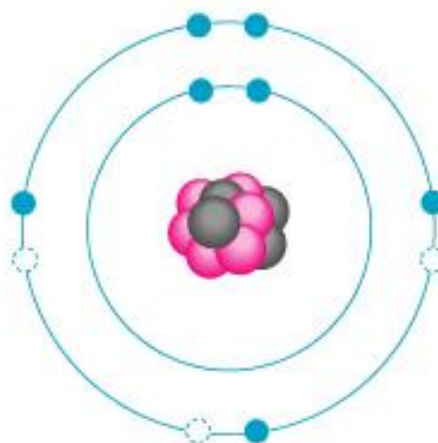
Electron



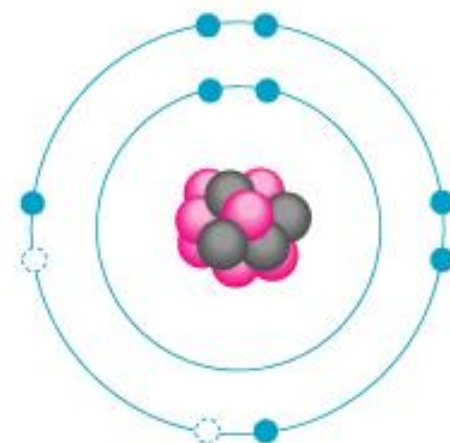
HYDROGEN (H)
Atomic number
= 1



CARBON (C)
Atomic number
= 6



NITROGEN (N)
Atomic number
= 7



OXYGEN (O)
Atomic number
= 8

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Octet Rule = atoms tend to gain, lose or share electrons so as to have 8 electrons

✓ C would like to

Gain 4 electrons

✓ N would like to

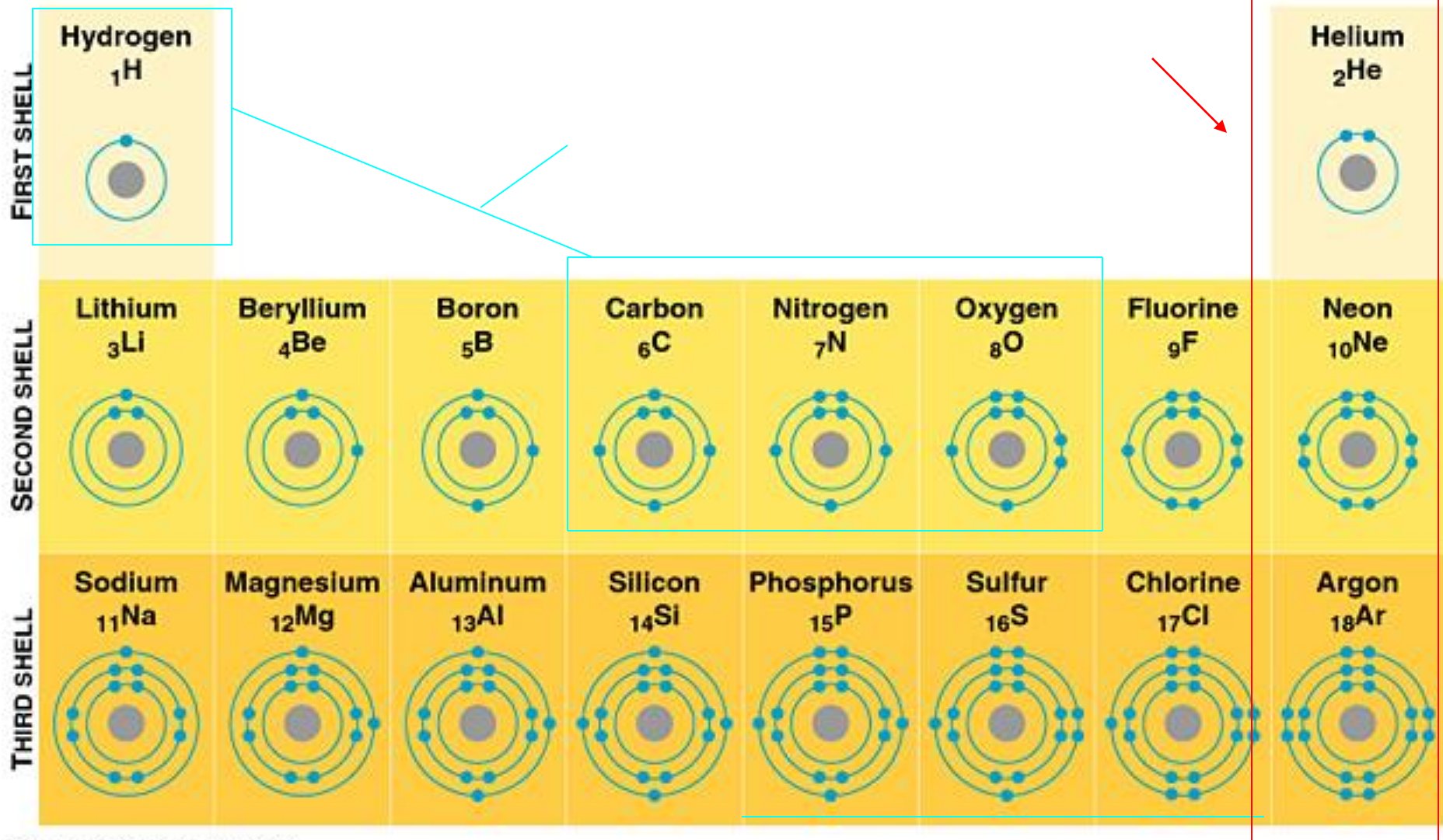
Gain 3 electrons

✓ O would like to

Gain 2 electrons

Why are electrons important?

- 1) Elements have different electron configurations
 - different electron configurations mean different levels of bonding



Electron Dot Structures

Symbols of atoms with dots to represent the valence-shell electrons



Chemical bonds: an attempt to fill electron shells

1. Ionic bonds –
2. Covalent bonds –
3. Metallic bonds

IONIC BOND

**bond formed between
two ions by the
transfer of electrons**

Formation of Ions from Metals

- **Ionic compounds** result when **metals** react with **nonmetals**
- Metals *lose* electrons to match the *number of valence electrons* of their nearest noble gas
- *Positive ions* form *when* the number of electrons are **less** than the number of protons

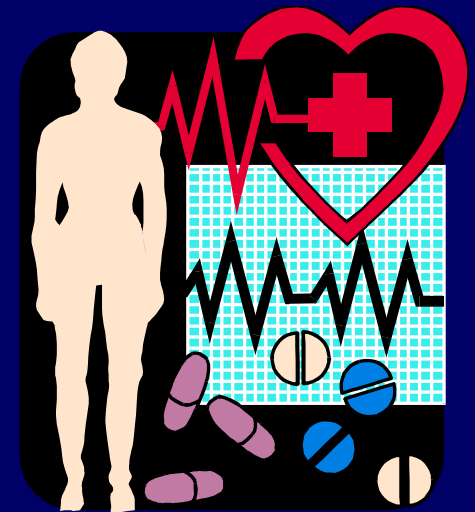
Group 1 metals \longrightarrow **ion** 1^+

Group 2 metals \longrightarrow **ion** 2^+

• Group 13 metals \longrightarrow **ion** 3^+

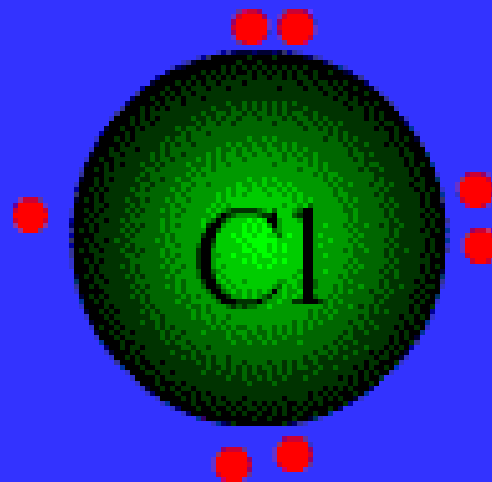
Ions from Nonmetal Ions

- In ionic compounds, nonmetals in 15, 16, and 17 gain electrons from metals
- Nonmetal add electrons to achieve the octet arrangement
- Nonmetal ionic charge:
3-, 2-, or 1-

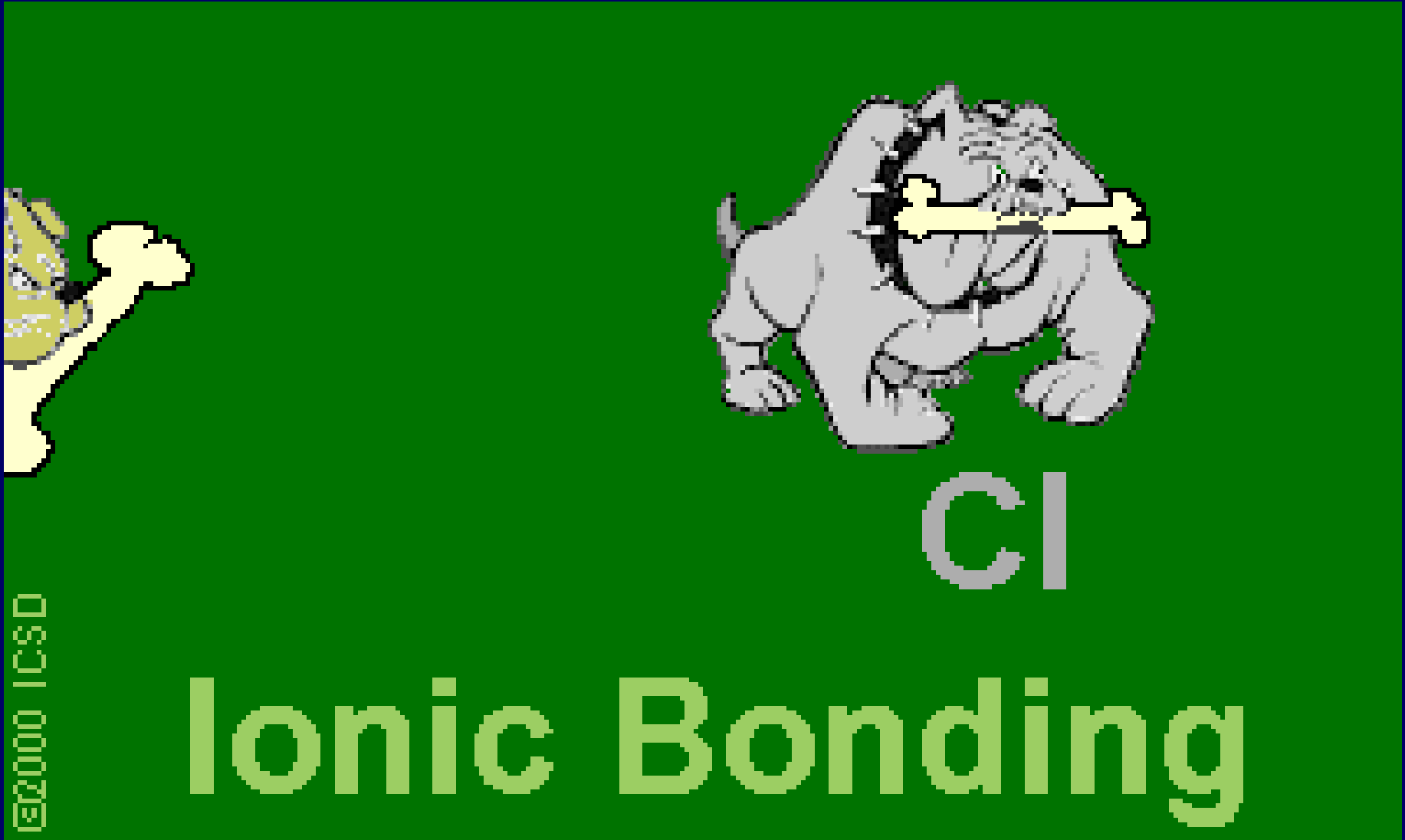


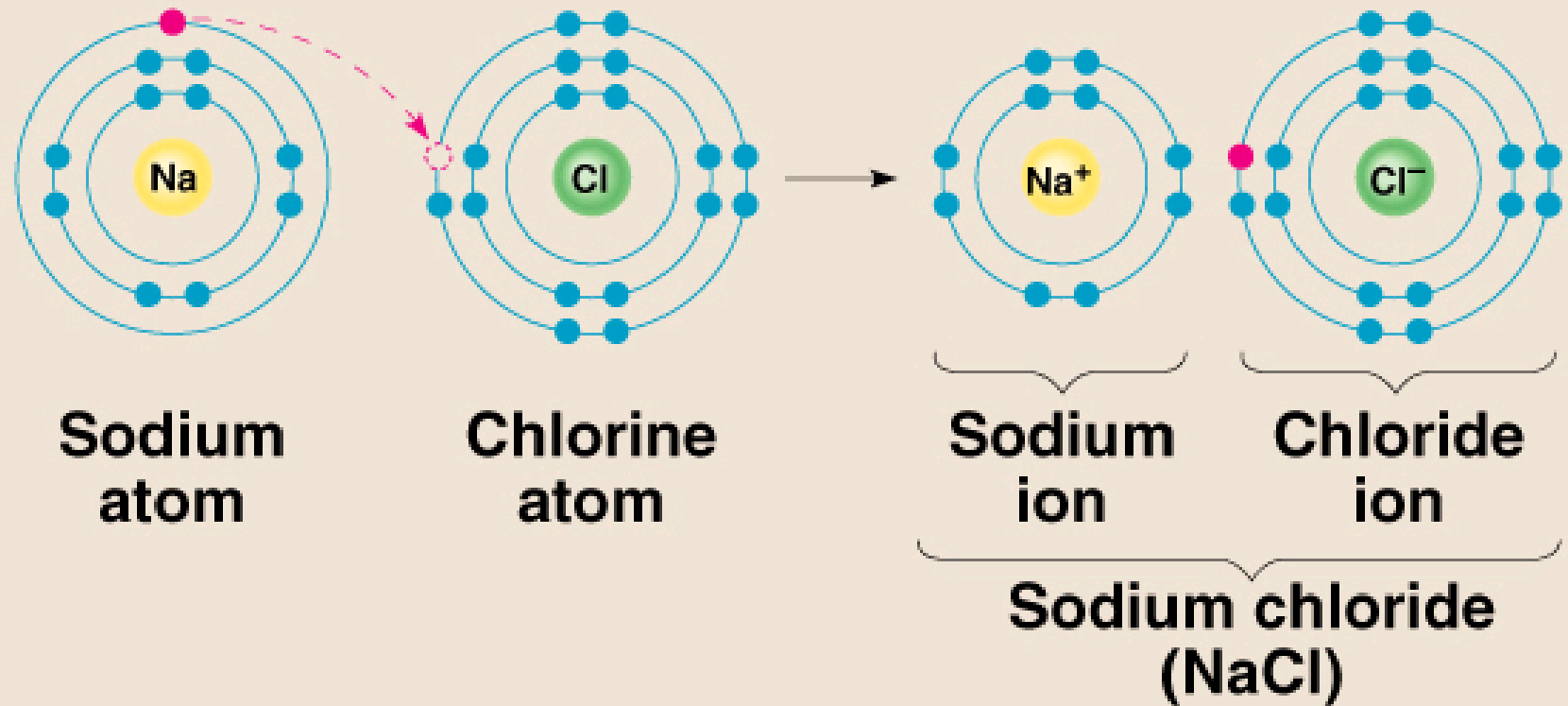
Ionic Bond

- Between atoms of metals and nonmetals with very different electronegativity
- Bond formed by transfer of electrons
- Produce charged ions all states. Conductors and have high melting point.
- Examples; NaCl, CaCl₂, K₂O



Ionic Bonds: One Big Greedy Thief Dog!

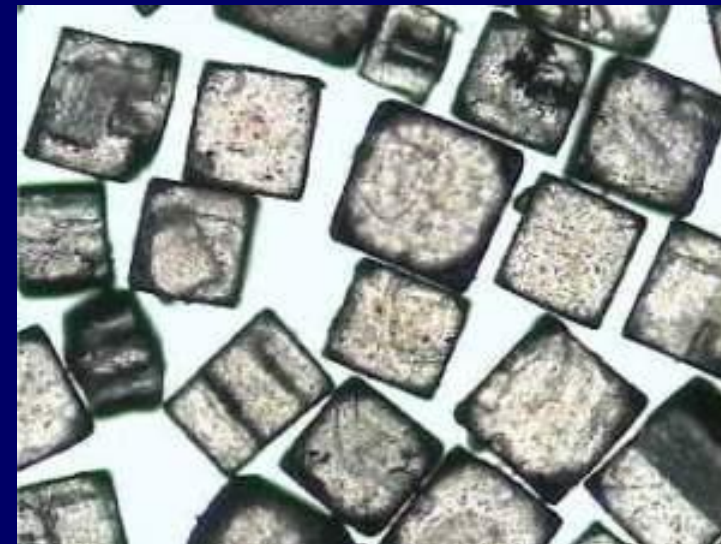
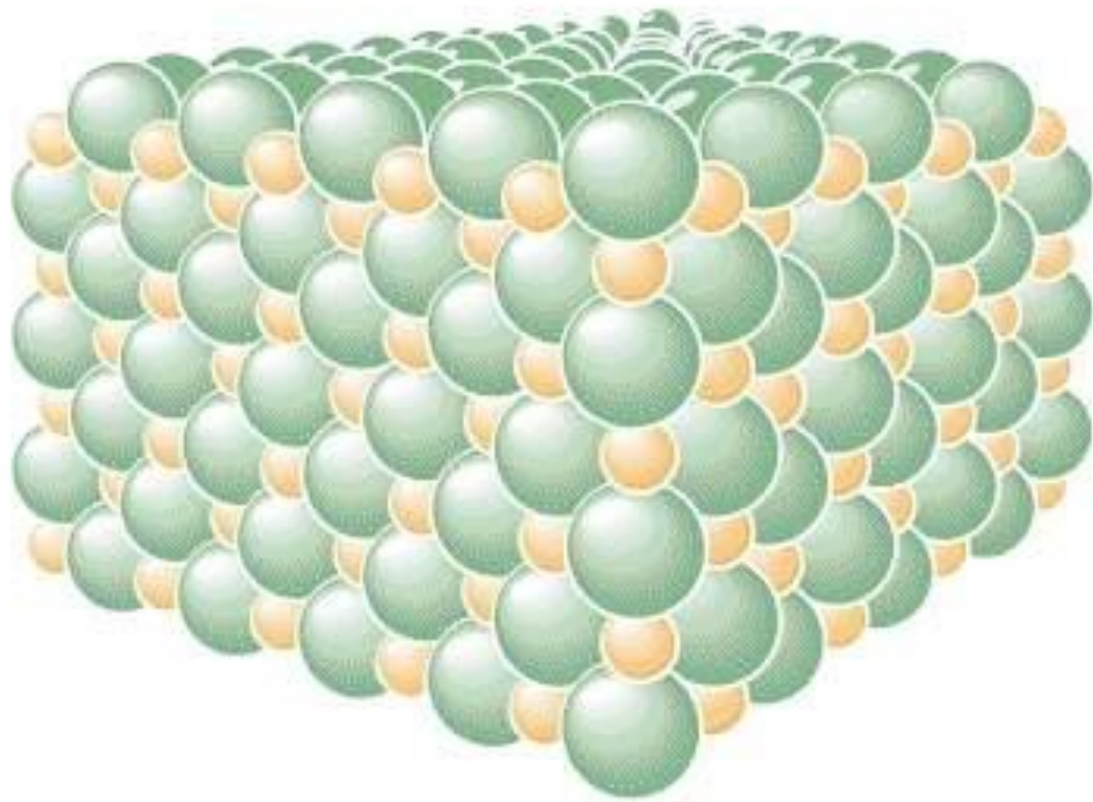






1). **Ionic bond** – electron from Na is transferred to Cl, this causes a charge imbalance in each atom. The Na becomes (Na⁺) and the Cl becomes (Cl⁻), charged particles or ions.

Formula Unit

- Ionic Compounds are crystalline structures
- Formula Unit – smallest ratio unit of a crystal
- NaCl, CaCl₂



 Sodium ion (Na^+)

 Chloride ion (Cl^-)

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Lattice Energy

- Energy released when one mole of an ionic crystalline compound is formed from gaseous ions.
- - value indicates energy release upon breaking
- Greater the number, greater attraction between the ions.

Rank in order of increasing mp

- LiF
- BeS
- Ca_3P_2
- KCl

- $\text{KCl} < \text{LiF} < \text{BeS} < \text{Ca}_3\text{P}_2$

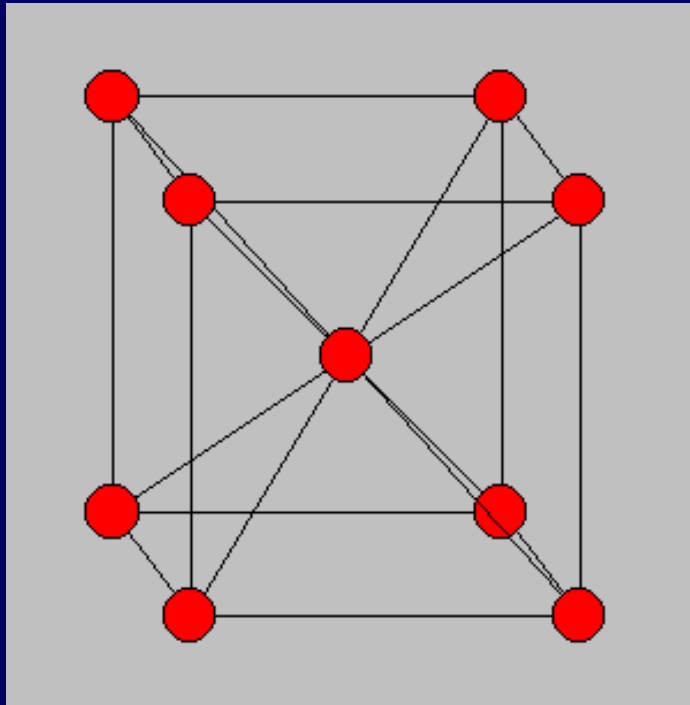
METALLIC BOND

**bond found in
metals; holds metal
atoms together
very strongly**

Metallic Bond

- Formed between atoms of metallic elements
- Electron cloud around atoms
- Good conductors at all states, lustrous, very high melting points
- Examples; Na, Fe, Al, Au, Co

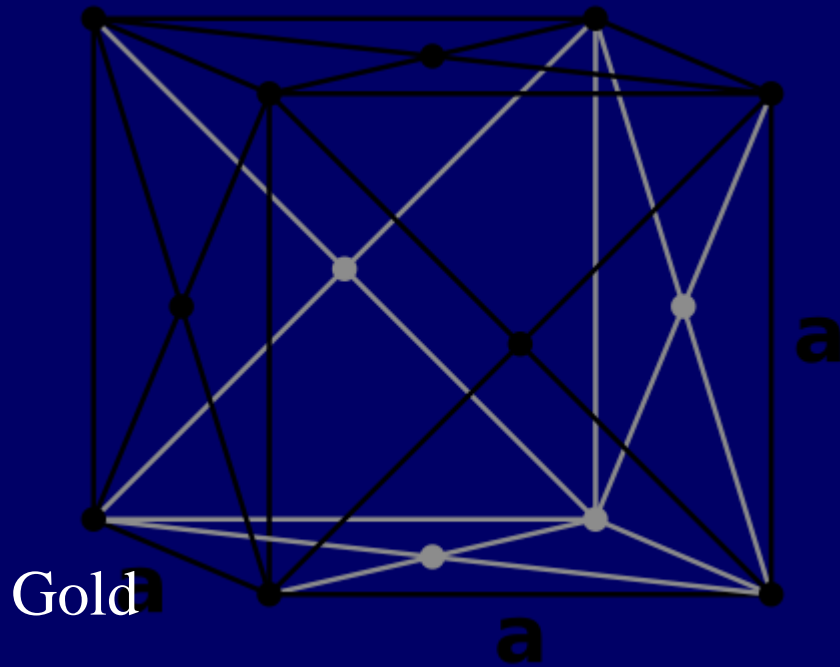
Body Centered Cubic



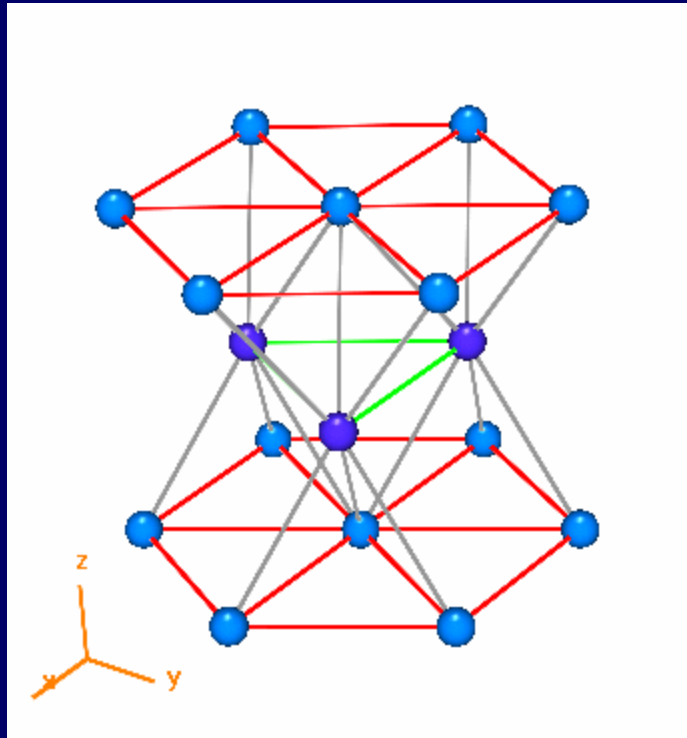
Chromium



Face-Centered Cubic

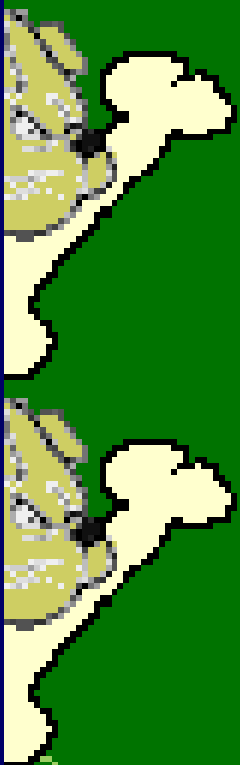


Hexagonal Close-Packed



<http://phycomp.technion.ac.il/~pavelba/hcps.gif> ^{Zinc}

Metallic Bonds: Mellow dogs with plenty of bones to go around.

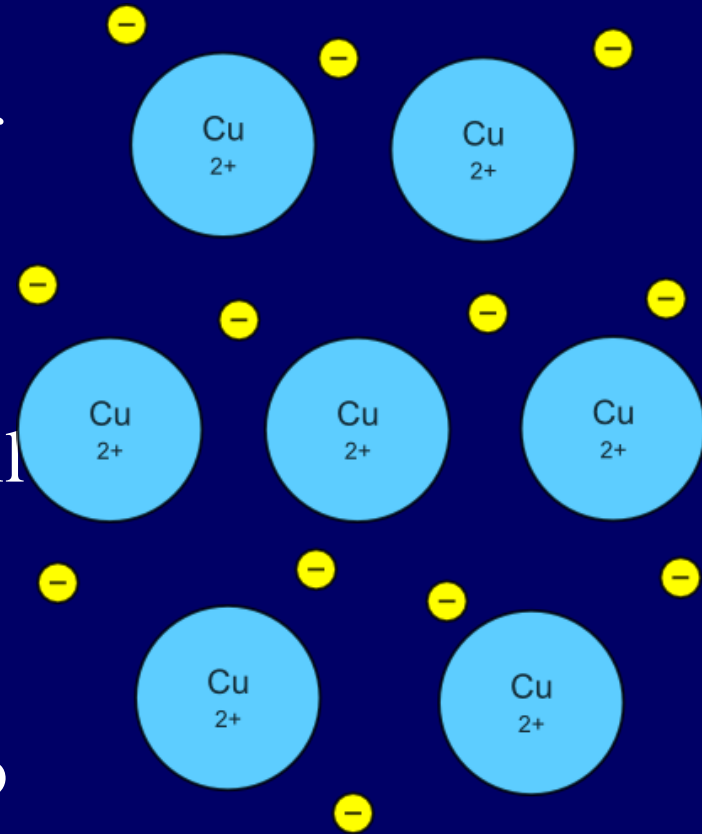


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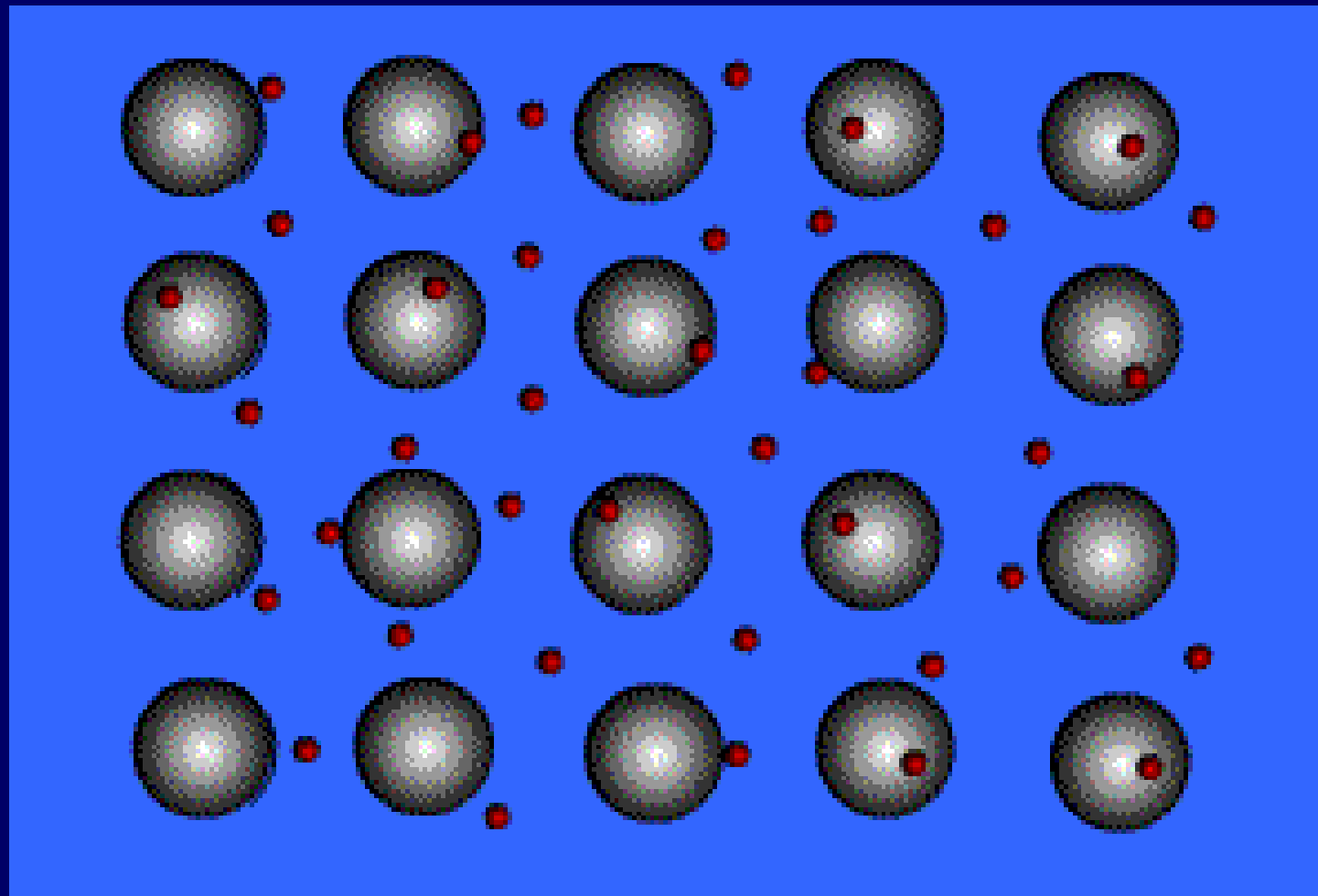
Metallic Bonding

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 all outer electrons to move freely throughout the metal
- ❑ Valence electrons do not belong to any one atom

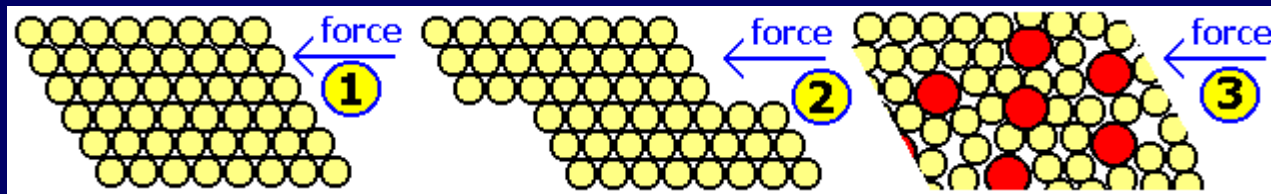


Ionic Bond, A Sea of Electrons



Metals Form Alloys

Metals do not combine with metals. They form Alloys which is a solution of a metal in a metal. Examples are steel, brass, bronze and pewter.



Alloys

- Mixtures of two or more elements, at least one of which is a metal.
- Made by melting, mixing, then cooling the metals.
- May contain non-metals like carbon.

Alloys

- Properties are superior to their components.
- Sterling silver
 - 92.5% Ag, 7.5% Cu
 - Harder than silver
- Bronze
 - 7:1 Cu to Sn (tin)

Alloys

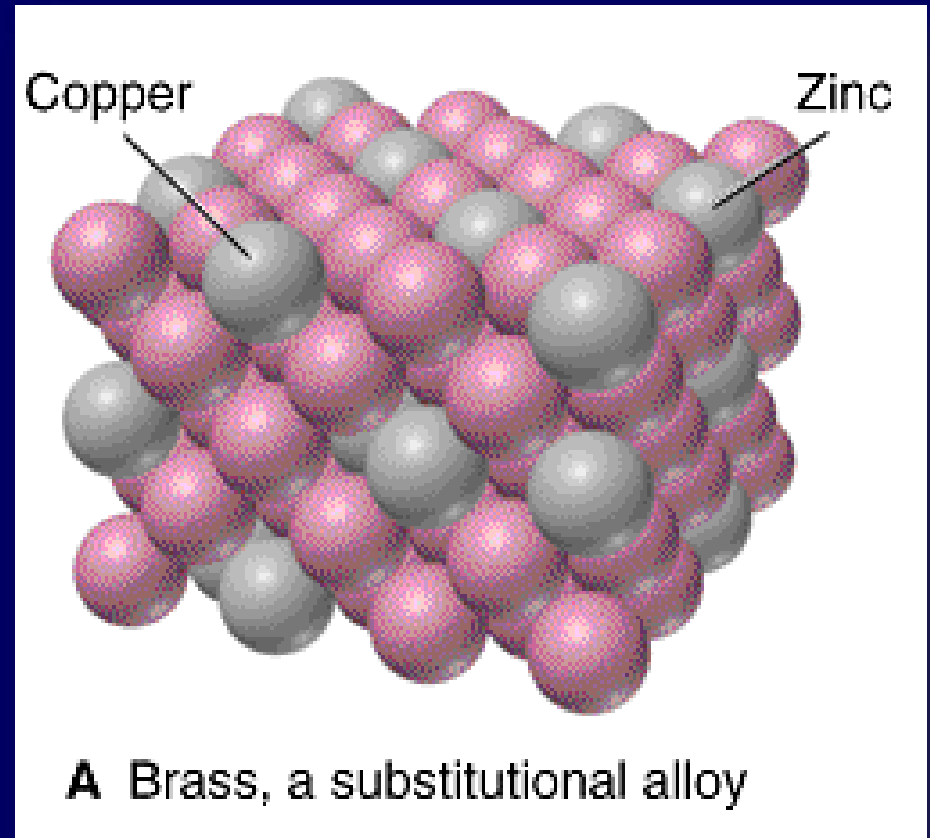
- Stainless Steel
 - Fe 80.6%, Cr 18%, C 0.4%, Ni 1%
- Cast Iron
 - Fe 96%, C 4%

Types of Alloys

- Two types of formation:
 - Substitutional alloys
 - Similar size atoms – replacement
 - Interstitial alloys
 - Different size atoms – smaller ions fill interstices (spaces between atoms)

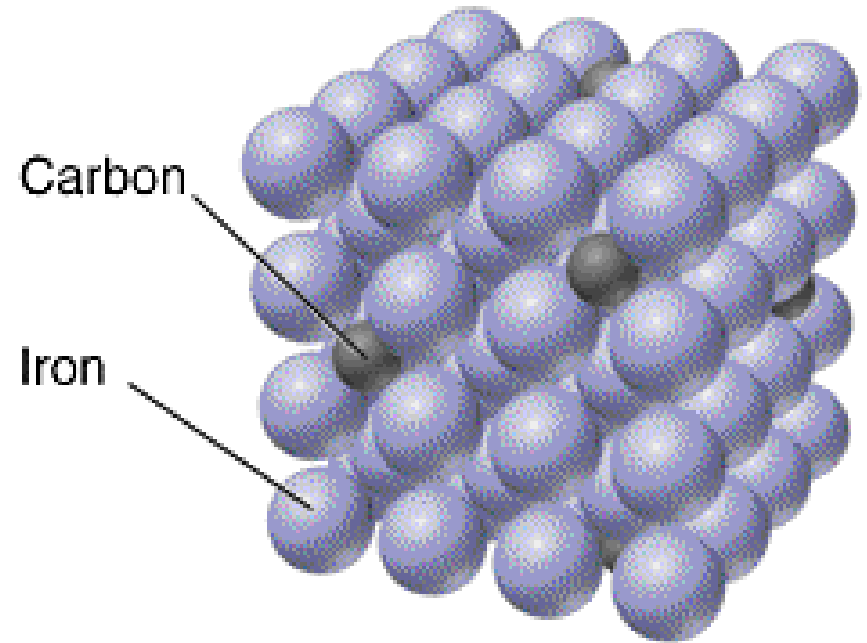
Metal Alloys

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



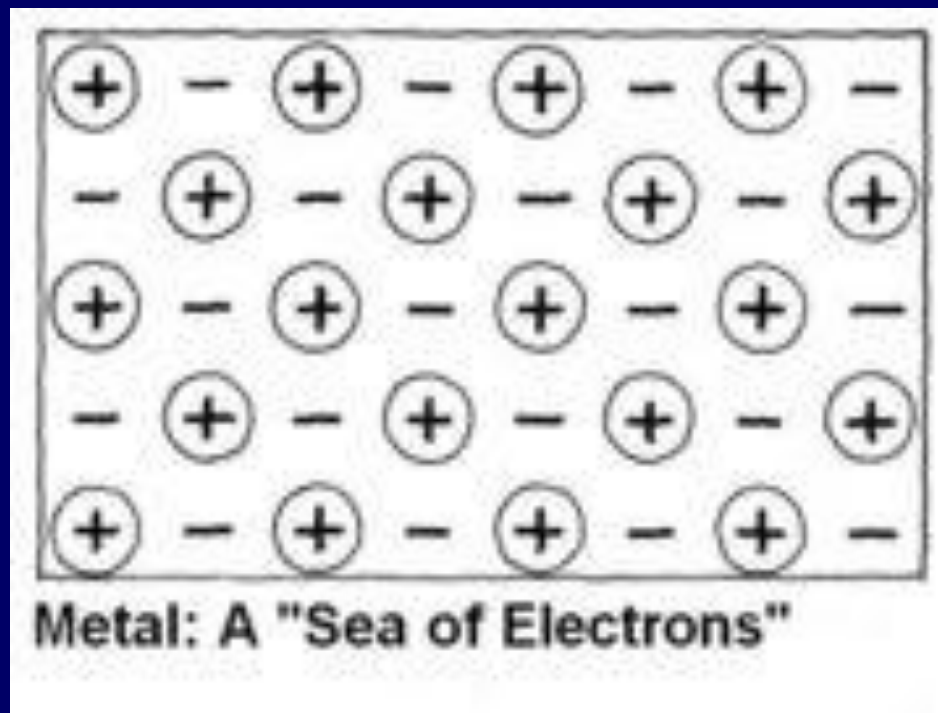
Metal Alloys

❖ **Interstitial Alloy:**
Interstices (holes) in
closest packed metal
structure are occupied
by small atoms.



B Carbon steel, an interstitial alloy

Why is a metal ductile but an ionic compound is not?

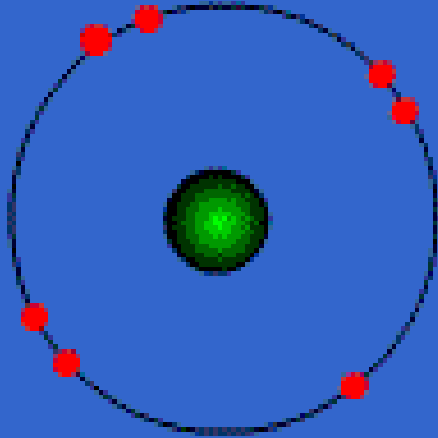


COVALENT BOND

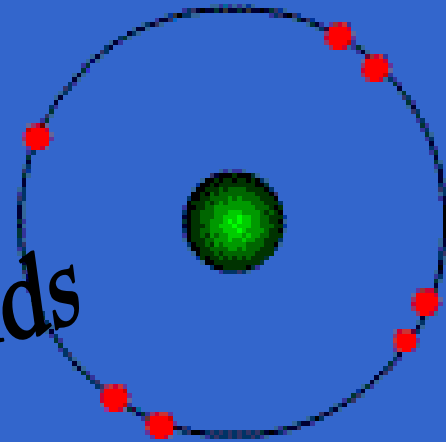
bond formed by the
sharing of electrons

Covalent Bond

- Between nonmetallic elements of similar electronegativity.
- Formed by sharing electron pairs
- Stable non-ionizing particles, they are not conductors at any state
- Examples; O_2 , CO_2 , C_2H_6 , H_2O , SiC



Covalent Bonds



**Bonds in all the
polyatomic ions
and diatomics
are all covalent
bonds**

NONPOLAR COVALENT BONDS

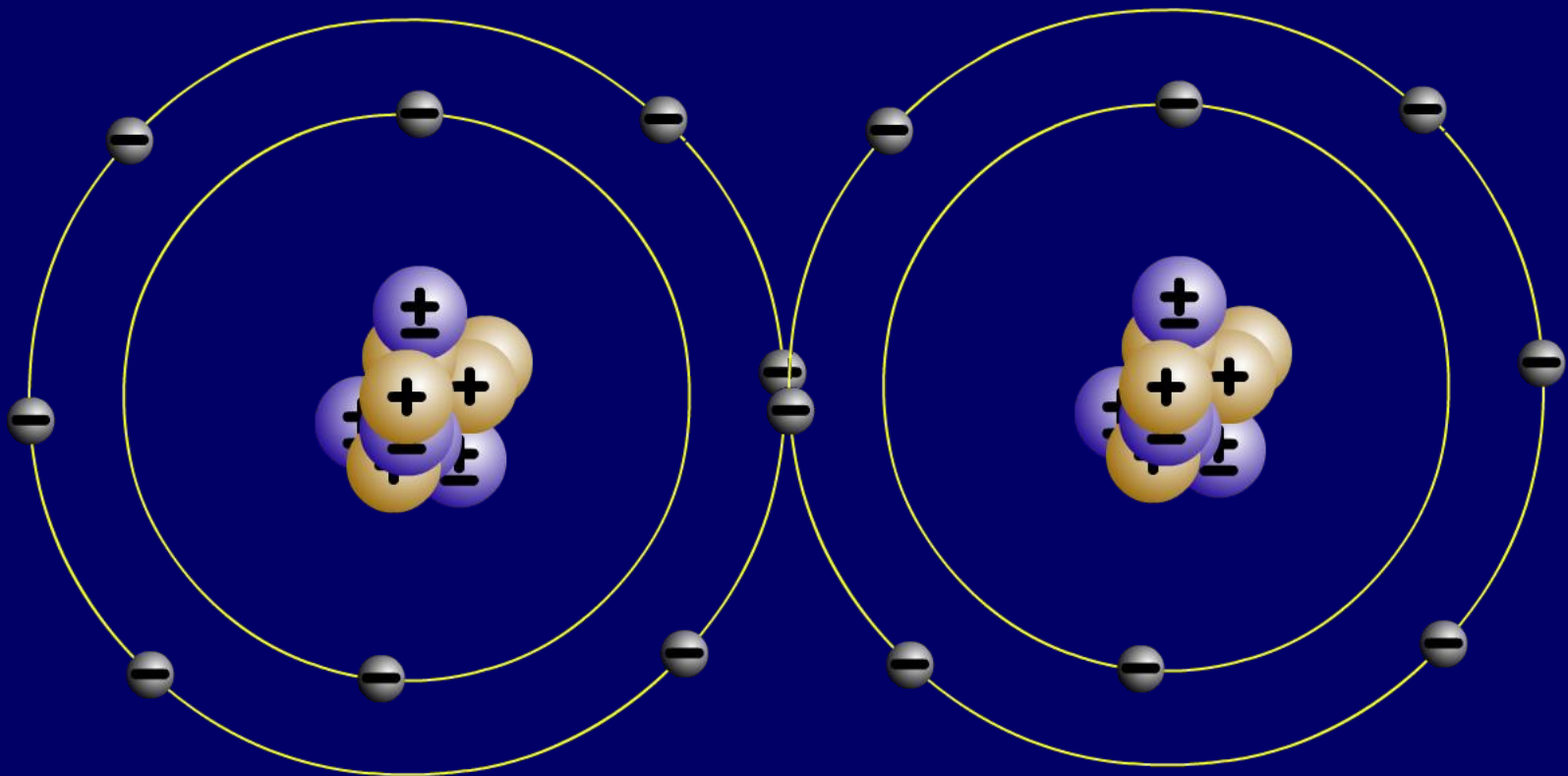
when electrons are
shared *equally*

H₂ or Cl₂

2. Covalent bonds- Two atoms share one or more pairs of outer-shell electrons.

Oxygen Atom

Oxygen Atom



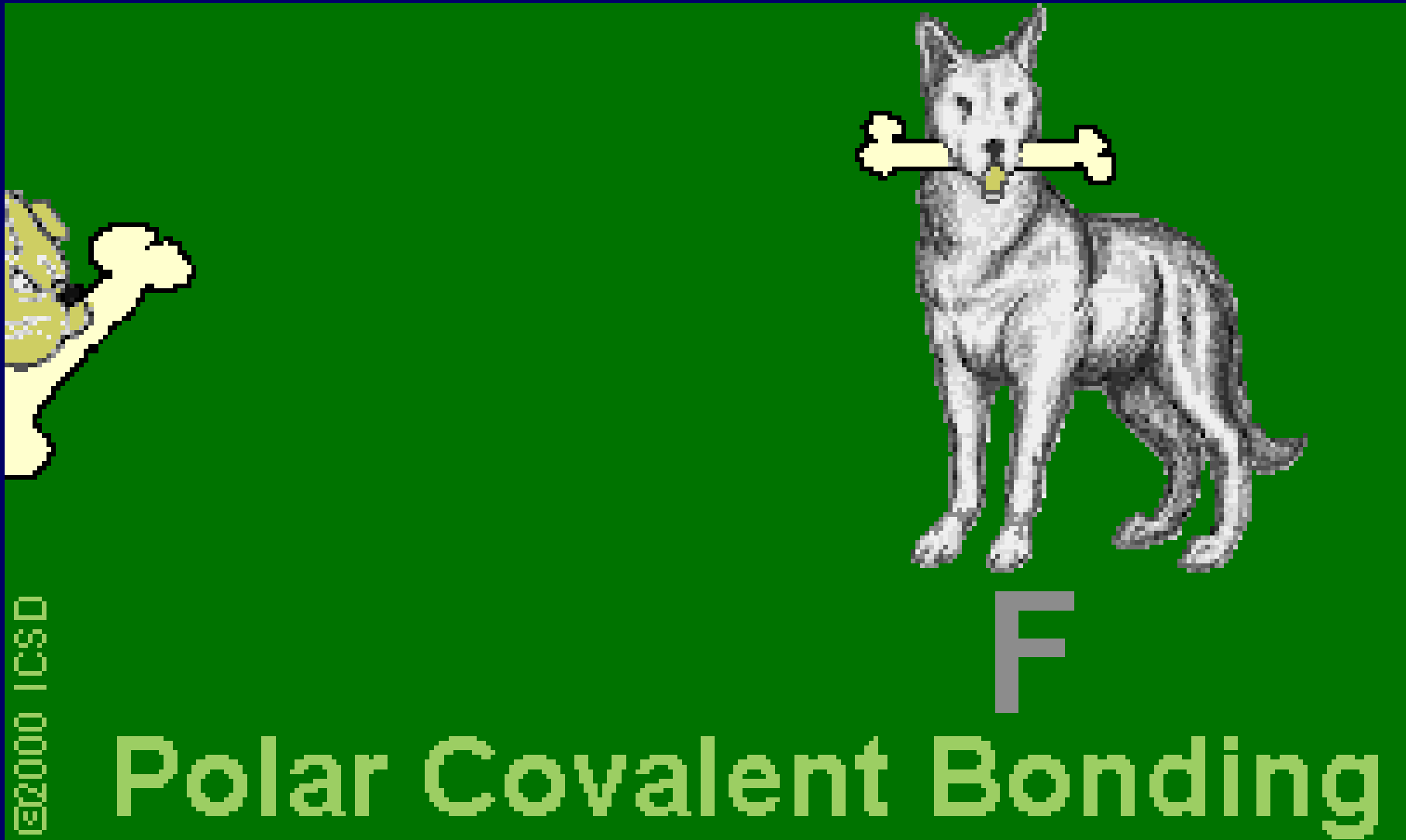
Oxygen Molecule (O_2)

POLAR COVALENT BONDS

when electrons are
shared but shared
unequally

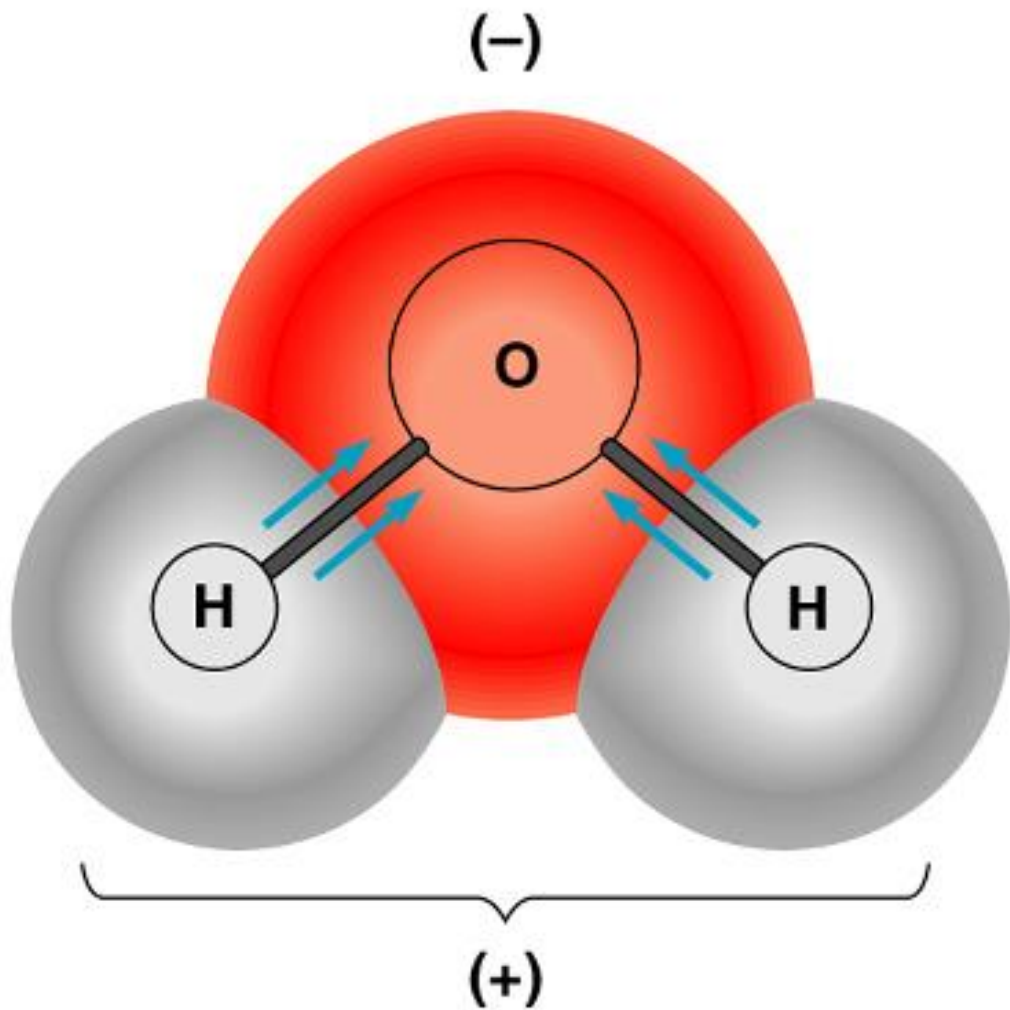


Polar Covalent Bonds: Unevenly matched, but willing to share.

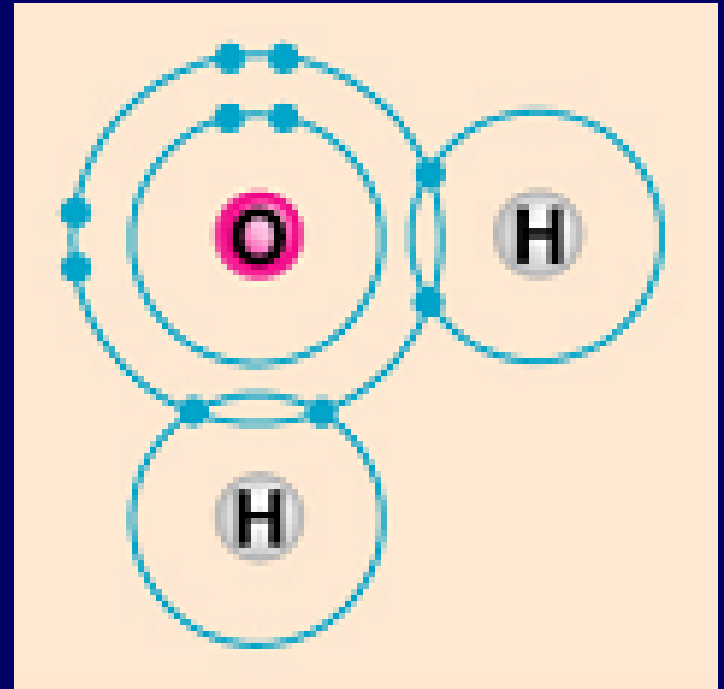


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Polar Covalent Bonding



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- water is a *polar molecule* because oxygen is more electronegative than hydrogen, and therefore electrons are pulled closer to oxygen.

