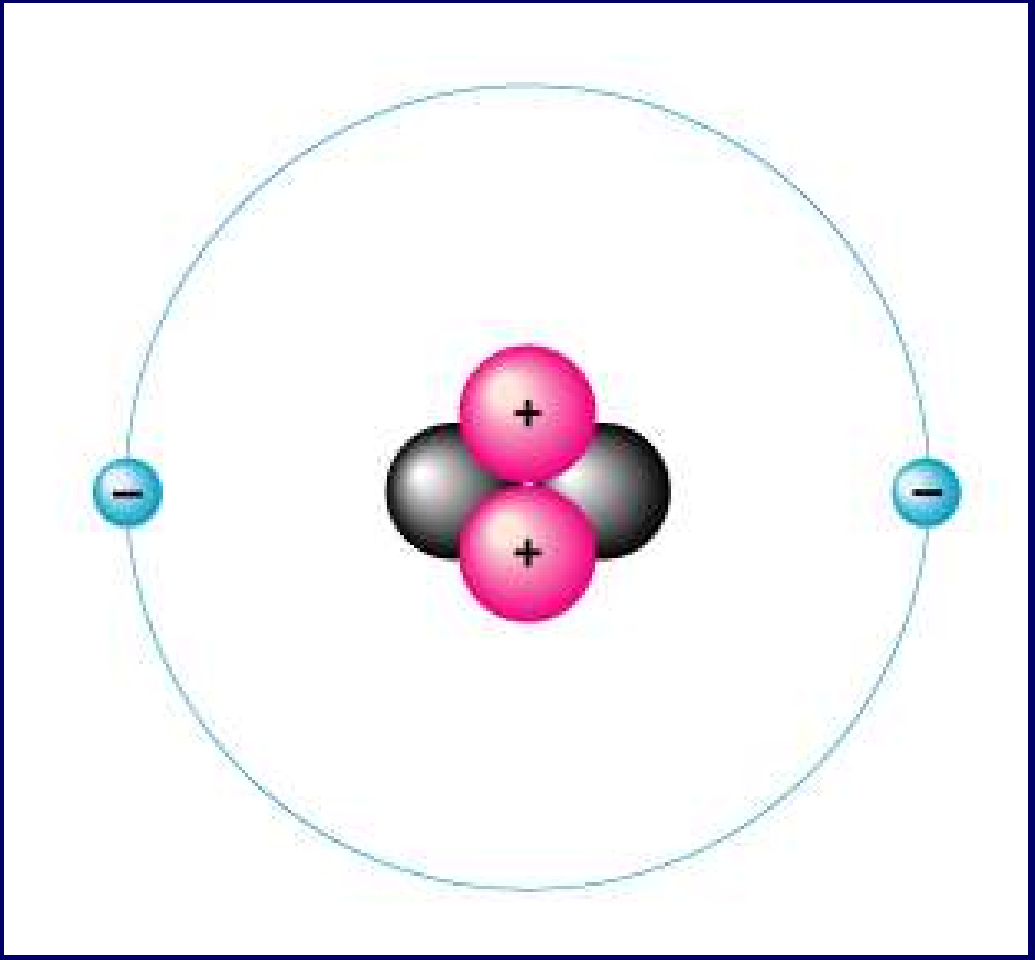
Chemical Bonds

Atom – the smallest unit of matter "indivisible"

Helium atom



electron shells (Rows) (Across)

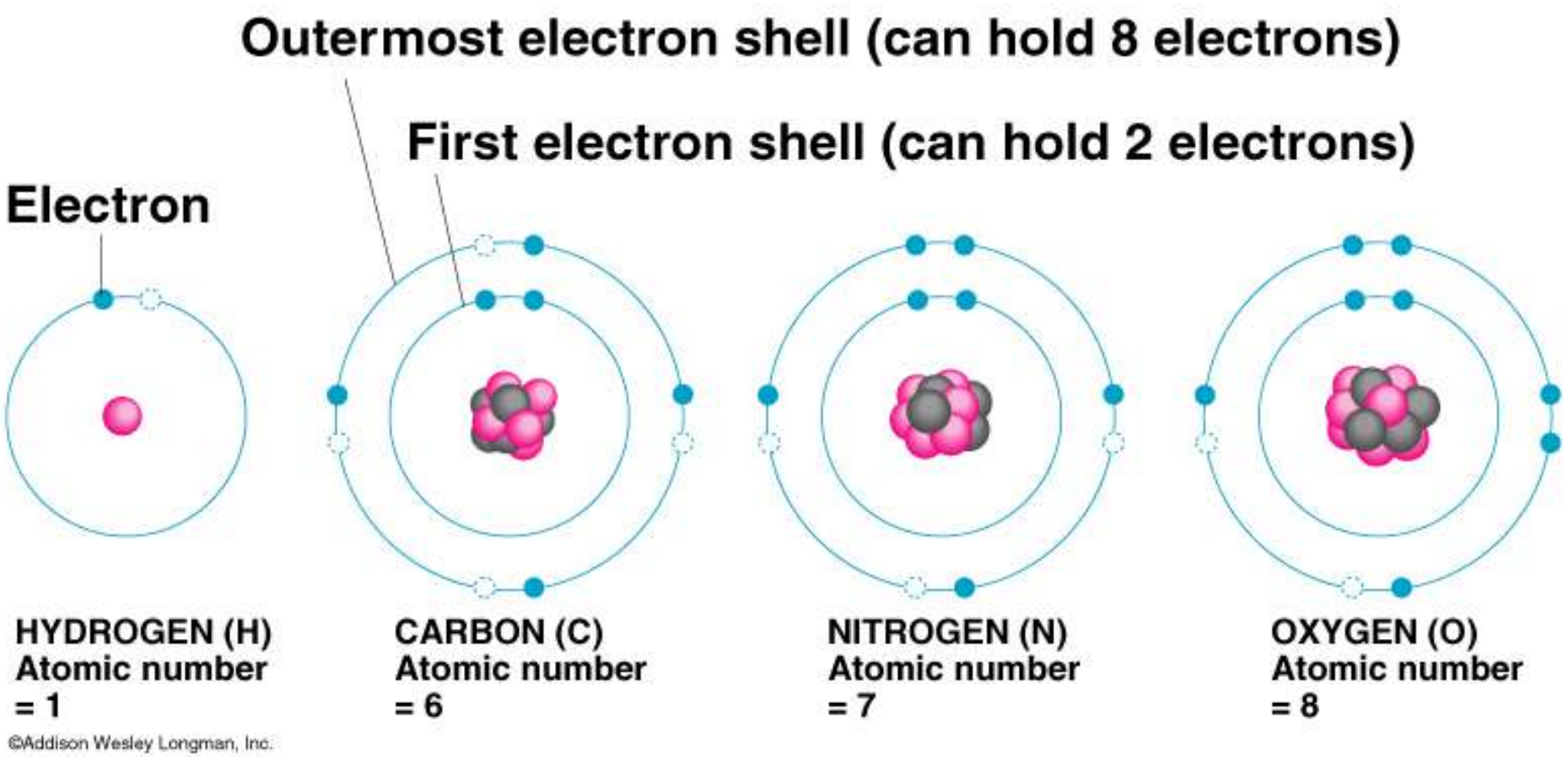
a) Atomic number = number of Electrons

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,
2) The 2nd shell can hold up to 8 electrons
3) The 3rd shell can hold up to 8 electrons
4) The 4th shell can hold up to 18 electrons and so forth.

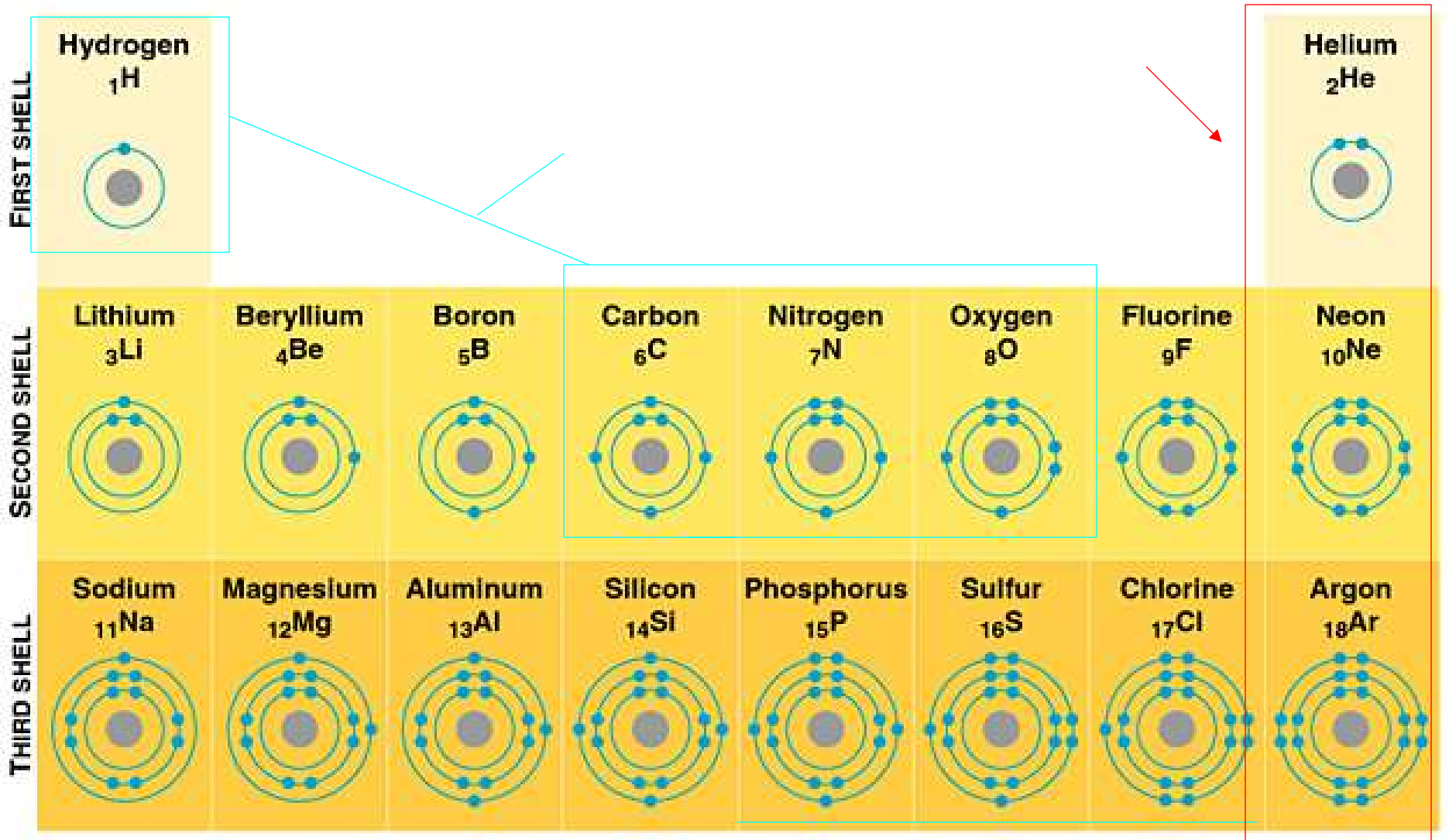


Octet Rule = atoms tend to gain, lose or share electrons so as to have 8 electrons

- ✓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

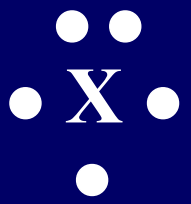
Chemical bonds: an attempt to fill electron shells

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

Learning Check

A.  would be the electron dot formula for

1) Na2) K3) Al

B.  would be the electron dot formula

1) B2) N3) P

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 ⟶ ion $^{1+}$

Group 2 metals ⟶ ion $^{2+}$

- **Group 13 metals ⟶ ion $^{3+}$**

Formation of Sodium Ion

Sodium atom **Sodium ion**

$$Na^{\bullet} - e^{-} \longrightarrow Na^{+}$$

Formation of Magnesium Ion

Magnesium atom **Magnesium ion**

$$Mg^{\bullet} - 2e^{-} \longrightarrow Mg^{2+}$$

Some Typical Ions with Positive Charges (Cations)

Group 1Group 2Group 13

$H^+Mg^{2+}Al^{3+}$

Li^+Ca^{2+}

Na^+Sr^{2+}

K^+Ba^{2+}

Learning Check

A. Number of valence electrons in aluminum

1) 1 e^- 2) 2 e^- 3) 3 e^-

B. Change in electrons for octet

1) lose 3e^- 2) gain 3 e^- 3) gain 5 e^-

C.Ionic charge of aluminum

1) 3- 2) 5- 3) 3^+

Solution

A. Number of valence electrons in aluminum

3) 3 e^-

B. Change in electrons for octet

1) lose 3e^-

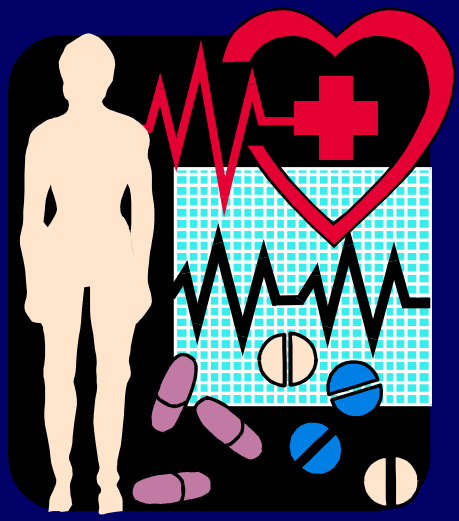
C.Ionic charge of aluminum

3) 3^+

Ions from Nonmetal Ions

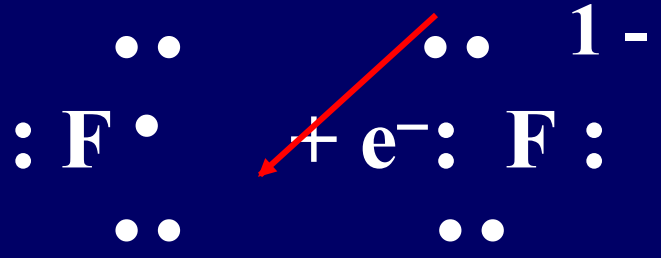
- In ionic compounds, nonmetals in 15, 16, and 17 gain electrons from metals
- Nonmetal add electrons to achieve the octet arrangement
- Nonmetal ionic charge:

3-, 2-, or 1-



Fluoride Ion

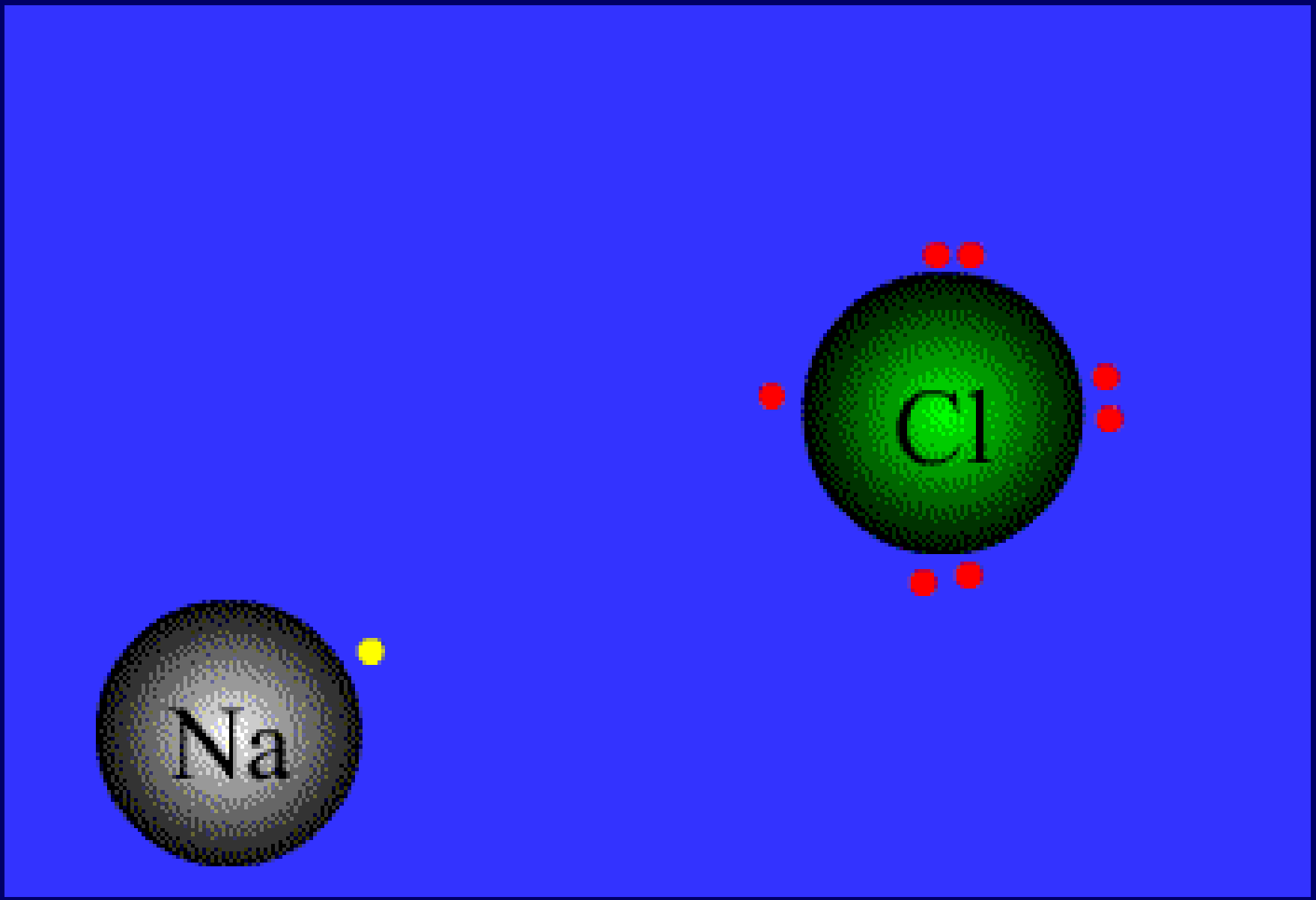
unpaired electronoctet



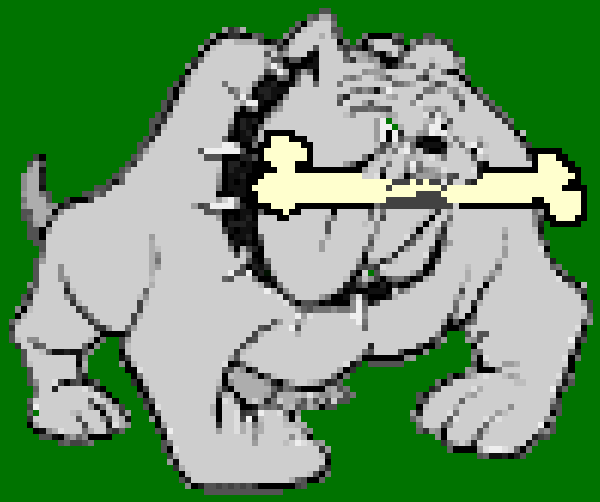
ionic charge

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; $NaCl$, $CaCl_2$, K_2O

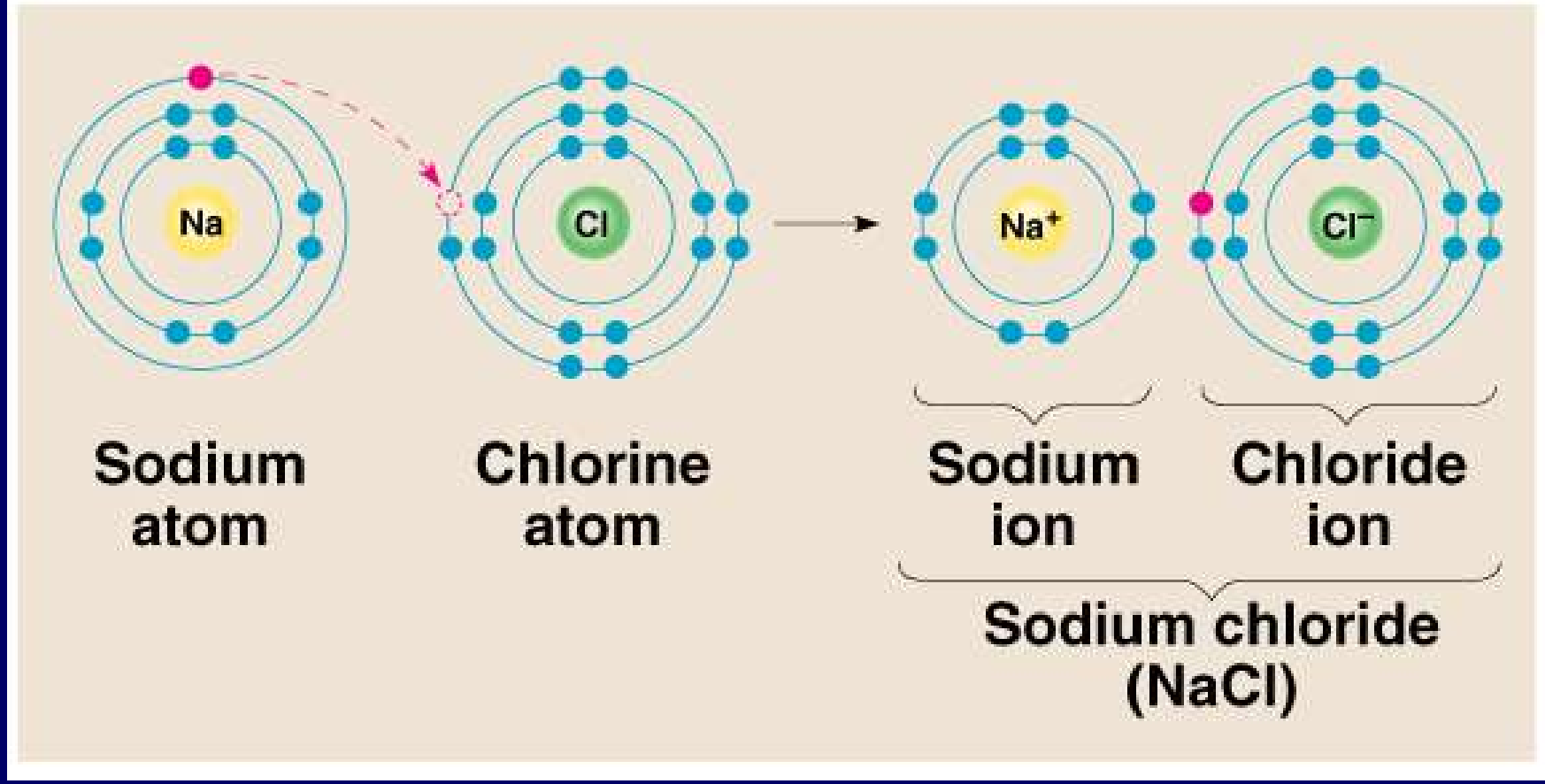

Cl
Na

Ionic Bonds: One Big Greedy Thief Dog!

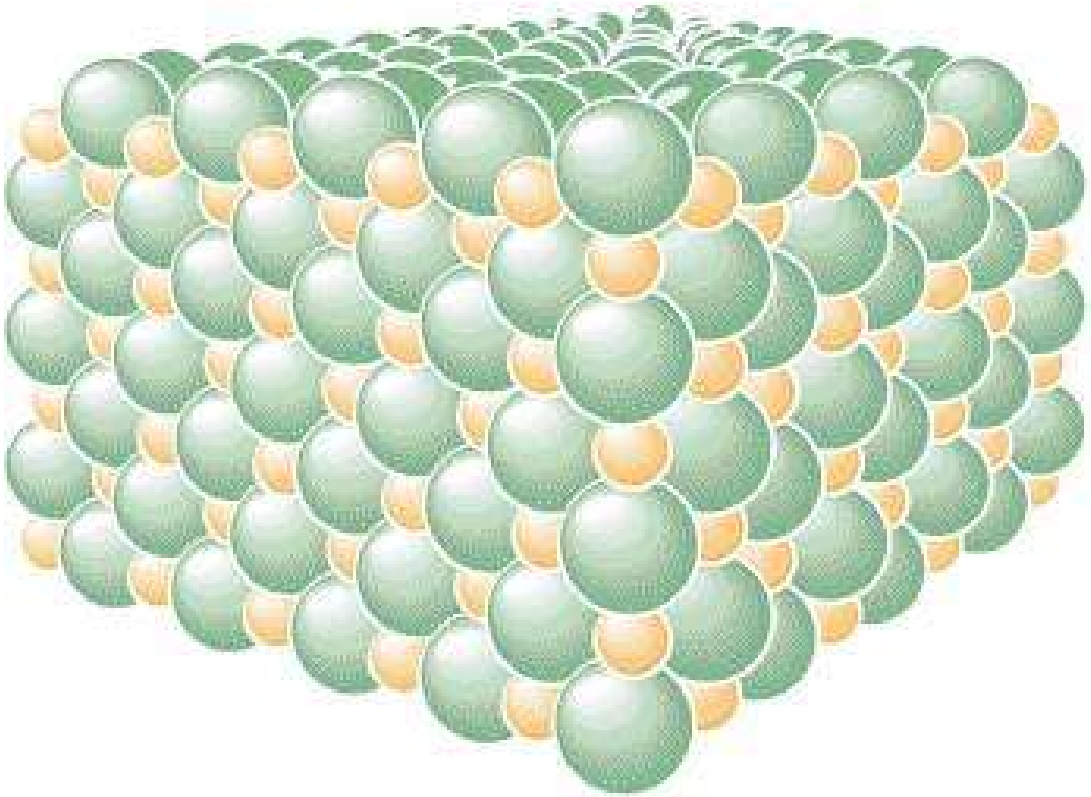


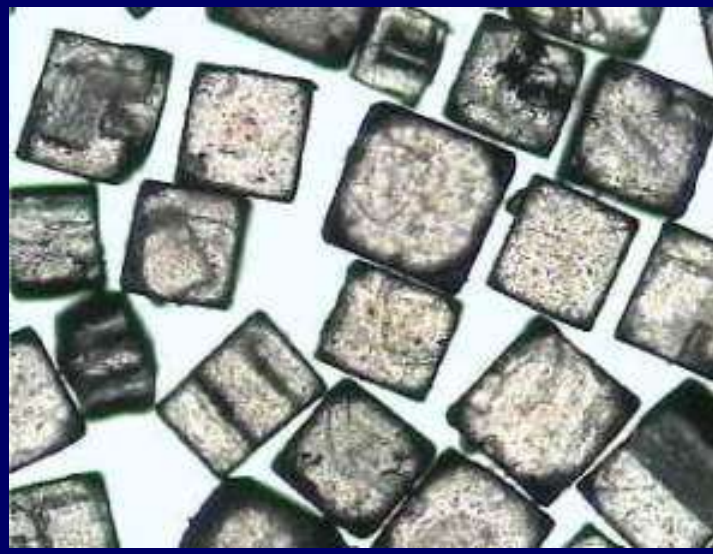
Cl

Ionic Bonding



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.





Sodium ion (Na^+)

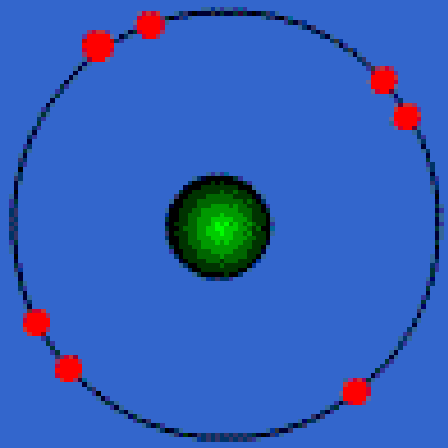
Chloride ion (Cl^-)

COVALENT BOND

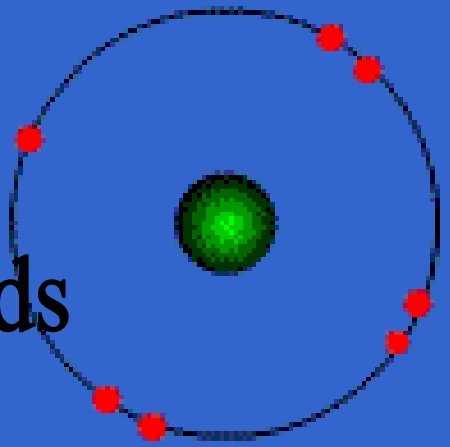
bond formed by the *sharing* of electrons

Covalent Bond

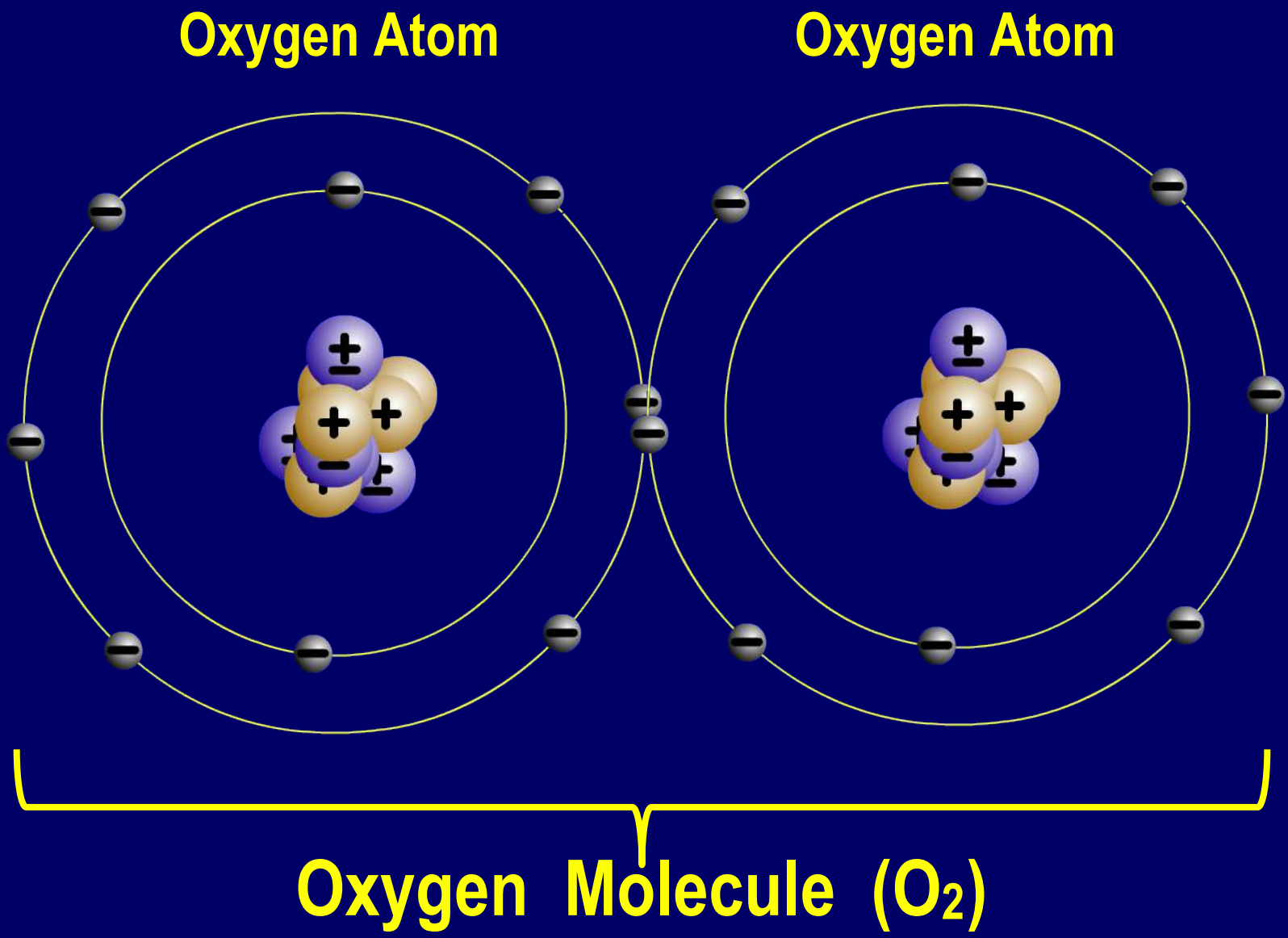
- Between nonmetallic elements of similar electronegativity.
- Formed by sharing electron pairs
- Stable non-ionizing particles, they are not conductors at any state
- Examples; O_2, CO_2, C_2H_6, H_2O, SiC



Covalent Bonds



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



METALLIC BOND

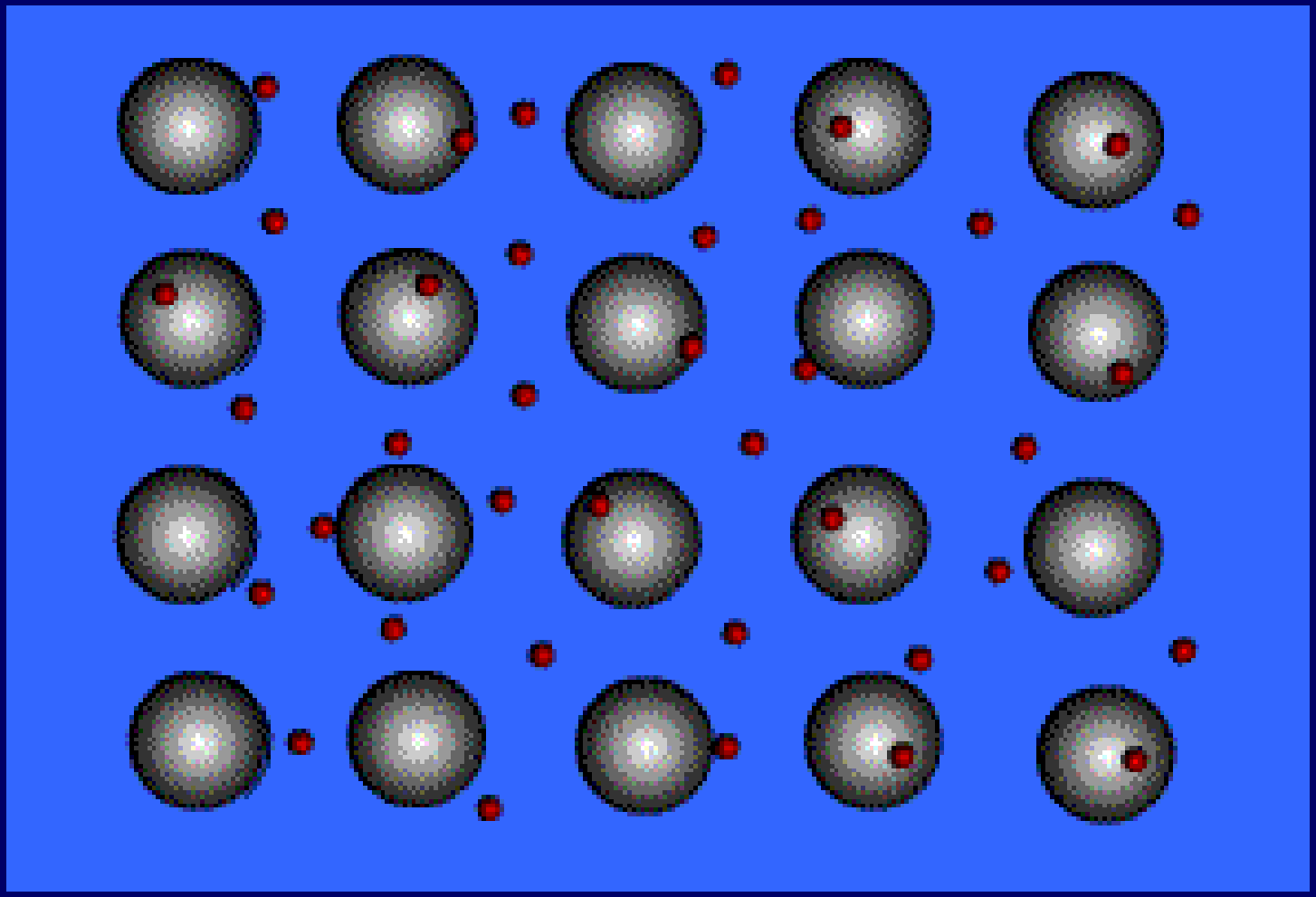
bond found in metals; holds metal atoms together very strongly

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

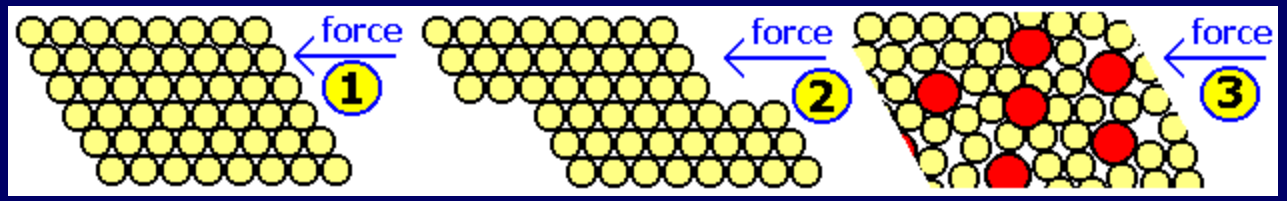
Metallic Bonds: Mellow dogs with plenty of bones to go around.

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.



Two Major Types of Bonding

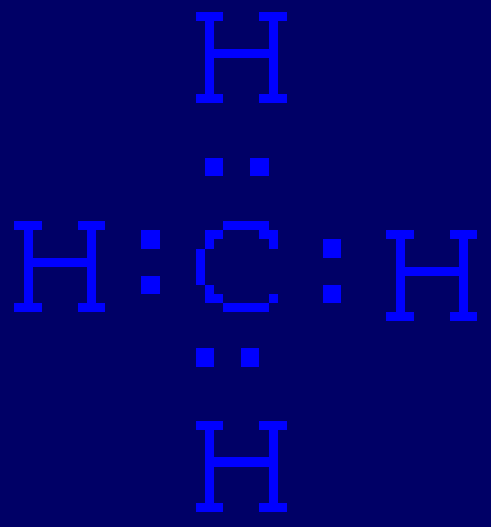
- **Ionic Bonding**
  - forms ionic **compounds**
  - transfer of e^-
- **Covalent Bonding**
  - forms **molecules**
  - sharing e^-

One minor type of bonding

- **Metallic bonding**
  - **Occurs between *like* atoms of a metal in the free state**
  - **Valence e- are mobile (move freely among all metal atoms)**
  - **Positive ions in a sea of electrons**
- **Metallic characteristics**
  - **High mp temps, ductile, malleable, shiny**
  - **Hard substances**
  - **Good conductors of heat and electricity as (s) and (l)**

Methane CH_4

- This is the finished Lewis dot structure



- **Step 1**
  - **count total valence e^- involved**
- **Step 2**
  - **connect the central atom (usually the first in the formula) to the others with single bonds**
- **Step 3**
  - **complete valence shells of outer atoms**
- **Step 4**
  - **add any extra e^- to central atom**

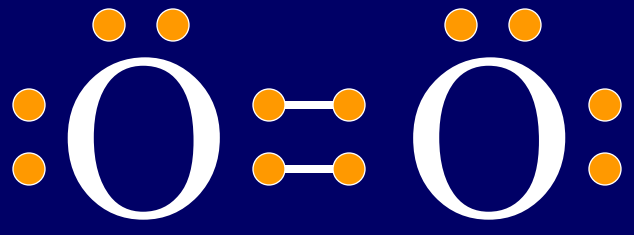
IF the central atom has 8 valence e^- surrounding it . . YOU'RE DONE!

Sometimes . . .

- You only have two atoms, so there is no central atom, but follow the same rules.
- Check & Share to make sure all the atoms are "happy".

Cl_2 Br_2 H_2 O_2 N_2 HCl

- DOUBLE bond
  - atoms that share two e- pairs (4 e-)



- TRIPLE bond
  - atoms that share three e- pairs (6 e-)