Lewis Dot Structures

And…

Ionic & Metallic Bonding

Chemistry Joke

Q: What is Mickey Mouse's favorite element?

A: Plutonium!!!!

Valence Electrons

- Electrons in the outer energy level.
- Determine chemical and physical properties of an element
- The group number of the representative elements is the same as the number of valence electrons.
- All of the elements within a given group will have the same number of valence electrons.

Valence Electrons

For example:

- Be is in Group 2A.
- There are 2 electrons in the outermost energy level.
- Be has an e configuration of $1s^2\ 2s^2$
- How many valence electrons will F have? 7

Valence Electrons

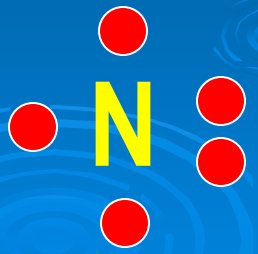
- Noble gases have a FULL valence shell of 8 electrons (ns^2np^6).
  - (Helium has a full valence shell with only 2 valence electrons.)
- Through bonding, other atoms "seek" a full shell of eight electrons.
  - This is called the **OCTET RULE**.
- Noble gases are unreactive (inert) because they already have a full shell!

Electron Dot Diagrams

- A visual representation of where the bonding electrons are in an atom
- The VALENCE electrons are shown as dots around the symbol for the element.
- This is called an **electron dot diagram** or a **Lewis dot structure**.

HOW TO MAKE A DOT DIAGRAM

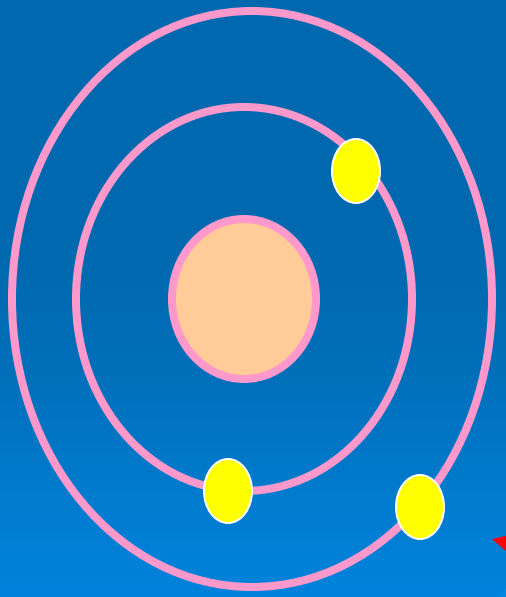
- Write the symbol for the element. N
- Decide how many valence electrons the element has. 5
- Using dots, place one dot per electron on each side of an imaginary box around the symbol.
- You must place one dot on each side of the box before doubling up.
  - Otherwise, the order doesn't matter.



Electron Dot Diagrams

Lithium has only 1 valence electron, so we only place one dot on our diagram.

Li•

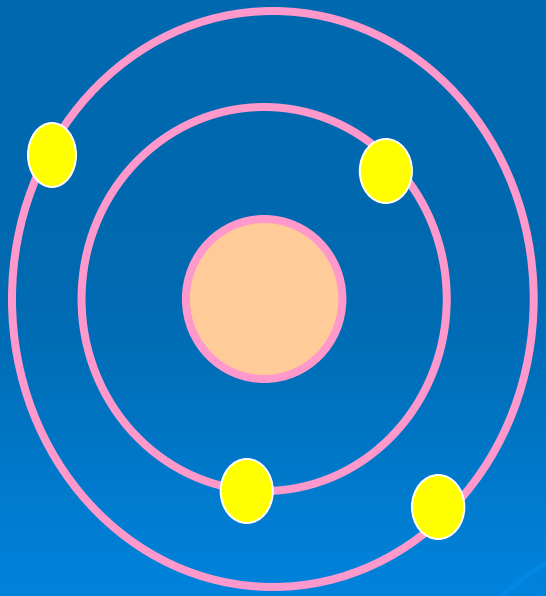


Lithium

1 valence electron!

Electron Dot Diagrams

Beryllium has 2 valence electrons, so we place two dots on our diagram.



Beryllium

TABLE 8.1 Electron-Dot Symbols

Element	Electron Configuration	Electron-Dot Symbol
Li	$[He]2s^1$	Li•
Be	$[He]2s^2$	•Be•
B	$[He]2s^2 2p^1$	•B•
C	$[He]2s^2 2p^2$	•C•
N	$[He]2s^2 2p^3$	•N:
O	$[He]2s^2 2p^4$	:O:
F	$[He]2s^2 2p^5$	:F:
Ne	$[He]2s^2 2p^6$	:Ne:

Ionic Bonding

- An atom is always trying to get a full outer energy level of eight electrons—Octet Rule.
- Atoms can gain, lose, or share valence (outer) electrons to complete their outer shell.
- When atoms get their full shells by completely giving or taking electrons from other atoms, an **Ionic Bond** is formed.

Ionic Bonding

- Involves
  - A metal and a nonmetal
    - A positively charged ion (the metal) CATION
    - A negatively charged ion (the nonmetal) ANION
- An electrostatic attraction happens!
  - (One atom loses an electron, the other gains it. They become oppositely charged → "bond" together!)

Cations vs. Anions

CATIONS

- Positive charge
- lose electrons
- metals
  - Groups 1, 2, 13, 14

ANIONS

- Negative charge
- Gain electrons
- Nonmetals
  - Groups 15, 16, 17

Formation of Cations

- Remember that cations are positively charged ions.
  - In cations there are more protons than electrons.
- An atom's loss of electrons produces a cation, or positively charged ion.
- Metallic elements and their cations have the same name
  - Sodium Atom: Na - Magnesium Atom: Mg
  - Sodium Cation: Na^{+} - Magnesium Cation: Mg^{2+}
- It is important to note that metallic elements and their cations behave differently.

Formation of Cations

- Most common cations are produced by the loss of valence electrons from metals
  - Most metals have 1-3 valence electrons that are easily removed.
    - When these electrons are removed it creates an octet on the outermost energy level.

Sodium

Na: $1s^2 2s^2 2p^6 3s^1$

Na^+: $1s^2 2s^2 2p^6$

Neon Atom: $1s^2 2s^2 2p^6$

Magnesium

Mg: $1s^2 2s^2 2p^6 3s^2$

Mg^{2+}: $1s^2 2s^2 2p^6$

Neon Atom: $1s^2 2s^2 2p^6$

Formation of Cations

- Transition Metals
  - The charges of cations formed by transition metals can vary.
    - For example Iron can form Fe2+ and Fe 3+
  - Some ions formed by transition metals do not have noble gas configurations and are exceptions to the octet rule.
    - These elements achieve pseudo noble-gas configurations.

Formation of Anions

- Remember that an anion is a negatively charged ion.
  - In anions there are more electrons than protons.
- The gain of negatively charged electrons produces an anion.
- Anions do not have the same name as the element from which they originated
  - The name of an anion typically ends in –ide.

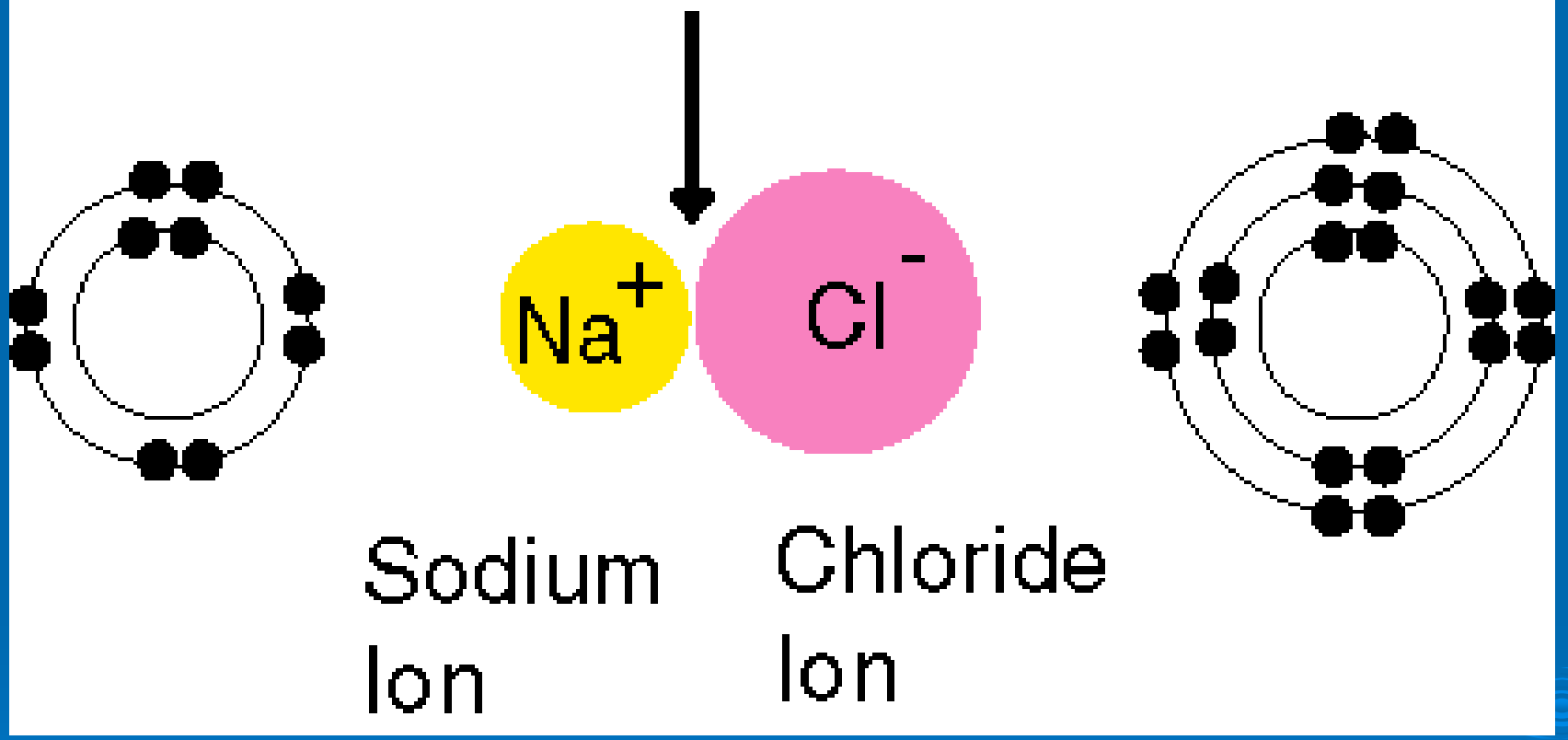
Formation of Anions

- Anions have valence shells that are close to full. It is easier for them to gain a noble gas configuration by gaining electrons.
- Ions produced by elements in group 7A are called halide ions.

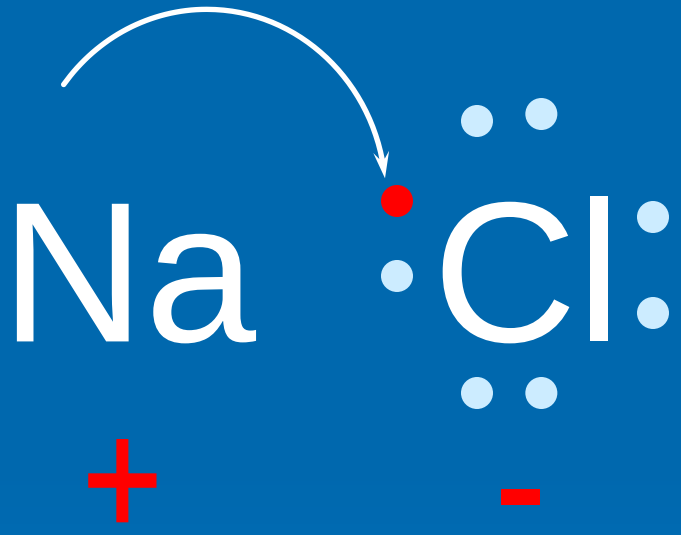
Ionic Bonding

- Are these pairs likely to form ionic compounds?
- Cl, Br — No—Both nonmetals that form negative ions.
- K, He — No—Helium is a noble gas that doesn't bond with anything.
- Na, Cl — Yes—Sodium is a metal that forms a positive ion, and chlorine is a nonmetal that forms a negative ion.

Electrostatic Attraction

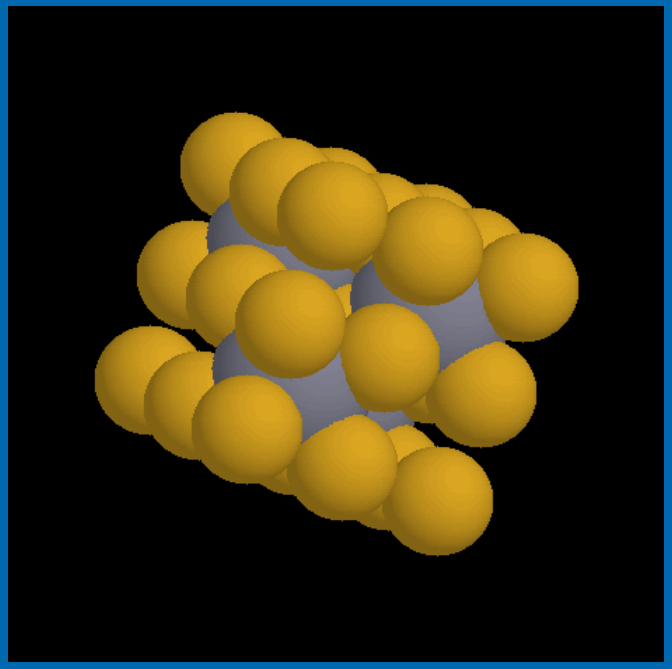


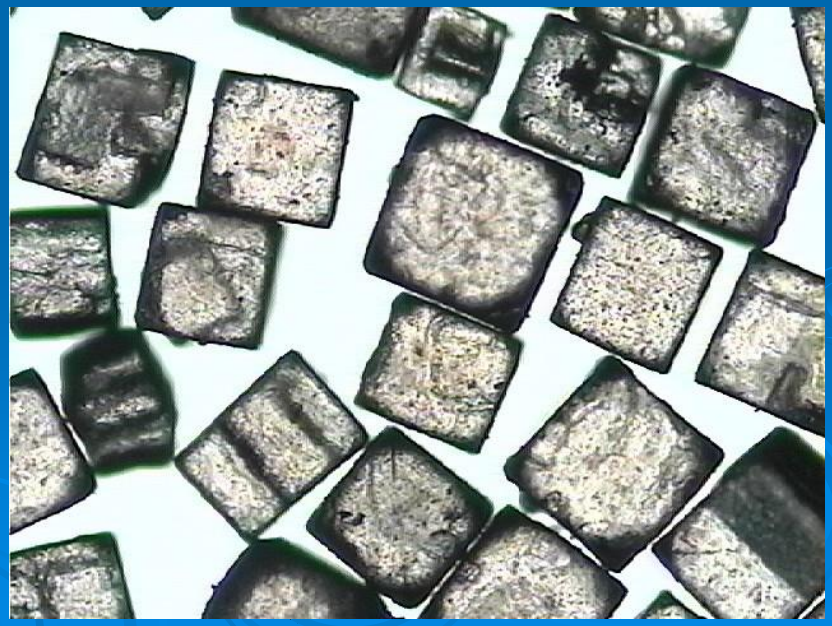
Ionic Bonding



Two ions now stuck together!

NaCl





Let's Look at This Reaction:

- http://www.visionlearning.com/library/module_viewer.php?mid=55
- http://www.youtube.com/watch?v=Mx5JJWI2aaw

4 Properties of Ionic Compounds

1. At room temp. most ionic compounds are a crystalline solid
2. Ionic compounds are brittle and shatter if hit
   - Ions of like charge are forced near each other.
3. Because of the strong electrostatic attractions, crystalline solids are very stable and have high melting points!
4. When melted or dissolved, ionic compounds can conduct electricity!

Sugar water

All of the charged particles (ions) enable a flow of current.

Salt water

Metallic Bonding

Metals are made of closely packed cations with mobile "de-localized" valence electrons.

The attraction of the free-floating valence electrons for the positively charged metal ions forms the metallic bond.

The mobile valence electrons make them good conductors of heat and electricity!

- **Malleable** – able to be pounded into sheets.
  - Metals do not shatter as mobile electrons keep the positive metal ions from getting too close to each other.

- **Ductile** – able to be drawn into wires