Chemistry 9 Review
&
Intro to Chemistry 10

Section 4.1: Atomic Theory and Bonding

Atoms and Compounds

- An **atom** is the **smallest particle** of an element that still has the **properties** of that element
  - An atom = proton(s) + neutron(s) + electron(s)

- Atoms **join together** to form **compounds**.
  - A compound is a **pure substance** that is composed of **two or more atoms** combined in a **specific way**.
  - Oxygen and hydrogen are atoms/elements; H_2O is a compound.

- A **chemical change** occurs when the **arrangement** of atoms in compounds **changes** to form **new** compounds.

Atomic Theory

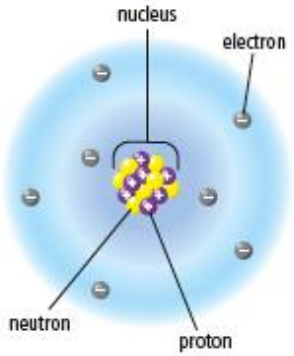
- Atoms are comprised of 3 subatomic particles

Table 4.1 Subatomic Particles

Name	Symbol	Electric Charge	Location in the Atom	Relative Mass
Proton	p	1+	Nucleus	1836
Neutron	n	0	Nucleus	1837
Electron	e	1−	Surrounding the nucleus	1

Atomic Theory

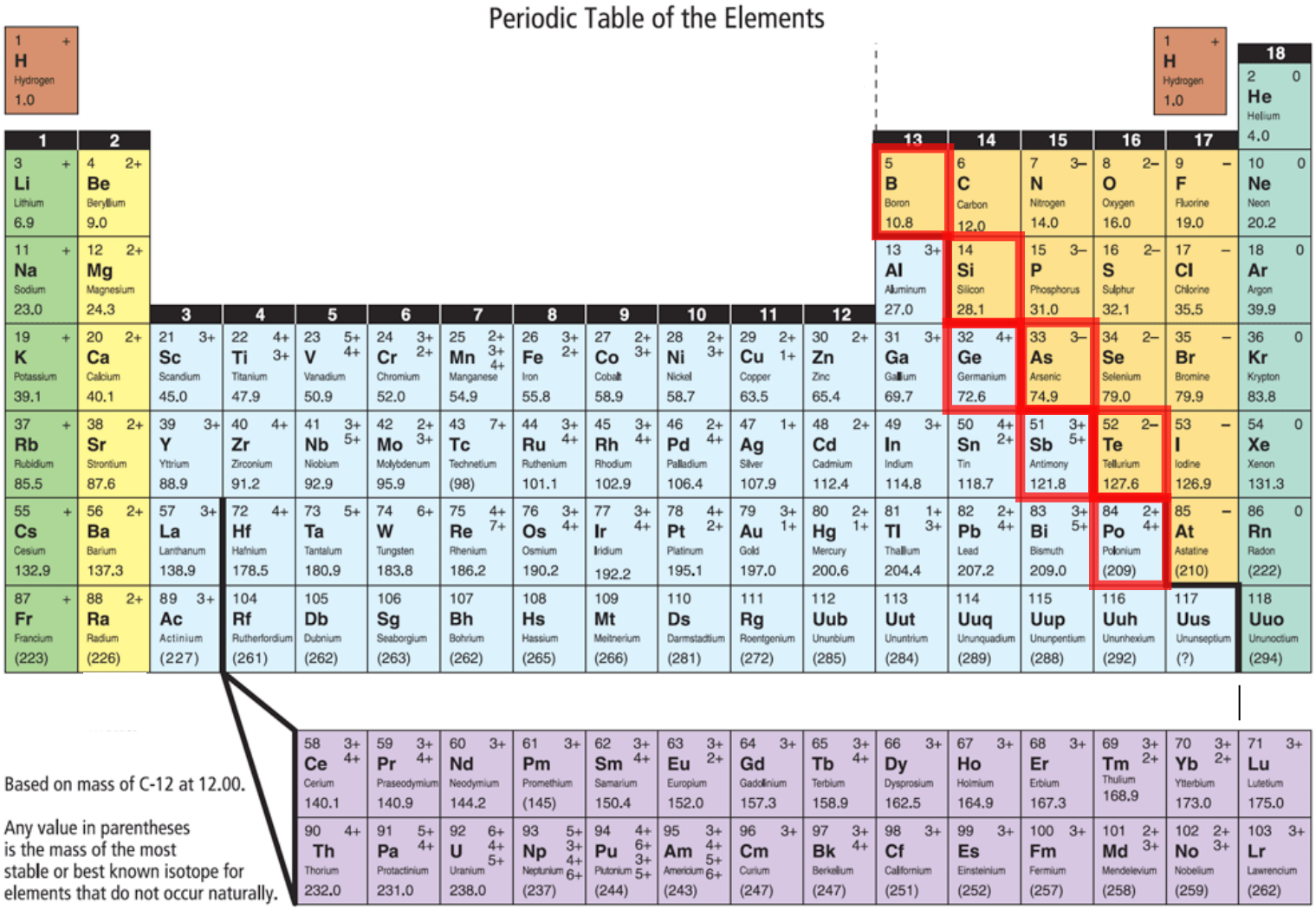
- The **center** of an atom is called the **nucleus**.
  - The nucleus is composed of protons and neutrons.
  - Electrons exist in the space surrounding the nucleus.
  - # of protons = # of electrons in every atom
  - Nuclear charge = charge on the nucleus = # of protons
  - Atomic number = # of protons = # of electrons



Organization of the Periodic Table

- In the periodic table elements are listed in order by their atomic number.
  - Metals are on the left (the transition metals range from group 3 to group 12), non-metals are on the right, and the metalloids form a "staircase" toward the right side.
  - Rows of elements (across) are called periods.
    - All elements in a period have their electrons in the same general area around their nucleus.
  - Columns of elements are called groups, or families.
    - All elements in a family have similar properties and bond with other elements in similar ways.
    - Group 1 = alkali metals
    - Group 2 = alkaline earth metals
    - Group 17 = the halogens
    - Group 18 = noble gases

The Periodic Table

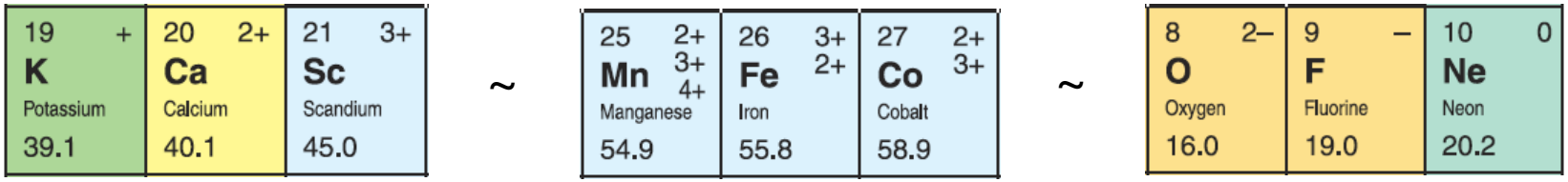


Where are the following?

- Atomic number
- Period
- Group/Family
- Metals
- Non-metals
- Transition metals
- Metalloids
- Alkali metals
- Alkaline earth metals
- Halogens
- Noble gases

Periodic Table and Ion Formation

- Atoms gain and lose electrons to form bonds.
  - The atoms become electrically charged particles called ions.
  - Metals lose electrons and become positive ions (cations).
    - Some metals (multivalent) lose electrons in different ways.
    - For example, iron, Fe, loses either two (Fe^{2+}) or three (Fe^{3+}) electrons
  - Non-metals gain electrons and become negative ions (anions).
  - Atoms gain and lose electrons in an attempt to have the same number of valence electrons (electrons farthest from the nucleus) as the nearest noble gas in the periodic table.



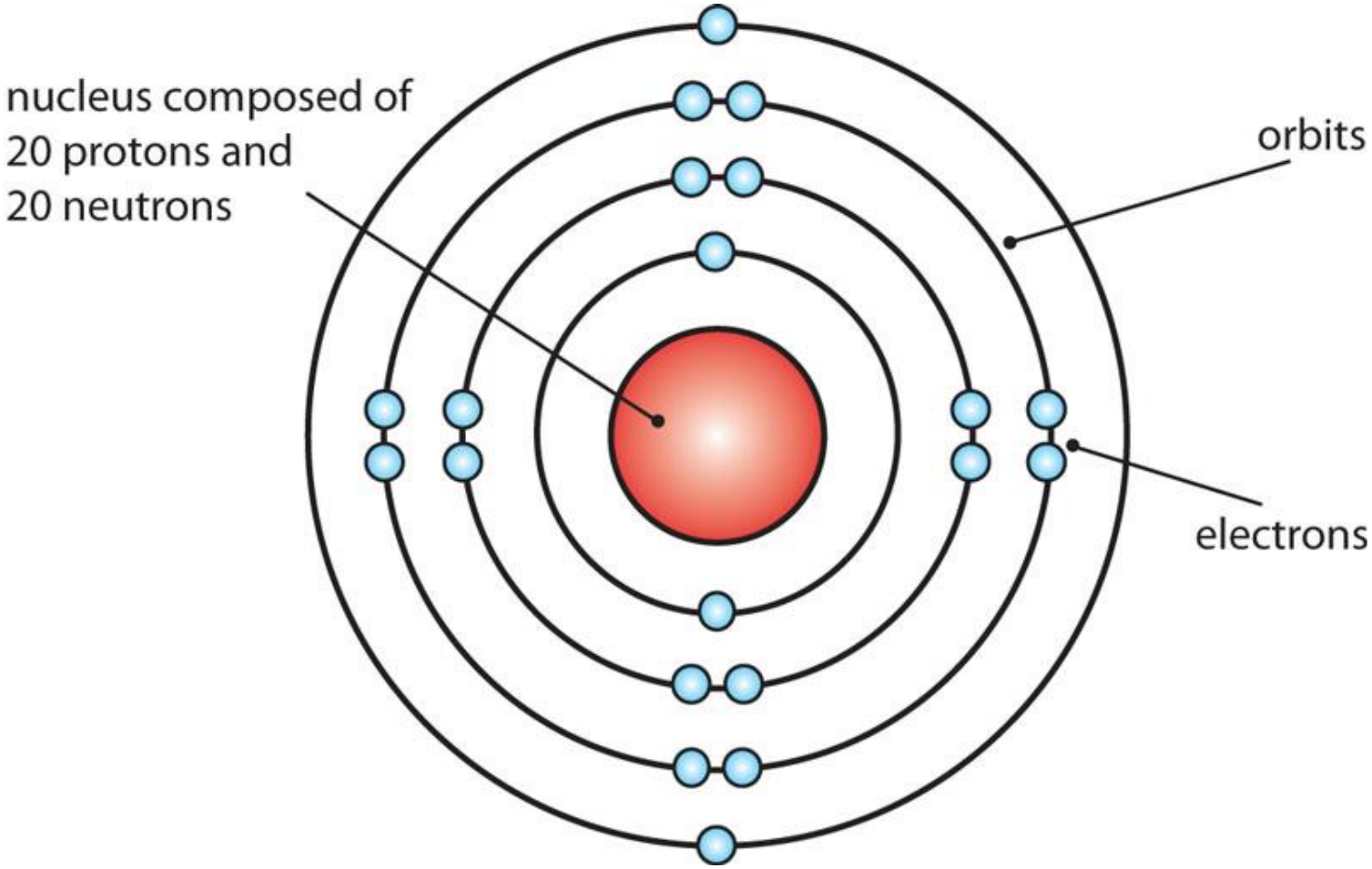
Bohr & Lewis Diagrams

Bohr Diagrams

- Show the arrangement of electrons in shells around the nucleus of an atom.
  - 1st shell = max. 2 electrons
  - 2nd shell = max. 8 electrons
  - 3rd shell = max. 8 electrons
  - 4th shell = max. 18 electrons

- The outermost shell that contains electrons is called the **valence shell**, and the electrons in this shell are called **valence electrons**.

Electron Orbitals/Shells



Bohr Diagrams Continued

- **Period** (**row**) number of element = **number** of occupied **shells** for that element

- Elements in the same **family** (**column**) have the same **number** of **valence electrons**.

Bohr Diagrams of Ions

- An atom's **ion charge** on the periodic table tells you how many electrons the atom will lose or gain to fill its valence shell.

Bohr Diagrams of Ions

- **Metal atoms** lose electrons to have a full valence shell (become positive **cations**).
  - Ex. Magnesium loses two electrons from its valence shell and forms a magnesium ion (Mg^{2+}).
  - The Bohr Diagram for a Mg^{2+} ion will have two less electrons and square brackets around it with a 2+ charge.

Bohr Diagrams of Ions

- **Non-metal atoms** gain electrons to have a full valence shell (become negative **anions**).
  - Ex. Sulfur gains two electrons into its valence shell and forms a sulfur ion (S^{2-}).
  - The Bohr Diagram for a S^{2-} ion will have two more electrons and square brackets around it with a 2− charge.

Formation of Compounds

- **Valence electrons** are involved in **chemical bonding** between elements.

- **Noble gases** have a **full valence shell** so they **don't** form compounds!

Forming Compounds

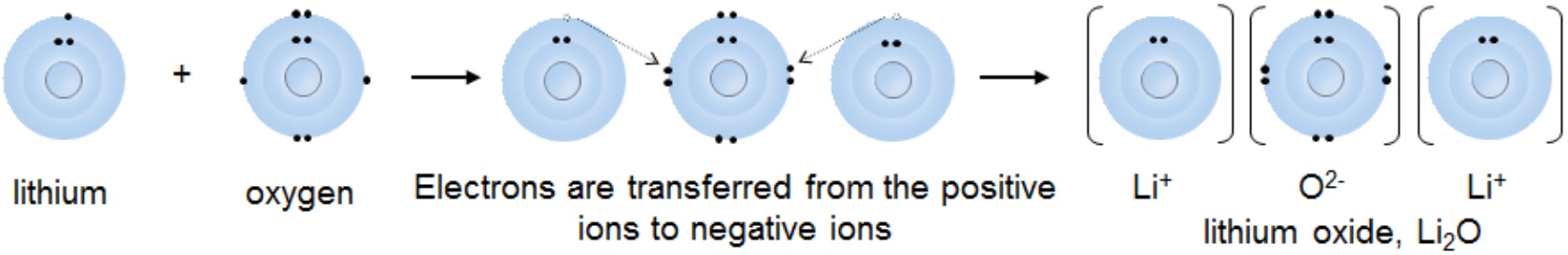
- **Ionic bonds** form when **electrons** are **transferred** from positive ions to negative ions.

- **Covalent bonds** form when electrons are **shared** between two **non-metals**.

  - Electrons stay with their atom but overlap with other shells.

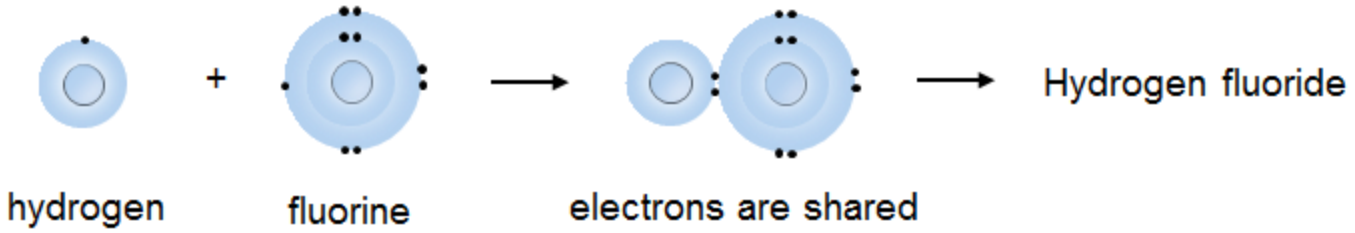
Forming Compounds – Ionic Bonds

- Ionic bonds are formed between positive ions and negative ions.
  - For example, lithium and oxygen form an ionic bond in the compound Li_2O.



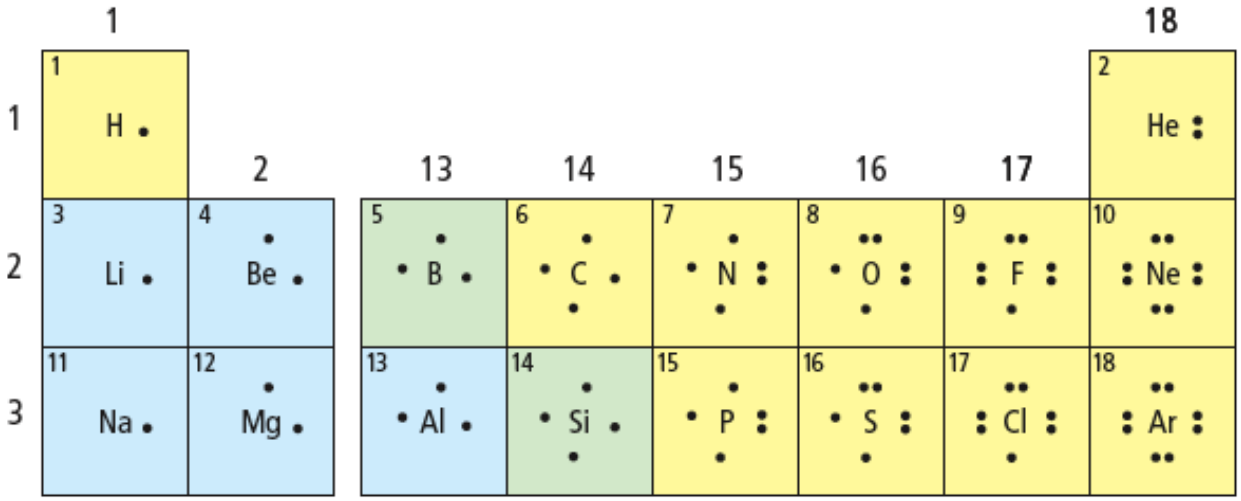
Forming Compounds – Covalent Bonds

- Covalent bonds are formed between two or more non-metals.
  - Electrons are shared between atoms.



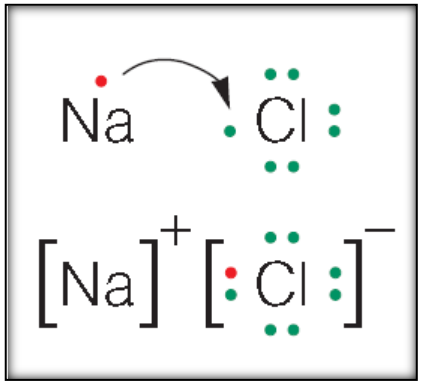
Lewis Diagrams

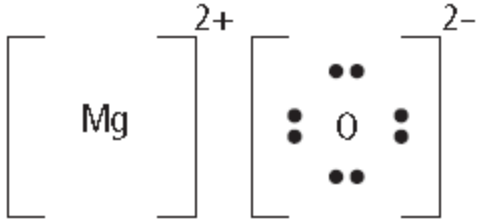
- They illustrate chemical bonding by showing only an atom's valence electrons and the chemical symbol.
  - **Dots** representing **electrons** are placed around the element symbols
  - Electron dots are placed **singly until the fifth electron** is reached then they are paired.



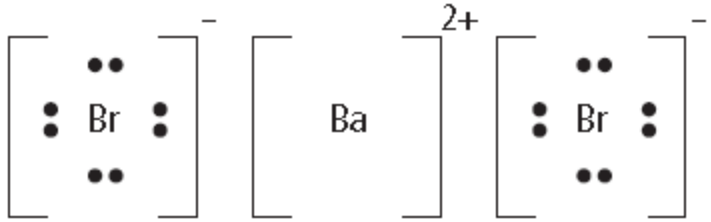
Lewis Diagrams of Ions and Ionic Bonds

- For **positive ions**, electron dots are **removed**.
- For **negative ions**, electron dots are **added**.
- Square brackets are placed around each ion to indicate transfer of electrons.





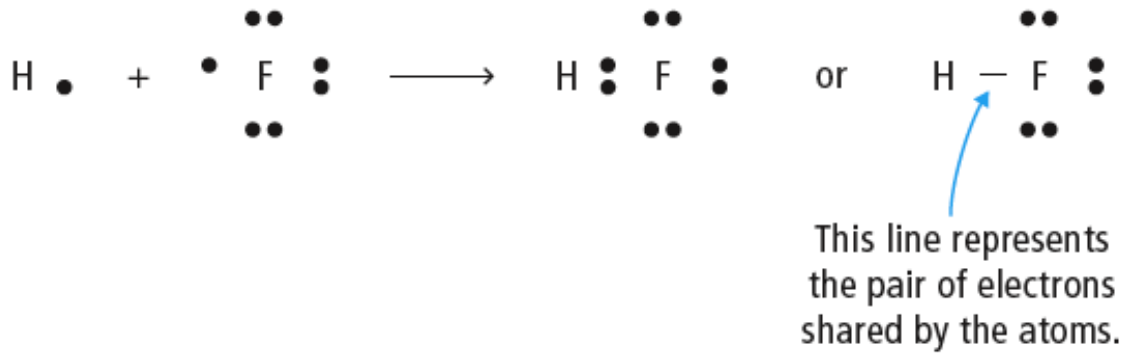
MgO



$BaBr_2$

Lewis Diagrams of Covalent Bonds

- Like Bohr diagrams, valence electrons are drawn to show sharing of electrons.
- The **shared pairs** of electrons are usually **drawn** as a **straight line**.



Lewis Diagrams of Diatomic Molecules

- Diatomic Molecules form between two atoms of the same type.