

## 9.1 Outline

- Lewis symbols and valence electrons
- Ionic bonding - electrostatic attractions between ions of opposite charge
- Covalent bonding - sharing of one or more electron pairs between atoms
- Bond polarity and electronegativity
- Drawing Lewis structures
- Resonances structures, exceptions to the octet rule, and strengths of covalent bonds

## 9.2 Chemical Bonds

**Chemical bond** – a strong attractive force that exists between atoms in a molecule. The three types of chemical bonds are as follows:

**ionic bond** a bond between oppositely charged ions. The ions are formed from atoms by transfer of one or more electrons.

**covalent bond**

## 9.3 Lewis Symbols

- The **valence electrons**, those that reside in the outermost shell of an atom, are responsible for chemical bonding.
- **Lewis symbol** (electron dot symbol) The chemical symbol for an element, with a dot for each valence electron.
- Dots are placed on the four sides of the chemical symbol, where each side can accommodate up to two electrons.

## 9.4 Ionic Bonding

- The combination of sodium metal and chlorine gas results in a violent Li

## 9.5 Lattice Energy

The energy associated with electrostatic interactions is governed by Coulomb's Law:

$$E_{el} = \frac{\kappa Q_1 Q_2}{d} \quad (9.1)$$

- Lattice energy increases with the charge on the ions.

- It also increases with decreasing size of ions.
- See the worked example entitled **Magnitudes of Lattice Energies**.

## 9.6 Magnitudes of Lattice Energies

Which substance would you expect to have the greatest lattice energy,  $\text{MgF}_2$ ,  $\text{CaF}_2$ , or  $\text{ZrO}_2$ ?



Because the product of the charge,  $Q_1Q_2$ , appears in the numerator of the equation above, the lattice energy will increase dramatically when the charges of the ions increase. Thus,

$$\begin{array}{llll} \text{MgF}_2 & Q_1=+2 & Q_2 & =-1 \\ \text{CaF}_2 & Q_1=+2 & Q_2 & =-1 \\ \text{ZrO}_2 & Q_1=+4 & Q_2 & =-2 \end{array}$$

$$\text{CaF}_2 < \text{MgF}_2 < \text{ZrO}_2$$

Table 9.1: Lattice Energies for Some Ionic Compounds

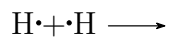
Compound	Lattice Energy (kJ/mol)	Compound	Lattice Energy (kJ/mol)
LiF	1030	MgCl <sub>2</sub>	2326
LiCl	834	SrCl <sub>2</sub>	2127
LiI	730		
NaF	910	MgO	3795
		3414	
		3217	
		7547	

## 9.7 Covalent Bonding

- In covalent bonds, atoms share electrons.
- There are several electrostatic interactions in these bonds:
  - Attractions between electrons and positive nuclei.
  - Repulsions between electrons
  - Repulsions between nuclei
  - Attractive forces must outweigh the repulsive ones

## 9.8 Lewis Structures

- Consider two Hydrogen atoms coming together to form a covalently bonded  $\text{H}_2$  molecule:



- The  $\text{H}_2$  molecule on the right, with its two electrons, exhibits the noble-gas configuration
- Consider two chlorine atoms coming together to form a covalently bonded  $\text{Cl}_2$  molecule:

