Formation of Binary Ionic Compounds and Lattice Energy Calculations

Lattice Energy: the change in energy that takes place (released) when separate gaseous ios are packed together to form an ionic solid. $M^+_{(g)} + X^-_{(g)} \longrightarrow MX_{(s)}$

Note the arrangement: In a sodium chloride structure. 6 ions of opposite ion surround each.

For the Formation of LiF: $Li_{(s)} + 1/2F_{2(g)} \longrightarrow LiF(s)$ calculate the ΔH_f^0 :

Write the accompanying equation for each step:

Step 1: Sublimation of Li	$Li_{(s)} \longrightarrow Li_{(g)}$	161 kJ/mol
Step 2: First Ionization of lithium	$Li_{(g)} \longrightarrow Li^+_{(g)} + e^-$	520 kJ/mol
Step 3: Dissociation of F_2 into F	$1/2F_{2(g)} \longrightarrow F_{(g)}$	154/2 kJ
Step 4: electron affinity of F	$F + e^- \longrightarrow F^-_{(g)}$	-328 kJ/mol
Step 5: Lattice Energy	$Li^+_{(g)} + 1/2F^-_{(g)} \longrightarrow LiF_{(s)}$	-1047 kJ/mol
Overall: Enthalpy of formation	$\mathbf{Li_{(s)} + 1/2F_{2(g)} \longrightarrow LiF_{(s)}}$	**-617 kJ/mol**

Relationships and Comparisons of Lattice Energy Calculations:

$$\text{Lattice Energy} = k\left(\frac{Q_1Q_2}{r}\right)$$

- Greater ionic charges is predicted to have greater lattice energy.
- Smaller size, r has shorter distance, gives greater lattice energy.
- Ionization energies are balanced by the large favored lattice energy

The Covalent Chemical Bond: A Model (An overview of scientific models)

A chemical bond can be viewed as forces that cause a group of atoms to behave as a unit.

Bonds seek its lowest possible energy.

CH_4 is 1652 kJ/mol lower in energy than the separate C and 4 H atoms. It is easier to think of this as CH_4 having 4 C-H bonds, each with an energy of 1652/4 = 413 kJ/mol of bonds. This model approach provides a framework to systematize chemical behavior.

Discrete bonds do not exist, this is only a model that agrees with our observations.

Covalent Bond energies and Chemical Reactions

Molecule	Measured C-H bond energy in kJ/mol
$HCBr_3$	380
$HCCl_3$	380
HCF_3	430
C_2H_6	410

Bond strengths vary with its environment, but the average strength is useful. Table 8.4

Bond lengths vary with the number of shared pairs single > double > single

Bond Energy and Enthalpy

Bond energies can be useful for calculating energies for reactions.

ΔH= sum of energies used to break bonds (positive) and form bonds (negative).

D= bond energy per mole. D always has a positive sign!

Δ*H*= ΣD (bonds broken) –	**ΣD (bonds formed)**
Energy required	Energy released
Reactants	Products

Ex. $CH_{4(g)} + 2Cl_2 + 2F_{2(g)} \longrightarrow CF_2Cl_{2(g)} + 2HF_{(g)} + 2HCl_{(g)}$

$\Delta H = 2438 \text{ kJ} - 3632 \text{ kJ} = -1194 \text{ kJ}$

Practice Problems for Study: P. 383 #43, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 62, 64, 65, 66, 107, 118, 120