BOND ENERGIES

Chemical reactions involve the breaking and making of bonds. Energy is *always* required to break a chemical bond. Often, this energy is supplied in the form of heat.

The **bond energy** is the amount of energy necessary to break *one mole* of bonds in a gaseous covalent substance to form products in the gaseous state at constant temperature and pressure.

The greater the bond energy, the more stable (stronger) the bond is, and the harder it is to break. Thus, bond energy is a measure of bond strengths.

We can estimate the energy change in a reaction by using the following equation:

$$H_{rxn} = \Sigma BE_{reactants} - \Sigma BE_{products}$$

The energy change of the reaction is equal to the energy required to break all the necessary bonds in the reactants *minus* the energy required to break the necessary bonds in the products (*minus* because we are actually forming bonds in the products, not breaking them). Using this equation, we can estimate the amount of energy released or absorbed in a particular reaction. Alternatively, we can estimate whether the products are more stable or less stable than the reactants.

Use the table of bond energies to calculate the estimated change of energy for the following reactions.

$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$

$N_2(g) + 3\ H_2(g) \longrightarrow 2\ NH_3(g)$

$CH_4(g) + Cl_2(g) \longrightarrow CH_3Cl(g) + HCl(g)$

$CO(g) + H_2O(g) \longrightarrow CO_2(g) + H_2(g)$

$H_2C{=}CH_2\ (g) + Br_2(g) \longrightarrow BrH_2C\quad CH_2Br\ (g)$

Some Average Single Bond Energies (kJ/mol)

H	C	N	O	F	Si	P	S	Cl	Br	I	
436	413	391	463	565	318	322	347	432	366	299	H
	346	305	358	485			272	339	285	213	C
		163	201	283				192			N
			146		452	335		218	201	201	O
				155	565	490	284	253	249	278	F
					222		293	381	310	234	Si
						201		326		184	P
							226	255			S
								242	216	208	Cl
									193	175	Br
										151	I

Comparison of Some Average Single and Multiple Bond Energies (kJ/mol)

Single Bonds		Double Bonds		Triple Bonds	
C—C	346	C=C	602	C≡C	835
N—N	163	N=N	418	N≡N	945
O—O	146	O=O	498		
C—N	305	C=N	615	C≡N	887
C—O	358	C=O	732*	C≡O	1072

Except in CO_2, where it is 799 kJ/mol