# Bond Enthalpy Assignment

1. Use Bond Enthalpies, (Table 10 in your Data Book), to estimate the enthalpy change, $\Delta H_{rxn}$, for the following reactions:

a) $2\,CO_{(g)} + O_{2(g)} \rightarrow 2\,CO_{2(g)}$ [Note: D (C≡O) = 955 kJ mol$^{-1}$]

b) $C_2H_{4(g)} + H_2O_{(g)} \rightarrow C_2H_5OH_{(g)}$

c) $C_2H_{2(g)} + O_{2(g)} \rightarrow 2\,CO_{2(g)} + H_2O_{(g)}$

d) $H_{2(g)} + Br_{2(g)} \rightarrow 2\,HBr_{(g)}$

e) $CH_{4(g)} + Cl_{2(g)} \rightarrow CH_3Cl_{(g)} + HCl_{(g)}$

**Answers:**

a) - 564 kJ b) - 38 kJ c) - 1739 kJ

2. a) Use bond energy terms to calculate the standard enthalpy change, $\Delta H°$, for the following reaction:

$C_2H_{6(g)} + Cl_{2(g)} \dashrightarrow C_2H_5Cl_{(g)} + HCl_{(g)}$

b) Calculate another value for this standard enthalpy change from heats of formation.

c) (? $H_f^0\ C_2H_5Cl_{(g)} = -136.4$ kJ mol$^{-1}$)

d) Write a short account of the reasons why the two values you have calculated differ from each other.

(**Answer:** a. –107 kJ b. 112.6 kJ c. bond enthalpies used are averages, because the environment of a bond will affect bond strength, however enthalpies of formation using Hess' Law more precise.)

3. a. Calculate the C - C bond dissociation energy in ethane, $C_2H_6$, given the following information:

$2C_{(g)} + 6H_{(g)} \longrightarrow C_2H_{6(g)}$ $\Delta H° = -2820$ kJ mol$^{-1}$

Given B.E (C-H) = - 412 kJ/mol

b. Calculate the C = C bond dissociation energy in ethene, $C_2H_4$, given the following information…

$2C_{(g)} + 4H_{(g)} \longrightarrow C_2H_{4(g)}$ $\Delta H° = -2260$ kJ mol$^{-1}$

c. Assuming that the sigma, σ - bonds in ethane and ethene are identical, calculate the approximate bond dissociation energy for the π - bond in ethene.

d. Would you expect ethene to be more or less reactive than ethane?

(**Answer:** a.+ 348 kJ mol$^{-1}$ b. + 612 kJ mol$^{-1}$ c. 264 kJ mol$^{-1}$ d. π - bond requires less energy to break than a s -bond, therefore a p-bond is more reactive in ethene.)

4. In principle, dinitrogen monoxide, $N_2O$, can decompose to $N_{2(g)}$ and $O_{2(g)}$:

$2N_2O_{(g)} \dashrightarrow 2N_{2(g)} + O_{2(g)}$

Use Bond Enthalpies, Table 10, from the IB Data Book to estimate the enthalpy change for this reaction.

(**Answer:** – 372 kJ mol$^{-1}$ )

5. Phosgene, $Cl_2CO$, is a highly toxic gas that was used as a weapon in World War I. Using bond enthalpies from the Data Book estimate the enthalpy change for the reaction of CO and $Cl_2$ to produce phosgene:

$CO_{(g)} + Cl_{2(g)} \dashrightarrow Cl_2CO_{(g)}$

(**Answer:** – 206 kJ mol$^{-1}$ )

6. Oxygen atoms can combine with ozone to form oxygen:

$O_{3(g)} + O_{(g)} \dashrightarrow 2O_{2(g)}$ $\Delta H°_{rxn} = -394$ kJ

Using $\Delta H°_{rxn}$ and the bond enthalpies from the IB Data Book, estimate the bond energy for the O - O bond in ozone, $O_3$. How does your calculated value compare with the energies of a O - O single bond and a O = O double bond? Explain the O - O bond energy in ozone using its structure.

(**Answer:** + 104 kJ mol$^{-1}$ )

7. The compound oxygen difluoride is quite unstable, giving $O_2$ and HF on reaction with water:

$OF_{2(g)} + H_2O_{(l)} \dashrightarrow O=O_{(g)} + 2\,H-F_{(g)}$ $\Delta H°_{rxn} = -318$ kJ

Using $\Delta H°_{rxn}$ and bond enthalpy data, calculate the bond dissociation energy of the O - F bond in $OF_{2(g)}$.

(**Answer:** + 192 kJ mol$^{-1}$ )