

Bond Enthalpy Assignment

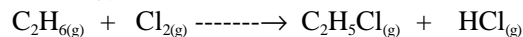
1. Use Bond Enthalpies, (Table 10 in your Data Book), to estimate the enthalpy change, ΔH_{rxn} , for the following reactions:

- a) $2 \text{CO}_{(g)} + \text{O}_{2(g)} \rightarrow 2 \text{CO}_{2(g)}$ [Note: $D(\text{C}\equiv\text{O}) = 955 \text{ kJ mol}^{-1}$]
 b) $\text{C}_2\text{H}_4(g) + \text{H}_2\text{O}(g) \rightarrow \text{C}_2\text{H}_5\text{OH}(g)$
 c) $\text{C}_2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2 \text{CO}_2(g) + \text{H}_2\text{O}(g)$
 d) $\text{H}_2(g) + \text{Br}_2(g) \rightarrow 2 \text{HBr}(g)$
 e) $\text{CH}_4(g) + \text{Cl}_2(g) \rightarrow \text{CH}_3\text{Cl}(g) + \text{HCl}(g)$

Answers:

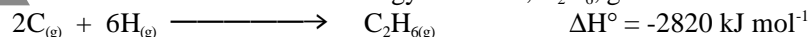
- a) -564 kJ b) -38 kJ c) -1739 kJ

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



- b) Calculate another value for this standard enthalpy change from heats of formation.
 c) ($? H_f^\circ \text{C}_2\text{H}_5\text{Cl}(g) = -136.4 \text{ kJ mol}^{-1}$)
 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:



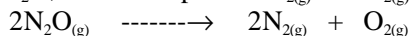
Given B.E (C-H) = -412 kJ/mol

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



- 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 σ - bond, therefore a π - bond is more reactive in ethene.)

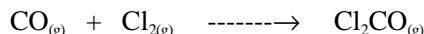
4. In principle, dinitrogen monoxide, N_2O , can decompose to $\text{N}_2(g)$ and $\text{O}_2(g)$:



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

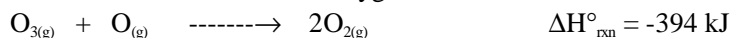
(Answer: -372 kJ mol⁻¹)

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:



(Answer: -206 kJ mol⁻¹)

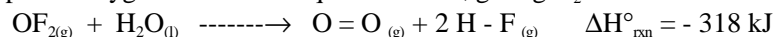
6. Oxygen atoms can combine with ozone to form oxygen:



Using $\Delta H^\circ_{\text{rxn}}$ 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:



Using $\Delta H^\circ_{\text{rxn}}$ and bond enthalpy data, calculate the bond dissociation energy of the O - F bond in



(Answer: +192 kJ mol⁻¹)