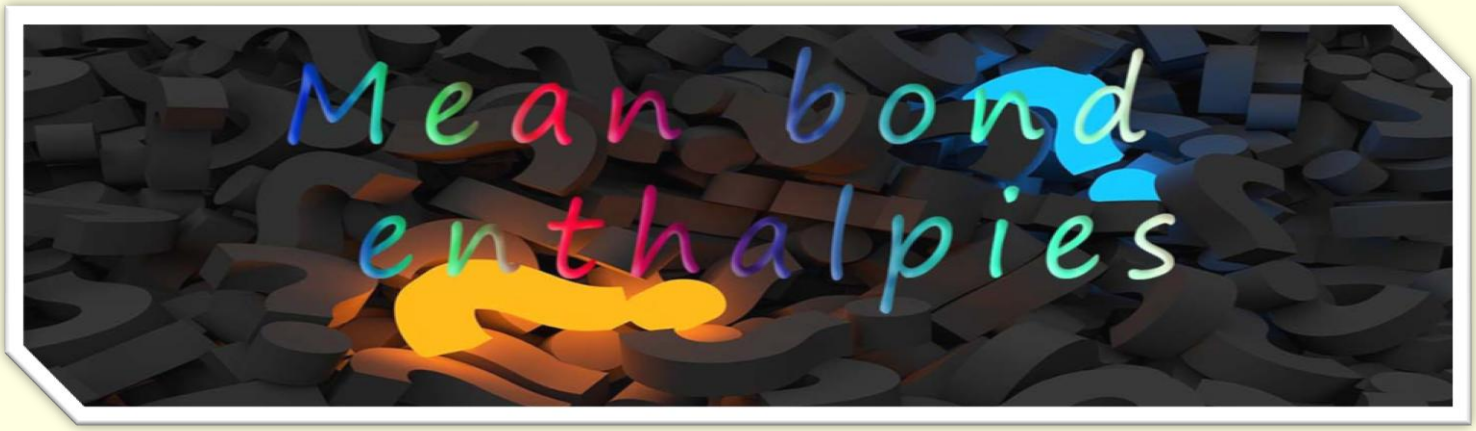

1. Define mean bond enthalpy.

2. Explain why any enthalpy changes calculated using mean bond enthalpy data will only be a good approximation and not 100% accurate.

3. Explain using bond enthalpies how you would decide if a reaction was endothermic or exothermic.

4. The table below contains some average bond enthalpy data, use the values given to answer the following questions.

bond	Bond enthalpy kJ/mol
C-C	347
C-H	413
O=O	498
C=O	805
O-H	464
C-O	358
C=C	602
N ≡ N	945
N-H	391
H-H	436
I-I	151
H-I	298

a. Calculate the enthalpy changes for the following reactions:

i. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

ii. $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$

iii. $C_2H_{4(g)} + H_{2(g)} \longrightarrow C_2H_{6(g)}$

5. The enthalpy change for the following reaction is -120kJ/mol

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

a. Calculate the mean C-Cl bond enthalpy given the following data.

bond	Bond enthalpy kJ/mol
Cl-Cl	243
C-H	413
H-Cl	431

Answers

1. Define mean bond enthalpy.

   Averages of bond dissociation enthalpy for a particular bond taken from a wide range of compounds.

2. Explain why any enthalpy changes calculated using mean bond enthalpy data will only be a good approximation and not 100% accurate.

   The mean bond enthalpies are average values only and a particular bond enthalpy will vary from molecule to molecule. So for example a C-H bond enthalpy will vary slightly across many molecules depending on, for example what functional groups are present on the molecule. Since bond strength will vary with electron distribution with a bond and this will vary depending on the environment in which the particular bond is to be found.

3. Explain using bond enthalpies how you would decide if a reaction was endothermic or exothermic.

   Since the enthalpy change (ΔH) is calculated from:

   $\Delta H = \Sigma$(bond enthalpies of bonds broken) - Σ(bond enthalpies of bonds formed)

   If the energy released by bond formation is more than is required for bond breaking then the reaction will be exothermic. Another way to say this is if the bonds in the products are stronger than the bonds in the reactants then more energy will be released by bond formation than is required for bond breaking and the reaction will be exothermic. The oposite argument is true for an endothermic reaction.

4. The table below contains some average bond enthalpy data, use the values given to answer the following questions.

bond	Bond enthalpy kJ/mol
C-C	347
C-H	413
O=O	498
C=O	805
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C-O	358
C=C	602
N ≡ N	945
N-H	391
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H-I	298

a. Calculate the enthalpy changes for the following reactions:

i. $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
N ≡ N	945	N-H =x6	391 x 6 = 2346
H-H x3	436 x3= 1308		
Total energy required to break all bonds in the reactants = 1308 + 945 = 2253		Total energy released by bond formation in the products = 2346	
ΔH= Σ(bond enthalpies of bonds broken) - Σ(bond enthalpies of bonds formed) 2253- 2346 = -93kJ			

ii. $H_{2(g)} + I_{2(g)} \longrightarrow 2HI_{(g)}$

Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
H-H	436	H-I x2	298 x 2 = 596
I-I	151		
Total energy required to break all bonds in the reactants = 436 + 151 = 587		Total energy released by bond formation in the products = 596	
ΔH= Σ(bond enthalpies of bonds broken) - Σ(bond enthalpies of bonds formed) 587- 596 = -9kJ			

iii. $C_2H_{4(g)} + H_{2(g)} \longrightarrow C_2H_{6(g)}$

Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
C=C	602	C-C	347
C-H x4	413 x4= 1652	C-H x6	413 x6= 2478
H-H	436		
Total energy required to break all bonds in the reactants = 602 + 1652 + 436 = 2690		Total energy released by bond formation in the products = 2478 + 347 =2825	
ΔH= Σ(bond enthalpies of bonds broken) - Σ(bond enthalpies of bonds formed) 2690- 2825 = -135kJ			

5. The enthalpy change for the following reaction is -120kJ/mol

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

a. Calculate the mean C-Cl bond enthalpy given the following data.

bond	Bond enthalpy kJ/mol
Cl-Cl	243
C-H	413
H-Cl	431

Bonds broken	Energy required/kJ/mol	Bonds formed	Energy released
Cl-Cl	243	C-H X3	413 X3 = 1239
C-H x4	413 x4= 1652	C-Cl	To find out
		H-Cl	431
Total energy required to break all bonds in the reactants = 243 + 1652=1895kJ		Total energy released by bond formation in the products = 1239 + 431 + C-Cl = 1670 + C-Cl	

ΔH= Σ(bond enthalpies of bonds broken) - Σ(bond enthalpies of bonds formed)

-120 = 1895 - (1670 + C-Cl)

Rearrange to give:

-120 = 225-C-Cl

So

C-Cl = 345kJ