5.3: Bond Enthalpies Study Worksheet

1. What is the definition of average bond enthalpy?

2. What assumptions do we need to make when using bond enthalpies to calculate the enthalpy change of a reaction?

3. Explain why when bond enthalpies (strengths) increase, bond length decreases. I want you to explain this on the atomic level-what's happening to protons and electrons. Electronegativity should also make an appearance in your response!

4. Use the average bond enthalpy data to calculate the enthalpy change, ΔH for A-H. For each calculation show all the steps and final units. Express your answer using the correct number of significant figures. Since addition and subtraction is involved follow the decimal place rule.

A. $CH_4(g) + 4\ Cl_2(g) \rightarrow CCl_4(g) + 4\ HCl(g)$
B. $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$
C. $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$
D. $H_2(g) + Br_2(g) \rightarrow 2\ HBr(g)$
E. $C_2H_6(g) + 3\ ½\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g)$
F. $C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(g)$
G. $C_2H_2(g) + 2\ ½\ O_2(g) \rightarrow 2\ CO_2(g) + H_2O(g)$
H. $3\ C(g) + 4\ H_2(g) \rightarrow C_3H_8(g)$

5. Identify the enthalpy of combustion reactions in questions A to H. Which is the best fuel and why?

Average bond enthalpies at 298K

Bond	ΔH / kJ mol^{-1}	Bond	ΔH / kJ mol^{-1}
H - H	436	C - H	412
D - D	442	Si - H	318
C - C	348	N - H	388
C = C	612	P - H	322
C ≡ C	837	O - H	463
C - C (benzene)	518	S - H	338
Si - Si	226	F - H	562
Ge - Ge	188	Cl - H	431
Sn - Sn	151	Br - H	366
N - N	163	I - H	299
N = N	409		
N ≡ N	944	C - O	360
P - P	172	C = O	743
O - O	146	C - N	305
O = O	496	C = N	613
S - S	264	C ≡ N	890
F - F	158	C - F	484
Cl - Cl	242	C - Cl	338
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6. Account for the differences in the strength of single, double and triple bonds by comparing
the average bond enthalpies of the C-O, C=O and C≡N bonds.

7. Account for the differences in the enthalpies of combustion for ethane, $C_2H_6(g)$, ethane,$C_2H_4(g)$ and ethyne, $C_2H_2(g)$

8. Determine the bond enthalpy for the HF bond in kJmol-1 in the reaction.
$H_2(g) + F_2(g) \rightarrow 2\ HF(g)$ $\Delta H = -521$ kJ

9. Use bond energy data to calculate the enthalpy when cyclopropane, C_3H_6 reacts with hydrogen to form propane, C_3H_8. The actual value found is -159 kJmol-1. State one reason why you think this differs from the value you have calculated. [3]

10. Consider the following reaction.

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

Use the values in the Chemistry data booklet calculate the enthalpy change, ΔH^o for the reaction.

11. Enthalpies of reactions, for example combustion, can be calculated using average bond enthalpies or enthalpies of formation. The two methods give closer results for cyclohexane, C_6H_{12} than they do for benzene, C_6H_6. Explain this difference.

*12. Discussion of the bond strength in ozone relative to oxygen in its importance to the atmosphere.

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