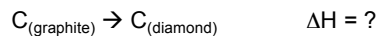


Thermochemistry 1

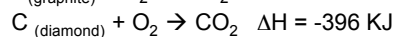
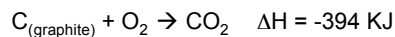
Hess's Law
Heat of Formation
Heat of Combustion
Bond Enthalpy

Hess's Law

Want:

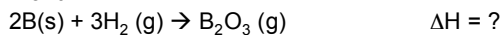


Given:

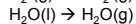
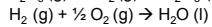
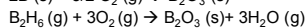
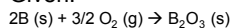


Hess's Law

Want:



Given:



Standard Enthalpy of Formation (ΔH_f)

- **Standard Enthalpy of Formation** - enthalpy change when one mole of a substance is formed from its elements, in their standard states, under standard conditions.
- Write equations to represent the following processes.
 - The standard enthalpy of formation of CH_3Br
 - The standard enthalpy of formation of $CH_3COC_2H_5$
 - The standard enthalpy of formation of $CaCO_3$
- All elements and diatomic molecules are assigned a value for enthalpy of formation equal to _____.
- ΔH_f may be negative or positive, if the enthalpy change is negative then energy is released and the reaction is _____, if it is positive then energy is taken in and it is _____.

Standard Enthalpy of Formation (ΔH_f)

- What is the ΔH_f for CuCl_2 (s)?
- What is the ΔH_f for 2 moles of FeCl_3 (s)?
- Remember, these are heats of FORMATION which means that the compound is being produced. If it on the reactant side, you must _____ the sign!

Standard Enthalpy of Combustion (ΔH_c)

- **Standard Enthalpy of Combustion** - enthalpy change when one mole of a substance is completely burned in oxygen under standard conditions.
- Energy is usually released in such a reaction ΔH_c , so it will usually be negative.
- $\Delta H_c [\text{C}_2\text{H}_6(\text{g})] = -1565 \text{ kJ/mol}$ means...

Write the following Equations

- The standard enthalpy of combustion of CH_4 (g)
- The standard enthalpy of combustion of $\text{Al}(\text{s})$

Example 1 (do not use Appendix)

- Calculate the standard enthalpy of formation of ethane (C_2H_6), given the following combustion data...
- $\text{C}(\text{graphite}) = -393 \text{ kJ/mol}$
- $\text{H}_2(\text{g}) = -286 \text{ kJ/mol}$
- $\text{C}_2\text{H}_6(\text{g}) = -1560 \text{ kJ/mol}$

Example 2 (do not use appendix)

- Calculate the standard enthalpy of combustion of propan-2-ol ($\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$), given the following data
- Enthalpies of combustion for C(graphite) = -393 kJ/mol and $\text{H}_2(\text{g}) = -286 \text{ kJ/mol}$.
- Enthalpy of formation of propan-2-ol = -318 kJ/mol

Examples

- Calculate the ΔH for the following reaction using the appendix
- $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$

- Is the reaction endothermic or exothermic? Why?

Examples

- How much heat will be released from the combustion of 1.80 g of C_6H_6 . Use the heat of formation data in the appendix.

Example

- The Thermite reaction can be used to produce molten iron for welding railway tracks together.
- $\text{Fe}_2\text{O}_3(\text{s}) + 2\text{Al}(\text{s}) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + 2\text{Fe}(\text{s})$
- Calculate the enthalpy change in the Thermite reaction, given the standard enthalpies of formation of iron (III) oxide and aluminum oxide are -823 and -1675 kJmol^{-1} , respectively.

Bond Enthalpies

- The strength of the bond in a diatomic covalent molecule is given by the bond dissociation energy.
- For example hydrogen, H₂ or H-H
- H₂(g) → 2H(g) BDE= +436 kJ

Bond Enthalpies

- In order to **break** a bond, **energy must be put in** (an _____ process with a _____ energy change)
- When **making** a bond, **energy is released** (an _____ process with a _____ energy change).

Bond Enthalpy Example 1

- Calculate the standard enthalpy of the reaction below.
- CH₃CH=CH₂ + H₂ → CH₃CH₂CH₃

Bond Energy Data

Bond	BET in kJmol ⁻¹
F-F	154
C=O	743
O-H	463
Br-Br	193
C-Br	276
H-Br	366
Cl-Cl	239
C-O	360
H-H	436
C-C	348
C-Cl	339
C-H	412
C=C	612
H-F	565
H-Cl	427
C-F	485
I-I	151
C-I	238
C=C	837
C-N	305
H-I	299

Bond Enthalpy Example 2

- Calculate the enthalpy change for the reaction below.
- $\text{CH}_3\text{CH}=\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCHBrCH}_3$

Bond Energy Data

Bond	BET in kJmol^{-1}
F-F	154
C=O	743
O-H	463
Br-Br	193
C-Br	276
H-Br	366
Cl-Cl	239
C-O	360
H-H	436
C-C	348
C-Cl	339
C-H	412
C=C	612
H-F	565
H-Cl	427
C-F	485
I-I	151
C-I	238
C=C	837
C-N	305
H-I	299