

Thermochemistry 2

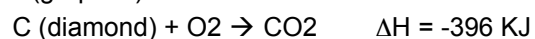
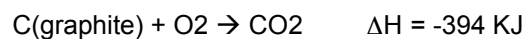
Hess's Law
Heat of Formation
Heat of Combustion
Bond Enthalpy

Hess's Law

Want:

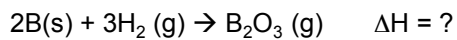


Given:

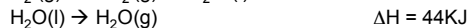
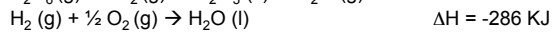
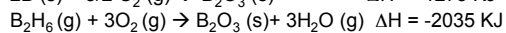
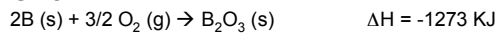


Hess's Law

Want:



Given:



Standard Enthalpy of Formation (ΔH_f)

- **Standard Enthalpy of _____** - enthalpy change when one mole of a substance is formed from its elements, in their standard states, under standard conditions.

Standard Enthalpy of Formation (ΔH_f)

- Write equations to represent the following processes.
- The standard enthalpy of formation of CH_3Br
- The standard enthalpy of formation of $\text{CH}_3\text{COC}_2\text{H}_5$
- The standard enthalpy of formation of CaCO_3

Standard Enthalpy of Formation (ΔH_f)

- What is the ΔH_f for CuS (s) ?
 - Look up in Appendix
- What is the ΔH_f for 2 moles of $\text{FeCl}_3 \text{ (s)}$?
- Remember, these are heats of FORMATION which means that the compound is being produced. If it on the reactant side, you must flip the sign!

Standard Enthalpy of Formation (ΔH_c)

- **Standard Enthalpy of _____** - 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.

Standard Enthalpy of Formation (ΔH_c)

- Write the reaction for the following...
- $\Delta H_c [\text{C}_2\text{H}_6(\text{g})] = - 1565 \text{ kJ/mol}$
- The standard enthalpy of combustion of $\text{CH}_4 \text{ (g)}$
- The standard enthalpy of combustion of Al(s)

Example 1 (do not use Appendix)

- Calculate the standard enthalpy of formation of ethane (C_2H_6), given the following combustion data...
- $C(\text{graphite}) = -393 \text{ kJ/mol}$
- $H_2(g) = -286 \text{ kJ/mol}$
- $C_2H_6(g) = -1560 \text{ kJ/mol}$

Example 2 (do not use appendix)

- Calculate the standard enthalpy of combustion of propan-2-ol ($CH_3CH(OH)CH_3$), given the following data
- Enthalpies of combustion for $C(\text{graphite}) = -393 \text{ kJ/mol}$ and $H_2(g) = -286 \text{ kJ/mol}$.
- Enthalpy of formation of propan-2-ol = -318 kJ/mol

Examples

- Calculate the ΔH for the following reaction using the appendix
- $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
- 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, H_2 or H-H
- $\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$ BDE= $+436$ kJ

Bond Enthalpies

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

Bond Enthalpy Example 1

- Calculate the standard enthalpy of the reaction below.
- $\text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_3$

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

Bond Enthalpy Example 2

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

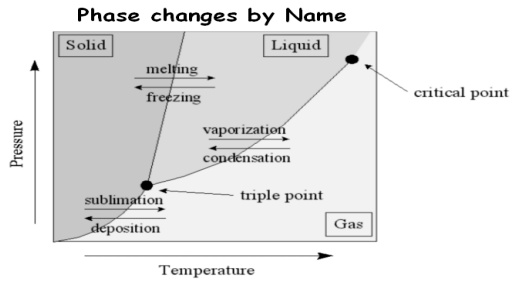
Bond Energy Data

Bond	BET in kJmol ⁻¹
F-F	154
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Phase Diagrams

- An area on a phase diagram represents one _____, a line represents the conditions under which two phases can exist in _____.
- The _____ point describes the conditions under which all three phases can coexist.
- The _____ point describes the maximum temperature that a liquid of the substance can exist.
 - Above this temperature the difference between the liquid and the gas disappear and the substance is referred to as a _____.

Phase Diagrams



Heating Curve

