

Enthalpy - H

Energy of a system which is open to the atmosphere.

$$\mathbf{H = E + PV}$$

We are concerned with changes in enthalpy.

$$\Delta H = \Delta E + \Delta(PV)$$

If a reaction is carried out in an open container the external pressure on the system is constant:

$$\Delta H = \Delta E + P\Delta V$$

Recall:

$$\Delta E = q + w$$

$$\Delta E = q - P\Delta V$$

$$q = E + P\Delta V$$

Therefore: $\Delta H = q$

Whenever a reaction is carried out against constant pressure, i.e. in an open container.

Calorimetry -

The science of measuring the quantities of heat that are involved with chemical or physical changes.

Heat Capacity - (C)

The amount of heat needed to raise the temp. of an object by 1°C.

$$C = \frac{\textit{Heat_Absorbed}}{\textit{Increase_in_Temperature}}$$

Specific Heat Capacity -

Amount of heat needed to raise the temp. of 1g of a substance 1°C.

Specific Heat of water: $\frac{4.184\text{J}}{\text{g}\cdot^{\circ}\text{C}}$

Molar Heat Capacity -

The amount of heat needed to raise the temp. of one mole of a substance 1°C.

Bomb Calorimeter-

A device used to carry out experiments at constant volume.

$$\Delta E = q + w$$

$$\Delta E = q - P\Delta V$$

In a bomb calorimeter ΔV is zero,

$$\Delta E = q \quad (V = \text{constant})$$

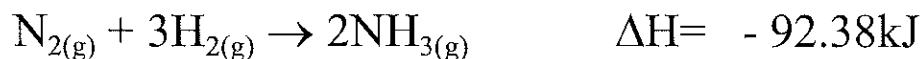
Hess's Law - (heat summation)

For any rxn that can be written as a series of steps, ΔH for the rxn is equal to the sum of the ΔH 's of the steps.

The chief use of Hess's law is to calculate the enthalpy change for a reaction for which data cannot be determined experimentally or are otherwise unavailable.

Thermochemical Equations include the value of ΔH .

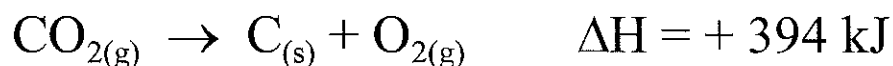
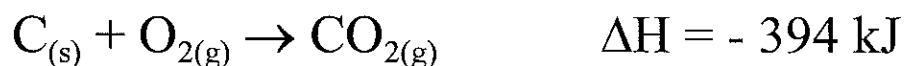
The **standard heat of reaction** is the value of ΔH for a reaction occurring under standard conditions (1 atm, 25°C) and involving the actual number of moles specified by the coefficients of the equation.



The above two thermochemical equations are for the **exothermic** reaction between nitrogen and hydrogen to form ammonia.

Rules for manipulating thermochemical equations:

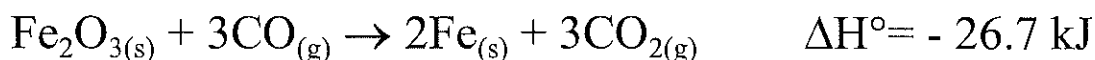
1. When an equation is reversed (written in the opposite direction), the sign of ΔH must also be reversed.



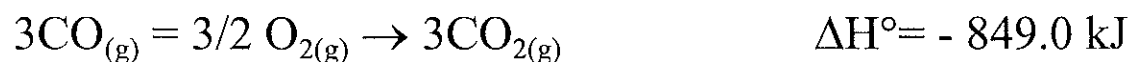
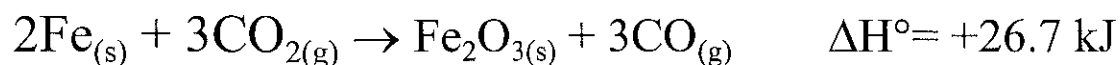
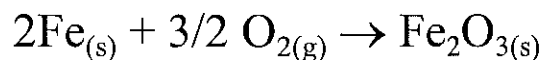
2. Formulas canceled from both sides of an equation must be for the substance in identical physical states.
3. If all the coefficients of an equation are

- multiplied or divided by the same factor, the value of ΔH° must likewise be changed.

Carbon monoxide is used in metallurgy to remove oxygen from metal oxides and thereby give the free metal. Given the following two thermochemical equations:



Determine ΔH° for the reaction:



Standard Enthalpy of Formation-

The change in enthalpy that accompanies the formation of 1 mole of a compound from its elements with all substances in their standard states at 25°C.

Standard state is 1 atm, 25°C. (1 M for solutions)

The enthalpy change for a given reaction can be calculated by subtracting the enthalpies of formation of the reactants from the enthalpies of formation of the products.

$$\Delta H_{\text{rxn}} = \sum \Delta H_{\text{(products)}} - \sum \Delta H_{\text{(reactants)}}$$

The enthalpy of formation of elements is zero.

examples