Homework - Worksheet

Extra Sheet on Heats of Formation

Heat of formation= Heat of Reaction or Heat of Combustion

ΔH These terms are used interchangeably.

Same as...

Molar heat of formation= Molar heat of reaction or Molar heat of combustion

H

Σn products $- \Sigma n$ reactants

Multi-Step Energy Calculations

Step 1: *Find H general*
-use Hess' law
-from equation
-use calorimetry

Step 2: *Find n (specific)*
-use mass (molar mass)
-use concentration
-use $n = \Delta H/H$

Step 3: *Find ΔH (specific), mass,* ΔT, etc.

General

Sample Problem

Ex. $2NaHCO_{3(s)}$ + 129.2kJ ⟶ $Na_2CO_{3(s)}$ + $CO_{2(g)}$ + $H_2O_{(g)}$

ΔH_r

What quantity of energy ΔH_r, is required to decompose 100. kg of $NaHCO_{3(s)}$?

specifics

$\Delta H = n H_r$

① General

$\Delta H = n H_r$

$H_r = \frac{\Delta H}{n}$

$H_r = +\frac{129.2 kJ}{2 mol NaHCO_3}$

$H_r = 64.6 kJ/mol$

② Specifics (n)

$n = 100\ 000 g \times \frac{1 mol NaHCO_3}{84.01 g}$

$n = 1190.33 mol$

③ Specific ($\Delta H = n H_r$)

$\Delta H_r = (1190.33 mol NaHCO_3)(\frac{64.6 kJ}{1 mol NaHCO_3})$

76895.318

$= +76900 kJ$

Sample Problem

Ex. $ZnS_{(s)} + 3/2O_{2(g)} \longrightarrow ZnO_{(s)} + SO_{2(g)}$ + 441.3 kJ

What quantity of energy, ΔH_r, can be obtained from roasting of 50.0kg of zinc sulfide ore?

$\Delta H_r = \Sigma n\,\text{products} - \Sigma n\,\text{reactants}$

$\Delta H_r = \left((1\,mol \times -350.5\,\frac{kJ}{mol}) + (1\,mol \times -296.8\,\frac{kJ}{mol}) \right) - \left((1\,mol \times -206.0\,\frac{kJ}{mol}) + (\frac{3}{2}\,mol \times 0\,\frac{kJ}{mol}) \right)$

$\Delta H_r = (-647.3\,kJ) - (-206.0\,kJ)$

$\Delta H_r = -441.3\,kJ$

① General

$\Delta H = nH_r$

$H_r = \frac{\Delta H}{n}$

$H_r = \frac{-441.3\,kJ}{1\,mol\ ZnS}$

$H_r = -441.3\,kJ/mol$

② Specific

$\Delta H_r = nH_r$

$n = 50000\,g \times \frac{1\,mol\ ZnS}{97.44\,g}$

$n = 513.1\,mol$

③ Specific ΔH

$\Delta H = H_r n$

$\Delta H = \frac{-441.3\,kJ}{1\,mol} \times 513.1\,mol$

$\Delta H = -226\,431.03\,kJ$

$\Delta H = -226.4\,MJ$

Calculate the mass of methane combusted when 3700. kJ of energy is released according to the following reaction.

$\Delta H_r = -802.7kJ$

$$CH_{4(g)} + 2O_{2(g)} \Rightarrow CO_{2(g)} + 2H_2O_{(g)} + 802.7kJ$$

(1) General $\Delta H_r = nH$

$m = mm \times n$

$H_r = \frac{\Delta H}{n}$

$H_r = \frac{-802.7kJ}{1mol}$

$H_r = -802.7kJ/mol$

(2) Specific

$\Delta H_r = nH_r \rightarrow n = \frac{\Delta H_r}{H_r}$

$n = -3700kJ \times \frac{1mol\ CH_4}{-802.7kJ}$

$n = 4.6 mol$

(3) Specific (mass).

$n = \frac{m}{mm}$

$m = (4.6mol)\left(\frac{16.05g}{1mol}\right)$

$m = 73.83g$

Worksheet #1-2

Multi-Step Energy Calculations can be used when energy produced in one chemical reaction is used to heat another substance. These calculations are very similar to calorimetry calculations.

total enthalpy change = quantity of heat

$$\Delta H_r = -q$$

Sample Problem

What mass of octane is completely burned during the heating of 20.L of aqueous ethylene glycol automobile coolant from -10^{o}C to 70^{o}C? The volumetric heat capacity of aqueous ethylene glycol is 3.7 kJ/L^{o}C.

Ex. $2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 18H_2O_{(s)} + 16CO_{2(g)}$

Worksheet #1-5