

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

$$\sum n_{\text{products}} - \sum n_{\text{reactants}}$$

Multi-Step Energy Calculations

Step 1: *Find H general*

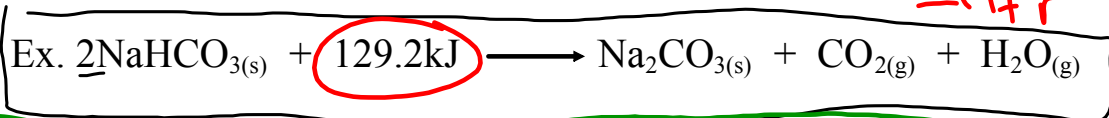
- use Hess' law
- from equation
- use calorimetry

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**



What quantity of energy ΔH_r is required to decompose 100. kg of $\text{NaHCO}_3(s)$?

Specifics

$\Delta H = n(H_r)$

① General

$\Delta H = nH_r$
 $H_r = \frac{\Delta H}{n}$
 $H_r = \frac{+129.2\text{kJ}}{2\text{mol NaHCO}_3}$
 $H_r = 64.6\text{kJ/mol}$

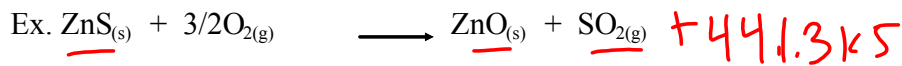
② Specifics (n)

$n = 100\,000\text{g} \times \frac{1\text{mol NaHCO}_3}{84.01\text{g}}$
 $n = 1190.33\text{mol}$

③ Specific ($\Delta H = nH_r$)

$\Delta H_r = (1190.33\text{mol}) \left(\frac{64.6\text{kJ}}{1\text{mol NaHCO}_3} \right)$
 $76\,895.318$
 $\approx 76\,900\text{kJ}$

Sample Problem



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

$$\begin{aligned} \Delta H_r &= \sum n_{\text{products}} - \sum n_{\text{reactants}} \\ \Delta H_r &= \left(1 \text{ mol} \times -350.5 \frac{\text{kJ}}{\text{mol}} \right) + \left(1 \text{ mol} \times -296.8 \frac{\text{kJ}}{\text{mol}} \right) \\ &\quad - \left(1 \text{ mol} \times -206.0 \frac{\text{kJ}}{\text{mol}} \right) + \left(\frac{3 \text{ mol}}{2} \times 0 \frac{\text{kJ}}{\text{mol}} \right) \\ \Delta H_r &= (-647.3 \text{ kJ}) - (-206.0 \text{ kJ}) \\ \Delta H_r &= -441.3 \text{ kJ} \end{aligned}$$

① General

$$\Delta H = n H_r$$

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

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

$$H_r = -441.3 \text{ kJ/mol}$$

② Specific

$$\Delta H_r = n H_r$$

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

$$n = 513.1 \text{ mol}$$

③ Specific ΔH

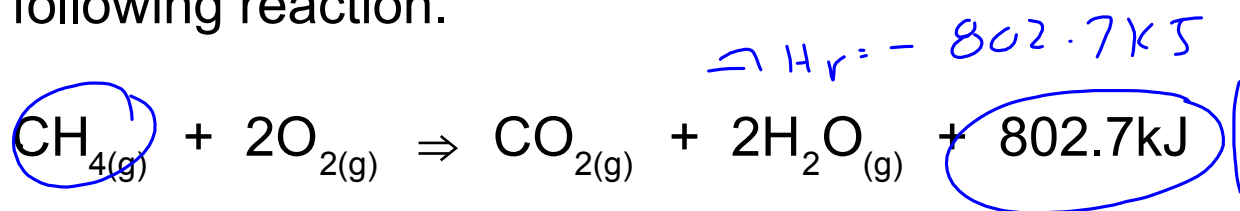
$$\Delta H = H_r n$$

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

$$\Delta H = -226431.03 \text{ kJ}$$

$$\Delta H = -226.4 \text{ MJ}$$

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



① General $\Delta H_r = nH$

$m: mm \times n$

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

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

$$H_r = -802.7\text{kJ/mol}$$

② Specific

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

$$n = \frac{-3700\text{kJ}}{-802.7\text{kJ}} \times \frac{1\text{mol CH}_4}{1\text{mol CH}_4}$$

$$n = 4.6\text{mol}$$

③ Specific (mass).

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

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

$$m = 73.83\text{g}$$



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°C to 70°C ? The volumetric heat capacity of aqueous ethylene glycol is $3.7 \text{ kJ/L}^{\circ}\text{C}$.



Worksheet #1-5

