

Multi-Step Energy Calculations

Step 1: *Find H_r general*

- use Hess' law
- from equation
- $\Delta H = nH$

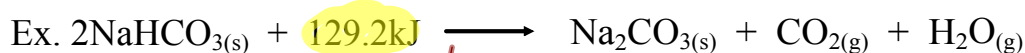
Step 2: *Find n (specific)*

- use mass (molar mass)
- use calorimetry
- use $n = \Delta H/H^\circ$

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

- use $\Delta H = nH^\circ$
- use calorimetry

Sample Problem



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

$$\Delta H_r = \sum n\Delta H_{fp} - \sum n\Delta H_r$$

Step 1: H_r (general)

$$\Delta H_r = nH_r$$

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

$$H_r = \frac{129.2 \text{ kJ}}{2 \text{ mol}}$$

$$H_r = \underline{\underline{64.6 \text{ kJ/mol}}}$$

Step 2: n (specific)

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

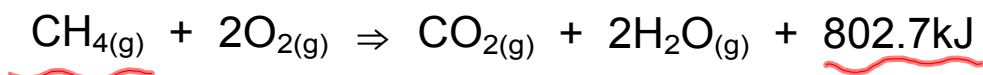
Step 3: ΔH_r (specific)

$$\Delta H_r = nH_r$$

$$\Delta H_r = (1190.33 \text{ mol}) \left(64.6 \frac{\text{kJ}}{\text{mol}} \right)$$

$$\Delta H_r = 76900 \text{ kJ}$$

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



Step 1: H_r (general)

$$\Delta H = nH_r$$

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

$$\Delta H_r = \sum nH_{f,p} - \sum nH_{f,r}$$

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

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

Step 2: n (specific)

$$\Delta H = nH_r$$

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

$$n = \frac{-3700\text{kJ}}{-802.7\text{kJ/mol}}$$

$$n = \underline{\underline{4.6094\text{mol}}}$$

Step 3: m (specific)

$$4.6094\text{mol CH}_4 \times \frac{16.05\text{g CH}_4}{1\text{mol CH}_4} = \boxed{73.98\text{g CH}_4}$$

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