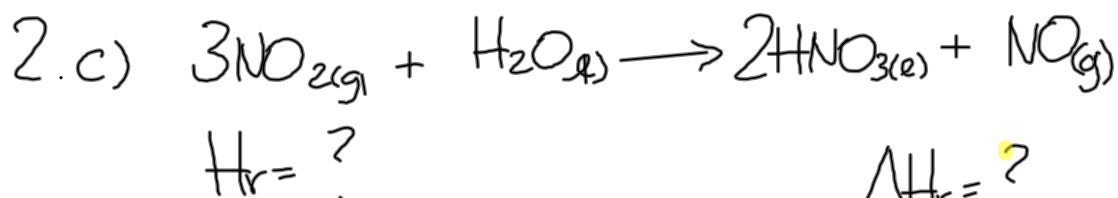


Worksheet



$$H_r = ?$$

$$\Delta H_r = ?$$

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

$$\Delta H_r = \left[(2 \text{ mol}) \left(-174.1 \frac{\text{kJ}}{\text{mol}} \right) + (1 \text{ mol}) \left(90.2 \frac{\text{kJ}}{\text{mol}} \right) \right] -$$

$$\left[(3 \text{ mol}) \left(33.2 \frac{\text{kJ}}{\text{mol}} \right) + (1 \text{ mol}) \left(-285.8 \frac{\text{kJ}}{\text{mol}} \right) \right]$$

$$\Delta H_r = (-258 \text{ kJ}) - (-186.2 \text{ kJ})$$

$$\Delta H_r = -71.8 \text{ kJ}$$

$$\Delta H_r = n H_r$$

$$H_r = \frac{\Delta H_r}{n} = \frac{-71.8 \text{ kJ}}{3 \text{ mol}} = -23.9 \text{ kJ/mol}$$

Multi-Step Energy Calculations

Step 1: *Find H° general*

- use Hess's law
- from equation
- use calorimetry

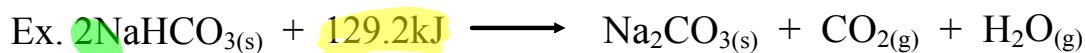
Step 2: *Find n (specific)*

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

Step 3: Find unknown quantity

- often ΔH (*specific*)
 - use $\Delta H = nH^\circ$
- mass
- volume

Sample Problem



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

Step 1: H_r (general)

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

$$\Delta H_r = 129.2 \text{ kJ}$$

$$\Delta H_r = n H_r$$

$$H_r = \frac{\Delta H_r}{n} = \frac{129.2 \text{ kJ}}{2 \text{ mol}} = \underline{\underline{64.6 \frac{\text{kJ}}{\text{mol}}}}$$

Step 2: n (specific)

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

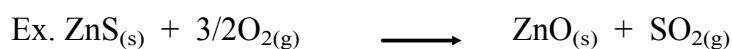
Step 3: ΔH_r (specific)

$$\Delta H_r = n H_r$$

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

$$\boxed{\Delta H_r = 76\,900 \text{ kJ}}$$

Sample Problem



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

Step 1: H_r (general)

$$\Delta H_r = \sum n H_{f_p} - \sum n H_{f_r}$$

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

$$\Delta H_r = -441.3 \text{ kJ}$$

$$\Delta H_r = n H_r$$

$$H_r = \frac{\Delta H_r}{n} = \frac{-441.3 \text{ kJ}}{1 \text{ mol}} = \underline{\underline{-441.3 \frac{\text{kJ}}{\text{mol}}}}$$

Step 2: n (specific)

$$50000 \text{ g ZnS} \times \frac{1 \text{ mol ZnS}}{97.44 \text{ g ZnS}} = \underline{\underline{513.136 \text{ mol ZnS}}}$$

Step 3: ΔH_r (specific)

$$\Delta H_r = n H_r$$
$$\Delta H_r = (513.136 \text{ mol}) \left(-441.3 \frac{\text{kJ}}{\text{mol}} \right)$$

$$\Delta H_r = -226000 \text{ kJ}$$

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

