

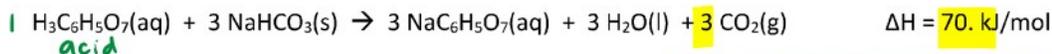
Enthalpy Stoich & Hess's Law

Friday, January 25, 2019 7:54 AM

EXOTHERMIC	ENDOTHERMIC
<ul style="list-style-type: none"> • system <u>loses</u> E • ΔH is <u>negative</u> value • E or "heat" can be placed on <u>product</u> side 	<ul style="list-style-type: none"> • System <u>gains</u> E • ΔH is <u>positive</u> value • E or "heat" can be placed on <u>reactant</u> side

Enthalpy Stoichiometry Practice

1. Citric acid reacts with sodium bicarbonate according to the balanced equation below.



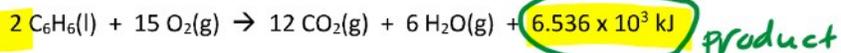
a. Calculate the quantity of heat, in joules, absorbed when 5.00 grams of sodium bicarbonate reacts with excess citric acid.

$$\frac{5 \text{ g NaHCO}_3}{84.01 \text{ g}} \times \frac{1 \text{ mol NaHCO}_3}{3 \text{ mol NaHCO}_3} \times 70 \text{ (kJ)} = 1.388 = \boxed{1.4 \text{ kJ}}$$

b. Calculate the grams of carbon dioxide produced when 300. kJ of heat are absorbed.

$$\frac{300 \text{ kJ}}{70 \text{ kJ}} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol CO}_2} \times 44.01 \text{ g CO}_2 = 565.8 = \boxed{570 \text{ g CO}_2}$$

2. The combustion of benzene, $\text{C}_6\text{H}_6(\text{l})$, in oxygen liberates heat according to the balanced equation below.



a. Is the reaction endothermic or exothermic? Explain your reasoning.

exothermic b/c energy is a product

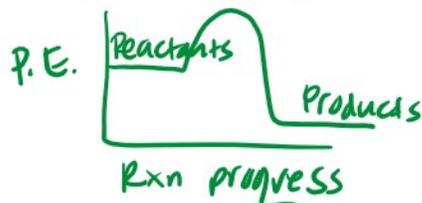
b. What is the value of ΔH ?

$$\Delta H = -6.536 \times 10^3 \text{ kJ/mol rxn}$$

c. Draw the potential energy diagram for this reaction.

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d. Calculate the quantity of heat released when 10.00 g of benzene is burned in excess oxygen.

$$\frac{10 \text{ g C}_6\text{H}_6}{78.12 \text{ g}} \times \frac{1 \text{ mol C}_6\text{H}_6}{2 \text{ mol C}_6\text{H}_6} \times 6.536 \times 10^3 \text{ kJ} = 418.3 \text{ kJ}$$

e. How many grams of benzene must be burned to evolve 1.00 kJ of heat?

$$\frac{1 \text{ kJ}}{6.536 \times 10^3 \text{ kJ}} \times \frac{2 \text{ mol C}_6\text{H}_6}{1 \text{ mol C}_6\text{H}_6} \times 78.12 \text{ g C}_6\text{H}_6 = 0.02390 \text{ g C}_6\text{H}_6$$

★ Coefficients = ΔH

Hess's Law

Desired Rxn

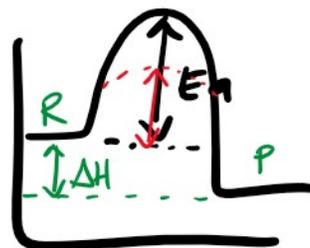
1. Calculate ΔH for the reaction: $\text{N}_2(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$.

Given: $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}(\text{g}) \quad \Delta H = 180 \text{ kJ/mol rxn}$

+ $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g}) \quad \Delta H = -112 \text{ kJ/mol rxn}$



$$\Delta H = 180 - 112 = 68 \text{ kJ/mol rxn}$$



2. Calculate ΔH for the reaction: $\text{C}_{\text{graphite}}(\text{s}) \rightarrow \text{C}_{\text{diamond}}(\text{s})$

Given: $\text{C}_{\text{graphite}}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \quad \Delta H = -394 \text{ kJ/mol rxn}$

~~$\text{C}_{\text{diamond}}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \quad \Delta H = -396 \text{ kJ/mol rxn}$ FLIP~~

+ $\text{CO}_2(\text{g}) \rightarrow \text{C}_{\text{diamond}}(\text{s}) + \text{O}_2(\text{g}) \quad \Delta H = +396$



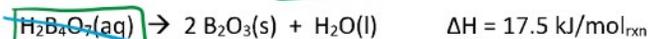
$$\Delta H = -394 + 396 = 2 \text{ kJ/mol rxn}$$

graphite (s) → diamond (s)

$$\Delta H = -394 + 396 = 2 \text{ kJ/mol rxn}$$

3. Calculate ΔH for the reaction: $2 \text{H}_3\text{BO}_3(\text{aq}) \rightarrow \text{B}_2\text{O}_3(\text{s}) + 3 \text{H}_2\text{O}(\text{l})$

Given: $4 \text{H}_3\text{BO}_3(\text{aq}) \rightarrow 4 \text{HBO}_2(\text{aq}) + 4 \text{H}_2\text{O}(\text{l}) \quad \Delta H = (-0.02 \text{ kJ/mol rxn})(4) = -0.08$



$$\Delta H = -0.08 + 17.5 + 11.3 = \frac{28.72}{2}$$

$$\Delta H = \frac{28.72}{2} = 14.36 \text{ kJ/mol rxn}$$

