

ENTHALPY PROBLEMS AND MASS-HEAT PROBLEMS

1. Given the following reaction: $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$

- _____ a. What is the ΔH_f of C_2H_6 ?
- _____ b. Is the ΔH_f of C_2H_6 always the same for any reaction involving C_2H_6 ?
- _____ c. What is the ΔH_f of the water vapor in the reaction?
- _____ d. Do the ΔH_f values indicate that C_2H_6 or water vapor is more stable at 25 °C?
- _____ e. What is the ΔH_{rxn} for the reaction?
- _____ f. Does the ΔH_{rxn} indicate that there is more enthalpy in the products or in the reactants?
- _____ g. Is the reaction endothermic or exothermic?
- _____ h. Based on the enthalpy change alone, would you expect the reaction to be spontaneous at room temperature?

2. Given the reaction $2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}$

- _____ a. What is the ΔH_f for pure iron in the above reaction?
- _____ b. What is the ΔH_{rxn} ?
- _____ c. Which is the more stable reactant in the reaction? Why?
- _____ d. Which is more stable, the C_2H_6 in the first reaction or the Fe_2O_3 in the second reaction? Why?
- _____ e. Based on the enthalpy change alone, would you expect the above reaction to be spontaneous at room temperature?
- _____ f. Do the products or the reactants in the above reaction have more enthalpy?
- _____ g. Is the above reaction endothermic or exothermic?

Write the thermochemical equation for the following reactions. Be sure to solve for ΔH and show it in its proper place in the balanced chemical equation!

1. nitrogen dioxide decomposes (when heated) into nitrogen monoxide and oxygen gas.
2. Methyl alcohol (CH_3OH) is completely combusted. Water vapor is one of the products. ($\Delta H_f = -201 \text{ kJ/mol}$ for methyl alcohol.)
3. Iron plus carbon dioxide yields iron(III) oxide plus carbon monoxide.
4. Liquid water is synthesized from its elements.
5. Carbon monoxide reacts with oxygen gas yielding carbon dioxide.
 - a. How much heat would be released per mole of carbon monoxide that reacts?
 - b. If 35 g of carbon monoxide is combined with excess oxygen, how many kJ of heat would be released?

c. If you wished to generate EXACTLY 100.0 kJ of heat, how many grams of carbon monoxide would you need to react?

d. How many grams of oxygen would be needed to generate the same amount of heat in part c?

e. If 80.00 kJ of heat are produced, how many grams of carbon dioxide are produced at the same time?

Key

25

ENTHALPY PROBLEMS AND MASS-HEAT PROBLEMS

1. Given the following reaction: $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$

-84,68 $\frac{\text{kJ}}{\text{mol}}$

a. What is the ΔH_f of C_2H_6 ?

yes

b. Is the ΔH_f of C_2H_6 always the same for any reaction involving C_2H_6 ?

-241.818 $\frac{\text{kJ}}{\text{mol}}$

c. What is the ΔH_f of the water vapor in the reaction?

~~55555~~ H_2O

d. Do the ΔH_f values indicate that C_2H_6 or water vapor is more stable at 25 °C?

-2855.58 $\frac{\text{kJ}}{\text{mol}}$

e. What is the ΔH_{rxn} for the reaction?

reactants

f. Does the ΔH_{rxn} indicate that there is more enthalpy in the products or in the reactants?

exothermic

g. Is the reaction endothermic or exothermic?

yes

h. Based on the enthalpy change alone, would you expect the reaction to be spontaneous at room temperature?

2. Given the reaction $2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}$

0

a. What is the ΔH_f for pure iron in the above reaction?

+~~16.752~~

b. What is the ΔH_{rxn} ?

CO_2 has lowest ΔH_f

c. Which is the more stable reactant in the reaction? Why?

Fe_2O_3 has lowest ΔH_f

d. Which is more stable, the C_2H_6 in the first reaction or the Fe_2O_3 in the second reaction? Why?

NO

e. Based on the enthalpy change alone, would you expect the above reaction to be spontaneous at room temperature?

products

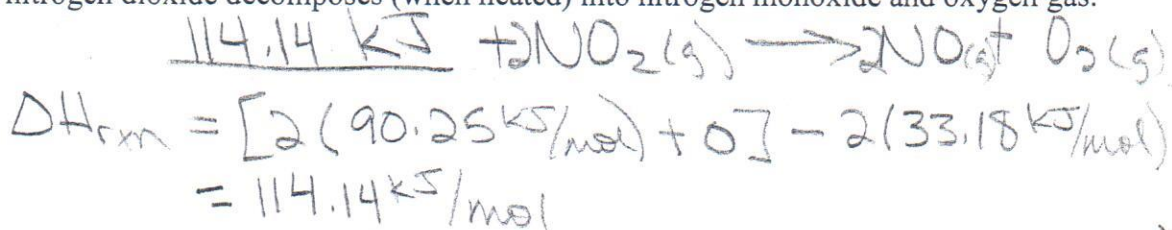
f. Do the products or the reactants in the above reaction have more enthalpy?

endothermic

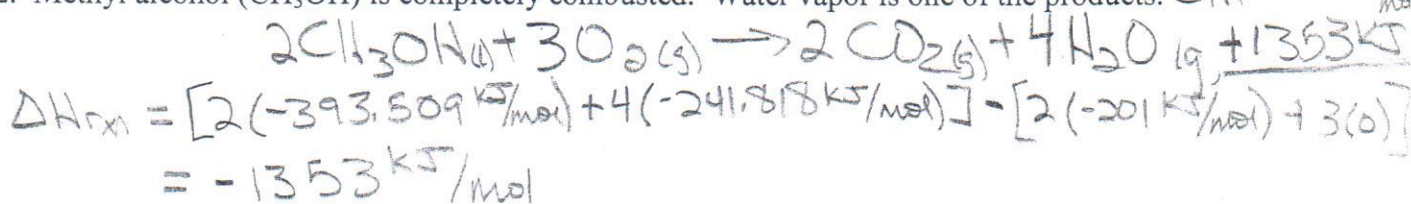
g. Is the above reaction endothermic or exothermic?

Write the thermochemical equation for the following reactions. Be sure to solve for ΔH and show it in its proper place in the balanced chemical equation!

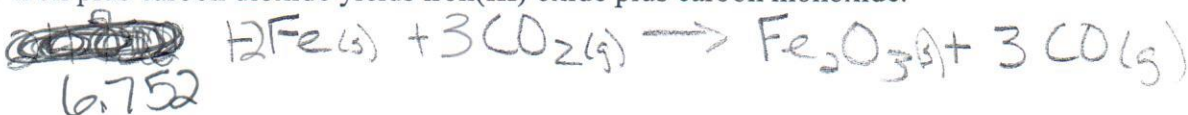
1. nitrogen dioxide decomposes (when heated) into nitrogen monoxide and oxygen gas.



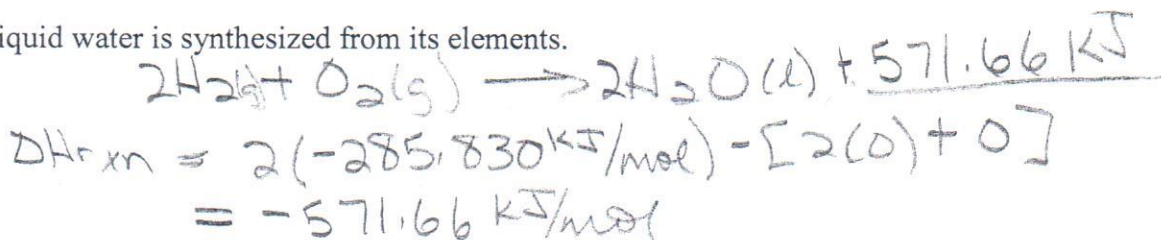
2. Methyl alcohol (CH_3OH) is completely combusted. Water vapor is one of the products. $\Delta H_f = -201 \frac{\text{kJ}}{\text{mol}}$



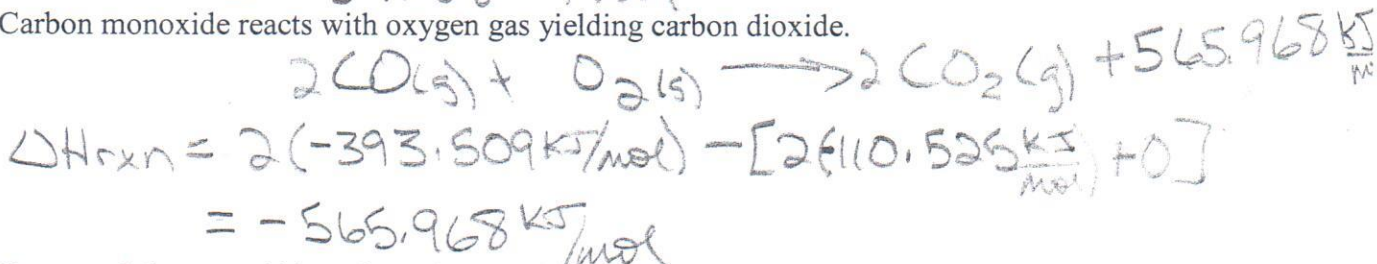
3. Iron plus carbon dioxide yields iron(III) oxide plus carbon monoxide.



4. Liquid water is synthesized from its elements.



5. Carbon monoxide reacts with oxygen gas yielding carbon dioxide.



- a. How much heat would be released per mole of carbon monoxide that reacts?

$$\frac{-565.968 \text{ kJ}}{2 \text{ mol CO}} = \boxed{-282.984 \text{ kJ/mol}}$$

- b. If 35 g of carbon monoxide is combined with excess oxygen, how many kJ of heat would be released?

$$\frac{35 \text{ g CO}}{28.01 \text{ g CO}} \times \frac{-565.968 \text{ kJ}}{2 \text{ mol CO}} = \boxed{-353.6 \text{ kJ}}$$

c. If you wished to generate EXACTLY 100.0 kJ of heat, how many grams of carbon monoxide would you need to react?

$$- \frac{100.0 \text{ kJ} | 2 \text{ mol CO} | 28.01 \text{ g}}{-565.968 \text{ kJ} | 1 \text{ mol CO}} = \boxed{9.898 \text{ g CO}}$$

d. How many grams of oxygen would be needed to generate the same amount of heat in part c?

$$- \frac{100.0 \text{ kJ} | 1 \text{ mol O}_2 | 31.998 \text{ g}}{-565.968 \text{ kJ} | 1 \text{ mol O}_2} = \boxed{5.654 \text{ g O}_2}$$

e. If 80.00 kJ of heat are produced, how many grams of carbon dioxide are produced at the same time?

$$- \frac{80.00 \text{ kJ} | 2 \text{ mol CO}_2 | 44.009 \text{ g}}{-565.968 \text{ kJ} | 1 \text{ mol}} = \boxed{12.44 \text{ g CO}_2}$$