Thermochemical Stoichiometry Practice:

name: SOLUTIONS

Given the equation: $2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (l)$ $\Delta H = -285.85\ kJ/mol$

1) a. How much energy is produced if 100.0 grams of H_2 are converted to water?

$2H_2 + O_2 \rightarrow 2H_2O + 571.7\ kJ$

2 moles — 571.7 kJ

$m = n \cdot M$

$m = 2(2)$

$m = 4g$ — 571.7 kJ

100g — x

$x = 14290\ kJ$

b. How many grams of H_2 would be required to produce 5000.0 kJ?

$2H_2 + O_2 \rightarrow 2H_2O + 571.7\ kJ$

2 moles — 571.7 kJ

$m = n \cdot M$

$m = 2(2)$

$m = 4g$ — 571.7 kJ

x — 5000 kJ

$x = 35g$

2) Given the equation: $4Fe(s) + 3\ O_2(g) \rightarrow 2Fe_2O_3(s) + 1648\ kJ$

a. Assuming that the iron is converted to iron (III) oxide as in the above equation, how much heat can be provided by a hot pack that contains 50.0 g of iron?

4 moles — 1648 kJ

$m = n \cdot M$

$m = 4(55.8)$

$m = 223.2g$ — 1648 kJ

50g — x

$x = 369\ kJ$

b. If the hot pack from part a. gives off heat at the rate of 42.0 kJ /hour, how long will it stay warm?

$\frac{369}{42} = 8.8\ hrs$

3) Given the equation: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H_{Formation} = -46.11$ kJ/mol

a. Re-write the chemical equation with the energy written inside the reaction

$N_2 + 3H_2 \rightarrow 2NH_3 + 92.22\,kJ$

b. What is the enthalpy change associated with the formation of 4.75 mol NH_3?

$N_2 + 3H_2 \rightarrow 2NH_3 + 92.22\,kJ$

2 moles — 92.22 kJ

4.75 moles — x

$x = 219$ kJ

c. How much energy will be released when 48g $H_2(g)$ react with excess $N_2(g)$ to form $NH_3(g)$?

$N_2 + 3H_2 \rightarrow 2NH_3 + 92.22\,kJ$

3 mole — 92.22 kJ

$m = n \cdot M$

$m = 3(2)$

$m = 6g$

48g — 92.22 kJ

x

$x = 734$ kJ

4) Given the equation: $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$ $\Delta H = -317.5$ kJ/mol

How much energy is released during the production of 5.0 g of CaO?

$2Ca + O_2 \rightarrow 2CaO + 635\,kJ$

2 moles — 635 kJ

$m = n \cdot M$

$m = 2(56)$

$m = 112g$

5g — 635 kJ

x

$x = 28.35$ kJ

5) Study the following hypothetical decomposition reaction. The enthalpy is given for decomposition of X_5Y_2.

$3X_5Y_2 \rightarrow 2XY_3 + 13X$ $\Delta H = 7654$ kJ/mol (décomp)

How many moles X would be produced if 182 500 KJ are used to decompose a given amount of X_5Y_2 ?

$3X_5Y_2 + 22962\,kJ \rightarrow 2XY_3 + 13X$

22962 kJ — 13 moles

182 500 kJ — x

$x = 103.3$ moles

6) Study the following reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O \qquad \Delta H_{(NH_3)} = -293 \text{ kJ/mol}$$

a) How much energy is released when 16 moles of O_2 are used?

$4NH_3 + \underbrace{5O_2}_{5 \text{ moles}} \rightarrow 4NO + 6H_2O + \underbrace{1172 \text{ kJ}}_{1172 \text{ kJ}}$

16 moles — x

$x = 3750.4$ kJ

b) How much energy is released when 170g of ammonia (NH_3) is used?

$\underbrace{4NH_3}_{4 \text{ moles}} + 5O_2 \rightarrow 4NO + 6H_2O + \underbrace{1172 \text{ kJ}}_{1172 \text{ kJ}}$

$m = n \cdot M$

$m = 4(17)$

$m = 68g$

170g — 1172 kJ

$x = 2930$ kJ — x

7) The following is a synthesis reaction for the formation of ammonium nitrate:

$$2N_2 + 4H_2 + 3O_2 \rightarrow 2NH_4NO_3 \qquad \Delta H_{(\text{synthesis})} = -364.7 \text{ kJ/mol}$$

a) How much energy is produced when 75g of O_2 is used?

$2N_2 + 4H_2 + \underbrace{3O_2}_{3 \text{ moles}} \rightarrow 2NH_4NO_3 + \underbrace{729.4 \text{ kJ}}_{729.4 \text{ kJ}}$

$m = n \cdot M$

$m = 3(32)$

$m = 96g$

75g — 729.4 kJ

x — $x = 570$ kJ

b) What mass of Nitrogen gas (N_2) must be used to produce 5000 kJ of energy?

$\underbrace{2N_2}_{2 \text{ moles}} + 4H_2 + 3O_2 \rightarrow 2NH_4NO_3 + \underbrace{729.4 \text{ kJ}}_{729.4 \text{ kJ}}$

$m = n \cdot M$

$m = 2(28)$

$m = 56g$

x — 729.4 kJ

5000 kJ — $x = 384g$