

HW 4

Chem 1151

12 pts

30. $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$; $\Delta E = q + w$; $q = -40.66 \text{ kJ}$; $w = -P\Delta V$

$$\text{Volume of 1 mol H}_2\text{O}(l) = 1 \text{ mol H}_2\text{O}(l) \times \frac{18.02 \text{ g}}{\text{mol}} \times \frac{1 \text{ cm}^3}{0.996 \text{ g}} = 18.1 \text{ cm}^3 = 18.1 \text{ mL}$$

$$w = -P\Delta V = -1.00 \text{ atm} \times (0.0181 \text{ L} - 30.6 \text{ L}) = 30.6 \text{ L atm} \times \frac{101.3 \text{ J}}{\text{L atm}} = 3.10 \times 10^3 \text{ J}$$

$$\Delta E = q + w = -40.66 \text{ kJ} + 3.10 \text{ kJ} = -37.56 \text{ kJ} \quad = 3.10 \text{ kJ}$$

38. a. $1.00 \text{ g CH}_4 \times \frac{1 \text{ mol CH}_4}{16.04 \text{ g CH}_4} \times \frac{-891 \text{ kJ}}{\text{mol CH}_4} = -55.5 \text{ kJ}$

b. $n = \frac{PV}{RT} = \frac{\frac{740}{760} \text{ atm} \times 1.00 \times 10^3 \text{ L}}{\frac{0.08206 \text{ L atm}}{\text{mol K}} \times 298 \text{ K}} = 39.8 \text{ mol CH}_4$

$$39.8 \text{ mol} \times \frac{-891 \text{ kJ}}{\text{mol}} = -3.55 \times 10^4 \text{ kJ}$$

c. This is a Limiting Reactant ~~Problem~~ ^{Problem}. From 38b, we have 39.8 mol CH_4 and will need

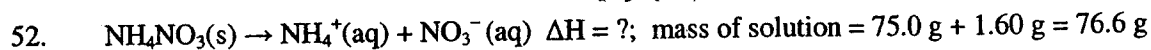
$$39.8 \text{ mol CH}_4 \left(\frac{2 \text{ mol O}_2}{1 \text{ mol CH}_4} \right) = 79.6 \text{ mol O}_2$$

But we have $\frac{2240 \text{ g}}{32 \frac{\text{g}}{\text{mol}}} = 70 \text{ mol O}_2$ on hand

so $\text{O}_2 = \text{LR}$

start w/ $70 \text{ mol O}_2 \left(\frac{-891 \text{ kJ}}{2 \text{ mol O}_2} \right)$

$$= -31,185 \text{ kJ}$$

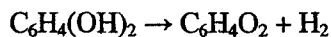


Heat lost by solution = Heat gained as NH_4NO_3 dissolves. To help eliminate sign errors, we will keep all quantities positive (q and ΔT), then deduce the correct sign for ΔH at the end of the problem. Here, since temperature decreases as NH_4NO_3 dissolves, heat is absorbed as NH_4NO_3 dissolves, so it is an endothermic process (ΔH is positive).

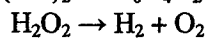
$$\text{Heat loss by solution} = \frac{4.18 \text{ J}}{\text{g } ^\circ\text{C}} \times 76.6 \text{ g} \times (25.00 - 23.34)^\circ\text{C} = 532 \text{ J} = \text{heat gain as } \text{NH}_4\text{NO}_3 \text{ dissolves}$$

$$\Delta H = \frac{532 \text{ J}}{1.60 \text{ g } \text{NH}_4\text{NO}_3} \times \frac{80.05 \text{ g } \text{NH}_4\text{NO}_3}{\text{mol } \text{NH}_4\text{NO}_3} \times \frac{1 \text{ kJ}}{1000 \text{ J}} = 26.6 \text{ kJ/mol } \text{NH}_4\text{NO}_3 \text{ dissolving}$$

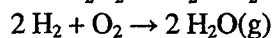
62.



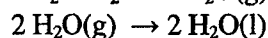
$$\Delta H = 177.4 \text{ kJ}$$



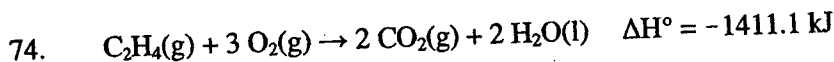
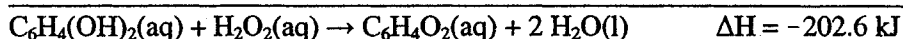
$$\Delta H = -(-191.2 \text{ kJ})$$



$$\Delta H = 2(-241.8 \text{ kJ})$$

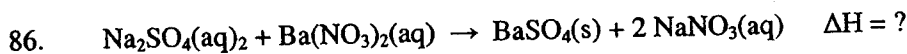


$$\Delta H = 2(-43.8 \text{ kJ})$$



$$\Delta H^\circ = -1411.1 \text{ kJ} = 2(-393.5) \text{ kJ} + 2(-285.8) \text{ kJ} - \Delta H_{\text{f}, \text{C}_2\text{H}_4}^\circ$$

$$-1411.1 \text{ kJ} = -1358.6 \text{ kJ} - \Delta H_{\text{f}, \text{C}_2\text{H}_4}^\circ, \quad \Delta H_{\text{f}, \text{C}_2\text{H}_4}^\circ = 52.5 \text{ kJ/mol}$$



$$1.00 \text{ L} \times \frac{2.00 \text{ mol}}{\text{L}} = 2.00 \text{ mol } \text{Na}_2\text{SO}_4; \quad 2.00 \text{ L} \times \frac{0.750 \text{ mol}}{\text{L}} = 1.50 \text{ mol } \text{Ba}(\text{NO}_3)_2$$

The balanced equation requires a 1:1 mole ratio between Na_2SO_4 and $\text{Ba}(\text{NO}_3)_2$. Because we have fewer moles of $\text{Ba}(\text{NO}_3)_2$ present, it is limiting and 1.50 mol BaSO_4 will be produced [there is a 1:1 mole ratio between $\text{Ba}(\text{NO}_3)_2$ and BaSO_4].

heat gain by solution = heat loss by reaction

$$\text{mass of solution} = 3.00 \text{ L} \times \frac{1000 \text{ mol}}{1 \text{ L}} \times \frac{2.00 \text{ g}}{\text{mL}} = 6.00 \times 10^3 \text{ g}$$

$$\text{heat gain by solution} = \frac{6.37 \text{ J}}{\text{g } ^\circ\text{C}} \times 6.00 \times 10^3 \text{ g} \times (42.0 - 30.0)^\circ\text{C} = 4.59 \times 10^5 \text{ J}$$

Because the solution gained heat, the reaction is exothermic; $q = -4.59 \times 10^5 \text{ J}$ for the reaction.

$$\Delta H = \frac{-4.59 \times 10^5 \text{ J}}{1.50 \text{ mol } \text{BaSO}_4} = -3.06 \times 10^5 \text{ J/mol} = -306 \text{ kJ/mol}$$