watch pg 1

Answer Key

## Molar Enthalpy Problems 1

$\Delta H_{soln}$ $\quad Q = mc\Delta T$

**1)** Calculate the molar heat of dissolution of sodium hydroxide given that 4.00 g of NaOH dissolved in 20.0 mL of water changes the temperature from 22.0 °C to 72.0 °C.

$$Q_{water} = \left(20.0\,mL \times \frac{1\,g}{1\,mL}\right)\left(\frac{4.19\,J}{g\cdot°C}\right)(72.0°C - 22.0°C)$$

$$= 4190\,J$$

$$Q_{NaOH} = -4190\,J$$

$$n_{NaOH} = 4.00\,g\,NaOH \times \frac{1\,mol\,NaOH}{40\,g} = 0.1000\,mol$$

$$\Delta H = \frac{Q}{n} = \frac{-4190\,J}{0.1000\,mol} = \frac{-41900\,J}{1\,mol} \times \frac{1\,kJ}{1000\,J} =$$

**Dissolution Equation with ΔH:** _____

$NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$ $\quad -41.9\,kJ/mol$ (pg 3)

$+41.9\,kJ$ $\quad m_{sub}$

**2)** If 24.42 g of potassium chlorate are dissolved in 1.0 kg of water, the temperature of the water drops from 24.0 °C ($T_i$) to 22.0 °C ($T_f$). ($m_{water}$)

Calculate the change in enthalpy for the dissolution of $KClO_3$.

$Q_{water} = mc\Delta T$

$$= \left(1.0\,kg \times \frac{1000\,g}{1\,kg}\right)\left(\frac{4.19\,J}{g\cdot°C}\right)(22.0°C - 24.0°C)$$

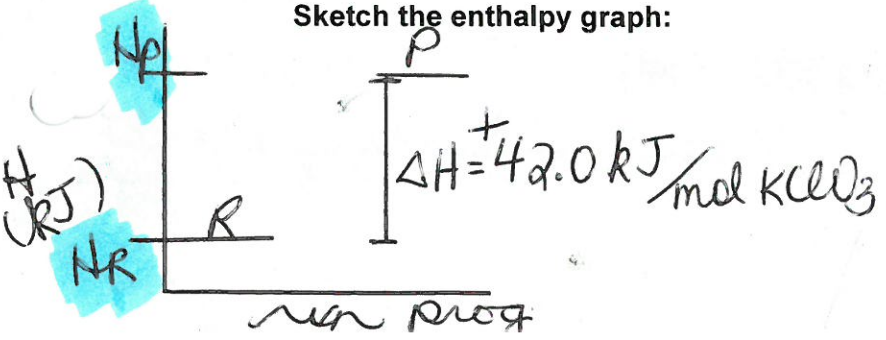
$$= -8380\,J \quad (2sf\ dec\ of\ mass\ of\ water)$$

$$Q_{sub} = +8380\,J$$

$$n_{sub} = 24.42\,g\,KClO_3 \times \frac{1\,mol}{122.5\,g} = 0.1993\,mol\,KClO_3$$

$$\Delta H = \frac{Q}{n} = \frac{+8380\,J}{0.1993\,mol} = +42000\,J \times \frac{1\,kJ}{1000\,J} = \frac{+42.0\,kJ}{1\,mol}$$

**Sketch the enthalpy graph:**



conc — vol — treat like water

3) A laboratory technician prepares 2.0 L of sodium nitrate solution with a concentration of 0.10 mol/L. The molar enthalpy for the dissolution of sodium nitrate is 36.0 kJ/mol. $= \Delta H$

The initial temperature of the water used is 24.0 °C. $- T_i$

What is the final temperature of the solution?

$T_f = ?$ ∴ Reverse

iv) $\Delta H = +\frac{36.0\ kJ}{1\ mol\ NaNO_3}$

iii) $n_{sub} = cV = \frac{0.10\ mol}{1\ L} \cdot 2.0\ L = 0.200\ mol$

ii) $Q_{sub}$? $\Delta H = \frac{Q_{sub}}{n_{sub}} \cdot n_{sub} = n_{sub}\Delta H = Q_{sub} = (0.200\ mol)\left(\frac{36.0\ kJ}{1\ mol}\right) = 7.2\ kJ$

i) $Q_{water} = -7.2\ kJ \times \frac{1000\ J}{1\ kJ} = -7200\ J$

**Equation including the heat energy:** $KNO_{3(aq)} + 36.0\ kJ \rightarrow K^+_{(aq)} + NO_{3(aq)}^-$

i) $\frac{Q}{mC} = \frac{mc\Delta T}{mc} = \frac{-7200\ J}{(2.0\ L \times \frac{1000\ mL}{1\ L})\left(\frac{4.19\ J}{g \cdot °C}\right)} = 0.86\ °C = \Delta T = T_f - T_i$

$T_f = +23.1\ °C$

4) How many grams of potassium hydroxide must dissolved in 100. mL of water at 25.0 °C to the change the water temperature after dissolution to 80.0 °C if the heat of reaction for the dissolution is – 55.0 kJ/mol? $\Delta H$ $= T_f$ $m_{H_2O}$ $T_i$

$Q_{water} = mc\Delta T$

$= (100.\ mL \times \frac{1\ g}{1\ mL})\left(\frac{4.19\ J}{g \cdot °C}\right)(80.0°C - 25.0°C)$

$= 23045\ J = 23000\ J$

$Q_{sub} = 23000\ J$

$n_{sub} = ?$

$\Delta H_{sub} = -55.0\ kJ\ mol\ KOH$ $\boxed{\frac{n \cdot \Delta H}{\Delta H} = \frac{Q \cdot x}{x\ \Delta H}}$ $= \frac{-23000\ J \times \frac{1\ kJ}{1000\ J}}{-55.0\ kJ\ mol}$

$n = 0.418\ mol\ KOH$

$0.418\ mol\ KOH \times \frac{56\ g}{1\ mol} = 23.4\ g\ KOH = m$ (39, 16, 1)

**Equation including the heat energy:** $KOH_{(s)} \rightarrow K^+_{(aq)} + OH^-_{(aq)} + 55.0\ kJ$

$\frac{1}{1} = \frac{mol}{mol}$