Molar Heat

Enthalpy Calculations

Remember

$\Delta H_{rnx\ sys} = \frac{-Q_{surr}}{n_{rnx\ sys}}$

Example 1

Dissolve 6.69g of LiCl in 100.0mL of water at 24.2°C in a calorimeter. The final temperature of the water is 37.4°C.

a) **What is the molar heat of dissolution for LiCl?**
b) **Write a thermochemical equation for the dissolution.**
c) **Create an enthalpy diagram.**

a) $\Delta T_{water} = 37.4°C - 24.2°C$
$= 13.0°C$

$n_{LiCl} = 6.69\,g\,LiCl \times \frac{1\,mol\,LiCl}{42.39\,g\,LiCl} = 0.158\,mol\,LiCl$

$Q_w = mc\Delta T$
$Q_w = (100.0\,g)(4.19\,\frac{J}{g°C})(13.0°C)$
$Q_w = 5530.8\,J$ or $5.531\,kJ$.

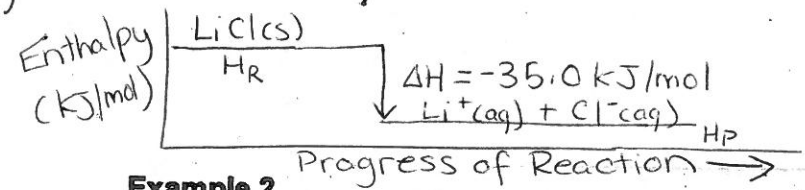
$\Delta H = \frac{-Q}{n}$ $\Delta H = \frac{-5.531\,kJ}{0.158\,mol\,LiCl}$

$\boxed{\Delta H = -35.0\,kJ/mol\ LiCl}$

b) $LiCl_{(s)} \rightarrow Li^+_{(aq)} + Cl^-_{(aq)} + 35.0\,kJ$

or $LiCl_{(s)} \rightarrow Li^+_{(aq)} + Cl^-_{(aq)}$
$\Delta H = -35.0\,kJ/mol$

c) Change in Enthalpy of LiCl



Example 2

Salicyclic acid is a skin care ingredient. To make it chemists first dissolve tablets. The heat of solution (ΔH) of salicyclic acid is -3.02 kJ/mol. One tablet containing 3.84 g of salicylic acid is placed in 0.100 L of water. What is the temperature change of the water?

$\Delta H = -3.02\,kJ/mol$
$3.84\,g\ C_7H_6O_3$
$V = 0.100\,L$ of water

1) $3.84\,g\,C_7H_6O_3 \times \frac{1\,mol\,C_7H_6O_3}{138.13\,g\,C_7H_6O_3}$
$= 0.02780\,mol\,C_7H_6O_3$

2) $\Delta H = \frac{-Q}{n}$
$-Q = \Delta H \times n$
$-Q = -3.02\,kJ/mol \times 0.02780\,mol$
$-Q = -0.08396\,kJ$
$Q = 83.96\,J$

3) $Q_{water} = mc\Delta T$
$83.96\,J = (100\,g)(4.19\,\frac{J}{g°C})\Delta T$
$\boxed{\Delta T = 0.200°C}$

Example 3

In a laboratory a water bath contains 12L of water that must be kept at a constant temperature. Accidentally a researcher spills 25.5 g of LiCl into this bath. Use the following table to determine ~~to determine~~ the mass of the appropriate substance that must be added to the water bath to return its temperature to the initial value.

Molar heats of solution

Substance	ΔH (kJ/mol)
LiCl	exo -35 $+\Delta T_{water}$
~~NaOH~~	~~-42~~
NH_4Cl	endo 16 $-\Delta T_{water}$

1) $25.5\,g\,LiCl \times \frac{1\,mol\,LiCl}{42.39\,g\,LiCl} = 0.6\,mol\,LiCl$ dropped into water.

2) $\Delta H = \frac{-Q}{n}$

$\frac{-35\,kJ/mol}{LiCl} = \frac{-Q_{water}}{0.6\,mol\,LiCl}$

$Q_W = 21.1\,kJ$.

↳ energy released into water.

3) You want to take away 21.1 kJ of energy from the water & put it in an endo reaction system so... NH_4Cl

$Q_W = -21.1\,kJ$

4) $\Delta H_{NH_4Cl} = \frac{-Q_W}{n}$

$16\,kJ/mol = \frac{-(-21.1\,kJ)}{n}$

$n_{NH_4Cl} = 1.31875\,mol$

5) $1.31875\,mol\,NH_4Cl \times \frac{53.5\,g\,NH_4Cl}{1\,mol\,NH_4Cl}$

$= 70.55\,g$ of NH_4Cl added.

Example 4

Sterno, a solid portable fuel also known as canned heat is burned in fondue pots. Its composed mainly of ethanol. C_2H_3OH. Cooking oil used in fondue pots has a specific heat capacity of 2.01 J/g°C and a density of 0.92 g/cm³.

At a dinner party, the temperature of 500.0 mL of cooking oil in a pot was increased from 25.0°C to 300.0°C. Given that ethanol burns as follows:

$$C_2H_3OH(s) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H = -278\ kJ/mol$$

How many grams of ethanol were burned to heat the oil to 300.0°C?

1) $500.0\,ml\ cooking\ oil = 500.0\,cm^3\ cooking\ oil$

$500.0\,cm^3 \times \frac{0.92\,g}{cm^3} = 460\,g\ cooking\ oil$

2) $Q_{cooking\ oil} = mC\Delta T$

$= 460\,g\left(2.01\,\frac{J}{g°C}\right)(275°C)$

$= 254265\,J$.

3) $\Delta H_{ethanol\ (rxn\ sys)} = \frac{-Q_{cooking\ oil\ (surroundings)}}{n_{ethanol\ (rxn\ sys)}}$

$-278\,kJ/mol = \frac{-254.265\,kJ}{n}$

$n_{ethanol} = 0.9146\,mol$

4) $0.9146\,mol\,ethanol \times \frac{44.06\,g\,ethanol}{1\,mol\,ethanol}$

$=$ **40.3 g C_2H_3OH were burned to heat the oil to 300.0°C**