Multi-Step Energy Calculations

Step 1: *Find H^o general*
-use Hess's law
-from equation
-use calorimetry

Step 2: *Find n (specific)*
-use mass (molar mass)
-use concentration
-use $n = \Delta H/H^o$

Step 3: *Find ΔH (specific)*
-use $\Delta H = nH^o$

Multi-Step Energy Calculations can be used when energy produced in one chemical reaction is used to heat another substance. These calculations are very similar to calorimetry calculations.

total enthalpy change = quantity of heat

$$\Delta H_r = q$$

Sample Problem

What mass of octane is completely burned during the heating of 20.L of aqueous ethylene glycol automobile coolant from -10.0°C to 70.0°C? The volumetric heat capacity of aqueous ethylene glycol is 3.7 kJ/L°C.

Ex. $2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 18H_2O_{(g)} + 16CO_{2(g)}$

Step 1: Hr (general)

$H_r = \frac{\Delta H_r}{n}$

$\Delta H_r = \Sigma nH_{fp} - \Sigma nH_{fr}$

$\Delta H_r = \left[(18\,mol)\left(-241.8\frac{kJ}{mol}\right) + (16\,mol)\left(-393.5\frac{kJ}{mol}\right)\right] - \left[(2\,mol)\left(-250.1\frac{kJ}{mol}\right) + (25\,mol)\left(0\frac{kJ}{mol}\right)\right]$

$\Delta H = -10148.2\,kJ$

$\Delta H_r = nH_r$

$H_r = \frac{\Delta H_r}{n} = \frac{-10148.2\,kJ}{2\,mol} = -5074.1\frac{kJ}{mol}$

Step 2: n (specific)

$\Delta H_r = -q$

$nH_r = -vC\Delta T$

$n\left(-5074.1\frac{kJ}{mol}\right) = -(20.\,L)\left(3.7\frac{kJ}{L°C}\right)(80.0°C)$

$n = 1.1667\,mol$

$M_m = \frac{m}{n}$

$\Delta H_r = nH_r$

$\Delta H_r = -q$

Step 3: m (specific)

$1.1667\,mol \times \frac{114.26\,g}{1\,mol} = \boxed{130\,g}$

Worksheet #1-5