Calculate the mass of methane combusted when 3700. kJ of energy is released according to the following reaction.

$$CH_{4(g)} + 2O_{2(g)} \Rightarrow CO_{2(g)} + 2H_2O_{(g)} + 802.7kJ$$

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

Step 1: H_r (general)

$\Delta H_r = nH_r$

$H_r = \frac{\Delta H_r}{n} = \frac{-802.7 kJ}{1 mol} = \underline{-802.7 kJ/mol}$

Step 2: n (specific)

$\Delta H_r = nH_r$

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

$n = \frac{-3700 kJ}{-802.7 kJ/mol}$

$n = 4.609 mol$

Step 3: m (specific)

$4.609 mol\ CH_4 \times \frac{16.05\ g\ CH_4}{1\ mol\ CH_4} = \boxed{73.98 g\ CH_4}$

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 -10ºC to 70ºC? The volumetric heat capacity of aqueous ethylene glycol is 3.7 kJ/LºC.

Ex. $2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 18H_2O_{(s)} + 16CO_{2(g)} + 10148.2\ \text{kJ}$

Step 1: Hr (general)

$\Delta H_r = nH_r$

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

Step 2: n (specific)

$\Delta H_c = -q$

$nH_c = -vC\Delta T$

$n(-5074.1\ \frac{\text{kJ}}{\text{mol}}) = -(20.\ \text{L})(3.7\ \frac{\text{kJ}}{\text{L}\cdot°\text{C}})(80.\ °\text{C})$

$n = 1.1667\ \text{mol}$

Step 3: m (specific)

$1.1667\ \text{mol}\ C_8H_{18} \times \frac{114.26\ \text{g}\ C_8H_{18}}{1\ \text{mol}\ C_8H_{18}} = \boxed{130\ \text{g}\ C_8H_{18}}$

Multi-Step Energy Calculations Worksheet