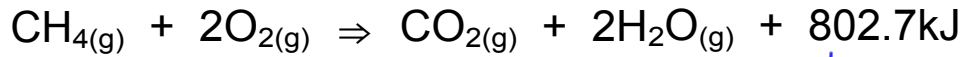


Calculate the mass of methane combusted when **3700. kJ** of energy is released according to the following reaction.



Step 1:  $H_r$ (general)

$$\Delta H_r = \sum n H_f - \sum n H_r$$

$$\Delta H_r = n H_r$$

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

Step 2:  $n$ (specific)

$$\Delta H_r = n H_r$$

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

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

$$n = 4.609\text{mol}$$

Step 3:  $m$ (specific)

$$4.609\text{mol CH}_4 \times \frac{16.05\text{g CH}_4}{1\text{mol CH}_4} = \boxed{73.98\text{g CH}_4}$$

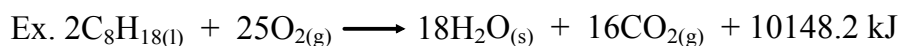
Multi-Step Energy Calculations can be used when energy produced in one chemical reaction is used to heat another substance. These calculations are very similar to calorimetry calculations.

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  $-10^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ ? The volumetric heat capacity of aqueous ethylene glycol is  $3.7 \text{ kJ/L}^{\circ}\text{C}$ .



Step 1:  $H_r$  (general)

$$\Delta H_r = n H_r$$

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

Step 2:  $n$  (specific)

$$\Delta H_c = -q$$

$$n H_c = -v C \Delta T$$

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

$$n = 1.1667 \text{ mol}$$

Step 3:  $m$  (specific)

$$1.1667 \text{ mol C}_8\text{H}_{18} \times \frac{114.2 \text{ g C}_8\text{H}_{18}}{1 \text{ mol C}_8\text{H}_{18}} = \boxed{130 \text{ g C}_8\text{H}_{18}}$$

# Multi-Step Energy Calculations Worksheet