Example problems:

$$2.016 \quad 32.00 \qquad\qquad 18.02$$
$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g) \; ; \; \Delta H = -484 \; kJ$$
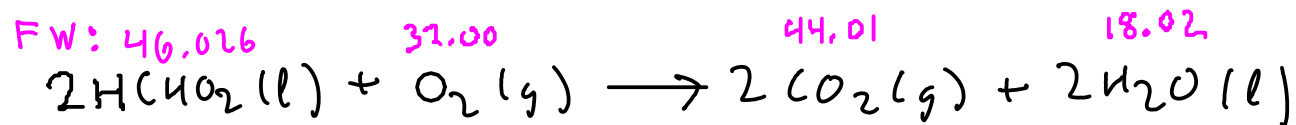
Calculate the enthalpy change for the combustion of 1.00 kg of hydrogen gas.

1 - Convert 1.0 kg of hydrogen gas to moles using formula weight (and kg ->g conversion)
2 - Convert moles hydrogen gas to enthalpy change using thermochemical equation

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$$2.016 g \; H_2 = mol \; H_2 \quad | \quad Kg = 10^3 g \quad | \quad 2 mol \; H_2 = -484 \; kJ$$

$$1.00 \; kg \; H_2 \times \frac{10^3 g}{Kg} \times \frac{mol \; H_2}{2.016 g \; H_2} \times \frac{-484 \; kJ}{2 mol \; H_2} = \boxed{-120000 \; kJ \; per \; kg \; H_2}$$

FW: 46.026   31.00   44.01   18.02

$$2 HCHO_2 (l) + O_2 (g) \longrightarrow 2 CO_2 (g) + 2 H_2O (l)$$

If 50.3 kJ of heat was released when 5.48 g of formic acid are burned at constant pressure, then what is the enthalpy change of this reaction per mole of formic acid?
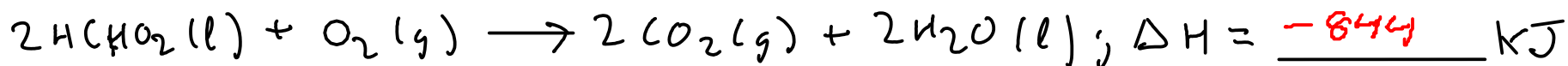
$$Q = -50.3 kJ \quad ; \Delta H = \frac{Q_{constant\ pressure}}{mol\ HCHO_2}$$

Find moles formic acid: $46.026 g\ HCHO_2 = mol\ HCHO_2$

$$5.48\ g\ HCHO_2 \times \frac{mol\ HCHO_2}{46.026 g\ HCHO_2} = 0.119063\ mol\ HCHO_2$$

$$\Delta H = \frac{-50.3 kJ}{0.119063\ mol\ HCHO_2} = \boxed{\frac{-422\ kJ}{mol\ HCHO_2} = \Delta H}$$

Based on the calculation above, can we complete this thermochemical equation?

$$2 HCHO_2 (l) + O_2 (g) \longrightarrow 2 CO_2 (g) + 2 H_2O (l) \quad ; \Delta H = \underline{-844}\ kJ$$

We calcul;ated the enthalpy change PER MOLE of formic acid (as is common in calorimetry experiments). This equation is based on TWO MOLES of formic acid, so the enthaply change is doubled.

$$4 NH_3 (g) + 5 O_2 (g) \rightarrow 4 NO (g) + 6 H_2O (g) ; \quad \Delta H = -906 \text{ kJ}$$
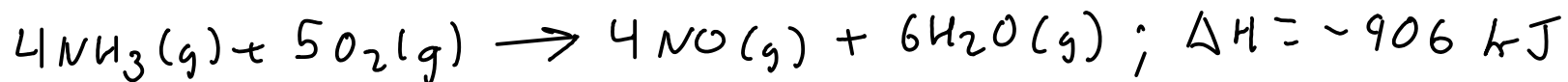
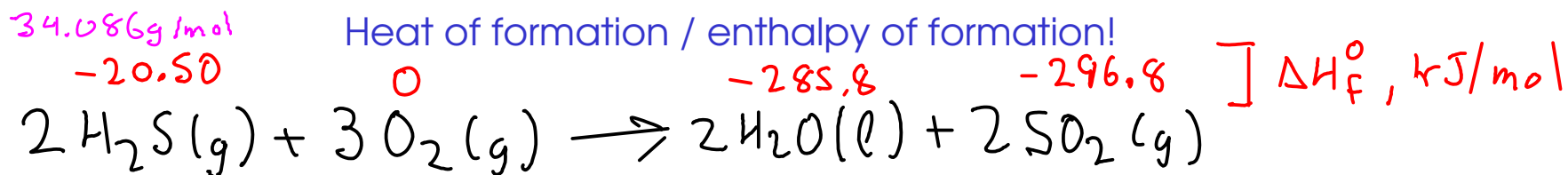What is the enthalpy change when 150. L of nitrogen monoxide are formed by this reaction at 25.0 C and 1.50 atm pressure?

1 - Convert 150 L of NO to moles using the ideal gas equation
2 - Convert moles of NO to enthalpy change using thermochemical equation

$PV = nRT$ | $P = 1.50 \text{ atm}$ $R = 0.08206 \frac{L \cdot atm}{mol \cdot K}$

$n = \frac{PV}{RT}$ | $V = 150. L$

         $T = 25.0°C = 298.2 K$ $n = ? \text{ mol } NO$

① $n_{NO} = \dfrac{(1.50 \text{ atm})(150. L)}{\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right)(298.2 K)} = 9.194822849 \text{ mol } NO$

$4 \text{ mol } NO = -906 \text{ kJ}$

②

$9.194822849 \text{ mol } NO \times \dfrac{-906 \text{ kJ}}{4 \text{ mol } NO} = \boxed{-2080 \text{ kJ}}$

Heat of formation / enthalpy of formation!

34.086 g/mol

$$2 H_2S(g) + 3 O_2(g) \longrightarrow 2 H_2O(l) + 2 SO_2(g)$$

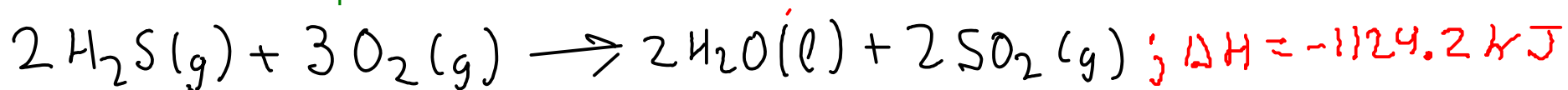with values: -20.50, 0, -285.8, -296.8] ΔH_f^o, kJ/mol

What is the enthalpy change at standard conditions when 25.0 grams of hydrogen sulfide gas is reacted?

1 - Find the enthalpy of the reaction as written with Hess's Law. See appendix C, pA-8
    for enthalpy of formation data
2 - Convert 25.0 g of hydrogen sulfide to moles using formula weight
3 - Convert moles hydrogen sulfide to enthalpy change using thermochemical equation

① $\Delta H = \sum \Delta H_{f,products}^o - \sum \Delta H_{f,reactants}^o$

$= [2(-285.8) + 2(-296.8)] - [2(-20.50) + 3(0)] = -1124.2 \text{ kJ}$

Thermochemical equation:

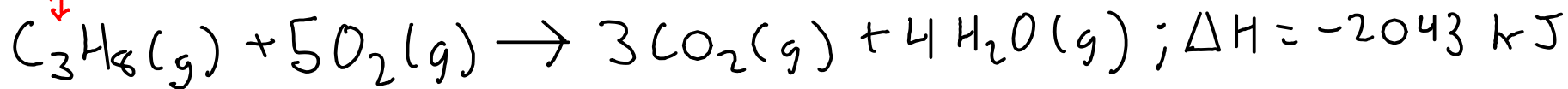$$2 H_2S(g) + 3 O_2(g) \longrightarrow 2 H_2O(l) + 2 SO_2(g) \; ; \; \Delta H = -1124.2 \text{ kJ}$$

$34.086 \text{ g } H_2S = \text{mol } H_2S$ | $2 \text{ mol } H_2S = -1124.2 \text{ kJ}$

$$25.0 \text{ g } H_2S \times \frac{\text{mol } H_2S}{34.086 \text{ g } H_2S} \times \frac{-1124.2 \text{ kJ}}{2 \text{ mol } H_2S} = \boxed{-412 \text{ kJ}}$$

② ③

propane

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g) \; ; \Delta H = -2043 \, kJ$$

Calculate the volume of propane gas at 25.0 C and 1.08 atm required to provide 565 kJ of heat using the reaction above.
1 - Convert the energy requirement to moles propane using the thermochemical equation
2 - Convert moles propane to volume using ideal gas equation

$mol \; C_3H_8 = -2043 \, kJ$

① $-565 \, kJ \times \dfrac{mol \; C_3H_8}{-2043 \, kJ} = 0.2765540871 \, mol \; C_3H_8$

$PV = nRT$

$V = \dfrac{nRT}{P}$

$n = 0.2765540871 \, mol \; C_3H_8 \qquad P = 1.08 \, atm$

$R = 0.08206 \dfrac{L \cdot atm}{mol \cdot k}$

$T = 25.0 \, °C = 298.2 \, k$

$$V = \dfrac{(0.2765540871 \, mol \; C_3H_8)(0.08206 \frac{L \cdot atm}{mol \cdot k})(298.2 \, k)}{(1.08 \, atm)} =$$

$$= \boxed{6.27 \, L \; C_3H_8 \; needed \; @ \; \begin{array}{c} 25.0 \, °C \\ 1.08 \, atm \end{array}}$$

END OF CHAPTER 6