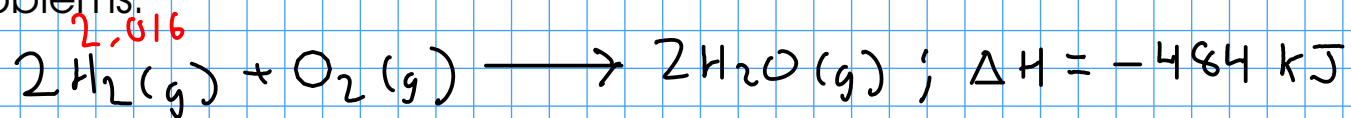


Example problems:



Calculate the enthalpy change for the combustion of 1.00 kg of hydrogen gas.

1- Convert 1.00 kg of hydrogen gas to moles (formula weight)

2- Convert moles of hydrogen gas to enthalpy (chemical equation)

$$2.016 \text{ g H}_2 = 1 \text{ mol H}_2 \quad 2 \text{ mol H}_2 = -484 \text{ kJ} \quad 10^3 \text{ g} = \text{kg}$$

$$1.00 \text{ kg H}_2 \times \frac{10^3 \text{ g}}{\text{kg}} \times \frac{1 \text{ mol H}_2}{2.016 \text{ g H}_2} \times \frac{-484 \text{ kJ}}{2 \text{ mol H}_2} = -120000 \text{ kJ}$$

$$\Delta H = -120000 \frac{\text{kJ}}{\text{kg}}$$

FW: 46.026



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?

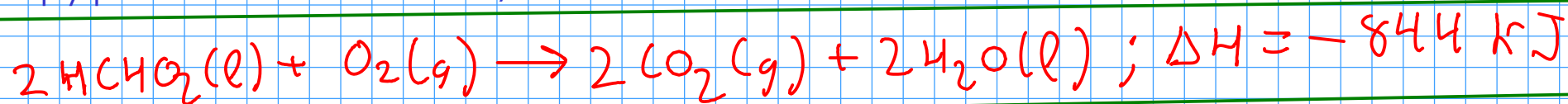
$$\Delta H = \frac{Q_{\text{constant pressure}}}{\text{moles HCHO}_2} = \frac{\text{kJ}}{\text{mol}}$$

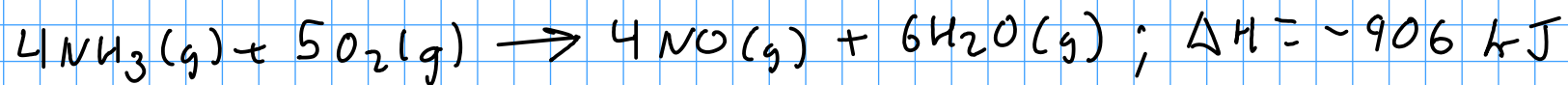
$$Q_{\text{constant pressure}} = -50.3 \text{ kJ}$$

$$5.48 \text{ g HCHO}_2 \times \frac{\text{mol HCHO}_2}{46.026 \text{ g HCHO}_2} = 0.119 \text{ mol}$$

$$\Delta H = \frac{-50.3 \text{ kJ}}{0.119 \text{ mol}} = -422 \text{ kJ/mol HCHO}_2$$

If we were asked to write the above in the form of a THERMOCHEMICAL EQUATION instead of enthalpy per mole of formic acid, how would we write it?





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- Use the ideal gas equation to convert 150, L of NO to moles NO.
- 2- Use the chemical equation to change moles NO to enthalpy

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

$$n = \frac{PV}{RT} \quad \left| \quad V = 150. \text{ L} \quad T = 25.0^\circ\text{C} = 298,2 \text{ K}$$

①

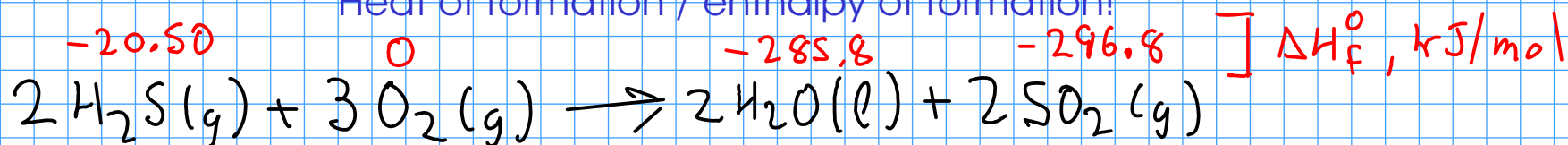
$$n_{\text{NO}} = \frac{(1.50 \text{ atm})(150. \text{ L})}{(0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(298,2 \text{ K})} = 9.19 \text{ mol NO}$$

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

$$9.19 \text{ mol NO} \times \frac{-906 \text{ kJ}}{4 \text{ mol NO}} = \boxed{-2080 \text{ kJ}}$$

②

Heat of formation / enthalpy of formation!



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

- 1 - Find the enthalpy of reaction (Hess' Law and heats of formation)
- 2 - Convert 25.0 g of hydrogen sulfide to moles hydrogen sulfide (formula weight)
- 3 - Convert moles hydrogen sulfide to enthalpy (chemical equation)

$$\Delta H_r = \sum \Delta H_f^\circ, \text{products} - \sum \Delta H_f^\circ, \text{reactants}$$

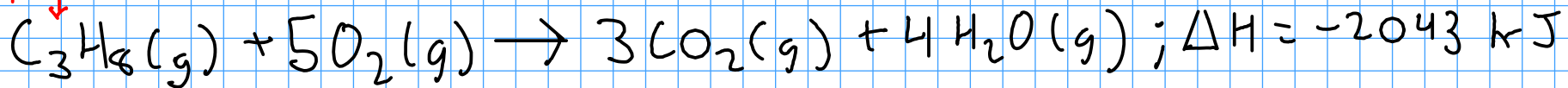
$$\begin{aligned} \textcircled{1} \quad & [2(-285.8) + 2(-296.8)] - [2(-20.50) + 3(0)] \\ & -1165.2 - (-41) \\ & \Delta H = -1124.2 \end{aligned}$$

$$34,086 \text{g H}_2\text{S} = 1 \text{ mol H}_2\text{S} \quad | \quad 2 \text{ mol H}_2\text{S} = -1124.2 \text{ kJ}$$

$$25.0 \text{ g H}_2\text{S} \times \frac{1 \text{ mol H}_2\text{S}}{34,086 \text{g H}_2\text{S}} \times \frac{-1124.2 \text{ kJ}}{2 \text{ mol H}_2\text{S}} = \boxed{-412 \text{ kJ}}$$

$\textcircled{2}$ $\textcircled{3}$

propane
↓



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 -565 kJ of energy to moles propane (chemical equation)
- 2- Convert moles of propane to volume (ideal gas equation)

$$1 \text{ mol C}_3\text{H}_8 = -2043 \text{ kJ}$$

$$-565 \text{ kJ} \times \frac{1 \text{ mol C}_3\text{H}_8}{-2043 \text{ kJ}} = 0.27655 \text{ mol C}_3\text{H}_8 \quad (1)$$

$$(2) \quad V = \frac{nRT}{P} \quad \left| \quad \begin{array}{l} n = 0.27655 \text{ mol C}_3\text{H}_8 \\ R = 0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} \\ T = 25.0^\circ\text{C} = 298.2 \text{ K} \end{array} \quad P = 1.08 \text{ atm} \right.$$

$$V = \frac{(0.27655 \text{ mol C}_3\text{H}_8) \left(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right) (298.2 \text{ K})}{(1.08 \text{ atm})}$$

$$= 6.27 \text{ L C}_3\text{H}_8 \text{ required}$$