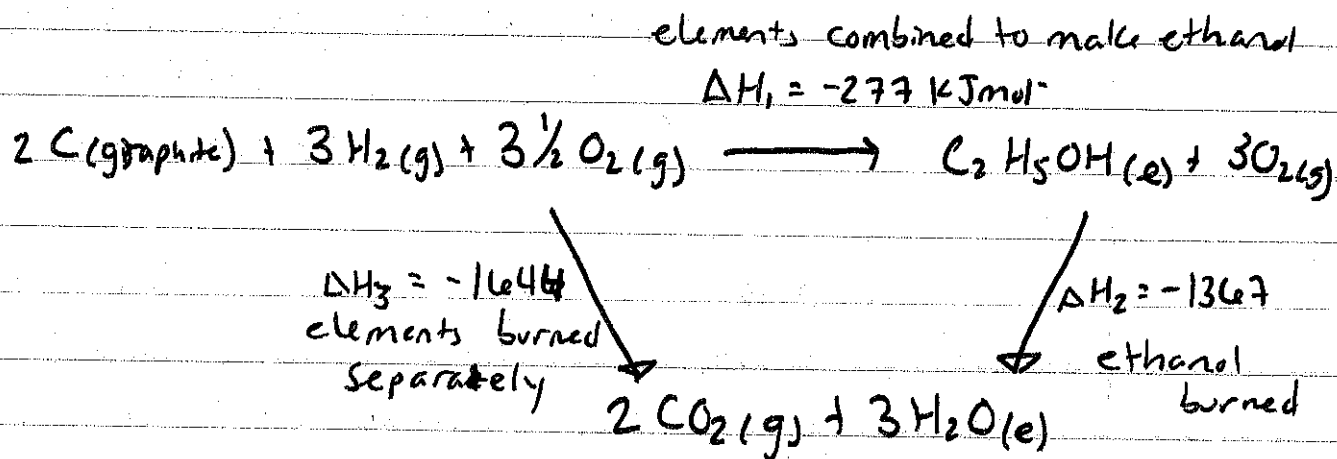


## 5.2 Hess's Law

Enthalpy cycles = Hess's Law

- enthalpy change for any chemical reaction is independent of route, provided starting conditions + final reactants + products are same
- allows for indirect measurement for rxns unable to do.

using Law of Conservation of Energy  
enthalpy cycles = 0



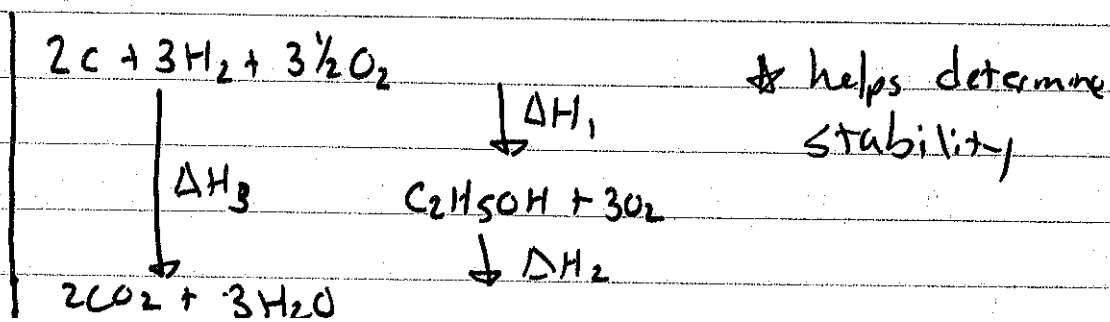
★ follow the arrows  $0 = \Delta H_1 + \Delta H_2 - \Delta H_3$

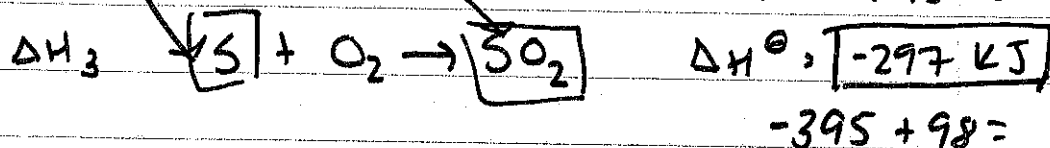
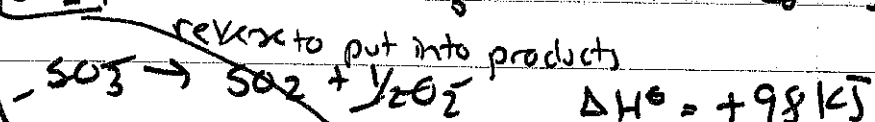
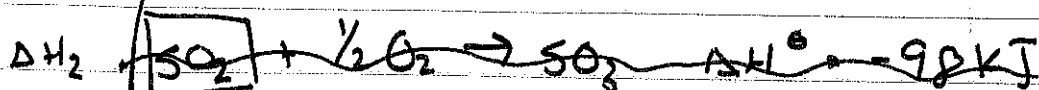
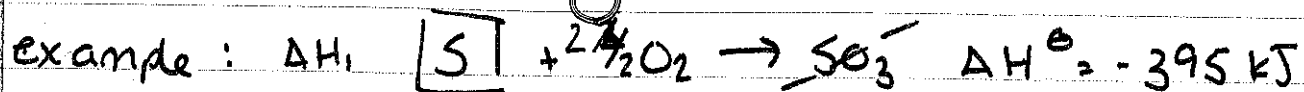
$\uparrow$  LoC Enrgy

$\downarrow$  arrows opposite direction

$$\therefore \Delta H_1 + \Delta H_2 = \Delta H_3$$

$$-277 + -1367 = -1644$$





standard enthalpy changes of a reaction ( $\Delta H^\ominus$ )

• measured under std conditions

$T = 298 \text{ K (25}^\circ\text{C)}$

$P = 1.00 \times 10^5 \text{ Pa (100 kPa)}$

$\Delta H_f^\ominus$  = std enthalpy change of formation

• Occurs when 1 mol of substance is formed from its elements in their std states

(pure form of substance under std conditions)

• Measurements taken under std conditions

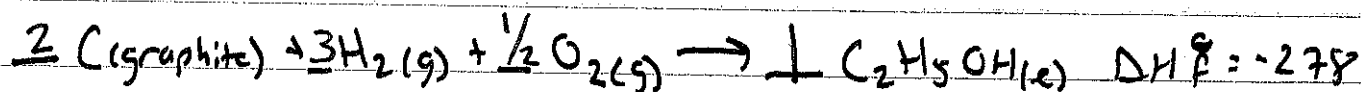
- Measure of stability

- Used to calculate changes for all rxns

Thermochemical equation

• elements  $\rightarrow$  compound

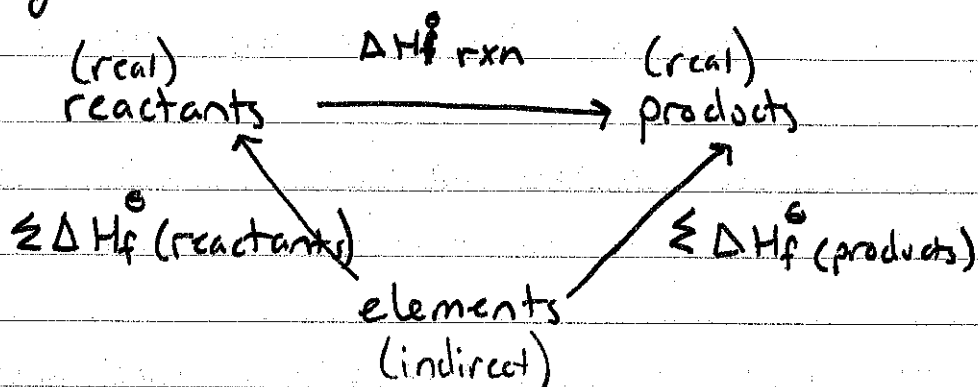
$\Delta H_f^\ominus$ : section 12



• Balance for 1 mol of substance

$\text{kJ mol}^{-1}$

Using  $\Delta H_f^\ominus$



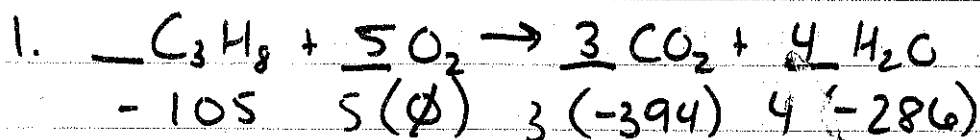
$$\therefore \Delta H_{\text{rxn}}^\ominus = \sum \Delta H_f^\ominus (\text{products}) - \sum \Delta H_f^\ominus (\text{reactants})$$

example: calculate  $\Delta H_{\text{rxn}}^\ominus$  for:



	$\Delta H_f^\ominus$
$\text{C}_3\text{H}_8$	-105
$\text{CO}_2$	-394
$\text{H}_2\text{O}$	-286

\*  $\Delta H_f^\ominus$  of an element in its most stable form = 0



$$\begin{aligned} 2. \quad \Delta H_{\text{rxn}}^\ominus &= \sum \Delta H_f^\ominus (\text{p}) - \sum \Delta H_f^\ominus (\text{r}) \\ &= [3(-394) + 4(-286)] - (-105) \\ &= -2221 \text{ kJ mol}^{-1} \end{aligned}$$