



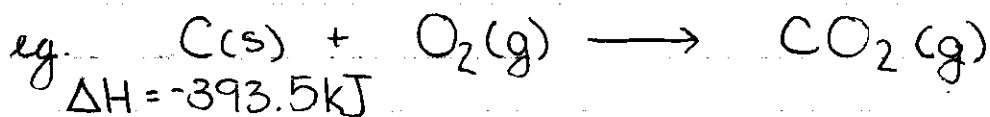
# Chemical Potential energy - Enthalpy

$\Delta H$  change in enthalpy

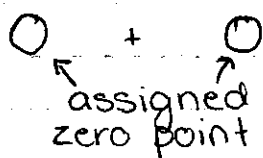
Choice of zero potential energy is important.

- every element in its natural state at standard conditions (25°C and one atmosphere of pressure) is given a zero potential energy
- therefore there are over 100 zero points in thermodynamics.

In order to determine the potential energy of any compound, simply compare its energy to that of its constituent elements.



potential energy



↑ comes from measurements

this is an example of a formation reaction (formation reaction is when compounds are formed directly from its constituent elements...)

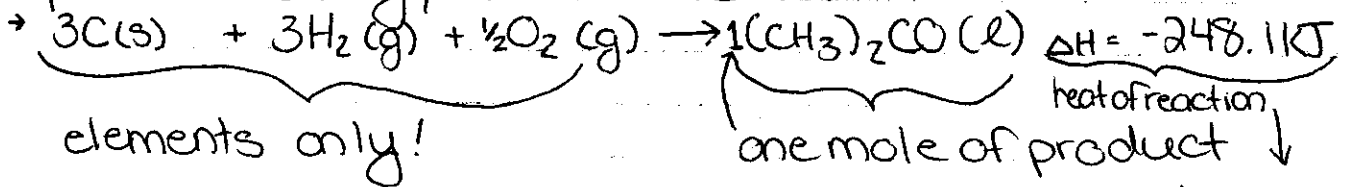
UNDERSTAND PAGE 799!!!!



↑ heat of formation  
enthalpy

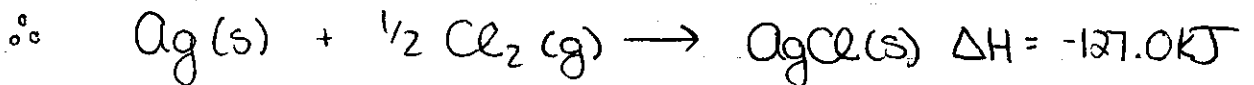
formula subscript present

This means two things  
 → using element zero points, this value is the potential energy of acetone



equivalent to the potential energy of acetone because the elements state at zero ← change in enthalpy

eg  $\Delta H^\circ \text{AgCl(s)} = -127.0\text{kJ}$

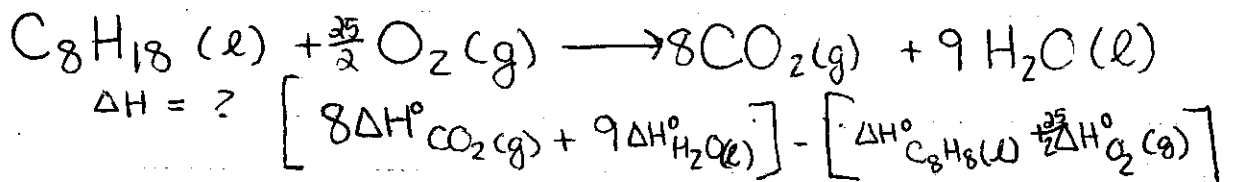


Heat Summation Rule - Hess' law abbreviated  
 For any reaction

$$\Delta H = \left[ \sum \Delta H^\circ \text{products} \right] - \left[ \sum \Delta H^\circ \text{reactants} \right]$$

"the sum of" potential energy  
 final - initial

eg. the combustion of octane



$$\Delta H = \left[ 8(-393.5\text{kJ}) + 9(-285.8\text{kJ}) \right] - \left[ (-250.1\text{kJ}) + \frac{25}{2}(0) \right]$$

$$\Delta H = -5470.1\text{kJ}$$

eg2. alternate use of the heat summation rule.

The heat of combustion for butane is  $-2877.4 \text{ kJ}$

given:  $\Delta H^\circ \text{CO}_2(\text{g}) = -393.5 \text{ kJ}$  and  $\Delta H^\circ \text{H}_2\text{O}(\text{l}) = -285.8 \text{ kJ}$

find the heat of formation for butane



$\Delta H^\circ = -2877.4 \text{ kJ}$  (change in enthalpy)

$$\Delta H = [4\Delta H^\circ \text{CO}_2(\text{g}) + 5\Delta H^\circ \text{H}_2\text{O}(\text{l})] - [\Delta H^\circ \text{C}_4\text{H}_{10}(\text{l}) + \frac{13}{2}\Delta H^\circ \text{O}_2(\text{g})]$$

$$-2877.4 \text{ kJ} = [4(-393.5 \text{ kJ}) + 5(-285.8 \text{ kJ})] - [\Delta H^\circ \text{C}_4\text{H}_{10}(\text{l}) + \frac{13}{2}(0)]$$

$$\Delta H^\circ \text{C}_4\text{H}_{10}(\text{l}) = -125.6 \text{ kJ}$$