Thermochemistry: Energy

Inspired by Paul Groves

A BLUFFER'S GUIDE

1. The 1st Law of Thermodynamics -
The energy of the universe is constant.

2. Endothermic $+q_{sytem}$ $-q_{surroundings}$
Exothermic $-q_{system}$ $+q_{surroundings}$

3. Specific heat – the amount of energy it takes to raise 1g of a substance by 1°C
Molar heat – the amount of energy it takes to raise 1mol of a substance by 1°C

4. The larger the specific heat, the more energy it takes to raise the temperature. Will heat slower.

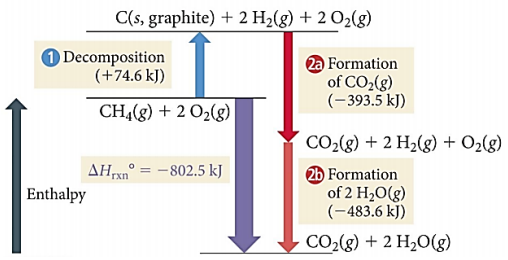
5. $Q = mC\Delta T$

6. Calorimetry:
$Q_{substance\ 1} = -Q_{substance\ 2}$
$T_{final\ substance\ 1} = T_{final\ substance\ 2}$
Temp is in CELSIUS not Kelvins for this topic!
1 kJ = 1000 J 1 calorie = 4.184 J

7. Standard State = the form of the element that has $\Delta H_f° = 0$ and $\Delta G_f° = 0$
- Pure gas at 1atm pressure
- Pure solid or liquid in most stable at 1atm and temp of interest (usually 25°C)
- Substances with a 1M solution

8. Formation Reactions – the reaction of elements in their standard state to form one mole of a pure compound
- Can have fractions as coefficients because making 1mol of the product.
- C(s, graphite) + ½ O_2(g) → CO(g)

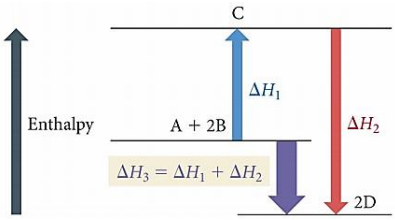
9. Enthalpy change:
$\Delta H° = \Sigma n \Delta H_f°(\text{products}) - \Sigma n \Delta H_f°(\text{reactants})$



10. Bond Energy:
ΣH(Bonds Broken) – ΣH(Bonds Formed)

"takes to break" and "free to form"
\+ -
endothermic *exothermic*

11. Hess's Law



12. Relationship between modifying the chemical equation and the ΔH_{rxn} value
- Multiplying a reaction by a number = multiply ΔH_{rxn} by the same number
- Reversing a reaction to go backwards = flip the algebraic sign on ΔH_{rxn}

13. Example Hess's Law Problem:

Calculate ΔH for the combustion of methane, CH_4:
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Cross out things that show up on both sides, then sum up your ΔH values

#	Reaction	ΔH°
1	$C + 2H_2 \rightarrow CH_4$	-74.80 kJ
2	$C + O_2 \rightarrow CO_2$	-393.50 kJ
3	$H_2 + ½\ O_2 \rightarrow H_2O$	-285.83 kJ

$CH_4 \rightarrow C + 2H_2$ +74.80 kJ
$C + O_2 \rightarrow CO_2$ -393.50 kJ
$2H_2 + O_2 \rightarrow 2H_2O$ 2 x (-285.83 kJ)
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ -890.36 kJ

14.

Heating and Cooling Curves
This is an example of water – can be done with any substance but the temperature values will be different. Also please note that the slope and length of lines are not drawn to scale. It is traditional to just draw the heating curve. A cooling curve would just be the opposite direction!