HW4

Enthalpy change (**Δ** H) – amount of chemical heat energy taken in (giving out) in a reaction. We can measure enthalpy change, but we cannot measure absolute value of enthalpy.
In an exothermic reactions heat is transferred from chemical reaction to the surrounding. Products have lower energy than reactants. Products are more stable. **Δ** H will be negative.
In endothermic reactions the surrounding gets colder. Products are less stable, they have higher energy than reactants. **Δ** H will be positive.
Lavoisier and Laplace law (1st law of thermodynamics) – the amount of energy released (or absorbed) during formation of a chemical compound is equal to the amount of energy absorbed (or released) when the same compound is destroyed.
$2H_2$ (g) + O_2 (g) → $2H_2O$ (aq) **Δ** H = - 573 kJ/mol (exothermic reaction)
Electrolysis of water
$2H_2O$ (aq) → $2H_2$ (g) + O_2 (g) **Δ** H = + 573 kJ/mol (endothermic reaction)

Hess's law. Amount of heat given or taken in the reaction is independent of the pathway between the initial and final state.

We want to obtain Na_2SO_4.
1. $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ **Δ** H=- 131 kJ/mol
2. $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$ **Δ** H =- 62 kJ/mol
$NaHSO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$ **Δ** H =-69 kJ/mol
-69-62=-131

We can use Hess's law if we cannot find enthalpy change from the experiment. We can take enthalpy changes from the known chemical reaction and mathematically manipulate chemical equations. For example, we want to know the enthalpy change for synthesis of methane directly from carbon. This reaction is very difficult to perform in the lab. We can do the following manipulations:

$C(s) + 2H_2(g) \rightarrow CH_4(g)$

ΔH for the reactions 1, 2 and 3 are known from the experiments

1. $CH_4(g) + 2O_2(g) \Rightarrow CO_2(g) + 2H_2O(aq)$ $\Delta H = -890\ kJ/mol$

2. $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394\ kJ/mol$

3. $2H_2(g) + O_2(g) \rightarrow 2H_2O(aq)$ $\Delta H = -572\ kJ/mol$

We can subtract reactions 2 and 3 from the first reaction, subtract ΔH as well. After subtraction we have the following equation:

$CH_4(g) - C(s) - 2H_2(g)$ $-890\ kJ/mol + 394\ kJ/mol + 572\ kJ/mol =$

$= 76\ kJ/mol$

We rearrange it:

$C + 2H_2 \rightarrow CH_4$

answer: ΔH of CH_4 formation = 76 kJ/mol

Questions:

1.What substance is more stable, graphite or diamond?

C (graphite) + O_2 → CO_2 **Δ** H=- 393.8 kJ/mol
C (diamond) + O_2 → CO_2 **Δ** H=- 395.7 kJ/mol

2. Calculate enthalpy change for the following reaction
$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$
The enthalpy change for these reactions are known
$2C(s) + O_2(g) \rightarrow 2CO(g)$ **Δ** H=- 222 kJ/mol
$C(s) + O_2(g) \rightarrow CO_2(g)$ **Δ** H=- 394 kJ/mol