**Hess' Law**

**The story so far...**

**Enthalpy (H) is the total heat energy content of a system**.

It is the sum of the potential energy stored in the bonds and the kinetic energy of the particles—think mechanical energy physics.

Since we normally do reactions at a given temperature we usually **ignore the kinetic energy component** and focus on just the potential energy of the system.

We cannot measure enthalpy but…we can measure the **change in enthalpy** aka:

* Enthalpy of reaction
* Molar enthalpy (of reaction)
* Heat of reaction
* Molar heat of reaction
* **ΔH**

The change in the amount of enthalpy between the reactants and the products in a reaction can be calculated the following ways:

**1) ∆H = Q/n** (experimentally)

**2) ∆H = BER – BEP** (from bond energy charts)

**3) ∆H = Hp - Hr** (from graphs)

And so it continues...

**4) ∆H = ΣHfproducts - ΣHfreactants aka Hess’ Law!**

(from heats of formation charts)

WTF (what the fluorine) is a **∆Hf**?????

**ΔHf** is the change in enthalpy that takes place during a **formation** reaction.

**ΔHf** are found on Heat of Formation Charts.

But what is a formation reaction?

**Formation Reaction: to be memorized!!**

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e.g. BCE for the formation of MgO

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e.g. BCE for the formation of CH3CH2OH

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Watch for:

* **1mole** of compound and
* **standard states** of the **elements**!

Otherwise it **is not** a formation rxn! This is how I will get you!!!!

**Place the Heats of Formation Chart at the front of your binder for easy reference!!**

Please note that the **heat of formation of an element** is assigned a value of **zero**.

The **elements** are the **reference level** (just like the ground or floor in physics class).

When compounds form from their elements the reaction either releases more energy than is absorbed (exo) or absorbs more energy than is released (endo).

**Using your Heats of Formation Chart find the ∆Hf for Al2O3.**

Write the formation equation for this compound as a thermochemical equation i.e. including the **∆H** in the equation:

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Write the formation equation for this compound as using ∆H notation:

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As a labeled enthalpy graph:

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Find the ∆Hrxn for the following reaction using:

**∆Hrxn = ΣHfproducts - ΣHfreactants**

**CH4(g) + 2 O2(g) → CO2(g) + 2 H2O(l)**

**Answer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

This is the **fast way** to calculate **∆Hrxn**.

This faster way can only be done using **∆Hf’s—if you have other ∆H’s it does not work!!**

Which means: there is a slower way to do it but it explains why the above formula works!

**Hess' Law**

Calculate my potential energy when I jump up onto the bench top.

My Fg is currently 158 lbs. (2.2 lbs = 1 kg)

Sketch what I did!

**Answer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Now what is my potential energy when I do this?

Sketch what I did!

**Answer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Why?**

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It doesn't matter how you determine the ∆H for a reaction--using 1 equation i.e. jumping up onto the bench top or by using a bunch of equations (step stools) that add up to the same equation.

**“Bench Top Equation” = This is where I want to get to!**

**CH4(g) + 2 O2(g) → CO2(g) + 2 H2O(l)**

Write the 3 formation reactions using the 3 **compounds** in the above equation.

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**BCE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ΔH = \_\_\_\_\_\_\_**

**Hess's law** states that the change of enthalpy in a chemical reaction (i.e. the heat of reaction at constant pressure) is independent of the pathway between the initial and final states.

**Hess's Law** of Constant Heat Summation (or just **Hess' Law**) states that regardless of the multiple stages or steps of a reaction, the total enthalpy change for the reaction is the sum of all changes.

You do not have to use Heats of Formation in order to add up equations to determine ∆H rxn for a particular equation.

Any equations may add to 1 equation (bench top equation). It is very important to determine **which equation is being asked for** i.e. what is the bench top equation!!

Given the following data:

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| **SrO(s) + CO2(g) → SrCO3(s)** | **ΔH = -234 kJ** |
| **2SrO(s) → 2 Sr(s) + O2(g)** | **ΔH = +1184 kJ** |
| **2SrCO3(s) → 2 Sr(s) + 2 C(s) + 3 O2(g)** | **ΔH = +2440 kJ** |

Find the **ΔHr** of the following reaction:

**Bench Top Equation: C(s) + O2(g) → CO2(g) ΔH = ?**

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