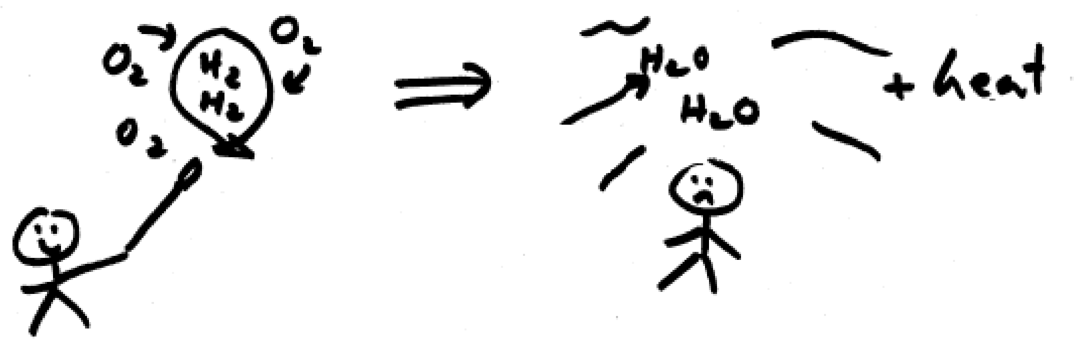
LECTURE 19. GETTING READY FOR THERMODYNAMICS

In class you learned that this reaction happens…

$2\ H_2 + O_2 \rightarrow 2\ H_2O$ …***a big H_2 balloon explosion!!!!***

You learned how to draw the structures; you learned that there were products and reactants that balanced stoichimetrically because of conservation of mass and change.

You also got to see an explosion because this is the reaction of a hydrogen balloon.



In understanding the stoichimetry, we paid no attention to the explosion and heat given off. We just counted up stuff to make sure mass and charge were conserved.

But now we are learning about ***thermodynamics***, and will be needing to account for all the energy change that occurs. Sure we want to conserve matter, but we want an accounting of all that energy in the reaction.

*****Thermodynamics is the study of the energy change in a system--whether it is energy in the form of heat as with the exploding balloon, or mechanical work, or creating order in a system.*****

So why is there energy change in a chemical reaction?

Simply, it is because of bonds breaking and bonds forming. So consider hydrogen and oxygen.

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                                   H
H-H   O = O        →          H        →    H-O-H
      H-H                      H                 H-O-H
       ⇩                       O             ⇩
                               O
Energy is needed                      Energy produced
to break bonds                        forming bonds
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This Δ Energy is what we measure and actually we will see that there are a variety of energy-related changes to measure as we work our way through thermodynamics:

Δ G	ΔH	ΔE	ΔS	w
Free energy	Enthalpy	Internal energy	Entropy	Work

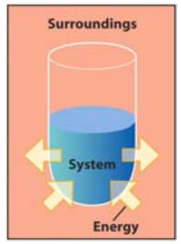
Each of these changes will get its own lecture as we develop a model for chemical thermodynamics.

Playing Ground for Thermodynamics: Universe, System and Surroundings

First we need to define our thermodynamic playground

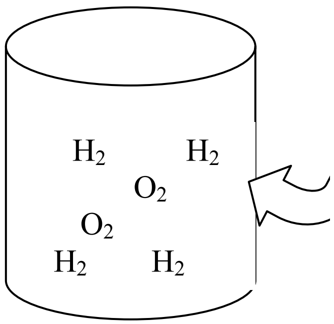
1. We are in a UNIVERSE (which is everything)
2. But we are only concerned with the SYSTEM (which in chemistry is the chemical reaction.)

We like to isolate the chemical reaction by putting it in a closed environment where everything else is the surroundings.



Universe = System + Surroundings

There are certain things we measure in the system. Like T, P, V, moles. These are **state functions** we learned about in the lectures on gases.



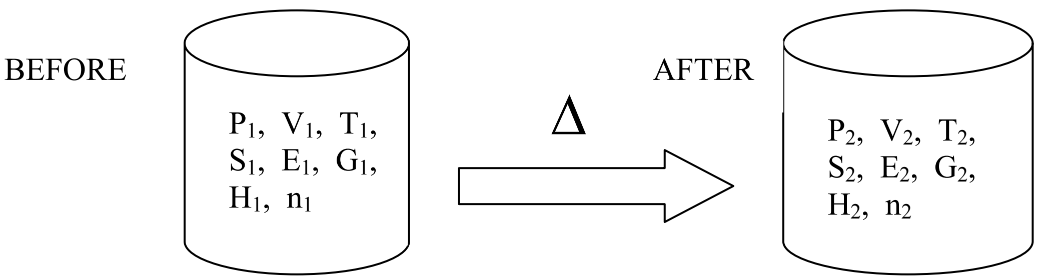
So in the system we can identify the following quantities…

T, P, V, n (gases)

and

E, H, S, G (thermo)

And actually, it isn't the state of the system. It is the CHANGE in state that matters.



So basically we will spend the rest of the semester calculating:

ΔV, ΔP, ΔT, Δn, ΔS, ΔG, ΔH, ΔE (changes in the state of the system)

Thermodynamic Laws are Coming

Just like when we discussed quantum mechanics, there are some boundaries or laws that govern the big picture of thermodynamics. We are already used to one notion, that of conservation. And for example when we were discussing stoichiometry in high school we learned that:

- All the mass in the universe is conserved

and

- All of the charge in the universe is conserved.

This made it easy to do things like balance chemical reactions.

Well a new conservation law is coming:

- All of the energy is the universe is conserved. ← the first law of thermodynamics

And we will also learn about a couple of other laws that bound what happens in our thermodynamic universe:

- The entropy in the universe is always increasing ← the second law of thermodynamics
- There is an absolutely lowest temperature. ← the third law of thermodynamics

So let's get started.