Spontaneity

<table>
<thead>
<tr>
<th>( \Delta H )</th>
<th>( \Delta S )</th>
<th>( \Delta G )</th>
<th>spontaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>+</td>
<td>always -</td>
<td>yes</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td>always +</td>
<td>no</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>either + or -</td>
<td>sometimes</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>either + or -</td>
<td>sometimes</td>
</tr>
</tbody>
</table>

**Spontaneity —>**

- this does not tell us why a chemical reaction occurs
- the energy doesn't disappear it just gets transformed from one form to another
- this helps us understand that the net energy is not changing

*The First Law of Thermodynamics*

*The energy of the universe is constant.

*In a chemical rxn, energy is neither created nor destroyed.

^-- this is the chemical definition

Examples of Spontaneous Processes:

- Water freezes when \( T = 0^\circ C \) and \( P = 1 \) atm.
- A candle burns. (Some spontaneous processes need a little push to get them going - needs to be lit by match)

- if something is spontaneous than the reverse of that is not spontaneous (aka the reverse does require energy)
- these examples are spontaneous but the reverse of them does require energy

**nonspontaneous change** - occurs only if surroundings supply continuous energy

- \( \text{CO}_2 \) and \( \text{H}_2\text{O} \) do not spontaneously produce wax and \( \text{O}_2 \)
- A change can only be spontaneous in one direction under a given set of conditions
Thermochemistry

Potential Energy:

- All matter contains potential energy that comes from position
- Chemical Potential energy is energy due to position on the molecular or even atomic level
- In a reaction electrons can release or gain potential energy
- When energy is produced in a reaction the reactants have more potential energy at the start and so they give some of it to the product.

Thermodynamics - the study of energy and its transformations

First Law - The energy of the universe is constant

Thermochemistry - the branch of thermodynamics that deals with heat in chemical and physical changes

also says that matter is neither created nor destroyed

Energy Transfer

- Going from N2+O2 → 2NO you will have a curve that starts low has a little bump and then ends higher because it is releasing energy

Energy Transfer