Entropy, Enthalpy, & Gibbs Free Energy

SCH 4U1

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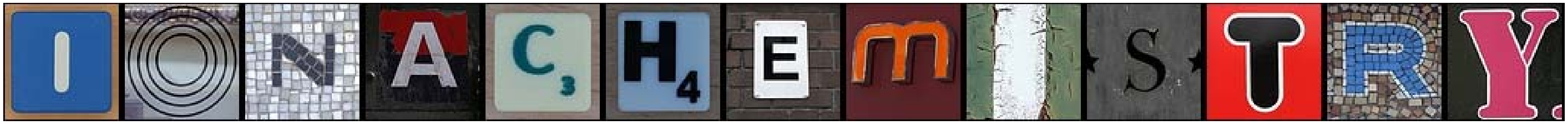


Last unit we learned about the energy changes that take place during physical and chemical changes.

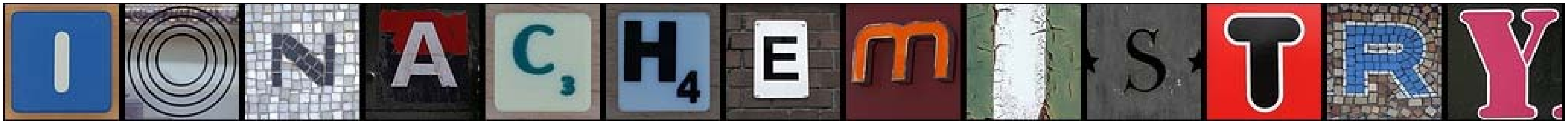
When the particles of one substance collide with another, there is a possibility they will react.

-activation is required, for example lighting a sparkler. Once lit, the available fuel combusts. This is an **exothermic** reaction, releasing large amounts of energy as heat and light.

Exothermic reactions are also spontaneous reactions = given the necessary activation energy to begin, the reaction occurs without continuous outside assistance, proceeding to completion in open systems.

In closed systems they establish a state of dynamic equilibrium.

The decomposition of water into its elements hydrogen and oxygen is endothermic. A continuous supply of energy is needed to sustain the reaction. I.E., electricity in an electrolysis apparatus. The reaction is nonspontaneous and will stop if energy is no longer supplied.



Our test on Friday involves in large part the calculation of enthalpy changes Δ*H* associated with a chemical reaction. The first half of the unit was called thermodynamics and was primarily about the exchange of energy between a chemical system and its surroundings.

The first law of thermodynamics [conservation of energy] states that an object or process gains an amount of energy, it does so at the expense of energy somewhere else in the universe.

SO........

When we learned about thermochemistry, we were taught that reactions with negative enthalpy changes ($\Delta H < 0$) are exothermic and those with positive enthalpy changes ($\Delta H > 0$) are endothermic. In general exothermic reactions tend to proceed spontaneously.

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Entropy

- Endothermic reactions such such electrolysis of water are nonspontaneous [it will stop if the energy source stops],

but......

There are some endothermic reactions that are spontaneous.

Entropy, S is a measure of disorder or randomness.

It could apply to a system:

It could apply to the surroundings:

It could apply to the universe as a whole:

- Heat tends to move spontaneously from hotter objects to cooler ones until thermal equilibrium is reached. Why?

- The reason is that the kinetic energy moves to create the most disordered system possible.

- Entropy is a measure of disorder or randomness in a system. Every isolated system becomes more disordered with time. In fact, the direction of time itself is governed by this.

- Energy must always be used to *reduce* the amount of randomness or entropy in a system.

- Examples of Increasing Entropy:
  - A Messy Bedroom
  - My classroom
  - Shuffling Cards
  - Shaking a Jar of Candy
  - Dye spreading in a solution
  - NaCl crystal dissolving

- The most disordered form is always most favoured. Because of this, the universe is heading towards thermal equilibrium and will eventually die a “heat” death, the end of days.

Life on Earth is due to the fact that we are not at thermal equilibrium (sun, interior heat). On a small scale, order can develop spontaneously:

sand dunes
galaxies
life
consciousness

Local states of very high order emerge despite the trend towards chaos. We as yet do not understand this process.

See Handouts