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General Chemistry II - Lecture 16

All systems try to
 reach / maintain their
 lowest energy



Spontaneous Processes

Before embarking on a discussion of the Second Law of Thermodynamics, we have to define two key concepts, the first of which is the idea of a spontaneous process. This is best done by example. Some spontaneous processes:

- Objects roll downhill (energy ↓)
- Sugar dissolves in water
- Organic compounds burn in air to yield carbon dioxide and water (energy ↓)
- Acids and bases neutralize each other in aqueous solution

We know from experience that some processes proceed spontaneously in one direction and not in the opposite direction.

$$\Delta G = \Delta$$

Thermodynamics is concerned with trying to explain why a process occurs spontaneously. Listed below are some spontaneous processes, along with the change in internal energy of the system associated with the process (recall that for most chemical processes, $\Delta U = \Delta H$).

1. Object rolls downhill (object lowers its gravitational potential energy)
2. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ $\Delta U = -1505 \text{ kJ}$
3. $H^+ + OH^- \rightarrow H_2O$ $\Delta U = -55 \text{ kJ}$

Can be explained by energy considerations

All of the above processes can be explained by energy considerations alone; they all result in a net decrease in the internal energy of the system. However, spontaneous processes do not always decrease the internal energy of a system, e.g.,

1. Ice \rightarrow water $\Delta U = 6 \text{ kJ}$ (spontaneous above 0°C)
2. $KCl(s) \xrightarrow{H_2O} K^+(aq) + Cl^-(aq)$ $\Delta U = 17 \text{ kJ}$ (spontaneous)

Endothermic Process

It is evident from the above examples that energy considerations alone are not sufficient to explain why a process is spontaneous. We need to appeal to another thermodynamic property to understand spontaneity.

Can't be explained by energy considerations

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