2.C.3
2nd Law of Thermo. and Entropy

General 2nd Law

Certain processes don't take place, even if they are consistent with the 1st law of thermodynamics: just because the algebra works doesn't mean it happens.

Specifically: Heat will not flow spontaneously from a cooler to warmer body.

Also, in a thermal cycle, heat energy cannot be completely transformed into mechanical work.

Forbids perpetual motion machines (Drinking Bird Demo).

General 2nd Law

Specifies direction in which a process takes place, and applies to all forms of energy.

Whereas the First Law of Thermo. dealt with *quantity* of energy, the Second Law deals with the *quality* of energy.

Can't put Humpty back together!

Entropy: Symbol = S

Change in entropy at constant temperature (isothermal process):

$$\Delta S = \frac{Q}{T}$$

S = Units: J/K
Q = Heat (J)
T = Temperature (K)

Why S? It's generally believed that Rudolf Clausius (definer of entropy) chose this to honor the French physicist Nicolas Sadi-Carnot.

Entropic Perspectives

ΔS is positive if a system absorbs heat and negative if it loses heat.

2nd Law stated: "The total entropy of an isolated system can never decreas over time: for every spontaneous process, entropy increases."

During any process, entropy of the universe can only increase or remain constant.

All natural processes move toward a state of greater disorder or disarray.

Real World Examples:

ΔS increases during perspiration: it takes heat energy to vaporize water, and the vaporized water has greater disorder than the liquid water.

Pasta salad: ingredients are chopped up, increasing their disorder. You could pick out the pieces and put them together again, but this would not be a natural process.

Also, your very movements to do so increase the entropy of the universe!

1. Entropy Math Example

What is ΔS if 15 kg of ice melts at 0 °C (273 K)?

First, find the energy gained by the ice (Unit 2.B.3):

$Q = L_F \bullet m$
$= 3.33 \text{ E } 5 \text{ J/kg} \bullet 15 \text{ kg}$
$= 5.0 \text{ E } 6 \text{ J}$

Then, compute ΔS:

$\Delta S = Q/T$
$= 5.0 \text{ E } 6 \text{ J}/273 \text{ K}$
$= 1.8 \text{ E } 4 \text{ J/K}$

Homework

Preview 2.C.4

2.C.3 Booklet Problems.
Due: Next Class

Entropy

Quantity that indicates natural direction of a process is entropy:

1. Measure of a system to do useful work.

2. Determines the direction of time – points out the forward flow of events.

3. Measure of disorder.

Systems move toward greater disorder – the more order, the lower the entropy.

Entropy of universe is increasing.