19.1   Entropy
A Review of Terminology

NH4NO3(s) in Water

System
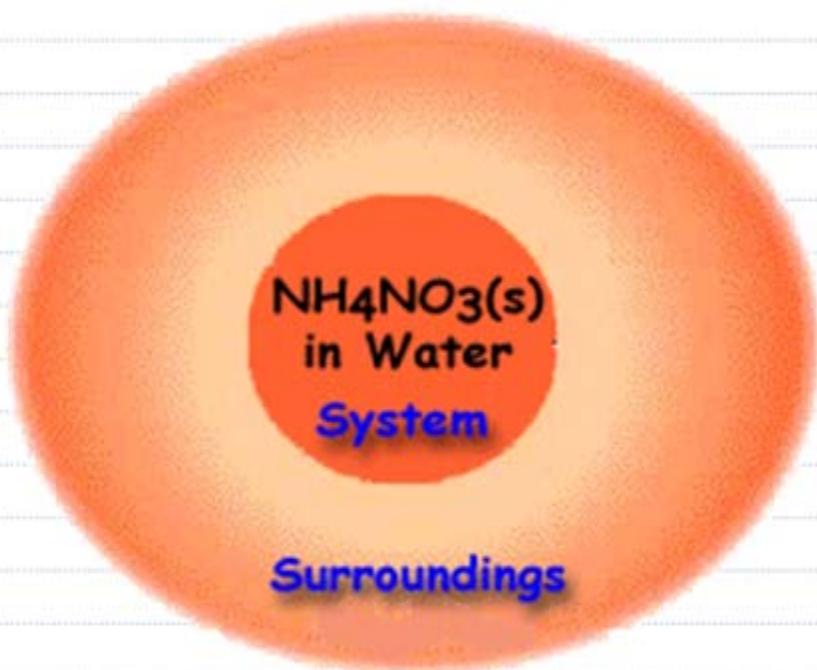
**Surroundings**

SYSTEM: What we are interested in ... the chemical reaction.

SURROUDINGS: Everything else.

UNIVERSE = SYSTEM + SURROUNDINGS

Chem III: Heat Transfer (Enthalpy) in the system.

$$\Delta H^{\circ}_{RXN} = \sum \Delta H^{\circ}_{f} \text{ (products)} - \sum \Delta H^{\circ}_{f} \text{ (Reactants)}$$

$\Delta H^{\circ}_{RXN} < 0$: Exothermic

$\Delta H^{\circ}_{RXN} > 0$: Endothermic

19.1   Entropy
Spontaneous Process V Nonspontaneous Process

Butane burner

Electrolysis of H₂O(l)

**SPONTANEOUS:**
Any process that is able to occur without being continously driven by an external source of energy

- May require an initial input of energy to overcome Eo to get it started.
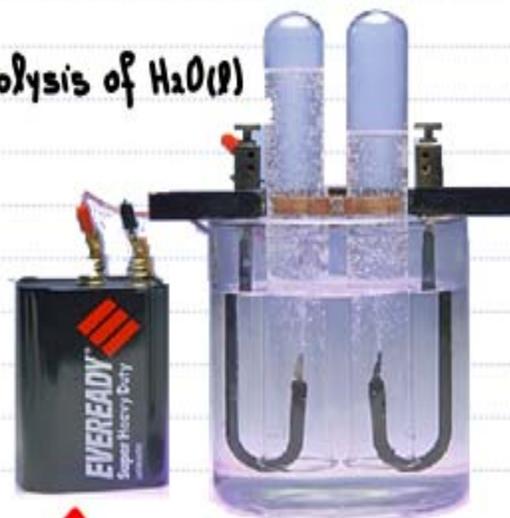
Requires a continuously external energy source.
Nonspontaneous

19.1   Entropy
Enthalpy a Measure of Spontaneity?

Nonspontaneous	Spontaneous

Nonspontaneous

$$2 H_2O(l) = 2 H_2(g) + O_2(g)$$

$\Delta H^{\circ}_{RXN} = 2 \Delta H^{\circ}_f H_2(g) + \Delta H^{\circ}_f O_2(g) - 2 \Delta H^{\circ}_f H_2O(l)$

$\quad = 2(0) \quad + \quad 0 \quad - 2(-285.8)$

$\quad = 571.6 \ kJ$

EndoThermic

Spontaneous

$$2 C_4H_{10}(g) + 13 O_2(g) = 8 CO_2(g) + 10 H_2O(g)$$
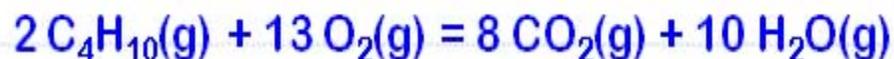
$\Delta H^{\circ}_{RXN} = 8 \Delta H^{\circ}_f CO_2(g) + 10 \Delta H^{\circ}_f H_2O(g) - 2 \Delta H^{\circ}_f C_4H_{10}(g) - 13 \Delta H^{\circ}_f O_2(g)$

$\quad = 8(-393.5) + 10(-241.8) - 2(-125.6) \quad - 13(0)$

$\quad = -5,314.6 \ kJ$

ExoThermic

$$H_2O(l) = H_2O(g)$$

$\Delta H^{\circ}_{RXN} = \Delta H^{\circ}_f H_2O(g) - \Delta H^{\circ}_f H_2O(l)$

$\quad = -241.8 - (-285.8)$

$\quad = 44 \ kJ$

EndoThermic ☹

19.1   Entropy

Entropy a Measure of Spontaneity?

NH4NO3(s) in Water

System
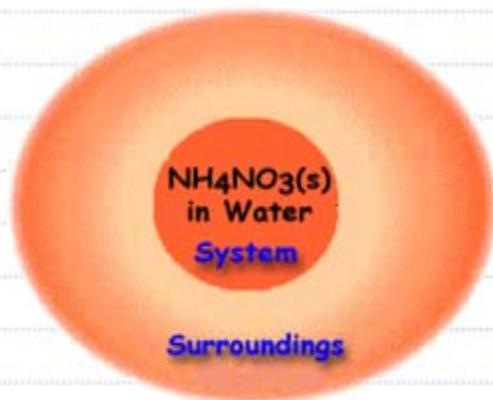
**Surroundings**

ENTROPY (S): a measure of disorder and the natural tendency to disorder.

SPONTANEOUS PROCESS: $\Delta S_{UNIVERSE} > 0$

$\Delta S_{UNIVERSE} = \Delta S_{SYSTEM} + \Delta S_{SURROUNDINGS} > 0$

$T = 0 K$

$S = 0$
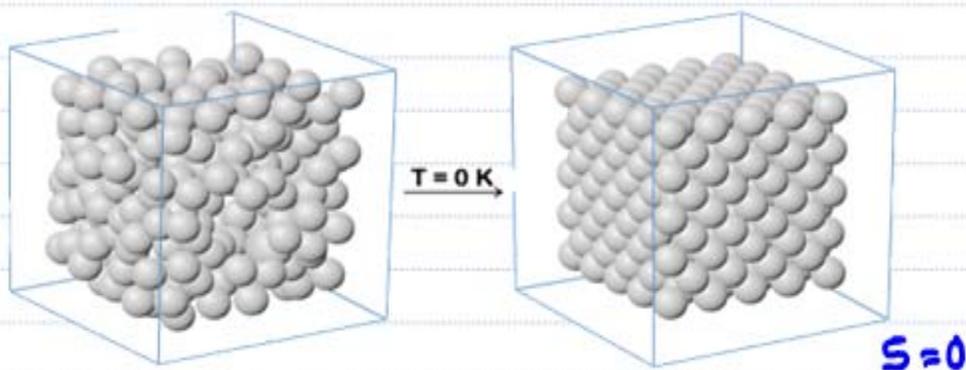
3RD LAW OF THERMODYNAMICS:

The entropy of a pure crystalline system is $\emptyset$ @ absolute zero.