# Thermodynamics

**Unit 16C:** Thermodynamics Review - Entropy

### Knowledge/Understanding Goals:

* “vernacular” definition of entropy
* determine whether a process is likely to increase or decrease Δ*S*

### Skills:

* calculate Δ*S* from qrev.
* calculate Δ*S*rxn from thermodynamic data

### Notes:

If you ask three chemists to define entropy, you will probably get three very different answers.

Most chemists agree that some chemical energy exists in the form of enthalpy, or heat energy. Entropy is the catch-all term for the rest of the energy.

Like enthalpy, entropy is a state variable, meaning that the entropy of a chemical or reaction is determined by the state of the chemicals, and is independent of the pathway. In thermodynamics, the variable *S* represents entropy.

If heat is used to produce a temperature change, then the heat equals the change in enthalpy of the system, ΔH.

However, if a system absorbs heat *without* the temperature changing, then the heat must be converted to something other than enthalpy—*i.e.,* entropy. Because the entropy change is highly dependent on temperature, temperature needs to be included in the equation.

For a reversible process:



where Δ*S* is the entropy change, *q* is the heat added, and *T* is the temperature (in Kelvin).

Just like with enthalpy, Δ*S* for a reaction can be calculated by:



In thermodynamic tables, standard entropy (S°) values are given at standard state, usually 25°C and 1 atm, and are used just like standard enthalpies of formation. By definition, S° for the H+ (aq) ion at 25°C is defined to be zero. All other S° values are calculated relative to the H+ ion.

S° values for elements and compounds are always positive. S° values for aqueous ions can be positive or negative.

Note that S° values are usually expressed in , whereas  values are usually expressed in .

## Predicting Δ*S* Changes

In general:

* For a given compound, the liquid phase has a higher entropy than the solid phase.
  + Ie: solid → liquid = +ΔS
* For a given compound, the gas phase has a significantly higher entropy than the liquid phase.
  + Ie: liquid → gas = +ΔS
* If a chemical reaction increases the number of moles of a gas, Δ*S* for the reaction will almost always be positive.
* Increasing the temperature of a substance increases its entropy.