N5 – Spontaneity





N6 – Entropy

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| **Key Concepts About Entropy** |
| **#1 -** a thermodynamic function that increases as the number of energetically equivalent ways of arranging the components increases, S. |
| **#2 –** Random systems have more energy dispersal and are more energetically stable, lower energy, than ordered systems |
| **#3 –** Increase in entropy of the universe is the driving force for spontaneous reactions.  |
| **#4 –** Nature proceeds toward the states that have the highest probabilities of existing. |

**Practice Problem:**For the Rx: **2NO(g) + O2(g) 🡪 2NO2(g)**

ΔS°rxn= -146.5 J/mol•K

Calculate the standard molar entropy of O2(g).

ΔS°NO(g) = 210.8 J/mol•K , ΔS°NO2(g) = 240.1 J/mol•K

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| **Some Changes that Increase Entropy** |
| **#1 -** Products are in a more dispersed arrangement. |
| **#2 -** Larger numbers of product molecules than reactant molecules. |
| **#3 -** Rxn’s that have an increase in temperature (exothermic). |
| **#4 –** Products that have more degrees of movement. |
| **#5 –** Products that have more molecular complexity. |

N7 – Gibbs Free Energy

**Gibbs free energy, *G*** - the maximum amount of work energy that can be released to the surroundings by a system for a constant temp and pressure system.

Gibbs free energy is often called the
**chemical potential** because it is similar to the storing of energy in a mechanical system.

Gibbs Mental Math



N7 – Gibbs Free Energy – Continued...







N7 – Gibbs Free Energy – Continued...again...

**A Variety of Helpful Equations**

∆Suniv = ∆Ssys + ∆Ssurr

∆Ssurr = – ∆Hsys / T

*−T∆Suniv = ∆Hsys−T∆Ssys*

*∆Gsys = ∆Hsys−T∆Ssys*

**

*∆G°= −RT ln(K)
where R=8.314J/mol•K*

*∆G = ∆G° + RT ln(Q)*

*– RT ln(K) = ∆H° – T∆S°*

 *y = m x + b*

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N7 – Gibbs Free Energy – still...sorry...not sorry 

**Practice Problems**

**#1 -** For the following Rx:

N2(g) + 3H2(g) 🡪 2NH3(g)

Calculate the standard Free Energy,

ΔG° for the rxn at 25°C.

ΔH°= -264kJ/mol ΔS°= -278 J/mol•K

**#2 -** Calculate the Boiling Point of BCl3.

BCl3(*l*) ↔ BCl3(g). Given:



**#3 -** Under standard conditions (1 atm of NH3, N2 and H2) and at 298 K, what substance(s) will be formed?
(∆G° = 33.4 kJ)

2 NH3(g) 🡪 N2(g) + 3 H2(g)

**#4 -** Calculate the equilibrium constant for this reaction at 298 K.

2 NH3(g) 🡪 N2(g) + 3 H2(g) (∆G° = 33.4 kJ)