Exam #2: 4-2-2020: **Please show all work for credit.** Don't Panic

Short Answers:

4. What is the second law of thermodynamics?

entropy always increases or stays constant (equilibrium) but never decrease over time in an isolated system. A cyclic process can't convert heat to work with 100% efficiency.

5. What is the third law of thermodynamics? Explain how this makes entropy different than energy or enthalpy.

The third law of thermodynamics shows entropy is an ever increasing value in the universe and there is a reference point where entropy is zero. Neither of the properties are seen in enthalpy or energy.

6. Why can't we build a perpetual motion machine?

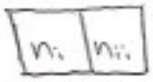
It violates the 1st and 2nd law. A machine can't run infinetly on a finite amount of energy as work is done some energy is always lost to heat and it would be creating energy if it did run indefinitely.

7. Why is Gibb's free energy usually more useful to chemists than Helmholtz energy?

Gibbs is more useful because it assumes constant pressure and temperature. Helmholtz assumes constant volume and temperature. Creating a constant volume system as a bench top chemist is much harder than having constant pressure from the atmosphere.

8. Give the mathematical definition of chemical potential. Explain why it is called a potential. Include at least one drawing. $\left(\frac{\partial G_i}{\partial n_i}\right)_{P,T,n_i} = \mu_i$

a potential is a natural change in direction where things move from high to low. So large amount of n_i becomes n_{ii} because it is naturally favorable, in the same way a ball always rolls down a hill from gravitational potential.



$n_i > n_{ii}$

9. Is the mixing of different types of molecules in an ideal gas spontaneous? Justify your answer using mathematical expressions for the chemical potential.

$$\Delta G_{mixing} = nRT \sum_i x_i \ln x_i$$

$x_i < 1$

so $\ln x_i < 0$

ΔG_{mixing} is always spontaneous!

10. For a given chemical reaction involving only gasses at equilibrium, if $\Delta G^\circ_{rxn} > 0$, will there be more product formed or more reactant. Justify your answer using one or more equations.

$$K_p = e^{\left(\frac{-\Delta G_{rxn}}{RT}\right)}$$

$\Delta G^\circ_{rxn} \uparrow$, $K_p \downarrow$ favor reactants