1. Please define the activity and activity coefficient for nonideal solutions. (10%)

2. Please derive the heat capacity at constant P, $C_p = C_V + \dfrac{TV\alpha^2}{\kappa}$, where α is the coefficient of thermal expansion and κ is the compressibility. (15%)

3. Please define the second law of thermodynamics in detail. (10%)

4. Please define the ionic strength and describe how it relates to the Debye-Hükel limiting law. (10%)

5. Please describe the van der Waals equation in detail. How is it different from the ideal gas law? (10%)

6. What is the surface tension? How to measure it? Please give a governor equation for your method. (15%)

7. What is the osmotic pressure? How to measure it? Please give a governor equation for your method. (15%)

8. Please indicate the difference between the Gibbs free energy and Helmholz free energy. (5%)

9. Please describe the Boltzmann distribution law. How does it relate to the entropy. (10%)

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