1. Please describe and explain (a) Critical temperature, (b) Dalton 's law of partial pressure, (c) Hybrid orbitals, (d) Osmotic pressure, (e) Ionization energy. **(20%)**

2. Calculate the $[H^+]$ in (a) 1.0 M Acetic acid ($HC_2H_3O_2$), $K_a = 1.7 \times 10^{-5}$, (b) 1.0×10^{-3} M Hydrocyanic acid (HCN), $K_a = 4.9 \times 10^{-10}$. **(10%)**

3. In an experiment, the initial concentration was 0.0015 M, After 455 sec, this was reduced to 0.00119 M. (a) Calculate the rate constant. (b) What is the value of the half-life? (c) How long will it take for the reaction to go to 95% completion? **(10%)**

4. A volume of 9.0 L of Ar at STP was added to a vessel that contained 3.0 L of O_2 at 45°C and 1.5 atm pressure. (a) What is the total pressure? (b) What is the partial pressure of each gas at STP after Ar is added? **(10%)**

5. Describe the relation between atomic electron structure and Nuclear Magnetic Resonance (NMR, 核磁共振儀). **(10%)**

6. Water is attracted to electrically charged rod, but carbon tetrachloride, CCl_4, is not electrically charged rod. Please explain. **(10%)**

7. The vaporization rate of liquid increased with higher temperature. Please use distribution of kinetic energies to explain. **(10%)**

8. Pressure has an effect on the solubility of oxygen in water but a negligible effect on the solubility of sugar. Please explain. . **(10%)**

9. Consider the molecules N_2H_4, N_2, and N_2F_2. Which molecule has the shortest nitrogen-nitrogen bond? Which has the longest nitrogen-nitrogen bond? **(10%)**