1. Solid calcium phosphate and aqueous sulfuric acid solution react to give calcium sulfate, which comes out of the solution as a solid. The other product is phosphoric acid, which remains in solution. Write a balanced equation for the reaction using a complete formula for the compounds with phase labels. **(10%)**

2. Iron forms a sulfide with the approximate formula Fe_7S_8. Assume the oxidation state of sulfur is -2, and that iron atoms exist in both +2 and +3 oxidation states. What is the ratio of Fe(II) atoms to Fe(III)atoms in this compound? **(10%)**

3. Calculate the root-mean-square (rms) speeds of N_2 molecules at 125 °C and 225 °C. Sketch approximate curves of the molecular speed distributions of N_2 at 125 °C and 225 °C. **(10%)**

4. The hyponitrite ion, $^{-}O—N{=}N—O^{-}$, exists in solid compounds as the trans isomer. Using valence bond theory, explain why *cis-trans* isomers might be expected for this ion. Draw structural formulas of the *cis-trans* isomers. **(10%)**

5. Please describe and explain (a) Arrhenius equation, (b) Colloid (c) Haber process, (d) Second law of thermodynamics, (e) Ideal gas law. **(20%)**

6. A buffer is prepared by adding 90.0 mL of 0.15 *M* NaF to 70 mL of 0.10 *M* HF. What is the pH of the final solution? **(10%)**

7. What is the concentration of $Ag^{+}(aq)$ ions in 0.10 *M* $AgNO_3$ that is also 1.0 *M* NH_3? K_f for $Ag(NH_3)_2^{+}$ ion is 1.7×10^{7}. **(10%)**

8. **(10%)** Calculate the emf of a cell operating with the following reaction at 25 °C, in which $[MnO_4^{-}] = 0.010$ M, $[Br^{-}] = 0.01$ M, $[Mn^{2+}] = 0.15$ M, and $[H^{+}] = 1.0$ M.

$$2\,MnO_4^{-}(aq) + 10\,Br^{-}(aq) + 16H{+}(aq) \rightarrow 2\,Mn^{2+}(aq) + 5Br_2(l) + 8H_2O(l)$$

9. Please explain the Brønsted-Lowry Concept of Acids and Bases, and give a suitable example as an illustration. **(10%)**