1. $FeClO_2$ and F_3ClO can both gain a fluoride ion to form stable anions. F_3ClO and F_3ClO_2 will both lose a fluoride ion to form stable cations. Draw the lewis structures and describe the hybrid orbitals used by chlorine in these ions. (10%)

2. In the world of molecules, what is symmetry? what is point group? What are the relationships between symmetry and point group? (10%)

3. What kinds of methods can be used to reveal the presence of hydrogen bonding ? Briefly describe the theory of each.(10%)?

4. Why aluminum foil is placed in hydrochloric acid, nothing happens for the first 30 seconds or so. This is followed by vigorous bubbling and the eventual disappearance of the foil. Explain these observations. (5%)

5. Lists at least 5 inorganic solid state materials and briefly describes their structure. (10%)

6. Semiconductor industry is one of the most important industry in Taiwan. What kinds of chemistry are involved in this industry. (5%).

7. Predict the structures and also discuss the bonding for the following molecules:

   $N(CH_3)_3$, $N(SiH_3)_3$ and $P(SiH_3)_3$. (9 points)

8. Propose the mechanism for the following reaction in acidic solution: (8 points)

   $[Co(NH_3)_5(^*OH_2)]^{3+} + NO_2^- \longrightarrow [Co(NH_3)_5(N^*OO)]^{2+} + H_2O$

9. The substitution reaction of cis -ML_4AX^{n+} is believed to proceed by "dissociation mechanism (D)" with TBP structure as the intermediate. The ratio of *cis* and *trans* products; ML_4AY^{n+} is obtained as 83.3% to 16.6%, respectively. Please rationalize this ratio. (10 points)

10. Suggest a two-step synthesis of lithium aluminum hydride ($LiAlH_4$), using only elements and Al_2Cl_6. Repeat this for $NaBH_4$, using B_2H_6. (8 points)

11. Reaction between Br_2AsF_6 and $KBrF_4$ in BrF_3 as solvent is a acid-base neutralisation. Please explain and indicate each acid and base, and also write down the reaction products. (7 points)

12. Draw the structures for the following molecules; (8 points)

    (a) $[NPClPh]_4$ (b) P_4O_{10} (c) $Sn_2F_5^-$ (d) $[B(OH)_4]^-$