

- Write the chemical formula for each of the following: (8%)
 - hypobromous acid
 - peroxomonosulfuric acid
 - pentaborane (II)
 - potassium trichloro(ethylene)platinate (II)
- Which of the following is more basic in water? (6%)
 - NH_2NH_2 or NH_2OH
 - NH_3 or NF_3
 - $(\text{CH}_3)_2\text{NH}$ or CH_3NH_2
- Explain why the bond angle of NF_3 (102.1°) is smaller than that of NH_3 (107.3°). (4%)
- Discuss the solubilities of KCl and AgNO_3 in $\text{NH}_3(\ell)$. (4%)
- What kind of electronic configuration of the d^n system will undergo a strong Jahn-Teller distortion in a weak octahedral field? Why? (6%)
- Suggest an explanation for the fact that $\text{Mn}(\text{CO})_4\text{NO}$ is diamagnetic. (25Mn) (4%)
- Determine the point group of the following: (8%)
 - P_4
 - B_2H_6
 - NiCl_4^{2-}
 - $\text{Ni}(\text{CN})_4^{2-}$
- Sketch the ESCA nitrogen 1s spectrum for each of the following: (8%)
 - trans- $[\text{Co}(\text{en})_2(\text{NO}_2)_2]\text{NO}_3$ (en = $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$)
 - NaN_3 . Explain your answer.
- What magnetic properties would you expect for the following species? Explain your answer. (8%)
 - B_2
 - $\text{Re}_2\text{Cl}_8^{2-}$ (eclipsed)
- How many d-d bands would you expect for a d^1 ion in an environment with (a) tetrahedral symmetry, T_d ; (b) trigonal symmetry, C_{3v} , derived from T_d by elongation along one C_3 axis? Explain your answer. (6%)
- The trimeric phosphonitridic chloride, $\text{P}_3\text{N}_3\text{Cl}_6$, consists of a planar six-membered ring. Describe, in detail, the bonding in the $\text{P}_3\text{N}_3\text{Cl}_6$ molecule. (5%)
- The N-N bond energy in F_2NNF_2 is only about 80 kJ/mol compared to 160 kJ/mol in H_2NNH_2 . Suggest a reason. (4%)

13. The conversion of diamond into graphite is a thermodynamically favorable (spontaneous) process, and yet one doesn't expect a diamond to change into graphite. Why? (4%)
14. Explain why the octahedral $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ion is pale red whereas the tetrahedral CoCl_4^{2-} ion is intense blue. (4%)
15. $[\text{W}(\text{CO})_5\text{Cl}]^-$ has the lower energy CO stretching frequency than $[\text{Re}(\text{CO})_5\text{Cl}]$ in the IR spectrum. Why? (4%)
16. For each of the following metal and ligand combinations, formulate the simplest neutral compound that follows the 18 e- rule. Draw a reasonable structure for each compound. (5%)
 (a) Ni, CO (b) Fe, Cp ($\pi\text{-C}_5\text{H}_5$), CO (c) Re, CO, H
 (d) Co, Cp, NO (e) V, CO, H.
17. For the following polynuclear complexes, indicate the total number of electrons, determine the number of M-M bonds present (assuming that all metals are coordinately saturated), and predict a structure, where Cp = $\pi\text{-C}_5\text{H}_5$. (6%)
 (a) $(\text{Cp})_2\text{Mo}_2(\text{CO})_4$ (b) $[\mu\text{-Br}-\mu\text{-CH}_2-(\text{Os}(\text{CO})_{10})]^-$
 (c) $[\mu\text{-PPH}_2]_2-[(\text{PPH}_2)(\text{CO})_3\text{FeIr}(\text{CO})_2(\text{PPH}_2)]$
18. Give hydrocarbon fragments, $[\text{CH}_m]^{n-}$ ($m=0, 1, 2, 3; n=0, 1, 2, 3, 4$), which are isolobal analog for each of the following metal fragments. (6%)
 (a) $[\text{PtCl}_3]^-$
 (b) $[(\pi\text{-C}_5\text{H}_5)\text{Ru}]^-$
 (c) $[\text{Fe}(\text{CO})_4]^+$
 (d) $[\text{Ni}(\text{CO})_2]$
 (e) $[\text{Re}(\text{CO})_5]$
 (f) $[\text{V}(\text{CO})_3\text{Br}_2]$