

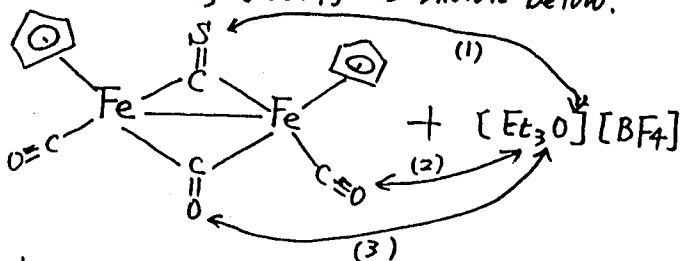


1. (a) Write out the electron configuration of manganese atom (25Mn) (2%)
 (b) Using Slater's rules, calculate the effective nuclear charge of a 3d electron in Mn. (3%)
2. The order of acidity of boron halides is $\text{BF}_3 < \text{BCl}_3 < \text{BBr}_3$. Suggest possible explanations. (4%)
3. Draw qualitatively the nitrogen 1s photoelectron spectrum of $[\text{Co}(\text{en})_2(\text{NO}_2)_2]\text{NO}_3$ ($\text{en} = \text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$) and give explanation. (5%)
4. Using "bent bond" to describe the triple bond in the acetylene molecule. (3%)
5. Name the following compounds in English: (a) Cs^+Au^- (b) B_4H_{10} (4%)
6. Which one in each of the following pairs has the higher IR absorption frequency for C-O bond: (a)  or  (b) $[\text{Mn}(\text{CO})_6]^+$ or $[\text{V}(\text{CO})_6]^-$? and give brief explanation. (6%)
7. Given the normalized wave functions of the three sp^2 hybrid orbitals
 $\psi_1 = \frac{1}{\sqrt{3}}\psi_s + \frac{\sqrt{2}}{\sqrt{3}}\psi_{px} + a\psi_{py}$, $\psi_2 = \frac{1}{\sqrt{3}}\psi_s - b\psi_{px} + c\psi_{py}$, $\psi_3 = \frac{1}{\sqrt{3}}\psi_s - b\psi_{px} - c\psi_{py}$
 Calculate a, b, and c. ($a > 0$, $b > 0$, $c > 0$) (3%)
8. Balance the following redox reactions:
 (a) $\text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{C}_2\text{O}_4 \rightarrow \text{CO}_2 + \text{Cr}^{3+}$ (acidic solution) (6%)
 (b) $\text{MnO}_4^- + \text{NO}_2^- \rightarrow \text{MnO}_2(\text{s}) + \text{NO}_3^-$ (basic solution)
9. Give brief explanations for the following observations.
 (a) $\text{Fe}(\text{NO}_2)_6^{4-}$ is an inert complex while FeF_6^{4-} is labile.
 (b) The $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ion is pink while the CoCl_4^{2-} ion is blue.
 (c) SiCl_4 is more easily hydrolyzed than CCl_4 . (12%)
 (d) Trisilylamine is planar and is a very weak base.
10. The absorption band in the visible spectrum of $\text{Ti}(\text{H}_2\text{O})_6^{3+}$ is of low intensity. It is somewhat broad and unsymmetrical. Explain these observations. (6%)
11. Explain how to differentiate experimentally between members of each pair of the following compounds. Describe two or more methods in addition to the X-ray diffraction.
 (a) $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ (b) cis- and trans- $[\text{Cr}(\text{en})_2\text{Cl}_2]^+$
 (c) $[\text{Co}(\text{NH}_3)_5\text{NO}_2]^{2+}$ and $[\text{Co}(\text{NH}_3)_5\text{ONO}]^{2+}$ (9%)
12. Complete the following equations: (6%)
 (a) $\text{Ag}^+ + \text{N}_3^- \xrightarrow{\text{H}_2\text{O}}$ (b) $\text{Pcl}_5 + \text{H}_2\text{O} \rightarrow$ (c) $\text{B}_3\text{N}_3\text{H}_6 + 3\text{HCl} \rightarrow$
13. Assign term symbols for $2p^1 3p^1$ electron configuration. (6%)
14. Explain why HBr and HI are prepared from protonation of NaBr and NaI, respectively, with H_3PO_4 but not with H_2SO_4 . (3%)
15. Explain why N,N'-dimethylformamide, HCONMe_2 , in $(\text{HCONMe}_2)\text{Mo}(\text{CO})_5$ is an O-donor rather than a N-donor? (3%)

(續第二頁)

16. Explain why $(\eta^6\text{-C}_6\text{H}_6)_2\text{Cr}$ can not be prepared from $\text{Cr}(\text{CO})_6$ and excess benzene at high temperature. (3%)
17. Explain why there are many carbonylate anions, $\text{M}(\text{CO})_x^{y-}$, $y=1, 2, 3$; $x=4, 5, 6$, whereas there is so far no isocyanide anion, $\text{M}(\text{CNR})_x^{y-}$, been found. (4%)
18. There are three possible reaction routes between $\text{cis}-(\eta^5\text{-C}_5\text{H}_5)_2\text{Fe}_2(\text{CO})_2(\mu_2\text{-CO})(\mu_2\text{-CS})$ and $[\text{Et}_3\text{O}][\text{BF}_4]$ as shown below.



Which route is the most possible? Explain your choice and write the predicted product. (6%)

19. It was found that the reaction between $\text{BrMn}(\text{CO})_5$ and CH_3Li gives $\text{cis-BrMn}(\text{CO})_4(\text{C}(\text{O}Li)(\text{CH}_3))$, $\begin{matrix} \text{CO} \\ \diagup \\ \text{Mn} \\ \diagdown \\ \text{CO} \end{matrix} \begin{matrix} \text{Br} \\ \diagup \\ \text{C} \\ \diagdown \\ \text{O}Li \\ \text{CH}_3 \end{matrix}$.

- (a) Explain why the reaction can not give a substitution product $\text{CH}_3\text{Mn}(\text{CO})_5$.
- (b) Explain why $\text{trans-BrMn}(\text{CO})_4(\text{C}(\text{O}Li)(\text{CH}_3))$ is not obtained. (6%)