國立中央大學八十八學年度碩士班研究生入學試題卷

所別: 化學研究所 不分組 科目: 無機化學 共 1 頁 第 1 頁

1. Draw Lewis diagrams, geometry and symmetry element for the following molecules and ions. (12 points)

   (a) $S_2O_4^{2-}$ (b) $Te_2O_2F_8$ (c) SeO_2F_2

2. Predict the order of IR-active CO stretching frequencies for the following compounds: (8 points)

   $Ni(CO)_4$, $Co(CO)_4^-$, $Fe(CO)_4^{2-}$, $Mn(CO)_4^{3-}$

3. Identify the lowest-energy spin-allowed transitions for high-spin $[Co(Hi)_6]^{2+}$ and low-spin $Co(Lo)_6^{2+}$. (10 points)

4. Explain why the ligand field (d-d) bands are shifted only slightly for $[CoX(NH_3)_6]^{2+}$ ions ($X= F^-$, Cl^-, Br^- and I^-), but charge-transfer bands are shifted greatly fir this series. (10 points)

5. Propose a mechanism for the olefin hydrogenation using Wilkinson's catalyst, $Rh(PPh_3)_3Cl$. (10 points)

6. The problem of chemical conversion (nitrogen "fixation") of N_2 to NH_3 is a significant one that illustrates the importance of thermodynamic concepts. Consider the relative ease of the steps

$$N_2 \xrightarrow{H_2} N_2H_2 \xrightarrow{H_2} N_2H_4 \xrightarrow{H_2} 2NH_3$$

   Which step is most costly (in terms of energy), and which of the species N_2, N_2H_2, or N_2H_4 therefore requires the greatest chemical activation (either by extreme temperature conditions or by catalytic combination) so as to weaken the NN link? The first three species exhibit a lone pair on each nitrogen. How does the lp/lp repulsion increase for $N_2 \rightarrow N_2H_2$ compare with that of $N_2H_2 \rightarrow N_2H_4$? (10 points)

7. Propose a rationale for the good solubility of BF_3 in benzene. Can you identify a HOMO and LUMO for the interaction? (10 points)

8. Name all types of chemical bonding in inorganic compounds and metals, briefly describes their characteristic properties and the similarity and difference between each other. (10 points)

9. Cadium sulfide, which has been tested as a photoconductor for xerography, is a semiconducting material with a band gap of 2.42 eV. (1eV equal to 96.5 kJ/mol.) What is the minimum wavelength of light needed to promote electrons from the valence band to the conduction band in CdS? What color of light is this? (10 points)

10. Give steps for syntheses of the following compounds from the elements. (10 points)

    (a) B_2F_4 (b) PF_3Cl_2 (c) POF_3 (d) SOF_2 (e) $SiFCl_3$