國立臺灣大學95學年度碩士班招生考試試題

1. Use the Born-Haber cycle and following data to calculate the enthalpy of formation of KBr. The first ionization energy of $K_{(g)}$ is 418.8 kJ mol^{-1}. The bond dissociation energy of $Br_{2\,(g)}$ giving 2 Br is 380.4 kJ mol^{-1}. The sublimation energy of $K_{(s)}$ is 81.3 kJ mol^{-1}. The evaporization energy of $Br_{2(l)}$ is 29.8 kJ mol^{-1}. The electron affinity energy of $Br_{(g)}$ is −324.7 kJ mol^{-1}. The lattice energy of KBr is −661.8 kJ mol^{-1}. 10%

2. Give Lewis dot structures and sketch the shapes of the following ion or compounds: (a) ClO_2^- (b) POF_3 (c) P_4O_6 (d) SOF_4 10%

3. Sketch all isomers of the following metal complexes. Indicate clearly each pair of enentiomers if any. ('en' is ethylenediamine and 'dien' is diethylenetriamine $NH_2C_2H_4NHC_2H_4NH_2$, a tridentate ligand.) (a) $[Pt(en)_2Cl_2]^{2+}$ (b) $[Co(NH_3)_2(H_2O)_2BrCl]^+$ (c) $[Re(dien)Br_2Cl]$ 10%

4. The Rydberg constant R_H for hydrogen is 1.097×10^7 m^{-1} and the Planck constant h = 6.636×10^{-34} J s. Determine the energies and wavelengths of two visible bands (for the transition from n = 3 and 4 to n = 2) in the atomic spectrum of hydrogen. 10%

5. Calculate the exact proton ion concentration $[H^+]$ for a solution prepared by adding 1.0×10^{-7} mole of HNO_3 into 1.00 L of water. (You must show your calculation). 10%

6. On the basis of 18-electron (EAN) rule, determine the expected charge x, y and z on the following organometallic compounds: (a) $[Co(CO)_3]^x$ (b) $[(CO)_3Ni\text{-}Co(CO)_3]^y$ (c) $[(\eta^5\text{-}C_5H_5)Fe(CO)_2]^z$ 10%

7. What is the hybridization for the central carbon atom of CO_2, sketch the two simple bonding π-molecular orbital of CO_2. 10%

8. The five *d* orbitals are separated into two groups of e_g and t_{2g} by the presence of an octahedral field created by six ligands. (a) Draw an energy diagram indicating which d orbitals are of e_g and t_{2g} (b) Sketch the diagram for strong and weak field for complex ML_6 with the metal in d^4 configuration. (c) Draw the energy diagram for the five d orbitals in a square plane d^8 complex ML_4. 14%

9. Give the point group of the following compounds: (a) CH_2Cl_2 (b) $[trans\text{-}Cr(H_2O)_2(NH_3)_4]^{3+}$ (c) PF_5 6%

10. Explain why diatomic oxygen molecule O_2 is a paramagnetic molecule using molecular orbital theory and compare the relative magnitude of bond dissociation energies for O_2^-, O_2 and O_2^+. 10%