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※請在答案卷內作答

1. (a) Describe the crystal structure of wurtzite ZnS. Also give coordination numbers of cations and anions. (4%) (b) What is the driving force for the formation of ionic solids? (2%) (c) How do you confirm the composition of ionic or metal crystals? Give 2 methods. (4%) (d) As quantum dots of CdS decrease in size, how would their absorption and emission peaks shift? What is the cause of this effect? (4%)

2. (a) Draw band structure of a p-type semiconductor. (4%) (b) Would a semiconductor's electrical conductivity increase or decrease with rising temperature? (2%) (c) In a redox reaction to form Au particles from $HAuCl_4$, how would you tune the cell potential to form various Au particles? Give one way. (3%) (d) Write the equation relating equilibrium constant K to ΔG^o, and the equation relating ΔG^o to standard cell potential. (4%) (e) Solutions of Au and Ag nanoparticles have purplish red and yellow colors, respectively. What is the origin of the color? (2%) How would the absorption band shift if Au or Ag particles become rod-shaped? (2%)

3. (a) Complete the reaction: $[Co(NH_3)_5X]^{2+} + [OH]^- \rightarrow$ If this equation is an elementary step, give its rate law. (4%) (b) An electron transfer occurring via a covalently bound bridging ligand is outer-sphere or inner-sphere mechanism? (2%) (c) What technique is used to determine organometallic complex structure? (2%)

4. (a) Discuss how a photocatalyst works. (4%) (b) How does a light-emitting diode (LED) work? (3%) (c) Give a metal or metal oxide nanoparticle-catalyzed reaction. (4%)

5. (a) Draw the Lewis structure for carbon monoxide. (2%) (b) In carbon monoxide, what are the formal charges of C and O? What are the oxidation states of C and O? Are the formal charges and oxidation states consistent? Why? (6%) (c) Construct the energy level diagram for the molecular orbitals of carbon monoxide. (6%) (d) Why the carbon monoxide usually coordinates to the transition metal through the carbon end? (2%)

6. Name the following complexes in English. (6%)
   (a) $[Co(H_2O)_6]Br_3$
   (b) $K_2[PtCl_4]$
   (c) $[Fe(NH_2CH_2CH_2NH_2)_2(NO_2)_2]I$

7. Draw the Lewis structure of all isomers for following compounds and indicate their point group: (10%)
   (a) $[Ir(NH_3)_3Cl_3]$
   (b) Tetraamminechloronitritocobalt(III) ion
   (c) μ-amido-μ-hydroxobis[tetraamminecobalt(III)] ion

注意：背面有試題

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8. The Nobel Prize in Chemistry was awarded to Karl Ziegler and Giulio Natta in 1963 and to Richard F. Heck, Ei-ichi Negishi and Akira Suzuki in 2010. The representative catalyst or reaction are Ziegler-Natta catalyst and Suzuki-Miyaura Cross-Coupling Reaction, respectively. Please (a) briefly describe the significance of these two discoveries. (4%) (b) write down the catalyst and other reagents as well as the chemical equations of these two reactions. (6%)

9. The complex $[Ni(CN)_4]^{2-}$ is diamagnetic but $[NiCl_4]^{2-}$ is paramagnetic with two unpaired electrons. $[Fe(CN)_6]^{3-}$ has only one unpaired electron but $[Fe(H_2O)_6]^{3+}$ has five unpaired electrons. Explain these experimental observation using simple crystal field theory. (8%)

注意：背面有試題