Problem Set – Inorganic/Organometallic Chemistry

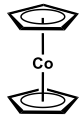
1. Draw an energy scheme and explain the crystal field splitting of the d-electrons in an octahedral complex. (4 p)

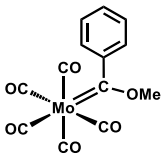
2. Draw an energy scheme and explain the crystal field splitting of the d-electrons in a square planar complex. (4 p)

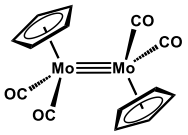
3. Draw an energy scheme and explain the crystal field splitting of the d-electrons in a tetrahedral complex. (4 p)

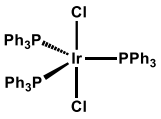
4. Explain the term *ligand field stabilisation energy*. What is a low-spin and what high-spin is a high-spin complex? (4 p)

5. Give the formal oxidation states, d^n configurations and valence electron counts for the following complexes: (8 p)

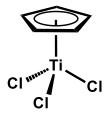


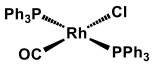


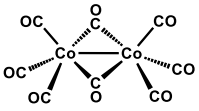


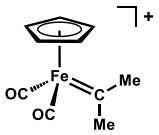


6. Give the formal oxidation states, d^n configurations and valence electron counts for the following complexes: (8 p)

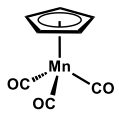


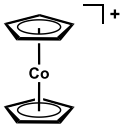


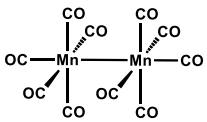


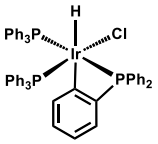


7. Give the formal oxidation states, d^n configurations and valence electron counts for the following complexes: (8 p)









8. Describe the bonding situation between a carbon monoxide (CO) ligand and a transition metal centre. Draw the relevant frontier orbitals and explain the terms *σ-donation* and *π-backdonation*. (8 p)

9. Describe the bonding situation between an ethylene ($H_2C=CH_2$) ligand and a transition metal centre. Draw the relevant frontier orbitals and explain the terms *σ-donation* and *π-backdonation*. (8 p)

10. Describe the bonding situation between a dihydrogen (H_2) ligand and a transition metal centre. Draw the relevant frontier orbitals and explain the terms *σ-donation* and *π-backdonation*. (8 p)

11. Give an example for a <u>pure</u> σ-donor ligand. Briefly explain your answer. (4 p)

12. Give an example for a σ-donor/π-donor ligand. Briefly explain your answer. (4 p)

13. Give two examples for ligands that are isoelectronic to CO. Briefly explain your answer. (4 p)

14. Explain the difference between trans-influence and trans-effect. (4 p)

15. What are polydentate ligands? Explain the chelate effect. (4 p)

16. ligand substitutions: explain the difference between an associative and dissociative mechanism. Give one example for each case. (8 p)

17. Give one example for an α-hydride elimination. What is the requirement for this reaction and what is the product? (8 p)

18. Give one example for a β-hydride elimination. What is the requirement for this reaction and what is the product? (8 p)

19. Give one example for the insertion of an alkene into a metal hydride bond. What is the requirement for this reaction and what is the product? (8 p)

20. What is a hydroformylation reaction and which elementary steps are involved? (8 p)

21. What kind of metal centres favour a reductive elimination? Justify your answer. (4 p)

22. What kind of metal centres favour an oxidative addition? Justify your answer. (4 p)

23. Give two examples for the formation of a transition metal hydride complex. (4 p)

24. Give two examples for the formation of a transition metal alkyl complex. (4 p)

25. Give two examples for the nucleophilic addition of an external reagent to a transition metal coordinated ligand. (4 p)