

Tutorial Sheet 1
Professor Sylvia Draper
SF- Transition Metal Coordination Chemistry

Questions on lectures 1, 2 and 3: Oxidation states, d-electrons, ligands, stability constants

HINT: Calculating oxidation states: e.g. $\text{K}_2[\text{Co}(\text{NH}_3)_2\text{Cl}_4]$

Counterions = 2K^+ $\therefore$ complex ion = $[\text{Co}(\text{NH}_3)_2\text{Cl}_4]^{2-}$

charge on complex ion = oxidation state of metal ion + charge of all ligands

$$-2 = \quad ? \quad + \quad [(2 \times 0) + (4 \times -1)]$$

$$-2 - [0 - 4] = \quad ?$$

$$? = +2 \text{ ie. Cobalt is in the } +2 \text{ oxidation state} = \text{Co}^{2+} \text{ or Co(II)}$$

The element Co has 9 d-electrons $\therefore$ the a Co(II) ion is d^7 .

1) For each of the following complexes specify

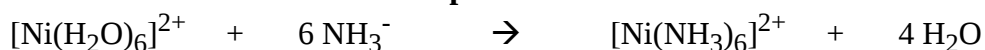
- i) the complex ion
- ii) the ligand(s) (draw them if they are complicated and mark the donor atoms)
- iii) the counterion
- iv) the coordination number (number of ligands attached to the metal centre)
- v) the oxidation state of the transition metal centre
- vi) the number of d electrons each transition metal centre has

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|--|---|
| a) $[\text{Cu}(\text{NH}_3)_6](\text{SO}_4)$ | b) $\text{K}_3[\text{Fe}(\text{ox})_3]$ |
| c) $[\text{Co}(\text{NO}_2)(\text{NH}_3)_5]\text{Cl}_2$ | d) $\text{Na}[\text{Fe}(\text{EDTA})]$ |
| e) $[\text{NH}_4][\text{Cr}(\text{NCS})_4(\text{NH}_3)_2]$ | f) $[\text{VO}(\text{acac})_2]$ |

2. Give the chemical formulae of the following complexes

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|--------------------------------------|--|
| g) Tetraamminezinc sulfate | h) Ammonium hexacyanoferrate(II) |
| i) Hexaaquochromium(III) perchlorate | j) Pentaamminechlorochromium(III) chloride |
| k) Potassium trisoxalatoferrate(III) | |

3. There are three mistakes in this expression.



Write out this equilibrium equation again, correcting the mistakes. Based on your corrected equilibrium reaction, write an expression for the equilibrium constant of the first step of the reaction and for the overall stability constant β .

2. If $\log \beta$ of $[\text{Fe}(\text{en})_3]^{2+}$ is 9.5 and $\log \beta$ of $[\text{Fe}(\text{EDTA})]^{2-}$ is 14.3, which of the two complexes is the more stable? Explain qualitatively why this is the case.

3. What is a macrocycle? What is the macrocyclic effect and how does it differ from the chelate effect?

Lecture 4: Geometry and isomerism

1. Draw each of the following coordination complexes. State whether the complex ion has isomers and, for those which do, draw the isomers and indicate which isomer is which (cis/trans, mer/fac etc).

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|--|--|
| a) $[\text{Co}(\text{H}_2\text{O})_6](\text{ClO}_4)_2$ | b) $[\text{Co}(\text{en})_2(\text{ox})]\text{Cl}$ |
| c) $[\text{Ni}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}_2$ | d) $[\text{Co}(\text{NO}_2)(\text{NH}_3)_5]\text{Cl}_2$ |
| e) $[\text{PdI}_2(\text{PPh}_3)_2]$ (sq planar) | f) $[\text{NiCl}_2(\text{PPh}_3)_2]$ (tetrahedral) |
| g) $[\text{Ru}(\text{bpy})_3](\text{NO}_3)_2$ | h) $[\text{NH}_4]_2[\text{Cu}(\text{CN})_3]$ |
| i) $\text{K}_2[\text{CoCl}_4]$ (tet) | j) $[\text{Co}(\text{NH}_3)_4(\text{NCS})_2]\text{Cl}_2$ |
| k) $[\text{NH}_4][\text{Cr}(\text{ox})_2(\text{H}_2\text{O})_2]$ | l) $[\text{RhCl}_3(\text{PMe}_3)_3]$ |
| m) $[\text{Ru}(\text{tpy})\text{Cl}_3]$ | n) $[\text{Co}(\text{NH}_3)_5\text{Br}](\text{SO}_4)$ |
| o) $[\text{Pd}(\text{SCN})_2(\text{dppe})]$ | p) $\text{Na}[\text{Co}(\text{EDTA})]$ |