CHEM 2 **Key begins on page 3.**
Problem Set Ch.22

1. What is the ***coordination number*** and the ***oxidation state*** of the central metal ion in each of the following complexes?

a) $[Ni(NH_3)_6]^{+2}$ ______ ______ d) $[AlF_6]^{-3}$ ______ ______

b) $[Cu(CN)_4]^{-2}$ ______ ______ e) $[Cr(NH_3)_3Br_3]$ ______ ______

c) $[Fe(C_2O_4)_3]^{-3}$ ______ ______ f) $[Ag(S_2O_3)_2]^{-3}$ ______ ______

2. Give the IUPAC names of:

a) $[Co(NH_3)_5Cl]Cl_2$ ______________________________

b) $K_2[Co(H_2O)(CN)_5]$ ______________________________

c) $Fe(H_2O)_5(OH)^{+2}$ ______________________________

3. Name the type of structural isomerism displayed by each of the following pairs. If no isomerism is possible, so indicate.

a) $[Fe(CN)_5SCN]^{-4}$ ______________________ c) $[Ni(NH_3)_5Cl]^{+1}$ ______________________

4. Write appropriate formulas for the following species.

a) diamminetetrachloronickelate(II) ion ____________________________

b) sodium diaquatetrahydroxoaluminate(III) ____________________________

5. What type of geometric structure would you predict for $[Au(CN)_2]^{-1}$? Explain.

6. Define the terms ***geometric isomerism*** and ***optical isomerism*** and give an example of each

7. Cyano complexes of transition metal ions (e.g., Fe^{+2} and Cu^{+2}) are often yellow in color, whereas, aqua complexes are often green or blue. Why is there this difference?

8. The hexaaquascandium(III) ion, $Sc(H_2O)_6^{+3}$, is colorless. Explain why this might be expected.

9. Describe how the crystal field theory makes possible an explanation of the fact that so many transition metal compounds are colored.

10. Describe the distribution of "d" electrons in $Ni(H_2O)_6^{+2}$, using crystal field theory. How many unpaired electrons are there in this ion?

11. The $Fe(H_2O)_6^{+3}$ ion has a pale purple color, and the $Fe(CN)_6^{-3}$ ion has a ruby red-color. What are the approximate wavelengths of the maximum absorbtion for each ion. Is the shift of wavelength in the expected direction? Explain.

CHEM 2

Problem Set Ch. 22

1. What is the ***coordination number*** and the ***oxidation state*** of the central metal ion in each of the following complexes?

	C#	OX		C#	OX
a) $[Ni(NH_3)_6]^{+2}$	6	+2	d) $[AlF_6]^{-3}$	6	+3
b) $[Cu(CN)_4]^{-2}$	4	+2	e) $[Cr(NH_3)_3Br_3]$	6	+3
c) $[Fe(C_2O_4)_3]^{-3}$	6	+3	f) $[Ag(S_2O_3)_2]^{-3}$	2	+1

2. Give the IUPAC names of:

a) $[Co(NH_3)_5Cl]Cl_2$ PENTAAMMINECHLOROCOBALT (III) CHLORIDE

b) $K_2[Co(H_2O)(CN)_5]$ POTASSIUM AQUAPENTACYANOCOBALTATE (III)

c) $Fe(H_2O)_5(OH)^{+2}$ PENTAAQUAHYDROXOIRON(III) ION

3. Name the type of structural isomerism displayed by each of the following pairs. If no isomerism is possible, so indicate.

a) $[Fe(CN)_5SCN]^{-4}$ LINKAGE ISOMERISM c) $[Ni(NH_3)_5Cl]^{+1}$ NONE

SCN IS "AMBIDENTATE" AND CAN BIND EITHER THROUGH THE SULFUR OR THE NITROGEN.

4. Write appropriate formulas for the following species.

a) diamminetetrachloronickelate(II) ion $Ni(NH_3)_2Cl_4^{-2}$

b) sodium diaquatetrahydroxoaluminate(III) $Na[Al(H_2O)_2(OH)_4]$

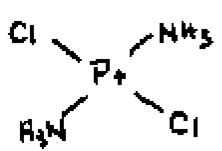
5. What type of geometric structure would you predict for $[Au(CN)_2]^{-1}$? Explain.

COMPLEXES WITH A COORDINATION NUMBER OF 2 USE SP HYBRIDIZATION, WHICH ACCORDING TO VSEPR THEORY ARE LINEAR IN ORDER TO MINIMIZE REPULSION.

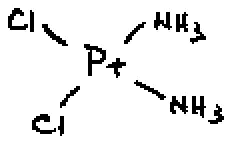
6. Define the terms ***geometric isomerism*** and ***optical isomerism*** and give an example of each

GEOMETRIC ISOMERS ARE ISOMERS IN WHICH THE ATOMS ARE JOINED TO ONE ANOTHER IN THE SAME WAY BUT OCCUPY DIFFERENT RELATIVE POSITIONS IN SPACE.

$Pt(NH_3)_2Cl_2$



TRANS



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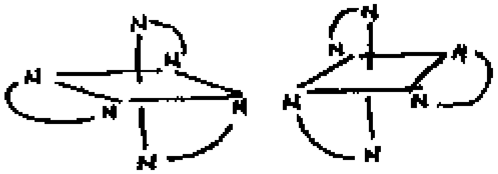
OPTICAL ISOMERS ARE ISOMERS THAT ARE NON SUPERIMPOSABLE MIRROR IMAGES. eg. $Co(en)_3^{+3}$



7. Cyano complexes of transition metal ions (e.g., Fe^{+2} and Cu^{+2}) are often yellow in color, whereas, aqua complexes are often green or blue. Why is there this difference?

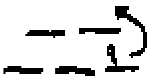
CN^- IS A STRONGER BONDING LIGAND THAN H_2O CAUSING A LARGER SPLIT IN THE d ORBITALS. ABSORBTION THEREFORE REQUIRES SHORTER WAVELENGTHS (~430 nm) THEREBY TRANSMITTING LONGER WAVELENGTHS (yellow). H_2O, ON THE OTHER HAND PRODUCES LESS SPLIT REQUIRING LESS ENERGY (LONGER λ) FOR ABSORBTION (~680 nm) AND TRANSMITS SHORTER WAVELENGTHS (BLUE)

8. The hexaaquascandium(III) ion, $Sc(H_2O)_6^{+3}$, is colorless. Explain why this might be expected.

Sc^{+1} HAS NO "d" ELECTRONS AND THEREFORE HAS NO TRANSITIONS THAT OCCUR IN THE VISIBLE REGION OF THE SPECTRUM.

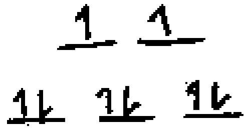
9. Describe how the crystal field theory makes possible an explanation of the fact that so many transition metal compounds are colored.

COLORED COMPOUNDS RESULT WHEN SOME VISIBLE WAVELENGTHS ARE ABSORBED, TRANSMITTING THE REMAINING ONES.
TRANSITION METAL COMPOUNDS HAVE COLORS RESULTING FROM e^- JUMPS, OR TRANSITIONS BETWEEN TWO CLOSELY SPACED d ORBITAL ENERGY levels THAT COME FROM CRYSTAL FIELD SPLITTING



10. Describe the distribution of "d" electrons in $Ni(H_2O)_6^{+2}$, using crystal field theory. How many unpaired electrons are there in this ion?

Ni^{+2} HAS A d^8 CONFIGURATION. THEREFORE, ITS HIGH AND LOW SPIN DISTRIBUTIONS WOULD BE IDENTICAL.



RESULTING IN 2 UNPAIRED e^-

11. The $Fe(H_2O)_6^{+3}$ ion has a pale purple color, and the $Fe(CN)_6^{-3}$ ion has a ruby red-color. What are the approximate wavelengths of the maximum absorbtion for each ion. Is the shift of wavelength in the expected direction? Explain.

(FROM TABLE 23.8)

$Fe(H_2O)_6^{+3}$ 530 nm

$Fe(CN)_6^{+3}$ 500 nm

THIS IS A LIKELY SHIFT SINCE CN^- IS A STRONGER LIGAND THEREFORE Δ WOULD BE LARGER, AND SINCE

$$\lambda = \frac{hc}{\Delta}$$

THIS WOULD CAUSE λ TO DECREASE