

**Chemistry 362 Mini-EXAM IV**  
Chapter 6

**Tuesday October 29, 2019**

**Professor Kim R. Dunbar**

**NAME:** \_\_\_\_\_

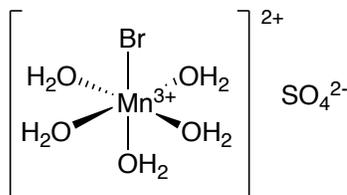
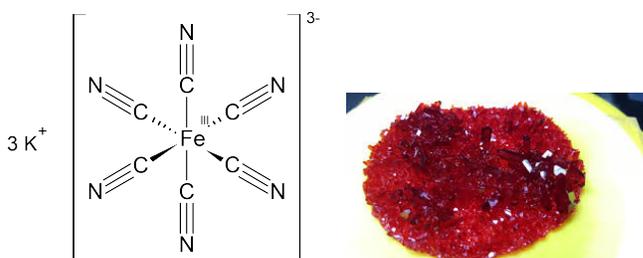
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**Total Points on Exam is 50 points**

1. **Draw the structures** of the following metal complexes (which are written in their IUPAC names) along with the counterions and make sure you indicate the number of the counterions when you write them outside the structures of the metal complexes. (6 pts)



The compound is the octahedral anion with six cyanides. There are three potassium ions outside the anion. Note: you don't have to draw the ligand with the triple bond



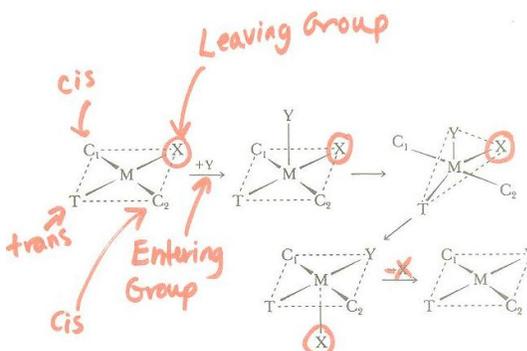
2. Indicate whether each of the following statements is **true** or **false**. **Justify your answer** with a brief explanation of why or why not the statement is true or false. (15 pts)

(a) Square planar substitution reactions typically occur by a Dissociative Mechanism.

**False** – square planar complexes have room for another ligand to enter the coordination sphere and usually occur by an Associative Mechanism

(b) The Associative Mechanism for substituting ligand X for ligand Y in square planar compounds goes through square pyramidal and trigonal bipyramidal intermediates that serve to exchange positions of X and Y

True – You didn't have to draw the mechanism below



(c) The H<sub>2</sub>O ligand is a stronger trans directing ligand than CN<sup>-</sup>

False – water is a sigma-donor and is at the lowest end of the trans-directing ligand series. Cyanide is a sigma-donor also but is a strong pi-acceptor as well and lies at the highest end of the trans-directing ligand series

(d) Octahedral complexes are typically fluxional

False – octahedral complexes are Not typically fluxional because they have to lose a ligand to rearrange unlike trigonal bipyramidal complexes which can rearrange through a distortion to square pyramidal

(e) Berry pseudo-rotation is a ligand rearrangement that proceeds through a tetrahedral intermediate.

False – the Berry pseudo-rotation involves a distortion through a square pyramidal intermediate

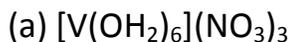
3. Indicate whether the complexes below exist as geometrical isomers or not. Circle your answer (8 pts)

(a) [Cr(H<sub>2</sub>O)<sub>4</sub>Cl<sub>2</sub>]<sup>+</sup> **YES** OR NO **cis and trans**

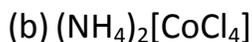
(b) [Pt(NH<sub>3</sub>)<sub>3</sub>Cl] **YES** OR **NO**

(c) (iii) [Co(NH<sub>3</sub>)<sub>3</sub>(H<sub>2</sub>O)<sub>3</sub>]<sup>3+</sup> **YES** OR NO **mer and fac**

4. Specify the oxidation states of the metal ions in the following complexes: (8 pts). *Show your work!*



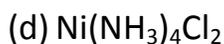
The  $\text{H}_2\text{O}$  ligands are neutral and there are three  $\text{NO}_3^-$  anions which tells us that the  $[\text{V}(\text{OH}_2)_6]^{3+}$  part is 3+ to balance the three counter anions. Therefore the V ion is +3 or III.



The  $\text{Cl}^-$  ligands are anions and there are two  $\text{NH}_4^+$  cations which tells us that the  $[\text{CoCl}_4]^{2-}$  part is 2- to balance the two counter cations. Therefore the Co ion is +2 or II.



The  $\text{CN}^-$  ligands are anions and there are four  $\text{K}^+$  cations which tells us that the  $[\text{Mn}(\text{CN})_6]^{4-}$  part is 4- to balance the four counter cations. Therefore the Mn ion is +2 or II.



The  $\text{NH}_3$  ligands are neutral and the  $\text{Cl}^-$  ligands are anions. The overall charge on the compound is zero. Therefore the Ni ion is +2 or II.

5. What kind of isomerism exists between  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$  (violet) and  $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$  (greyish-green)? Circle your answer (2 pts)

a. linkage isomerism

**b. solvate or ionization isomerism**

c. coordination isomerism

6. Describe inner-sphere electron transfer and what affects the rates of this type of redox reaction? (5 pts)

An inner-sphere reaction goes through a ligand – bridged intermediate. The nature of the X bridge and its ability to “conduct” the electron from one metal to another affects the rates. Better overlap with metals means higher rates of  $e^-$  transfer.

7. Define the following as described in class and in the notes. (6 pts)

(a) Coordination Complex

Coordination Complex - The defining characteristic of a coordination compound or "complex" is that a metal ion is surrounded by atoms or molecules (either neutral or ionic) in a particular geometry. Furthermore, these ions and molecules are capable of existing independently of each other.

(b) Ligand (and include the three main classifications of ligands in your answer).

A ligand is any molecule or ion that has at least one electron pair that can be donated to a metal atom or ion.

Classifications

1. The type of bonding they engage in  
 $\pi$ -donation,  $\sigma$ -donation,  $\pi$ -accepting
2. The number of electrons that they donate
3. The "denticity" of a ligand which refers to how many total donor sites for binding