

2. (9 points) Give short answers to each of the following. Answer with words.

A. State the Second Law of Thermodynamics:

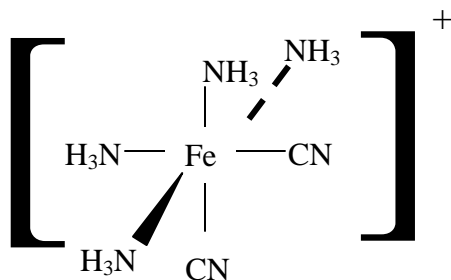
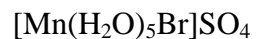
B. Define the concept of entropy, and give a set of units that can be used to express it:

C. Explain why the standard enthalpy of formation of an element is zero, but its standard entropy is nonzero:

3. (8 points) Name each of the following complexes. Make certain your answer identifies the correct structural and geometric isomer (do not worry about optical isomerism for this question):

A.

B.



4. (8 points) Draw each of the following compounds. If the compound possesses optical isomers, draw each of them. Polydentate ligands may be abbreviated (*i.e.* their structure need not be drawn in detail).

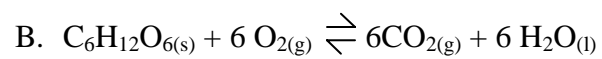
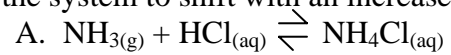
A. *trans*-diamminedichloroplatinum(II)

B. sodium tetrabromo(ethylenediamine)cobaltate(III)

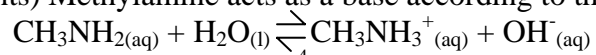
5. (8 points) A solution containing the complex ion $[\text{Cr}(\text{CN})_6]^{3-}$ absorbs violet light, but transmits all other colors.
- A. What color does the solution appear to be to the human eye? Explain your answer.
- B. Do you expect this ion to be paramagnetic or diamagnetic? Explain your answer.
6. (8 points) In acidic solution, the iodate ion may be reduced according to the reaction $\text{IO}_3^- (\text{aq}) \rightarrow \text{I}^- (\text{aq})$. Write a balanced net ionic equation for the reduction of sodium iodate by iron(II) nitrate in acidic solution.

7. (8 points) 1.0g of calcium hydroxide are added to 1.0 L of 1.0 M sodium hydroxide solution. Does a precipitate form? Prove your answer ($K_{sp} = 6.5 \times 10^{-6}$ for calcium hydroxide).

8. (12 points) For each of the following reactions, calculate the standard entropy and enthalpy change of reaction **and** state how you would expect the equilibrium of the system to shift with an increase in temperature. Justify your answer.



9. (8 points) Methylamine acts as a base according to the following reaction:

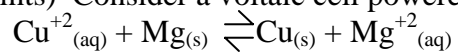


For this reaction, $K_b = 4.4 \times 10^{-4}$.

- A. What is the standard free energy of reaction?

- B. What is the free energy for this reaction if $[\text{CH}_3\text{NH}_2] = 0.05\text{M}$ and $[\text{CH}_3\text{NH}_3^+] = 0.025\text{M}$ in a $\text{pH} = 10$ solution?

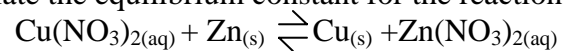
10. (12 points) Consider a voltaic cell powered by the following net ionic equation:



A. Calculate the standard cell potential for this system.

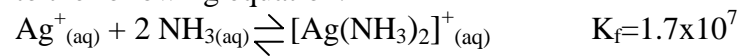
B. Calculate the emf for a cell made from a 0.5M solution of copper ions and a 3.0×10^{-5} M solution of magnesium ions at 25°C.

C. Calculate the equilibrium constant for the reaction

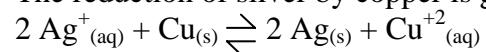


11. (14 points)

A. Calculate the standard free energy for the complexation of silver according to the following equation:

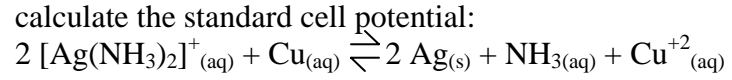


B. The reduction of silver by copper is given by the reaction:



Calculate the standard cell potential for this reaction, and use it to find the standard free energy for this reaction.

C. Calculate the free energy for the following reaction, and from this calculate the standard cell potential:



D. Explain in words why the voltage should be lower for a cell based on diamminesilver(I) ion instead of silver ion.