CH 223 Spring 2024:

Problem Set #6

Instructions

Step One (all sections):

- **Learn the material** for Problem Set #6 by **reading Chapter 18 and Chapter 19** of the textbook and/or by watching the videos found on our website (https://mhchem.org/223)
- **Try the problems** for Problem Set #6 found on the next pages on your own first. Use separate paper and write out your answers, showing all of your work. If you write the answers on the problem set itself, you will receive fewer points. Include your name on your problem set!

Step Two:

All sections: **Watch the recitation video** for Problem Set #6:
http://mhchem.org/v/x.htm

Self correct *all* of the problems while viewing the video. Mark correct problems with a star (or other similar mark), and correct all incorrect problems (show the correct answer and the steps required to achieve it.) *Note* that Section 01 and Section H1 will not be going over this problem set in recitation.

Due dates:

- *Section 01:* due **Wednesday, June 5 at 9 AM in AC 1303**
- *Section H1:* due **Wednesday, June 5 at 1:10 PM in AC 2501**
- *Section W1:* Submit Problem Set #6 via **email (mike.russell@mhcc.edu)** as a single PDF file (use CamScanner (https://camscanner.com), CombinePDF (https://combinepdf.com), etc.) **by 11:59 PM Wednesday, June 5.**

If you have any questions regarding this assignment, please email (mike.russell@mhcc.edu) the instructor! Good luck on this assignment!

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** Complete problem set on separate pieces of paper showing all work, circling final answers, etc.*
** Self correct your work before turning it in to the instructor.*

Covering: **Chapters Eighteen** *and* **Chapter Nineteen** *and* **Chapter Guide Six**
Important Tables and/or Constants: "**Coordination Compounds**" *(Handout)*

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1. Write an equation for the reaction of potassium and hydrogen. Name the product. Is it ionic or covalent? Predict one physical property and one chemical property of this compound.
2. Write an equation for the reaction of sodium with each of the halogens. Predict at least two physical properties that are common to all of the alkali metal halides.
3. $Ca(OH)_2$ has a K_{sp} of 5.5 x 10^{-5}, whereas K_{sp} for $Mg(OH)_2$ is 5.6 x 10^{-12}. Calculate the equilibrium constant for the reaction:

   $$Ca(OH)_2(s) + Mg^{2+}(aq) \rightleftharpoons Ca^{2+}(aq) + Mg(OH)_2(s)$$

   Explain why this reaction can be used in the commercial isolation of magnesium from seawater.
4. Gallium hydroxide, like aluminum hydroxide, is amphoteric
   a. Write balanced equations for the reaction of solid $Ga(OH)_3$ with aqueous HCl and NaOH.
   b. What volume of 0.0112 M HCl is needed to react completely with 1.25 g of $Ga(OH)_3$?
5. Use data in the Thermodynamic Table in Problem Set #5 to calculate the enthalpy and free energy change for the reaction: $2\ NO_2(g) \rightarrow N_2O_4(g)$
   Is this reaction exothermic or endothermic? Is the reaction product- or reactant-favored?
6. The overall reaction involved in the industrial synthesis of nitric acid is:

   $$NH_3(g) + 2\ O_2(g) \rightarrow HNO_3(aq) + H_2O(\ell)$$

   a. Calculate $\Delta G°$ for this reaction. *Note:* $\Delta G°$ for $HNO_3(aq)$ = -111.25 kJ/mol
   b. Calculate the equilibrium constant for this reaction at 25 °C.
7. Sulfur forms a range of compounds with fluorine. Draw Lewis electron dot structures for S_2F_2 (connectivity is FSSF), SF_2, SF_4, SF_6 and S_2F_{10}. What is the oxidation number of sulfur in each of these compounds?
8. The halogen oxides and oxoanions are good oxidizing agents. For example, the reduction of bromate ion has an $E°$ value of 1.44 V in acid solution:

   $$2\ BrO_3^{-1}(aq) + 12\ H^+(aq) + 10\ e^- \rightarrow Br_2(aq) + 6\ H_2O(\ell)$$

   Is it possible to oxidize aqueous 1.0 M Mn^{2+} to aqueous MnO_4^{-1} with 1.0 M bromate ion? *Use the redox table in Problem Set #5 to answer this problem.*
9. The hypohalite ions, XO^{-1}, are the anions of weak acids. Calculate the pH of a 0.10 M solution of NaClO. What is the concentration of HClO in this solution? K_b (ClO^-)= 2.9 * 10^{-7}
10. Identify two transition metals ions with the following electron configurations:
    a. [Ar]$3d^6$
    b. [Ar]$3d^{10}$
    c. [Ar]$3d^5$
    d. [Ar]$3d^8$
11. Match up the isoelectronic ions in the following list:

    $$Cu^+\ Mn^{2+}\ Fe^{2+}\ Co^{3+}\ Fe^{3+}\ Zn^{2+}\ Ti^{2+}\ V^{3+}$$

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12. Identify the products of each reaction and balance the equation:
    a. $CuSO_4(aq) + Zn(s) \rightarrow$
    b. $Zn(s) + HCl(aq) \rightarrow$
13. One of the following nitrogen compounds or ions is not capable of serving as a ligand: NH_4^+, NH_3, NH_2^{-1}. Identify this species and explain your answer.
14. Give the oxidation number of the metal in each of the following complexes:
    a. $[Fe(NH_3)_6]^{2+}$
    b. $[Zn(CN)_4]^{2-}$
    c. $[Co(NH_3)_5(NO_2)]^+$
    d. $[Cu(en)_2]^{2+}$
15. Give the formula of a complex constructed from one Cr^{3+} ion, two ethylenediamine ligands, and two ammonia molecules. Is the complex neutral or is it charged? If charged, give the charge.
16. Write formulas for the following ions or compounds:
    a. diamminetriaquahydroxochromium(II) nitrate
    b. hexaammineiron(III) nitrate
    c. pentacarbonyliron(0) (where the ligand is CO)
    d. ammonium tetrachlorocuprate(II)
17. Name the following ions or compounds:
    a. $[Co(H_2O)_4Cl_2]^+$
    b. $Co(H_2O)_3F_3$
    c. $[Pt(NH_3)Br_3]^{-1}$
    d. $[Co(en)(NH_3)_3Cl]^{2+}$
18. Give the name or formula for each ion or compound as appropriate:
    a. tetraaquadichlorochromium(III) chloride
    b. $[Cr(NH_3)_5SO_4]Cl$
    c. sodium tetrachlorocobaltate(II)
    d. *trans*-diaquadioxalatochromate(III) ion (oxalato = oxalate ion)
    e. $[Rh(en)_3]^{3+}$
19. In which of the following complexes are geometric isomers possible? If isomers are possible, draw their structures and label them as *cis* or *trans*, or as *fac* or *mer*.
    a. $[Co(H_2O)_4Cl_2]^+$
    b. $Co(NH_3)_3F_3$
    c. $[Pt(NH_3)Br_3]^{-1}$
    d. $[Co(en)_2(NH_3)Cl]^{2+}$
    e. Does 2-butanol exhibit optical isomerism? Draw a Lewis structure and explain.
20. A platinum-containing compound, known as Magnus's green salt, has the overall formula $[Pt(NH_3)_4][PtCl_4]$ (in which both platinum ions are Pt^{2+}). Name the cation and the anion.

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