CH 223 Practice Problem Set #6

*This is a **practice problem set** and not the actual graded problem set that you will turn in for credit. Answers to each problem can be found at the end of this assignment.*

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

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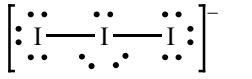
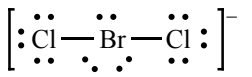
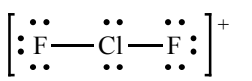
1. Write balanced chemical equations for the reaction of hydrogen gas with oxygen, chlorine, and nitrogen.
2. Write a balanced chemical equation for the preparation of H_2 (and CO) by the reaction of CH_4 and water. Using a table of thermodynamic data, calculate $\Delta H°$, $\Delta G°$, and $\Delta S°$ for this reaction.
3. Complete and balance the equations for the following reactions.
   a. $Na(s) + Br_2(l) \rightarrow$
   b. $Mg(s) + O_2(g) \rightarrow$
   c. $Al(s) + F_2(g) \rightarrow$
   d. $C(s) + O_2(g) \rightarrow$ (assume an excess of oxygen has been added)
4. Calcium oxide, CaO, is used to remove SO_2 from power plant exhaust. These two compounds react to give solid $CaSO_3$. What mass of SO_2 can be removed using 1.2×10^3 kg of CaO?
5. Aluminum dissolves readily in hot aqueous NaOH to give the aluminate ion, $Al(OH)_4^{-1}$, and H_2. Write a balanced equation for this reaction. If you begin with 13.2 g of Al, what volume (in milliliters) of H_2 gas is produced when the gas is measured at 735 mm Hg and 22.5 °C?
6. Use a table of thermodynamic data to calculate the enthalpy and free energy change for the reaction: **$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$** Is this reaction exothermic or endothermic? Is the reaction product- or reactant-favored?
7. Write the balanced equation for the reaction of hydrazine in acid solution ($N_2H_5^{+1}$) with $IO_3^{-1}(aq)$ to give N_2 and I_2. Calculate $E°$ for this reaction using a table of reduction potentials (look online for these values.)
8. If an electrolytic3cell for producing F_2 operates at 5.00×10^3 amps (at 10.0 V), what mass of F_2 can be produced per 24-hour day? Assume the conversion of F^{-1} to F_2 is 100%.
9. When BCl_3 gas is passed through an electric discharge, small amounts of the reactive molecule B_2Cl_4 are produced. (The molecule has a B-B covalent bond.)
   a. Draw a Lewis electron dot structure for B_2Cl_4.
   b. Describe the hybridization of the B atoms in the molecule and the geometry around each B atom.
10. How would you extinguish a sodium fire in the laboratory? What is the worst thing you could do?
11. You are given a stoppered flask that contains either hydrogen, nitrogen, or oxygen. Suggest an experiment to identify the gas.
12. Halogens form polyhalide ions. Sketch Lewis electron dot structures and describe the molecular geometry for the following ions:
    a. I_3^{-1}
    b. $BrCl_2^{-1}$
    c. ClF_2^{+1}

13. Give the electron configuration for each of the following ions, and tell whether each is paramagnetic or diamagnetic.
    a. Cr^{3+}
    b. V^{2+}
    c. Ni^{2+}
    d. Cu^{+}
14. The following equations represent various ways of obtaining transition metals from their compounds. Balance each equation.
    a. $Cr_2O_3(s) + Al(s) \rightarrow Al_2O_3(s) + Cr(s)$
    b. $TiCl_4(l) + Mg(s) \rightarrow Ti(s) + MgCl_2(s)$
    c. $[Ag(CN)_2]^{-1}(aq) + Zn(s) \rightarrow Ag(s) + [Zn(CN)_4]^{2-}(aq)$
    d. $Mn_3O_4(s) + Al(s) \rightarrow Mn(s) + Al_2O_3(s)$
15. Which of the following ligands is expected to be monodentate and which might be polydentate?
    a. CH_3NH_2 b. CH_3CN c. N_3^{-1} d. en e. Br^{-1} f. phen
16. Give the oxidation number of the metal ion in each of the following compounds.
    a. $[Mn(NH_3)_6]SO_4$ b. $K_3[Co(CN)_6]$ c. $[Co(NH_3)_4Cl_2]Cl$ d. $Cr(en)_2Cl_2$
17. Write formulas for the following ions or compounds.
    a. dichlorobis(ethylenediamine)nickel(II)
    b. potassium tetrachloroplatinate(II)
    c. potassium dicyanocuprate(I)
    d. tetraamminediaquairon(II)
18. Name the following ions or compounds.
    a. $[Ni(C_2O_4)_2(H_2O)_2]^{2-}$
    b. $[Co(en)_2Br_2]^{+1}$
    c. $[Co(en)_2(NH_3)Cl]^{2+}$
    d. $Pt(NH_3)_2(C_2O_4)$
19. Give the name or formula for each ion or compound, as appropriate.
    a. pentaaquahydroxoiron(III) ion
    b. $K_2[Ni(CN)_4]$
    c. $K[Cr(C_2O_4)_2(H_2O)_2]$
    d. ammonium tetrachloroplatinate(II)
20. Draw all possible geometric isomers of the following.
    a. $Fe(NH_3)_4Cl_2$
    b. $Pt(NH_3)_2(SCN)(Br)$ (SCN^{-1} is bonded to Pt^{2+} through S)
    c. $Co(NH_3)_2(NO_2)_3$ (NO_2^{-1} is bonded to Co^{3+} through N)
    d. $[Co(en)Cl_2]^{-1}$
21. In water, the titanium(III) ion, $[Ti(H_2O)_6]^{3+}$, has a broad absorption band at about 500 nm. What color light is absorbed by the ion?
22. A transition metal complex absorbs 425-nm light. What is its color?
    a. red b. green c. yellow d. blue
23. Give the formula of the complex formed from one Co^{3+} ion, two ethylenediamine molecules, one water molecule, and one chloride ion. Is the complex neutral or charged? If charged, give the net charge on the ion.

Answers to the Practice Problem Set:

1. *Answers:*
   $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$
   $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$
   $3\ H_2(g) + N_2(g) \rightarrow 2\ NH_3(g)$
2. $CH_4(g) + H_2O(g) \rightarrow 3\ H_2(g) + CO(g)$; $\Delta H^o = 205.9$ kJ, $\Delta S^o = 214.7$ J/K, $\Delta G^o = 141.9$ kJ (*Note:* Answers will vary depending on table used)
3. *Answers:*
   a. $2\ Na(s) + Br_2(\ell) \rightarrow 2\ NaBr(s)$
   b. $2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$
   c. $2\ Al(s) + 3\ F_2(g) \rightarrow 2\ AlF_3(g)$
   d. $C(s) + O_2(g) \rightarrow CO_2(g)$
4. 1.4×10^6 g
5. $2\ Al(s) + 2\ NaOH(aq) + 6\ H_2O(\ell) \rightarrow 2\ Na^+(aq) + 2\ Al(OH)_4^-(aq) + 3\ H_2(g)$; 1.84×10^4 mL
6. $\Delta H^o = -114.1$ kJ, $\Delta G^o = -72.6$ J/K; exothermic and product-favored
7. $5\ N_2H_5^+(aq) + 4\ IO_3^-(aq) \rightarrow 5\ N_2(g) + H^+(aq) + 2\ I_2(aq) + 12\ H_2O(\ell)$; $E° = (1.195 - (-0.23) = 1.43$ V (*Note:* Answers will vary depending on table used)
8. 8.51×10^4 g
9. a. B-B single bond, each B has two Cl atoms connected via sigma bond b. sp^2, trigonal planar
10. Use inert dry chemical fire extinguisher; Na reacts with water!
11. Insert glowing splint: H will ignite, O will burst into flame, N will extinguish flint
12. *Answers:*
    a.  linear
    b.  linear
    c.  bent
13. a. $[Ar]3d^3$, paramagnetic b. $[Ar]3d^3$, paramagnetic c. $[Ar]3d^8$, paramagnetic d. $[Ar]3d^{10}$, diamagnetic
14. *Answers:*
    a. $Cr_2O_3(s) + 2\ Al(s) \rightarrow Al_2O_3(s) + 2\ Cr(s)$
    b. $TiCl_4(\ell) + 2\ Mg(s) \rightarrow Ti(s) + 2\ MgCl_2(s)$
    c. $2\ [Ag(CN)_2]^-(aq) + Zn(s) \rightarrow 2\ Ag(s) + [Zn(CN)_4]^{2-}(aq)$
    d. $3\ Mn_3O_4(s) + 8\ Al(s) \rightarrow 9\ Mn(s) + 4\ Al_2O_3(s)$
15. *monodentate:* a, b, c, e *polydentate:* d, f
16. a. Mn^{2+} b. Co^{3+} c. Co^{3+} d. Cr^{2+}
17. a. $[NiCl_2(en)_2]$ b. $K_2[PtCl_4]$ c. $K[Cu(CN)_2]$ d. $[Fe(NH_3)_4(H_2O)_2]^{2+}$

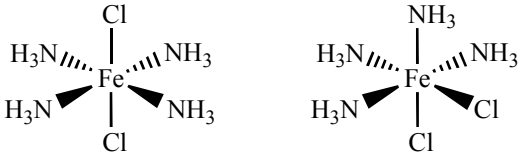
18. Answers:

a. diaquabis(oxalato)nickelate(II) ion
b. dibromobis(ethylenediamine)cobalt(II) ion
c. amminechlorobis(ethylenediamine)cobalt(III) ion
d. diammineoxalatoplatinum(II)

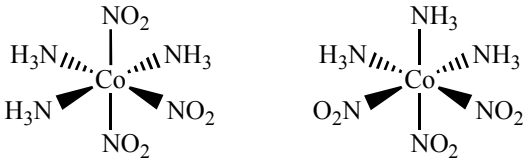
19. Answers:

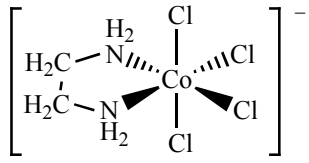
(a) $[Fe(H_2O)_5OH]^{2+}$
(b) potassium tetracyanonickelate(II)
(c) potassium diaquabis(oxalato)chromate(III)
(d) $(NH_4)_2[PtCl_4]$

20. Answers:

a. 

b. 

c. 

d. 

21. yellow
22. yellow
23. $[Co(en)_2(H_2O)Cl]^+$, aquachlorobis(ethylenediamine)cobalt(III) ion. The complex has a +1 charge