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 Nineteen** *and* **Chapter Twenty-one** *and* **Chapter Guide Six**
Important Tables and/or Constants: "**Coordination Compounds**" *(Handout),* "**Organic Chemistry Nomenclature Guide**" *(Handout)*, "**Organic Chemistry Lab**" *(Handout in Lab Packet)*

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1. 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^{+}
2. 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. $Mn_3O_4(s) + Al(s) \rightarrow Mn(s) + Al_2O_3(s)$
3. 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
4. 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. $Cr(en)_2Cl_2$
5. Write formulas for the following ions or compounds.
   a. dichlorobis(ethylenediamine)nickel(II)
   b. potassium tetrachloroplatinate(II)
   c. potassium dicyanocuprate(I)
   d. tetraamminediaquairon(II)
6. 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. $Pt(NH_3)_2(C_2O_4)$
7. 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)
8. 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. $[Co(en)Cl_2]^{-1}$

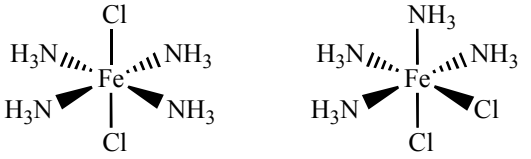
9. Give the formula of the complex formed from one Co^{3+} ion, two ethylenediamine molecules, one water molecule, and one chloride ion. Is the complex neutral or charged? If charged, give the net charge on the ion.
10. What is the name of the straight (unbranched) chain alkane with the formula C_7H_{16}? What is the molecular formula for an alkane with 9 carbon atoms?
11. Which of the following is an alkane? Which could be a cycloalkane?
    a. C_2H_4
    b. C_5H_{10}
    c. $C_{14}H_{30}$
    d. C_7H_8
12. Draw the structure of each of the following compounds: a. 2,3-dimethylhexane
    b. 3-ethylheptane
13. Draw structures for the *cis* and *trans* isomers of 4-methyl- 2-hexene.
14. Give the systematic name or structure for the following alcohols, amines and ethers.
    a. $CH_3CH_2CH_2OH$
    b. $CH_3CH_2CH_2CH_2OH$
    c. ethylamine
    d. dipropylamine
    e. dibutyl ether
    f. 1-methoxypropane
15. Draw structural formulas for a. 2-pentanone, b. hexanal, and c. pentanoic acid.
16. Draw structural formulas for the following compounds: a. 1,3-dichlorobenzene
    b. 1-bromo-4-methylbenzene
17. Draw structural formulas for the following acids and esters:
    a. 2-methylhexanoic acid
    b. pentyl butanoate (which has the odor of apricots)
    c. octyl acetate (which has the odor of oranges)
18. Aldehydes and carboxylic acids are formed by oxidation of primary alcohols, and ketones are formed when secondary alcohols are oxidized. Typical oxidizing agents include $K_2Cr_2O_7$ or $KMnO_4$. Give the name and formula for the alcohol that, when oxidized, gives the following products:
    a. $CH_3CH_2CH_2CHO$
    b. 2-hexanone
19. Ketones can be reduced with $LiAlH_4$ or $NaBH_4$ to create alcohols. Describe how to prepare 2-pentanol beginning with the appropriate ketone.
20. Draw the structure and give the systematic name for the products of the following reactions:
    a. $CH_3CH{=}CH_2 + Br_2 \rightarrow$
    b. $CH_3CH_2CH{=}CHCH_3 + H_2 \rightarrow$
21. The compound 2-bromobutane is a product of addition of HBr to an alkene. Identify the alkene and give its name.
22. Draw structural formulas for all the alcohols with the formula $C_4H_{10}O$. Give the systematic name of each.
23. Draw structural formulas for all the primary amines with the formula $C_4H_9NH_2$. Name them.
24. Give structural formulas and systematic names for the three structural isomers of trimethylbenzene, $C_6H_3(CH_3)_3$.

25. Match up the isoelectronic ions in the following list:

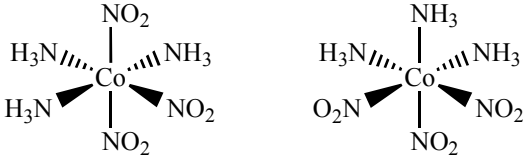
Cu^{+} Mn^{2+} Fe^{2+} Co^{3+} Fe^{3+} Zn^{2+} Ti^{2+} V^{3+}

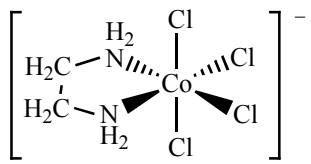
26. Identify the products of each reaction and balance the equation:
    a. $CuSO_4(aq) + Zn(s) \rightarrow$
    b. $Zn(s) + HCl(aq) \rightarrow$
27. One of the following nitrogen compounds or ions is not capable of serving as a ligand: NH_4^{+}, NH_3, NH_2^{-1}. Identify this species and explain your answer.
28. 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. $[Rh(en)_3]^{3+}$
29. Draw the structure for cycloheptane. Is the seven-member ring planar? Is this an isomer of n-heptane? Explain.

Answers to the Practice Problem Set:

1. a. [Ar]3d^3, paramagnetic b. [Ar]3d^3, paramagnetic c. [Ar]3d^8, paramagnetic d. [Ar]3d^{10}, diamagnetic
2. *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. $3\ Mn_3O_4(s) + 8\ Al(s) \rightarrow 9\ Mn(s) + 4\ Al_2O_3(s)$
3. *monodentate:* a, b, c, e *polydentate:* d, f
4. a. Mn^{2+} b. Co^{3+} c. Co^{3+} d. Cr^{2+}
5. a. $[NiCl_2(en)_2]$ b. $K_2[PtCl_4]$ c. $K[Cu(CN)_2]$ d. $[Fe(NH_3)_4(H_2O)_2]^{2+}$
6. *Answers:*
   a. diaquabis(oxalato)nickelate(II) ion
   b. dibromobis(ethylenediamine)cobalt(II) ion
   c. amminechlorobis(ethylenediamine)cobalt(III) ion
   d. diammineoxalatoplatinum(II)
7. *Answers:*
   (a) $[Fe(H_2O)_5OH]^{2+}$
   (b) potassium tetracyanonickelate(II)
   (c) potassium diaquabis(oxalato)chromate(III)
   (d) $(NH_4)_2[PtCl_4]$
8. *Answers:*
   a.


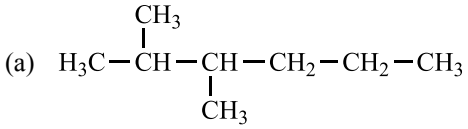
   b.

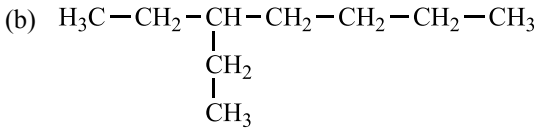

   c.


   d.


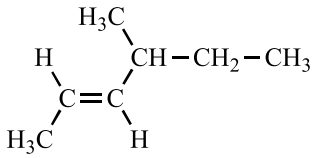
9. $[Co(en)_2(H_2O)Cl]^+$, aquachlorobis(ethylenediamine)cobalt(III) ion. The complex has a +1 charge
10. n-heptane; C_9H_{20}
11. c. $C_{14}H_{30}$ is an alkane b. C_5H_{10} could be a cycloalkane

12. *Answers:*

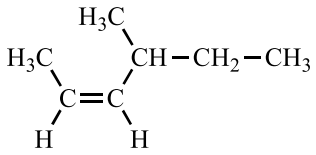
(a) 

(b) 

13. *Answers:*



trans-4-methyl-2-hexene

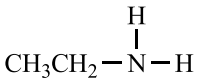


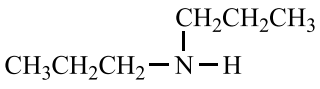
cis-4-methyl-2-hexene

14. *Answers:*

a. 1-propanol

b. 1-butanol

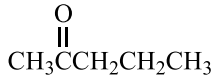
c. $C_2H_5NH_2$ 

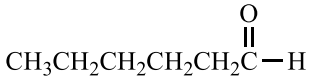
d. $(C_3H_7)_2NH$ 

e. $C_4H_9OC_4H_9$

f. $CH_3OCH_2CH_2CH_3$

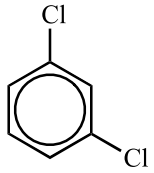
15. *Answers:*

a. 

b. 

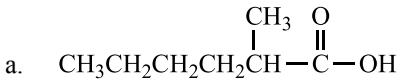
c. 

16. *Answers:*

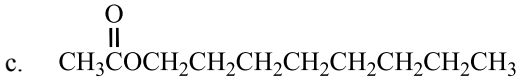
a. 

b. 

17. *Answers:*

a. 

b. 

c. 

18. *Answers:*

a. $CH_3CH_2CH_2CH_2-OH$ 1-butanol

b. $CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_2CH_2CH_2CH_3$ 2-hexanol

19. Reduction of 2-pentanone with $LiAlH_4$ or $NaBH_4$

20. *Answers:*

a. $H_3C-\underset{\displaystyle Br}{\underset{|}{C}}H-CH_2-Br$ 1,2-dibromopropane

b. $CH_3CH_2CH_2CH_2CH_3$ pentane

21. Using 1-butene, $H_2C{=}CHCH_2CH_3 + HBr \rightarrow CH_3CHBrCH_2CH_3$

22. *Answers:*

$HO-CH_2CH_2CH_2CH_3$ 1-butanol

$CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_2CH_3$ 2-butanol

$HO-CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$ 2-methyl-1-propanol

$CH_3\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle OH}{\overset{|}{C}}}}CH_3$ 2-methyl-2-propanol

23. *Answers:*

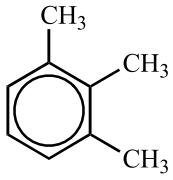
$H_2N-CH_2CH_2CH_2CH_3$ 1-butylamine

$CH_3\underset{\displaystyle NH_2}{\underset{|}{C}}HCH_2CH_3$ 2-butylamine

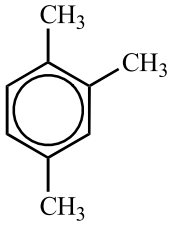
$H_2N-CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$ 2-methyl-1-propylamine

$CH_3\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle NH_2}{\overset{|}{C}}}}CH_3$ 2-methyl-2-propylamine

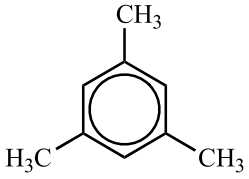
24. *Answers:*



1,2,3-trimethylbenzene



1,2,4-trimethylbenzene



1,3,5-trimethylbenzene

25. Cu^+ and Zn^{2+}; Mn^{2+} and Fe^{3+}; Fe^{2+} and Co^{3+}; Ti^{2+} and V^{3+}

26. a. $Cu(s) + ZnSO_4(aq)$ b. $ZnCl_2(aq) + H_2(g)$

27. NH_4^+

28. Give the name or formula for each ion or compound as appropriate:

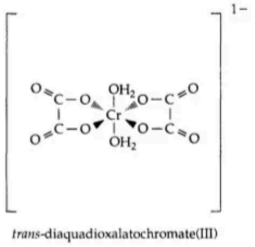
a. tetraaquadichlorochromium(III) chloride

b. $[Cr(NH_3)_5SO_4]Cl$

c. sodium tetrachlorocobaltate(II)

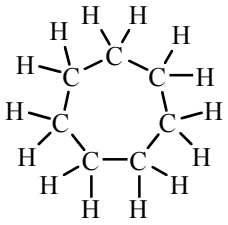
d. *trans*-diaquadioxalatochromate(III) ion (oxalato = oxalate ion)

e. $[Rh(en)_3]^{3+}$



trans-diaquadioxalatochromate(III)

29. Draw the structure for cycloheptane. Is the seven-member ring planar? Is this an isomer of n-heptane? Explain.



The ring is not planar. The geometry around each carbon atom is tetrahedral.

This is not an isomer of n-heptane; the number of atoms is different.