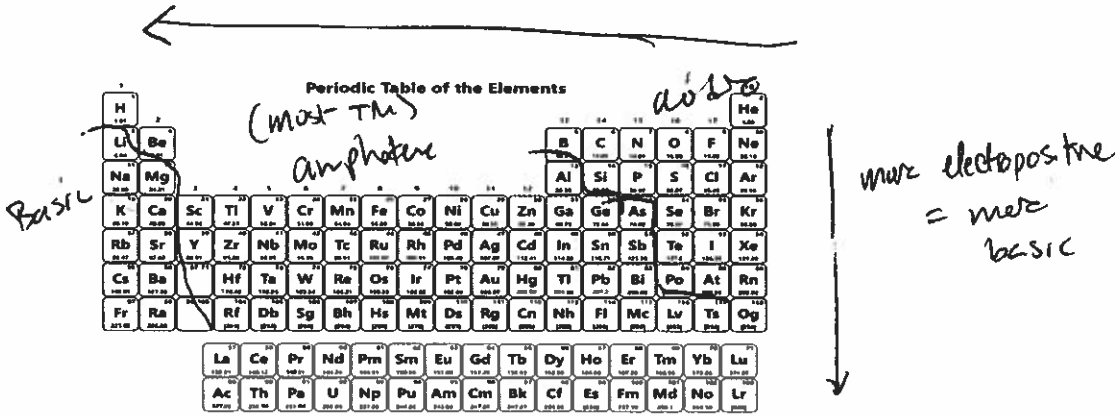
CHEM 362 – Fall 2019
Prof K .R. Dunbar
TA: Ellen Song

PLTL Worksheet #5:
Coordination Chemistry and Anions

1. *Oxides, Hydroxides, Alkoxides*
   a. Draw arrows on the period table and describe the general rules in predicting whether an oxide will be basic, acidic or amphoteric.



   b. Write a chemical equation for a basic (or ionic) oxide

$Na_2O + H_2O \longrightarrow 2\,NaOH$ (form ^-OH in water)

   c. Write a chemical equation for an acidic (or covalent) oxide

$SO_3 + H_2O \rightarrow H_2SO_4$ (form acid in water)

   d. Write the two chemical reactions for the amphoteric oxide, Cr_2O_3.

1) $Cr_2O_3(s) + 6H^+(aq) + 9H_2O \longrightarrow 2[Cr(H_2O)_6]^{3+}$

2) $Cr_2O_3(s) + {}^-OH + H_2O \longrightarrow [Cr(OH)_6]^{3-}$

   e. Why does O2- exist only in ionic lattices?

O^{2-} cannot exist as a discrete ion in aqueous solutions. It would hydrolyze

$O^{2-} + H_2O \rightarrow 2\,^-OH$

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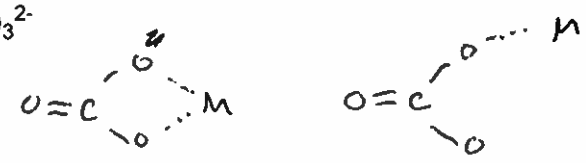
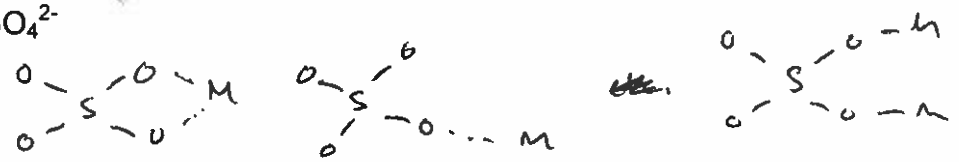
2. *Oxo anions*
   a. Many oxoanions can act as ligands and coordinate in more than one way. For the following molecules, draw how they might potentially bind to a metal center:

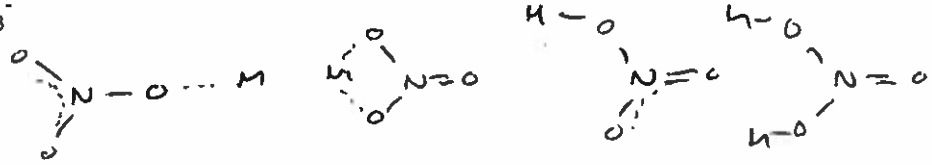
      i. CO_3^{2-}



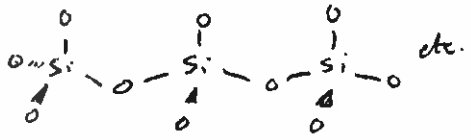
      ii. SO_4^{2-}

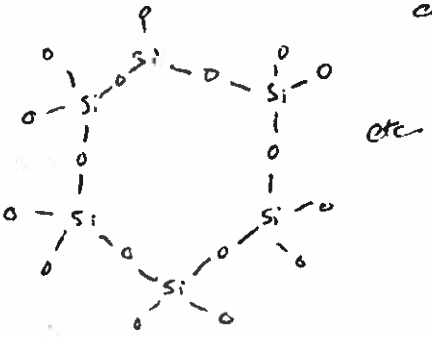


      iii. NO_3^-



3.
   a. What is a silicate? How are they different from borates?
      silicate = Si and O, made up of SiO_4 units
      Borates = BO_4, but not necessarily. (Ti units, shared more general term for Boron oxygen compounds
   b. Draw some different ways that 2D silicate networks can be built up (Hint chains? Rings?)





   c. What is meant by the terms isopoly and heteropoly anions? ~~Draw~~ Give an example of each.
      isopoly anion = one type of metal and oxygen
      heteropoly anion = 2+ elements (one metal) and oxygen
      ie. dichromate $[Cr_2O_7]^{2-}$
      ie $[CrMo_6O_{24}H_6]^{3-}$

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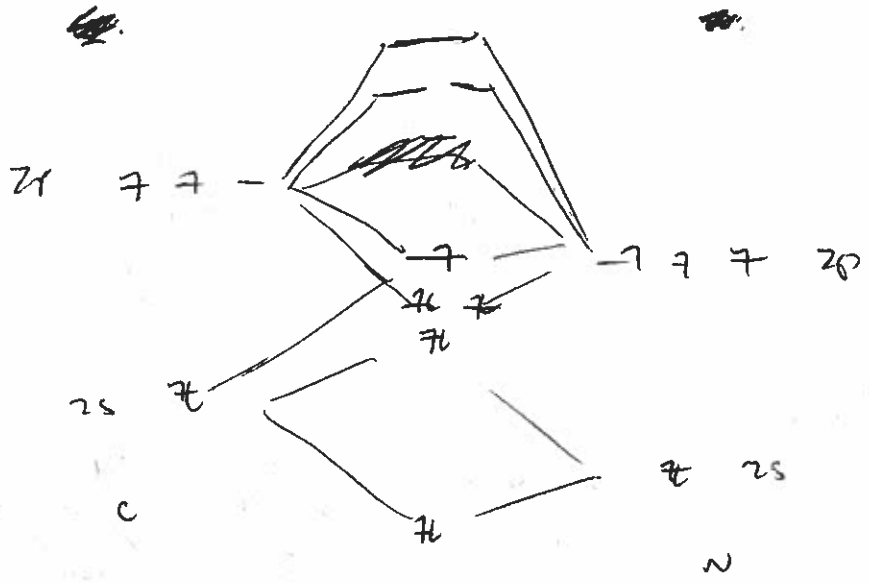
4. *CN vs CO (and some more MO Practice)* should be ANION
   a. Draw MO diagrams for CN^- and CO

CN & CO are isoelectronic



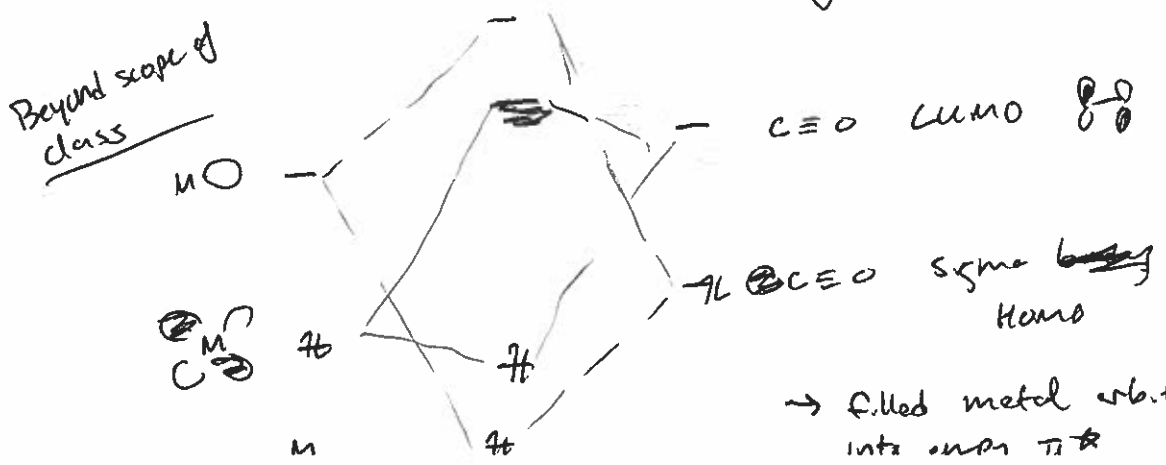
   b. Using the MO diagrams, and taking into account what Dr. Dunbar discussed in class, explain the differences in how CN and CO bond to metals

CN^- bonds through C.

CO is also reactive through C. This is b/c HOMO has more C character/ contribution

Note that for CO, the orbital energies will be lower. This makes the LUMO lower, and so it will be a better π acceptor.

↳ CO backbonding!



→ filled metal orbital puts e⁻ into empty π*

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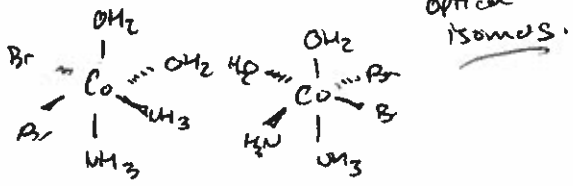
5. *Coordination Chemistry – nomenclature, ligands and isomerism*
   some of
   [These are examples from your notes]. Based on the given chemical formula:
   a. Draw the possible structures and name the types of isomerism present in the structures you drew.
   b. For each structure, give the IUPAC name.
   c. For each ligand within the structure, name the binding mode (ie. Monodentate? Bidentate? Etc)

will be covered after Tuesday I think

all are monodentate in these examples except (en) # 4 bidentate

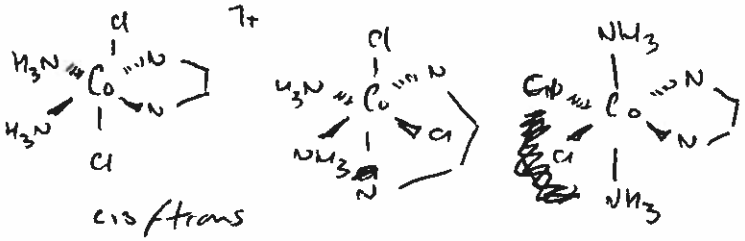
$Co(NH_3)_2(Br)_2(OH)_2$



optical isomers.

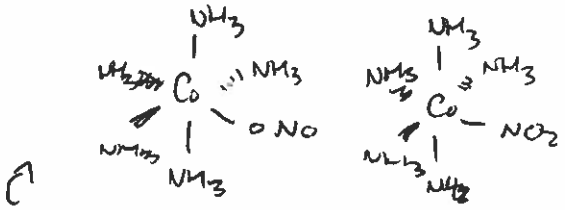
cis-dibromo-cis diammine-cis-diaquacobalt (III)

$[Co(en)(NH_3)_2Cl_2]^{2+}$



cis/trans isomers.

$[Co(NH_3)5NO_2]Cl_2$

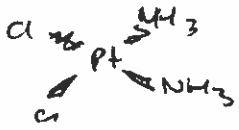


pentaamminenitrito cobalt

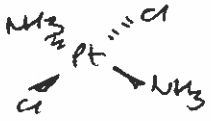
Linkage isomers

pentaamminenitro cobalt (III)

$Pt(NH_3)_2(Cl)_2$



cis-diamminedichloroplatinum



trans-diamminedichloro platinum.