Inorganic Cummulative Exam

October 6, 2016

1. Draw out the structures and determine the oxidation state, d-electron count, valence electron count, and geometry of the following compounds.

a. $[RhCl(NBD)]_2$ (NBD = norbornadiene)

b. Cp_2ZrMe_2

c. $[Ir(COD)(PCy_3)(pyr)]^+$

d. $(bipy)PtCl_2$

2. For the following combinations of transition metals and ligands, draw out their lowest energy structure. Use as many of each metal or ligand as necessary to achieve the formation of the lowest energy structure. Clearly define the geometry of the complex and if the complex is less than 18 e^- provide an explanation.

a. (Os)(O)

b. Re(Me)(O)

c. $Ir(Cp^*)(PMe_3)(H)$

3. For the following metal-ligand bonds, draw the bonding and antibonding orbital interactions as cartoons and as part of an orbital diagram with appropriate relative energy levels.

a. Ir-COE in $[(COE)IrCl]_2$

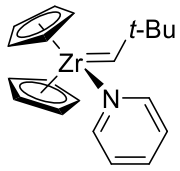
b. Rh-H in $(Ph_3P)_3RhH$

c. 

in $[(allyl)PdCl]_2$

4. Draw the α- and π-bonding MO diagram for $(Ph_3P)_2(CO)IrCl$. Illustrate the orbital cartoons for the FMOs.

5. Illustrate the frontier molecular orbitals of a bent metallocene complex. Then use these frontier molecular orbitals to describe whether or not the following complex is stable. An electron-counting explanation is insufficient.



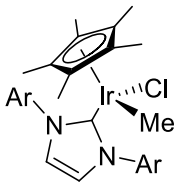
6. Which compound has the higher CO stretching frequency? Why?

a. $Cr(CO)_6$ or $Ni(CO)_4$

b. $Mo(CO)_3(PF_3)_3$ or $Mo(CO)_3(PPh_3)_3$

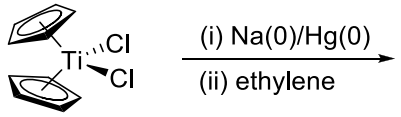
c. $[Ag(CO)]^+$ or CO

7. The NHC ligand in the iridium complex illustrated below is considered to only be a s-donor to the metal center. Use orbital cartoons to describe why this NHC contains a stable 3-coordinated carbon atom that can donate electron-density to the metal center.



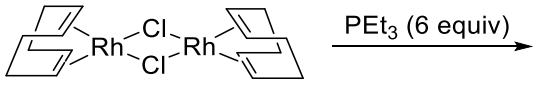
8. Predict the products.

a.



What diagnostic resonances in the ^{1}H and ^{13C} NMR spectra would determine whether or not this reaction went to completion?

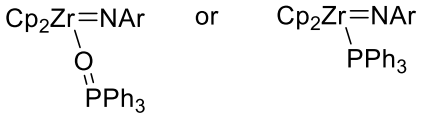
b.



What diagnostic resonances in a ^{31}P NMR spectrum would determine whether or not this reaction went to completion?

9. Which compound is more stable? Why? Consider the thermodynamic effects of bond strength (both overlap and Coulombic components).

a.



b.