

1. Complete the periodic table below: (10 pts.)

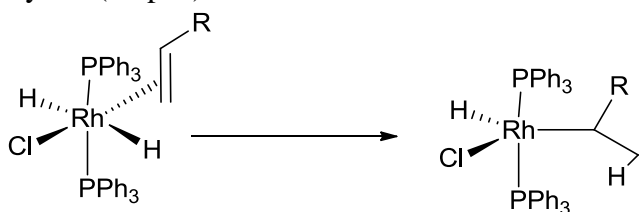
Group 3	4	5	6	7	8	9	10	11
Sc								

2. Predict the order of reactivity of MeTiCl_3 with the following ligands: NMe_3 , PMe_3 , CO . Briefly explain your reasoning. (10 pts.)

3. In class we described two important reactions that metal-alkyls can undergo. List these two reactions and give an example, generic or specific. (15 pts.)

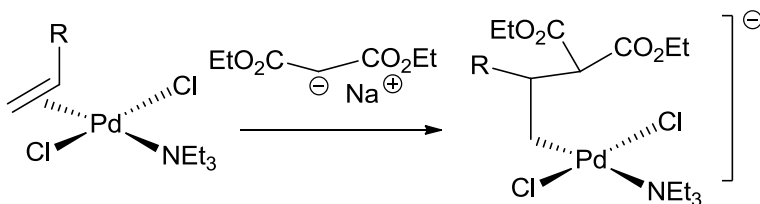
4. Identify the following reactions by the type of process occurring. *CHE-334* identify 4 of 5; *CHE-534* identify all. (15 pts.)

a)

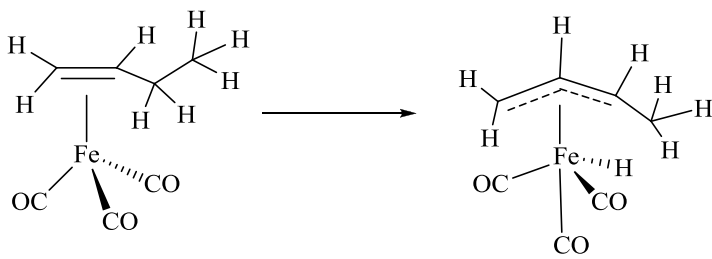


Rxn type:

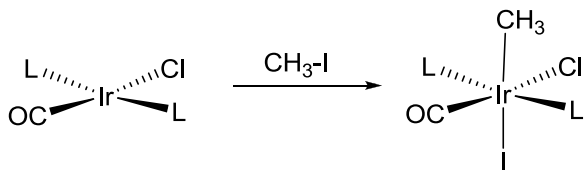
b)



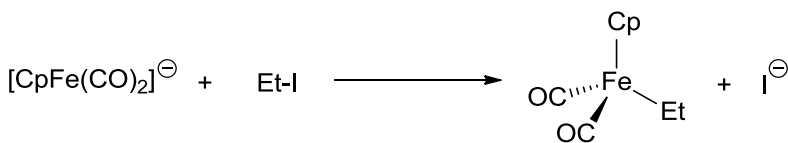
c)



d)



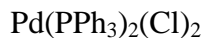
e)



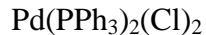
Questions 5 and 6: *CHE-334* answer one of two. *CHE-534* answer one completely and one part of the other question. (15 pts.)

5. Answer the following questions about two common forms of palladium.

a) Predict the molecular geometry of the palladium complexes shown below. Draw their pseudo-three dimensional structures in the space below and label the geometry.

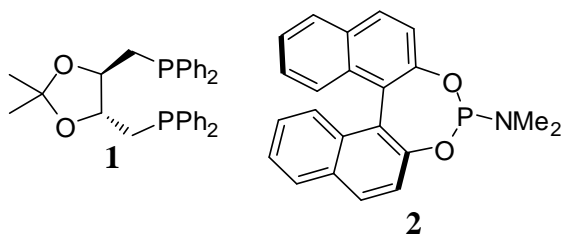


b) Draw the palladium d orbital electronic structure for both metal complexes. Place the correct number of palladium electrons in the orbital diagrams.



c) Briefly explain why these two palladium transition metal complexes have different geometries.

6. In their effort to further optimize organometallic reactions and related catalytic processes, chemists have created many complex phosphorus ligands. Two examples are shown below. Compare and contrast these two ligands in the questions below.



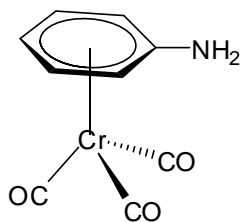
a) Draw a hypothetical complex with each of these ligands and a palladium atom (PdL_n).

b) Compare and contrast the steric and electronic effects of both ligands in a complex with a palladium atom.

c) Overall, which complex will occupy more space around the palladium metal? **1** or **2** (circle one)

Overall, which complex will have a more electron rich palladium metal? **1** or **2** (circle one)

7. Answer the questions about the metal-arene complex shown below. *CHE-334* answer 3 of 5 parts; *CHE-534* answer 4 of 5 parts. (15 pts.)

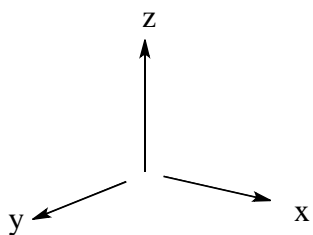


a) Provide the oxidation state of the metal, the d^n count, the total electron count and the coordination number (CN) for the complex.

b) What is the likely hapticity of the benzene ring in binding to the Cr? Briefly explain your answer.

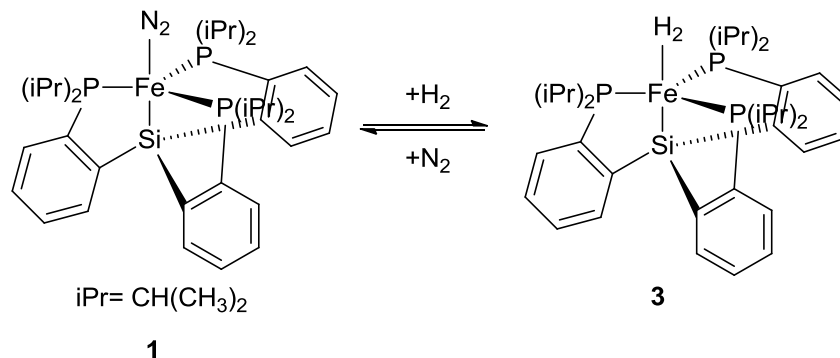
c) Show one example of a benzene interaction with the Cr that has a different hapticity.

d) Draw one example of a molecular orbital interaction between a Cr d orbital and a benzene MO.

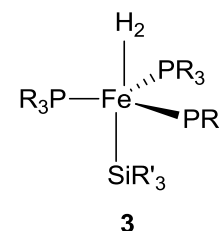
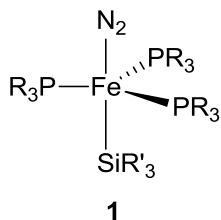


e) What effect do you think the $\text{Cr}(\text{CO})_3$ binding to the benzene ring will have on the amine group basicity?

8. A recent article in the literature entitled “A Nonclassical Dihydrogen Adduct of $S = 1/2$ Fe(I)” reported on the equilibrium shown below. (Hint: Si is located immediately below C on the periodic table.) CHE-334 answer 5 of 7 parts; CHE-534 answer 6 of 7 parts. (20 pts.)



a) The equilibrium between **1** and **3** is a ligand substitution reaction. Show the possible paths, including intermediates, for this ligand substitution. Be sure to label each possible path by the type of ligand substitution process. You may use the abbreviated forms of the complex shown below to limit your drawing.



b) For all intermediates, determine the metal oxidation state, total electron count and coordination number.

c) Which path do you think is more likely and why?

d) The hydrogen complex **3** with the iron can exist in two possible forms. Draw both possible forms and label them as described in class.

e) Which factors will determine whether one complex occurs over the other?

f) The nitrogen (N_2) ligand usually binds like a carbon monoxide (CO) ligand. Show how this would look in the space below. Highlight the interactions with Fe that would be expected with N_2 if it were acting just like a CO ligand. Again, you can use the abbreviated drawing of the complex to save time.

g) Compare the N_2 ligand bonds with the same CO bonds. Would you expect them to be stronger or weaker? Briefly explain.