Introduction to Organometallic Chemistry
A. G. Samuelson

III) Questions based on \( \eta^m \) (m=even) ligands

12. Metal alkene complexes
13. Alkynes \( \eta_2 \) bonding
14. Metal dihydrogen and hydrides
15. Migratory Insertion reaction with alkynes
16. \( \eta^m \) (m=4 dienes and m=2n, polyenes)

2. Explain the following observations
   
   (a) Olefins have different chemical shifts and \(^{13}\)C-\(^1\)H coupling constants on binding to a metal.
   (b) Cyclooctatetraene forms a \( \eta^4 \) complex with Fe(CO)\(_3\). Uranium forms a \( \eta^8 \) complex with the same ligand.
   (c) The IR spectra of \([\text{C}_2\text{H}_4\text{PtCl}_2]_2\) shows a C=C stretching frequency of 1506 cm\(^{-1}\) whereas the first organometallic compound synthesized by Zeise shows a C=C stretching frequency at 1516 cm\(^{-1}\)

3. Suggest suitable methods for the preparation of

   \[
   \begin{align*}
   \text{Cp}_2\text{Mo(C}_2\text{H}_2) & ; \\
   [\text{Fe(CO)}_4(\text{C}_2\text{H}_4)] & ; \\
   [\text{Co}_2(\text{CO})_6(\text{C}_2\text{H}_2)] & ;
   \end{align*}
   \]

4. Draw the molecular orbitals of cyclobutadiene and match them with the orbitals on a 3d transition metal.

5. Complete the following equations giving the structure and electron count of the organometallic products

   a. Pt(PPh\(_3\))\(_3\) + CH\(_2\)=C=CH\(_2\) \(\rightarrow\)

   b. RuCl\(_3\) + 1,4-cyclohexadiene + Ethanol (reflux) \(\rightarrow\)

   c. Ph – C \equiv C – Ph + CO\(_2\)(CO)\(_8\) \(\rightarrow\)

   d. C\(_2\)F\(_4\) + Pt(PPh\(_3\))\(_3\) \(\rightarrow\)

   e. NiCl\(_2\) + AlR\(_3\) + C\(_4\)H\(_6\) \(\rightarrow\) (butadiene)