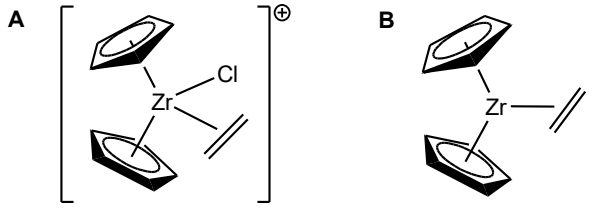
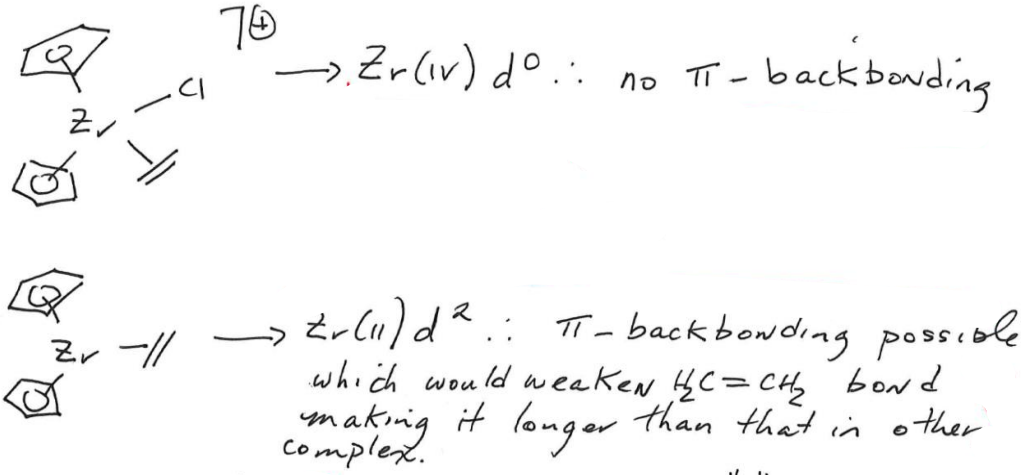
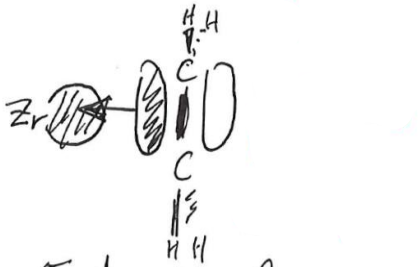
Winter 2026 - Chemistry 3840
Assignment #3 Answer Key

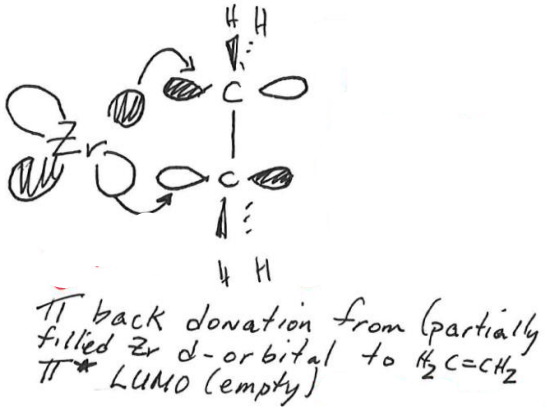
1. Which of the following two zirconium complexes would have a longer alkene C=C bond? Explain. (14 points)



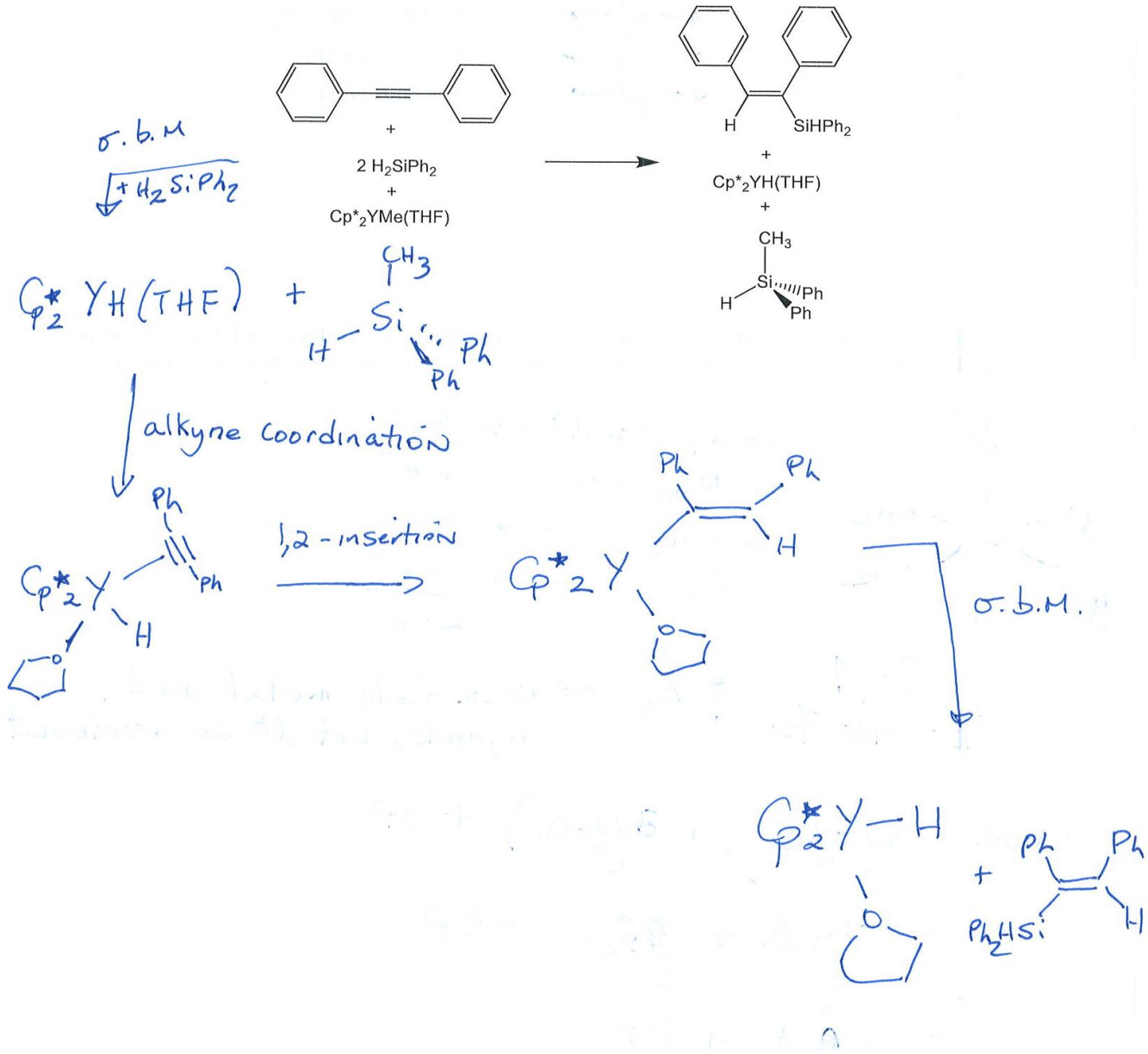


b)

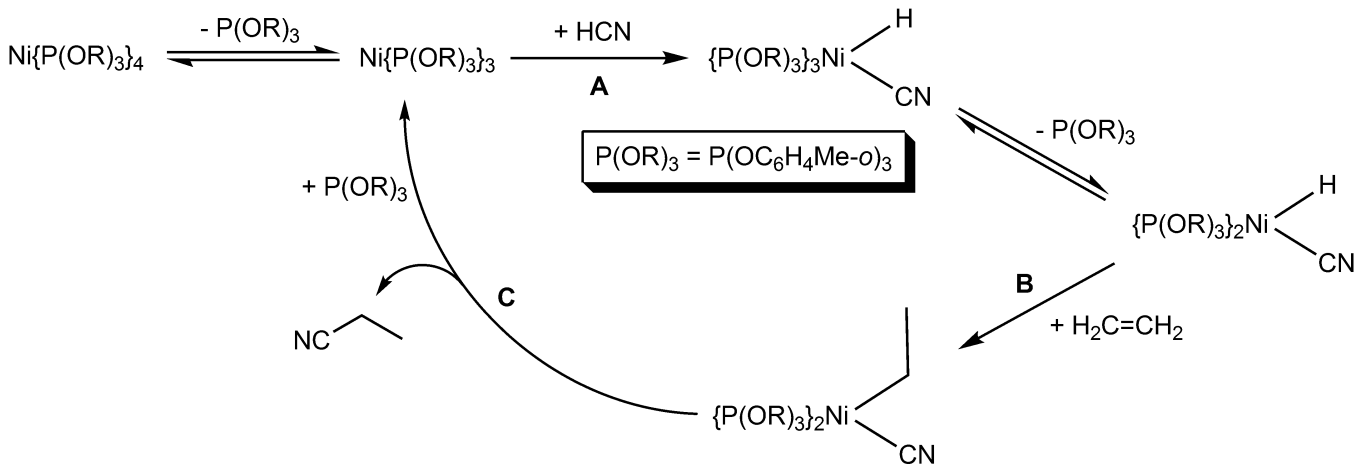




2. Provide a reasonable mechanism (based **only** on the fundamental reactions learned in class) to explain the following. Note that it is not necessary to draw transition states or use arrows to indicate electron movement, but the structure of every intermediate is required. Indicate in words (5 or less/reaction) what type of fundamental reaction(s) are taking place in each step of the mechanism. It is not necessary to draw transition states or to use arrows to indicate electron movement. (10 points)



3. Indicate what fundamental organometallic reactions are taking place in steps **A**-**C** of the following catalytic cycle. No explanation is required. (6 points)



A = H–CN oxidative addition

B = alkene coordination and 1,2-insertion

C = C–C reductive elimination

4. Reactions of $Ni(CO)_4$ in which phosphines [L = PR_3] replace CO to give the family $Ni(CO)_3L$ occur at the same rate for different phosphines. Is the reaction dissociative or associative Why? (12 points)

Ni(0), d^{10}, 18 electron. Strong field ligands. Highly unlikely to exceed 18 electron rule, as would be required for an associative mechanism that would proceed through the 20 electron intermediate $[Ni(CO)_4(PR_3)]$

Reaction is dissociative (or Id) → rate is independent of L. CO dissociation is R.D.S.

5. $[Cu(NH_3)_4(H_2O)_2]^{2+}$ is very dark blue, while $[Cu(H_2O)_6]^{2+}$ is pale blue. Explain fully. (14 points)

→ NH_3 is a stronger field ligand than H_2O

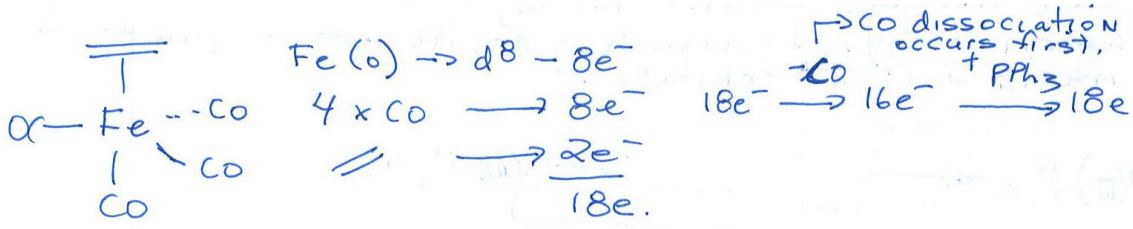
∴ $[Cu(NH_3)_4(H_2O)_2]^{2+}$ (I) will have a larger Δ_o than $[Cu(H_2O)_6]^{2+}$ (II).

→ ∴ I will absorb lower wavelength energy (yellow-green) and emitting dark blue.

II will absorb higher wavelength energy (orange-red) and emitting light blue.

6. Would you predict the following substitution reaction to proceed by an associative or dissociative mechanism? Briefly explain your reasoning. (6 points)

$[Fe\{\eta^2\text{-}(H_2C{=}CH_2)\}(CO)_4] + PPh_3 \rightarrow [Fe\{\eta^2\text{-}(H_2C{=}CH_2)\}(PPh_3)(CO)_3] + CO$



→ While Fe(o) is low in spectrochemical series of metals CO and = are very strong field ligands. Thus, unreasonable to expect an e^- count > 18 would be energetically reasonable. Thus, the reaction must proceed via a dissociative mechanism

7. Provide a mechanism (based on the fundamental reactions that you have learned) to explain the following. Note that it is not necessary to draw transition states or use arrows to indicate electron movement, but the structure of every intermediate is required. Indicate in words (5 or less/reaction) what type of fundamental reaction(s) are taking place in each step of the mechanism. It is not necessary to draw transition states or to use arrows to indicate electron movement. (6 points)