Counting the electrons and Interpreting CO stretching frequencies and phosphine complexes

Exercise 1: Count the valence electrons on the metal atom for a) $[Mo(CO)_6]$; b) $[Fe(CO)_4]^{2-}$; c) $[Fe(CO)_4(PEt_3)]$; d) $[Rh(Me)(CO)_2(PPh_3)]$.

Exercise 2: Count the valence electrons on the metal atom for a) $[Co_2(CO)_8]$; b) $[Fe_2(CO)_9]$.

Exercise 3: Which of the two isoelectronic compounds $[Cr(CO)_6]$ and $[V(CO)_6]^-$ will have the higher CO stretching frequency and why?

Exercise 4: Which of the two chromium compounds $[Cr(CO)_5(PEt_3)]$ and $[Cr(CO)_5(PPh_3)]$ will have the lower CO stretching frequency and why? And which will have a shorter M-C bond?

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Exercise 5: Which of the two iron compounds [$Fe(CO)_5$] and [$Fe(CO)_4(PEt_3)$] will have the higher CO stretching frequency and why? And which will have the longest M-C bond?

Exercise 6: Provide plausible reasons for the differencies in IR wavenumbers between each of the following pairs: a) [$Mo(CO)_3(PF_3)_3$] 2040, 1991 cm^{-1} versus [$Mo(CO)_3(PMe_3)_3$] 1945, 1851 cm^{-1}; b) [$MnCp(CO)_3$] 2023, 1939 cm^{-1} versus [$MnCp^*(CO)_3$] 2017, 1928 cm^{-1}.

Determining the structure of a carbonyl from IR data

Exercise 7: The complex $[Cr(CO)_4(PPh_3)_2]$ has one very strong IR absorption band at 1189 cm^{-1} and two other very weak bands in the CO stretching region. The ν_{CO} of $[Cr(CO)_6]$ is at 2000 cm^{-1}. a) Why in this compound is lower? b) What is the probable structure of this compound?

Exercise 8: The complex $[PtCl_2(CO)_2]$, a carbonyl of a third row M(II) metal, shows ν_{CO} = 2175 cm^{-1}. $[W(Cp)_2(CO)_2]$, another third row M(II) carbonyl, shows ν_{CO} = 1872 and 1955 cm^{-1}. What do these differences indicate in terms of M-CO bonding?