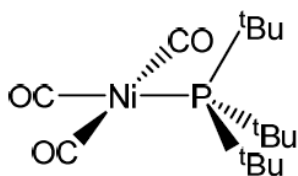# Tutorial 3
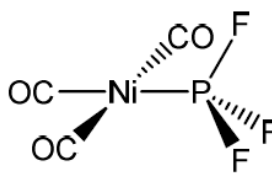
Q1. Using the 18 electron rule, determine whether the following complexes are electron precise or not.

1) $Cr(CO)_6$

2) $(\eta^5\text{-}C_5H_5)Fe(CO)_2Cl$

3) $[Mn(CO)_6]^+$

4) $(CO)_5Mn-Mn(CO)_5$

Q2. Using the bonding schemes for metal carbonyl and metal phosphine complexes explain the difference observed in v(CO) by FTIR spectroscopy for the trans-CO ligand of the following complexes.

$v(CO)_{trans} = 2056$ cm^{-1} $v(CO)_{trans} = 2111$ cm^{-1}

Q3. The carbon-carbon bond distance in ethylene is 133.7 pm compared to 137.5 pm in $[PtCl_3(C_2H_4)]^-$ and 143 pm in $[Pt(PPh_3)_2C_2H_4]$. Explain this observation.

Q4. Assuming that the following complexes are electron precise (the 18 electron rule is obeyed), determine the identity of the transition metal M.

a) $(\eta^4-C_4H_6)M(CO)_3$ (Hint: $\eta^4-C_4H_6$ is 1,4–butadiene)

b) $[(\eta^5-C_5H_5)M(CO)_2]_2$ (Hint: Assume M=M double bond)

Q5. Rationalize the trend in each of the following sets of IR-active CO stretching frequencies (cm^{-1}):

(a)

$Ni(CO)_4$ 2040

$[Co(CO)_4]^-$ 1890

$[Fe(CO)_4]^{2-}$ 1730

$[Mn(CO)4]^{3-}$ 1670
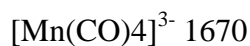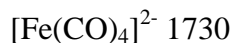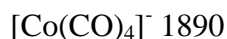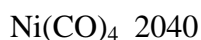
(b)

$[(\eta^6\text{-}C_6H_6)Cr(CO)_3]$ 1980, 1908

$[CpMn(CO)_3]$ 2027, 1942

Q6. Consider the complex ions $[\textbf{Fe(NH}_3)_6]^{3+}$, $[\textbf{Ru(NH}_3)_6]^{3+}$, $[\textbf{Co(NH}_3)_6]^{2+}$ and $[\textbf{Ir(NH}_3)_6]^{2+}$. Which **ONE** of these complexes will definitely **NOT** show a **Jahn-Teller distortion**? Explain why.

[HINT: the magnetic moments of the Fe and Co complexes are *considerably* higher than those of their heavier congeners, Ru and Ir, respectively.]

Q7. Explain why $[\textbf{FeF}_6]^{3-}$ is colourless while $[\textbf{CoF}_6]^{3-}$ is coloured.