Introduction: Electron counting is a *formalism* and does not necessarily reflect the distribution of electrons in a compound. There are many compounds that violate the 18-Electron Rule, but we will not be concerned with those in this class.

There are two methods of counting electrons in transition metal compounds and this often leads to confusion amongst students. The two methods are usually called the Covalent or Neutral Ligand method and the Ionic method. The key is to follow instructions as to which method to use (when given), be consistent (labeling the method that you are using is recommended), use the ionic method when a ligand is specifically listed in a problem as an ion, and use the covalent or neutral ligand method when the oxidation state of the metal is unknown.

The Ionic Method: Remove all of the ligands from the metal. If necessary add the proper number of electrons to each ligand to bring it to a closed valence shell state.

<u>Example</u>: How many electrons are donated by en in the complex ion $[Co(en)_2(Cl)_2]^+$?

<u>Solution</u>: The oxidation state of cobalt is +3, so it has 6 electrons. Remove the two chloride ions (closed valence shell). Each chloride ion can donate 2 electrons. Add up all the electrons, subtract from 18, and divide by two to get the number of electrons from each en: $\frac{18-(2\times 2+6)}{2}=4$.

<u>Example</u>: How many electrons are donated by each CN^- in $[Os(CN)_6]^{4-}$?

<u>Solution</u>: Count 6 electrons for Os^{2+}. The number of electrons donated by each CN^- is $\frac{18-6}{6}=2$.

The Covalent of Neutral Ligand Method: Remove the ligands and make them neutral. This method does not give us any immediate information about the oxidation state of the metal, so we must assign that in a separate step. For this reason, many chemists prefer the ionic method.

Example: How many electrons are donated by en in the complex ion $[Co(en)_2(Cl)_2]^{+}$?

Solution: Neutral cobalt has 9 electrons, each chlorine atom can donate one electron. One electron is subtracted for the positive charge. The total electrons is subtracted from 18 and divided by two to get the number of electrons donated by each en: $\frac{18-(9+2\times 1-1)}{2}=4$.

Example: How many electrons are donated by each CN in $[Os(CN)_6]^{4-}$?

Solution: Count 8 electrons for neutral Os and 4 electrons for the negative charge. The number of electrons donated by each CN is $\frac{18-(8+4)}{6}=1$.