CHEM 101  
Chemistry II  
Problem Set X

1) a) $K_2[CoCl_4]$
   b) $[Ru(NH_3)_6(H_2O)]^{3+}$
   c) $[Cr(H_2O)_4(NO_2)_2]I$
   d) $[Pt(NH_3)_4I_2][PtI_4]$  

2) a) Potassium tetrachloroplatinate(II) 
   b) Potassium hexacyanoferrate(III) (a much less pretty name than its old one: Potassium ferricyanide) 
   c) Bis(ethylenediamine)dinitritoiron(III) chloride 
   d) Pentaamminechlorocobalt(III) dicyanoaurate(I)  

3a) Gold here must be $+3$. Au$^{3+}$ has an electron configuration of $d^8$. Since tetrahedral has more than zero unpaired electrons, and we have none, we must have square planar here. We have $(d_{xz})^2(d_{yz})^2(d_{xy})^2(d_{x^2-y^2})^0$ as the occupancy for the complex.  
   b) It is pretty clear here that Ni must be $+2$ here, Ni$^{2+}$ has an electron configuration of $d^8$. Square planar would have no unpaired electrons, so we must have tetrahedral as our geometry. We have $(d_{x^2-y^2})^2(d_{z^2})^2(d_{xy})^2(d_{yz})^1(d_{x^2-y^2})^1$ as the occupancy for the complex.  
   c) Here, trying the different structures helps figure out the kind of ligands we have. For example, the NO$_2$ ligand can be either nitrite (NO$_2^-$) or nitrogen dioxide (NO$_2$). When one does this, one finds, given that ammine is a neutral ligand, it must be NO$_2$ (nitrogen dioxide), so we get the Pt as $+2$. Pt$^{2+}$ has an electron configuration: 5d$^8$. For a square-planar complex, there would be no unpaired electrons, so we must have a tetrahedral complex, which we do. We have $(d_{x^2-y^2})^2(d_{z^2})^2(d_{xy})^2(d_{yz})^1(d_{x^2-y^2})^1$ as the occupancy for the complex.  
   d) It is pretty clear that we have Mn$^{2+}$ here, which has an electron configuration of $d^5$, Only tetrahedral would allow for this number of unpaired electrons from a d$^5$ complex. We have $(d_{x^2-y^2})^1(d_{z^2})^1(d_{xy})^1(d_{yz})^1(d_{x^2-y^2})^1$ as the occupancy for the complex.  

4) If we had a regular planar geometry, it would be a hexagonal geometry, which could look like any of the following: 

Since, as you can see, there are three isomers possible, the existence of only two isomers does rule out hexagonal planar geometry. (Arguing that we just haven’t seen the third one, while logically correct, is not chemically correct; very good inorganic synthetic methodologies exist, and, were it possible, we would have made it.)
5) Looking at the Ag(NH$_3$)$_2^+$ ion, we find that Ag$^+$ is d$^{10}$, whereas Cu$^{2+}$ is d$^9$. The silver complex is therefore expected to be colourless since there are no orbitals to which the d-electrons can be excited. (Another way to say this, spectroscopically, is that there are no allowed transitions.) (This was a harder question unless you read the chapter a bit.)