

1) (6 points) Give the following information for Rh^{3+} .

- a) ground-state electron configuration (long form)
 $45 - 3 = 42 e^-$
- b) number of valence d electrons
- c) number of unpaired electrons for the *gas phase ion* $\uparrow\uparrow\uparrow\uparrow\uparrow$
- d) magnetism (paramagnetic or diamagnetic) for the *gas phase ion*
- e) spin state (high or low) for the ion in a *strong octahedral ligand field*
- f) magnetism (paramagnetic or diamagnetic) for *ion in part e* $--$

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^6$

6

4

paramagnetic

low

diamagnetic

2) (4 points) Write the name of the following coordination compounds

- a) $Na[Fe(CO)_4H]$ sodium tetracarbonyl hydrido ferrate (0)
- b) $[Cr(CO)_4(OH)_2]NO_2$ tetracarbonyl dihydroxo chromium(III) nitrite
- c) $[Co(H_2NCH_2CH_2NH_2)_3](SO_4)_3$ triethylene diammine cobalt(III) sulfate
- d) $(NH_4)_2[Ni(C_2O_4)_2(H_2O)_2]$ ammonium diqua bisoxalato nickelate(II)

3) (4 points) Based on elemental analysis, the empirical formula of a platinum compound is Cl_4PtK_2 . Conductivity analysis indicates that 1 formula unit yields 3 ions when dissolved in water. Addition of aqueous $AgCl$ to the unknown's solution does not give a precipitate.

- a) Write the coordination compound's formula.
- b) Write the name of this coordination compound.
- c) What is the geometry of the coordination complex?
- d) What is the number of unpaired electrons in the coordination complex?

K_2PtCl_4

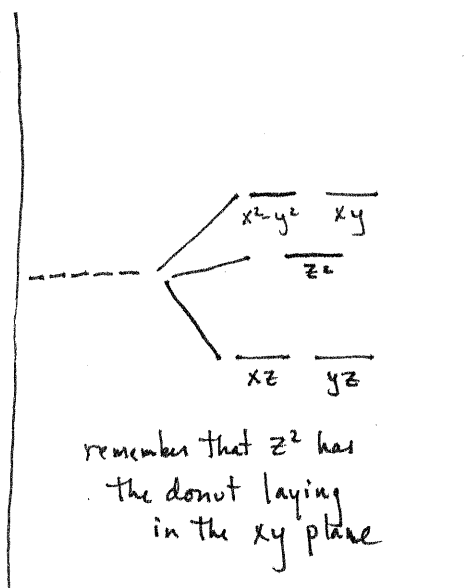
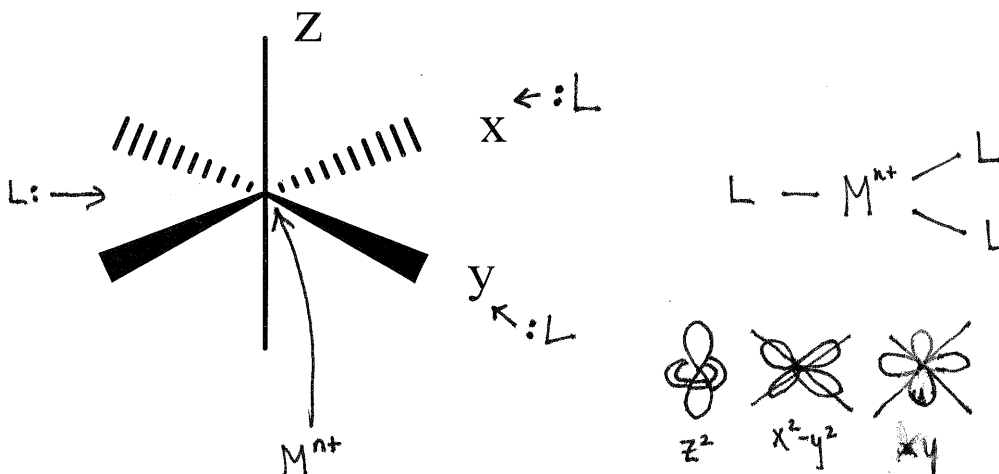
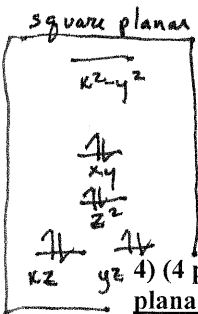
potassium tetrachloro platinate(II)

square planar

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$PtCl_4^{2-}$ Pt^{2+} , d^8

(4 points) Starting with a gas phase metal ion containing degenerate d orbitals, bring in ligands to form a trigonal planar structure. Predict the orbital energy diagram. Use the axes system shown.



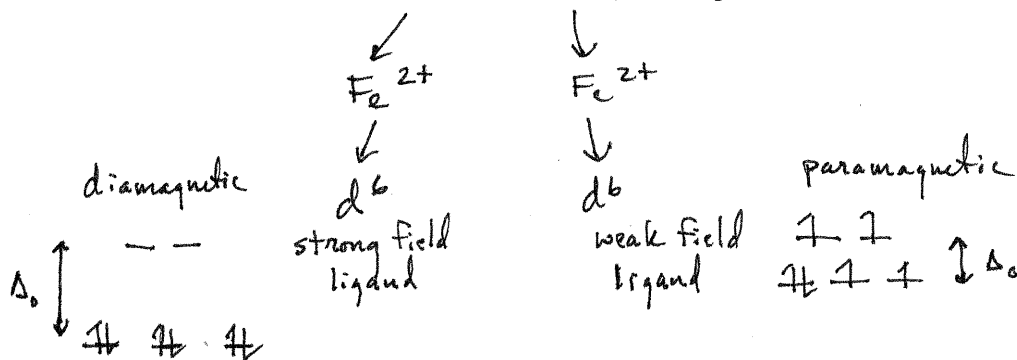
5) (4 points) Look at the picture on page 959 of the Zumdahl text. Explain the observed color of the coordination compounds based on the spectrochemical series.

a) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ magenta \rightarrow absorbed color \approx green \rightarrow lower energy \rightarrow smaller Δ_o

b) $\text{K}_3[\text{Fe}(\text{CN})_6]$ orange \rightarrow absorbed color \approx blue \rightarrow higher energy \rightarrow larger Δ_o

- a) The smaller Δ_o corresponds to weaker field ligands which ~~that~~ NH_3 and Cl^- are.
 b) The larger Δ_o corresponds to stronger field ligands which CN^- is.

6 (2 points) Which is more likely to be paramagnetic, $\text{Fe}(\text{CN})_6^{4-}$ or $\text{Fe}(\text{H}_2\text{O})_6^{2+}$? Explain.

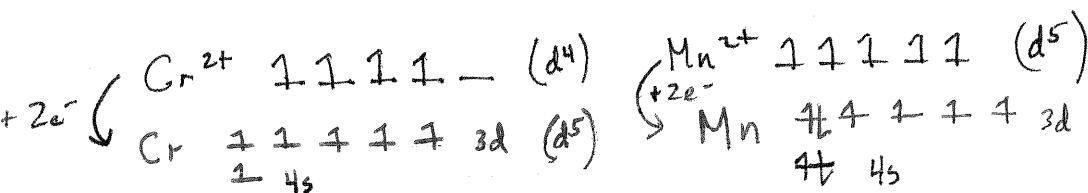


7) (4 points) Refer to page 947 of the Zumdahl text. Cr^{2+} has $\mathcal{E}^\circ = -0.91 \text{ V}$ and Mn^{2+} has $\mathcal{E}^\circ = -1.18 \text{ V}$.

- a) Which ion is more easily reduced all other factors being equal?
 b) Explain your answer in part a. Note, citing half-filled d orbitals is not sufficient.

a) Cr^{2+}

b) Cr^{2+} has the more positive reduction potential (more negative ΔG°)



The $d^5 \text{Mn}^{2+}$ is more stable than the $d^4 \text{Cr}^{2+}$ but the Mn^{2+} requires pairing twice to Cr^{2+} 's none. More energy required to pair up like charges.

8) (2 points) Refer to page 947 of the Zumdahl text. The range of the 1st ionization potentials is 2.82 eV and that of the 3rd ionization potential is 14.96 eV. Explain this difference for the first row d block elements.

As n e^- is removed the net charge on the atom increases. This lowers the energy of the atom's orbitals. This becomes most pronounced after the 4s e^- s are removed. The net +2 charge lowers the energy of the 3d orbitals substantially. Z_{eff} also increases from left to right which leads to the late d block metals usually having the higher ionization energy (1st or 3rd).