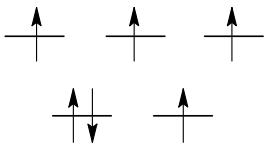
SECTION 1 STUDY QUESTIONS

SOLUTIONS

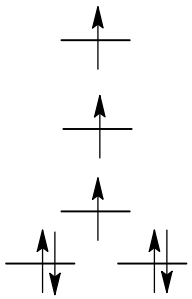
1. (a) tetrahedron is always high spin, therefore d^6 has 4 unpaired electrons



(b) H_2O is a weak-field ligand, therefore get high spin situation. Co^{2+} is d^7, therefore the compound has 3 unpaired electrons

(c) Cr^{3+} is d^3, therefore 3 unpaired electrons

(d) Square planar you normally assume is "high spin," therefore d^7 has 3 unpaired electrons: (note - this is the order for a π-donor, will be slightly different for π-acceptor)

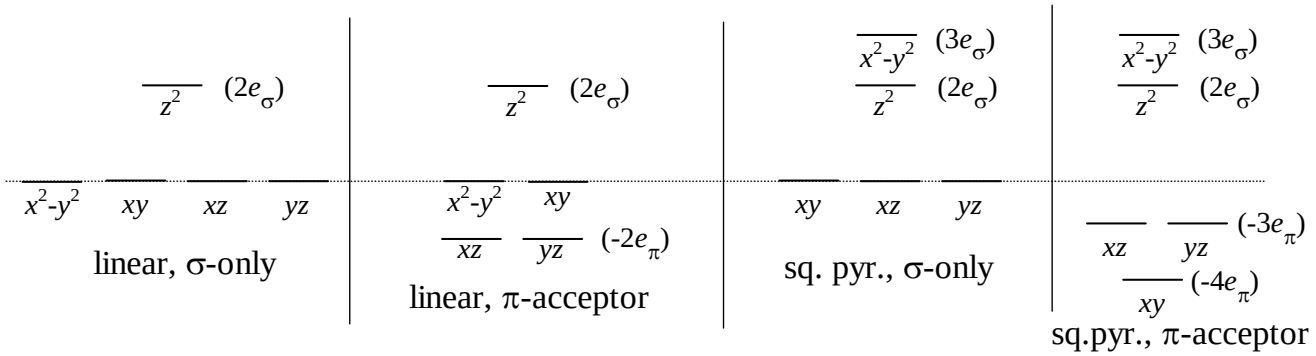


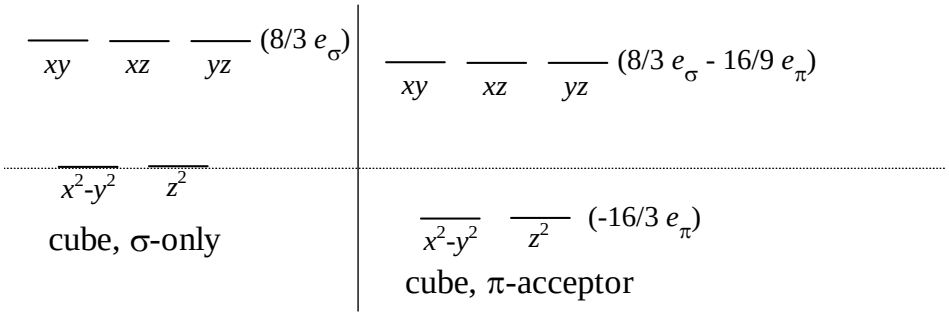
(e) $\mu_B = [N(N+2)]^{½}$ (where N = # of unpaired electrons)

Solving the quadratic equation gives N = 4.2 (call it 4 unpaired electrons)

5. Both of these compounds have 6 ligands. Ni_{2+} is d^8 is often square planar, Cu^{2+} is d^9 and often Jahn-Teller distorted. Therefore, neither case likes O_h symmetry. Luckily, for the first two cases, the symmetry is lowered as a result of the presence of two unlike ligands (each en has two σ-only N donors, H_2O is a π-donor), which lowers the symmetry and allows the metals to have their distortions. However, when there are six N-donors in $M(en)_3^{2+}$, the resulting complex is very close to O_h symmetry (it actually has D_3, but the metal itself sees 6 identical N atoms), so the distortion wants to kick in and go to square planar complexes instead. Thus, the O_h-like complex has low stability.

6. For (b) trigonal planar, see class notes.
For (d) trigonal bipyramidal, see Assignment 1.
For (e), you can just double the values for positions 7, 8, 9, 10





7., 8. Will post after assignment 1 handed in.

9. Co(II) is d^7.
O_h high spin would have 3 unpaired electrons, $\mu_B = [3(3+2)]^{½} = 3.87\ \mu_B$.
O_h low spin would have 1 unpaired electrons, $\mu_B = [1(1+2)]^{½} = 1.73\ \mu_B$.
T_d (must be high spin) would have 3 unpaired electrons, $\mu_B = [3(3+2)]^{½} = 3.87\ \mu_B$.
D_{4h} "low spin" would have 3 unpaired electrons, $\mu_B = [3(3+2)]^{½} = 3.87\ \mu_B$.
D_{4h} "high spin" would have 3 unpaired electrons, $\mu_B = [3(3+2)]^{½} = 1.73\ \mu_B$.

13. The four σ-only donors are in the order expected ($Cl^- < F^- < NH_3 \approx$ en) based on the strength of the σ-bonds (N forms the strongest σ-bond, and so on down the line). H_2O forms a σ-bond roughly the same strength as NH_3, but is also a π-donor, which makes the Δ_O smaller for H_2O. Similarly, CN^- forms a σ-bond similar in strength to NH_3, but is a π-acceptor, so Δ_O increases significantly.

17. As with #13, H_2O is exceptionally weak because it is a π-donor.

21. (a) Cr^{2+}, d^4, high spin O_h, $\mu_B = 4.90\ \mu_B$.
(b) Cr^{2+}, d^4, low spin O_h, $\mu_B = 2.83\ \mu_B$.
(c) Fe^{3+}, d^5, T_d (high spin), $\mu_B = 5.92\ \mu_B$.
(d) Fe^{3+}, d^5, low spin O_h, $\mu_B = 1.73\ \mu_B$.
(e) Ni^{2+}, d^8, O_h, $\mu_B = 2.83\ \mu_B$.
(f) Cu^{2+}, d^9, $\mu_B = 1.73\ \mu_B$.