

Admin:

1) Return test 2

Last time:

film "An Inconvenient Truth"

Quiz (part of final). Return quizzes

Last Wed: up to

nomenclature of complexes

**Today: (1) student survey**

**(1) Crystal field theory**

**(1) Bonding**

a) crystal field theory can best explain:

magnetic properties (spin)

stability of coordination compds

b) valence bond theory

insight on geometry

Write down the e confign

of transition elements: say:  $30\text{Zn}$ :

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} \dots = 30$

(Zn a 2B element = has properties

similar to 2A like Mg which has  $3s^2$ )

Elements between: 21-29 are

first row transition elements

(they are in 4th row of periodic table.

We'll limit ourselves to this

first row transition elements.)

Say  $29\text{Cu}$ :  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

(note that  $3d^{10}$  is filled first before  $4s^1$ )

Cu is group 1B

$21\text{Sc}$ : [Ar]  $4s^2 3d^1$      $22\text{Ti}$ : [Ar]  $4s^2 3d^2$

$23\text{V}$ : [Ar]  $4s^2 3d^3$      $24\text{Cr}$ : [Ar]  $4s^1 3d^5$

$25\text{Mn}$ : [Ar]  $4s^2 3d^5$      $26\text{Fe}$ : [Ar]  $4s^2 3d^6$

$27\text{Co}$ : [Ar]  $4s^2 3d^7$      $28\text{Ni}$ : [Ar]  $4s^2 3d^8$

$29\text{Cu}$ : [Ar]  $4s^1 3d^{10}$

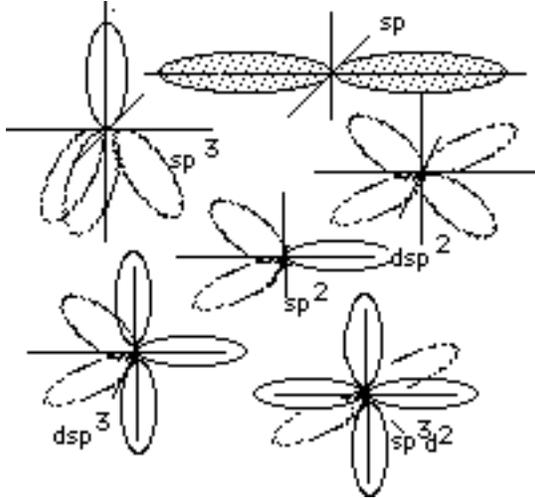
Valence Bond Theory (VBT)

and Crystal(Ligand) Field Theory (CFT)

as applied to the octahedral complex.

Let us summarize these two theories:

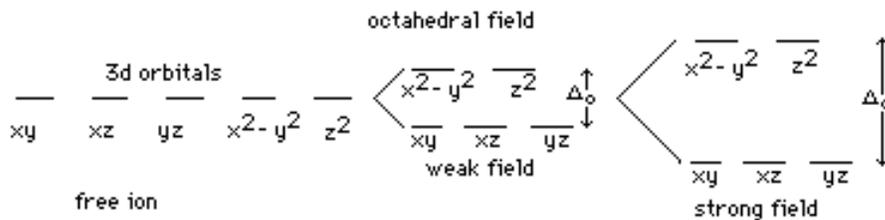
VBT: Involves hybrid orbitals:  
 Review hybrid orbitals(Chapt 9  
 (p316) if you are not comfortable  
 with these hybridzn orbitals.



Crystal field theory treats ligands' interaction as primarily electrostatic in nature. Ligand's electrons exert an electric field (*crystal field*) that affects energy levels of d-orbitals differently.

In crystal field theory, focus is on the energy levels:

Again: the energy separations,  $\Delta_o$ , is affected by crystal's electric field.  $\Delta =$  crystal field splitting energy



and, tetrah are weak field while sq plan are strong field (none otherwise known contradictory to this generalization).

Transition metals tend to have close-packed structs, with coord # = 12 (recall hcp crystals)

Result: these are very dense; have strong metallic bonds, high melting pts & boiling p, & relatively higher heats of fusion and vaporizn than those of groups 1A & 2A (as well as 2B).

Typical oxidation numbers are:

Sc +3, Ti +4, V +5, Cr +3,+6,

Mn 2+,4+,5+, Fe 2+,3+,

Co 2+,3+, Ni 2+, Cu +1,+2

Read up on properties of the above transition metals: - its ores, its unique props, its usefulness (for your own enrichment)

spectrochemical series: lists

weak vs strong field ligands:

halides (F<sup>-</sup>, Cl<sup>-</sup>), C<sub>2</sub>O<sub>4</sub><sup>2-</sup> < H<sub>2</sub>O

< NH<sub>3</sub> = en < phen < CN

Color depends on perception of complementary color:

400 violet, 500 blue, 550 green,

600 yellow, 700 red.

Recall the color wheel.

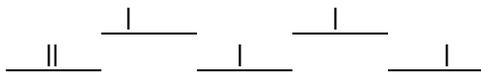
Absorption depends on *d to d transitions* which depends on splitting energy,  $\Delta$

Consider octahedral complexes:

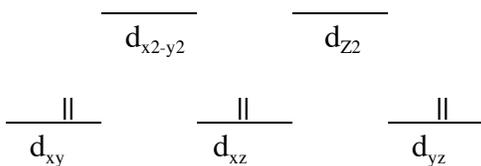
Consider  ${}_{26}\text{Fe}^{2+}$  in weak field and strong field:

(Another:  ${}_{27}\text{Co}^{3+}$ ) [Ar]3d<sup>6</sup>:4s<sup>2</sup>

so if weak: spin=4 (*high spin*)



and if strong: spin=0 (*low spin*)



So weak field gives higher spin and so on.

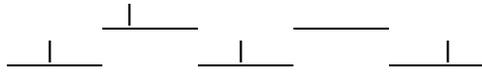
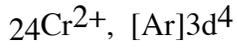
4 of 4

Another example: potassium hexachlorochromate(II):



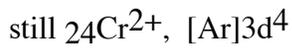
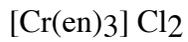
complex is  $[Cr(Cl)_6]$ .

Remember halides => weak ligand; weak field,

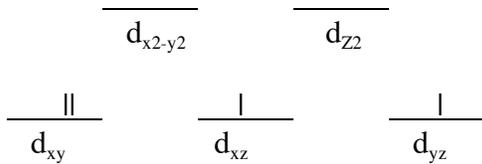


and  $spin=4$ .

compare with  
potassium tris(ethylenediammine)chromate(II):



Remember en => strong ligand; strong field,



$spin=2$ . (less spin than weak field)

color is different.