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Chem 103 Lecture 26 PS 158

Admin:

1) Return test 2

**Test 2** Class average:

91(61%)  $\pm$  23(15%); high = 139(93%)

A  $\geq$  118; B  $\geq$  105; C  $\geq$  75; D  $\geq$  55

**Film on Friday 8:15-10 am PS158:**

**“An Inconvenient Truth”**



**Required attendance 8-8:50 am**

**Chem 103 students please sit in center seats**

**8-8:13 am**

**5-point mandatory quiz (part of Final Exam).**

**Material: Chapt 21 section 1**

**Relate it to chapt 20 (belt of stability,**

**Binding Energy/nucl)**

**Last time:**

1. activity
2. units measuring exposure to radioactivity: tissue damage
3. carbon dating

**Today: coordination complexes**

(chapter 22.6 -22.7; included in final exam)

**Lecture:**

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Chapt 21:

1) elements formation - origins

15 B years ago; big bang, 1 sec  $10^{32}$ K to  $10^9$  2hr: to  $10^7$ (suitable for H, He)

nuclear burning: fusion up to formation of Fe inside stars

H burning:  $4 \text{ H} \rightarrow \text{He}$

He burning:  $2 \text{ He} \rightarrow \text{Be}$

$\text{Be} + \text{He} \rightarrow \text{C}$

Goes as fusion results in greater stability of nucleus (until Fe)

Temperature rises in time (millions, billions of years scale)

Formation of heavier elements: not by fusion

By s process: slow capture of n: nuclei become beta emitters

By r process: rapid process occurring during explosive stage of star.

Nuclei are captured within short time making possible series of reactions involving unstable isotopes

Terrestrial elements: READ UP ON THIS

**Coordination chemistry: Mainly Chapt 22.6 on**

(1) Transition elements have

electron config'n: (noble gas)(n-1)d<sup>x</sup>ns<sup>y</sup>

n = period number, x=(1-10), y=(1,2)

transition elements can form

coordination compounds in solution

(2) A **complex**: "coordination complexes"

("complex ions") are metal cations

(acting as Lewis acids, empty orbitals,

e-pair acceptors) which are bound to

ligands,(Lewis bases, unshared e pairs,

e pair donors)

eg:  $\text{Ni}^{2+} + \text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)]^{2+}$

brackets are used to indicate complex.

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(2a) **coordination** (dative) **covalent bond**.

Usually not as strong

as regular covalent but can be quite strong.

(2b) coordination complex is a different chemical species than just metal ion by itself: diff properties.

$\text{CuSO}_4$  (aq)

different from *coordination compound*:

$[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$

(3) Coordination number = # sites bound to ligand

EG:  $\text{M} + 2\text{L} \rightarrow \text{ML}_2$  (L at 2 sites, like  $\text{Ag}(\text{NH}_3)_2$ )  
that's coord # = 2  $\text{NH}_3$  acts as monodentate ligand.

Monodentate = "one tooth".

Polydentate ligands bind > 1 site.

eg. ethylene diamine ("en") = bidentate,

$:\text{NH}_2\text{-CH}_2\text{-CH}_2\text{-H}_2\text{N}:$

another: Oxalate:  $\text{C}_2\text{O}_4^{2-}$

phenanthroline = "phen"

Hexadentate examples:

ethylene diamine tetraacetic acid ("EDTA");

$(\text{:OOC})_2\text{:N-CH}_2\text{-CH}_2\text{-N:-(COO:}^-)^2$

Chelators = "claws". Polydentate ligands

Charge of complex consistent with oxidation #'s

eg. cation:  $[\text{Co}(\text{en})_2(\text{H}_2\text{O})\text{Cl}]^{2+}$

### **Nomenclature:**

eg. Coordination compound  $[\text{Co}(\text{en})_2(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$

aquachlorobis(ethylenediammine)cobalt(III)chloride  
(the cation is a complex)

$\text{K}_2[\text{CoCl}_4]$  potassium tetrachlorocobaltate(II).

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(the anion is a complex)

For naming coordination complexes

(read pages 1065-1067)

naming coordination compounds:

- 1) salt: name the cation first then anion (as usual)
- 2) in complex, ligands first (alphabetically) then metal
- 3) anionic ligands end with -o, neutral ligand is name of ligand (exceptions: aquo, carbonyl, ammine)
- 4) use greek letters di, tri, tetra; but if ligand name already has these, then use bis, tris, tetrakis
- 5) oxid'n # of metal is written in roman numerals
- 6) if complex is anion, metal name ends with -ate.

Names of common ligands: (table 22.4)

$\text{Br}^-$  bromo,  $\text{CO}_3^{2-}$  carbonato,  $\text{Cl}^-$  chloro,  $\text{CN}^-$  cyano,  $\text{F}^-$  fluoro,  $\text{OH}^-$  hydroxo,  $\text{C}_2\text{O}_4^{2-}$  oxalato,  $\text{NH}_3$  ammine, CO carbonyl,  $\text{H}_2\text{O}$  aqua

Others: en = ethylene diammine,

(-ate becomes ato, ite => ito, ide=> o, neutral name same as molec,

name:



=tetraamminecopper(II) sulfate



=potassium tetrachlorocobaltate(II)



= aquachlorodi(ethylenediammine)cobalt(III) chloride

**coordination geometry:**

refers to geometry of complex

for example: 4 Ligands binding can

be either square planar or tetrahedral

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depending on the tightness of binding.

consider only monodentates

ML<sub>2</sub> " linear", Ag(NH<sub>3</sub>)<sub>2</sub>

ML<sub>4</sub>: tetrahedral or square planar

ML<sub>6</sub>: octahedral

Isomerism: same formula but diff properties

linkage isomerism: eg :NO<sub>2</sub><sup>-</sup> (nitro) or ONO:<sup>-</sup> (nitrito)

geometric isomers:

cis-trans isomers in sq planar and octahedr

chiral complexes (handedness)-enantiomers.

similar physical but diff optical properties

called optical isomers

Possibilities for tetrahedral complexes

MA<sub>4</sub>, MA<sub>3</sub>B, MA<sub>2</sub>B<sub>2</sub>, MA<sub>2</sub>BC      one isomer

MABCD 2 isomers; mirror images (optical isomers)

MA<sub>2</sub>B<sub>2</sub> sq planar: 2 geo isomers: cis and trans

Octahedral: many possibilities: