Homework: Chapter 23

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9:30 PM

Problems: 6, 9, 11, 15, 16, 17, 24, 25, 32, 41, 47, 49, 50, 55, 56, 63, 64, 75, 85, 91,98, 99, 102, 127

6.

a. The lanthanide contraction is responsible for the decrease in atomic size resulting from the increase in nuclear charge.
b. How does it affect atomic size down a group of transition elements? Increases
c. How does it influence the densities of the Period 6 transition elements? Greatly increase

9.

a. What difference in behavior distinguishes a paramagnetic substance from a diamagnetic one? Paramagnetic has unpaired electrons and is attracted to a magnetic field.
b. Why are paramagnetic ions common among the transition elements but not the main-group elements? Because transition elements have the d orbital which consists of up to 5 electron pairs
Why are colored solutions of metal ions common among transition elements but not the man-group elements?
Because they exist with unpaired electrons which allows them to absorb multiple wavelengths of light.

(11) (a) Ru^{44} $[Kr]4d^7 5s^1$

(b) Cu^{29} $[Ar]3d^{10}4s^1$

(c) Ni^{28} $[Kr]3d^8 4s^2$

(15) (a) Cr^{3+} $[Ar]3d^1 4s^2$
1 unpaired e^-

(b) Ti^{4+} $[Ar]$
0 unpaired e^-

(c) Co^{3+} $[Ar]3d^6 4s^1$

(d) Ta^{2+} $[Xe]4f^{14}5d^3$

(16) highest possible oxidation states
(a) Ta^{+5} (b) Zr^{+4} (c) Mn^{+7}

(17) (a) Nb^{+5} (b) Y^{+3} (c) Tc^{+7}

(24) CrO_3 is more acidic because Cr is in higher oxidation state

(25) MnO_2 is more basic because Mn is in a lower oxidation state

(32) (a) Eu^{2+} $[Xe]4f^7$
Eu^{3+} $[Xe]4f^6$
r^{4+} $[Xe]4f^5$

(32) Eu [Xe] ...

Eu^{3+} [Xe] $4f^6$

Eu^{4+} [Xe] $4f^5$

the ½ filled f orbital is most stable

(b) Tb [Xe] [↑↓] [↑↓] (6s) [↑] [↑] [↑] [↑] [↑] [↑] [↑] [↑] [↓] (4f) [ ] [ ] [ ] [ ] [ ]

Tb^{2+} [Xe] $4f^9$

Tb^{3+} [Xe] $4f^8$

Tb^{4+} [Xe] $4f^7$

Tb^{4+} most stable because ½ filled f orbital

(41) $Cr(OH)_4^- + H^+ \rightarrow Cr(OH)_3(s) + H_2O$

$Cr(OH)_3(s) + H^+ \rightarrow Cr(H_2O)_2(OH)_4(aq)$

(47) The coordination number of a metal ion in a complex ion is the number of ligands. The oxidation number is different although sometimes related since the coordination number tends to be double the oxidation number.

49. What geometries are associated with the coordination numbers 2,4, and 6? 2-linear, 4-square planar or tetrahedral, 6-octahedral

50. Cobalt (III) - 6, Platinum(II) - 4, Platinum(IV) - 8

55. .

a.

$[Ni(H_2O)_6]Cl_2$	Hexaaquanickel(II) chloride

b.

$[Cr(en)_3](ClO_4)_3$	Tri(ethylenediamine)chromium(III) perchlorate

c.

$K_4[Mn(Cn)_6]$	Potassium Hexacyanomanganate(II)

56. .

a.

$[Co(NH_3)_4](NO_2)_2]Cl$	Tetraaminedinitrogendioxidecobate(III)

b.

$[Cr(NH_3)_6][Cr(CN)_6]$	Hexaaminecromate(III) hexacyanochromate(III)

c.

$K_2[CuCl_4]$	Potassium tetrachlorocuprate(II)

(63) (a) 4 NH_3 Zn SO_4

$[Zn(NH_3)_4]SO_4$

(b) 5 NH_3 Cl Cr Cl

$[Cr(NH_3)_5Cl]Cl_2$

(c) $Na_3[Ag(S_2O_3)_2]$

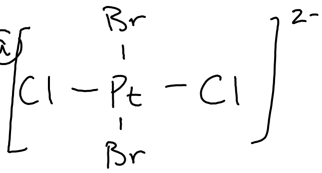
(64) (a) $2Br^-$ 2(en) Co (III) SO_4^{2-}

$[CoBr_2(en)_2]_2 SO_4^{2-}$

(b) 6 NH_3 Cr(III) / 5 Cl Cu(II)
$[Cr(NH_3)_6][CuCl_5]$

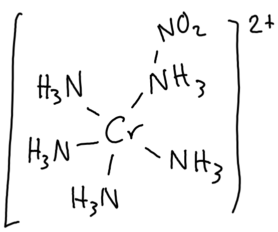
(c) K 6 CN^- Fe(II)
$K_4[FeCN_6]$

75 (a)



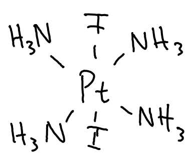
cis-trans

(b)



linkage

(c)



cis-trans

85. .

a. What is the crystal field splitting energy?
   The difference in energy between e_g and t_{2g} sets of orbitals

b. How does it arise for an octahedral field of ligands?
   Electrostatic interactions between metal ion and ligands. The ligands come fron x,y, and z axes. D_{x2-y2} and d_{z2} orbitals are higher in energy and d_{xy} d_{yz} and d_{xz} are lower in energy.

c. How is it different for a tetrahedral field of ligands?
   Ligands do not aproace form the x, y, and z axis. Interaction is greator for d_{xy}, d_{yz}, and d_{xz} orbitals than d_{x2-y2} and d_{z2} orbitals.

91 (a) $[Cr(H_2O)_6](ClO_3)_2$
Cr(II)
$[Ar]4s^1 3d^5$ Cr
$Cr^{2+} = [Ar]3d^4$
d = 4

(b) $[Mn(CN)_6]^{2-}$
Mn(IV)
$Mn = [Ar]4s^2 3d^5$

$Mn = [Ar]4s^2 3d^5$

$Mn^{+4} = [Ar]4s^2 3d^1$

d = 1

ⓒ $[Ru(NO)(en)_2Cl]Br$

Ru(II)

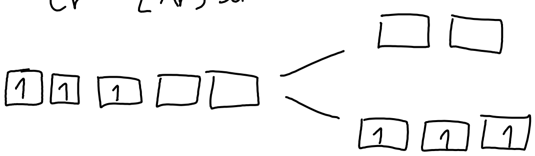
$Ru = [Kr]5s^2 4d^6$

$Ru^{+2} = [Kr]5s^1 4d^5$ or $[Kr]4d^6$

d = 5

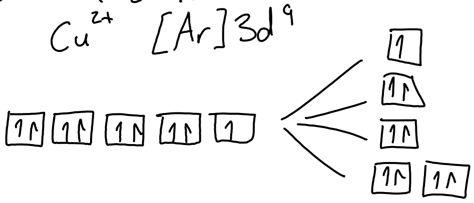
(98) ⓐ $[Cr(H_2O)_6]^{3+}$

Cr^{3+} $[Ar]3d^3$



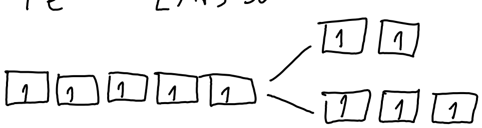
ⓑ $[Cu(H_2O)_4]^{2+}$

Cu^{2+} $[Ar]3d^9$



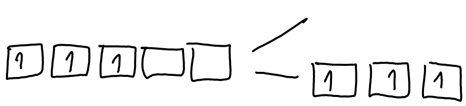
ⓒ $[FeF_6]^{3-}$

Fe^{3+} $[Ar]3d^5$



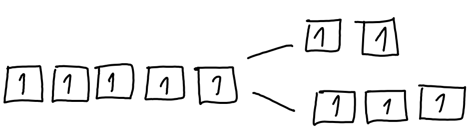
(99) ⓐ $[Cr(CN)_6]^{3-}$

Cr^{3+} $[Ar]3d^3$



ⓑ $[Rh(CO)_6]^{3+}$

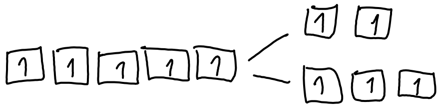
Rh^{3+} $[Kr]5s^1 4d^5$



ⓒ $[Co(OH)\ ]^{3-}$

(c) $[Co(OH)_6]^{3-}$

Co^{3+} $[Ar]4s^1 3d^5$



(102) $[Cr(H_2O)_6]^{3+} < [Cr(NH_3)_6]^{3+} < [Cr(NO_2)_6]^{3-}$

(127) In $[Cr(NH_3)_6]^{3+}$ it absorbs blue-violet range and the human eye perceives the complimentary color yellow-orange. In $[Cr(H_2O)_6]^{3+}$ it absorbs red and we perceive the complimentary color blue-gray. Both are octahedral and have the same coordination number. In each substance there are 2 d orbital electrons in the Cr^{3+}.

In the hexaaquachromate(III) red is absorbed by the electrons lowest arrangement: