ATOMS, MOLECULES AND RESEARCH

COORDINATION CHEMISTRY – SPRING – WEEK 6

Chapter 10

(9) $Co = 4s^2\ 3d^7$ $Co(II) = 3d^7$

Tetrahedral:

↑ ↑ ↑ t_2

↑↓ ↑↓ e

tetrahedral

3 upaired electrons

$\mu_s = \sqrt{n(n+2)}$ BM

$\mu_s = \underline{3.87\ BM}$

Octahedral:

↑ ↑ e_g

↑↓ ↑↓ ↑ t_{2g}

octahedral

3 unpaired electrons

$\mu_s = \underline{3.87\ BM}$

Square planar:

—

↑

↑↓

↑↓ ↑↓

square planar

one unpaired electron

$\mu_s = \sqrt{n(n+2)}$ BM

$\mu_s = \underline{1.73\ BM}$

(11) $[Co(H_2O)_6]^{3+}$ = d^6 case, low spin, LFSE = $-\frac{12}{5}\Delta_o$

$[Co(H_2O)_6]^{2+}$ = d^7 case, high spin, LFSE = $-\frac{4}{5}\Delta_o$

$[Co(H_2O)_6]^{3+}$ = d^6 case, low spin, LFSE = $-\frac{12}{5}\Delta_o$

$[Co(H_2O)_6]^{2+}$ = d^7 case, high spin, LFSE = $-\frac{4}{5}\Delta_o$

↑ ↑

↑↓ ↑↓ ↑

Co(II)
d^7 case

— —

↑↓ ↑↓ ↑↓

Co(III)
d^6 case

[illegible]

#2

~~an oxidizing agent, the $[Co(NH_3)_6]^{3+}$ does not.~~

(4) $[Co(H_2O)_6]^{3+}$ LFSE $= -\frac{12}{5}\Delta_o$, $\Delta_o = 18{,}000\ cm^{-1}$

$\therefore$ LFSE $= \underline{-43{,}200\ cm^{-1}}$

$[Co(H_2O)_6]^{2+}$ LFSE $= -\frac{4}{5}\Delta_o$, $\Delta_o = 9{,}700\ cm^{-1}$

$\therefore$ LFSE $= \underline{-7{,}760\ cm^{-1}}$

$\therefore$ The energy difference when Co(III) is reduced to Co(II) ~~for~~ the hexaaqua complex $= 35{,}440\ cm^{-1}$

$[Co(NH_3)_6]^{3+}$ LFSE $= -\frac{12}{5}\Delta_o$, $\Delta_o = 24{,}000\ cm^{-1}$

LFSE $= -57{,}600\ cm^{-1}$

$[Co(NH_3)_6]^{2+}$ LFSE $= -\frac{4}{5}\Delta_o$, $\Delta_o = 10{,}200\ cm^{-1}$

LFSE $= -8{,}160\ cm^{-1}$

$\therefore$ The energy difference ~~between~~ when Co(III) is reduced to Co(II) for the hexammine complex is $49{,}440\ cm^{-1}$

$\therefore$ It is easier to reduce the $[Co(H_2O)_6]^{3+}$ complex than $[Co(NH_3)_6]^{3+}$. $\therefore$ $[Co(H_2O)_6]^{3+}$ is a better oxidizing agent.

(12) $[Co(CO)_4]^{2+}$ ← typo in text Co^{2+} d^7

t_2 ↑ ↑ ↑ } $\frac{2}{5}\Delta_t$

e ↑↓ ↑↓ } $\frac{3}{5}\Delta_t$

$n = 3$

$\mu_s = \sqrt{n(n+2)}$ B.M.

$= 3.87$ BM

$LFSE = 4\left(-\frac{3}{5}\Delta_t\right) + 3\left(\frac{2}{5}\Delta_t\right)$

$= -\frac{6}{5}\Delta_t$

$[Cr(CN)_6]^{4-}$ Cr^{+2}

-6

d^4 case

Strong field

— — e_g

↑↓ ↑ ↑ t_{2g}

$n = 2$

$\mu_s = \sqrt{n(n+2)}$ BM $= 2.83$ BM

$LFSE = 4\left(-\frac{2}{5}\Delta_o\right) = -\frac{8\Delta_o}{5}$

$[Fe(H_2O)_6]^{3+}$ Fe^{3+} d^5 case

weak field

↑ ↑ e_g

↑ ↑ ↑ t_{2g}

$n = 5$

$\mu_s = \sqrt{n(n+2)}$ BM $= 5.92$ BM

$LFSE = 3\left(-\frac{2}{5}\Delta_o\right) + 2\left(\frac{3}{5}\Delta_o\right) = +0$ [illegible]

$[Co(NO_2)_6]^{4-}$ Co^{2+} d^7 case

Strong field

-6

↑ — e_g

↑↓ ↑↓ ↑↓ t_{2g}

$n = 1$ $\mu_s = 1.73$ BM

$LFSE = 6\left(-\frac{2}{5}\Delta_o\right) + 1\left(\frac{3}{5}\Delta_o\right)$

$= -\frac{9}{5}\Delta_o$

$[Co(NH_3)_6]^{3+}$ Co^{3+} d^6 case

— — e_g

1L 1L 1L t_{2g}

$n = 0$

$\mu_s = 0$

$LFSE = 6\left(-\frac{2}{5}\Delta_o\right) = -\frac{12}{5}\Delta_o$

MnO_4^- Mn^{+7} d^0 case

+7 −8

— — e_g

— — — t_{2g}

$n = 0$

$\mu_s = 0$

$LFSE = 0$

$[Cu(H_2O)_6]^{2+}$ d^9 case

1L 1 e_g

1L 1L 1L t_{2g}

$n = 1$

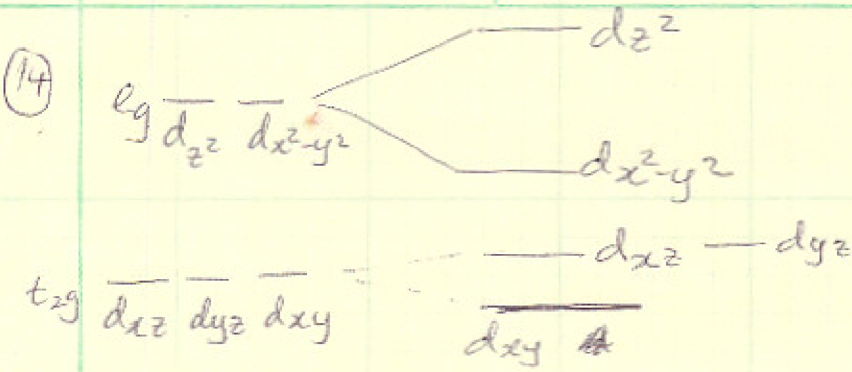
$\mu_s = \sqrt{n(n+2)}\ BM = 1.73\ BM$

$LFSE = 6\left(-\frac{2}{5}\Delta_o\right) + 3\left(\frac{3}{5}\Delta_o\right)$

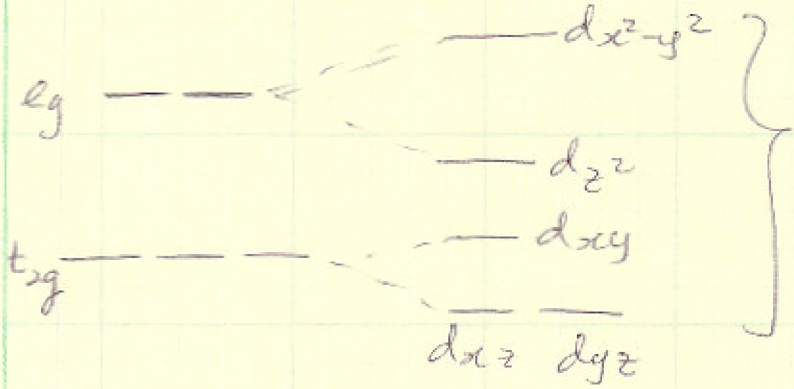
$= -\frac{3}{5}\Delta_o$

* Matt: If students have selected high spin instead of low spin (or vise versa) please grade accordingly.

(14)



compression along z axis } orbitals that are directed along the z axis become destabilized.



elongation along the z axis.