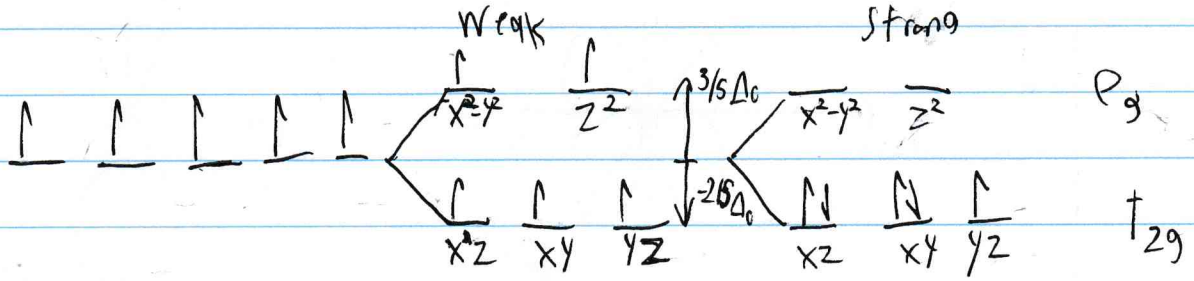
Exam 4 Problems

Problem 1

(a): $8 - 3 = 5$

(b):



(c): (i): High spin; 5; $(t_{2g})^3 (e_g)^2$
(ii): Low spin; 1; $(t_{2g})^5$

(d): $3 \cdot \frac{-2}{5}\Delta_o + 2 \cdot \frac{3}{5}\Delta_o = 0$

(e): $5 \cdot \frac{-2}{5}\Delta_o = \frac{-10}{5}\Delta_o$

(f): Recall $e = h\nu$ and $c = \nu\lambda \Rightarrow \nu = \frac{c}{\lambda}$ implies

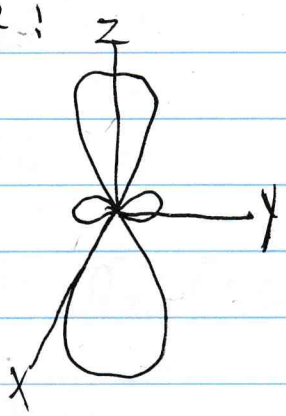
$$e = \frac{hc}{\lambda} = \frac{3 \cdot 10^8 \text{ m s}^{-1} \cdot 6.626 \cdot 10^{-34} \text{ J s}}{700 \text{ nm} \cdot \frac{1 \text{ meter}}{1{,}000{,}000{,}000 \text{ nm}}} = 2.84 \cdot 10^{-19}$$

divide by 1000 and multiply by Avogadros number:

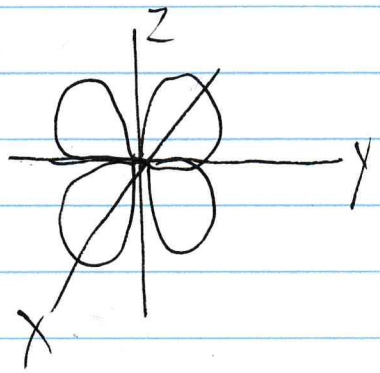
171.01 KJ/mol.

Problem 2

(a) d_{z^2} :



d_{yz} :



(b) d_{z^2} is unstable relative to d_{yz}.

Problem 3

(a): First order

(b): Second order

(c): $R = k[O_2][NO]^2$

(d): $1 + 2 = 3$

(e): Solve for k in

$$R = k\left(1.10 \cdot 10^{-2}\ \text{mol}\ L^{-1}\right)\left(1.30 \cdot 10^{-2}\ \text{mol}\ L^{-1}\right)^2 = 3.21 \cdot 10^{-3}\ \frac{\text{mol}}{s}$$

$$= k\ \ 1.86 \cdot 10^{-6}\ \ \text{mol}^3\ L^{-3} = 3.21 \cdot 10^{-3}\ \ \text{mol}^{-1}\ s^{-1}$$

implies

$$k = 1725.8\ \ \text{mol}^{-4}\ L^3\ s^{-1}$$

Problem 4

Recall

$t_{1/2} = \frac{0.693}{k} = 28.1\,y \Rightarrow k = 0.02[illegible]\,y^{-1}$

Thus

$k = 0.025\,y^{-1} = [illegible] \cdot \frac{y}{3.154 \cdot [illegible]} =$

$= 0.025\,y^{-1} \cdot \frac{1\,y}{3.154 \cdot 10^{7}\,s} = 7.926 \cdot 10^{-10}\,s^{-1}$

Thus by plugging into

$[A] = 3.0 \cdot 10^{14}\,Bq \cdot e^{-7.926 \cdot 10^{-10} \cdot 2.365 \cdot 10^{9}} = 4.6 \cdot 10^{13}$

Problem 5

Can split into half reactions:

$Pb(OH)_4^{2-} \rightarrow PbO_2$

$ClO^- \rightarrow Cl^-$

Nothing except for O and H needs to be balanced; on reactants

$\rightarrow PbO_2 + 2H_2O$

$\rightarrow Cl^- + H_2O$

and balance H with H^+

$Pb(OH)_4^{2-} \rightarrow PbO_2 + 2H_2O$ unchanged

$ClO^- + 2H^+ \rightarrow Cl^- + H_2O$

and balance charge:

$\rightarrow + 2e^-$

$+2e^- \rightarrow$

Thus we have

$Pb(OH)_4^{2-} + ClO^- + 2H^+ \rightarrow PbO_2 + 3H_2O + Cl^-$

or for a basic solution,

$Pb(OH)_4^{2-} + ClO^- \rightarrow PbO_2 + H_2O + Cl^- + 2OH^-$

Problem 5 Cont

~~Problem 6~~

(d): $Pb(OH)_4^{2-}$ is the reducing agent, ClO^- is the oxidizing agent

Problem 6

(a): Au^{+} has the highest E° and is thus the strongest oxidizing agent

(b): Zn^{2+} has the ~~highest~~ lowest E° and thus is the strongest reducing agent.

(c): Sn and Ni

Problem 7

We should have that

$$\Delta_0 E_{cell} \simeq (E^\circ_{cathode} - E^\circ_{anode}) - (0.0257\,V/n) \cdot \ln(Q)$$

Plugging in,

$$\Delta E_{cell} \simeq (-0.13 - 0.12) - (0.0257/2) \ln\left(\frac{0.003}{0.15 \cdot 0.2}\right)$$

$$\simeq 0.37\,V$$