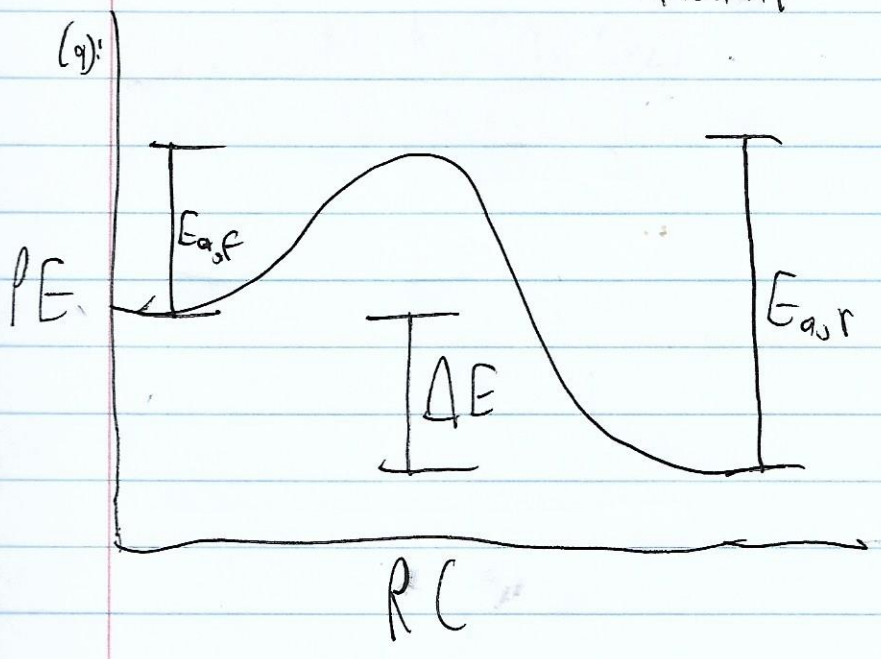
Final Exam Solutions
Problem 1

(a):



Exothermic

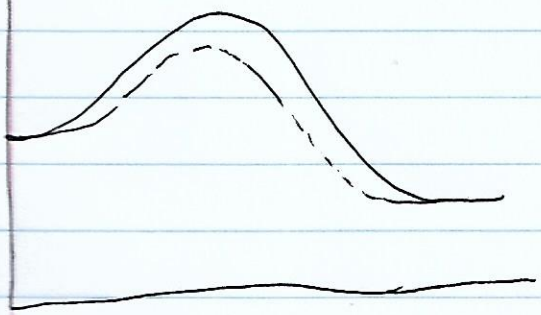
(b): $-16.2\ kJ/mol = E_{a,f} - E_{a,r}$.

(c): $408/244 = 1.66$.

(d): both increase, but k_{-1} increases more.

(e): since $K = \frac{k}{k_{-1}}$, it decreases.

(f):



Catalyst lower $E_{a,f}$ and $E_{a,r}$.

Problem 2

(a): 0.1 $M s^{-1}$

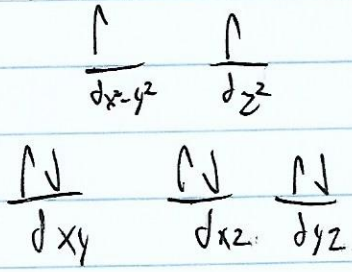
(b): $5 \cdot 10^{-5}$ M.

Problem 3

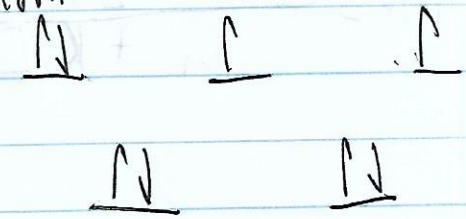
$$\text{rate} = \frac{2 k_1 k_2 [NO]^2 [O_2]}{k_1 + k_2 [O_2]}$$

Problem 4

Octahedral



Tetrahedral



Both are paramagnetic

Problems

Oxidation # is 3.

Problem 6

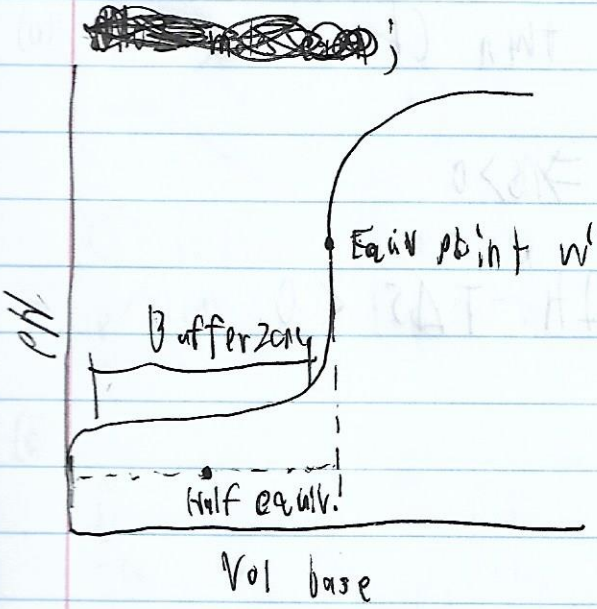
(a): 285 kJ/mol

(b): B_{12} has a lower potential, thus it is a better reducing agent

Problem 7

$K_a = 2.6 \cdot 10^{-4}$

Problem 8



Problem 9

0.02 moles each

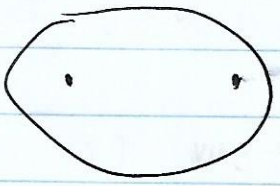
Problem 10

(a): Endothermic; Cl_2 is more stable than Cl.

(b): Positive; increase in mole count $\Rightarrow \Delta S > 0$

(c): No; we need T s.t. $\Delta G = \Delta H - T\Delta S < 0$.

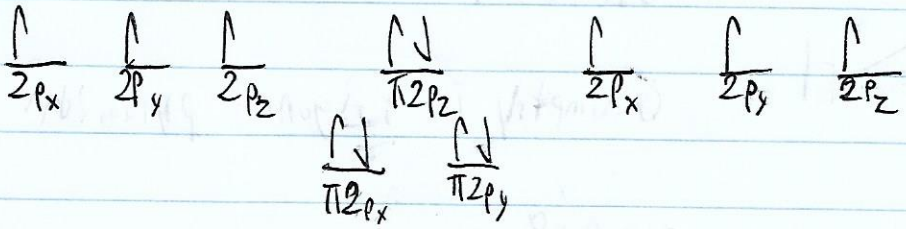
Problem 11

(a): σ: 

σ^*: 

σ is lower in energy since electrons like being in the most positively charged areas.

(b):



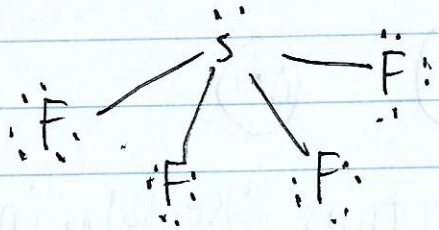
(c): $(\sigma_{2s})^2 (\sigma_{2s}^*)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi 2p_z)^2$

(d): 3

(e): N_2^- N N_2

Problem 12

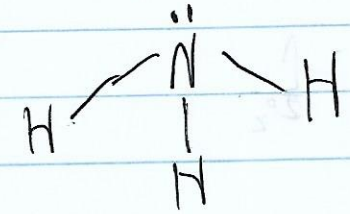
(a): SN is 5



Geometry is see-saw

Expected bond angles are $<90°$ and $<120°$

(b): SN is 4



Geometry is trigonal pyramidal

Expected angle is $<109.5°$

$\sigma(N2sp^3, H1s)$

Problem 13

(a): Lower; since higher Z implies a stronger nucleus-electron bond

(b): decreases; shielding effect

(c): low; it has no affinity for electrons y an d thus is more likely to give it ~~it~~ up; thus low ionization energy.

Problem 14

(a): Assuming each photon is of sufficient energy, each photon ejects an electron; supplying more photons ejects more electrons.

(b): The energy per photon, and thus ν or λ, is what provides the energy and thus velocity of the electon.

(c): Threshold frequency is the minimum frequency of photons to eject electrons; it is dependent on how much the metal wants to hold onto the electron

Problem 15

(a): Recall $c = \nu\lambda$ and $e = h\nu$; then

$$e = \frac{hc}{\lambda} = \frac{1.99 \cdot 10^{-25}\ m^3\ kg\ s^{-2}}{3.89 \cdot 10^{-7}\ m} = 5.111 \cdot 10^{-19}\ J.$$

(b): $5.111 \cdot 10^{-19}\ J \cdot \frac{1\ kJ}{1000\ J} \cdot \frac{0.0166}{1\ mole} \cdot$ avogadros $= 5.111\ KJ$