Chemistry 1210 Exam 2 - Jordan. Fall 1999 Form A

Name_____

ID_____

By submitting this exam, I certify that I have neither given nor recieved unauthorized aid.
Useful information: $E = h\nu$, $1/\lambda = R[1/n_1^2 - 1/n_2^2]$, $\lambda\nu = c$, $c = 3.00 \times 10^8$ m/s, $h = 6.626 \times 10^{-34}$ Js, $R = 1.097 \times 10^{-2}$ nm^{-1}, $C_F = E_v$ - (#bonds + $E_{nonbonding}$)

(1) Write the net ionic reactions for the following ionic reactions

(a) $Ca(NO_3)_2 + Na_2(CO_3)$ ------> $2\ NaNO_3 + CaCO_3$

+2) $Ca^{2+}_{(aq)} + (CO_3)^{2-}_{aq} \rightarrow CaCO_{3(s)}$

(b) $LiCl + Ag(NO)_3$ -------> $AgCl + LiNO_3$

+2 $Cl^-_{(aq)} + Ag^+_{(aq)} \rightarrow AgCl_{(s)}$

(2) Write the net acid-base reactions for the following

+2 (a) $NH_3 + HCl$ ----->

$NH_3 + H^+ \rightarrow NH_4^+$

+2 (b) $HClO_4 + NaOH$ -------->

$H^+ + OH^- \rightarrow H_2O$

(3) Balance the following half reaction in basic solution. Is this reaction an oxidation or a reduction?

$NO \longrightarrow NO_3^-$

O^{2-} $\quad$ O^{2-}

N^{2+} $\quad$ $3(-2) + N = -1$

$-6 + N = -1$

N^{5+}

$NO \longrightarrow NO_3^-$

add e^-s

$NO \longrightarrow NO_3^- + 3e^-$

add $\bar{O}H$

$4\bar{O}H + NO \rightarrow NO_3^- + 3e^-$

add H_2O

$4\bar{O}H + NO \rightarrow NO_3^- + 3e^- + 2H_2O$

oxidation

(4) Balance the following reaction in acidic media. List the balanced half reactions.

$PbO_2 + Br^- \rightarrow PbO + Br_2$

O^{2-} Br^{-1} Pb^{2+} Br^0

Pb^{4+} O^{2-}

oxidative $\frac{1}{2}$ rxn

$Br^- \rightarrow Br_2$

↓ balance Br

$2Br^- \rightarrow Br_2$

↓ add e^-s

$2Br^- \rightarrow Br_2 + 2e^-$

↓ balance charge

↓ balance H

$2Br^- \rightarrow Br_2 + 2e^-$

reductive $\frac{1}{2}$ rxn

$PbO_2 \rightarrow PbO$

↓ add e^-s

$PbO_2 + 2e^- \rightarrow PbO$

↓ add H^+

$2H^+ + PbO_2 + 2e^- \rightarrow PbO$

↓ add H_2O

$2H^+ + PbO_2 + 2e^- \rightarrow PbO + H_2O$

full rxn

$2Br^- \rightarrow Br_2 + 2e^-$

$2H^+ + PbO_2 + 2e^- \rightarrow PbO + H_2O$

$2H^+ + 2Br^- + PbO_2 + 2e^- \rightarrow Br_2 + 2e^- + PbO + H_2O$

$2H^+ + 2Br^- + PbO_2 \rightarrow Br_2 + PbO + H_2O$

(5) The following balanced redox reaction has been the basis of blood alcohol determinations of ethanol (C_2H_5OH).

$$C_2H_5OH + 2Cr_2O_7^{2-} + 16H^+ \text{------>} 2CO_2 + 4Cr^{3+} + 11H_2O$$

If a sample required 10.23 mL of a 0.204 M solution of $K_2Cr_2O_7$ to neutralize the ethanol, how much ethanol was in the sample?

$10.23\,mL = 0.01023\,L$

$0.204 \frac{moles}{L} \times 0.01023\,L = 2.09 \times 10^{-3}\ moles\ Cr_2O_7^{2-}$

$2.09 \times 10^{-3}\ moles\ Cr_2O_7^{2-} \times \frac{1\ mole\ C_2H_5OH}{2\ moles\ Cr_2O_7^{2-}} =$

$1.04 \times 10^{-3}\ moles\ of\ C_2H_5OH$

✓ (6) Who is credited with creating the periodic table and how did he organize his periodic table?

+2 Mendeleev

+1 each

mass & reactivity

Mendeleev.

He organized the elements by increasing mass.

He put "triads" of similarly reacting chemicals in vertical columns.

(7) How many electrons can the n = 3 shell hold. Break this down by subshell and make sure to show all work.

$n=3$ $\ell=0,1,2$

$\ell=0$ s subshell $m_\ell=0$, 1 orbital, 2 electrons

$\ell=1$ p subshell $m_\ell=-1,0,1$ 3 orbitals, 6 electrons

$\ell=2$ d subshell $m_\ell=-2,-1,0,1,2$ 10 electrons

10

6

+ 2

18 electrons total

(8) For the hydrogen atom, what is the wavelength of light that corresponds to the transition from the n = 3 level to the n = 1 level. What is the energy of this light?

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = 1.097\times10^{-2}\ nm^{-1}\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$$

$$\frac{1}{\lambda} = 1.097\times10^{-2}\ nm^{-1}(0.889) = \frac{1}{\lambda} = 9.75\times10^{-3}\ nm^{-1}$$

$$\lambda = 103\ nm$$

$E = h\nu$ $\quad \lambda\nu = c$

$$103\ nm \times \frac{1\ m}{10^9\ nm} = 1.02\times10^{-7}\ m$$

$$(1.02\times10^{-7}\ m)\,\nu = 3.00\times10^{8}\ \frac{m}{s}$$

$$\nu = 2.93\times10^{15}\ \frac{1}{s}$$

$$E = (6.626\times10^{-34}\ J\,s)(2.93\times10^{15}\ \frac{1}{s})$$

$$E = 1.94\times10^{-18}\ J$$

✓ (9) Write the electron configurations for the following species (do not use noble gas abbreviations such as [Ar]$3s_2$...).

+2 (a) C $\quad 1s^2 2s^2 2p^2$

+2 (b) Se^{2-} $\quad 1s^2 2s^2 2p^6 3s^2 3p^4$

(10) Arrange the following by increasing 1st ionization energy.

Na, S, Cs, F, Ne

Cs < Na < S < F < Ne

(11) Arrange the following by increasing electronegativity.

Cl F, K Li K < Li < Cl < F

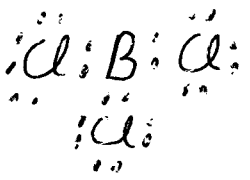
(12) Order the following by increasing lattice energy

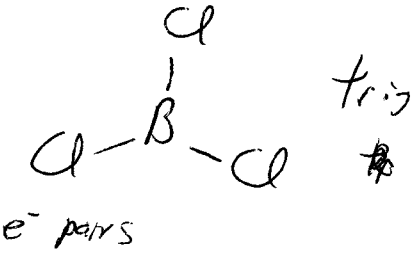
LiF, AlN, MgF_2, NaBr, MgO

NaBr < LiF < MgF_2 < MgO < AlN

(13) Write the Lewis Dot structures and give the VSEPR geometries (draw and name) for the following species

(a) BCl_3

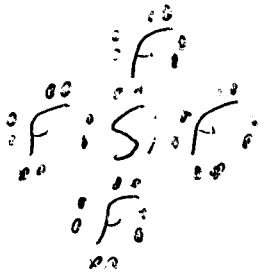




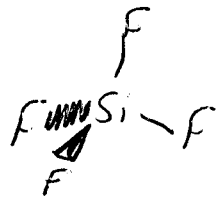
trigonal planar

3 e⁻ pairs

(b) SiF_4



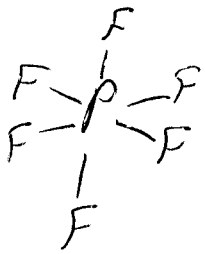
4 e⁻ pairs tetrahedral



(c) PF_6^-

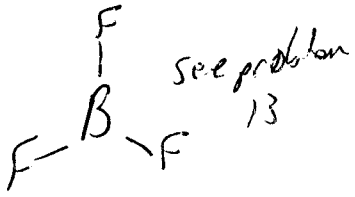
6 e⁻ pairs

octahedral



(14) What is the hybridization around the central atom for the following (for Valence Bond Theory bonding purposes)?

(a) BF_3

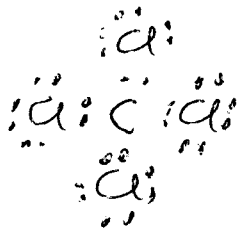


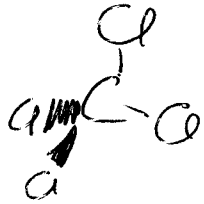
see problem 13

sp^2

4 total

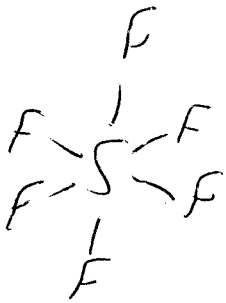
(b) CCl_4





sp^3

(c) SF_6



sp^3d^2

(15) Using the Molecular Orbital diagram given on the next page, predict if the Ne_2 molecule would be stable (have bonding) and list it's bond order. Would Ne_2^+ be stable? What would the bond order for Ne_2^+ be?

Ne_2 Ne has 8 valence electrons

Ne_2 → 16 electrons

$$\text{bond order} = \frac{E_{\text{bonding}} - E_{\text{anti-bonding}}}{2}$$

4 e^-s in σ orbitals 4 e^-s in π orbitals

∴ 8 e^-s in bonding orbitals

4 e^-s in σ^* orbitals, 4 e^-s in π^* orbitals

∴ 8 e^-s in anti-bonding orbitals

$$\text{bond order} = \frac{8-8}{2} = 0$$ no bonds, not stable

Ne_2^+ 15 electrons.

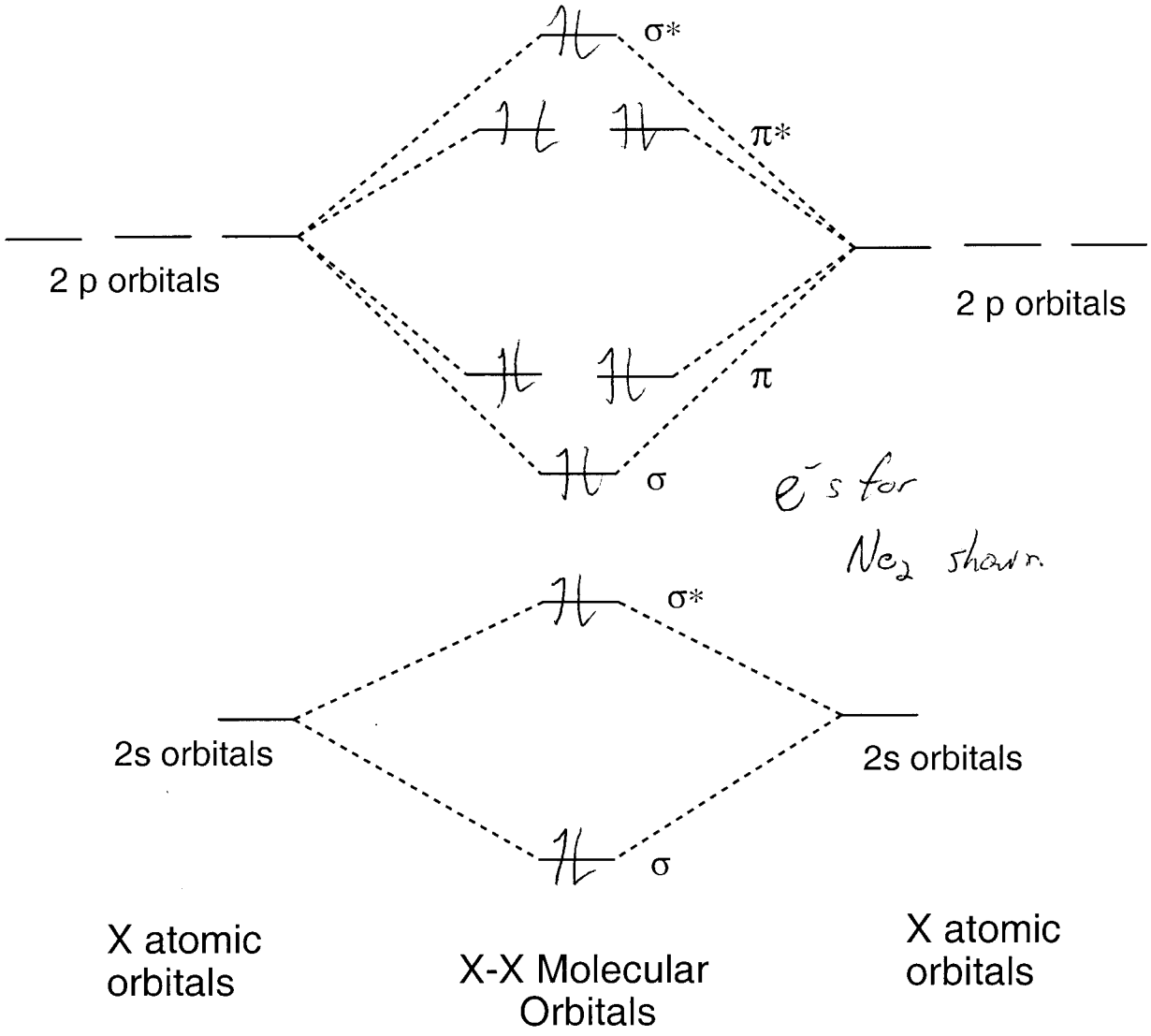
8 e^-s in bonding orbitals

7 e^-s in anti-bond orbitals

$$\text{bond order} = \frac{8-7}{2} = \boxed{\frac{1}{2}}$$

somewhat stable

Molecular Orbital Diagram for Diatomic Molecules
X-X



(Extra Credit) What bond angle would you expect for the F-Be-F angle in BeF_2