

97%

CHM 2045
General Chemistry I
Exam I (form C)
Spring 2012

Name: Steven Romeiro

Part A: (10 points) Matching: match each of the following to their major contribution by placing the letter of the contribution next to the scientist.

C 1. Dalton

- a. Defined the nature of an element
- b. Isolated nitrogen gas from soybeans

I 2. Rutherford

- c. Father of Atomic Theory
- d. Law of Conservation of Energy

K 3. Thomson

- e. Law of Conservation of Mass
- f. Determined the neutron charge

G 4. Millikan

- g. Determined the electron charge
- h. Determined the proton charge

C 5. Lavosier

- i. Discovered the nucleus
- j. Discovered the neutron
- k. Discovered the electron
- l. Discovered the proton

Part B: (18 points) Multiple Choice: for each of the following pick the best answer and place the letter for that answer in the space provided.

D 1. The accuracy of an experimental calculation relates directly to

- a. How close all measured values are to each other
- b. The temperature in the lab
- c. The type of equipment used

D 2. The actual value for the calculation

C 2. Iron (II) and Iron (III) are consider to be

- a. Isomers of each other
- b. Different elements

C 3. Ions

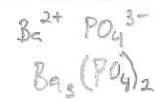
- d. Isotopes

A 3. The empirical formula of a compound is $C_5H_{10}O_3$, which of the following could be its molecular formula?

- a. $C_{35}H_{70}O_{21}$
- b. $C_{65}H_{121}O_{27}$
- c. $C_{10}H_{15}O_6$
- d. $C_{15}H_{30}O_{11}$
- e. $C_{20}H_{20}O_{20}$

7

- C 4. Which of the following is a homogeneous mixture?
- A mixture of mineral oil and water
 - A mixture made by mixing 2.0mL of gasoline (a non-polar hydrocarbon) in 50.0mL of water
 - A mixture of soluble potassium nitrate and water
 - A mixture of salt and pepper
- C 5. The atomic number
- Changes when the element become a positive ion
 - Is always equal to the number of electrons
 - Is always the same for a given element
 - Is the same as the number of neutrons
- B 6. Barium Phosphate has how many atoms of oxygen in each formula unit?
- 7
 - 8
 - 13
 - 4



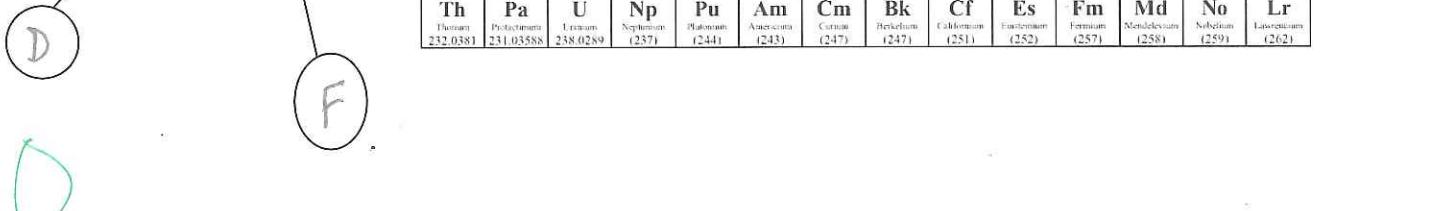
Part C: (33 points) Completion: for each of the following give a brief but complete answer.

1. (5 points) For each of the following place the correct letter in the circle provided
- Main group
 - Halogen
 - Noble gas
 - Alkali metal
 - Transition group
 - Alkaline earth metals

The Periodic Table of the Elements

1 H Hydrogen 1.00794	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Boron 9.012182
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050
19 K Potassium 39.0983	20 Ca Calcium 40.078
37 Rb Rubidium 85.4678	21 Sc Scandium 44.955910
55 Cs Cesium 132.90545	22 Ti Titanium 47.867
87 Fr Francium (223)	23 V Vanadium 50.9415
88 Ra Radium (226)	24 Cr Chromium 51.9961
89 Ac Actinium (227)	25 Mn Manganese 54.938049
90 Th Thorium (232)	26 Fe Iron 55.845
104 Rf Rutherfordium (261)	27 Co Cobalt 58.93200
105 Db Dubnium (126)	28 Ni Nickel 58.6934
106 Sg Sg (126)	29 Cu Copper 63.546
107 Bh Bh (126)	30 Zn Zinc 65.39
108 Hs Hs (126)	31 Ga Gallium 69.723
109 Mt Moscovium (126)	32 Ge Germanium 72.61
110 Lw Livermorium (126)	33 As Arsenic 74.92160
111 Cm Curium (126)	34 Se Selenium 75.96
112 Bk Berkelium (127)	35 Br Bromine 79.904
113 Fm Fermium (125)	36 Kr Krypton 83.80
114 Es Einsteinium (125)	37 At Astatine (210)
115 Cf Californium (125)	38 Rn Radon (222)
116 Am Americium (125)	39 O Oxygen 15.9994
117 Cm Curium (125)	40 F Fluorine 18.9984032
118 Bk Berkelium (125)	41 Ne Neon 20.1797

58 Ce Ce 140.116	59 Pr Pr 140.99765	60 Nd Nd 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium (232)	91 Pa Protactinium 231.03588	92 U Uranium (238)	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (252)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)



2. (6 points) For each of the following state whether it is a chemical or a physical change.

a. Baking a cake chemical

b. The formation of hail Physical

c. The deposition of water vapor to form snow physical

3. (6 points) File in the missing information in the table.

Symbol	Protons	Electrons	Neutrons
Ta ⁺²	73	71	108
At ⁻¹	85	86	125

4. (6 points) A new element has just been discovered in a rock sample from Saturn. The following information has been determined about the element. Because the element came from Saturn the new chemical symbol for this element is Sa. Use the following information.

Isotope	# of protons	Atomic mass
1	154	332.812
2	154	334.119
3	154	335.488

$$333 - 154 = 179$$

$$334 - 154 = 180$$

$$335 - 154 = 181$$

What is the isotopic symbol for each?



5. (10 point) For the following chemical reactions give the balance chemical equation (make sure to include the state of each substance).

- a. Aqueous aluminum hydroxide reacts with aqueous sulfuric acid to form solid aluminum sulfate and liquid water.



- b. Liquid pentene (C_5H_{10}) undergoes combustion with gaseous oxygen to produce gaseous carbon dioxide and gaseous water.



0

Al_2O_3

Part D: (39 points) Calculation problems: For each of the following problems: show all your work, give your final answer in the box provided, remember significant figures and units.

- (9 points) You have a rectangular piece of aluminum oxide it measures 12.3mm by 3.45mm by 11.9mm. If the density of aluminum oxide is 3.22g/cm^3 how many oxygen atoms are found in the piece?

$$\begin{aligned} \text{Volume} &= 12.3\text{mm} \times \frac{1\text{cm}}{100\text{mm}} = .123\text{cm}^3 = .123\text{cm} \times .0345\text{cm} \times .119\text{cm} = 5.05 \times 10^{-4}\text{cm}^3 \\ 3.45\text{mm} \times \frac{1\text{cm}}{100\text{mm}} &= .0345\text{cm} \quad \text{mass} = \frac{3.22}{\text{cm}^3} \times 5.05 \times 10^{-4}\text{cm}^3 \\ .119\text{mm} \times \frac{1\text{cm}}{10\text{mm}} &= .119\text{cm} \quad \underline{\text{mass}} = \underline{.00163\text{g Al}_2\text{O}_3} \end{aligned}$$

$$\begin{aligned} \frac{.00163\text{g Al}_2\text{O}_3}{101.96\text{g Al}_2\text{O}_3} &= 1.60 \times 10^{-5} \text{mol Al}_2\text{O}_3 \times \frac{3\text{mol O}}{1\text{mol Al}_2\text{O}_3} \\ &= 4.80 \times 10^{-5} \text{mol O} \times \frac{6.022 \times 10^{23} \text{atoms}}{\text{mol O}} \\ &= \underline{2.90 \times 10^{19} \text{atoms of O}} \end{aligned}$$

2.90 $\times 10^{19}$ atoms of O
 ← 22.
 power of ten
 -2

- (9 points) Calculate the atomic mass of a new element that has three naturally occurring isotopes.

Isotope	Atomic mass	Percentage
1	228.9	46.42
2	229.7	31.36
3	231.2	22.22

$$(228.9 \times .4642) + (229.7 \times .3136) + (231.2 \times .2222) = 229.66194$$

$$= \underline{229.7 \text{amu}}$$

229.7 amu

2

3. (9 points) Determine the percent composition for each element in Copper (II) phosphate.



$$\text{Cu} = \frac{63.55}{380.59} * 100\% * 3 \text{ mol Cu} = 50.1\%$$

$$\text{P} = \frac{30.97}{380.59} * 100\% * 2 \text{ mol P} = 16.3\%$$

$$\text{O} = \frac{16.00}{380.59} * 100\% * 8 \text{ mol O} = 33.6\%$$

Cu = 50.1 %
P = 16.3 %
O = 33.6 %

5.887 / 1000 = 5.887 x 10^-3
need 6

4. (12 points) When a 2.991mg sample of a carbon, hydrogen, oxygen compound is burned in combustion analysis 5.887mg of carbon dioxide and 2.812mg of water are obtained. What is the empirical formula for the compound?

$$2.991 \text{ mg} * \frac{1 \text{ g}}{1000 \text{ mg}} = .002991 \text{ g}$$

$$5.887 \text{ mg CO}_2 * \frac{1 \text{ g}}{1000 \text{ mg}} = .005887 \text{ g CO}_2$$

$$2.812 \text{ mg H}_2\text{O} * \frac{1 \text{ g}}{1000 \text{ mg}} = .002812 \text{ g H}_2\text{O}$$

$$C = \frac{.005887 \text{ g CO}_2}{44.01 \text{ g/mol CO}_2} * \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = \frac{1.338 * 10^{-4} \text{ mol C}}{1 \text{ mol CO}_2} * \frac{12.01 \text{ g C}}{1 \text{ mol C}} = .001607 \text{ g C}$$

$$H = \frac{.002812 \text{ g H}_2\text{O}}{18.02 \text{ g/mol H}_2\text{O}} * \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = \frac{3.121 * 10^{-4} \text{ mol H}}{1 \text{ mol H}_2\text{O}} * \frac{1.01 \text{ g H}}{1 \text{ mol H}} = 3.152 * 10^{-4} \text{ g H}$$

$$O = .002991 \text{ g} - .001607 \text{ g C} - .001922 \text{ g H} = .001069 \text{ g O}$$

$$O = \frac{6.681 * 10^{-3}}{6.681 * 10^{-3}} = 1 * 3 = 3$$

Exam Total: 97 / 100 *Very Good* C₆H₁₄O₃



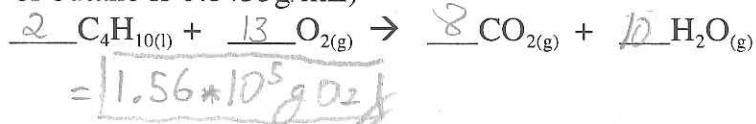
$$C = \frac{1.338 * 10^{-4}}{6.681 * 10^{-3}} = 2 * 3 = 6$$

$$H = \frac{3.121 * 10^{-4}}{6.681 * 10^{-3}} = 4.67146 * 3 = 14.014 = 14$$

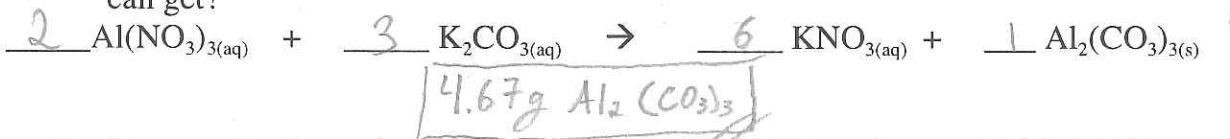
Chapter 4, 7 and 8

Problem/Concept Overview

1. Determine the grams of oxygen need to burn 13.6 gal of butane. (assume the density of butane is 0.8453g/mL)



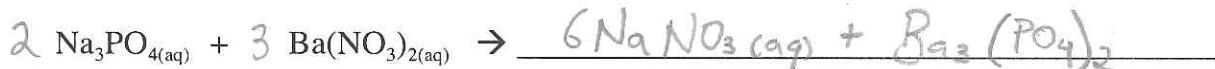
2. If you combine 32.4mL of a 1.23M $\text{Al}(\text{NO}_3)_3$ solution with 25.6mL of a 1.67M K_2CO_3 solution what is the maximum yield of aluminum carbonate you can get?



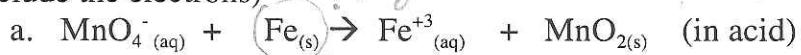
3. Suppose the theoretical yield for a reaction is 19.87g and your yield is 14.79g, what is the percent yield of your reaction?

$$\frac{14.79}{19.87} * 100\% = 74.43\%$$

4. Complete and balance the following double displacement reactions:



5. For the following redox reactions show the oxidation and reduction half reactions (include the electrons)



Reduction half:



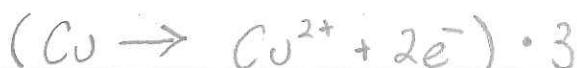
Oxidation half:



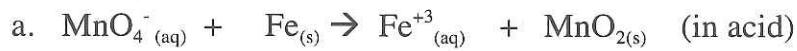
Reduction half:



Oxidation half:



6. For each of the following redox reactions give the full balanced redox



7. Define and understand:

- a. Amplitude
- b. Frequency
- c. Wavelength

8. Where does an emission spectra come from?

9. What were the major points associated with Bohr's theory and what was the major problem with it?

10. What is Heisenberg uncertainty principle and how does it relate to an electron?

11. What are the four quantum numbers and what are the restrictions on each?

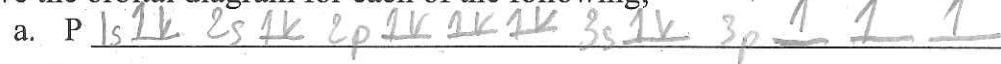
12. Understand the shape of the s, p and d orbitals.

13. Be able to draw the s and p orbitals

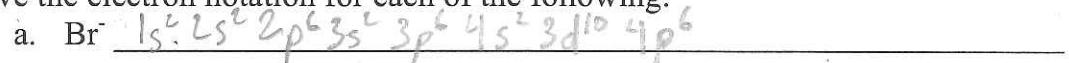
14. What is effective nuclear charge and how does it explain the ionization energy of an electron?

15. How can you use the orbital diagram of an atom to determine its magnetic properties? *On next Exam*

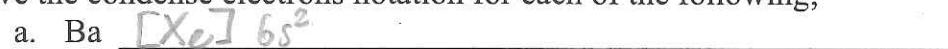
16. Give the orbital diagram for each of the following;



17. Give the electron notation for each of the following:



18. Give the condensed electron notation for each of the following;



19. For each of the following give the four quantum number that describe the last electron of that element:

- a. Ge n = 4 l = 1 m_l = 0 m_s = + 1/2
b. Zn n = 3 l = 2 m_l = 2 m_s = - 1/2

20. Determine the frequency and energy (per photon and per mole) associated with light having a wavelength of 684.5nm.

a. Frequency = $4.380 \times 10^{14} \text{ s}^{-1}$ $\gamma = \frac{c}{\lambda}$

b. Energy per photon = $2.902 \times 10^{-19} \text{ J/phot}$ E = h γ

c. Energy per mole = 174.8 kJ/mol E = 6.022×10^{23}

21. Determine the wavelength of a 345g object moving at 45 mph.

Wavelength = $9.6 \times 10^{-26} \text{ nm}$

$$\gamma = \frac{h}{mv}$$

22. Determine the wavelength and energy of light emitted from an element as an electron falls from shell level 7 to shell level 2.

Wavelength : 397.0 nm

Energy : $5.004 \times 10^{-19} \text{ J}$ E = hc

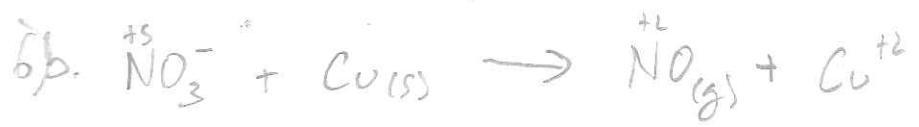
23. For each of the following circle the correct answer:

a. Which is bigger: Br or Br

b. Which is bigger: Ca or Ca⁺

c. Which has the highest electron affinity: Ca or C or Cl

d. Which of the following has the lowest ionization energy: N or Na or Mg



CHM 2045
General Chemistry I
Exam II Form C
Spring 2012

Name: Steven Romano

Date: 3 - 6 - 12

Part A Multiple Choice: For each of the following choose the best answer and place the letter of that answer in the blank to the left of the number. This section is worth a total of 24 points.

C

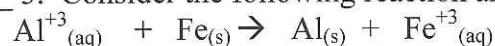
1. What is the driving force of a redox reaction?
 - a. The formation of a solid
 - b. The formation of a gas
 - c. The transfer of electrons
 - d. The formation of a weak electrolyte

C

2. The percent yield of a reaction is
 - a. Theoretical
 - b. Always less than 90%
 - c. A measure of well the reaction went
 - d. Based on the natural lost of matter

D

3. Consider the following reaction and determine the oxidizing agent



- a. Fe
- b. Fe^{+3}
- c. Al
- d. Al^{+3}

D

4. Formic acid is a weak organic acid, it is consider to be a.....

- a. Strong electrolyte
- b. A basic ion
- c. Non-electrolyte
- d. Weak electrolyte

D

5. Which of the following would have an s^1d^{10} configuration beyond the noble gas core?

- a. Cu
- b. Ag
- c. Au
- d. All of the above

D

6. How many valance electrons does "silicon" have:

- a. 5
 - b. 8
 - c. 2
 - d. 4
- A
7. Which of the following has the highest energy photons?

- a. Ultraviolet
- b. Infrared
- c. X-ray
- d. Microwaves

2

C 8. If an atom gives off light in the infrared range than some electron had fall to

- a. 1
- b. 2
- c. 3
- d. all of the above

B 9. How many nodes are found in a "p" subshell;

- a. 0
- b. 1
- c. 2
- d. 3

D 10. Which of the following element will feel an effective nuclear charge of +6?

- a. Oxygen
- b. Sulfur
- c. Selenium
- d. All of the above

D 11. If you have 4.4 moles of solute and you want a 1.1 M solution you would bring the solution to what volume?

- a. 1.0 L
- b. 2.0 L
- c. 3.0 L
- d. 4.0 L

~~12.~~ Consider the following reaction, what is(are) the spectator ion(s)?

- $$\text{H}_2\text{SO}_{4(\text{aq})} + \text{NaOH}_{(\text{aq})} \rightarrow \text{AlSO}_{4(\text{s})} + \text{H}_2\text{O}_{(\text{l})}$$
- a. Na^+
 - b. SO_4^{2-}
 - c. $\text{SO}_4^{2-}, \text{Na}^+$
 - d. There are no spectator ions

D 13. Which of the following is the biggest?

- a. Al
- b. C
- c. Ca
- d. Sr

B 14. Which of the following is least metallic?

- a. Pb
- b. B
- c. Be
- d. Na

Part B Completion: Answer the following questions as completely as possible. This section is worth 40 points.

1. (5 pts) Suppose a subshell with $l=13$ did exist, how many electrons could you put in this subshell (show work or explain your final answer)

$l = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13$
of orbitals = $1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27$
of e^- per orb = $2, 6, 10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50^{*+}$

(3) 54
3 68

Work on Scratch Paper

2. (4 pts) For the following reaction: complete the double displacement, give the states of each of the products and balance the final equation.



3. (6 pts) On another planet (with purple unicorn) there exist an element 119. On this planet the m_l value starts at $+l$ and go to $-l$ instead of $-l$ to $+l$. What four quantum numbers would be used to describe the last electron in an element with 119 electrons on this planet?

Work space:

$$n = 1, 2, 3, 4, 5, 6, 7, 8$$

$$l = 0, 1, 2, 3, 4, 5, 6, 7$$

$$m_l = 0, \pm 1, \pm 2, \pm 3, \pm 4, \pm 5, \pm 6, \pm 7$$

$$8s^1 = n=8$$

$$l=0$$

$$m_l=0$$

$$m_s=\pm 1/2$$

a. $n = 8$

b. $l = 0$

c. $m_l = 0$

d. $m_s = \pm 1/2$

4. (6 pts) Give the predicted and the actual condensed electron notation for "Au⁺¹" and explain why the actual configuration results in a more stable ion.

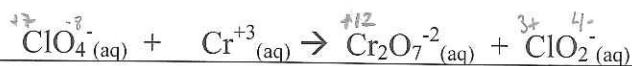
Predicted: $[\text{Xe}] 6s^1 4f^14 5d^9$

Actual: $[\text{Xe}] 6s^0 4f^{14} 5d^{10}$

Why? Because a full d shell results in a more stable ion rather than a full s shell

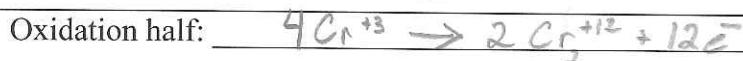
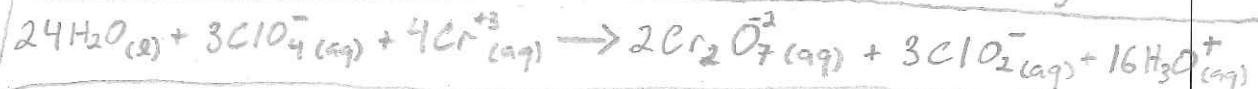
O

5. (12 pts) Give the half reactions, the full balanced redox and the oxidizing and reducing agents for the following redox reaction: (the reaction is in acidic solution)



Redox Work space:

($4e^- + \text{Cl}^{+2} \rightarrow \text{Cl}^{3+}$) · 3 red half
 $(2\text{Cr}^{+3} \rightarrow \text{Cr}_2^{+12} + 6e^-) \cdot 2$ oxid half



Balanced redox in acidic solution:



Reducing agent: $4\text{Cr}^{+3}_{(\text{aq})}$

Oxidizing agent: $3\text{ClO}_4^{\text{-}}_{(\text{aq})}$

6. (7 pts) Give the four quantum numbers for the last electron in Mo and in Tc. What is unique about these numbers?

Mo n= 4 l= 2 $m_l = \frac{+2}{+2}$ $m_s = \frac{+1/2}{+1/2}$

Tc n= 4 l= 2 $m_l = \frac{+2}{+2}$ $m_s = \frac{+1/2}{+1/2}$

Unique why? These elements have the same electron configuration. Mo mimics Tc by having a half filled d shell + losing one e^- from the S shell

0

Part C Problems: For each of the following problems: show your work, remember sig. figs., and units. When you get your final answer place your answer in the box. This section is worth 32 points.

Possible Formulas and Constants

$$E = h \nu$$

$$\lambda \nu = c$$

$$\lambda = h / (m v)$$

$$E = (h c) / \lambda$$

$$1/\lambda = R [(1/n_f^2) - (1/n_i^2)]$$

$$E = 2.179 \times 10^{-18} J [(1/n_f^2) - (1/n_i^2)]$$

$$R = 1.097 \times 10^7 m^{-1}$$

$$h = 6.626 \times 10^{-34} J \cdot s$$

$$c = 2.998 \times 10^8 m/s$$

1. (12 pts) Calculate the Wavelength (in nm) and Energy of light (in J/mol) that would be released as an electron falls from $n = 6$ to $n = 3$

$$\frac{1}{\lambda} = 1.097 \times 10^7 m^{-1} \left(\frac{1}{9} - \frac{1}{36} \right) \rightarrow \frac{1}{\lambda} = 1.097 \times 10^7 m^{-1} \left(\frac{1}{12} \right)$$

$$\left(\frac{1}{\lambda} \right) = (914166.6667 m^{-1})^{-1} \rightarrow \lambda = 1.093892434 \times 10^{-6} m \left(\frac{1 \cdot 10^9 nm}{m} \right)$$

$$\boxed{\lambda = 1094 nm}$$

$$E = \frac{(6.626 \cdot 10^{-34} J \cdot s)(2.998 \cdot 10^8 m/s)}{(1.094 \cdot 10^{-6} m)}$$

$$E = 1.81579099 \times 10^{-19} J$$

$$\boxed{E = 1.816 J}$$

This is photon

Wave length: $1094 nm$

Energy: ~~1.816 J~~

~~-4~~

2. (10 pts) A lovebug having a mass of $3.452 g$ is flying at a rate of $8.765 \times 10^7 mm/sec$, what is the wavelength associated with this lovebug as it flies as it moves?

$$\lambda = \frac{h}{m \cdot v} \quad m = .003452 kg \quad v = mm/s \cdot \frac{1m}{1 \cdot 10^3 mm} = 87650 m/s$$

$$\lambda = \frac{J \cdot S}{kg \cdot m/s} = \frac{J \cdot S^2}{kg \cdot m} = \frac{kg \cdot m^2}{s^2 \cdot m} \cdot \frac{s^2}{kg \cdot m} = \frac{kg \cdot m^2}{kg \cdot m^2} = m \left(\frac{1 \cdot 10^9 nm}{m} \right) = nm$$

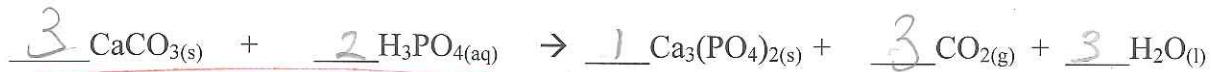
$$\lambda = \frac{(6.626 \times 10^{-34} \frac{kg \cdot m^2}{s^2} \cdot s^2)}{(.003452 kg) (87650 m)} = 2.18992239 \times 10^{-36} m \left(\frac{1 \cdot 10^9 nm}{m} \right)$$

$$\boxed{\lambda = 2.190 \times 10^{-27} nm}$$

$$\boxed{\lambda = 2.190 \times 10^{-27} nm}$$

4

3. (10 pts) The following chemical reaction is run using , determine the theoretical yield of calcium phosphate in grams when 5.11mL of 2.951 M H₃PO₄ reacts with 34.16g CaCO₃? (balance first)



$$2.951 \frac{\text{mol}}{\text{L}} * .00511 \text{ L} = .0150796 \text{ mol H}_3\text{PO}_4$$

$$\frac{34.16 \text{ g CaCO}_3}{100.086 \text{ g/mol}} = .3413064764 \text{ mol CaCO}_3$$

$$.0150796 \left(\frac{1}{2}\right) \left(\frac{310.18 \text{ g}}{\text{mol}}\right) = 2.33869 \text{ g}$$

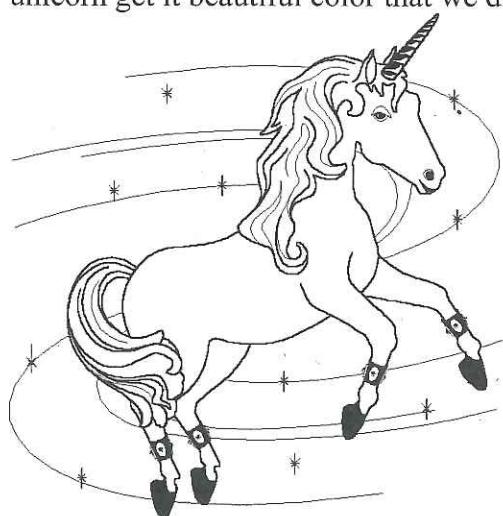
(1)

$$[= 2.34 \text{ g}]$$

2.34 Ca₃(PO₄)₂

Exam Total 84 /100%
good

Bonus: (2 pts) What color is the grass the unicorn eat? Purple (this is where the unicorn get it beautiful color that we discussed in class)



7

CHM 2045
Exam 3 Review
Chapters 5, 9 and 10

***NOTE: The following will also act as a guide for the third exam, it is not intended to replace the text reading, the lecture, or the problems.

1. What are the 4 main gases found in dry air in order of their abundance? (most to least)
2. What is Pressure?
3. What are the common units of pressure?
4. The following are sample calculation that you should be able to do for the 2nd exam
 - a. Convert 569 mmHg into atm
$$0.749 \text{ atm}$$
 - b. The pressure of a 3.45g of a gas with a density of 1.63g/L is 458mmHg. What is the new volume of the gas if the pressure is increased to 1098mmHg?
$$V_2 = 0.888 \text{ L} \quad 884 \text{ L}$$
 - c. What is the volume of a gas at 56.7°C if the original volume of a gas was 136mL at 129°C?
$$V_2 = 0.112 \text{ L}$$

- d. How many gram of Helium would you have in a 46.7L sample at 67.4°C and 632mmHg?
$$m = 5.56 \text{ g}$$

e. What is the density of methane (CH_4) at 78.9°C and 237mmHg ?

$$d = 0.173 \text{ g/L}$$

f. What is the average molar mass of a mixture of gases if 34.6g occupy 45.6L at 57.9°C and 1045mmHg ?

$$\text{mm} = 14.98 \text{ g/mol}$$

$$15.02 \text{ g/mol}$$

g. Determine the liters of Oxygen need for the complete combustion of 768g of benzene (C_6H_6) if the reaction is run at 23.5°C and 765mmHg ? *This should be 765mmHg*



$$V = 1.78 \text{ L}$$

$$1780 \text{ L}$$

h. What is the partial pressure of Nitrogen in dry air at 31°C and 796mmHg ?

$$P_{\text{N}_2} = 0.82$$

$$621 \text{ mmHg}$$

i. How fast is the average Ne atom traveling in a sample that is 34.9°C ?

$$617 \text{ m/s}$$

j. Which of the following gases will effuse faster and by how much? (CO_2 or CO)

$\text{CO} = 1.25$ * faster than CO_2

$$\frac{\text{rate CO}}{\text{rate CO}_2} = \sqrt{\frac{44.01}{28.01}} = 1.253 \text{ rate CO}$$

5. Show how you can get Avogadro's Law from the ideal gas law?

~~_____~~

6. What is the main difference between effusion and diffusion?

7. List the main points of the KMT?

- a. Particles of Gas are always moving
- b. Attraction between Particles is negligible
- c. Moving Particles bounce off & continue moving
- d. There is a lot of empty space between Particles
- e. Average Kinetic energy is proportional to Kelvin Temperature

8. What interactions must be consider for bonding to occur?

- a. Nucleus to Nucleus Repulsion
- b. Electron to Electron Repulsion
- c. Nucleus to Electron Attraction

9. Why does bonding occur?

forms when the Potential energy of the bonded atoms is less than the Potential energy of the separate atoms

10. What is polarity? Covalent bond between unequal atoms resulting in the unequal sharing of electrons

11. Fill in the following table with respect to bonding :

Type of Bond	Type of elements involved	Bond Characteristic
Ionic	Metals & Non-Metals	electrons transferred
Covalent	Non-Metals	electrons shared
Metallic	Metals	electrons pooled

12. Define and give the general trend for electronegativity? Measure of the pull of an atom has on bonding electrons. Increases up & right on Periodic Table

13. Define each of the following by electronegativity difference: a non-polar bond, a polar bond and an ionic bond

Bond type	Electronegativity different
Pure Covalent	if the difference is 0
Non-polar covalent	difference 0.1 to 0.4
Polar covalent	difference 0.5 to 1.9
Ionic	difference is larger or equal to 2.0

14. List the following in order of decreasing repulsion? (lone-pair/lone-pair, lone-pair/bond-pair, bond-pair/bond-pair)

a. Lone - Pair Lone - Pair

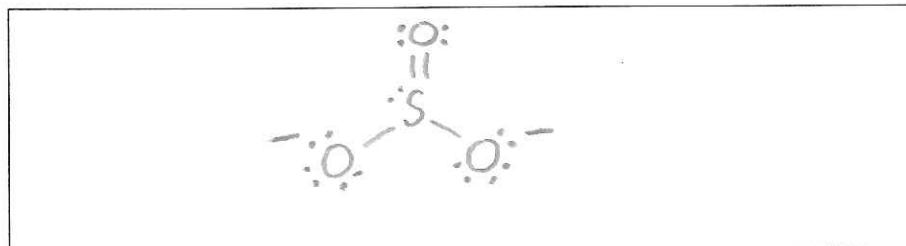
b. Lone - Pair Bonding - Pair

c. Bonding - Pair Bonding - Pair

15. What is the relationship of repulsion to bond angle?

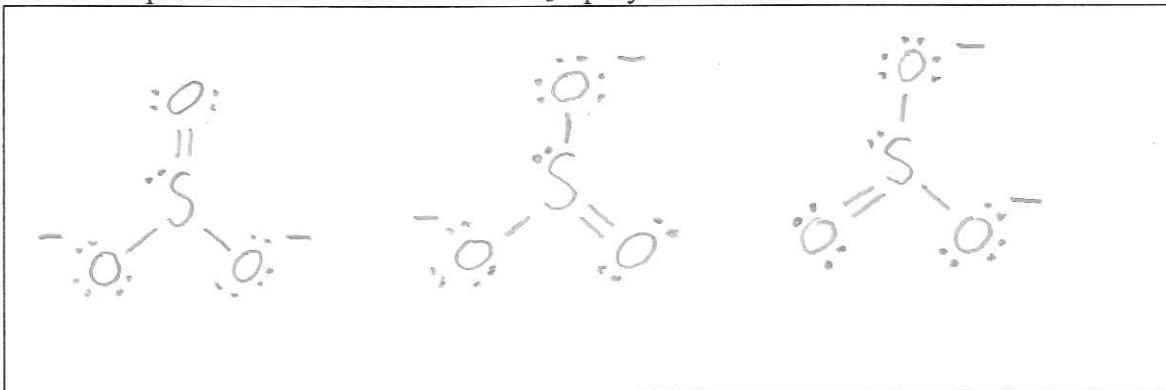
The stronger the repulsion between pairs the greater the bond angle between those pairs

16. Produce the charge minimized structure for SO_3^{2-} (show the formal charge on each atom and then give the overall charge on the oxygen)

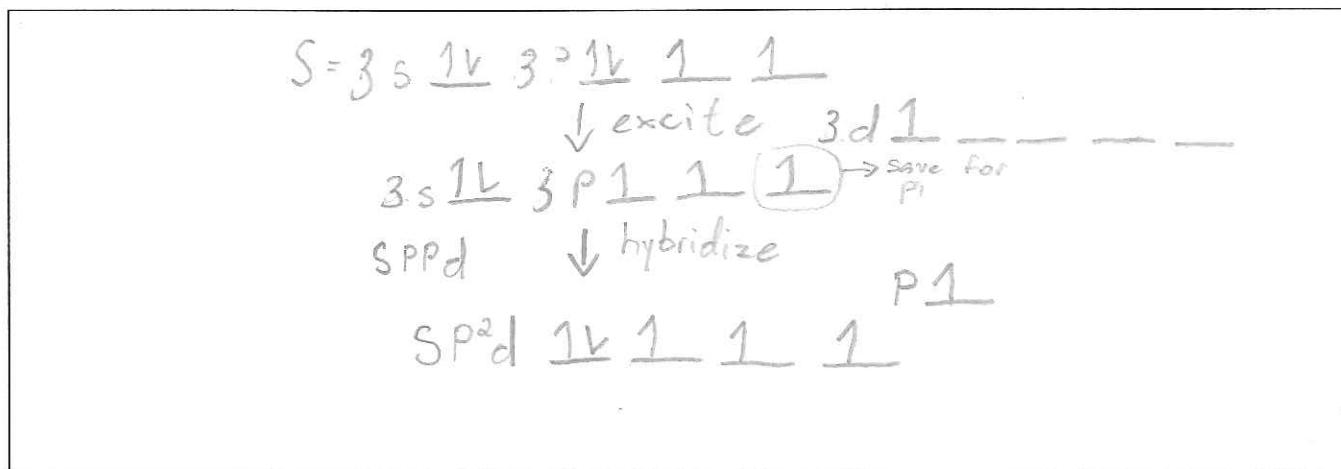


$$\text{Overall} = \frac{-2}{3}$$

17. Show all possible resonance for the SO_3^{2-} poly atomic ion

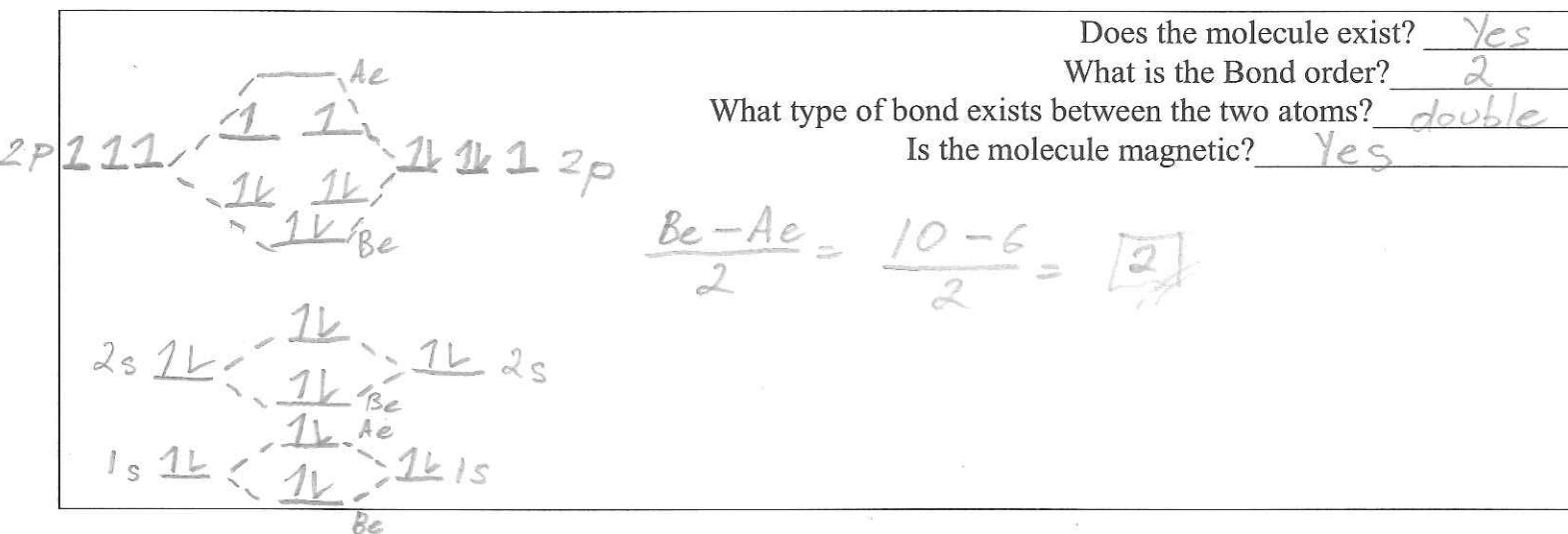


18. Describe with diagrams the hybridization of the Sulfur atom in SO_3^{2-}



How to pick diagram order
for P?

19. Do an MO diagram for any NO, state whether the molecule exist, what the bond order is, what type of bond is present and whether or not the compound it magnetic. (standardized the p to 1221)



20. Complete the following table.

Molecule or Ion	Lewis Dot Structure	Molecular Shape	Polar or Nonpolar	Hybridization of the Central Atom
CBrH ₃	$\begin{array}{c} \text{:Br:} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	Tetrahedral	Polar	SP ³
BF ₃	$\begin{array}{c} \text{:F}-\text{B}-\text{F:} \\ \\ \text{:F:} \\ \dots \end{array}$	Trigonal Planar	Non Polar	SP ²
XeCl ₄	$\begin{array}{c} \text{:Cl:} \\ \\ \text{:Cl}-\text{Xe}-\text{Cl:} \\ \\ \text{:Cl:} \end{array}$	Square planar	Non Polar	SP ³ d ²
PCl ₅	$\begin{array}{c} \text{:Cl:} \\ \\ \text{:Cl}-\text{P}-\text{Cl} \\ \\ \text{:Cl:} \end{array}$	Trigonal Bipyramidal	Non Polar	SP ³ d
CO ₃ ²⁻	$\begin{array}{c} \text{:O:} \quad \text{:O:}^- \\ \\ \text{C} \\ \\ \text{:O:} \end{array}$	Trigonal Planar	Polar	SP ²

Exam Review 3

1) Nitrogen (N_2) 78%, Oxygen (O_2) 21%

Argon (Ar) 0.9%, Carbon Dioxide (CO_2) 0.04%

2) Pressure = $\frac{\text{Force}}{\text{Area}}$

3) mm Hg, ATM, Torr, inHg, PSI, Pa, KPa

4) @ 569 mm Hg \rightarrow ATM

$$569 \cancel{\text{mm Hg}} * \frac{1 \text{ ATM}}{760 \cancel{\text{mm Hg}}} = 0.749 \text{ ATM}$$

⑥ Mass = 3.45 g
 $P_1 = 458 \text{ mm Hg}$ $V_2 = ?$ $P_2 = 1098 \text{ mm Hg}$
 Density = 1.63 g/L

$$V_1 = \frac{3.45 \cancel{\text{g}}}{1.63 \cancel{\text{g/L}}} = 2.12 \text{ L} \quad P_1 V_1 = P_2 V_2$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

$$P_1 = \frac{458 \text{ mm Hg}}{760 \text{ mm Hg}} = 0.603 \text{ ATM}$$

$$P_2 = \frac{1098 \text{ mm Hg}}{760 \text{ mm Hg}} = 1.44 \text{ ATM}$$

$$V_2 = \frac{0.603 \cancel{\text{ATM}} \cdot 2.12 \text{ L}}{1.44 \cancel{\text{ATM}}}$$

$$V_2 = 0.888 \text{ L}$$

$$\textcircled{c} \quad T_2 = 56.7^\circ\text{C}, V_1 = 136 \text{ mL}, T_1 = 129^\circ\text{C}$$

$$V_2 = ?$$

$$T_1 = 273.15 \text{ K} + 129 \text{ C} = 402.2 \text{ K}$$

$$T_2 = 273.15 \text{ K} + 56.7 \text{ C} = 329.9 \text{ K}$$

$$V_1 = 136 \text{ mL} * \frac{1 \text{ L}}{1000 \text{ mL}} = 0.136 \text{ L}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{MTA} \quad V_2 = \frac{V_1 T_2}{T_1}$$

$$V_2 = \frac{0.136 \text{ L} * 329.9 \text{ K}}{402.2 \text{ K}}$$

$$V_2 = 0.112 \text{ L}$$

$$\textcircled{d} \quad V = 46.7 \text{ L}, T = 67.4^\circ\text{C} = P = 632 \text{ mmHg}$$

pH mm 8P0L = He Mass = ?

$$PV = nRT$$

$$P = \frac{632 \text{ mmHg}}{760 \text{ mmHg}} = 0.832 \text{ atm}$$

$$n = \frac{PV}{RT}$$

$$T = 273.15 \text{ K} + 67.4 \text{ C} = 340.6 \text{ K}$$

$$n = \frac{0.832 \text{ atm} * 46.7 \text{ L}}{0.08206 \frac{\text{L atm}}{\text{mol K}} * 340.6 \text{ K}}$$

$$He = 4.0026 \text{ g/mol}$$

$$n = 1.39 \text{ mol}$$

$$m = 1.39 \text{ mol} * \frac{4.0026 \text{ g}}{\text{mol}}$$

$$m = 5.56 \text{ g}$$

(e) Density of Methane (CH_4) $T = 78.9^\circ\text{C}$

$$d = \frac{\text{MM} \cdot P}{R \cdot T}$$

$$T = 78.9 + 273.2 \text{ K} = 352.1 \text{ K}$$

$$P = \frac{237 \text{ mm Hg}}{760 \text{ mm Hg}} = 0.312 \text{ ATM}$$

$$\text{MM } \text{CH}_4 = 12.01 + (1.01 \times 4) = 16.05 \text{ g/mol}$$

$$d = \frac{16.05 \text{ g/mol} \times 0.312 \text{ atm}}{0.08206 \frac{\text{L atm}}{\text{mol K}} \times 352.1 \text{ K}}$$

$$d = 0.173 \text{ g/L}$$

(f) Average Molar Mass

$$d = \frac{\text{MM} \cdot P}{R \cdot T}$$

$$m = 34.6 \text{ g} \quad V = 45.6 \text{ L} \\ T = 57.9^\circ\text{C} \quad P = 1045 \text{ mm Hg}$$

$$d = \frac{34.6 \text{ g}}{45.6 \text{ L}} = 0.758 \text{ g/L}$$

$$\text{MM} = \frac{d \cdot R \cdot T}{P} = \frac{(0.758 \text{ g/L})(0.08206 \frac{\text{L atm}}{\text{mol K}})(331.1 \text{ K})}{(1.38 \text{ ATM})}$$

$$\boxed{\text{MM} = 14.9 \text{ g/mol}}$$



$$m = 768 \text{ g} \quad T = 23.5^\circ\text{C} \quad P = 765 \text{ mm Hg} * \frac{1000 \text{ mm Hg}}{1 \text{ atm}}$$

$$V = ?$$

$$PV = nRT \quad V = \frac{nRT}{P}$$

$$P = 765000 \text{ mm Hg}$$

$$\frac{768 \text{ g C}_6\text{H}_6}{78.12 \text{ g/mol}} = 9.83 \text{ mol C}_6\text{H}_6 \times \frac{15 \text{ mol O}_2}{2 \text{ mol C}_6\text{H}_6} = \boxed{n = 73.7 \text{ mol O}_2}$$

$$V = \frac{(73.7 \text{ mol})(0.08206 \frac{\text{L atm}}{\text{mol K}})(296.7 \text{ K})}{(1.01 \times 10^3 \text{ atm})}$$

$$\boxed{V = 1.78 \text{ L}}$$

(h) Partial Pressure of N_2 in air $T = 31^\circ C$

$p_{\text{H}_2\text{O(g)}} = 9$

$$P_{N_2} = P_T \cdot X_{N_2}$$

$$X_{N_2} = 0.78$$

$$P = 796 \text{ mm Hg}$$

$$P_T = \frac{796 \text{ mm Hg}}{760 \text{ mm Hg}} = 1.05 \text{ atm}$$

$$P_{N_2} = 1.05 \cdot 0.78$$

$$\boxed{P_{N_2} = 0.82}$$

(i) Speed of Average Ne at $34.9^\circ C$

$$\text{Speed of Ne} = \sqrt{\frac{3RT}{M}}$$

$$v_{\text{rms}} = \sqrt{\frac{3(8.314 \frac{\text{J}}{\text{mol K}})(307.9 \text{ K})}{(0.02018 \frac{\text{kg}}{\text{mol}})}} = 617 \frac{\text{m}}{\text{s}}$$

$$617 \frac{\text{kg} \cdot \text{m}^2}{\text{s}^2 / \text{kg}} = \boxed{617 \frac{\text{m}^2}{\text{s}^2}}$$

(j) Which will effuse faster CO or CO_2 ?

$$\frac{\text{Rate}_1}{\text{Rate}_2} = \sqrt{\frac{\text{Molar Mass}_2}{\text{Molar Mass}_1}}$$

$$\frac{\text{Rate } CO_2}{\text{Rate } CO} = \sqrt{\frac{44.01}{28.01}} = \text{rate } CO_2 = 0.7978$$

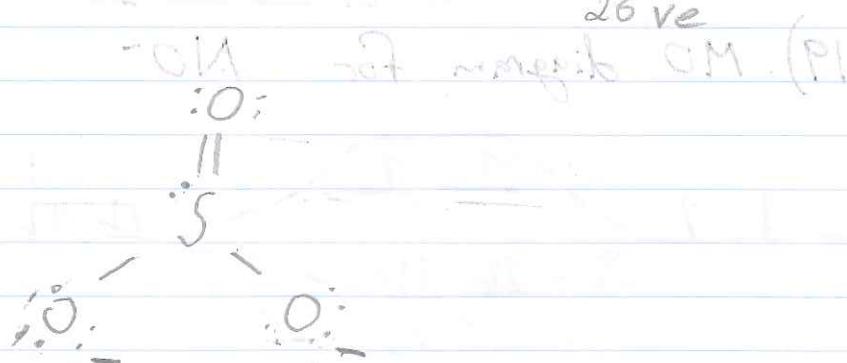
$$\frac{\text{Rate } CO}{\text{Rate } CO_2} = \sqrt{\frac{28.01}{44.01}} = \boxed{\text{Rate } CO = 1.253}$$

5) Avogadro's = $\frac{V_1}{n_1} = \frac{V_2}{n_2}$ from $PV = nRT$

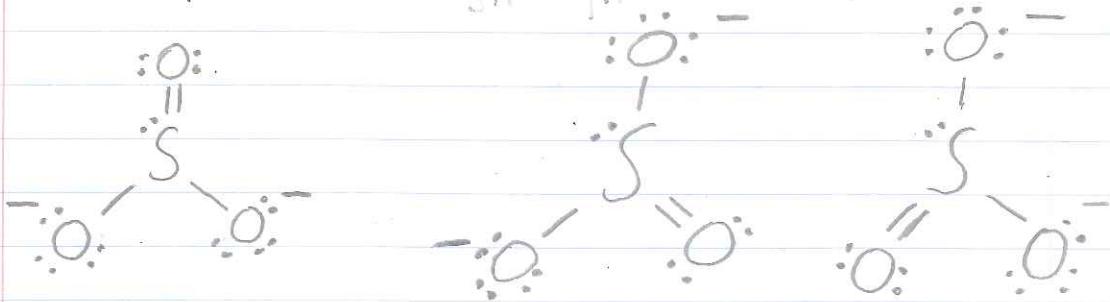
6) Effusion = Process by which collection of molecules escape through a small hole into a vacuum

Diffusion = Process of a collection of molecules spreading out from a high concentration to a low concentration

16) Charge Minimized Structure SO_3^{2-}



17) All possible resonance structure for SO_3^{2-}



18) Hybridize Sulfur in SO_3^{2-}

$S \quad 2s \underline{1} \underline{k} \quad 2p \underline{1} \underline{k} \quad 1 \quad 1$

$\downarrow \text{excite} \quad = \quad 2d \underline{1} \underline{k} \quad - \quad - \quad -$

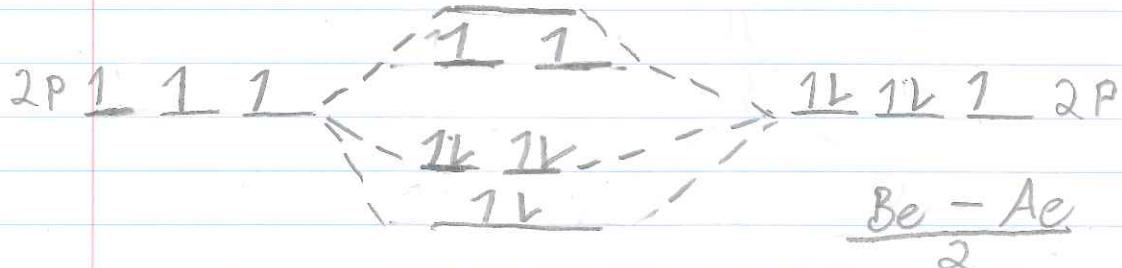
$2s \underline{1} \underline{k} \quad 2p \underline{1} \quad 1 \quad 1 \quad \textcircled{1}$

$\text{sppd} \quad \downarrow \text{hybridize}$

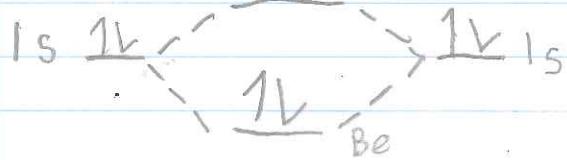
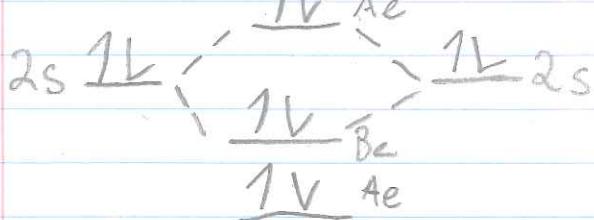
$\text{SPd} \quad \underline{1} \underline{k} \quad \underline{1} \quad \underline{1} \quad \underline{1}$

19) MO diagram for NO^-

$16e^-$



$$\frac{10 - 6}{2} = \boxed{2}$$



CHM 2045
General Chemistry I
Exam 3C
Fall 2012

Name: Steven Romeo

Part A Multiple Choice: For each of the following questions choose the best answer, and place the letter of that answer to the left of the question. This section is worth a total of 28 points.

C 1. How many pi bonds would be found in O₂?

- a. 3
- b. 2
- c. 1
- d. 0

B 2. What is the electron pair geometry PF₅?

- a. Bent
- b. Trigonal bipyramidal
- c. Tetrahedral
- d. Linear

A 3. If an element has 7 valence electrons, but in a molecule it has 8 bonds and no lone pairs what is its formal charge?

- a. -1
- b. +1
- c. 0
- d. Cannot be determined

Omit 4. In MO theory a bond order of 3 indicates:

- a. no bond
- b. a single bond
- c. a double bond
- d. an unstable bond

A 5. Which of the following has the central atom in a sp² hybridization state?

- a. CO₃⁻²
- b. PO₃⁻³
- c. SO₄⁻²
- d. All of the above
- e. None of the above

A 6. Which of the following give the greatest repulsion in a VSEPR shape?

- a. Lone pair-Lone pair
- b. Bond pair-Bond pair
- c. Lone pair-Bond pair
- d. All have equal repulsion

0

C 7. An uneven number of electrons is best described as:

- a. A metallic bond
- b. An unstable bond
- c. A covalent bond
- d. An ionic bond

B 8. The overlapping "p" orbital form

- a. A gamma bond
- b. A pi bond
- c. An alpha bond
- d. A sigma bond

A 9. The polarity of a molecule is based on:

- a. Bond polarity and molecular shape
- b. Electron polarity and electron pair geometry
- c. Bond polarity only
- d. Electron polarity only

A 10. The ideal gas law using standard units for Pressure and Volume because..

- a. All gas laws do
- b. The R value is in those units
- c. Because volume has an effect on pressure
- d. Because pressure has an effect on volume

B 11. Which of the following is largest component of dry air?

- a. O₂
- b. N₂
- c. CO₂
- d. Ar

D 12. Effusion is defined as:

- a. The flow of a gas from high concentration to low concentration
- b. The non-ideal behavior of polar gases of high molar mass
- c. The mixing of gasses to equilibrium
- d. The passage of a gas through a small hole to a vacuum

A 13. Suppose a mixture of two gases has a total pressure of 2.60 atm pressure, if one gas has a pressure 1.34 atm then what is the volume of that gas?

- a. 48.5%
- b. 51.6%
- c. 50.2%
- d. Cannot be determined without know the gas's molar mass

$$P_T = 2.60$$

$$P_A = 2.60 - 1.34$$

$$P_A = \frac{1.26}{2.60} \times 100\% = 48.5\%$$

D 14. Which of the following elements could form an expanded octet when bonded to two fluorine atoms?

- a. O
- b. S
- c. Se
- d. Kr
- e. Ne



6

Si $s\bar{1}k$ $p\bar{1} \bar{1}$

S $s\bar{1}k$ $p\bar{1} \bar{1} \bar{1}$

Part B Completion: For each of the following give the requested information, please show the information clearly. This section is worth a total of 43 points.

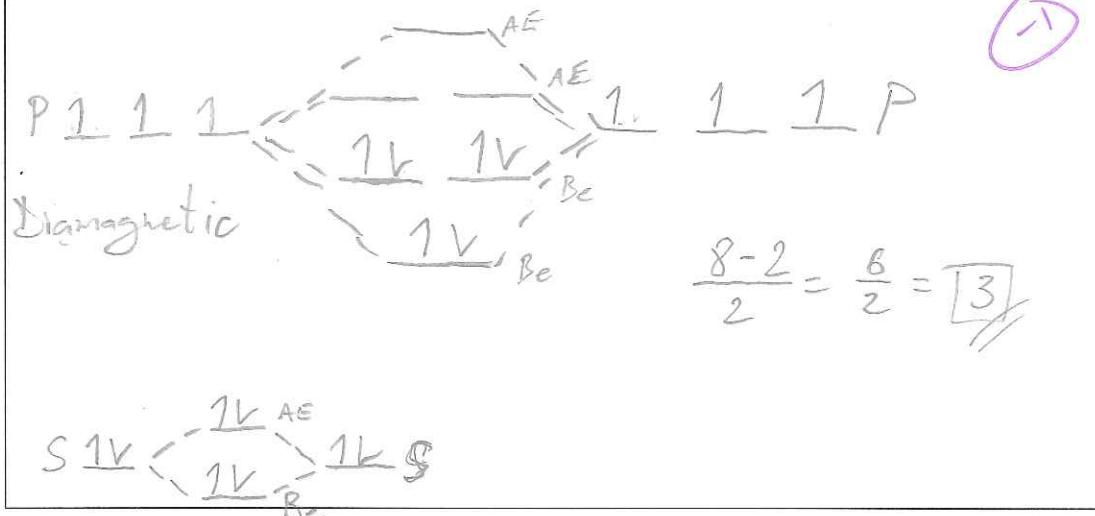
1. (8 pts) Using a molecular orbital diagram, MO theory and bond order, explain whether or not SiS could exist, and its magnetic nature?

Bond order: 3

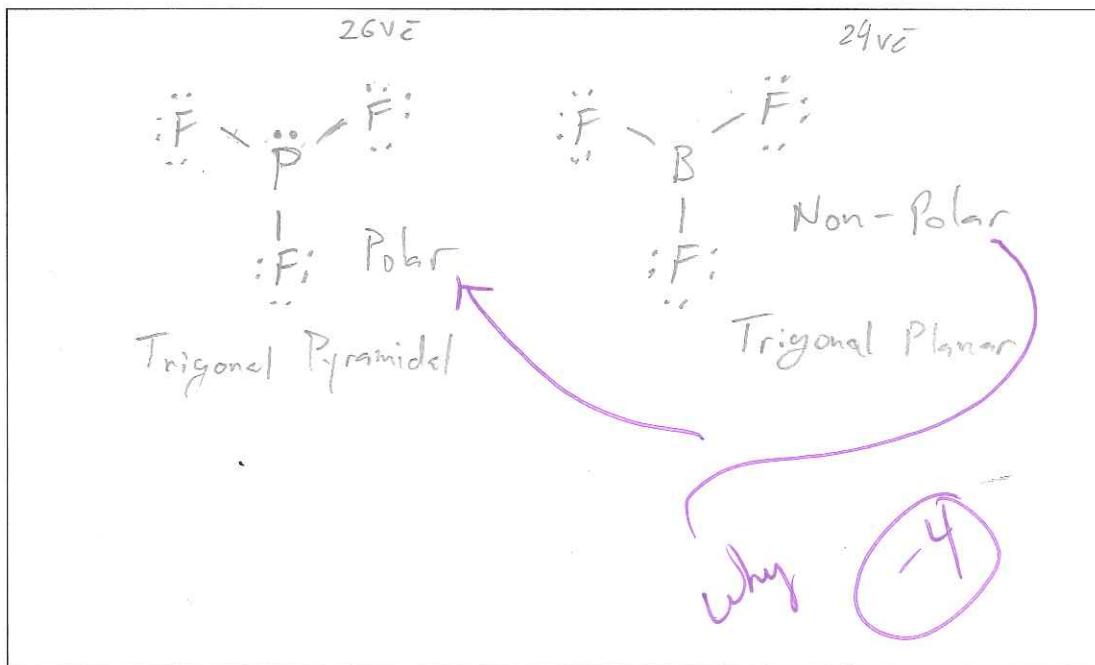
Can it exist: Yes

What type of bond would exist between the atoms: Triple

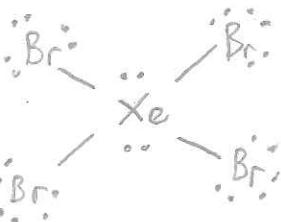
Is it magnetic: No, diamagnetic



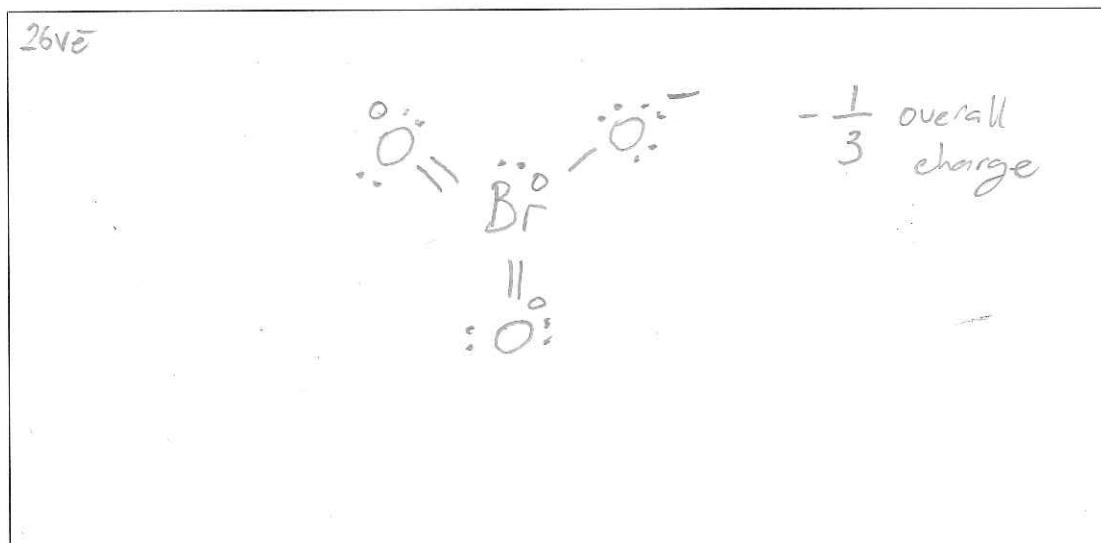
2. (6 points) Compare and contrast the polarity of PF_3 and BF_3



3. (16 points) For each of the following molecules: draw the Lewis dot structure include any formal charges that may be present, give the name of the shape, state whether the molecule is polar or non-polar and give the hybridization of the central atom.

Formula	Lewis dot structure (Charge minimized)	Molecular Shape Name	Polar/ Non-polar	Hybridization of the Central Atom
$36ve^-$ $XeBr_4$		Square Planar	Non Polar	SP^3d^2
$24vc^-$ NO_3^-		Trigonal Planar	Polar	SPd ②

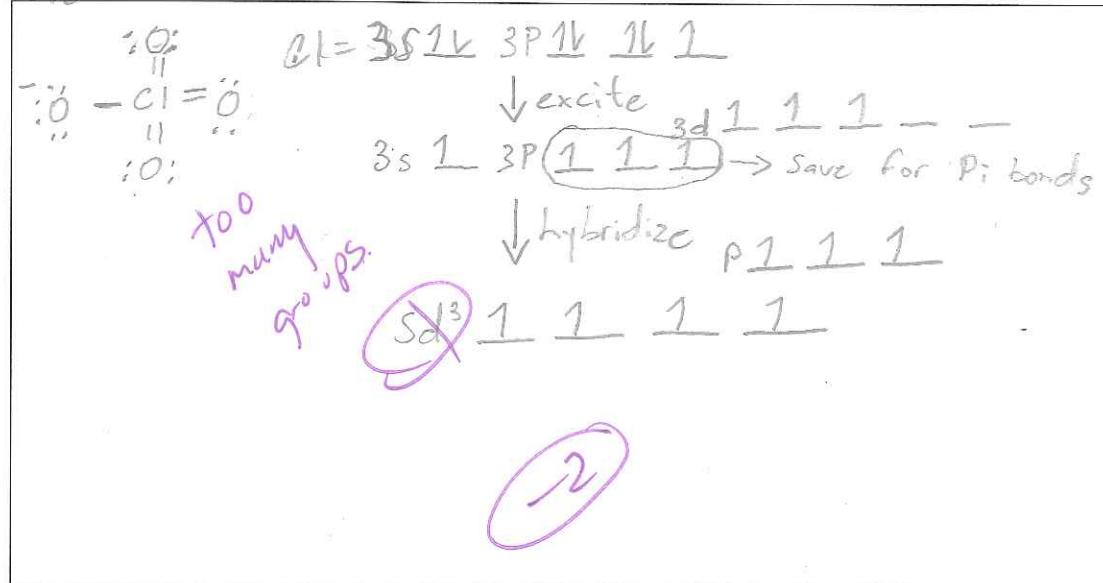
4. (6 points) (a) Show the Lewis dot structure for BrO_3^- in a charge minimized state
 (b) show the formal charge on each atom and (c) give the overall charge on the oxygen



3

5. (7 pts) Using diagrams and words explain how the Chlorine in ClO_4^- would undergoes hybridization. (make sure to show and minimize any formal charges and give the complete hybridization process)

32/6



Part C Problems: For each of the following problems: show your work, remember sig. figs., and units. When you get your final answer place your answer in the box. This section is worth 29 points.

Possible Formulas and Constants

$$\text{rate}_1/\text{rate}_2 = \sqrt{\text{M}_2/\text{M}_1} \quad u = \sqrt{3RT/M}$$

$$d = (\text{MM P}) / (\text{R T}) \quad PV = nRT$$

1. (10 pts) What is the root mean square speed of a Xe gas molecule at 678.2°C?

$$T = 678.2 + 273.2$$

$$T = 951.4 \text{ K}$$

$$u_{\text{rms}} = \sqrt{\frac{3(8.314 \frac{\text{J}}{\text{mol K}})(951.4 \text{ K})}{0.13129 \frac{\text{kg}}{\text{mol}}}} = \sqrt{180744 \frac{\text{J}}{\text{kg}}} \\ = \sqrt{180744 \frac{\text{kg m}^2}{\text{s}^2}} = \boxed{425.1 \frac{\text{m}}{\text{s}}}$$

425.1 $\frac{\text{m}}{\text{s}}$

2

$$\text{mm CF}_4 = 88.01 \text{ g/mol}$$

$$T = 321.8 + 273.2$$

$$P = 933.2 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}}$$

$$T = 595.0 \text{ K}$$

$$P = 1.23 \text{ atm}$$

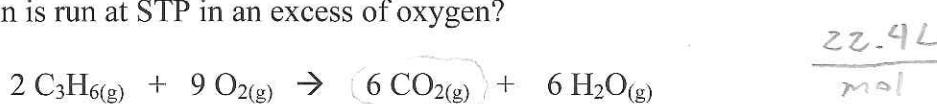
2. (10 pts) Determine the density of CF_4 gas at 321.8°C and 933.2mmHg .

$$d = \frac{\text{mm} \cdot P}{R \cdot T} = \frac{88.01 \text{ g/mol} \cdot 1.23 \text{ atm}}{0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 595.0 \text{ K}} = \boxed{2.22 \text{ g/L}}$$

Sig figs D

2.22 g/L

3. (9 point) How many grams of carbon dioxide could be produced from the complete combustion of 21.9L of propene (C_3H_6) if the following combustion reaction is run at STP in an excess of oxygen?



$$21.9 \text{ L C}_3\text{H}_6 * \frac{\cancel{\text{mol}}}{22.4 \text{ L}} * \frac{6 \text{ mol CO}_2}{2 \text{ mol C}_3\text{H}_6} * \frac{44.01 \text{ g CO}_2}{\cancel{\text{mol}}} = 129.083 \text{ g CO}_2$$

$$= \boxed{129 \text{ g CO}_2}$$

129 g CO_2

Total 83 /100

Hood

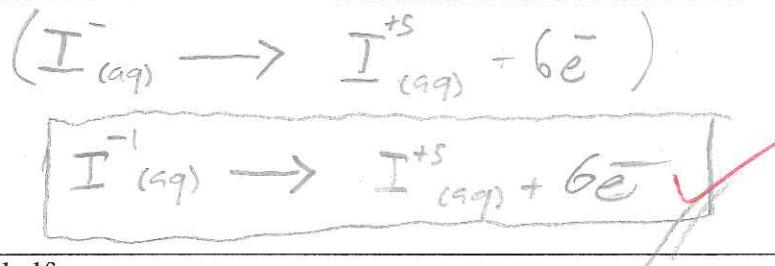
94% ✓

Name: Steven Romano

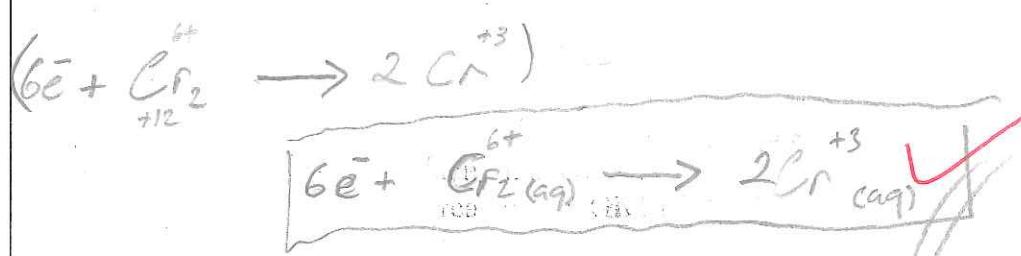
Consider the following Redox reaction: a. Give the balanced reduction half reaction, b. Give the balanced oxidation half reaction, c. Give the full balanced redox reaction in acid, d. What is the reducing agent, and e. What is the oxidizing agent.



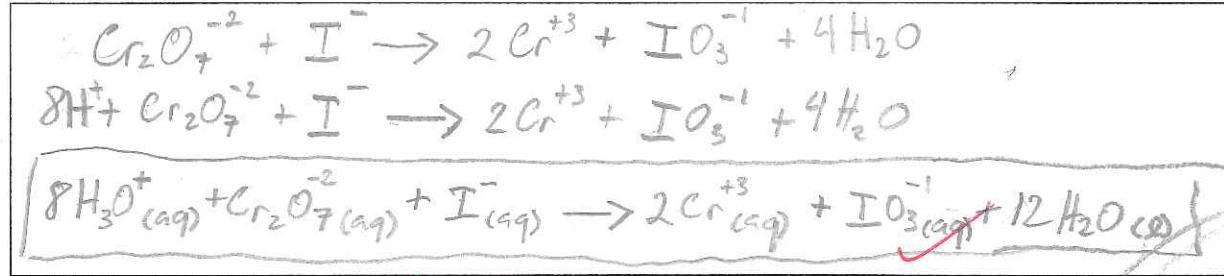
Oxidation half:



Reduction half:



Full Balanced redox reaction in acid:



Reducing agent: Iodine I^-
Oxidizing agent: Chromium $\text{Cr}_2\text{O}_7^{2-}$