CHEMISTRY DEPARTMENT
UNIVERSITY OF BOTSWANA

CHE 101 GENERAL CHEMISTRY I TEST 3

24 April 2004 TIME ALLOWED: THREE HOURS

SURNAME_____ **FIRST NAME**_____ **ID**_____

WRITE ALL ANSWERS ON THIS QUESTION PAPER

The exam has two parts. For section A (multiple-choice questions), circle the number for the correct answer for each question. For questions in Section B, use the space provided to write your answers. If you need additional space, write on the back of the printed pages.

You may detach the Periodic Table

IMPORTANT: It is the student's responsibility to report if any page is missing in the paper. The paper has 10 pages in addition to the Periodic Table.

Avogadro's constant = 6.02×10^{23} atoms/mol or molecules/mol
R = 0.08206 L atm K^{-1} mol^{-1} and 62.3639 L torr K^{-1} mol^{-1}
1atm = 760torr
h = 6.63×10^{-34} J s
c = 3.00×10^{8} m/s
1nm = 10^{-9}m
1J = 1Kg m^2 s^{-2}

MC	1	2	3	4	5	TOTAL

Section A: Multiple Choice

Circle the letter for the one correct answer in each question

Which of the following elements has chemical properties similar to oxygen?

1) fluorine 2) hydrogen 3) nitrogen 4) sulfur 5) boron

2. A piece of metal ore weighs 8.25 g. When it is placed into a container of water, the liquid level rises from 21.25 mL to 26.47 mL. What is the density of the ore?

1) 1.58g/mL 2) 0.633g/mL 3) 0.312g/mL 4) 3.21g/mL 5) 8.25 g/mL

3. What is the empirical formula for an organic compound that contains 49.97% carbon, 10.51% hydrogen, and 39.52% fluorine by mass?

1) $C_4H_{10}F$ 2) $C_4H_{10}F_2$ 3) $C_4H_{10}F_4$ 4) $C_{25}F_2$ 5) C_2H_5F

4. Which are isotopes? An atom with an atomic number of 34 and a mass number of 76 and an atom with:

1) an atomic number of 32 and a mass number of 76.
2) an atomic number of 34 and a mass number of 80.
3) 34 neutrons and 42 protons.
4) 76 protons and 34 neutrons.
5) 32 protons and 78 neutrons

5. How many protons (p), neutrons (n), and electrons (e) are in one ion of $^{26}_{12}Mg^{2+}$?

1) 12 p, 14 n, 12 e 2) 12 p, 14 n, 10 e 3) 12 p, 26 n, 10 e
4) 12 p, 14 n, 14 e 5) 12p, 14n, 11e

6. NO_2^- is

1) nitrate 2) nitrite 3) nitrogen dioxide
4) nitrogen (II) oxide 5) dioxynitride

7. How many grams are there in 0.5 0mol of CF_2Cl_2?

1) $4.14X10^{-3}$ g 2) 60.5 g 3) 121 g 4) 242 g 5) 484 g

8. How many grams of calcium chloride are needed to produce 10.0 g of potassium chloride? $CaCl_2\,(aq) + K_2CO_3\,(aq) \rightarrow 2\,KCl + CaCO_3$

1) 3.36 g 2) 7.45 g 3) 14.9 g 4) 29.8 g 5) 37.3 g

9. What is the **sum** of the coefficients when the following equation is balanced using the lowest, whole numbered coefficients?

$$\_\,PH_3\,(g) + \_\,O_2\,(g) \rightarrow \_\,P_4O_{10}\,(s) + \_\,H_2O\,(g)$$

1) 10 2) 12 3) 19 4) 22 5) 38

10. If 10.0 g of calcium metal reacts with water and produces 5.00 g of calcium hydroxide, what is the percent yield for the following reaction?

$$Ca\,(s) + 2\,H_2O\,(l) \rightarrow Ca(OH)_2\,(s) + H_2\,(g)$$

1) 13.35% 2) 27.0% 3) 50.0% 4) 92.4% 5) 110%

11. What is the concentration of the final solution when 0.065 L of a 12 M HCl solution is diluted to 0.15 L?

1) $2.8X10^{-2}$ M 2) $5.2X10^{3}$ M 3) 28 M 4) 5.2 M 5) 2.8 M

12. How many grams of NaCl are formed in the reaction of 1000 mL of 0.500 M HCl with excess NaOH? $HCl + NaOH \rightarrow NaCl + H_2O$

1) 29.25 g 2) 58.5 g 3) 14.63 g 4) 7.33 g 5) 3.67 g

13. How many electrons does each barium and each nitrogen exchange to form Ba_3N_2?

1) Ba loses 2 and N gains 2
2) Ba loses 2 and N gains 3
3) Ba loses 3 and N gains 2
4) Ba gains 2 and N loses 3
5) Ba loses 2 and N loses 3

14. Under acidic conditions, the bromate ion is reduced to the bromide ion. The balanced half-reaction for this process is:

1) $BrO_3^- + 6H^+ + 6e^- \rightarrow Br^- + 3H_2O$
2) $2BrO_3^- + 12H^+ \rightarrow Br_2^- + 6H_2O + 3e^-$
3) $2BrO_3^- + 6H_2O \rightarrow 2Br^- + 12H^+ + 6O_2 + 8e^-$
4) $2BrO_3^- + 12H^+ \rightarrow Br_2^- + 6H_2O + 3e^-$
5) None of the above answers is correct

15. If 3.0 L of helium at 20^0C is allowed to expand to 4.4 L, with the pressure remaining the same, what is the new temperature?

1) 157^0C 2) 430^0C 3) 702^0C 4) -30^0C 5) 30^0C

16. A mixture of gases contains 4.46 mol of Ne, 0.74 mol of Ar, and 2.15 mol of Xe. What is the partial pressure of the Ne if the total pressure is 2.00 atm?

1) 0.10 atm 2) 0.20 atm 3) 0.40 atm 4) 0.59atm 5) .2 atm

17. What is the molar mass (molecular weight) of a gas which has a density of .30 g/l measured at 27^0 C and 0.40 atm?

1) 38.0 g/mol 2) 48 g/mol 3) 61.5 g/mol 4) 80.2 g/mol 5) 98.9 g/mol

18. How many grams of water will be produced from 7.5L of O_2 measured at STP in a combustion reaction? $CH_4 + 2O_2 \rightarrow CO_2 + 2\,H_2O$

1) 10.7 g 2) 9.33g 3) 4.67 g 4) 10.7 g 5) 6.03 g

19. What are the shapes of orbitals with $l = 0$ and $l =$, respectively?

1) sphere, donut 2) sphere, dumbbell 3) donut, sphere
4) donut, dumbbell 5) both dumbells

20. In $1s^22s^22p^63s^23p^64s^23d^6$, which electrons are valence electrons?

) 3p 2) 3s 3) 1s 4) 3d 5) 2s

21. What are the values of the quantum numbers n, l, and m_l for orbitals in the 4d subshell?

1) n = 4, l = 2, $m_l = -l$ to $+l$ 2) n = 4, l = 3, m_l = -2, -1, 0, +1, +2
3) n = 3, l = 1, m_l = -1, 0, +1 4) n = 5, l = 3, m_l = -2, -1, 0, +1, +2
5) none of these answers

22. What is the number of unpaired electrons found in arsenic-71 and titanium-48, respectively?

1) 2, 3 2) 3, 2 3) 5, 4 4) 4, 5 5) 1,1

23. What type of bonding is found in the compound $(NH_4)_2SO_4$?

1) only covalent 2) only ionic 3) both covalent &ionic
4) metallic 5) both ionic & metallic

24. What is the geometry of the BrF_5 molecule?

1) tetrahedral 2) trigonal bipyramidal 3) octahedral
4) square planar 5) linear

25. The bond order of the N-O bonds of NO_2^-:

1) 1 2) 1.5 3) 2 4) 2.5 5) 3

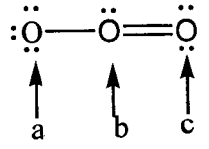
26. Which covalent bond is the most polar?

1) N-F 2) F-F 3) Cl-F 4) C-F 5) C-H

27. The definitive distinction between ionic bonding and covalent bonding is that:

1) ionic bonding involves a sharing of electrons and covalent bonding involves a transfer of electrons.
2) ionic bonding involves a transfer of electrons and covalent bonding involves a sharing of electrons.
3) ionic bonding requires two nonmetals and covalent bonding requires a metal and a nonmetal.
4) covalent bonding requires two metals and ionic bonding requires a metal and a nonmetal.
5) none of the above answers is correct.

28. What are the formal charges of oxygen atoms, a, b, and c respectively in ozone?



1) a = +1, b = 0, c = +1
2) a = -1, b = 0, c = +1
3) a = - , b = +1, c = 0
4) a = b = c = 0
5) a = 0, b = 0, c = -1

29. A hydrogen bond is most likely found between an H and which atom?

1) C 2) P 3) O 4) I 5) B

30. What is the hybridization of the central atom in SF_4?

2) dsp^3 3) d^2sp^3 4) dsfp 5) sp^3

**************End of section A**************

Section B

Answer each question in the space provided. If you require more space, use the back of the page. You may do your rough work on the back of the printed pages, but cross it out before submitting your paper. SHOW your work and reasoning in each question; answers without logical calculations will NOT be given credit. (40%)

1a) Write the correct chemical formula for the following compounds (3 marks)

mercury (I) sulfide _____

cesium sulfate

nitrogen trifluoride

b) Write the correct name for the following materials (3 marks)

Li_2SO_3

K_2HPO_4

P_4O_{10}

c) Which of the above compounds in parts a and b above is most likely to consist of ONLY covalent bonds? (2 marks)

_____ _____

d) Indicate the order of lattice energies (highest energy first) of the following:

LiC $MgCl_2$, MgO _____ (2 marks)

2a) Calculate the average atomic mass of carbon from the following data: carbon-12, exact mass = 12 amu, abundance, 98.90%; carbon-13, exact mass = 13.003 amu, abundance, 1.10%.

(4 marks)

b) Can a photon have mass? Explain by showing equations. (2 marks)

3a) How many mL of 0.550 M HI are needed to react with 25.0 mL of 0.217 M $Ca(OH)_2$?

(4 marks)

b) For the above reaction, show:

The net ionic equation: _____ (1 mark)

The spectator ions: _____ (1 mark)

4a) What is the maximum amount in grams of potassium hydride that can be obtained from 0.405 g of hydrogen and 30.0 g of potassium according to the following equation?

$$2\,K(s) + H_2(g) \rightarrow 2\,KH\,(s)$$ (4 marks)

b) Although the above equation is already balanced, assume you are the first person to have balanced it. Show the steps that were necessary to do this.(Hint: The hydrogen in KH does not have an oxidation number of +1.) (2 marks)

c) In the above equation:

What is the oxidizing agent? _____ (1 mark)

What is the reducing agent? _____ (1 mark)

5a) Write the electron configurations and Lewis electron dot formulas for the following: (6 marks)

species	electron configuration	Lewis symbol
hydrogen atom		
nitrogen atom		
nitride ion		
magnesium atom		
magnesium ion		
iodide ion		

b) Draw two resonance structures for $ClNO_2$ (2 marks)

c) Discuss the concept of electronegativity as it applies to a bond between Br and F in the compound Br-F. (2 marks)

P R OD C TABLE OF THE ELEM NT

H .00794																	8 2 H 4 00260
3 Li 6.941	4 Be 9.01218											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.179
11 Na 22.9898	12 Mg 24.305											13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.08	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.8
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.22	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.6	53 I 126.9	54 X 3 29
55 Cs 132.905	56 Ba 137.33	71 Lu 174.967	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.908	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	09 M (268)	110 Ds (269)	111 U (2)	112 Uub (269)		14 uq		116 Uuh		8

Lan thanid	57 La 138.906	58 Ce 140.12	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 161.930	68 Er 167.26	69 Tm 166.934	70 Yb 173.04
ctinides	89 Ac 227.028	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)