



**ΠΑΜΙΒΙΑ UNIVERSITY**  
**OF SCIENCE AND TECHNOLOGY**

**FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES**

**DEPARTMENT OF BIOLOGY, CHEMISTRY AND PHYSICS**

<b>QUALIFICATION:</b> BACHELOR OF SCIENCE	
<b>QUALIFICATION CODE:</b> 07BOSC	<b>LEVEL:</b> 5
<b>COURSE CODE:</b> GNC501S	<b>COURSE NAME:</b> GENERAL CHEMISTRY 1A
<b>SESSION:</b> JULY 2023	<b>PAPER:</b> THEORY
<b>DURATION:</b> 3 HOURS	<b>MARKS:</b> 100

<b>SECOND/SUPPLEMENTARY OPPORTUNITY EXAMINATION QUESTION PAPER</b>	
<b>EXAMINER(S)</b>	MRS. LEONORITHA R. NAOMAS
<b>MODERATOR:</b>	DR. MARIUS MUTORWA

<b>INSTRUCTIONS</b>
<ol style="list-style-type: none"><li>1. Answer ALL the questions.</li><li>2. Write clearly and neatly.</li><li>3. Number the answers clearly</li><li>4. All written work must be done in blue or black ink and sketches can be done in pencil</li><li>5. No books, notes and other additional aids are allowed</li></ol>

**PERMISSABLE MATERIALS**

Non-programmable calculators

**ATTACHMENTS**

1. List of useful constants
2. Periodic Table

**THIS QUESTION PAPER CONSISTS OF 9 PAGES**

(Including this front page, list of useful constants and Periodic Table)



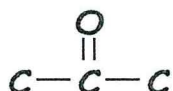
- There are 20 multiple choice questions in this section. Each question carries 3 marks.
  - Answer ALL questions by selecting the letter of the correct answer.
  - Choose the best possible answer for each question, even if you think there is another possible answer that is not given.
1. Which of the following pairs of species is **not** a conjugate acid-base pair?
    - A. HCl and  $\text{H}^+$
    - B.  $\text{HSO}_4^-$  and  $\text{SO}_4^{2-}$
    - C.  $\text{H}_2\text{SO}_4$  and  $\text{HSO}_4^-$
    - D.  $\text{H}_2\text{O}$  and  $\text{OH}^-$
  2. Which of the following reactions illustrate  $\text{Al}(\text{OH})_3$  acting as a Lewis acid?
    - A.  $\text{Al}(\text{OH})_3 \rightarrow \text{Al}^{3+} + 3\text{OH}^-$
    - B.  $\text{Al}(\text{OH})_3 + \text{OH}^- \rightarrow \text{Al}(\text{OH})_2\text{O}^- + \text{H}_2\text{O}$
    - C.  $\text{Al}(\text{OH})_3 + \text{OH}^- \rightarrow \text{Al}(\text{OH})_4^-$
    - D.  $\text{Al}(\text{OH})_3 + 3\text{H}^+ \rightarrow \text{Al}^{3+} + 3\text{H}_2\text{O}$
  3. Calculate the hydroxide ion concentration of a solution if its pH is 6.389.
    - A.  $1.00 \times 10^{-14}$  mol/L
    - B.  $4.08 \times 10^{-7}$  mol/L
    - C.  $9.92 \times 10^{-7}$  mol/L
    - D.  $2.45 \times 10^{-8}$  mol/L
  4. Consider each of the following pairs of acids. Which statement is correct?
    - A.  $\text{ClO}_2$  is a stronger acid than  $\text{HClO}_4$ .
    - B.  $\text{H}_2\text{SO}_4$  is a stronger acid than  $\text{H}_2\text{SeO}_4$ .
    - C.  $\text{H}_2\text{O}$  is a stronger acid than HF.
    - D.  $\text{H}_2\text{S}$  is a stronger acid than  $\text{H}_2\text{Se}$ .
  5. According to Bohr Theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon? Use the equation:  $E_n = (-2.18 \times 10^{-18} \text{ J})(1/n^2)$ 
    - A.  $n = 5$  to  $n = 3$
    - B.  $n = 6$  to  $n = 1$
    - C.  $n = 4$  to  $n = 3$
    - D.  $n = 6$  to  $n = 5$



6. Which of the following elements has the largest ionization energy?
- Na
  - Ne
  - F
  - K
7. In Bohr's model of the hydrogen atom, the radius of an orbit
- is proportional to  $n^2$ .
  - is smallest for the highest energy state.
  - increases when a photon of light is emitted from an excited atom.
  - can have any value that is larger than the ground-state radius.
8. Which of the following statements about periodic properties is incorrect?
- Both electron affinity and ionization energy decrease down a group.
  - Atomic size increases to the right across a period.
  - Ionization energy increases to the right across a period.
  - Atomic size increases down a group.
9. Deviations from the ideal gas law are less at:
- high temperatures and high pressures
  - high temperatures and low pressures
  - low temperatures and high pressures
  - low temperatures and low pressures
10. Determine the number of moles of aluminum in  $2.154 \times 10^{-1}$  kg of Al.
- 5816 mol
  - 7.984 mol
  - $6.02 \times 10^{23}$  mol
  - 4.801 mol
11. This equation is unbalanced:  $\text{PCl}_3 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_3 + \text{HCl}$  When it is correctly balanced, the coefficients are, respectively:
- 1,3,1,1
  - 1,1,1,3
  - 1,3,1,3
  - 2,3,2,3
12. What is the correct name for  $\text{Pb}(\text{ClO}_2)_2$ :
- lead(II) chlorite
  - lead dichlorite
  - lead (II) chlorate
  - lead chlorate



13. What is the correct formula for mercury(I) sulfide?
- a) HgS
  - b) Hg<sub>2</sub>S
  - c) Hg<sub>2</sub>SO<sub>4</sub>
  - d) Hg<sub>2</sub>SO<sub>3</sub>
14. What would happen to the average kinetic energy of the molecules of a gas sample if the temperature of the sample increased from 20°C to 40°C?
- A. It would double.
  - B. It would become half its value.
  - C. It would decrease.
  - D. It would increase.
15. Which conditions of P and T are most ideal for a gas?
- A. low P, high T
  - B. high P, low T
  - C. high P, high T
  - D. depends on the gas
16. How many actual double bonds does the benzene ring possess?
- A. None, carbon-carbon bonds in benzene are delocalized around the ring
  - B. 1 double bond
  - C. 2 double bonds
  - D. 3 double bonds
17. The functional group given below is characteristic of organic \_\_\_\_\_.



- A. ketones
  - B. acids
  - C. aldehydes
  - D. esters
18. Give the IUPAC name of this compound: CH<sub>3</sub>OCH<sub>2</sub>CH<sub>3</sub>.
- A. dimethyl ether
  - B. methoxyethane
  - C. methylethyloxiide
  - D. propyl ether





19. Which is NOT a physical property of alcohols or phenols?
- A. Phenols are generally only slightly soluble in water.
  - B. The solubilities of normal primary alcohols in water decrease with increasing molecular weight.
  - C. The hydroxyl group of an alcohol is nonpolar.
  - D. Due to hydrogen bonding, boiling points of alcohols are much higher than those of corresponding alkanes.
20. The general formula for noncyclic alkynes is:
- A.  $C_nH_{2n}$
  - B.  $C_nH_n$
  - C.  $C_nH_{2n+2}$
  - D.  $C_nH_{2n-2}$



**SECTION B:****[40]**

There are FOUR questions in this section. Answer all Questions.

Show clearly, where necessary, how you arrive at the answer as the working will carry marks.

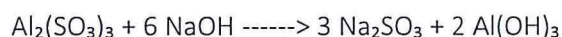
**Question 1****[10]**

Ethylene dibromide was used as a grain pesticide until it was banned. Calculate the:

- empirical formula and
- molecular formula for ethylene dibromide given its approximate molar mass of 190 g/mol and its percent composition: 12.7% C, 2.1% H, and 85.1% Br.

**Question 2****[8]**

Given the following equation:



- If 10.0 g of  $\text{Al}_2(\text{SO}_3)_3$  is reacted with 10.0 g of NaOH, determine the limiting reagent
- Determine the number of moles of  $\text{Al}(\text{OH})_3$  produced.
- Determine the number of grams of  $\text{Na}_2\text{SO}_3$  produced.
- Determine the number of grams of excess reagent left over in the reaction.

**Question 3****[13]**

3.1 The osmotic pressure of a 0.010 M aqueous solution of  $\text{CaCl}_2$  is found to be 0.674 atm at 25 °C.

- Calculate the van't Hoff factor,  $i$ , for the solution. (3)
- How would you expect the value of  $i$  to change as the solution becomes more concentrated? Explain. (2)

3.2 At 63.5 °C the vapor pressure of  $\text{H}_2\text{O}$  is 175 torr, and that of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) is 400 torr. A solution is made by mixing equal masses of  $\text{H}_2\text{O}$  and  $\text{C}_2\text{H}_5\text{OH}$ .

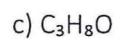
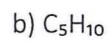
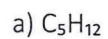
- What is the mole fraction of ethanol in the solution? (3)
- Assuming ideal-solution behavior, what is the vapor pressure of the solution at 63.5 °C? (3)
- What is the mole fraction of ethanol in the vapor above the solution? (2)



**Question 4**

[9]

5.1 Draw all possible open-chain structures for the following molecular formulas and name them: (9)



END OF EXAMINATION

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USEFUL CONSTANTS:

Gas constant,  $R = 8.3145 \text{ J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} = 0.083145 \text{ dm}^3 \cdot \text{bar} \cdot \text{mol}^{-1} \cdot \text{K}^{-1} = 0.08206 \text{ L atm mol}^{-1} \cdot \text{K}^{-1}$

$1 \text{ Pa} \cdot \text{m}^3 = 1 \text{ kPa} \cdot \text{L} = 1 \text{ N} \cdot \text{m} = 1 \text{ J}$

$1 \text{ atm} = 101\,325 \text{ Pa} = 760 \text{ mmHg} = 760 \text{ torr}$

Avogadro's Number,  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

Planck's constant,  $h = 6.626 \times 10^{-34} \text{ Js}$

Speed of light,  $c = 2.998 \times 10^8 \text{ ms}^{-1}$





## PERIODIC TABLE OF THE ELEMENTS

1																	18					
1 <b>H</b> 1.00794																	2 <b>He</b> 4.00260					
2																	13	14	15	16	17	
3 <b>Li</b> 6.941	4 <b>Be</b> 9.01218											5 <b>B</b> 10.81	6 <b>C</b> 12.011	7 <b>N</b> 14.0067	8 <b>O</b> 15.9994	9 <b>F</b> 18.9984	10 <b>Ne</b> 20.179					
11 <b>Na</b> 22.9898	12 <b>Mg</b> 24.305											13 <b>Al</b> 26.9815	14 <b>Si</b> 28.0855	15 <b>P</b> 30.9738	16 <b>S</b> 32.06	17 <b>Cl</b> 35.453	18 <b>Ar</b> 39.948					
19 <b>K</b> 39.0983	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.9559	22 <b>Ti</b> 47.88	23 <b>V</b> 50.9415	24 <b>Cr</b> 51.996	25 <b>Mn</b> 54.9380	26 <b>Fe</b> 55.847	27 <b>Co</b> 58.9332	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.546	30 <b>Zn</b> 65.38	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59	33 <b>As</b> 74.9216	34 <b>Se</b> 78.96	35 <b>Br</b> 79.904	36 <b>Kr</b> 83.8					
37 <b>Rb</b> 85.4678	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.9059	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.9064	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.906	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.868	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.69	51 <b>Sb</b> 121.75	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.29					
55 <b>Cs</b> 132.905	56 <b>Ba</b> 137.33	71 <b>Lu</b> 174.967	72 <b>Hf</b> 178.49	73 <b>Ta</b> 180.948	74 <b>W</b> 183.85	75 <b>Re</b> 186.207	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.22	78 <b>Pt</b> 195.08	79 <b>Au</b> 196.967	80 <b>Hg</b> 200.59	81 <b>Tl</b> 204.383	82 <b>Pb</b> 207.2	83 <b>Bi</b> 208.908	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)					
87 <b>Fr</b> (223)	88 <b>Ra</b> 226.025	103 <b>Lr</b> (260)	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (264)	108 <b>Hs</b> (265)	109 <b>Mt</b> (268)	110 <b>Uun</b> (269)	111 <b>Uuu</b> (272)	112 <b>Uub</b> (269)		114 <b>Uuq</b>		116 <b>Uuh</b>		118 <b>Uuo</b>					

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