



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

KAKUMA CAMPUS

UNIVERSITY EXAMINATIONS

MAIN EXAM

2021/2022 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER EXAMINATION

FOR THE BSc. HUMAN NUTRITION AND DIETETICS

COURSE CODE: SCH 100

COURSE TITLE: FUNDAMENTALS OF CHEMISTRY I

DATE: 20/4/2022

TIME: 8:00-10:00 AM

INSTRUCTIONS TO CANDIDATES:

Answer all questions

MMUST observes ZERO tolerance to examination cheating

Paper Consists of 5 Printed Pages. Please Turn Over.

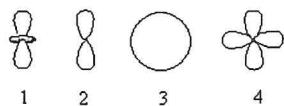
▶

QUESTION ONE

- a) Give a brief description of the Bohr model of the hydrogen atom. (3 marks)
- b) A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the energy level ($n = 3$) to the energy level ($n = 2$).
- i) Calculate the energy emitted in this transition.
- ii) Calculate the wavelength of light emitted. (4 marks)
- c) Explain the meaning of each of the following (3 marks)
- i) Aufbau principle
- ii) Electron affinity
- iii) Ionization energy
- d) There are four (4) quantum numbers used to describe an electron in an atomic orbital. By using the following sets of quantum numbers, state the maximum number of electrons in an atom in each case. (3 marks)
- i) $n = 2, l = 1, ml = 0$
- ii) $n = 1, l = 0$
- iii) $n = 3, l = 2, ml = 1, ms = +\frac{1}{2}$
- e) A metallic element 'X' can exist as X^+ , X^{2+} and X^{5+} ions
- i) Write the chemical formula for compounds formed from the combination of the X ions and CrO_4^{2-} . (1 mark)
- ii) Suggest a possible classification of the element in the periodic table (1 mark)
- f) Explain the trend in the following properties of elements across a period in the periodic table
- i) Atomic Radius (2 marks)
- ii) Ionization Energy (2 marks)

QUESTION TWO

- a) Which of the following diagrams represent d -orbitals? (1 mark)



- b) The atom A has a ground state configuration $[\text{Xe}]4f^{14}5d^{10}6s^26p^5$. Explain the group and period of this element hence classify it appropriately. **(3 marks)**
- c) Place electrons in the boxes below to show the lowest energy electron configuration of a nitrogen atom. (Use all electrons, not just valence electrons.) **(2 marks)**
- d) A section of the periodic table with all identification features removed is shown below.

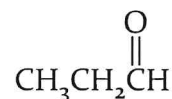
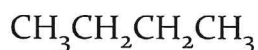
| | | |
|---|---|---|
| V | W | X |
| | Y | Z |

Which element is the least metallic? Give a brief explanation for your choice. **(2½ marks)**

- e) Use the atomic theory to explain the following.
- Why within a family such as the halogens, the ionic radius increases as the atomic number increases. **(2 marks)**
 - In terms of electron configuration and shielding, why is the atomic radius of sodium smaller than that of potassium? **(2 marks)**
 - In terms of electron configurations and shielding, why do atoms get smaller as you move across a period? **(2 marks)**
 - With reference to both their particle and their wave nature, describe the similarities and differences between gamma radiation and radio waves. Which has higher energy? **(2 marks)**
 - Describe the two opposing forces between particles in the nucleus, and with reference to these forces, explain why the ratio of neutrons to protons required for a stable nuclide increases as the number of protons in a nucleus increases. **(2½ marks)**

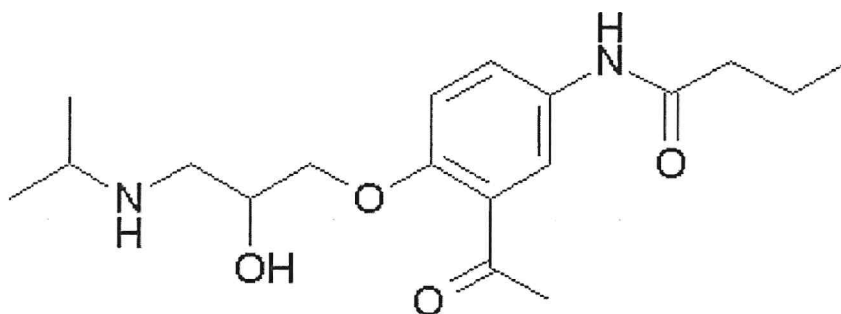
QUESTION THREE

- a) Give at least three structural isomers for the molecular formula, C_4H_8 . **(4 Marks)**
- b) Arrange the following molecules in increasing order of boiling points. Explain your answer. **(4 Marks)**

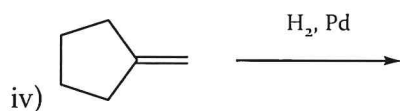
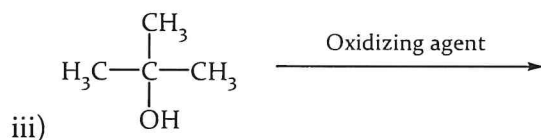
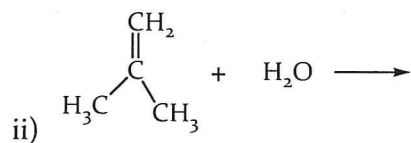
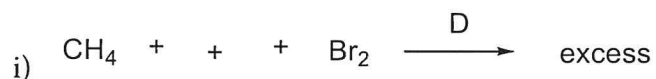


- c) Acebutolol is a compound found in a class of drugs called beta-blockers, which are used to lower blood pressure, lower heart rate, reduce angina (chest pain), and reduce the risk of recurrent heart attacks. Identify the functional group(s) that appear in acebutolol.

(3 marks)



- d) Give products for the reactions given below and where applicable identify the major product (4 Marks)

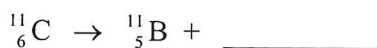
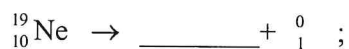
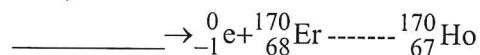


- e) Balance the equation for the reaction given below taking place in basic solution (3 Marks)



QUESTION FOUR

- a) Ethylene glycol is a compound often used as an anti-freeze in cars in cold weather. It is an organic compound known to contain 38.7% carbon and 9.7 % hydrogen. The remainder is oxygen
- Calculate the empirical formula of ethylene glycol (2½ marks)
 - If the molecular mass of ethylene glycol is found to be 62, calculate its molecular formula (2 marks)
- b. Using your knowledge of nuclear chemistry to answer the following questions:
- Explain why ${}^4_2\text{He}$, ${}^{12}_6\text{C}$ and ${}^{16}_8\text{O}$ are especially stable. (2 marks)
 - Consider three isotopes of neon, ${}^{18}_{10}\text{Ne}$, ${}^{20}_{10}\text{Ne}$, and ${}^{24}_{10}\text{Ne}$. Neon-20, which is the most abundant isotope of neon, is stable. One of the other nuclides undergoes beta emission, and the remaining nuclide undergoes positron emission. Identify the isotope that makes each of these changes, and explain your choices. (3 marks)
 - Complete and balance the following nuclear reaction. (4½ marks)



APPENDIX I

Important Constants for Question One

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

Speed of light (in a vacuum), $c = 2.998 \times 10^8 \text{ms}^{-1}$

Rydberg's constant, $R_H = 2.178 \times 10^{-18} \text{J}$

Elements of the Periodic Table

| | | | | | | | | | | | | | | | | | | | | | |
|---|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|--------------------------|--------------------------|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
| | | | | | | | | | | | | | | | | | 8A (18) | | | | |
| | 1A (1) | | | | | | | | | | | | | | | | 2 (18) | | | | |
| 1 | 1 H 1.008 | | | | | | | | | | | | | | | | 2 He 4.003 | | | | |
| | 2A (2) | | | | | | | | | | | | | | | | | | | | |
| 2 | 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 3 | 11 Na 22.99 | 12 Mg 24.31 | | | | 3B (3) | 4B (4) | 5B (5) | 6B (6) | 7B (7) | 8B (8) (9) (10) | | | 1B (11) | 2B (12) | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 4 | 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.88 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 | | | |
| 5 | 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 | | | |
| 6 | 55 Cs 132.9 | 56 Ba 137.3 | 57 La 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.9 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) | | | |
| 7 | 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (266) | 107 Bh (262) | 108 Hs (265) | 109 Mt (266) | 110 (269) | 111 (272) | 112 (277) | As of mid-1999, elements 110 through 112 have not yet been named. | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|-------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| 6 | Lanthanides | 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 | 71 Lu 175.0 |
| 7 | Actinides | 90 Th 232.0 | 91 Pa (231) | 92 U 238.0 | 93 Np (237) | 94 Pu (242) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (260) |