



KENYATTA UNIVERSITY

SUPPLEMENTARY/SPECIAL EXAMINATIONS 2021/2022

EXAMINATION FOR THE DEGREE OF BACHELOR OF PHARMACY (BPharm Level I)

SCH 110: CHEMISTRY I

AUGUST 2022

TIME: 3 HOURS

Useful information

Speed of light $c = 2.997926 \times 10^8 \text{ ms}^{-1}$

Avogadro constant $N_A = 6.022045 \times 10^{23} \text{ mol}^{-1}$

Plank constant $h = 6.626176 \times 10^{-34} \text{ J s}$

$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$

Useful information:

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$= 0.08206 \text{ litre} - \text{atmosphere mol}^{-1} \text{ K}^{-1}$$

$$0^\circ \text{C} = 273.15 \text{ K}$$

$$1 \text{ atm pressure} = 760 \text{ mmHg}$$

$$= 101,325 \text{ Nm}^{-2}$$

SECTION A: INTRODUCTION TO INORGANIC CHEMISTRY

Q1. (a) Define the following terms:

[3 marks]

- Isoelectric species
- Isotopes
- Hybridization

(b) Write the electron configuration of the following species:



[1 mark]



[1 mark]

(c) Determine the oxidation number of the underlined atoms in each of the following species:



[3 marks]

(d) Using the VSEPR theory draw shapes of the following molecules:

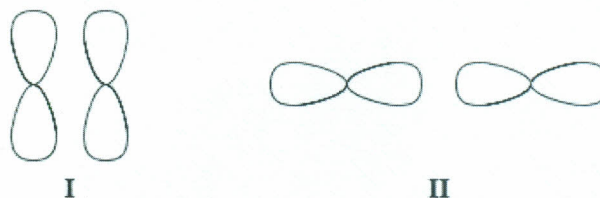


[2 marks]

(e) Draw the Lewis structure of the following compounds:

i) NaCl ii) NH_4^+ [2 marks]

(f) Diagrams I and II show two p orbitals on adjacent atoms in different relative orientations.



(g) State the type of bonds that are formed when the orbitals overlap in:

i) I [1 mark]

ii) II [1 mark]

Q2. (a) State any two assumptions made by Bohr in order to explain hydrogen spectrum

[2 marks]

(b) The energy change in a hydrogen atom ΔE in an electronic transition is given by

$$\Delta E = 2.18 \times 10^{-18} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ Joules}$$

Determine

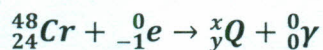
- i. The energy for transition $n=5$ to the $n=2$ state in the hydrogen atom [2 marks]
- ii. The frequency for the transition [2 marks]
- iii. The wavelength of the transition [2 marks]

(c) Briefly describe the three quantum numbers obtained from the Schrodinger wave equation which is fundamental in quantum mechanics. [6 marks]

Q3. (a) Determine the number of neutrons, protons and electrons present in the given species



(b) Complete and balance the following nuclear equation [3 marks]



- (c) You are provided with a solution of potassium permanganate of unknown concentration and you are required to **standardize** it using sodium oxalate solution (in acidic media). If 0.2482 g $\text{Na}_2\text{C}_2\text{O}_4$ is dissolved in water and titrated with 23.36 cm^3 of KMnO_4 . The redox reaction is:



- i) Calculate the number of moles in 0.2482 g $\text{Na}_2\text{C}_2\text{O}_4$ [2 marks]
 ii) Determine the molarity of KMnO_4 [4 marks]

SECTION B: INTRODUCTION TO PHYSICAL CHEMISTRY

- Q1. (a) State the three properties that define an ideal gas [3 marks]
 (b) For a sample of an ideal gas, determine the temperature at which 0.2 mole occupies 2 litres at a pressure of 2 atmospheres [2 marks]
 (c) Express Charles's law in mathematical form, explaining what the various terms represent [3 marks]
 (d) A gas mixture containing 0.3 mole of helium and 0.1 mole of argon is confined in a 10 litre vessel at 298K. Calculate the total pressure of the gas mixture [2 marks]

Q2. (a) For the chemical equilibrium:



give the dimensions of both K_p and K_c [2 marks]

(b) For the equilibrium:



Calculate the value of K_p , giving the proper dimensions [3 marks]

(c) (i) State the le Chatelier's principle [2 marks]

(ii) Explain the effect of changes in pressure on the position of equilibrium of the reaction:



Q3. (a) Determine the hydrogen ion concentration of a solution with $pH = 3$ [1 mark]

(b) For an aqueous solution $[OH^-] = 10^{-4} M$. Determine the pH of the solution [1 mark]

(c) (i) Define the term buffer solution [2 marks]

(ii) Explain the workings of a buffer solution [3 marks]

(d) An aqueous solution of sodium ethanoate turns litmus bluish. Explain, giving relevant chemical equations [3 marks]

Q4. (a) State Raoult's law [2 marks]

(b) The vapor pressures of pure water and pure ethanol at $25^\circ C$, are 23.8 mmHg and 61.2 mmHg respectively. Determine the vapor pressure of a solution made by mixing equal number of mole of water and ethanol at $25^\circ C$ [3 marks]

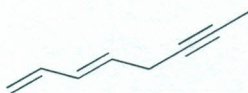
(c) The solubility product of silver chloride, $AgCl$, is $2.8 \times 10^{-10} \text{ mol}^2 \text{ litre}^{-2}$ at $25^\circ C$. Determine the solubility of the salt, at the same temperature [3 marks]

(d) Determine the pH of a 0.3M solution of a monoprotic acid with $K_a = 1.85 \times 10^{-5}$ [2 marks]

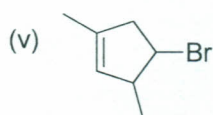
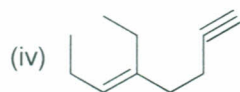
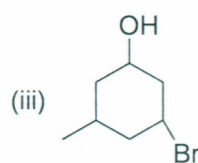
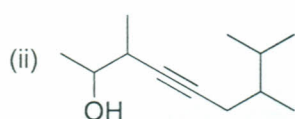
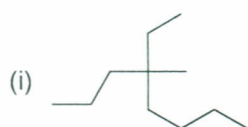
SECTION C: INTRODUCTION TO ORGANIC CHEMISTRY

Q1. (a) Caffeine, a stimulant found in coffee, tea, and certain soft drinks, contains C, H, O, and N. Combustion of 1.000 mg of caffeine produces 1.813 mg CO_2 , 0.4639 mg H_2O , and 0.2885 mg N_2 . Estimate the molar mass of caffeine, which lies between 150 and 200 g/mol. [6 marks]

(b) Give molecular formula of the following molecule and write a balanced chemical equation when it undergoes combustion [3 marks]



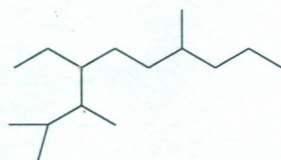
(c). Give the IUPAC name to each of the following compounds, indicating the stereochemistry where appropriate. [6 marks]



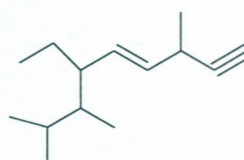
Q2. (a) Cyclobutane (**1**) can be brominated to bromocyclobutane (**2**) using molecular bromine in presence of light. Write down the initiation, propagation and termination for the free radical chain reaction. [4 marks]



(b) Give a simple visual chemical test you would perform to differentiate between the following pairs of compound. [2 marks]

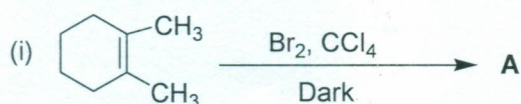


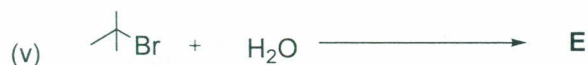
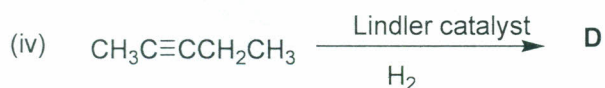
and



(c) Combustion of 0.105 g of an organic compound gave 0.257 g carbon dioxide and 0.035 g of water. If the molecular mass of this compound is 108 g, calculate Empirical formula of this compound [C = 12.01, H = 1.00, O = 16.0] [3 marks]

(d) Provide the structure(s) of the major organic compounds that are expected in the following reactions. Indicate the stereochemistry where necessary. [6 marks]



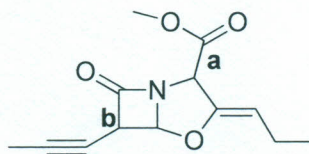


Q3. Define the following terms with an example as applied in organic chemistry.

[4 marks]

- Geminal diol
- Polar covalent bond
- Catenation
- Pyrolysis

(b) The chemical structure given is of a hypothetical organic molecule. Use it to answer the following questions



- Predict the type of hybridization for the labeled atoms **a** and **b** [2 marks]
- How many Pi bonds are present in this molecule? [1 mark]
- How many primary carbons are present in this molecule? [1 mark]
- Give any two polar covalent bonds in the molecule, [2 marks]