



# **KIBABII UNIVERSITY**

**UNIVERSITY EXAMINATIONS  
2020/2021 ACADEMIC YEAR**

**FIRST YEAR FIRST SEMESTER  
MAIN EXAMINATIONS**

**FOR THE DEGREE OF B. ED (SCIENCE)**

**COURSE CODE: SCH 112**

**COURSE TITLE: INTRODUCTION TO ORGANIC CHEMISTRY**

**DATE: 19/05/2021**

**TIME: 2:00-4:00PM**

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## **INSTRUCTIONS TO CANDIDATES**

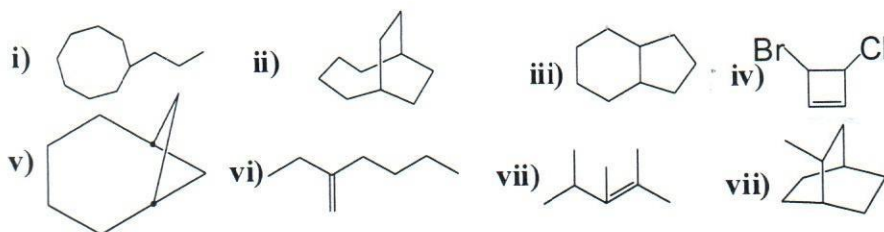
**TIME: 2 Hours**

**Answer question ONE and any TWO of the remaining**

**KIBU observes ZERO tolerance to examination cheating**

### Question 1 (30 marks)

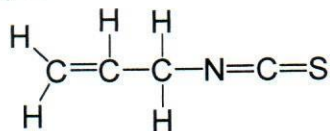
- a) Define the following terms
- Heterolysis
  - Hybrid orbitals
  - Nucleophile
  - Carbanion
  - Isomers
- [5 marks]
- b) Draw the shapes of the orbitals formed when the following orbitals overlap. Indicate the type of bonds formed.
- S and S orbitals
  - End to end overlap of p orbitals
  - Side to side overlap of p orbitals
- [3 marks]
- c) i). Write the electron configuration of oxygen atom (indicate all orbitals that contain the electrons) [1 mark]
- ii). Indicate all the orbitals that contain the valence electrons and give the number of valence electrons in oxygen atom. [2 marks]
- iii). The orbitals containing the valence electrons in oxygen atom overlap to give hybrid orbitals. Identify the hybrid orbitals formed. [1 mark]
- iv). Draw the shape of the structure that has the orbitals formed in c (iii) above. Indicate the number of electrons in each hybrid orbitals. [2 marks]
- d) Give structures of the following compounds
- 1-bromo-3-ethyl-5-methylcyclohexane
  - 3-ethyl-2-pentene
  - 1-methylcyclobutene
  - 1-ethenylcyclohexene
  - 1-triiodo-4-dimethyl-2-nonyne
  - 4,4-dimethyl-2-pentyne
  - Propylcyclopentane
- [8 marks]
- e) Give IUPAC names for the following compounds.



[8 marks]

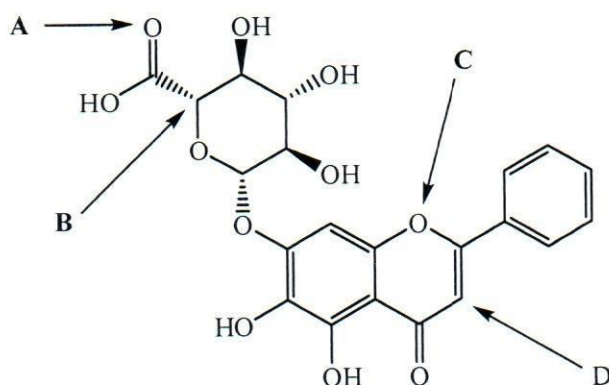
### Question 2 (20 marks)

- a) Draw a diagram showing all of the atomic orbitals in the molecule shown below. Indicate the orbitals that overlap to form sigma ( $\sigma$ ) bonds, those that overlap to form pi ( $\pi$ ) bonds and those which hold lone pair of electrons. Do not draw the back lobes of the hybrid orbitals.



[12 marks]

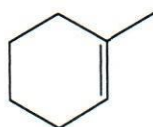
- b) Below is the structure of Baicalin, an anti-HIV agent.



- i). Identify and name all the functional groups present in the compound. [6 marks]  
ii). What is the hybridization of the atoms labelled **A**, **B**, **C** and **D** [2 marks]

### Question 3 (20 marks)

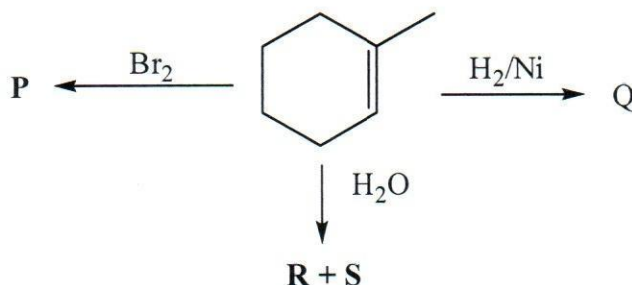
- a) State *Zaitsev's rule* [2 marks]  
b) Alkenes are prepared by elimination reactions in which a carbon-carbon single bond is converted to a double bond. Draw a *carbocation mechanism* for dehydration of propan-2-ol. [4 marks]  
c) Compound **A** is an unsaturated hydrocarbon that can be used as the starting material for the production of organic compounds.



Compound A

- i). What is the molecular formula of compound **A**? [1 mark]

ii). The flowchart shows three addition reactions of compound **A**



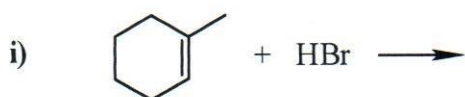
iii). Draw the structures of the organic products **P**, **Q**, **R** and **S** formed in the reactions. [4 marks]

iv). What are the essential conditions for the reaction of compound **A** with  $\text{H}_2\text{O}$ ? [2 marks]

v). Using curly arrows, outline the mechanism for the reaction of compound **A** with  $\text{Br}_2$  [4 marks]

vi). Name the mechanism in part (v). [1 mark]

d) Give the structures of the most stable carbocation intermediates you would expect in these reactions.



[2 marks]

#### Question 4 (20 marks)

a) An alkane reacts with a halogen in the presence of light to form an alkyl halide as shown in the equation below.



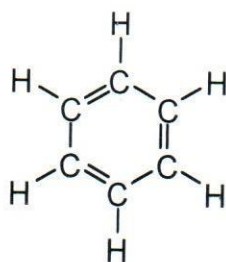
The reaction has a *free radical mechanism*; therefore, it has initiation, propagation and termination steps. Show the initiation, propagation and termination steps in the above reaction. [6 marks]

- b) When 9.83mg of an unknown chemical compound extracted from human sweat glands was submitted for elemental analysis, it was found to contain carbon, hydrogen and oxygen only. After combustion, 23.26mg of  $\text{CO}_2$  and 9.52mg of water were produced.
- Calculate the empirical formula of this compound
  - The molecular mass for this compound is 130g/mol. Calculate the molecular formula of this compound
  - Determine the index of hydrogen deficiency for this molecule
  - Give a possible bond line structure for this compound. [14 marks]

**Question 5 (20 marks)**

- Distinguish between functional group isomerism and position isomerism. [2 marks]
- Draw and name all possible structural isomers of the hydrocarbon  $\text{C}_4\text{H}_8$  [3 marks]
- Give the functional group of the isomers identified in 5 (b) above. [2 marks]
- Alkanes react with oxygen to form  $\text{CO}_2$  and  $\text{H}_2\text{O}$ 
  - Write a balanced equation for the reaction between ethane and oxygen. [2 marks]
  - What are the uses of this reaction? [2 marks]
- Arrange the bond lengths of the following hybridizations, from the shortest to the longest:  $\text{sp} - \text{sp}$ ,  $\text{sp}^3 - \text{sp}^3$ ,  $\text{sp}^2 - \text{sp}^2$ ,  $\text{sp}^3 - \text{sp}^2$ ,  $\text{sp}^3 - \text{sp}$ ,  $\text{sp}^2 - \text{sp}$ . [2 marks]
- Why is the C-H bond in ethane shorter and stronger than the C-H bond in ethene? [3 marks]

- g) Benzene has the structure shown below



- Draw the Lewis structure of benzene [2 mark]
- Draw a skeletal structure of benzene [2 mark]