UGANDA MARTYRS UNIVERSITY

UNIVERSITY EXAMINATIONS

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES

END OF SEMESTER FINAL ASSESMENT

SEMESTER 1, 2023/2024

COURSE:	BACHELOR OF SCIENCE WITH EDUCATION
YEAR:	THREE
EXAM:	PHYSICAL ORGANIC STEREOCHEMISTRY
SEMESTER:	I
DATE:	DECEMBER 12, 2023
TIME:	9:30am – 12:30pm
DURATION:	3 HOURS

Instructions

- *This examination contains **SEVEN** questions*
- *Answer only **FIVE** questions*
- *Begin each question on a fresh page*
- *All questions carry equal marks*

Question one

(a) Explain the following terms (2 marks each)
   (i) Hybridization
   (ii) Covalent bond
   (iii) Lewis base
   (iv) Lewis acid
   (v) Electrophile
   (vi) Nucleophile

(b) Explain what determines the relative strength of Bronsted acid (4 marks)

(c) Define the term P^{K_a} and discuss how it is used to predict the direction in which the reaction is favoured (4 marks)

Question two

The reaction between *tert*-butylbromide and water proceeds via the SN1 mechanism. Unlike S_N2 which is a single-step reaction, S_N1 reaction involves multiple steps.

Reaction: $(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr$

(a) Write the three step mechanism for the SN1 reaction (5 marks)

(b) Explain why SN1mechanism is preferred to SN2 in the above reaction (5 marks)

(c) Draw the energy diagram for the SN1 reaction (4 marks)

(d) Explain the effect of substrate structure on the SN1 reaction rate (6 marks)

Question three

(a) Giving a suitable example in each case, explain what is meant by the following terms as used in stereochemistry (2marks@).

(i) Constitutional isomers

(ii) Functional isomers

(iii) Position isomers

(iii) Metamerism

(iv) Tautomerism

(b) Apart from structural isomerism, there is stereoisomerism. Using suitable examples, explain the term stereoisomerism (3marks).

(c) Distinguish between:

(i) Conformational isomers and Configurational isomers (4marks)

(ii) Enantiomers and diastereomers (3marks)

Question four

Optically active compounds have chiral centers and optically inactive compounds are said to be achiral.

(a) What does the term optically active mean? (3marks)

(b) Giving a suitable example in each case, explain what is meant by:

(i) Chiral centre (3marks)

(ii) Achiral centre (3marks)

(iii) Meso compound (3marks)

(b) Lactic acid, $CH_3CH(OH)COOH$, and 2-bromobutane are optically active compounds. Show the structures of:

(i) S-Lactic acid (1mark)

(ii) R-2-bromobutane (1mark)

(c) 2-bromobutane was strongly heated with aqueous solution of potassium hydroxide to form a compound Z.

(i) Write down the mechanism of the reaction between 2-brombutane and potassium hydroxide to form Z (4marks).

(ii) Predict whether Z is optically active or not. Justify your choice (2marks)

Question five

(a)(i) What is a racemic mixture? (2marks)

(ii) Why are racemic mixtures optically inactive? (3marks)

(b) Describe how you would resolve two enantiomers in a racemic mixture using:

(i) A resolving agent (5marks)

(ii) An enzyme (5marks)

(c) (i) What is specific rotation?
(1mark)

(ii) Explain the terms dex-rotatatory and levo-rotatatory (4marks)

Question six

(a) Explain what is meant by chiral synthesis (5 marks)

(b) Give the difference between stereospecific and stereo selective reactions (6 marks)

(c) Classify the following as chiral or achiral. Give reasons. (9 marks)

(i) H_2O

(ii) CH_2BrCl

(iii) $CHBrClF$

Question seven

(a) Predict and explain the relative acidities of,

(i) Cyclopentadiene versus 1,4-pentadiene (5 marks)

(ii) Propene and 1, 3-pentadiene (5 marks)

(b) Discuss the molecular orbitals of carbon in

(i) Ethylene (5 marks)

(ii) Ethane (5 marks)

END