



MACHAKOS UNIVERSITY

University Examinations 2020/2021 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF EDUCATION (SPECIAL NEEDS EDUCATION)

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF EDUCATION (SCIENCE),

SCH 303: STEREOCHEMISTRY, CONFORMATIONAL STUDIES AND REACTION
MECHANISMS

DATE: 11/8/2021

TIME: 11.00-1.00 PM

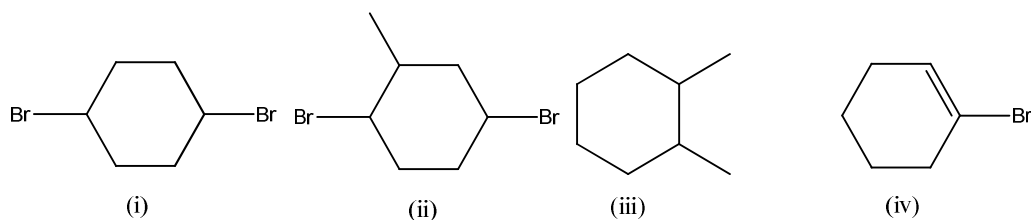
INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

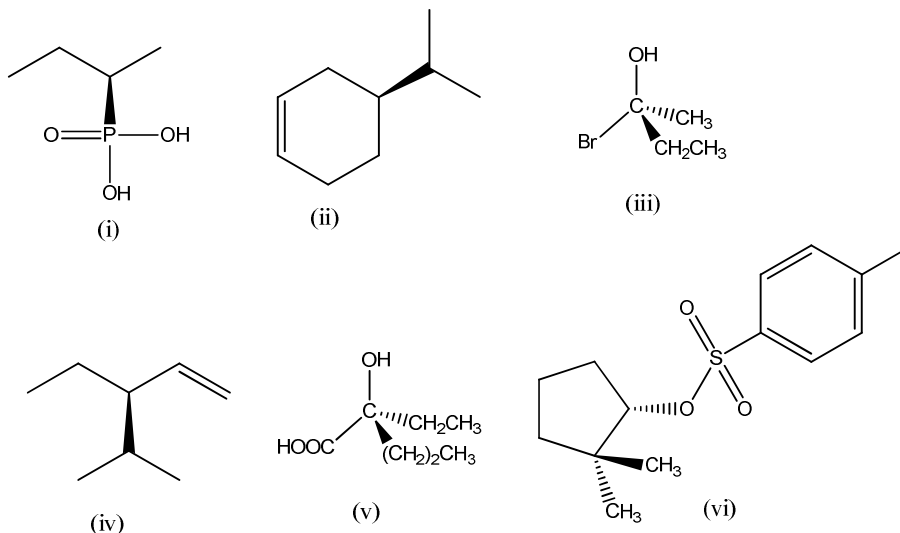
SECTION A

QUESTION ONE (30 MARKS)

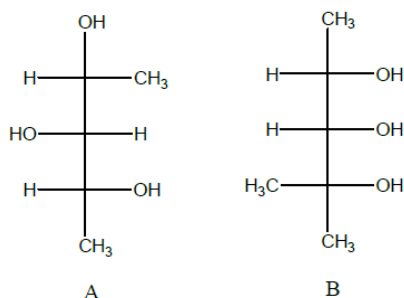
- a) Explain briefly (in one or two short sentences) the meaning of the following basic stereochemical terms. (5 marks)
- Chirality
 - Constitutional isomers
 - Configuration
 - Conformational isomers
 - Atropisomers
- b) Identify which of the following molecules have a stereogenic centre (4 marks)



- c) Find the absolute configuration (R, S) of the following chiral compounds (6 marks)



- d) For the following Fischer projections, determine the configuration at each stereocentre and convert them into corresponding dash wedge formula. (5 marks)



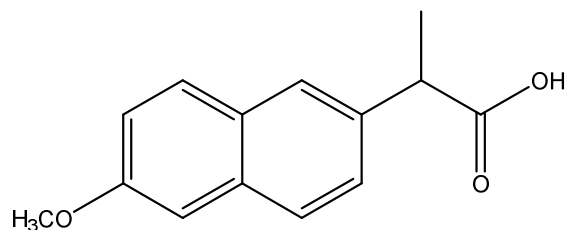
- e) Explain why meso compounds are said to be optically inactive (1 mark)
- f) Draw a Newman projection of the most stable and least stable conformation of 2-methylpropane (4 marks)
- g) Draw the structure of (1R, 2R)-1-bromo-2-chlorocyclobutane. Take particular care to properly indicate stereochemistry. (2 marks)
- h) Draw the Fischer projection of (S)-2-hydroxybutanoic acid. (3 marks)

SECTION B

QUESTION TWO (20 MARKS)

- a) Discuss the Baeyer strain theory and its shortcomings (5 marks)
- b) Chiral drugs are recommended for prescriptions as a single enantiomer. Naproxen (shown below) is an anti-inflammatory drug, which is mandated to be sold at greater than 97% enantiomeric excess (e.e.). The specific rotation of the R-enantiomer (in CHCl_3) is $+65.5^\circ$. During a quality control exercise, a chemist sampled from a 50 kg batch of Naproxen

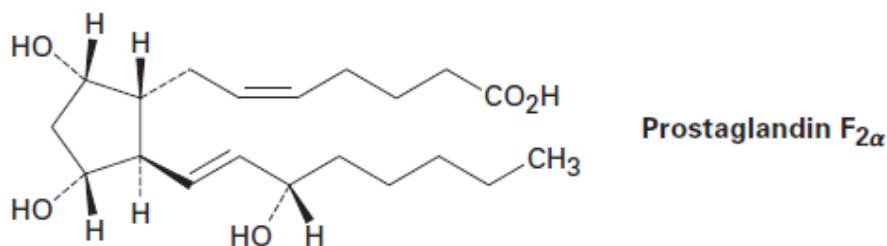
produced at a pharmaceutical industry. She dissolved 2.6 g of product in 10 mL of chloroform and measured an optical rotation of $+15.2^\circ$ in a 10 cm (1 dm) polarimeter.



- i. Draw the R-enantiomer of Naproxen (2 marks)
 - ii. Calculate the optical purity of the sample and determine whether it meets the set standard for it to be marketed (4 marks)
 - iii. Determine the mass of the 50 kg batch, which is actually the (+)(R)-enantiomer (2 marks)
- c) Describe the source of angle strain and torsional strain present in cyclopropane. (2 marks)
 - d) Explain why the alkane formed by hydrogenation of (S)-4-methyl-1-hexene is optically active while the one formed by hydrogenation of (S)-3-methyl-1-pentene is not. (2 marks)
 - e) Dextrorotatory (d, +) and levorotatory (l, -) notation used in optical rotation are different from R, S configurations. Explain. (3 marks)

QUESTION THREE (20 MARKS)

- a) Discuss the resolution of enantiomers by providing appropriate examples. (6 marks)
- b) Discuss the importance of stereochemistry in nature and in pharmaceutical industry. (4 marks)
- c) Draw two different chair conformations of cis-1,3-dimethylcyclohexane and determine which of the two conformations is most stable (4 marks)
- d) Determine the specific rotation if a solution of a compound (30.0 g/100 mL of solution) has a measured rotation of $+15^\circ$ in a 2 dm tube. (3 marks)
- e) Prostaglandin $F_{2\alpha}$, a hormone that causes uterine contraction during childbirth, has the following structure. Determine if the two hydroxyl groups (-OH) on the cyclopentane ring and the two carbon chains attached to the ring are cis or trans to each other. (3 marks)

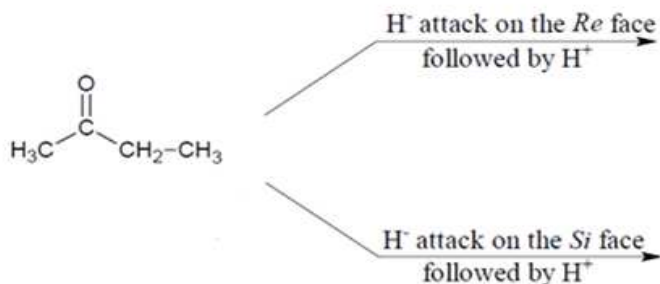


QUESTION FOUR (20 MARKS)

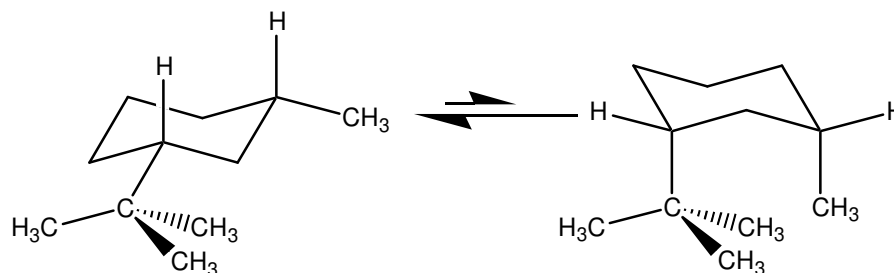
- a) Discuss all the conformations of butane along C2-C3 bond and draw the potential energy diagram for all the conformations. (8 marks)
- b) Explain the source of torsional strain, steric strain, and angle strain (6 marks)
- c) Determine the products that are formed from acid-catalyzed hydration of racemic ($\pm$)-4-methyl-1-hexene. What can you say about the relative amounts of the products? Is the product mixture optically active? (6 marks)

QUESTION FIVE (20 MARKS)

- a) Provide the products formed when ketone shown below reacts with a Grignard reagent through attack on Si face and Re face. Be careful to show the correct stereochemistry of the products. (4 marks)



- b) *cis*-1-*tert*-butyl-3-methylcyclohexane can exist in one of the two conformations shown below. Providing reasons, indicate the most stable conformation. (3 marks)



- c) Using thalidomide as an example, discuss the importance of commercializing enantiopure drug compounds. (3 marks)
- d) Draw a dash-wedge structure for the following molecules (10 marks)
- (3R)-3-methyl-5-hexen-3-ol
 - (1R)-1-bromo-1,3,3-trimethylcyclohexane
 - (1R, 3R)-1,3-dibromo-1,3-dimethylcyclohexane
 - (1S, 3R)-1-ethyl-1,3-dimethylcyclopentane
 - (1R)-1-fluoro-1-chloropropane