MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF EDUCATION (SPECIAL NEEDS)

SCH 303: STREOCHEMISTRY, CONFORMATIONAL STUDIES AND REACTION MECHANISMS

DATE: x/12/2022 **TIME: 2 Hours**

INSTRUCTIONS:

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

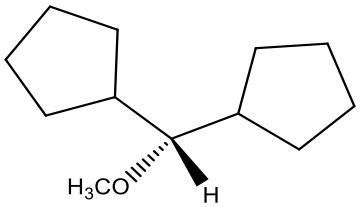
SECTION A

QUESTION ONE (COMPULSORY) (30 MARKS)

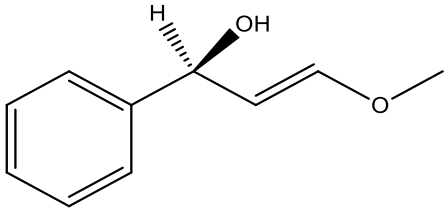
a) Briefly describe the types of Stereoisomers. (4 marks)

b) Outline four ways of testing chirality. (4 marks)

c) Assign the (R,S) configuration at each chirality centre in the following molecules. (8 marks)



(i)



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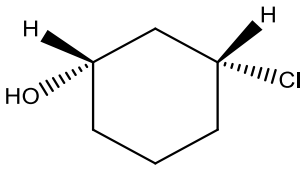

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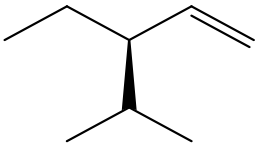

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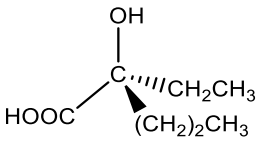

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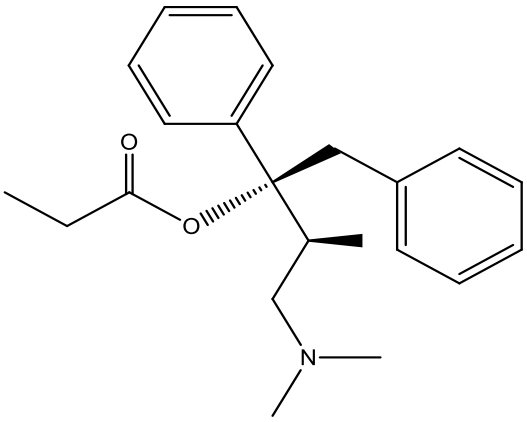
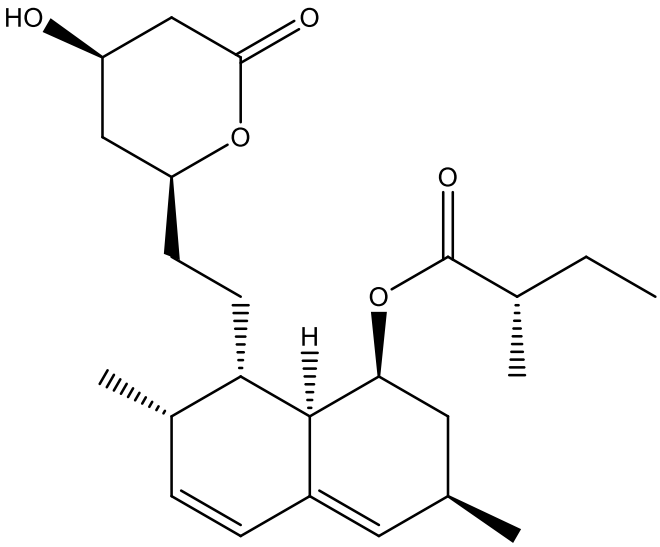


(vi)

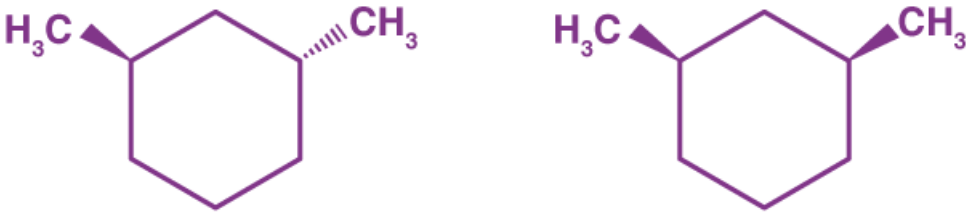
d) Mark all the chirality centres in the formula of the lipid-lowering drug lovastatin shown below with an asterisk (*) and determine the number of stereoisomers the molecule possesses. (6 marks)



lovastatin

e) Draw a Newman projection of the most stable and least stable conformation of 2-methylpropane. (4 marks).

f) Provide the relationship between the two molecules below. (2 marks)



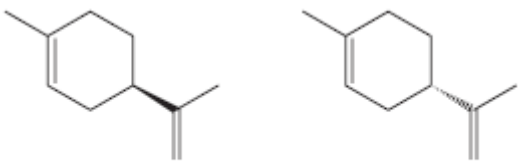
g) Explain what chiral synthesis entails. (2 marks)

SECTION B

QUESTION TWO (20 MARKS)

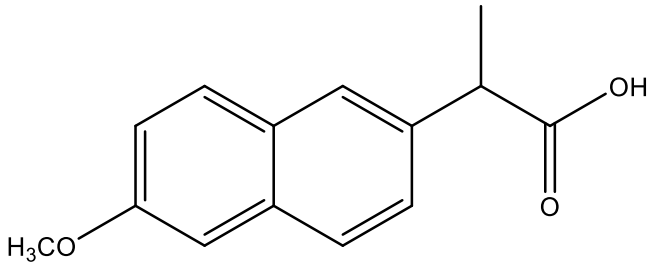
a) Give the importance of Stereochemistry in association with the Thalidomide Disaster. (4 marks)

b) The two enantiomers of limonene shown below behave differently in that the first enantiomer is primarily responsible for the odor of oranges while the second is responsible for the odor of lemons. Discuss. (4 marks).



(+)-Limonene (–)-Limonene

c) 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°. 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° 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)

d) Meso compounds are said to be optically inactive. Discuss. (4 marks)

QUESTION THREE (20 MARKS)

a) Discuss three strategies of separating enantiomers. (9 marks)

b) (i) An aqueous solution of pure stereoisomer X of concentration 0.10 g mL^{-1} had an observed rotation of -30° in a 1.0-dm tube at 589.6 nm (the sodium D line) at 25 °C. Calculate its $[\alpha]_D$ to be at this temperature. (4 marks)

(ii) Under identical conditions but with concentration 0.050 g mL^{-1}, a solution of X had an observed rotation of +165°. Rationalize how this could be and recalculate $[\alpha]_D$ for stereoisomer X. (3 marks)

c) (-)-2-butanol has a specific rotation of -13.5°, while the specific rotation of (+)-2-butanol is +13.5. Calculate the optical purity of a mixture containing (+) and (-)-2-butanol if the mixture has an observed rotation of -8.55°. Determine the composition for both (+) and (-)-2-butanol. (4 marks)

QUESTION FOUR (20 MARKS)

a) Describe the source of angle strain and torsional strain present in cyclopropane. (4 marks)

b) Draw the two chair conformations of cis-1-isopropyl-4-methylcyclohexane. Evaluate if the two conformations are equivalent. If not, determine which would be more stable and the preferred conformation at equilibrium. (4 marks)

d) Draw the Newman projections for all three staggered conformations of 2,2-dimethylpentane, looking down the C3-C4 bond. Select the most stable conformation. (4 marks)

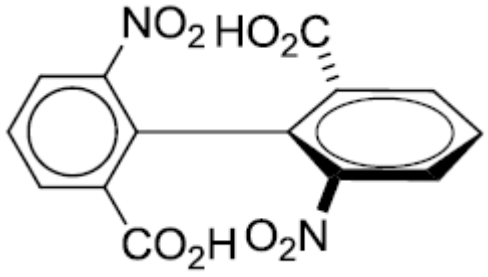
e) 1,3-diaxial interactions are a form of steric stain encountered in substituted chair conformation of cyclohexane. Illustrate how they occur. (2 marks)

f) Describe the torsional strain and steric strain and provide the main difference between the two. (6 marks)

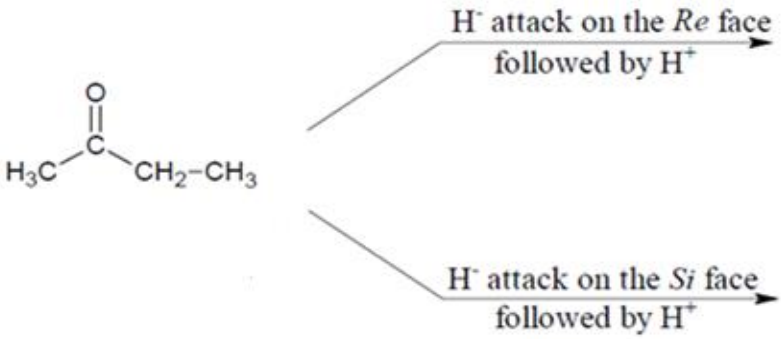
QUESTION FIVE (20 MARKS)

a) Providing examples, outline the three categories of molecules that display axial chirality. (6 marks)

b) Determine the configuration of the molecule below that displays axial chirality. (2 marks)



c) Provide the products formed when the 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)



c) 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)

d) Assign the hydrogens in the molecule below as either Pro-R or Pro-S and provide the difference between enantiotopic and diasterotopic prochiral hydrogens. (6 marks)