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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2018/2019 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER REGULAR

EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: **CHE 203**

COURSE TITLE: **ORGANIC CHEMISTRY II**

DATE: 25TH APRIL, 2019 **TIME: 9.00 AM – 12.00 PM**

INSTRUCTION TO CANDIDATES

- **SEE INSIDE**

THIS PAPER CONSISTS OF 5 PRINTED PAGES **PLEASE TURN OVER**

CHE 203: ORGANIC CHEMISTRY II

STREAM: BED (Science) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **ALL** questions.*

ii. *Diagrams may be used whenever they serve to illustrate the answer.*

Question One

a) What do you understand by the following terms:

(i) Organic chemistry. (3 Marks)

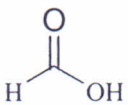
(ii) The structural theory. (2 Marks)

b) List two central premises in the structural theory using examples where appropriate. (4 Marks)

c) The methyl carbocation ($^{+}CH_3$) and the methyl carbanion ($^{-}CH_3$) have the same formula mass (15.03). However, $^{+}CH_3$ is a powerful Lewis acid while $^{-}CH_3$ is a powerful Lewis base. In addition, $^{+}CH_3$ has a trigonal planar structure while $^{-}CH_3$ has a trigonal pyramid structure. Explain. (5 Marks)

Question Two

a) Consider the following table of organic molecules with comparable molecular weights (M.Wt) but very different boiling points (Bpt):

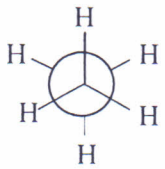
	 propane	 ethanol	 dimethyl ether	 formic acid
MF	C_3H_8	C_2H_6O	C_2H_6O	CH_2O_2
M.wt	44.1	46.07	46.07	43.03
B.pt	-42^0C	78.2^0C	-24^0C	100.8^0C
Acidity(pK_a)	-	15.9	-	3.77

(i) Propane has the lowest boiling point. Explain. (2 Marks)

(ii) Explain the huge difference in boiling points between ethanol and dimethyl ether though both have the same molecular formula (MF). (4 Marks)

(iii) Though the molecules have almost the same molecular weight, ethanol and formic acid have a huge difference in their p*K*a values. Explain. [Hint: Start by explaining what p*K*a is and what determines its magnitude]. (6 Marks)

b) Carry out a conformational analysis for rotation about the C_2-C_3 sigma bond of *n*-butane ($CH_3CH_2CH_2CH_3$) from -180° to 180° by drawing the Newman projections at increments of 60° and showing the energy changes in a sketch of potential energy (PE) vs rotation. The first Newman projection at -180° is drawn below. (5 Marks)



c) Account for the difference between the boiling points of *cis*-2-butene (4°C) and *trans*-2- butene (1°C). (4 Marks)

Question Three

a) Define the following terms:

(i) Enantiomers. (1 Mark)

(ii) Meso compound. (1 Mark)

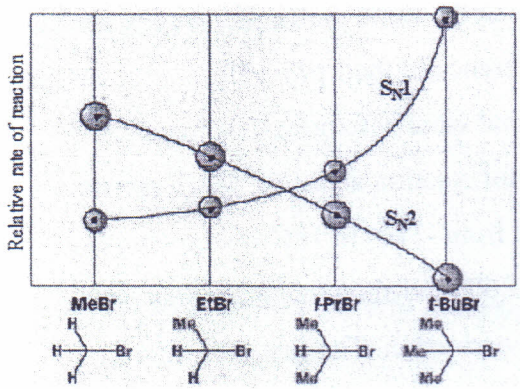
b) Consider the following molecules:

(i) Name them using IUPAC nomenclature. (2 Marks)

(ii) One of the two has two stereoisomers (enantiomers) while the other is achiral. Explain. (3 Marks)

(iii) Draw the two enantiomers mentioned in **(ii)** above, designating each as (*R*) or (*S*). (You can use either perspective or Fischer projection formulas). (2 Marks)

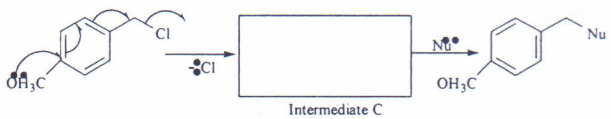
c) For the reaction Nü- + R-X $\longrightarrow$ Nu-R + :X-, the following has been observed:



(i) Give the general order of reactivity of alkyl halide substrates towards S_N2 reactions and provide a reason for your answer. (3 Marks)

(ii) Give the general order of reactivity of alkyl halide substrates towards S_N1 reactions and provide one reason for your answer. (3 Marks)

d) The following reaction has been observed to occur:



(i) Follow the arrows and draw the structure of intermediate (**C**). (2 Marks)

(ii) On the structure of intermediate (**C**) you have just drawn and the nucleophile, draw arrows that show the formation of the final product. (1 Mark)

(iii) How would you classify this reaction: S_N1 or S_N2? Give a reason for your answer. (2 Marks)

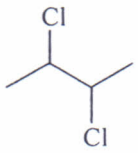
Question Four

a) 3-Methyl-1-butene reacts with H-Br to give a mixture of three products (**K**, **L** and **M**).

(i) Draw the structures of the three and, with an appropriate reason, identify the major product. (4 Marks)

(ii) Which of the three products would have been the major product if a trace amount of organic peroxide was added to the reaction mixture, noting that radicals do not rearrange? (2 Marks)

b) The following molecule has three stereoisomers. Explain and draw them, indicating the stereochemistry on each stereocenter (you can use either Fischer projections or perspective formulas). (5 Marks)



c) Two substitution products result from the reaction of 3-chloro-3-methyl-1-butene with sodium acetate (CH_3CO_2Na) in acetic acid under S_N1 conditions. Identify the products. (4 Marks)

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