



SOUTH EASTERN KENYA UNIVERSITY
UNIVERSITY EXAMINATIONS 2016/2017

**FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF
SCIENCE (CHEMISTRY & GEOLOGY), AND BACHELOR OF EDUCATION
(SCIENCE)**

**SCH 202: CHEMISTRY OF ALKYL HALIDES, ALCOHOLS, AROMATIC COMPOUNDS,
ETHERS & EPOXIDES, ALKENES AND ALKYNES**

14TH DECEMBER, 2016

TIME: 8.00-10.00 A.M

INSTRUCTIONS TO CANDIDATES

(a) Answer question One and any other Two questions

**(b) Question 1 carries 30 marks while the other questions carry
20 marks each**

(c) Illustrate your answers with well label diagrams where applicable

Question 1 (30 marks)

(a) Draw the structural formula of the following compounds (2 marks)

- i. 4-bromo-1, 2-dimethylbenzene.
- ii. Trans-1, 2-epoxy-4-methylcyclohexane.
- iii. Trans-1-chloro-2-methoxycyclobutane.
- iv. 4-methyl-1, 3-dioxane.

(b) 1,4 - Dioxane is made commercially by the acid catalyzed dehydration of an alcohol

(5 marks)

- i. Using a chemical equation, show which alcohol will dehydrate to give 1, 4-dioxane? **(2 marks)**
- ii. Propose a reaction mechanism for this reaction? **(3 marks)**
- (c) Give the difference in each of the following with a chemical equation/ compound in each case? **(4 marks)**
- i. Nucleophilicity and Basicity **(1 mark)**.
- ii. Friedel crafts alkylation and acylation**(1 mark)**.
- iii. Oxidation and Reduction **(1 mark)**.
- iv. Non-aromatic and anti-aromatic **(1 mark)**.
- (d) Alkynes can be hydrated using two methods.
- i. Differentiate two hydration methods of alkynes? **(2 marks)**
- ii. Write out the reaction of 1-cyclohexyl-acetylene in presence of $\text{HgSO}_4/\text{H}_3\text{O}^+$.
(1 mark)
- iii. What will be the effect of using unsymmetrical internal alkyne? **(1 mark)**
- (e) Starting with benzene as the raw material **(4 marks)**
- i. Show the synthetic root for the m-nitrobenzoic acid?**(2 marks)**.
- ii. Using the reaction equation show the effect using $\text{HNO}_3/\text{H}_2\text{SO}_4$ before oxidation using KMnO_4/H^+ ? **(2 marks)**
- (f) 1-methylcyclohexanol undergoes acid catalyzed dehydration to form two alkenes
(3 marks)
- i. Show the reaction mechanism for the formation of two products**(2 marks)**
- ii. Account for the formation of two products**(1 mark)**
- (g) With the aid of chemical equation differentiate between:

i. Substitution and Elimination reaction (2 marks)

ii. S_N1 and S_N2(1 mark)

iii. E₁ and E₂ (1 mark)

(h) Show how you would synthesize the following alcohols by adding Grignard reagents to ethylene oxide (4 marks)

i. 2-phenylethanol

ii. 2-(4-methyl hexan) ethan-1-ol

Question 2 (20 marks)

a.) Bimolecular dehydration can be used for industrial synthesis of symmetrical dialkyl ethers

i. Give the elimination and substitution chemical equations for bimolecular dehydration of ethanol(1 mark).

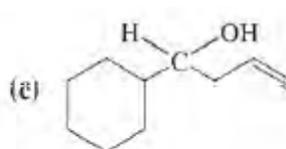
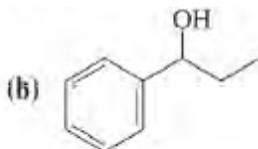
ii. Give the detailed reaction mechanism for formation of the two products (4 marks).

iii. Write the S_N2 and E₂ reaction mechanism for the reaction sodium propoxide and tert-butyl bromide (3 marks).

iv. Indicate which reaction in (iii) above will be preferential and why? (1 mark)

v. Propose a better synthesis to favor S_N2 reaction in iii above (3 marks)

b.) Show two ways you could synthesize each of the following secondary alcohols by adding an appropriate Grignard reagent to an aldehyde? (8 marks)



Question 3

- a) Benzene undergoes electrophilic substitution reaction to form different aromatic compounds. Discuss the effects of substituents on:
- i. Rate of the reaction(**3 marks**)
 - ii. Orientation of the reaction (**5 marks**)
 - iii. Trisubstitution on benzene ring(**2 marks**)
- b) Electrophilic substitution is the main reaction aromatic compounds undergo.
- i. Explain why aromatic compounds undergo electrophilic aromatic substitution (**3 marks**)
 - ii. Starting with benzene, show the general mechanism of electrophilic aromatic substitution (**3 marks**)
 - iii. Show the mechanism of nitration of benzene (**4 marks**)

Question 4 (20 marks)

- a) When 3-iodo-2, 2-dimethyl butane is treated with silver nitrate in ethanol, three elimination products are formed. Give their structures, and predict which ones are formed in larger amounts (**5 marks**)
- b) Each of the carbocations in question (a) above can also react with ethanol to give substitution products.
- i. Give the structures of the substitution products formed in these reactions (**2marks**)
 - ii. Postulate the possible reaction mechanisms of the products in 4 (b) (i) above (**3 marks**).

c) Predict the elimination products of the reactions below? When two alkenes are possible, predict which one will be the **major** product? Explain your answers showing the degree of substitution of each double bond in the products? **(6 marks)**

- i. 2 bromopentane + $\text{CH}_3\text{O}^- \text{Na}^+$
- ii. 3 bromo-3-methyl pentane + $\text{CH}_3\text{O}^- \text{Na}^+$
- iii. 2 bromo-3-ethyl pentane + NaOH
- iv. Cis-1-bromo-2-methylcyclohexane + $\text{CH}_3\text{CH}_2\text{O}^- \text{Na}^+$

d) Which of this reaction are likely to produce both elimination and substitution products?
(4 marks)

Question 5 (20 marks)

a) Using chemical equations where necessary, discuss the following factors affecting $\text{S}_{\text{N}}2$ reactions.

- i. Strength of the nucleophiles **(3 marks)**.
- ii. Type of the solvent **(7 marks)**.
- iii. Steric hindrance on the nucleophile **(3 marks)**.
- iv. Substrate **(7marks)**.