2411/303
ORGANIC CHEMISTRY
June/July 2020
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ANALYTICAL CHEMISTRY

ORGANIC CHEMISTRY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
answer booklet;
non-programmable scientific calculator.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **ALL** the questions in section **A** and any **THREE** questions from section **B** in the answer booklet provided.*
*Each question in section **A** carries **4** marks while each question in section **B** carries **20** marks.*
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A (40 marks)

Answer ALL the questions in this section.

1. Name the homologous series to which each of the following compounds belong:

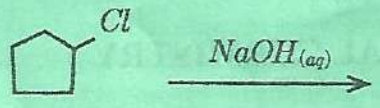
   (a) $CH_3CH_2CH_2OH$; (1 mark)

   (b) CH_3COCH_3; (1 mark)

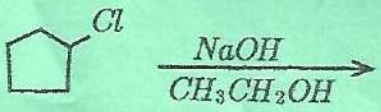
   (c) $CH_3CH(NH_2)CH_3$; (1 mark)

   (d) CH_3OCH_3. (1 mark)

2. Complete the following reaction equations by giving the product and its systematic name.

   (a) 

   (2 marks)

   (b) 

   (2 marks)

3. When 2-methyl-propan-2-ol is heated with a carboxylic acid R, in the presence of a catalyst, an ester, $C_7H_{14}O_2$ is formed.

   (a) Draw the structural formula of the ester and give its systematic name. (2 marks)

   (b) Identify the carboxylic acid R. (1 mark)

   (c) Name a suitable catalyst for the reaction. (1 mark)

4. Write structural formulae of each of the following compounds:

   (a) Diethyl ether. (1 mark)

   (b) Anisole. (1 mark)

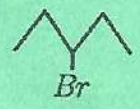
   (c) Thiophene-2-carboxylic acid. (1 mark)

   (d) Methylbutanoate. (1 mark)

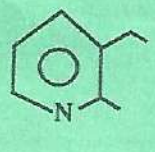
5. Explain why amines have lower boiling points than alcohol of comparable molecular weight. (4 marks)

6. With the aid of general structural formulae, differentiate between a primary alkylhalide and a tertiary alkylhalide. (4 marks)

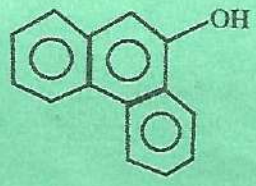
7. Give the systematic name of each of the following compounds:

(a) 

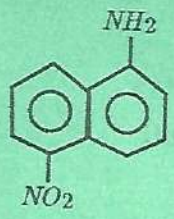
(1 mark)

(b) 

(1 mark)

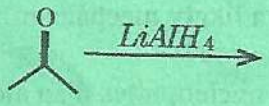
(c) 

(1 mark)

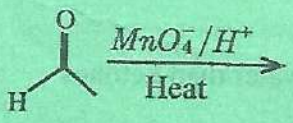
(d) 

(1 mark)

8. Complete the following reactions and identify each as either reduction or oxidation.

(a) 

(2 marks)

(b) 

(2 marks)

9. (a) State Markovnikoff's rule. (1 mark)

(b) Write the products in the following reactions and indicate the predominant product using letter (P).

(i) 

($1\frac{1}{2}$ marks)

(ii) 

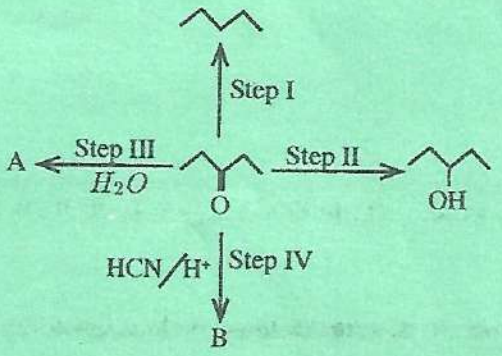
($1\frac{1}{2}$ marks)

10. Draw and name all the structural isomers with the formula C_4H_9Br. (4 marks)

SECTION B (60 marks)

*Answer any **THREE** questions from this section.*

11. (a) The following scheme shows some reactions of a ketone.



(i) Draw the structures of compounds **A** and **B**. (2 marks)

(ii) Name the type of compound labelled **A**. (1 mark)

(iii) Identify the reagents and conditions in step I and step II. (4 marks)

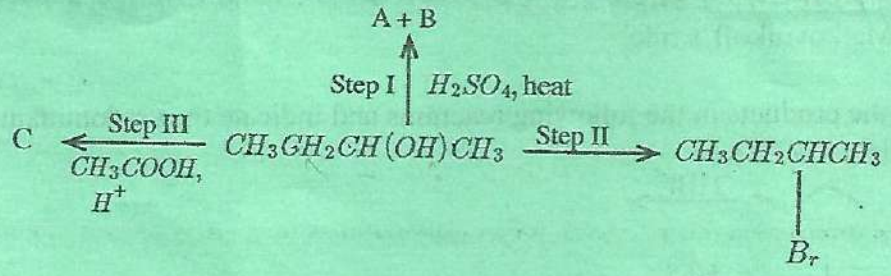
(iv) Name the type of reaction taking place in step I. (1 mark)

(b) Propanol reacts with 1-butene in the presence of free radicals initiators to give $CH_3CH_2COCH_2CH_2CH_2CH_3$. Outline the steps for a likely mechanism. (7 marks)

(c) (i) Explain why ketones are less reactive towards nucleophiles than aldehydes. (2 marks)

(ii) Explain why aldehydes are more soluble in water than ketones. (3 marks)

12. (a) Study the following reaction scheme and answer the questions that follow.



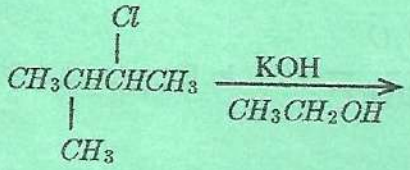
(i) Identify the type of reactions taking place in steps I, II and III. (3 marks)

(ii) Draw structures of compound **A, B** and **C** and give their systematic names. (6 marks)

(iii) Name a suitable reagent for step III. (1 mark)

(b) (i) State Zaitser rule. (1 mark)

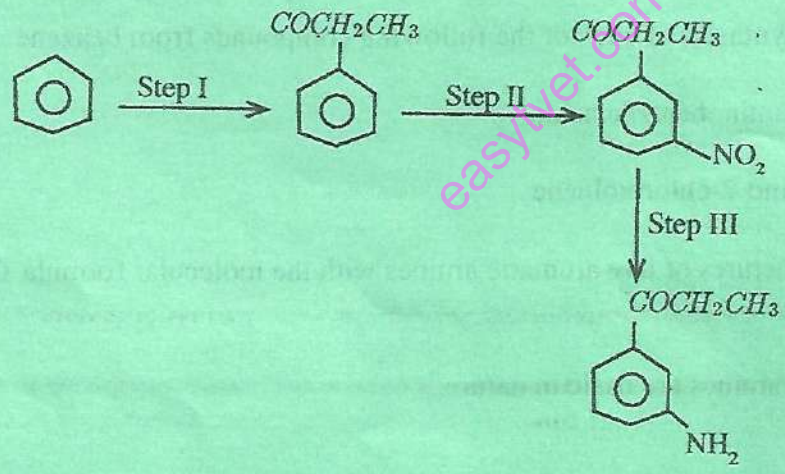
(ii) Complete the following elimination reaction and indicate the predominant product with letter (P). (3 marks)



(iii) Account for the formation of the predominant product in (b) (ii) above. (4 marks)

(iv) Name **two** methods via which carbocation rearrangement occurs. (2 marks)

13. (a) The scheme below shows preparation of a benzene derivative.

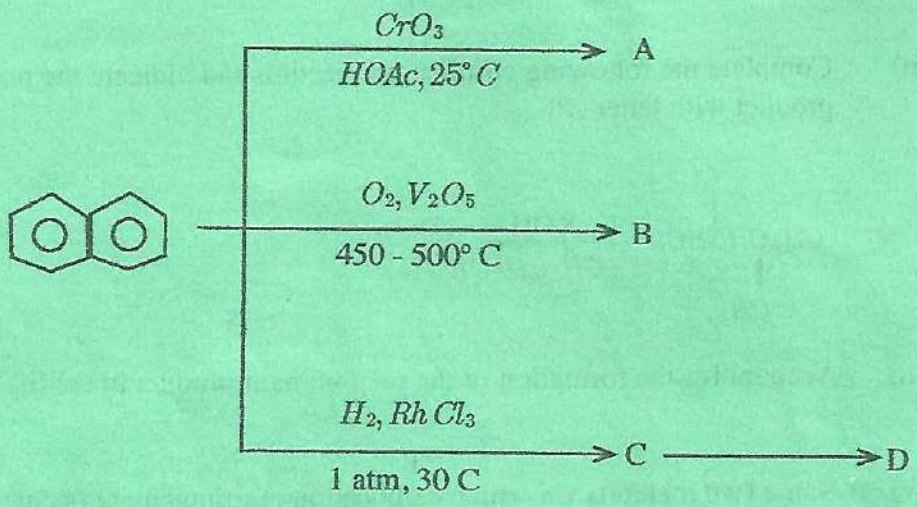


(i) Name the type of reaction and suitable reagents for steps I, II and III. (6 marks)

(ii) Write an equation showing how the electrophile is formed from the reagents in step I. (2 marks)

(iii) Write a reaction mechanism for the reaction that takes place in step I. (4 marks)

(b) Naphthalene undergoes the following reactions:



(i) Draw the structural formulae of **A, B, C** and **D**. (4 marks)

(ii) Name the compounds **A, B, C** and **D**. (4 marks)

14. (a) Outline the synthesis of each of the following compounds from benzene.

(i) para-aminobenzoic acid; (7 marks)

(ii) 4-amino-2-chlorotoluene. (7 marks)

(b) Write the structures of **five** aromatic amines with the molecular formula C_7H_9N. (5 marks)

(c) Explain why amines are basic in nature. (1 mark)

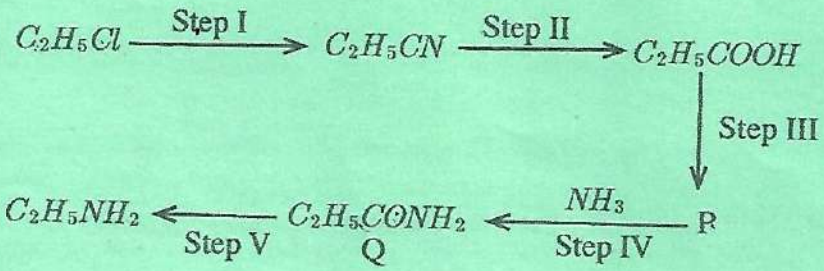
15. (a) Write the structural formulae for each of the following acid derivatives:

(i) propioritrile; (1 mark)
(ii) isopropyl-2-fluorobutanoate; (1 mark)
(iii) 3-chloropropylbenzoate; (1 mark)
(iv) 3-phenylhexamyl chloride. (1 mark)

(b) (i) Explain why 2-naphthoic acid is not made from 2-chloronaphthalene. (2 marks)

(ii) Using equations, explain how 2-naphthoic acid is prepared in a haloform reaction. (6 marks)

(c) Study the following reaction scheme and answer the questions that follow.



(i) Name the reagents and conditions necessary for steps I, II and V. (5 marks)

(ii) Give the structure and name of compound P. (2 marks)

(iii) Name compound Q. (1 mark)

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