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2411/303
ORGANIC CHEMISTRY
Oct./Nov. 2018
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;

scientific calculator (non - programmable).

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 indicated.

Candidates should answer the questions in English.



This paper consists of 6 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.

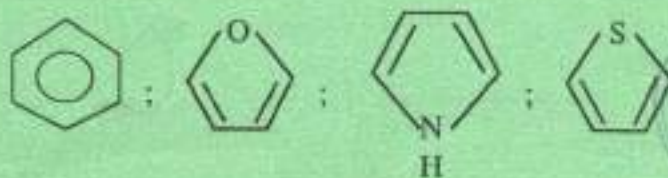
1. (a) Give the structure and IUPAC name of the product formed from the reaction between n-propylbromide and methanol. (2 marks)
- (b) 3,3-dimethyl-1-butene gives a mixture of products when treated with hydrogen iodide. Give the structural formulae and IUPAC names of these products. (2 marks)
2. (a) Define the following terms:
- (i) chain-growth polymers; (1 mark)
- (ii) step-growth polymers. (1 mark)
- (b) Draw structures for the following compounds:
- (i) benzylmethylamine; (1 mark)
- (ii) N,N-dimethyl-p-toluidine. (1 mark)
3. Write all the possible structural isomers corresponding to the molecular formula C_8H_{10} . (4 marks)
4. Give reason(s) for the following observations:
- (a) ethanamide is less basic than ethylamine; (2 marks)
- (b) ketones are generally less reactive than aldehydes towards nucleophiles. (2 marks)
5. Draw structures for the following organic compounds:
- (a) 1,5-dinitronaphthalene;
- (b) 2-Bromo-3,3-dimethylpentane;
- (c) 4-chloropyridine;
- (d) 3,3-dimethyl-2-butanone. (4 marks)
6. With reasons, give the products of monobromination of the following compounds:
- (a) toluene; (2 marks)
- (b) p-toluene sulfonic acid. (2 marks)

7. (a) Describe how the 'Lucas test' can be used to distinguish between butan-1-ol and butan-2-ol. (2 marks)
- (b) Give the structural formula and name of the organic compound formed by butan-2-ol in Lucas test. (2 marks)
8. Complete the following reactions by writing the products formed:
- (a) $\text{CH}_3\text{CH}_2\text{COCH}_3 \xrightarrow{\text{LiAlH}_4, \text{H}^+}$ (1 mark)
- (b) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH} \xrightarrow{\text{KMnO}_4, \text{H}^+}$ (1 mark)
- (c) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH} \xrightarrow[\text{(PCC)}]{\text{Pyridinium chlorochromate}}$ (1 mark)
- (d) $\text{CH}_3\text{COCH}_3 \xrightarrow{\text{H}_2, \text{Ni}}$ (1 mark)
9. Explain why pentanol has a lower boiling point than pentanoic acid. (4 marks)
10. Outline a method that can be used to synthesize benzoic acid from phenylethene. (4 marks)

SECTION B (60 marks)

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

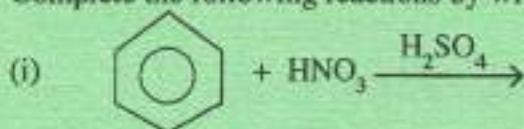
11. (a) Starting with benzene, outline the Harworth synthesis of naphthalene showing all the intermediates. (10 marks)
- (b) With reasons, arrange the following compounds in order of increasing reactivity. (6 marks)



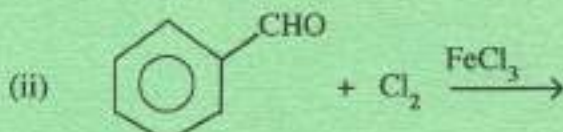
- (c) Explain why naphthalene is more reactive than benzene. (4 marks)

12. (a) Pyrrole undergoes substitution mainly at position two (2). Explain using resonance structures why substitution is preferred at position two. (6 marks)

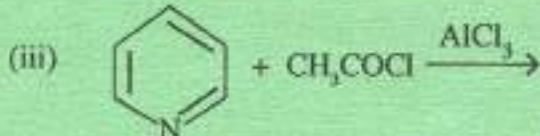
(b) Complete the following reactions by writing the principal products:



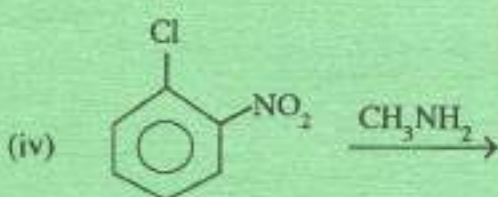
(1 mark)



(1 mark)



(1 mark)



(1 mark)

(c) Explain why Friedel-Crafts alkylation often gives polysubstitution products, but Friedel-Crafts acylation does not. (4 marks)

(d) (i) Name any two ortho-para directing groups that are deactivating. (2 marks)

(ii) Draw two resonance structures of naphthalene. (2 marks)

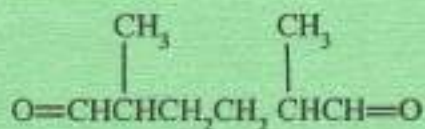
(e) Write an equation for the reaction between pyridine and ammonia and name the product. (2 marks)

13. (a) Deduce the structures of the following alkenes:

(i) an alkene $\text{C}_{10}\text{H}_{20}$ on ozonolysis yields only $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3$. (4 marks)

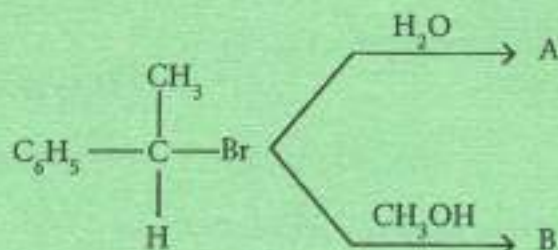
(ii) an alkene C_9H_{18} on ozonolysis gives two products, $(\text{CH}_3)_2\text{CCHO}$ and $\text{CH}_3\text{COCH}_2\text{CH}_3$. (2 marks)

(iii) A compound C_8H_{14} adds one mole of hydrogen gas and an ozonolysis yield the dialdehyde.



(4 marks)

- (b) (i) Write the structure of the products in the following reactions represented by letters A and B. (2 marks)



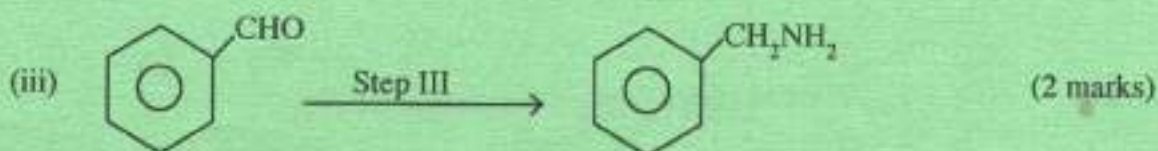
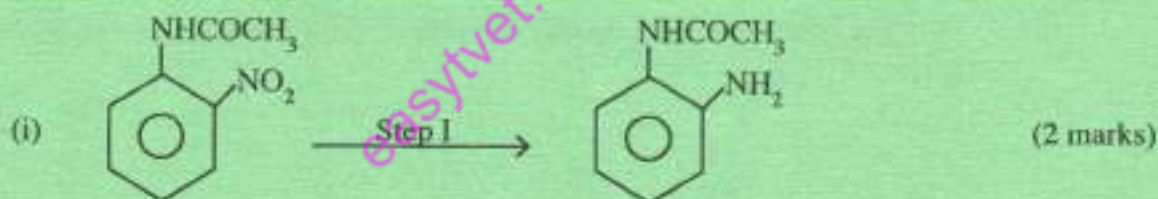
- (ii) Explain the formation of the products in (b) (i) above. (2 marks)

- (c) Compare and account for the differences between an alkylhalide, RX, and its parent alkane, RH, in terms of:

- (i) dipole moment; (2 marks)
 (ii) boiling point; (2 marks)
 (iii) density. (2 marks)

14. (a) Explain why aromatic amines are weaker bases than aliphatic amines. (4 marks)

- (b) Complete the following reactions by indicating the reaction conditions required:

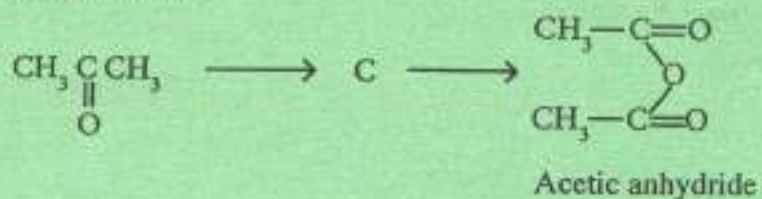


- (c) Amines react with alkylhalides to form higher order amines.

- (i) Name the type of reaction taking place. (1 mark)
 (ii) Write an equation for the reaction between ethylamine and excess methylchloride. (3 marks)
 (iii) Outline the mechanism for the reaction in (ii) above. (4 marks)

- (d) Give two uses of nitrogen compounds. (2 marks)

15. (a) The scheme below shows preparation of acetic anhydride. Study it and answer the questions that follow.



- Give the structure and name of compounds C and D. (4 marks)
- (b) Give the products formed when acetic anhydride reacts with:
- (i) H_2O ; (1 mark)
 - (ii) NH_3 ; (2 marks)
 - (iii) $\text{C}_2\text{H}_5\text{OH}$; (2 marks)
 - (iv) C_6H_6 with AlCl_3 . (1 mark)
- (c) Outline a reaction scheme that can be used to convert 2-chlorobutanoic acid to 3-chlorobutanoic acid. (5 marks)
- (d) Using ethanol as the only organic compound, show how HOCH_2COOH can be prepared. (5 marks)

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