

PART IV

ORGANIC CHEMISTRY

SET 1 : SECTION B (CGCEB 2009)

Organic Chemistry

- 7 1.0 g of an organic compound A containing carbon and hydrogen only, on analysis gave 0.86 g of carbon and 0.14 g of hydrogen. On treating A with acidified water, a compound B of molecular mass 74 was obtained. The reaction of B with concentrated sulphuric acid at 170 °C gave compound A

- (a) (i) Calculate the empirical formula of A -----

(ii). Is compound A likely to be an alkane or an alkene? Give reasons -----

(iii). From the reaction that produces B, deduce the molecular mass of A -----

(iv). Deduce the molecular formula of A -----

(v). Compound A exhibits stereoisomerism. Draw and label the isomers -----

8 marks

- (b) Ethene is obtained on a large scale from the process of cracking in the petrochemical industry.

- (i). What is cracking? -----

(ii). Write an equation of a reaction in which ethene is obtained by cracking -----

(iii). Write the equations of TWO important reactions of ethene which make it important industrially and in everyday life -----

(iv). What TWO environmental problems do these industrial uses of ethene cause? -----

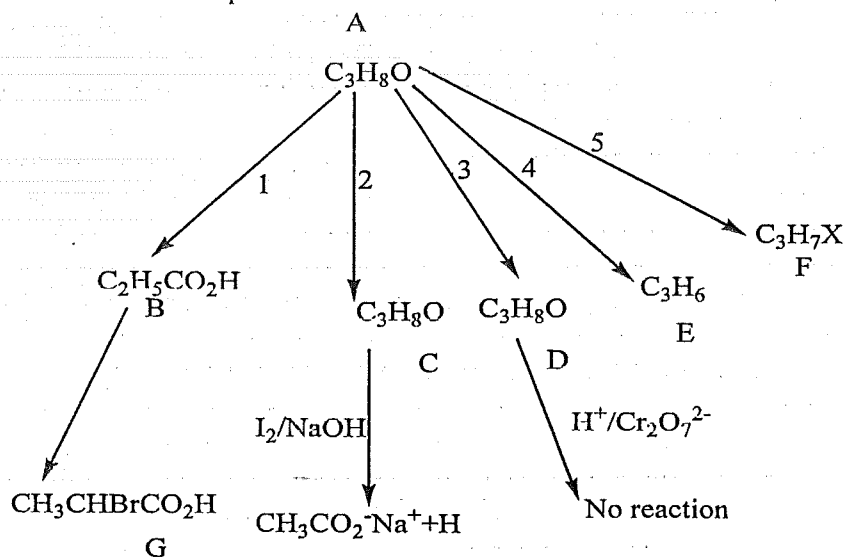
(c) Consider the alkene $\text{CH}_3\text{CH}=\text{CHC}_2\text{H}_5$
(i). Give the reagents or series of reagents that will convert it into a ketone, and give the systematic name of the ketone -----

(ii). Give one general method of preparing the alkene above -----

(iii). How can the presence of an alkene bond be tested? Give reagents, conditions and results -----

6 marks

- 8 The compound A, C_3H_8O , is an alcohol. Answer the questions based on the properties and reactions of this compound



- (a) (i) Give the general formula of the aliphatic alcohols -----
 (ii). Give the formulae of the first two members of the homologous series of the compound A -----

 (iii). What type of hybridization exists in the carbon atoms in the compound A? -----
 (iv). What is the geometry associated with the carbon in the compound? -----
 (b) With reference to the series of reactions of compound A, above
 (i). Give the systematic name of compound B -----
 (ii). Draw the structures of C and D
 C: -----
 D: -----
 (iii). Identify a reaction that is a dehydration and give the reagents and reaction conditions for the reaction
 Dehydration -----
 Reagents and reaction conditions -----
 (iv). Identify a reaction that is an oxidation process and give the reagents and reaction conditions.
 Oxidation -----
 Reagent and reaction conditions -----
 (v). Identify the compound H giving its formula -----

8 marks

- (c) In step (5), hydrogen halide is bubbled through the alcohol under reflux.
 (i). Give two reasons why it is necessary to carry out the reaction under reflux -----

 (ii). This halogenation takes place in three steps. Write the three steps
 Step 1 -----
 Step 2 -----

E-CHEMISTRY SELF TUTORIALS FOR ADVANCED LEVEL

Step 3

- (iii). What type of mechanism is involved in these halogenations? -----

6 marks

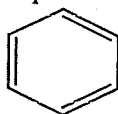
(d) B can be converted to G which is optically active

- (i). Give the reagents required for the conversion of B to G -----

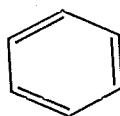
- (ii). Draw the isomers of compound G, putting an asterix on the asymmetric carbon atom(s) -----

2 marks

9 The benzene molecule can be represented by the structures



and



- (a) Suggest one evidence that shows that the chemistry of benzene cannot be explained on the basis of the structures above -----

1 mark

(b) Benzene undergoes electrophilic substitution to produce nitrobenzene.

- (i). Identify the electrophile -----

- (ii). Give the reagents and reaction conditions for the nitration of benzene -----

- (iii). Outline the mechanism for the nitration reaction -----

- (iv). Further nitration to the dinitro-product is difficult. Give the structure of the possible product on further nitration and explain why this is difficult -----

7 marks

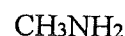
(c) Nitrobenzene is used to produce aniline ($C_6H_5NH_2$) which is basic.

- (i). Give the reagent and reaction conditions for this conversion -----

- (ii). Why are amines basic? -----

- (iii). What separation technique would you use to obtain a pure sample of aniline in the reaction in c(i) above? -----

- (iv). Arrange the following nitrogen-containing compounds, in order of increasing base strength. Explain your reasoning. -----



Trend -----

Explanation: -----

8 marks

(d) Aniline reacts with aqueous sodium nitrite ($NaNO_2$) and dilute hydrochloric acid (HCl). The resulting solution reacts with a solution of 2-naphthol in aqueous sodium hydroxide.

E-CHEMISTRY SELF TUTORIALS FOR ADVANCED LEVEL

- (i). Give the equation for the reaction of aniline with aqueous sodium nitrite and dilute hydrochloric acid, giving the reaction conditions, and name of the organic product. -----

- (ii). Draw the structure of the product which is formed on reaction with 2-naphthol -----

- (iii). What name is given to the reaction occurring in (d)(ii)? -----

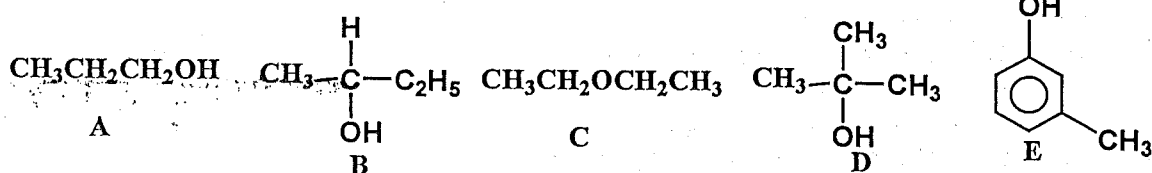
- (iv). What is the significance of the compounds of the type produced by the reaction in (d)(ii)? -----

5 marks

SET 2 : SECTION B (CGCEB 2010)

Organic Chemistry

7. This question concerns the compounds A to E shown below.



- (a) Using the letters, A to E,
 - (i). Identify the compounds which are of the same homologous series and are structural isomers -----
 - (ii). Choose a PAIR that shows functional group isomerism -----

3 marks
- (b) Give the molecular formula of B and its systematic name
 Molecular formula -----
 Systematic name -----

2 marks
- (c) Identify (i) a primary alcohol -----
 (ii) a tertiary alcohol -----
- (d) State what would be observed and the product formed when D is treated with conc HCl/ZnCl₂ (Lucas reagent) and warmed -----

2 marks
- (e) (i) what compound is obtained when A and B react separately with acidified potassium dichromate?
 A. -----
 B. -----
 (ii). How would the products of the reactions of e(i) above be distinguished by means of a chemical test? Give reagents, reaction conditions and observations. -----

E-CHEMISTRY SELF TUTORIALS FOR ADVANCED LEVEL

4 marks

- (f) When D is treated with conc H_2SO_4 at 170°C it gives a compound F. Give the structure of F -----

1 marks

- (g) (i) Which one of the two A or B will have the higher boiling point? -----
Why? -----

- (ii). What is the most common use of C in the laboratory and what precaution must be taken when using C?

Use -----

Precaution -----

4 marks

- (h) Give the product(s) (if any) when A and E are separately treated with bromine water.

A. -----

E. -----

8. (a) Distinguish between empirical and molecular formulac -----

2 marks

- (b) Papaverine which is an alkaloid in opium contains carbon, hydrogen, nitrogen, and oxygen. Quantitative analysis of papaverine gave 70.8% carbon, 4.1% nitrogen, 6.2% hydrogen and a molecular mass of 339.

- (i). Determine the empirical formula of papaverine. -----

- (ii). The molecular formula of papaverine -----

- (iii). Comment on the two formulae obtained in b(i) and b(ii) above -----

7 marks

- (c) The compound A, $\text{C}_4\text{H}_{10}\text{O}$, gives white fumes when treated with solid PCl_5 , and is optically active. It reacts with concentrated sulphuric acid at 170°C to give the alkene B, $\text{CH}_3\text{CH}=\text{CHCH}_3$

- (i). Give the organic product of the reaction of A with PCl_5 -----

- (ii). What is the structural formula of A? -----

- (iii). Compound A shows optical isomerism. Draw and indicate the structural features of A that makes it optically active. -----

- (iv). Give the name of the product B -----

5 marks

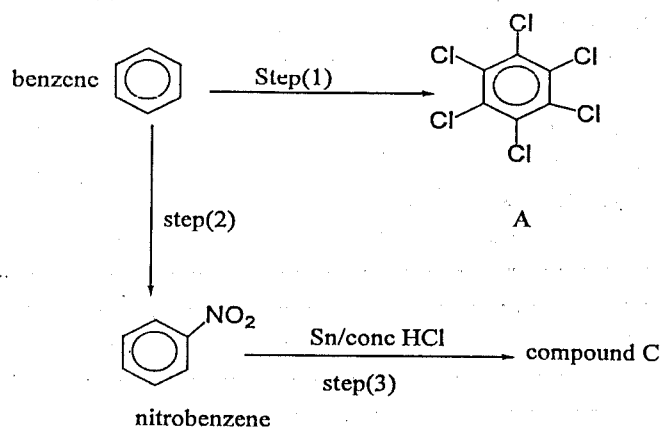
- (d) Give the structure of the product and the type of reaction when ethanal reacts with the reagents below.

E-CHEMISTRY SELF TUTORIALS FOR ADVANCED LEVEL

Reactant	Structure of product	Types of reaction
NaBH_4		
HCN(aq)		
Acidified MnO_4^-		

6 marks

9. Below is a reaction scheme



- (a) (i) Draw another way of representing the benzene molecule -----
 (ii) What type of hybridisation is shown by the carbon atom of benzene? -----

2 marks

- (b) (i) Give the reagents, conditions, type of reaction represented by step (1)
 Reagents -----
 Conditions -----
 Type of reaction -----
 (ii). Give the name of the compound A -----

3 marks

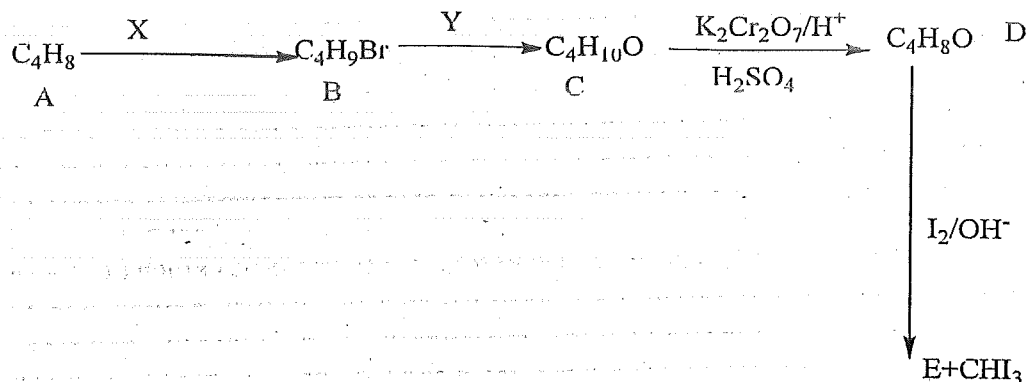
- (c) Give the reagents, conditions and type of reaction represented by step (2)
 Reagents -----
 Conditions -----
 Type of reactions -----

3 marks

- (d) Give the name and structure at compound C -----

2 marks

(e) A series of reactions are shown below



- (i). Identify the reagents X ----- and Y -----
- (ii). What are the structures of
 - A. -----
 - B. -----
 - C. -----
- (iii). What would be observed when the reaction of C to D is taking place? -----
 Reasons -----
- (iv). Identify product E -----
- (v). Of what importance is the reaction that yields E and CHI₃ in organic chemistry? -----

9 marks

SET 3 : SECTION B (CGCEB 2011)

Organic Chemistry

7. A compound X of molecular mass 103 contains carbon, hydrogen, nitrogen and oxygen only. On analysis it is found to contain 46.6% carbon, 8.74% hydrogen, 13.6% nitrogen and 31.1% oxygen. (RAM O=16, C=12, H=1, N=14)

- (a) Calculate:
 - (i). The empirical formula of X -----
 - (ii). The molecular formula of X -----

2 marks

- (b) How could the presence of nitrogen in the compound be identified? Give reagents and expected result only -----

3 marks

- (c) The compound X has both an amino and a carboxylic acid functional group and is optically active.

- (i). What is a functional group? -----

- (ii). Write the structure of the carboxylic acid functional group -----

- (iii). Propose the structure for X -----

3 marks

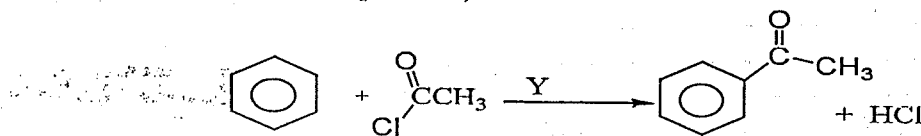
- (d) Draw a spread out structure of X and put an asterisk on the asymmetric carbon atom -----

1 marks

- (e) Give reagents and observations of a simple chemical test to identify the presence of the amino group in a compound. -----

3 marks

- (f) Ethanoyl chloride (CH_3COCl) reacts with benzene, according to the equation below to give phenylethanone (acetophenone)



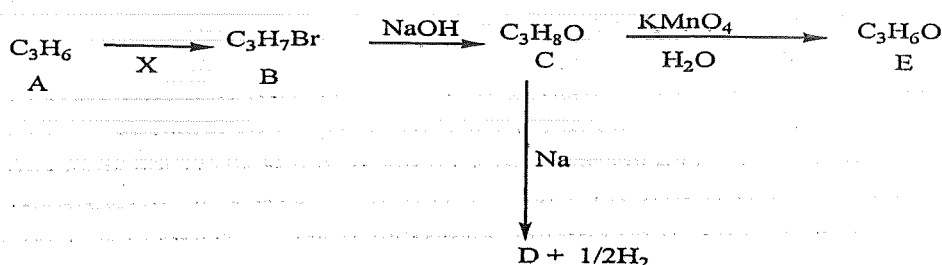
- (i). Identify the reagent Y and give the condition for the reaction
Reagent Y: -----
Condition: -----
- (ii). Explain why the reagent must be used dry? -----

- (iii). What substance(s) would be obtained when phenylethanone (acetophenone) reacts with:
A. NaOH/I_2 -----
B. 2,4-dinitrophenylhydrazine -----
C. Hydrogen cyanide gas -----
- (iv). If 2 g of ethanoyl chloride were used and 1.95 g of phenylethanone obtained (RAM: $\text{Cl}=35.5$, $\text{C}=12$, $\text{O}=16$) calculate:
A. The theoretical yield -----

B. The percentage yield -----

8 marks

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



- (i). Identify the compounds A, B, C, D, E by drawing their structures
 - A. _____
 - B. _____
 - C. _____
 - D. _____
 - E. _____
 - (ii). Identify the reagent X (for the conversion of A to B) -----
 - (iii). What physical change is observed when C is converted to E? What name is given to this type of reaction? -----
 - (iv). Write a complete equation for the conversion of C to D -----
 - (v). Name the compound E -----
- 10 marks
- (b) (i) State Markownikoff's Rule -----
 - (ii). Give two conditions under which anti Markownikoff addition will take place. -----
- 3 marks
- (c) Compound A can be polymerised to a macromolecule.
- (i). Explain what you understand by the term polymerisation -----
 - (ii). Identify the type of polymerisation undergone by A -----
- 2 marks
- (d) The molecules $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ and $\text{HO}_2\text{C}(\text{CH}_2)_4\text{CO}_2\text{H}$ polymerise
- (i). Give the structure of the polymer -----
 - (ii). What type of bond is formed in the above process? -----
- 2 marks

E-CHEMISTRY SELF TUTORIALS FOR ADVANCED LEVEL

- (e) Compound E exhibits isomerism.

Draw the structure of the isomers of E and identify the type of isomerism these illustrate -

3 marks

9. (a) An organic molecule has the molecular formula C_4H_8

- (i). Draw four (4) possible isomers of the molecule

A. -----

B. -----

C. -----

D. -----

- (ii). Some of the isomers will react with hydrogen gas. Choose one of them and write an equation for the reaction. -----

5 marks

- (b) (i) Write out the structural formulae of the four (4) alcohols that can be deduced from the molecular formula $C_4H_{10}O$ -----

- (ii). List the alcohols in b (i) above in order of increasing boiling point (least boiling point first) and explain.

Order-----

Explanation-----

7 marks

- (c) Alkenes can be prepared by warming an alcohol at 180°C with concentrated sulphuric acid

- (i). What is the role of the concentrated sulphuric acid? -----

- (ii). Write the mechanism of the dehydration of propanol $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$. -----

- (iii). Propanol can be oxidised to propanoic acid using potassium dichromate (VI). What condition is necessary for the oxidation to take place? -----

- (iv). How could you know that propanol has been oxidised? -----

- (d) (i) Write an equation for the combustion of propanol in excess oxygen. -----

6 marks

- (ii). Why is the reaction in d (i) above useful in the car industry? -----

2 mark