BINDURA UNIVERSITY OF SCIENCE EDUCATION
SCIENCE AND MATHEMATICS EDUCATION DEPARTMENT
DIPLOMA IN SCIENCE EDUCATION

COURSE: DC004/DCH006 ORGANIC CHEMISTRY

TIME 2 HOURS

ANSWER QUESTION 1 AND TWO QUESTIONS FROM SECTION A AND TWO OTHER QUESTIONS FROM SECTION B. EACH QUESTION CARRIES 20 MARKS

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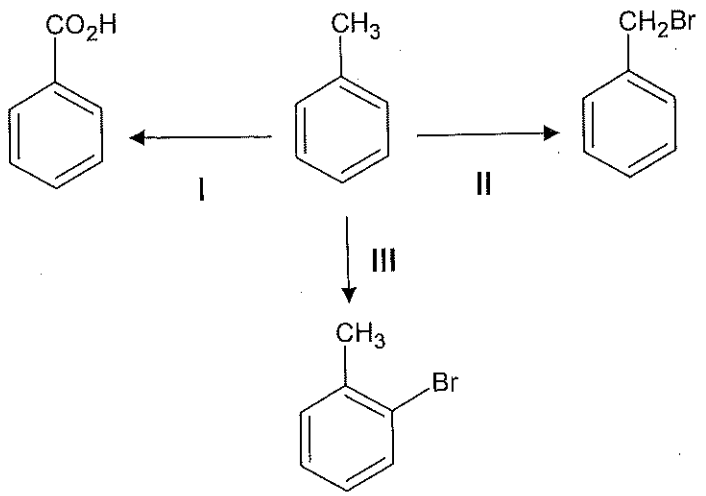
1 (a) Define the following terms:
(i) Free Radical
(ii) Nucleophile
(iii) Hydrocarbon
(iv) Functional group [4x2 marks]

(b) Give structures corresponding to the following compounds:
(i) Ethyl ethanoate [2 marks]
(ii) Benzoic acid [2 marks]
(iii) Methylbenzene [2 marks]

(c) Classify the following compounds according to the functional group.
(i) CH_3CH_2COOH
(ii) $CH_3COOCH_2CH_3$
(iii) CH_3CHO
(iv) CH_3COCH_3
(v) $CH_3CH_2CH_2NH_2$
(vi) CH_3CH_2OH [6 marks]

SECTION A: ANSWER ANY TWO QUESTIONS

2 Some chemical transformations of methylbenzene are given below



Compound A

(a) (i) Name the reaction mechanisms labelled I and III. [2 marks]

(ii) State the reaction conditions for reactions I and III. [5 marks]

(iii) Give an outline of the mechanism for reaction II. [8 marks]

(b) There are two positional isomers for compound **A**.

(i) Draw their structural formulae. [4 marks]

(ii) Suggest which of the two is more likely to be formed alongside compound **A**. [1 mark]

3 (a) 2-bromobutane reacts with hydroxide ions under different sets of conditions to give two different product mixtures **B** and **C**:

$$C_4H_{10}O \ (\mathbf{B}) \xleftarrow{\ I\ } CH_3CHBrCH_2CH_3 \xrightarrow{\ II\ } C_4H_8 \ (\mathbf{C})$$

(i) Describe the conditions necessary for reaction I. [3 marks]

(ii) Describe the conditions necessary for reaction II. [3 marks]

(b) Product C is a mixture of three isomers all of which decolorise bromine water.

(i) Draw displayed formulae for the three isomers. [9 marks]

(ii) Construct equations for the reactions of two of these isomers with bromine water. [4 marks]

(iii) Name the type of reaction. [1 mark]

4 (a) Alcohols **D** and **E** are isomers,

$CH_3CH(OH)CH_2CH_3$ (**D**) $(CH_3)_3COH$ (**E**)

(i) Classify the alcohols into 1°, 2° or 3° alcohol. [2 marks]

(ii) Draw the structural formula of 2 other alcohols which are isomers of **D** and **E**. [2 marks]

(iii) What reagent will be used to dehydrate **D** and **E** to alkenes. [1 mark]

(iv) Draw the structural formulae of the three isomers that are obtained by dehydrating **D**. [6 marks]

(v) Describe a reaction that can be used to distinguish between **D** and **E**. [2 marks]

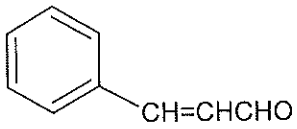
(vi) What observations would be made in each case? [3 marks]

(b) Draw the displayed structure of the compound formed when **D** reacts with ethanoyl chloride, CH_3COCl. [2 marks]

(c) Draw diagrams to show how **D** gives rise to optical isomerism. [2 marks]

SECTION B: ANSWER ANY TWO QUESTIONS.

5. Cinnamaldehyde, F, is used in fragrances for its jasmine-like odour. F contains two functional groups other than the benzene ring. These functional groups behave independently of each other. The structure of cinnamaldehyde is shown below:



Cinnamaldehyde, F

(a) Name the functional groups present in the molecule. [2 marks]

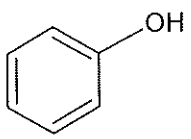
(b) The presence of unsaturation in this molecule can be shown by reaction with bromine dissolved in hexane.
(i) What is the observable result of this test? [2 marks]
(ii) Give the equation of the reaction taking place. [3 marks]
(iii) Give the structure of the organic product formed if bromine water is used. [3 marks]

(c) How would you test for the presence of the $\rangle C{=}O$ group in this molecule. [2 marks]

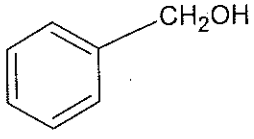
(d) Give the structure of the molecule produced when the -CHO Group in cinnamaldehyde:
(i) reacts with HCN [2 marks]
(ii) is oxidized [2 marks]
(iii) is reduced [2 marks]

(e) Give the structure of the compound formed if the product in (d)(i) is reacted with H_2SO_4. [2 marks]

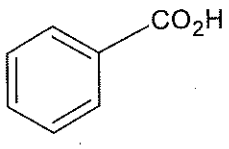
6. (a) Name the following compounds. [3 marks]



E



F



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(b) Show how each of the three compounds would react with the following reagents and in each case give the equation of the reaction:
(i) Na [6 marks]
(ii) NaOH [5 marks]

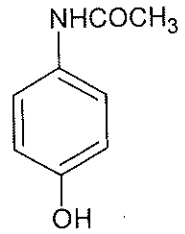
(c) Esters of carboxylic acids are often used as synthetic fruit flavours. Ethylbutanoate, **H**, is a major component of strawberry and pineapple flavourings.

$$CH_3CH_2CH_2CO_2CH_2CH_3$$
H

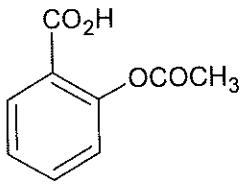
(i) What reagents and conditions do you need to synthesize **H** from butanoic acid? [3 marks]

(ii) Give the name and displayed formula of a compound that can be used in place of butanoic acid? [3 marks]

7. Paracetamol and Aspirin are widely used today as both have 'analgesic' (pain-killing action). They are readily absorbed from the intestines and rapidly diffuse into the tissues. Their formulas are given below:



Paracetamol



Aspirin

(a) Name the functional groups in each of the two compounds. [4 marks]

Each drug has a group which is easily hydrolysed, e.g. by enzymes in the intestines.

(b) (i) Name the group which is hydrolysed in each compound. [2 marks]

(ii) Write the formulae of the two hydrolysis products of paracetamol. [4 marks]

(iii) Write the formulae of the two hydrolysis products of aspirin. [4 marks]

(c) Outline the preparation, starting from benzene of:

(i) Nitrobenzene. [2 marks]

(ii) Phenylamine. [4 marks]

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