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

COURSE: DC003/DCH006 ORGANIC CHEMISTRY
TIME 2 HOURS

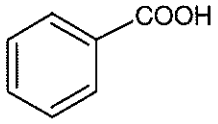
ANSWER QUESTION ONE AND FOUR OTHERS. EACH QUESTION CARRIES 20 MARKS

****

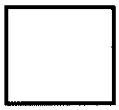
1 (a) Draw structures corresponding to the following compounds:
(i) Phenol
(ii) Phenylamine
(iii) Butan-2-one
(iv) Butan-2-ol
(v) Methanoic acid [5x2 marks]

(b) Define the following terms:
(i) Homologuous series [2 marks]
(ii) Optical isomers [2 marks]
(iii) Functional group [2 marks]

(c) Name the following compounds.
(i) $CH_2CHCH_2CH_3$
(ii) CH_2OHCH_2OH
(iii)



(iv)



[4 marks]

SECTION A: ANSWER ANY TWO QUESTIONS

2 (a) Alkanes are saturated hydrocarbons.
(i) Explain the terms ***saturated*** and ***hydrocarbon***. [2 marks]
(ii) Explain why alkanes are generally unreactive. [2 marks]
(iii) Write a balanced equation for the complete combustion of cyclohexane [2 marks]

(b) Methane reacts with bromine to give bromomethane and hydrogen bromide.

(i) By what mechanism does bromine react with methane? [1 mark]

(ii) Write a balanced equation for the reaction. [2 marks]

(iii) What type of bond breaking is involved in this reaction? [1 mark]

(iv) What essential conditions are required in this reaction? [2 marks]

(c) For the reaction between bromine and methane, write equations for:

(i) The initiation step [2 marks]

(ii) The propagation steps [4 marks]

(iii) A termination reaction [2 marks]

3 An organic compound **A** has the following composition by mass:
C, 35.1%; H, 6.6%; Br, 58.3%.

(a) Calculate the empirical formulae of **A**. [3 marks]

(b) When **A** is treated with aqueous alkali, 2-methlypropan-1-ol is formed.
Write an equation for the reaction including displayed formulae of the organic product. [3 marks]

(c) When **A** is refluxed with ethanolic potassium hydroxide, an alkene, **B** is formed. **B** reacts with hydrogen bromide to give compound **C**.

(i) Give the displayed formula of **B** [2 marks]

(ii) Give the displayed formula of **C** [2 marks]

(d) Chloroethane, CH_3CH_2Cl, reacts with ammonia, NH_3 to produce an amine.

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

(ii) Give the structural formula of the organic product formed. [2 marks]

(iii) Give the mechanism of the reaction. [5 marks]

(iv) State and explain how the rate of this reaction changes when chloroethane is replaced by lodoethane. [2 marks]

4. There are four alcohols of molecular formula $C_4H_{10}O$ which are structural isomers. Three of these alcohols are given below:

$CH_3CH_2CH_2CH_2OH$	$CH_3CH(OH)CH_2CH_3$	$(CH_3)_3COH$
Butan-1-ol	Butan-2-ol	2-methylpropan-2-ol

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

(ii) Give the structural formula of the fourth alcohol which is isomeric with those above. [2 marks]

(b) On heating with concentrated sulphuric acid (H_2SO_4) butan-2-ol is converted into a mixture of alkenes.

(i) Give the name and type of reaction taking place. [1 mark]

(ii) Give the structural formulae of two of the alkenes formed. [4 marks]

(c) (i) Give the name and the structural formula of the organic product when butan-1-ol is heated with acidified potassium dichromate (VI) and the product is removed by distillation as it forms. [3 marks]

(ii) Give the name and structural formula of the organic product formed when butan-2-ol is heated under reflux with acidified potassium dichromate for 20 minutes. [3 marks]

(iii) State the type of reaction occurring in c(ii). [1 marks]

(d) When 2-methylpropan-2-ol is heated with a carboxylic acid in the presence of a catalyst, an ester $C_6H_{12}O_2$ is formed.

(i) Give the structural formula of this ester of molecular formula $C_6H_{12}O_2$. [2 marks]

(ii) Name the carboxylic acid needed to form the ester in (d) (i) [1 mark]

SECTION B: ANSWER ANY TWO QUESTIONS.

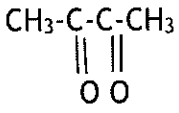
5. Three compounds **E**, **F**, and **G** all have the molecular formula C_3H_6O. **E** is an alcohol, **F** is a ketone and **G** is an aldehyde.

(a) Draw possible structural formulae for **E**, **F** and **G**. [6 marks]

(b) Describe tests (reagents, conditions and observations with each compound) that would allow you to show that:

(i) **E** is an alcohol whereas **F** and **G** are not [3 marks]
(ii) **F** and **G** are carbonyl compounds whereas **E** is not [3 marks]
(iii) **G** is an aldehyde whereas **E** and **F** are not [3 marks]

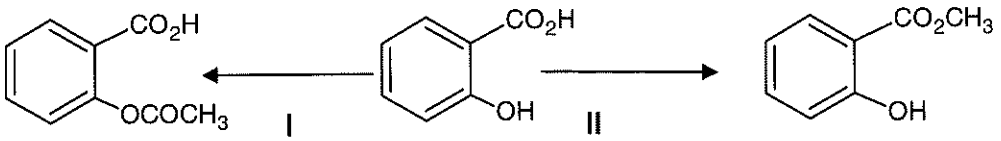
(c) One of the compounds responsible for the flavor of butter is butane-2,3-dione.



Give the structural formulae of the organic products formed when butane-2,3-dione reacts completely with:

(i) H_2/Ni [2 marks]
(ii) I_2/OH^- [3 marks]

6. Compound **H**, is a useful intermediate for making aspirin and oil of wintergreen.



Aspirin **H** Oil of wintergreen

(a) (i) Identify the functional groups in **H**. [2 marks]
(ii) Suggest suitable reagents and conditions for reactions I and II. [6 marks]

(b) Draw the structural formulae of the organic products formed when **H** reacts with:

(i) Na_2CO_3 [2 marks]
(ii) NaOH [2 marks]
(iii) Dilute HNO_3 [2 marks]

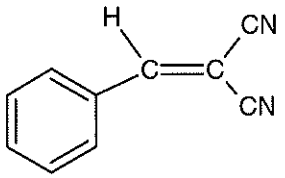
(c) When an asprin tablet was crushed up in water and titrated with 1M NaOH, 13.9 cm^3 of alkali were required to neutralize its acidity.

(i) Calculate the moles of aspirin reacted. [2 marks]

(ii) Calculate the mass of aspirin in the tablet [2 marks]

(d) A soluble aspirin contains the calcium salt of aspirin. Suggest a reagent that could be used to convert aspirin into its calcium salt. [2 marks]

7. (a) The active component of tear gas is called **CS** and has the following structure



Draw the structures of organic compounds expected to be formed when **CS** reacts with each of the following reagents:

(i) Bromine [3 marks]

(ii) Hot aqueous sulphuric acid [3 marks]

(iii) A mixture of concentrated nitric acid and sulphuric acid [3 marks]

(iv) Hydrogen in the presence of a nickel catalyst [3 marks]

(b) **CS** is readily hydrolysed to non-irritant products.

(i) Which one of the reagents in (a) would do this? [2 marks]

(ii) What types of stereoisomers, if any, are possible for **CS**? [1 mark]

(c) (i) Explain why propylamine is a stronger base than ammonia [3 marks]

(ii) Explain why propylamine is classifed as Bronsted-Lowry base. [2 marks]

END OF PAPER