1. Which of the structures below is an aldehyde?

A. $CH_3CH_2\overset{\overset{\displaystyle O}{\|}}{C}H$

B. $CH_3\overset{\overset{\displaystyle O}{\|}}{C}CH_3$

C. $CH_3CH_2\overset{\overset{\displaystyle O}{\|}}{C}OH$

D. $CH_3\overset{\overset{\displaystyle O}{\|}}{C}OCH_3$

(1)

2. What product results from the reaction of $CH_2{=}{=}CH_2$ with Br_2?

A. CHBrCHBr

B. CH_2CHBr

C. CH_3CH_2Br

D. CH_2BrCH_2Br

(1)

3. What is the final product formed when CH_3CH_2OH is refluxed with acidified potassium dichromate(VI)?

A. CH_3CHO

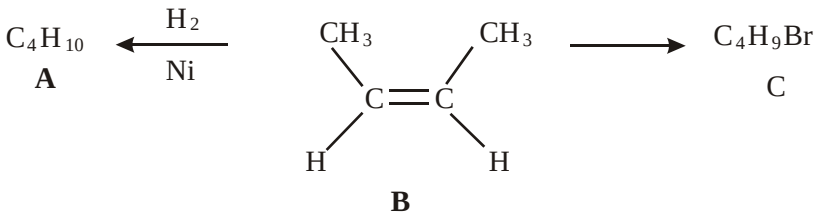
C. $CH_2{=}{=}CH_2$

D. CH_3COOH

B. $HCOOCH_3$

(1)

4. Two reactions of an alkene, **B**, are shown below.



(i) State the name of **A** and write an equation for its complete combustion. Explain why the incomplete combustion of **A** is dangerous.

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(5)

(ii) Outline a test to distinguish between **A** and **B**, stating the result in each case.

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(3)

(iii) Write an equation for the conversion of **B** to **C.** State the type of reaction taking place and draw the structure of **C.**

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(3)
(Total 11 marks)

5. (i) A compound **D** has the molecular formula $C_2H_4O_2$ and is obtained from a reaction between methanoic acid and methanol. Write an equation for this reaction and state the name of **D.**

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(3)

(ii) A second compound, **E**, has the same molecular formula as **D** and has acidic properties.

State the name of compound **E**.

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(1)

(Total 4 marks)

6. The first synthetic thread was made from a polyester. A section of the polyester is drawn below:

$$—CH_2COO—CH_2COO—CH_2COO—$$

(i) Give the structural formula of the monomer (containing two functional groups) that could be used to make this polyester and state the names of the two functional groups.

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(3)

(ii) State, giving a reason, whether this polyester is made by a condensation reaction or an addition reaction.

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(2)
(Total 5 marks)

7. Which of the substances below is **least** soluble in water?

A. $CH_2OHCHOHCH_2OH$

B. $CH_3\overset{\overset{\displaystyle O}{\|}}{C}CH_3$

C. $CH_3CH_2\overset{\overset{\displaystyle O}{\|}}{C}OH$

D. $CH_3\overset{\overset{\displaystyle O}{\|}}{C}OCH_3$

(1)

8. How many different tripeptides can be prepared from three amino acids?
(Each amino acid is used only once in a given tripeptide.)

A. 1

B. 3

C. 6

D. 9

(1)

9. Which substance(s) could be formed during the incomplete combustion of a hydrocarbon?

I. Carbon

II. Hydrogen

III. Carbon monoxide

A. I only

B. I and II only

C. I and III only

D. II and III only

(1)

10. Which formulas represent butane or its isomer?

I. $CH_3(CH_2)_2CH_3$

II. $CH_3CH(CH_3)CH_3$

III $(CH_3)_3CH$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1)

11. Which compound can exist as optical isomers?

A. $CH_3CHBrCH_3$

B. $CH_2BrCHBrCH_3$

C. $CH_2BrCHBrCH_2Br$

D. $CHBr_2CHBrCHBr_2$

(1)

12. (i) List **three** characteristics of an homologous series, and explain the term *functional group.*

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(3)

(ii) Ethanol and ethanoic acid can be distinguished by their melting points.
State and explain which of the two compounds will have a higher melting point.

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(2)

(iii) Draw the **four** different structures of alcohols of formula C_4H_9OH. Identify the structure that exists as optical isomers and give a reason for your answer.

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(4)
(Total 9 marks)

13. (i) Ethanoic acid reacts with ethanol in the presence of concentrated sulfuric acid and heat. Identify the type of reaction that takes place. Write an equation for the reaction, name the organic product formed and draw its structure.

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(4)

(ii) State and explain the role of sulfuric acid in this reaction.

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(2)

(iii) State **one** major commercial use of the organic product from this type of reaction.

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(1)

(Total 7 marks)

14. For the two compounds $HCOOCH_2CH_3$ and $HCOOCHCH_2$:
I II

(i) State and explain which of the two compounds can react readily with bromine.

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(2)

(ii) Compound II can form polymers. State the type of polymerization compound II undergoes, and draw the structure of the repeating unit of the polymer.

(2)
(Total 4 marks)

15. Which is the correct description of the following reaction?

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

A. Addition

B. Condensation

C. Dehydration

D. Hydrogenation

(1)

16. Which statement about neighbouring members of all homologous series is correct?

A. They have the same empirical formula.

B. They differ by a CH_2 group.

C. They possess different functional groups.

D. They differ in their degree of unsaturation.

(1)

17. Which type of compound must contain a minimum of three carbon atoms?

A. An aldehyde

B. A carboxylic acid

C. An ester

D. A ketone

(1)

18. What is the IUPAC name for $CH_3CH_2CH(CH_3)_2$?

A. 1,1-dimethylpropane

B. 2-methylbutane

C. isopentane

D. ethyldimethylmethane

(1)

19. The compound C_2H_4 can be used as a starting material for the preparation of many substances.

(a) Name the compound C_2H_4 and draw its structural formula.

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(2)

(b) In the scheme below, state the type of reaction and identify the reagent needed for each reaction.

$$C_2H_4 \xrightarrow{\textbf{A}} CH_3CH_2OH \xrightarrow{\textbf{B}} CH_3COOH$$

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(4)

(c) C_2H_4 can be converted into one of the compounds below in a single step reaction.

C_2H_3Cl $C_2H_4Cl_2$

Draw the structural formula for each of these compounds and identify the compound which can be formed directly from C_2H_4.

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(3)

(d) One of the two compounds in (c) has an isomer. Draw the structural formula of the isomer and explain why it can not be formed directly from C_2H_4.

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(2)

(e) C_2H_4 can also react to form a polymer. Name this **type** of polymer and draw the structural formula of a section of this polymer consisting of three repeating units.

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(2)

(f) Polymers can also be formed in a different type of reaction. Identify this type of reaction and name two different types of such polymers.

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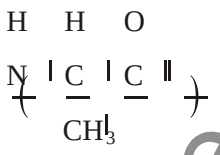
(3)
(Total 16 marks)

20. The polymer with the repeating unit



exists as optical isomers.

(i) State a test for optical isomers.

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(ii) Identify the chiral centre in the repeating unit.

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(iii) Draw the two enantiomeric forms of the repeating unit.

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(Total 4 marks)

21. Which compound can exist as optical isomers?

A. H_2NCH_2COOH

B. CH_2ClCH_2Cl

C. CH_3CHBrI

D. $HCOOCH_3$

(1)

22. Which product is formed by the reaction between CH_2CH_2 and HBr?

A. CH_3CH_2Br

B. CH_2CHBr

C. BrCHCHBr

D. CH_3CHBr_2

(1)

23. Which compound has the lowest boiling point?

A. $CH_3CH_2CH(CH_3)CH_3$

B. $(CH_3)_4C$

C. $CH_3CH_2CH_2CH_2CH_3$

D. $CH_3CH_2OCH_2CH_3$

(1)

24. Which species will show optical activity?

A. 1-chloropentane

B. 3-chloropentane

C. 1-chloro-2-methylpentane

D. 2-chloro-2-methylpentane

(1)

25. What type of reaction does the equation below represent?

$$CH_2{=}CH + Br_2 \rightarrow BrCH_2CH_2Br$$

A. substitution

B. condensation

C. reduction

D. addition

(1)

26. The alkanes are a homologous series of saturated hydrocarbons.

State the meaning of each of the following terms.

(i) *homologous* series

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(2)

(ii) *hydrocarbon*

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(1)

(iii) *saturated*

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(1)
(Total 4 marks)

27. (a) (i) State and explain the trend in the boiling points of the first five alkanes.

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(2)

(ii) Explain why the enthalpies of combustion of alkanes are negative values.

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(1)

(b) State the products of the complete combustion of alkanes.

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(2)
(Total 5 marks)

28. The plastic PVC, poly(chloroethene), is made from the monomer chloroethene, C_2H_3Cl, by a polymerization reaction.

(i) Draw the structural formula of chloroethene.

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(1)

(ii) State the type of polymerization reaction that occurs to make poly(chloroethene) and identify the structural feature needed in the monomer.

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(2)

(iii) Draw the structure of the repeating unit of poly(chloroethene).

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(1)

(iv) Explain why monomers are often gases or volatile liquids, whereas polymers are solids.

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(2)
(Total 6 marks)

29. Hexanedioic acid and 1,6-diaminohexane react together to form a synthetic polymer. There are many natural polymers, some of the most familiar being proteins formed from 2-amino acids.

(i) Give the structural formula of each monomer in the synthetic polymer.

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(2)

(ii) State the type of polymerization reaction that occurs between these two monomers and identify the structural feature needed in the monomers.

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(2)

(iii) Draw the structure of and state the type of linkage formed in this polymer, and identify the other product of this polymerization reaction.

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(3)

(iv) The structures of some 2-amino acids are shown in Table 20 of the Data Booklet. Using alanine as an example, explain what is meant by the term *optical activity*, identify the structural feature that needs to be present and illustrate your answer with suitable diagrams of both isomers.

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(3)

(v) Identify a 2-amino acid from Table 20 which does **not** show optical activity.

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(1)

(vi) Polyesters are formed in a similar polymerization reaction to proteins. Their monomers are esters. State **one** use of esters and identify the **two** compounds that react together to form the ester ethyl methanoate.

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(3)
(Total 14 marks)

30. (a) The manufacture of low-density polyethene uses a free-radical reaction mechanism.

(i) State the names of the **three** steps common to most free-radical mechanisms.

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(2)

(ii) One step in the mechanism can be represented as follows:

$$R_3C\bullet + CH_2{=}{=}CH_2 \rightarrow R_3C{-}CH_2{-}CH_2\bullet$$

Outline what happens in this step, by reference to the electrons involved.

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(2)

(b) State the type of mechanism and the catalyst used in the manufacture of high-density polyethene.

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(2)
(Total 6 marks)

31. Which compound is a member of the same homologous series as 1-chloropropane?

A. 1-chloropropene

B. 1-chlorobutane

C. 1-bromopropane

D. 1,1-dichloropropane

(1)

32. Which formula is a correct representation of pentane?

A. $CH_3CH_2CHCH_2CH_3$

B. $(CH_3CH_2)_2CH_3$

C. $CH_3(CH_2)_3CH_3$

D. $CH_3(CH_3)_3CH_3$

(1)

33. What is the organic product of the reaction between ethanol and ethanoic acid?

A. CH_3CHO

B. CH_3COOCH_3

C. $CH_3CH_2COOCH_3$

D. $CH_3COOCH_2CH_3$

(1)

34. Explain why the **incomplete** combustion of hydrocarbons is harmful to humans.

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(Total 2 marks)

35. Give the structural formulas for the isomers of molecular formula C_4H_{10} and state the name of each one.

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(Total 4 marks)

36. Several compounds have the molecular formula $C_3H_6O_2$.

Three of them, **A**, **B** and **C**, have the following properties:

A is soluble in water and is acidic
B and **C** are neutral and do not react with bromine.

(a) Give a structural formula for each of these compounds and name them.

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(6)

(b) (i) Explain the solubility and acidity of **A** in water.

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(2)

(ii) Write an equation for the reaction of **A** with sodium hydroxide solution.

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(1)

(iii) Explain why **B** and **C** do not react with bromine.

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(1)

(c) State and explain which one of **A**, **B** or **C** has the highest boiling point.

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(2)

(d) (i) Name the class of compounds to which **B** and **C** belong and state a use of this class of compounds.

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(2)

(ii) Name the **two** classes of compounds used to form **B** or **C**, and state the other product formed in this reaction.

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(3)

(e) Suggest the structural formula of an isomer of $C_3H_6O_2$ which does react rapidly with bromine. Name this type of reaction, and describe an observation that can be made during the reaction.

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(3)

(Total 20 marks)