



IB Chemistry – SL

Topic 10 Questions

1. Which of the structures below is an aldehyde?

- A. $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{CH}$
- B. $\text{CH}_3\overset{\text{O}}{\parallel}\text{CCH}_3$
- C. $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{COH}$
- D. $\text{CH}_3\overset{\text{O}}{\parallel}\text{COCH}_3$

(Total 1 mark)

2. What product results from the reaction of $\text{CH}_2=\text{CH}_2$ with Br_2 ?

- A. CHBrCHBr
- B. CH_2CHBr
- C. $\text{CH}_3\text{CH}_2\text{Br}$
- D. $\text{CH}_2\text{BrCH}_2\text{Br}$

(Total 1 mark)

3. What is the final product formed when $\text{CH}_3\text{CH}_2\text{OH}$ is refluxed with acidified potassium dichromate(VI)?

- A. CH_3CHO
- B. $\text{CH}_2=\text{CH}_2$
- C. CH_3COOH
- D. HCOOCH_3

(Total 1 mark)

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

I. Carbon II. Hydrogen III. Carbon monoxide

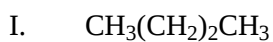
- A. I only
- B. I and II only
- C. I and III only



D. II and III only

(Total 1 mark)

5. Which formulas represent butane or its isomer?



A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(Total 1 mark)

6. 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.

(Total 1 mark)

7. What is the IUPAC name for $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2$?

A. 1,1-dimethylpropane

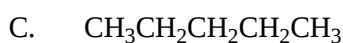
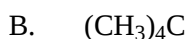
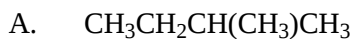
B. 2-methylbutane

C. isopentane

D. ethyldimethylmethane

(Total 1 mark)

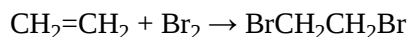
8. Which compound has the lowest boiling point?



(Total 1 mark)



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



- A. substitution
- B. condensation
- C. reduction
- D. addition

(Total 1 mark)

10. 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

(Total 1 mark)

11. Which formula is a correct representation of pentane?

- A. $\text{CH}_3\text{CH}_2\text{CHCH}_2\text{CH}_3$
- B. $(\text{CH}_3\text{CH}_2)_2\text{CH}_3$
- C. $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$
- D. $\text{CH}_3(\text{CH}_3)_3\text{CH}_3$

(Total 1 mark)

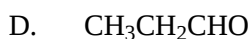
12. How many structural isomers are possible with the molecular formula C_6H_{14} ?

- A. 4
- B. 5
- C. 6
- D. 7

(Total 1 mark)

13. Which compound is a member of the aldehyde homologous series?

- A. CH_3COCH_3
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}_2\text{COOH}$



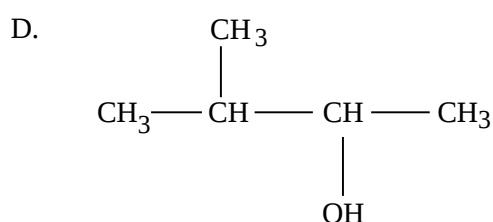
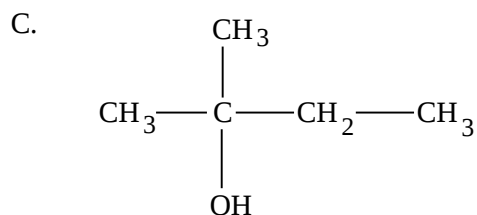
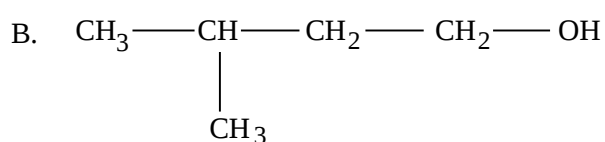
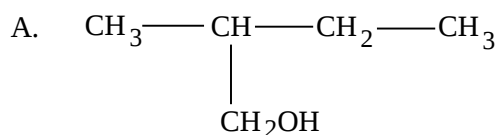
(Total 1 mark)

14. Which type of compound can be made in one step from a secondary alcohol?

- A. an aldehyde
- B. an alkane
- C. a carboxylic acid
- D. a ketone

(Total 1 mark)

15. Which formula represents a tertiary alcohol?



(Total 1 mark)

16. Which reaction type is typical for halogenoalkanes?

- A. nucleophilic substitution
- B. electrophilic substitution
- C. electrophilic addition
- D. nucleophilic addition

(Total 1 mark)

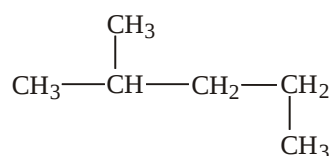
17. Which substance is **not** readily oxidized by acidified potassium dichromate(VI) solution?

- A. propan-1-ol
- B. propan-2-ol
- C. propanal
- D. propanone

(Total 1 mark)



18. What is the correct name of this compound?



- A. 1,3-dimethylbutane
- B. 2,4-dimethylbutane
- C. 2-methylbutane
- D. 2-methylpentane

(Total 1 mark)

19. Propane, C_3H_8 , undergoes incomplete combustion in a limited amount of air. Which products are most likely to be formed during this reaction?

- A. Carbon monoxide and water
- B. Carbon monoxide and hydrogen
- C. Carbon dioxide and hydrogen
- D. Carbon dioxide and water

(Total 1 mark)

20. What is/are the product(s) of the reaction between ethene and hydrogen bromide?

- A. $\text{CH}_3\text{CH}_2\text{Br}$
- B. $\text{CH}_3\text{CH}_2\text{Br}$ and H_2
- C. $\text{CH}_2\text{BrCH}_2\text{Br}$
- D. $\text{CH}_3\text{BrCH}_2\text{Br}$ and H_2

(Total 1 mark)

21. Which are characteristics typical of a free radical?

- I. It has a lone pair of electrons.
- II. It can be formed by the homolytic fission of a covalent bond.
- III. It is uncharged.



- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

(Total 1 mark)

22. Which of the following products could be formed from the oxidation of ethanol?

- I. ethanal
 - II. ethanoic acid
 - III. ethane
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

(Total 1 mark)

23. What is the reaction type when $(\text{CH}_3)_3\text{CBr}$ reacts with aqueous sodium hydroxide to form $(\text{CH}_3)_3\text{COH}$ and NaBr ?

- A. Addition
- B. Elimination
- C. $\text{S}_{\text{N}}1$
- D. $\text{S}_{\text{N}}2$

(Total 1 mark)

24. Which species is a free radical?

- A. $\bullet\text{CH}_3$
- B. $^+\text{CH}_3$
- C. $^-\text{CH}_3$
- D. $:\text{CH}_3$

(Total 1 mark)

25. Which compound is a tertiary halogenoalkane?



- A. $(\text{CH}_3\text{CH}_2)_2\text{CHBr}$
- B. $\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{Br}$
- C. $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{Br}$
- D. $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{Br}$

(Total 1 mark)

26. Which species reacts most readily with propane?

- A. Br_2
- B. $\text{Br}\cdot$
- C. Br^-
- D. Br^+

(Total 1 mark)

27. An organic compound **X** reacts with excess acidified potassium dichromate(VI) to form compound **Y**, which reacts with sodium carbonate to produce $\text{CO}_2(\text{g})$.

What is a possible formula for compound **X**?

- A. $\text{CH}_3\text{CH}_2\text{COOH}$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- D. $(\text{CH}_3)_3\text{COH}$

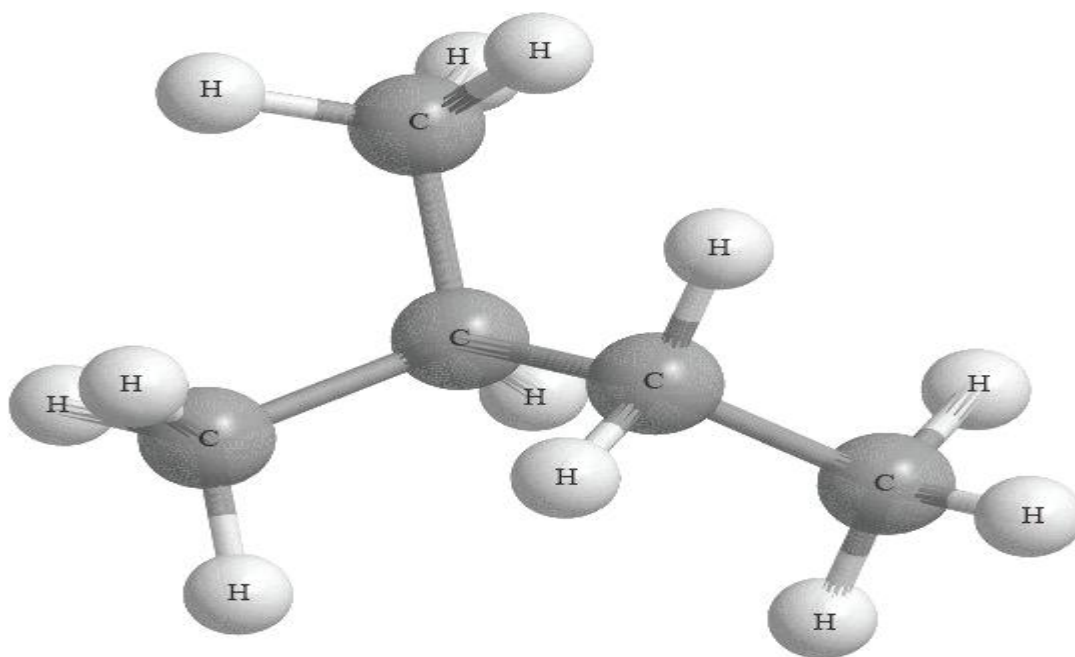
(Total 1 mark)

28. Which statement about successive members of all homologous series is correct?

- A. They have the same empirical formula.
- B. They differ by a CH_2 group.
- C. They have the same physical properties.
- D. They differ in their degree of unsaturation.

(Total 1 mark)

29. The following is a three-dimensional representation of an organic molecule.



Which statement is correct?

- A. The correct IUPAC name of the molecule is 2-methylpentane.
- B. All the bond angles will be approximately 90° .
- C. One isomer of this molecule is pentane.
- D. The boiling point of this compound would be higher than that of pentane.

(Total 1 mark)

30. Which compound forms when hydrogen bromide is added to but-2-ene?

- A. 2-bromobutane
- B. 2,3-dibromobutane
- C. 1-bromobutane
- D. 1,2-dibromobutane

(Total 1 mark)

31. Which products can be potentially obtained from crude oil and are economically important?

- I. Plastics
- II. Margarine
- III. Motor fuel

- A. I and II only
- B. I and III only
- C. II and III only



D. I, II and III

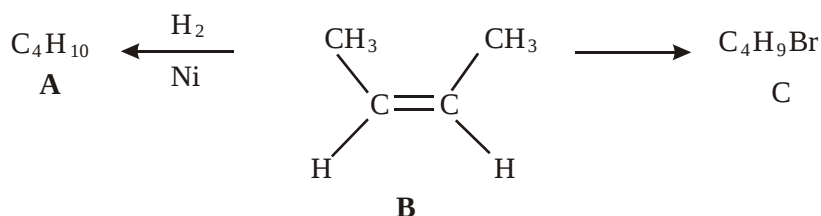
(Total 1 mark)

32. Propane, C_3H_8 , undergoes incomplete combustion in a limited amount of air. Which products are most likely to be formed during this reaction?

- A. Carbon monoxide and water
- B. Carbon monoxide and hydrogen
- C. Carbon dioxide and hydrogen
- D. Carbon dioxide and water

(Total 1 mark)

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

[illegible]

(Total 11 marks)

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

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(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.

(Total 4 marks)

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

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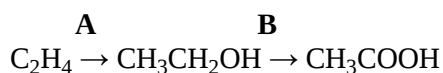
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- (b) In the scheme below, state the type of reaction and identify the reagent needed for each reaction.



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(4)

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



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)

36. 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)

37. The hydrolysis of 2-iodo-2-methylpropane by $0.10 \text{ mol dm}^{-3} \text{ KOH(aq)}$ to form 2-methylpropan-2-ol is an example of nucleophilic substitution.

Give equations to illustrate the S_N1 mechanism for this reaction.

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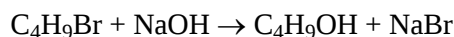
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(Total 2 marks)

38. The molecular formula $\text{C}_4\text{H}_9\text{Br}$ represents four structural isomers, all of which can undergo nucleophilic substitution reactions with aqueous sodium hydroxide. An equation to represent all these reactions is



- (a) Explain what is meant by the term *nucleophilic substitution*. (2)
- (b) The main mechanism for a tertiary halogenoalkane is S_N1 . Give the equations for this substitution reaction of the tertiary isomer of $\text{C}_4\text{H}_9\text{Br}$. Show the structures of the organic reactant and product and use curly arrows to show the movement of electron pairs. (4)
- (c) The main mechanism for a primary halogenoalkane is S_N2 . Give the mechanistic equation for this substitution reaction of the straight-chain primary isomer of $\text{C}_4\text{H}_9\text{Br}$, showing the structures of the organic reactant and product, and using curly arrows to show the movement of electron pairs. (4)
- (d) Give a structural formula for the secondary isomer and for the other primary isomer. State the name of each isomer. (4)

(Total 14 marks)

39. Write equations to show the mechanisms of the following reactions. In each case, show the structure of the intermediate and organic product, and use curly arrows to show the movement of electron pairs.



(i) the reaction between KOH and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$.

(3)

(ii) the reaction between KOH and $(\text{CH}_3)_3\text{CCl}$.

(2)

(Total 5 marks)

40. Some alcohols are oxidized by heating with acidified potassium dichromate(VI). If oxidation does occur, identify the possible oxidation products formed by each of the alcohols below. Indicate if no oxidation occurs.

Butan-1-ol

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Butan-2-ol

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2-methylpropan-2-ol

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(Total 4 marks)

41. Chlorine and ethane react together to form chloroethane.

(a) State the condition needed for the reaction to occur.

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(1)

(b) Write equations to represent initiation, propagation and termination steps in the reaction.



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(4)

(Total 5 marks)

42. CH_3COCH_3 is the first member of the ketone homologous series. Draw the full structural formula of the next member of this homologous series and predict how its melting point compares with that of CH_3COCH_3 .

(Total 2 marks)

43. (i) Write an equation for the reaction between but-2-ene and bromine, showing the structure of the organic product.

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(2)

- (ii) State the type of reaction occurring.

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(1)

(Total 3 marks)

44. CH_3COCH_3 can be prepared in the laboratory from an alcohol. State the name of this alcohol, the type of reaction occurring and the reagents and conditions needed for the reaction.

(Total 5 marks)

45. 2-bromobutane can be converted into butan-2-ol by a nucleophilic substitution reaction. This reaction occurs by two different mechanisms.



(i) Give the structure of the transition state formed in the S_N2 mechanism. (2)

(ii) Write equations for the S_N1 mechanism. (2)

(Total 4 marks)

46. Ethene is an unsaturated hydrocarbon used as a starting material for many organic chemicals.

(a) Draw the structural formula of ethene and state the meaning of the term *unsaturated hydrocarbon*. (2)

(b) State an equation for the conversion of ethene to ethanol and identify the type of reaction. (2)

(c) Describe the complete oxidation of ethanol and name the product. Include the conditions, reagents required and any colour changes. (4)

(d) State an equation for the reaction between ethanol and the product of complete oxidation in (c). Include any other reagent required for this reaction. Name the organic product and state **one** possible use of this product. (4)

(Total 12 marks)

47. Ethene is an unsaturated hydrocarbon used as a starting material for many organic chemicals.

(a) State the meaning of the term *unsaturated hydrocarbon*. (1)

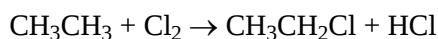
(b) State an equation for the conversion of ethene to ethanol and identify the type of reaction. (2)

(c) Describe the complete oxidation of ethanol. Include the conditions, reagents required and any colour changes. Name the organic product **X**. (4)

(d) State an equation for the reaction between ethanol and compound **X**. Include any other reagent required. Name the organic compound **Z** and state **one** use of this product. (4)

(Total 11 marks)

48. The equation for a reaction of ethane is



The mechanism of this reaction involves initiation, propagation and termination steps. Describe this reaction, including equations for each step and the role of ultraviolet light.

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(Total 5 marks)

49. (i) Draw the structural formula of propan-2-ol. (1)

(ii) Identify the alcohol as primary, secondary, **or** tertiary. (1)

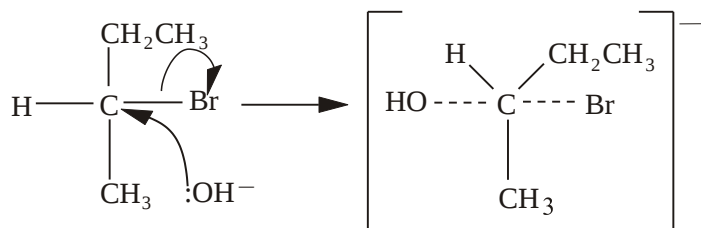
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(iii) Identify the organic product formed by the oxidation of this alcohol using acidified potassium dichromate(VI) solution. (1)

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(Total 3 marks)

50. Secondary halogenoalkanes can undergo nucleophilic substitution reactions by both $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ mechanisms. The mechanism showing the formation of the transition state in the reaction between 2-bromobutane and potassium hydroxide can be represented as follows.



- (a) Identify the type of mechanism shown.

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(1)

- (b) State and explain how the following changes would alter the rate of the reaction by this mechanism.

- (i) using water instead of potassium hydroxide.

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(2)

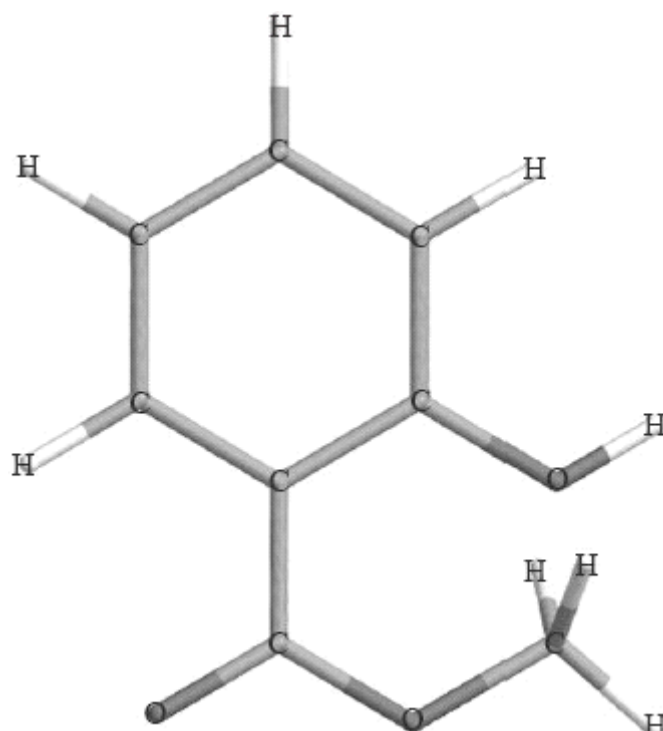
- (ii) using bromoethane instead of 2-bromobutane.

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(Total 5 marks)

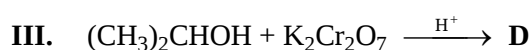
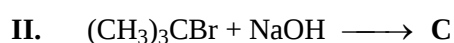
51. The following is a computer-generated representation of the molecule, methyl 2-hydroxy benzoate, better known as oil of wintergreen.

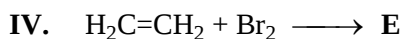


- (i) Deduce the empirical formula of methyl 2-hydroxy benzoate and draw the full structural formula, including any multiple bonds that may be present. The computer-generated representation shown does not distinguish between single and multiple bonds. (2)
- (ii) In this representation, two of the carbon-oxygen bond lengths shown are 0.1424 nm and 0.1373 nm. Explain why these are different and predict the carbon-oxygen bond length in carbon dioxide. (2)
- (iii) Name all the functional groups present in the molecule. (2)
- (Total 6 marks)

52. (i) State and explain the trend in the boiling points of the first six alkanes involving straight-chains. (2)
- (ii) Write an equation for the reaction between methane and chlorine to form chloromethane. Explain this reaction in terms of a free-radical mechanism. (5)
- (Total 7 marks)

53. (i) Identify the formulas of the organic products, A–E, formed in the reactions, I–IV:





(5)

- (ii) $\text{H}_2\text{C}=\text{CH}_2$ can 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.

(2)

(Total 7 marks)

54. Ethene, propene and but-2-ene are members of the alkene homologous series.

- (a) Describe **three** features of members of a homologous series.

(3)

- (b) State and explain which compound has the highest boiling point.

(3)

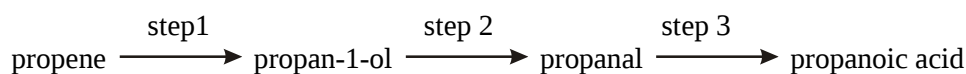
- (c) Draw the structural formula and give the name of an alkene containing five carbon atoms.

(2)

- (d) Write an equation for the reaction between but-2-ene and hydrogen bromide, showing the structure of the organic product. State the type of reaction occurring.

(3)

- (e) Propene can be converted to propanoic acid in three steps:



State the type of reaction occurring in steps 2 and 3 and the reagents needed. Describe how the conditions of the reaction can be altered to obtain the maximum amount of propanal, and in a separate experiment, to obtain the maximum amount of propanoic acid.

(5)

- (f) Identify the strongest type of intermolecular force present in each of the compounds propan-1-ol, propanal and propanoic acid. List these compounds in decreasing order of boiling point.

(4)

(Total 20 marks)

55. (a) State **two** characteristics of a homologous series.

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(2)

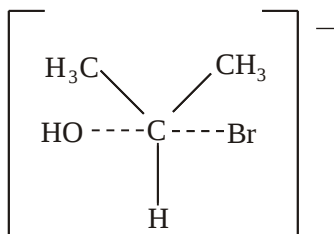
- (b) Describe a chemical test to distinguish between alkanes and alkenes, giving the result in each case.

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(3)
(Total 5 marks)

56. The following transition state is formed during the reaction of a halogenoalkane with aqueous sodium hydroxide:



- (a) Deduce the structure of the halogenoalkane. Classify it as primary, secondary or tertiary, giving a reason for your choice.

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(2)

- (b) The mechanism of this reaction is described as S_N2 . Explain what is meant by the symbols in S_N2 . Predict a rate expression for this reaction.

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(3)

- (c) The same halogenoalkane reacts with sodium hydroxide by an S_N1 mechanism. Deduce the structure of the intermediate formed in this reaction.

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(1)

(Total 6 marks)

57. (a) List **two** characteristics of a homologous series.

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(1)

- (b) 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)

- (c) Draw the **three** isomers containing the alcohol functional group of formula C_4H_9OH .

(2)
(Total 5 marks)