

10.1 Fundamentals of Organic Chemistry

Question Paper

Course	DPIB Chemistry
Section	10. Organic Chemistry
Topic	10.1 Fundamentals of Organic Chemistry
Difficulty	Medium

Time allowed: 70
Score: /52
Percentage: /100

Question 1a

- a) Organic compounds are classified into families called a *homologous series*.

State three features of members belonging to the same *homologous series*.

[3 marks]

Question 1b

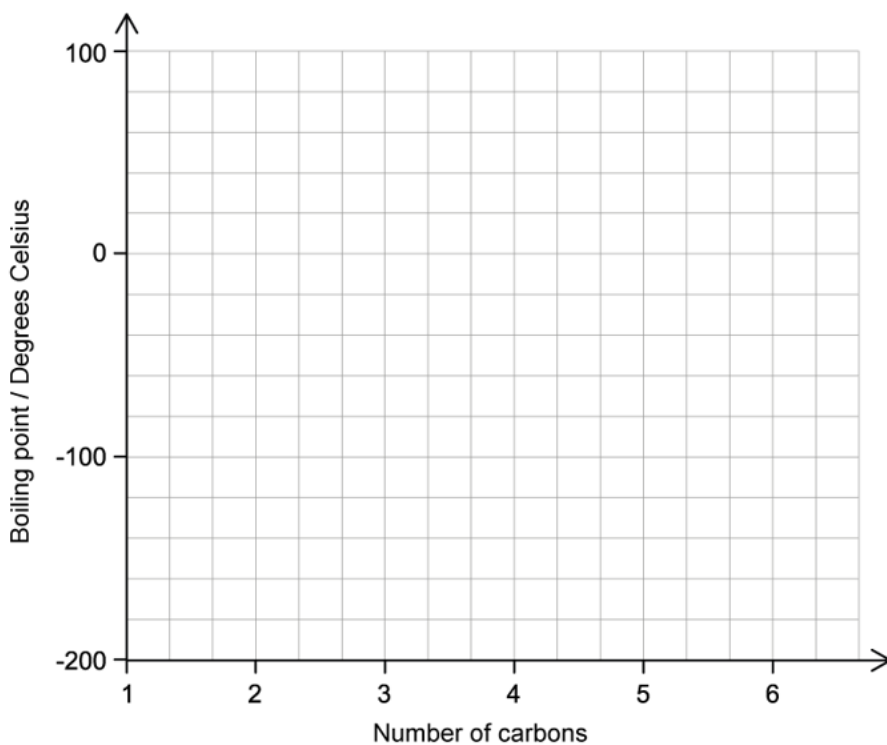
b) **Table 1** shows the boiling points of the first five members of the alkane family.

Table 1

Alkane	Boiling point/ °C
methane	-162
ethane	-89
propane	-42
butane	-1
pentane	36

On the axes below in **Figure 1**, draw a graph of boiling point against the number of carbon atoms in the alkanes. Estimate the boiling point of the next member of the homologous series, hexane, C_6H_{14} , and show on your graph how you arrived at your estimated boiling point.

Figure 1



Estimated boiling point of hexane : _____ °C

[4 marks]

Question 1c

- c) State the general formula for an alkyne and give the molecular formula and name of the fifth member of the alkyne family.

[2 marks]

Question 1d

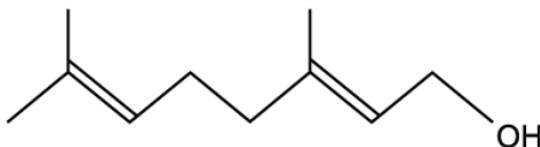
- d) The boiling point of ethyne, C_2H_2 , is $-84\text{ }^\circ\text{C}$.

State with, with a reason, whether the boiling point of ethyne would be expected to be higher or lower than the boiling point of ethane, C_2H_6 .

[2 marks]

Question 2a

- a) Geraniol is a colourless component of rose oil whose structure is shown in **Figure 1**.

Figure 1

- State the names of the two functional groups found in geraniol.
- Deduce the molecular formula of geraniol.
- Draw the displayed formula of geraniol.

[3 marks]**Question 2b**

- Butan-2-ol is an organic compound used industrially to make butanone.
- Draw the displayed structure of butan-2-ol.
- Draw the displayed structures of a positional isomer and a functional group isomer of butan-2-ol.

[3 marks]

Question 2c

- c) Draw and name all the branched-chain isomers of butan-2-ol.

[2 marks]

Question 2d

- d) State, with a reason, the class of alcohols which butan-2-ol belongs to.

[1 mark]

Question 3a

- a) The formulae of four organic compounds are given in **Table 1**. Write the names of the compounds in the second column.

Table 1

compound	name
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$	
$\text{CH}_3\text{CH}_2\text{COCH}_3$	
$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$	

[2 marks]

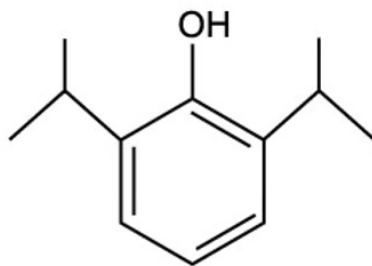
Question 3b

- b) Which of the compounds in part (a) are structural isomers of each other and what type of isomerism do they show?

[2 marks]

Question 3c

- c) Propofol is a drug used to reduce consciousness during medical procedures. The skeletal structure of propofol is given in Figure 1.

Figure 1

- i) Determine the empirical formula of propofol.
- ii) Identify the number of positional isomers of propofol (not including propofol).
- iii) State the names of two functional groups found in propofol.

[3 marks]

Question 3d

- d) Valeric acid, $C_5H_{10}O_2$, is a straight chain carboxylic acid found in the plant *Valeriana officinalis*.
- i) State the general formula for a carboxylic acid.
- ii) Give the systematic name for valeric acid.
- iii) Draw a condensed structural formula for valeric acid.

[3 marks]**Question 4a**

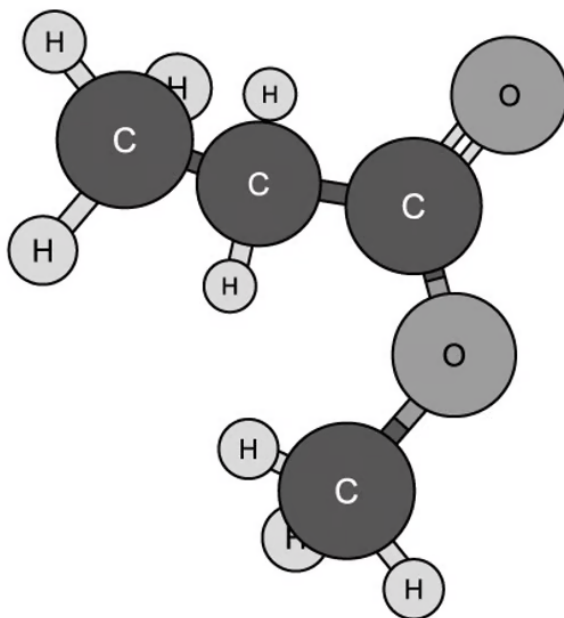
- a) Draw and name all the possible isomers of C_6H_{14} .

[5 marks]

Question 4b

- b) **Figure 1** below shows a three-dimensional structure of a molecule.

Figure 1



- i) Using IUPAC rules state the name of this molecule.
- ii) Draw and name a functional group isomer of this molecule.

[2 marks]

Question 4c

- c) Explain the difference between a tertiary haloalkane and a tertiary amine, using suitable diagrams to illustrate your answer.

[2 marks]

Question 4d

- d) Three important nitrogen containing functional groups used in chemical synthesis are carboxamides, nitriles and amines.

Draw the Lewis structure of each of these functional groups.

[3 marks]

Question 5a

- a) Benzene is an aromatic hydrocarbon which is often drawn as **Figure 1**. Discuss the physical evidence that justifies this structure for benzene.

Figure 1

[2 marks]

Question 5b

- b) Benzene and cyclohexene are both *unsaturated* molecules, but cyclohexene reacts with bromine water and benzene does not.
- i) State the meaning of the terms *saturated* and *unsaturated* as applied to organic molecules.
- ii) Explain this difference in reactivity and write an equation for the reaction between cyclohexene and bromine.

[3 marks]

Question 5c

- c) **Table 1** below shows the enthalpy changes for the hydrogenation of cyclohexene, benzene, and the theoretical molecule 1,3,5-cyclohexatriene.

Table 1

Compound	Enthalpy of hydrogenation
Cyclohexene, C ₆ H ₁₀	-120
Benzene, C ₆ H ₆	-208
1,3,5-cyclohexatriene, C ₆ H ₆	?

The equations for the hydrogenation reactions are:



- i) Use the data in **Table 1** to determine the enthalpy of hydrogenation of the theoretical molecule 1,3,5-cyclohexatriene.
- ii) Discuss the difference between the enthalpy of hydrogenation of benzene and of 1,3,5-cyclohexatriene.

[3 marks]

Question 5d

- d) An unknown aromatic compound has the molecular formula $C_8H_8O_2$.

Deduce the structural formula of **two** isomers of this compound which contain an ester group.

[2 marks]