



# Chem!stry

Name: ..... ( )

Class: .....

Date: ..... / ..... / .....

## Organic Chemistry Short Answer Questions

### Question 1.

- a) Show that ethanoic acid and glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>) have the same empirical formula:

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.....

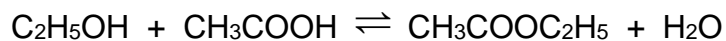
- b) What name is given to substances which have the same molecular formula but different structures?

.....

- c) Draw the full structural formulae of **two** compounds which have a molecular formula of C<sub>5</sub>H<sub>12</sub>:

### Question 2.

Ethyl ethanoate can be prepared by the following reaction:



- a) What is meant by the symbol  $\rightleftharpoons$  ?

.....

- b) State the essential experimental conditions required to make ethyl ethanoate by this reaction:

.....

- c) Name the homologous series of which ethyl ethanoate is a member:

.....

### Question 3.

a) Name the homologous series represented by each of the following general formulae:

i)  $C_nH_{2n+2}$ : .....

ii)  $C_nH_{2n+1}OH$ : .....

b) State two general characteristics of a homologous series, other than the existence of a general formula:

.....  
.....

### Question 4.

To which homologous series of organic compounds does each of the compounds **A**, **B**, **C** and **D** belong?

<b>A</b>	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{Br} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	Series: .....
<b>B</b>	$\begin{array}{c} \text{H} \quad \quad \text{O} \\   \quad \quad // \\ \text{H}-\text{C}-\text{C} \\   \quad \quad \backslash \\ \text{H} \quad \quad \text{O}-\text{C}-\text{H} \\ \quad \quad \quad   \\ \quad \quad \quad \text{H} \end{array}$	Series: .....
<b>C</b>	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	Series: .....
<b>D</b>	$\begin{array}{c} \text{H} \quad \quad \text{H} \\ \quad \quad \backslash \quad / \\ \quad \quad \text{C}=\text{C} \\ \quad \quad / \quad \backslash \\ \text{H} \quad \quad \text{H} \end{array}$	Series: .....

b) Which of the compounds **A**, **B**, **C** or **D** will undergo addition polymerisation?

Name the polymer which it forms:

i) Compound: .....

ii) Name of polymer: .....

**Question 5.**

The following passage is taken from a student's notebook:

*When bromine is added to ethane, the colour of the mixture changes from colourless to orange.*

*The product of this reaction is 1,1-dibromoethane.*

*This is an example of an elimination reaction.*

Unfortunately, the passage contains many errors. Re-write the passage so that it is chemically correct:

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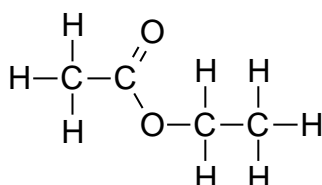
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**Question 6.**

An organic compound has the structural formula shown below:



a) Give the full systematic name of the compound:

.....

b) Give the molecular formula of this compound:

.....

c) Give the empirical formula of this compound:

.....

d) Calculate the percentage (by mass) of carbon in this compound:

### Question 7.

a) Write the balanced chemical equation for the complete combustion of methane:

.....

b) State a chemical test that could be used to identify each of the reaction products:

.....

.....

c) Calculate the volume of **air**, measured at room temperature and pressure, that is required for the complete combustion of 2.0 g of methane:

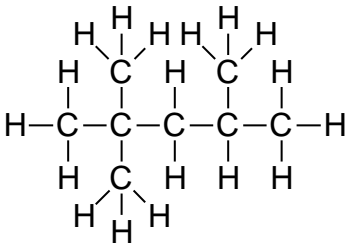
d) Name the poisonous gas that is formed when methane burns in a limited supply of air. Briefly explain why this gas is poisonous:

.....

.....

### Question 8.

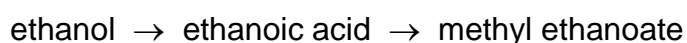
Complete the table below:

Structural Formula	Name
	
	<i>trans</i> -but-2-ene

Structural Formula	Name
$  \begin{array}{cccc}  & \text{H} & \text{H} & \text{H} & \text{H} \\  &   &   &   &   \\  \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\  &   &   &   &   \\  & \text{H} & \text{H} & \text{O} & \text{H} \\  & & &   & \\  & & & \text{H} &   \end{array}  $	
	Ethyl propanoate

**Question 9.**

Look at the following reaction sequence:



**a)** Acidified potassium dichromate(VI) solution will convert ethanol to ethanoic acid.

**i)** Name the type of chemical reaction that takes place.

.....

**ii)** Describe the colour change that would be observed during this reaction:

.....

**b)** Name the reagents and the conditions that are required to make the ester methyl ethanoate form ethanoic acid:

.....

**c)** Name and draw the structure of a macromolecule which contains the same linkage as that in the ester methyl ethanoate:

Name of macromolecule: .....

Structure of macromolecule:

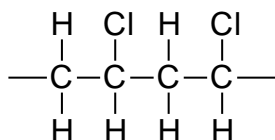
**Question 10.**

Use the information given below to deduce the identity of each of the lettered compounds **A** to **D** in the account. Give either the name or the molecular formula for each compound:

The gaseous alkene **A** has a relative molecular mass ( $M_r$ ) of 28. **A** removes the orange colour from aqueous bromine, forming a dense liquid **B**.

Sodium hydroxide removes hydrogen bromide from **B** to form another hydrocarbon **C** which has the general formula  $C_nH_{2n-2}$ .

**C** undergoes an addition reaction with hydrogen chloride to form an unsaturated product **D** which is used to manufacture the polymer shown in the diagram below:



**A** .....

**B** .....

**C** .....

**D** .....

**Question 11.**

Explain the term *hydrocarbon*. Give the name and molecular formula of a specific example to illustrate your answer:

Explanation:

.....  
.....

Name of specific example:

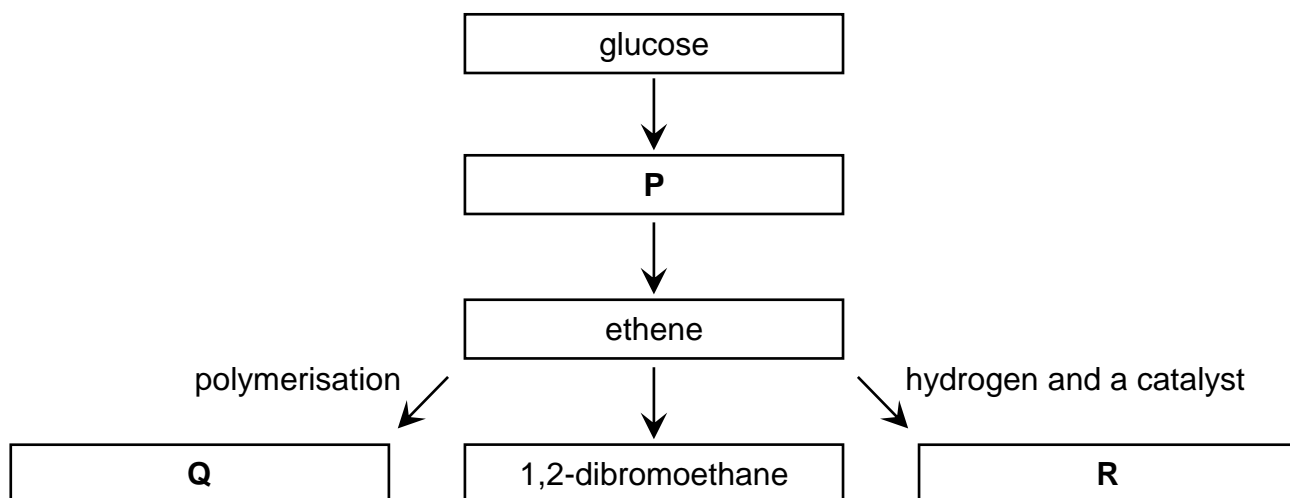
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Molecular formula of specific example:

.....

**Question 12.**

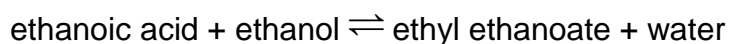
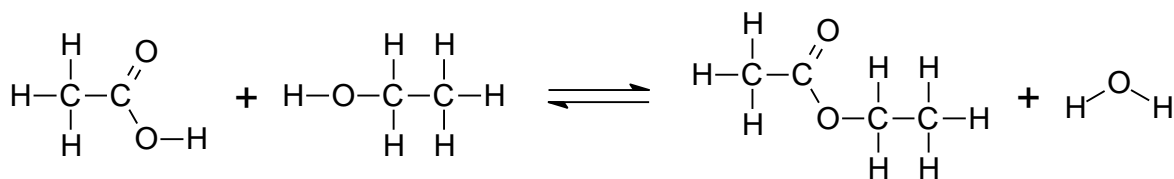
Carefully study the reaction scheme below and use it to answer the questions that follow:



- a) i)** Give the names of the substances and the conditions needed to ferment glucose:  
Substances: .....  
Conditions: .....
- ii)** Give the name of the gas that is produced during the fermentation of glucose and describe a chemical test for this gas:  
Name of gas: .....  
Test for gas: .....  
Observation: .....
- b) i)** Give the name and molecular formula of substance **P**:  
Name: .....  
Molecular formula: .....
- ii)** Give the names of substances **Q** and **R**:  
Substance **Q**: .....  
Substance **R**: .....
- c)** Write the equation for the addition reaction between propene and bromine:  
.....

**Question 13.**

Ethyl ethanoate is made from a reaction between ethanoic acid and ethanol:



The table below gives the relative molecular masses for the reactants and products in the reaction:

Chemical	Relative Molecular Mass ( $M_r$ )
Ethanoic acid	60
Ethanol	46
Ethyl ethanoate	88
Water	18

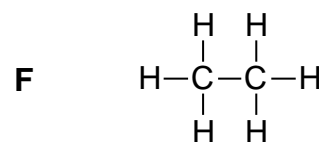
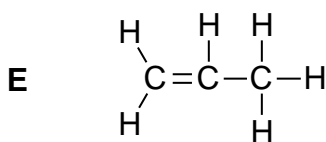
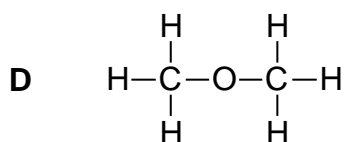
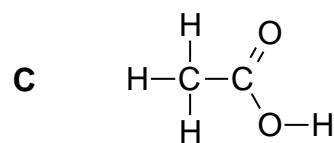
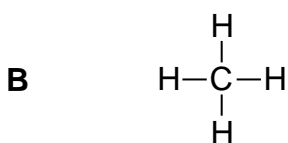
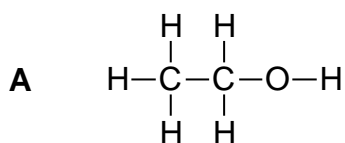
In an experiment, 3.0 g of ethanoic acid and 4.6 g of ethanol were heated together with a catalyst.

- a) What mass of ethyl ethanoate would be made if there was 100% conversion?
- b) In the experiment, only 2.20 g of ethyl ethanoate were obtained. What was the percentage yield of ethyl ethanoate?



### Question 14.

The following questions refer to the compounds with the structures drawn below:



Using the letters **A** to **F** as appropriate, answer the following questions:

**a)** Which compound is an unsaturated hydrocarbon?

.....

**b)** Which compounds are members of the same homologous series?

.....

**c)** Which compound reacts with sodium carbonate?

.....

**d)** Which compounds are isomers of each other?

.....

### Question 15.

Ethyne,  $\text{C}_2\text{H}_2$ , burns in oxygen to produce a very hot flame. The temperature of the flame is so high that it can be used to cut metal.

**a) i)** Write a balanced chemical equation for the complete combustion of ethyne:

.....

**ii)** Is this reaction exothermic or endothermic? Is  $\Delta H$  for this reaction positive or negative?

.....

**b)** Calcium carbide,  $\text{CaC}_2$ , is a greyish white solid. Ethyne can be made by the reaction of calcium carbide with water. Calcium hydroxide is the other product of the reaction. Write a balanced chemical equation, including state symbols, for the reaction between calcium carbide and water:

.....

### Question 16.

The following terms are used in the descriptions of organic compounds:

*alcohol*

*alkane*

*alkene*

*amide*

*hydrocarbon*

*polymer*

From the list, choose **two** terms which can be applied to each of the compounds given below:

- i) Methane: ..... and .....
- ii) Hexene: ..... and .....
- iii) Poly(ethene): ..... and .....
- iv) Nylon: ..... and .....

### Question 17.

A hydrocarbon **X** contains 82.7 % carbon (by mass) and has a relative molecular mass of 58. **X** slowly reacts with chlorine in the presence of sunlight.

- a) Deduce the molecular formula of **X**.
- b) Give **two** pieces of evidence that suggest that **X** is an alkane.
- c) Define the term **isomerism**. Write down the full structural formulae of the isomers of **X**.

### Question 18.

**Y** is a colourless organic liquid. **Y** reacts with sodium to produce hydrogen and also reacts with concentrated sulphuric acid to produce propene. **Y** and ethanoic acid have the same relative molecular masses.

- a) Identify **Y** and write equations for the reactions that are taking place.
- b) Under what conditions does **Y** react with ethanoic acid? Write the equation for the reaction and name the organic product.

### Question 19.

One of the hydrocarbons in petrol has the molecular formula  $C_8H_{18}$ . When petrol is burned in a motor car engine the exhaust fumes contain approximately 9% carbon dioxide, 5% carbon monoxide, 4% oxygen, 2% hydrogen, 0.2% hydrocarbons and 0.2% oxides of nitrogen.

- a) What is meant by the term "hydrocarbon"?
- b) The gases listed above make up 20.4% of the composition of the exhaust fumes. What gas makes up the greater percentage of the remaining gases?
- c) Suggest a reason for the presence of (i) carbon dioxide, (ii) carbon monoxide, (iii) oxides of nitrogen, in the exhaust fumes.
- d) Butene and butane can be formed by a process known as cracking, whereby a larger hydrocarbon molecule is broken down by a high temperature:



- i) Is  $C_8H_{18}$  an alkane or an alkene? Explain your answer. Give one chemical test by which you could distinguish between an alkane and an alkene.
  - ii) Write an equation to show how hydrogen could be formed from  $C_4H_{10}$  by cracking.
- e) Give two reasons why car exhaust pipes tend to rust more quickly than the bodywork although both are made of steel.
  - f) Assuming that air contains one-fifth of oxygen by volume, calculate the minimum volume of air at room temperature and pressure needed for the complete combustion of 57 g of the hydrocarbon of molecular formula  $C_8H_{18}$ .

### Question 20.

Cooking oil (boiling range 230 – 270°C) is a mixture of esters. The oil can be converted into a solid by reaction with hydrogen.

- a) What evidence is there to support the statement that cooking oil is a mixture? Name another experimental technique that could be used to confirm that cooking oil is a mixture.
- b) i) Oils react with hydrogen to form fats in a reaction similar to that used to convert alkenes into alkanes. Briefly explain how an oil can be converted into a fat.
- ii) 10 g of hydrocarbon ( $M_r = 800$ ) completely reacted with 1.8 dm<sup>3</sup> of hydrogen measured at room temperature and pressure. Calculate the number of moles of hydrogen that react with one mole of hydrocarbon. Hence deduce how many C=C bonds there are in a single molecule of this oil.
- c) Name one of the products obtained from the hydrolysis of a fat.
- d) Give **two** reasons why slices of potato cook more quickly in oil than whole potatoes in water.
- e) Name a synthetic material that has the same linkages as cooking oil. Give one use of this synthetic material.
- f) Suggest a suitable solvent for removing cooking oil spilt onto clothing.

### Question 21.

The table below shows some information about two homologous series; the alkanes and the acid chlorides.

Alkanes	Acid Chlorides	
	Name	Formula
C <sub>2</sub> H <sub>6</sub>	ethanoyl chloride	CH <sub>3</sub> COCl
C <sub>3</sub> H <sub>8</sub>		C <sub>2</sub> H <sub>5</sub> COCl
C <sub>4</sub> H <sub>10</sub>	butanoyl chloride	C <sub>3</sub> H <sub>7</sub> COCl
C <sub>5</sub> H <sub>12</sub>	pentanoyl chloride	C <sub>4</sub> H <sub>9</sub> COCl

Use the information in the table to answer the following questions.

- a) Name the acid chloride with the highest boiling point.

.....

b) Deduce the name of the acid chloride with the formula  $C_2H_5COCl$

.....

c) The general formula for the alkanes is  $C_xH_{(2x+2)}$ .

Deduce the general formula for the acid chlorides.

.....

d) i) Name the products of the complete combustion of an alkane.

.....

ii) Would you expect the products of complete combustion of the acid chlorides to be the same as in i) ? Explain your reasoning.

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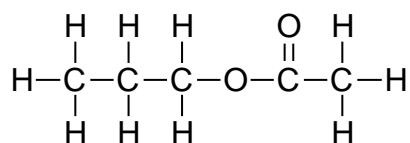
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### Question 22.

This is the structure of an ester made in a reversible reaction between a carboxylic acid and an alcohol.



a) State the conditions for this reaction.

.....

b) Draw the structure of the carboxylic acid used in the reaction.

c) Write an equation for this reaction.

.....

**Question 23.**

The table shows some information about a homologous series of carbon compounds called ethers.

Name	Number of Carbon Atoms	Formula	Boiling Point / °C
methoxymethane	2	CH <sub>3</sub> OCH <sub>3</sub>	-24.8
methoxyethane	3	CH <sub>3</sub> OC <sub>2</sub> H <sub>5</sub>	7.0
methoxypropane	4	CH <sub>3</sub> OC <sub>3</sub> H <sub>7</sub>	
	5		70.3

- a) Deduce the name and formula of the ether that contains five carbon atoms.

Name: .....

Formula: .....

- b) i) Suggest a value for the boiling point of methoxypropane.

.....

- ii) Explain why the boiling points of this homologous series increases down the series.

.....

- c) Place a tick (✓) in each of the correct boxes to show which of the following statements about ethers are true, and which are false.

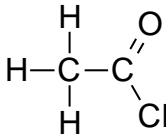
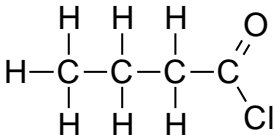
	True	False
The general formula of an ether is C <sub>n</sub> H <sub>(2n+2)</sub> O		
The ethers are hydrocarbons		
The ethers are all liquids at room temperature and pressure		
The ethers are saturated compounds		

- d) One of the first anaesthetics used to stop pain during surgical operations was ethoxyethane, C<sub>2</sub>H<sub>5</sub>OC<sub>2</sub>H<sub>5</sub>. It is explosively flammable, and so was very hazardous for doctors to use. Write an equation for the complete combustion of ethoxyethane.

.....

**Question 24.**

The table shows some information about the homologous series of a class of organic compounds called acyl chlorides.

Name	Condensed Formula	Display Formula
ethanoyl chloride	CH <sub>3</sub> COCl	
butanoyl chloride	C <sub>3</sub> H <sub>7</sub> COCl	

- a) i) Fill in the table to show the name, condensed formula and displayed formula of the acyl chloride that occurs between ethanoyl chloride and butanoyl chloride in the homologous series.
- ii) Explain how you can tell that these molecules are from the same homologous series.
- .....
- .....
- iii) Predict the condensed formula for the acyl chloride that contains nine carbon atoms.
- .....
- b) Butanoyl chloride reacts with ethanol in the following reaction.
- $$\text{C}_3\text{H}_7\text{COCl} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_3\text{H}_7\text{COOC}_2\text{H}_5 + \text{compound X}$$
- i) Name the ester that is formed by this reaction.
- .....
- ii) Name compound X.
- .....

**Question 25.**

The table shows the names and structures of some hydrocarbons.

Number of Carbon Atoms	Alkane	Cycloalkane	Alkene
5	<p>pentane</p> <pre>       H   H   H   H   H                         H - C - C - C - C - C - H                               H   H   H   H   H           </pre>	<p>cyclopentane</p> <pre>       H   H                   C   C      / \ / \     H   C   C   H      \ / \ /       C   C                   H   H           </pre>	<p>pentene</p> <pre>       H   H   H   H   H                         H - C - C - C - C = C                               H   H   H   H   H           </pre>
6	<p>hexane</p> <pre>       H   H   H   H   H   H                             H - C - C - C - C - C - C - H                                   H   H   H   H   H   H           </pre>	<p>cyclohexane</p> <pre>       H   H   H                       C   C   C      / \ / \ / \     H   C   C   C   H      \ / \ / \ /       C   C   C                       H   H   H           </pre>	<p>hexene</p> <pre>       H   H   H   H   H   H                             H - C - C - C - C - C = C                                   H   H   H   H   H   H           </pre>
7	<p>heptane</p> <pre>       H   H   H   H   H   H   H                                 H - C - C - C - C - C - C - C - H                                       H   H   H   H   H   H   H           </pre>	<p>cycloheptane</p> <pre>       H   H   H   H                           C   C   C   C      / \ / \ / \ / \     H   C   C   C   C   H      \ / \ / \ / \ /       C   C   C   C                           H   H   H   H           </pre>	<p>heptene</p> <pre>       H   H   H   H   H   H   H                                 H - C - C - C - C - C - C = C                                       H   H   H   H   H   H   H           </pre>

a) Cycloalkanes are an example of a homologous series.

i) Explain how the formulae of the cycloalkanes in the table show this.

.....

ii) Suggest **two** differences in physical properties between cyclopentane and cycloheptane.

.....

.....



iii) The molecular formula of pentadecane is  $C_{15}H_{32}$ . Give the molecular formula for cyclopentadecane.

.....

b) Are cycloalkanes isomers of alkanes? Explain your reasoning.

.....

.....

c) The percentage of carbon and hydrogen in some molecules are shown in the table.

Name of Molecule	Percentage of Carbon by Mass	Percentage of Hydrogen by Mass
hexane	84	16
hexene	86	14
cycloheptane	86	14

Explain why the percentages of carbon and hydrogen are the same for hexene and cycloheptane, but different for hexane.

.....

.....

.....

.....

d) Bromine water can be used in a test to distinguish between cycloalkanes and alkenes. Describe the results that would be obtained if this test is carried out on separate samples of cyclooctane and octene.

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**Question 26.**

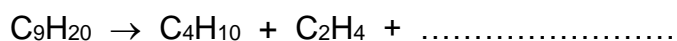
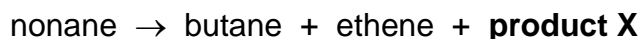
An oil refinery uses two different processes, Process 1 and Process 2, to crack naphtha. The table below shows some information about the percentage yields of products from each process.

	Process 1	Process 2
Hydrogen	1	1
Methane	18	14
Ethene	32	20
Propene	13	15
C <sub>4</sub> Hydrocarbons	9	10
C <sub>5</sub> to C <sub>8</sub> Hydrocarbons	27	40

a) The refinery sells ethene and C<sub>5</sub> to C<sub>8</sub> hydrocarbons. Ethene is used to make addition polymers, and C<sub>5</sub> and C<sub>8</sub> hydrocarbons are added to petrol. Use the information given to explain why the refinery must use both processes to meet the high demand for both ethene and C<sub>5</sub> to C<sub>8</sub> hydrocarbons.

b) During cracking, molecules of nonane, C<sub>9</sub>H<sub>20</sub>, produce three different products; butane, ethene and **product X**.

i) Complete the equation to show the formation of **product X**.



ii) Draw the **structural formulae** of ethene and **product X** in the boxes below.

Structural formula of ethene:

Structural formula of **product X**:

- Scan the QR code given below to view the answers to this assignment.



[http://www.chemist.sg/organic\\_chem/assignments/short\\_answer\\_ans.pdf](http://www.chemist.sg/organic_chem/assignments/short_answer_ans.pdf)