Organic Chemistry – 2019 Nov IGCSE

1. 0620/31/O/N/19/No.2

Biogas is made by fermenting animal and vegetable waste.

(a) The table shows the percentage composition of the gases present in a sample of biogas.

substance present	percentage present in biogas
carbon dioxide	28.5
hydrogen	1.0
methane	62.0
nitrogen	
water vapour	2.4
other substances	0.1
total	100.0

Deduce the percentage of nitrogen present in this sample of biogas.

..... [1]

(b) (i) Balance the chemical equation for the complete combustion of methane.

$$CH_4 + ...O_2 \rightarrow CO_2 + ...H_2O$$ [2]

(ii) Which **one** of these compounds belongs to the same homologous series as methane?

Draw a circle around the correct answer.

methanoic acid **methanol** **propane** **propanol** **propene** [1]

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(iii) Methane is present in the refinery gas fraction produced by the fractional distillation of petroleum.

Match the fractions on the left with their uses on the right.
The first one has been done for you.

fraction	use
refinery gas	making roads
fuel oil fraction	making chemicals
bitumen	fuel for heating and cooking
naphtha fraction	fuel for ships

[2]

(c) (i) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen.

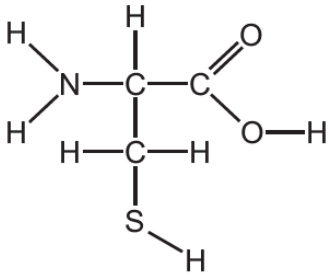
[1]

(ii) State **one** use of hydrogen.

..... [1]

(d) The biogas contains a small amount of compound **C**.

The structure of compound **C** is shown.



(i) On the structure shown, draw a circle around the carboxylic acid functional group. [1]

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(ii) How many different types of atoms are present in compound **C**?

..... [1]

(e) Describe the manufacture of ethanol by fermentation.
In your answer include:

- the names of the substances needed for fermentation
- the conditions needed for fermentation.

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..... [4]

[Total: 14]

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2. 0620/32/O/N/19/No.2

Biogas is made by fermenting animal and vegetable waste.

(a) The table shows the percentage composition of the gases present in a sample of biogas.

substance present	percentage present in biogas
carbon dioxide	
hydrogen	1.0
methane	61.5
nitrogen	8.5
water vapour	2.2
other substances	0.1
total	100.0

Deduce the percentage of carbon dioxide present in this sample of biogas.

..... [1]

(b) **(i)** During the fermentation, carbon dioxide reacts with hydrogen to produce methane and water.

Complete the chemical equation for this reaction.

$$CO_2 + ...H_2 \rightarrow CH_4 + ...H_2O$$ [2]

(ii) Methane and ethane are in the same homologous series.

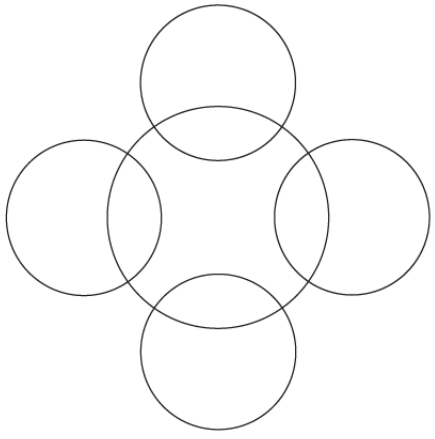
What is meant by the term *homologous series*?

.....

.....

..... [2]

(iii) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of methane, CH_4. Show outer shell electrons only.



[2]

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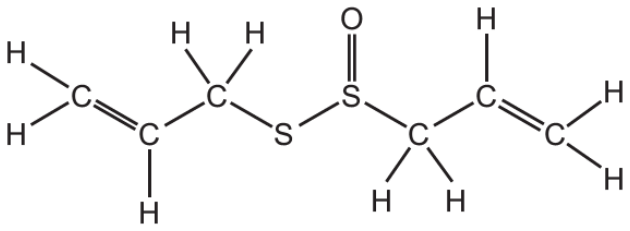
(c) Helium and hydrogen can both be used to fill balloons.

Suggest **one** advantage of using helium rather than hydrogen to fill balloons.

..... [1]

(d) The biogas fermentation mixture contains a small amount of compound **C**.

The structure of compound **C** is shown.



(i) On the structure shown, draw a circle around a functional group which reacts with aqueous bromine. [1]

(ii) How many different types of atoms are present in compound **C**?

..... [1]

(e) Ethanol is produced by fermentation of a mixture of plant sugars.

Describe how ethanol can be separated from the rest of the fermentation mixture by fractional distillation.
In your answer:

- describe how to do the fractional distillation
- explain how ethanol is separated from the rest of the fermentation mixture using fractional distillation.

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.....

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..... [4]

[Total: 14]

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3. 0620/33/O/N/19/No.2

Biogas is made by fermenting animal and vegetable waste.

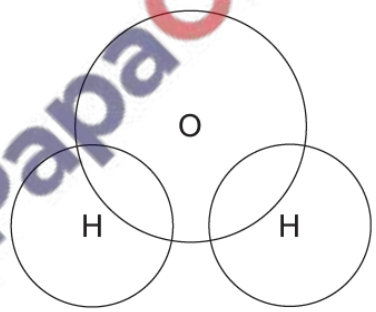
(a) The table shows the percentage composition of the gases present in a sample of biogas.

substance present	percentage present in biogas
carbon dioxide	36.8
hydrogen	0.6
methane	54.5
nitrogen	6.5
water vapour	
other substances	0.1
total	100.0

(i) Deduce the percentage of water vapour present in this sample of biogas.

..... [1]

(ii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of water. Show outer shell electrons only.



[2]

(iii) Describe a chemical test for water.

test .....

observation .....

[2]

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(b) (i) Balance the chemical equation for the oxidation of methane to form hydrogen.

$$.....CH_4 + O_2 \rightarrow 2CO + ...H_2$$ [2]

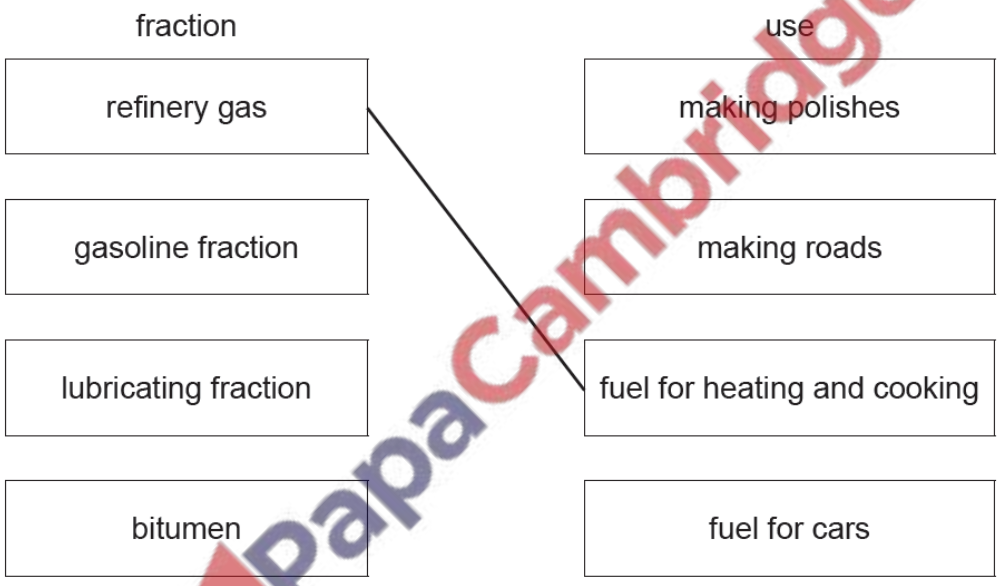
(ii) Which **one** of these compounds belongs to the same homologous series as methane?

Draw a circle around the correct answer.

butane **butene** **methanoic acid** **methanol** [1]

(c) Methane is present in the refinery gas fraction produced by the fractional distillation of petroleum.

(i) Match the fractions on the left with their uses on the right.
The first one has been done for you.



[2]

(ii) Describe the fractional distillation of petroleum.
In your answer:

- state the physical property on which the separation of the fractions depends
- describe how the distillation is done to separate the fractions.

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..... [3]

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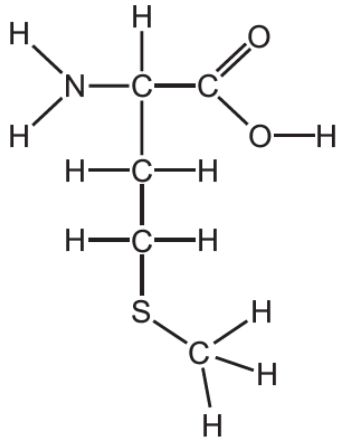
(d) The biogas fermentation mixture contains a small amount of compound **M**.

The structure of compound **M** is shown.



(i) On the structure shown, draw a circle around the carboxylic acid functional group. [1]

(ii) How many different types of atoms are present in compound **M**?

..... [1]

[Total: 15]

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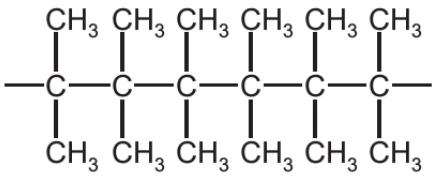
4. 0620/41/O/N/19/No.5

(a) Part of the structure of synthetic polymer **A** is shown.



(i) What type of synthetic polymer is **A**?

..... [1]

(ii) Deduce the empirical formula of polymer **A**.

..... [1]

(iii) Draw the structure of the monomer from which polymer **A** is made.

[2]

(b) The formula C_4H_{10} represents two different structural isomers.

(i) What is meant by the term *structural isomers*?

.....

.....

..... [2]

(ii) Draw the structures of **two** structural isomers with the formula C_4H_{10}.
Show all of the atoms and all of the bonds.

[2]

(iii) All structural isomers of C_4H_{10} are flammable.

Write a chemical equation for the **incomplete** combustion of C_4H_{10}.

..... [2]

[Total: 10]

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5. 0620/42/O/N/19/No.5

Methanol, CH_3OH, is a member of the homologous series of alcohols.

(a) Methanol can be made from methane in a two-step process.

step 1 Methane is reacted with chlorine gas to produce chloromethane, CH_3Cl.

step 2 CH_3Cl is reacted with sodium hydroxide to produce CH_3OH and one other product.

(i) What conditions are needed in **step 1**?

..... [1]

(ii) Write the chemical equation for the reaction which occurs in **step 1**.

..... [1]

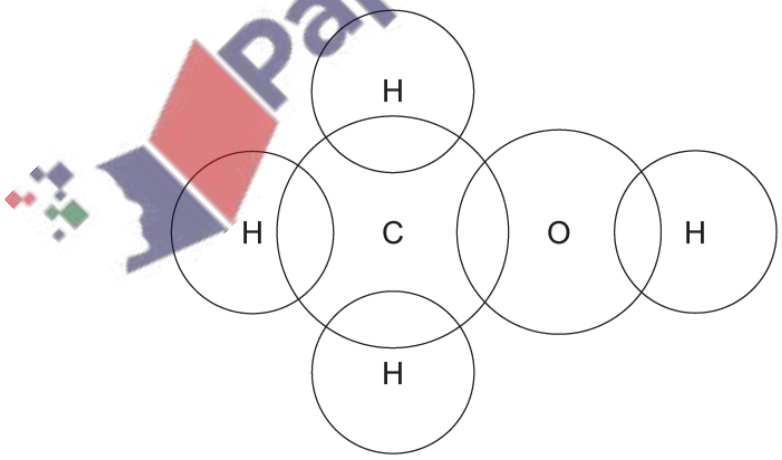
(iii) State the type of organic reaction occurring in **step 1**.

..... [1]

(iv) Complete the chemical equation for **step 2**.

$$CH_3Cl + NaOH \rightarrow CH_3OH + \text{.....}$$ [1]

(b) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of methanol. Show outer shell electrons only.



[2]

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(c) Methanol reacts with propanoic acid to form an ester with a molecular formula $C_4H_8O_2$.

(i) Name the ester formed when methanol reacts with propanoic acid.

..... [1]

(ii) Name **one** other substance formed when methanol reacts with propanoic acid.

..... [1]

(iii) Draw the structure of an ester which is a structural isomer of the ester named in **(c)(i)**. Show all of the atoms and all of the bonds.

[3]

(iv) State the conditions needed to form an ester from a carboxylic acid and an alcohol.

..... [1]

[Total: 12]

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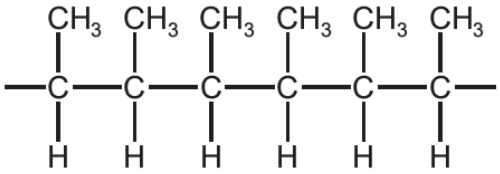
6. 0620/43/O/N/19/No.7

Addition polymerisation and condensation polymerisation are two types of polymerisation.

(a) Which functional group is present in all the monomers which are used to make addition polymers?

..... [1]

(b) Part of an addition polymer is shown.



(i) How many monomer units are needed to make the part of the addition polymer shown?

..... [1]

(ii) Draw the structure of the monomer that is used to make this addition polymer. Show all of the atoms and all of the bonds.

Name the monomer.

name .....
[2]

(iii) State the empirical formula of:

the monomer .....

the polymer. .....
[2]

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(c) Complex carbohydrates are natural condensation polymers. They can be broken down into colourless monomers which can then be separated and identified.

X is a complex carbohydrate.

Starting with a sample of **X**, describe how to produce, separate, detect and identify the monomers which make it up.

Your answer should include:

- the name of the process used to break down **X** into its monomers
- **two** types of substance that can be used to break down **X**
- the name of the process used to **separate** the monomers
- the method used to **detect** the monomers after they have been separated
- the method used to **identify** the monomers after they have been separated and detected.

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..... [6]

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(d) Synthetic polyamides are condensation polymers.

(i) Name a synthetic polyamide.

..... [1]

(ii) Synthetic polyamides can be made by reacting carboxylic acids with amines.

Name the other substance that is produced in this reaction.

..... [1]

[Total: 14]