FOR OFFICIAL USE

N5

National Qualifications 2017

Mark

X713/75/01

Chemistry
Section 1 — Answer Grid And Section 2

MONDAY, 8 MAY

1:00 PM – 3:00 PM

X7137501

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 80

SECTION 1 — 20 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on *Page 02*.

SECTION 2 — 60 marks

Attempt ALL questions.

You may refer to the Chemistry Data Booklet for National 5.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

X7137501 01

SECTION 1 — 20 marks

The questions for Section 1 are contained in the question paper X713/75/02.

Read these and record your answers on the answer grid on *Page 03* opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

2. There is **only one correct** answer to each question.

3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample Question

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

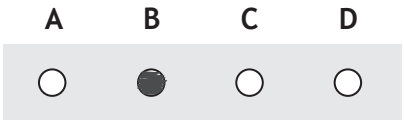
A fractional distillation

B chromatography

C fractional crystallisation

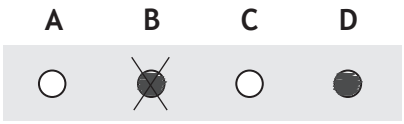
D filtration.

The correct answer is **B** — chromatography. The answer **B** bubble has been clearly filled in (see below).

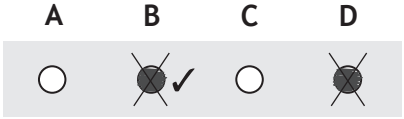


Changing an answer

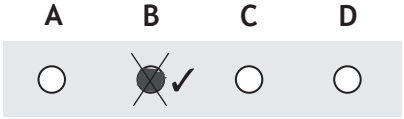
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:



or



SECTION 1 — Answer Grid

0BJ20AD1

	A	B	C	D
1	○	○	○	○
2	○	○	○	○
3	○	○	○	○
4	○	○	○	○
5	○	○	○	○
6	○	○	○	○
7	○	○	○	○
8	○	○	○	○
9	○	○	○	○
10	○	○	○	○
11	○	○	○	○
12	○	○	○	○
13	○	○	○	○
14	○	○	○	○
15	○	○	○	○
16	○	○	○	○
17	○	○	○	○
18	○	○	○	○
19	○	○	○	○
20	○	○	○	○

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SECTION 2 —60 marks

Attempt ALL questions

1. A sample of argon contains three types of atom.

$^{36}_{18}Ar$ $^{38}_{18}Ar$ $^{40}_{18}Ar$

(a) State the term used to describe these different types of argon atom. **1**

(b) Explain why the mass number of each type of atom is different. **1**

(c) This sample of argon has an average atomic mass of 36·2.

State the mass number of the most common type of atom in the sample of argon. **1**

[Turn over

2. Read the passage below and attempt the questions that follow.

Hydrogen Storage

The portable storage of hydrogen (H_2) is key to the development of hydrogen fuel cell cars. While many chemists focus their attention on the use of metal alloys and hydrides for storing hydrogen, others have investigated the potential use of carbon nanotubes.

A carbon nanotube is a tiny rolled up sheet of graphite. A research team has designed a pillared structure made up of vertical columns of carbon nanotubes which stabilise parallel graphene sheets. Graphene sheets are layers of carbon which are one atom thick.

Lithium atoms are added to the pillared structure to increase the hydrogen storage capacity. Researchers claim that one litre of the structure can store 41 g of hydrogen gas, which comes close to the US Department of Energy's target of 45 g.

Adapted from *InfoChem Magazine* (RSC), Nov 2008

(a) Name the term used to describe a tiny rolled up sheet of graphite. **1**

(b) Name the metal added to the pillared structure to increase the hydrogen storage capacity. **1**

(c) Calculate the number of moles of hydrogen that, researchers claim, can be stored by one litre of this structure. **2**

Show your working clearly.

[Turn over for next question

DO NOT WRITE ON THIS PAGE

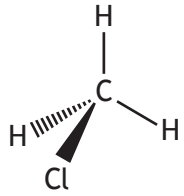
3. Chlorine can form covalent and ionic bonds.

(a) Chlorine gas is made up of diatomic molecules.

Draw a diagram, showing all outer electrons, to represent a molecule of chlorine, Cl_2. **1**

(b) Chloromethane is a covalent gas with a faint sweet odour.

The structure of a chloromethane molecule is shown.



State the name used to describe the shape of a molecule of chloromethane. **1**

3. (continued)

(c) When chlorine reacts with sodium the ionic compound sodium chloride is formed.

A chloride ion has a stable electron arrangement.

Describe how a chlorine atom achieves this stable electron arrangement. **1**

(d) Covalent and ionic compounds have different physical properties.

Complete the table by circling the words which correctly describe the properties of the two compounds. **2**

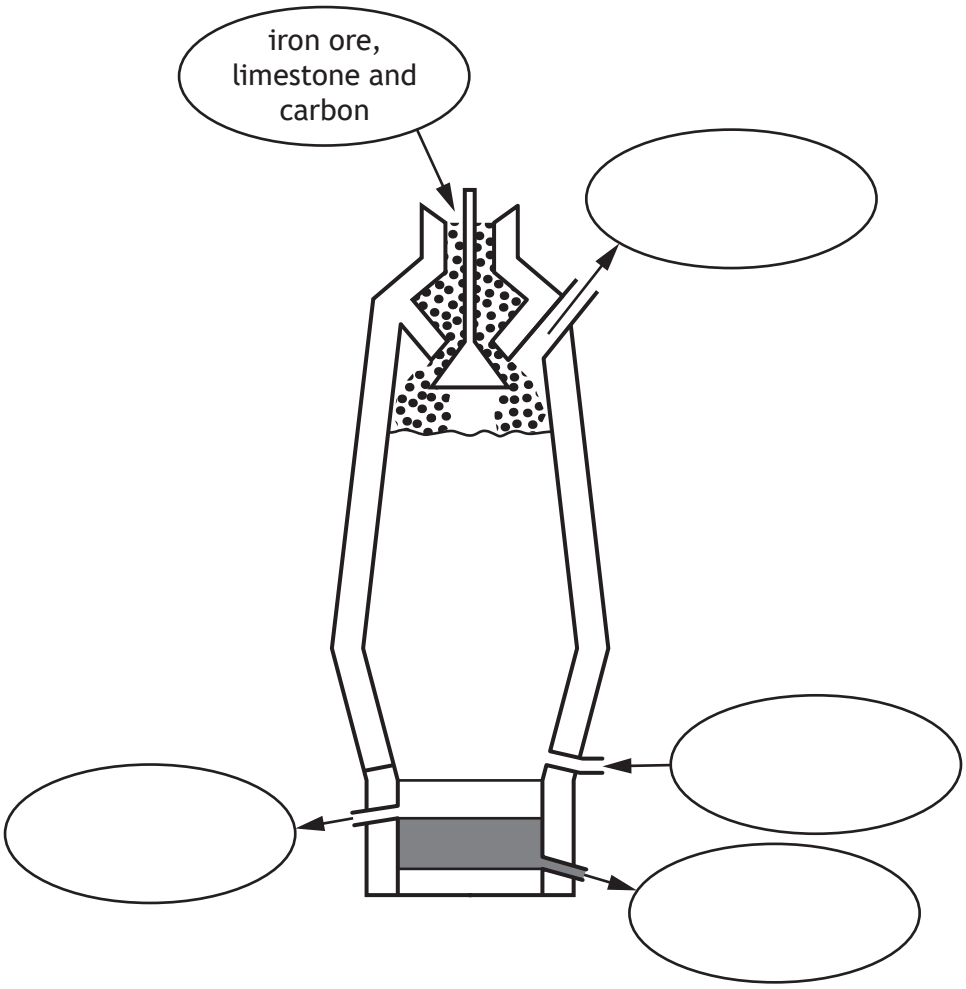
Compound	*Melting point*	*Conductor of electricity*
chloromethane gas	high / low	yes / no
solid sodium chloride	high / low	yes / no

[Turn over

4. Iron is produced from iron ore in a blast furnace.

(a) Iron ore, limestone and carbon are added at the top of the blast furnace. Hot air is blown in near the bottom of the furnace and, through a series of chemical reactions, iron is produced. Waste gases are released near the top of the furnace. A layer of impurities is also produced which floats on top of the iron. The iron and impurities both flow off separately at the bottom of the furnace.

(i) Use this information to complete the diagram. **2**



4. (a) (continued)

(ii) Explain why the temperature at the bottom of the blast furnace should not drop below 1538 °C. **1**

You may wish to use the data booklet to help you.

(b) Rusting occurs when iron is exposed to air and water.

During rusting, iron initially loses two electrons to form iron(II) ions. These ions are further oxidised to form iron(III) ions.

Write an ion-electron equation to show iron(II) ions forming iron(III) ions. **1**

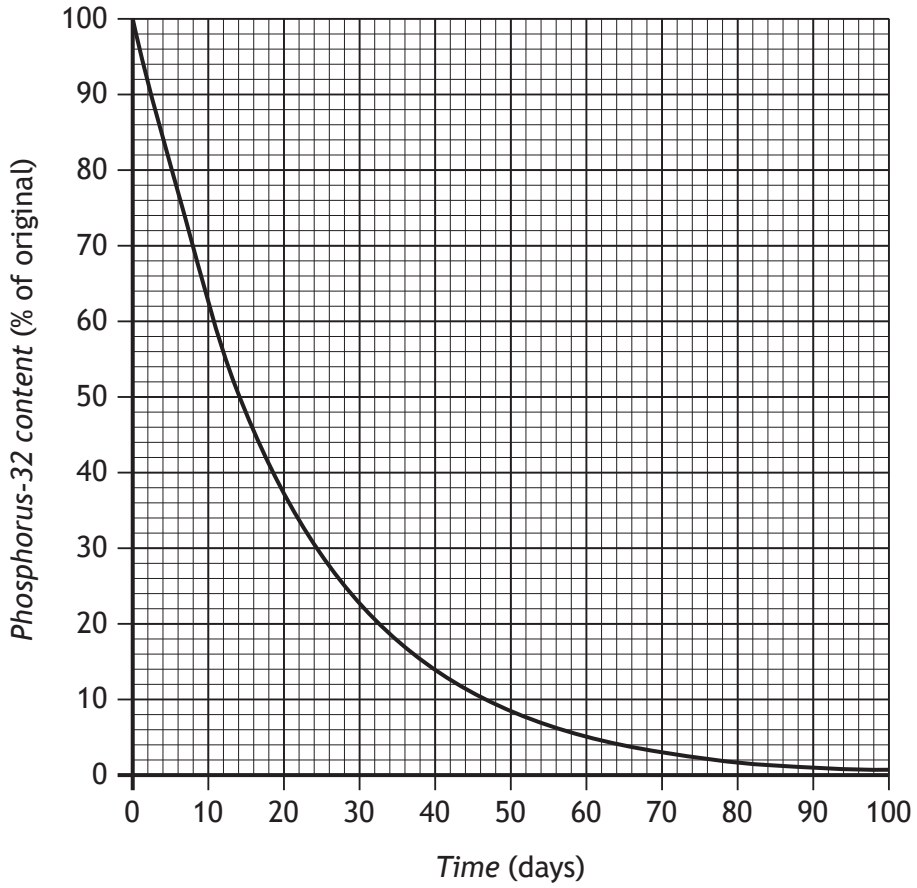
You may wish to use the data booklet to help you.

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

5. Phosphorus-32 is a radioisotope used in the detection of cancerous tumours.

(a) The graph shows how the percentage of phosphorus-32 in a sample changes over a period of time.



(i) Using the graph, calculate the half-life, in days, of phosphorus-32. **1**

(ii) Using your answer to part (a) (i), calculate the time, in days, it would take for the mass of a 20 g sample of the radioisotope to decrease to 2·5 g. **2**

(b) Phosphorus-32 decays by emitting radiation.

During this decay the atomic number increases by 1.

Name the type of radiation emitted when phosphorus-32 decays. **1**

6. A student wanted to investigate whether copper could be used as a catalyst for the reaction between zinc and sulfuric acid.

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

Using your knowledge of chemistry, suggest how the student could investigate this. **3**

[Turn over

7. Carboxylic acids can be used in household cleaning products.

(a) Name the functional group found in all carboxylic acids. **1**

(b) Carboxylic acids have a range of physical and chemical properties. Melting point is an example of a physical property.

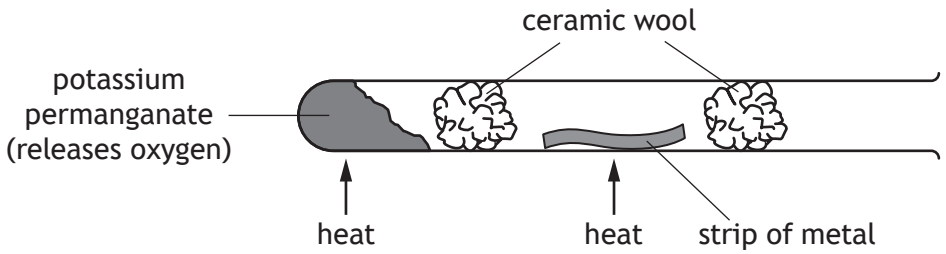
The table gives information about propanoic acid and butanoic acid.

Carboxylic acid	*Melting point* (°C)
propanoic acid	–21
butanoic acid	–5

(i) Draw a structural formula for butanoic acid. **1**

(ii) Explain why butanoic acid has a higher melting point than propanoic acid. **2**

8. A teacher demonstrated the following experiment.



The results are shown in the table.

Metal	*Observation*
zinc	glowed brightly
copper	dull red glow
silver	no reaction

(a) (i) Describe what would be observed if the experiment was repeated using magnesium. **1**

(ii) The teacher repeated the experiment using copper powder.

State the effect this would have on the rate of the reaction between copper and oxygen. **1**

(b) Magnesium also reacts with steam to produce magnesium oxide and hydrogen gas.

$$Mg(s) + H_2O(g) \longrightarrow MgO(s) + H_2(g)$$

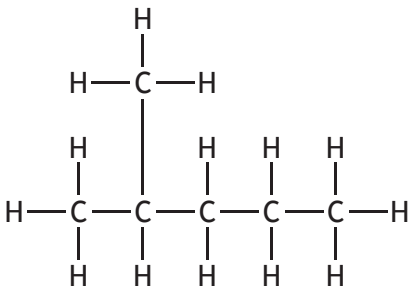
Identify the substance which is being oxidised. **1**

[Turn over

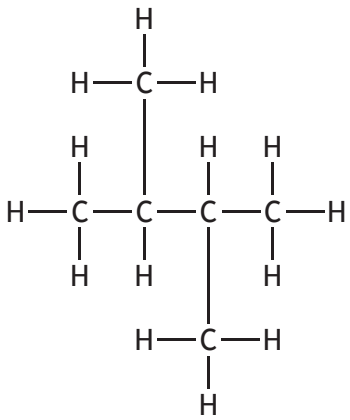
9. The alkanes are a homologous series of saturated hydrocarbons.

(a) State what is meant by the term homologous series. **1**

(b) The structural formula of two alkanes is shown.



2-methylpentane



2,3-dimethylbutane

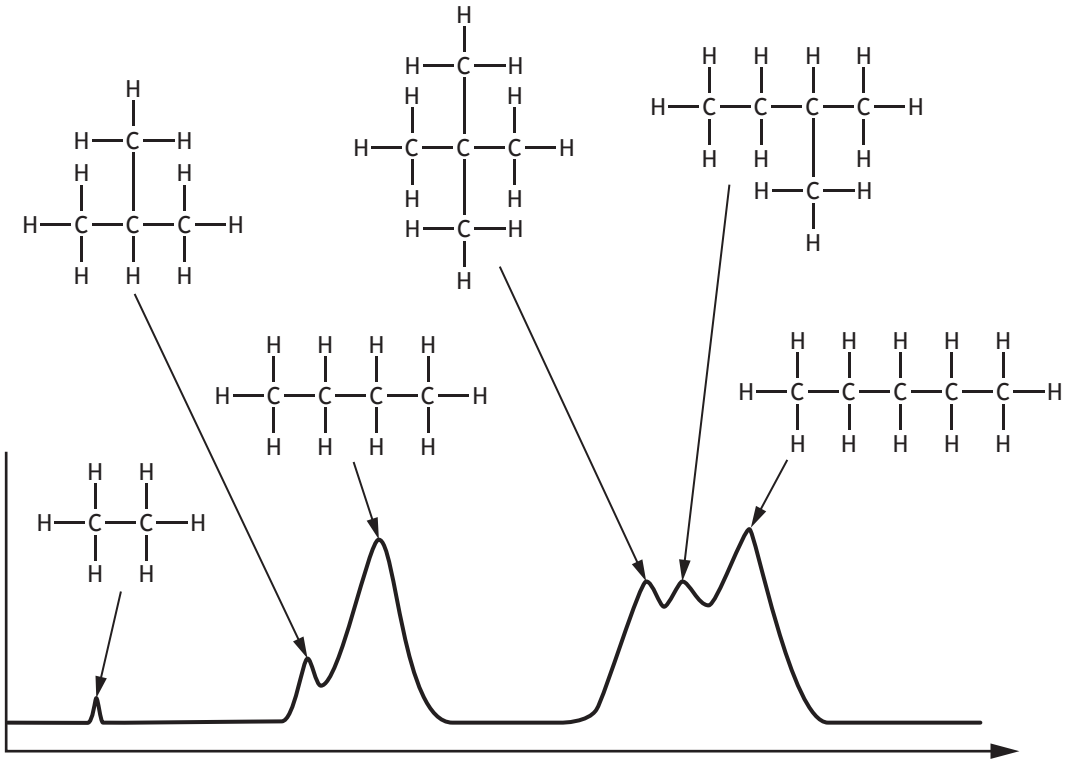
State the term used to describe a pair of alkanes such as 2-methylpentane and 2,3-dimethylbutane. **1**

MARKS

DO NOT WRITE IN THIS MARGIN

(c) The alkanes present in a mixture were separated using a technique known as HPLC. The mixture was vaporised and then passed through a special column. Different alkanes take different amounts of time to pass through the column.

The results are shown.



Time taken to pass through the column

(i) Write a general statement linking the structure of the alkane to the length of time taken to pass through the column. **1**

(ii) Propane was added to the mixture and the HPLC technique was repeated.

Draw an arrow on the graph to show the expected time taken for propane to pass through the column. **1**

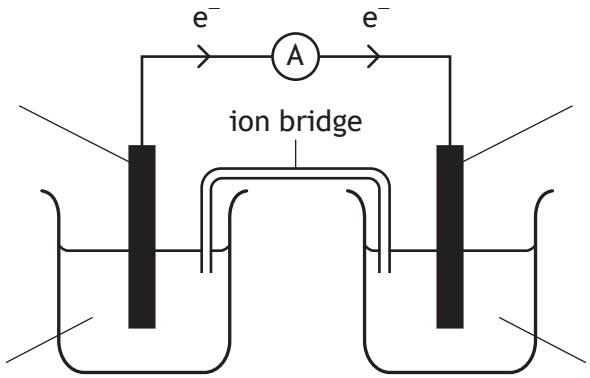
(An additional diagram, if required, can be found on *Page 27*.)

10. A student set up an electrochemical cell using aluminium and copper electrodes as well as aluminium sulfate solution and copper(II) sulfate solution.

(a) (i) Complete the labels on the diagram to show the electrochemical cell which would give the direction of electron flow indicated. **1**

You may wish to use the data booklet to help you.

(An additional diagram, if required, can be found on *Page 27*.)



(ii) The two reactions which take place in the cell are

$$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$$

$$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$$

Write the redox equation for the overall reaction. **1**

(b) Calculate the percentage by mass of aluminium in aluminium sulfate, $Al_2(SO_4)_3$. **3**

Show your working clearly.

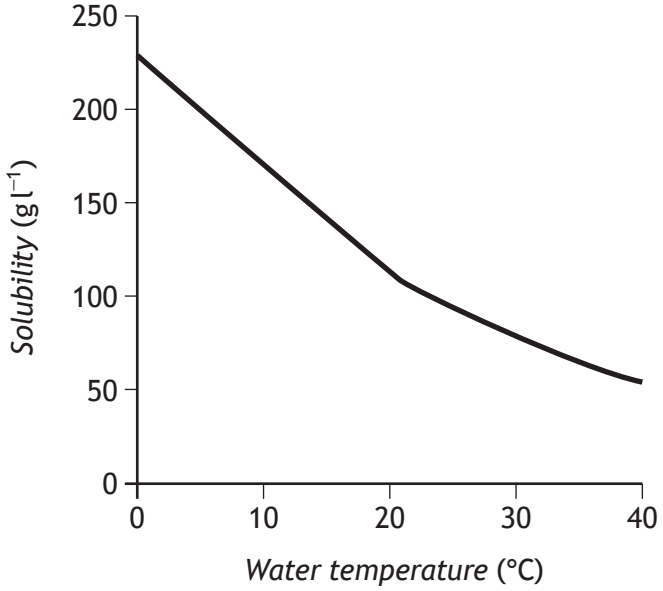
11. Sulfur dioxide is an important industrial chemical.

Sulfur dioxide dissolves in water to produce sulfurous acid.

$$SO_2(g) + H_2O(\ell) \longrightarrow H_2SO_3(aq)$$

(a) Explain the change in the pH of the solution as sulfur dioxide dissolves. **2**

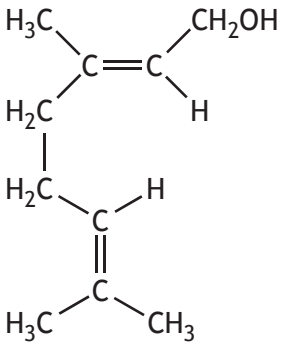
(b) The graph shows the solubility of sulfur dioxide at different temperatures.



Describe the general trend in solubility as the temperature of the water increases. **1**

[Turn over

12. Geraniol is an essential oil known to have anti-inflammatory properties. A structure for the geraniol molecule is shown.



(a) Circle a functional group found in the geraniol molecule. **1**

(An additional diagram, if required, can be found on *Page 28*.)

12. (continued)

(b) One of the compounds used to flavour foods is geranyl propanoate.

Name the family to which geranyl propanoate belongs. **1**

(c) A student prepared a sample of geranyl propanoate from geraniol and propanoic acid.

$$\text{geraniol} + \text{propanoic acid} \longrightarrow \text{geranyl propanoate} + \text{water}$$

$$C_{10}H_{18}O + C_3H_6O_2 \longrightarrow C_{13}H_{22}O_2 + H_2O$$

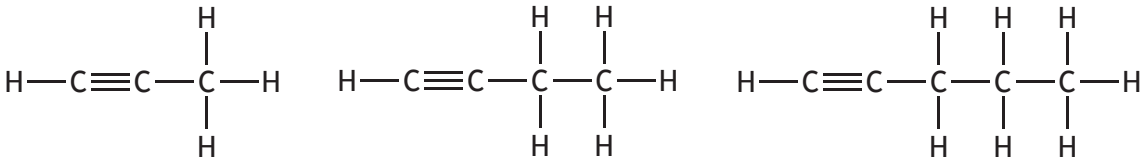
15·4 g of geraniol was reacted with excess propanoic acid.

Calculate the mass, in grams, of geranyl propanoate which would be produced. **3**

Show your working clearly.

[Turn over

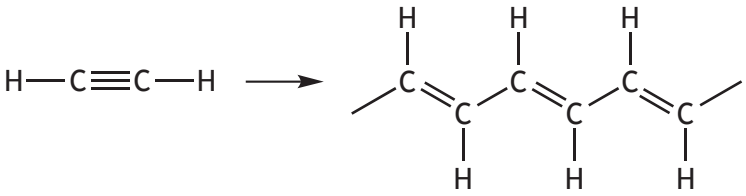
13. The alkynes are a family of hydrocarbons which contain a carbon to carbon triple bond. Three members of this family are shown.



propyne but-1-yne pent-1-yne

(a) Suggest a general formula for the alkyne family. **1**

(b) Ethyne can undergo polymerisation to form poly(ethyne).



(i) Draw the repeating unit in the polymer poly(ethyne). **1**

(ii) Name the type of polymerisation taking place when ethyne is converted to poly(ethyne). **1**

MARKS

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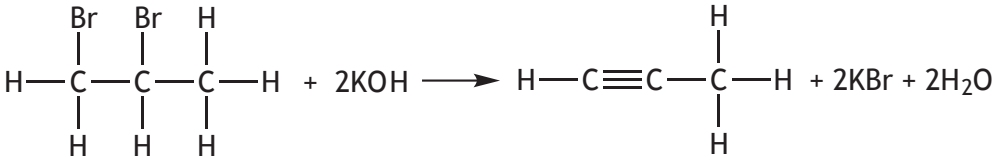
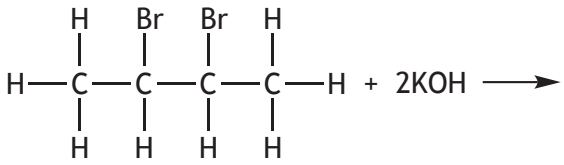
(c) Alkynes can be prepared by reacting a dibromoalkane with potassium hydroxide solution.



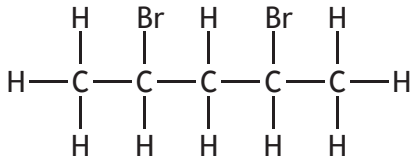
1,2-dibromopropane propyne

(i) Draw the **full** structural formula for the alkyne formed when 2,3-dibromobutane reacts with potassium hydroxide. **1**



2,3-dibromobutane

(ii) The structure for 2,4-dibromopentane is shown below.

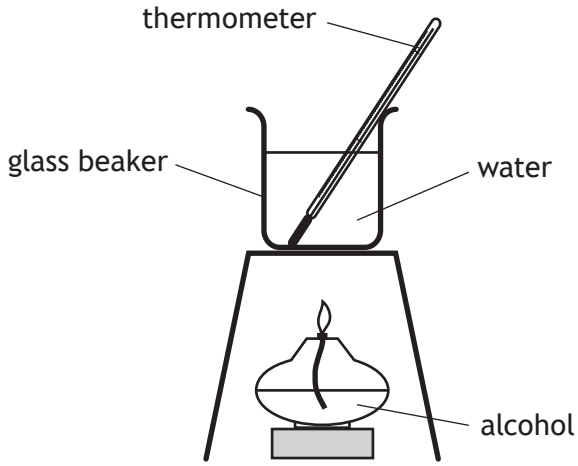


2,4-dibromopentane

Suggest a reason why 2,4-dibromopentane does **not** form an alkyne when it is added to potassium hydroxide solution. **1**

[Turn over

14. (a) A group of students carried out an experiment to measure the energy produced when 5 g samples of different alcohols were burned.



The results are shown.

Alcohol	*Energy released* (kJ)
propan-1-ol	158
butan-1-ol	170
pentan-1-ol	179
hexan-1-ol	185

(i) Draw a structural formula for hexan-1-ol. **1**

(ii) Predict the energy released, in kJ, if the same mass of heptan-1-ol was burned. **1**

14. (continued)

(b) The energy released when an alcohol burns can be used to heat liquids other than water.

The data below was collected when the energy released, by burning an alcohol, was used to heat a sodium chloride solution.

Energy released when the alcohol was burned (kJ)	13·3
Initial temperature of sodium chloride solution (°C)	15
Final temperature of sodium chloride solution (°C)	49
Mass of sodium chloride solution heated (g)	100

Calculate the specific heat capacity, in $kJ\,kg^{-1}\,°C^{-1}$, of the sodium chloride solution. **3**

You may wish to use the data booklet to help you.

Show your working clearly.

[Turn over for next question

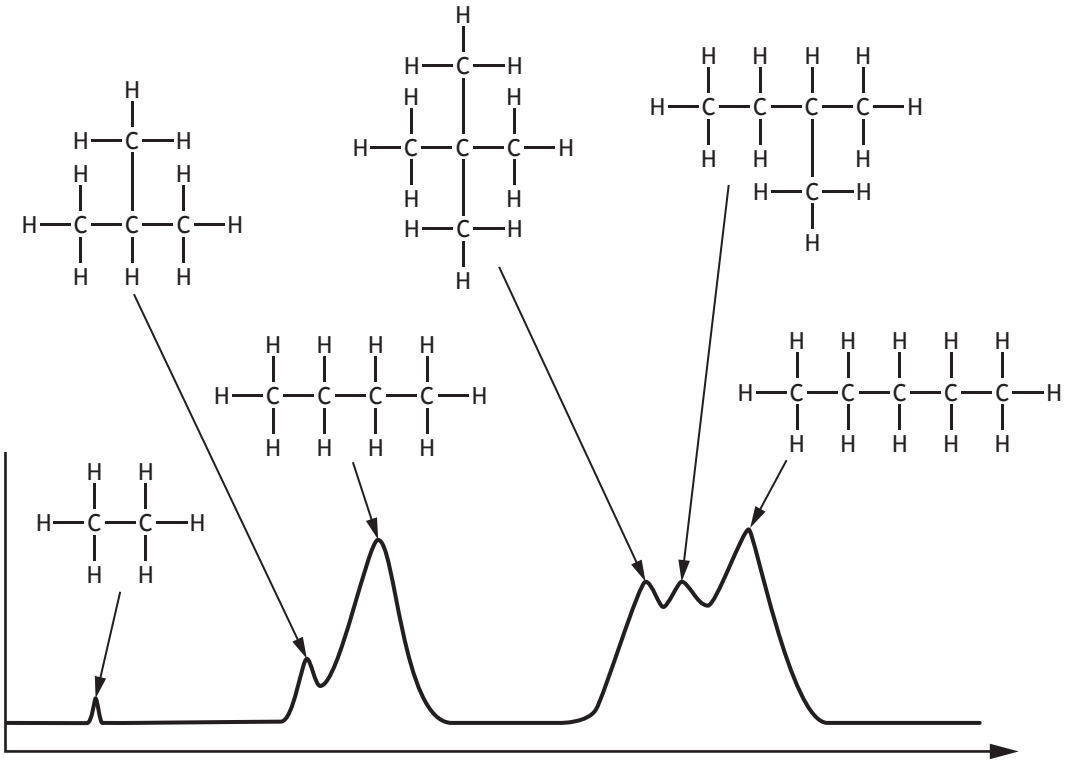
15. A student was given two solutions of sodium carbonate, one solution with a concentration of 0·1 mol l^{-1} and the other with a concentration of 0·2 mol l^{-1}.

Using your knowledge of chemistry, suggest how the student could distinguish between the solutions. **3**

[END OF QUESTION PAPER]

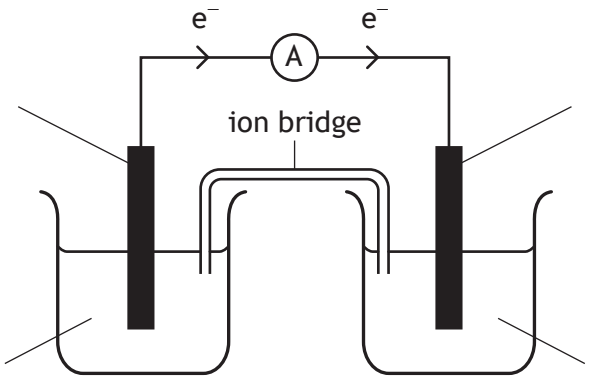
ADDITIONAL SPACE FOR ANSWERS

Additional diagram for Question 9 (c) (ii)



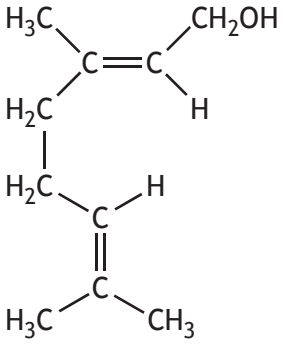
Time taken to pass through the column

Additional diagram for Question 10 (a) (i)



ADDITIONAL SPACE FOR ANSWERS

Additional diagram for Question 12 (a)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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