FOR OFFICIAL USE

N5

National Qualifications 2024

Mark

X813/75/01

Chemistry
Section 1 — Answer grid and Section 2

THURSDAY, 23 MAY
1:00 PM – 3:30 PM

X8137501

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 — 100

SECTION 1 — 25 marks
Attempt ALL questions.
Instructions for the completion of Section 1 are given on *page 02*.

SECTION 2 — 75 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 ©

X8137501 01

SECTION 1 — 25 marks

The questions for Section 1 are contained in the question paper X813/75/02.

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

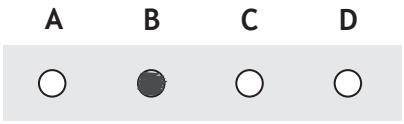
A fractional distillation

B chromatography

C fractional crystallisation

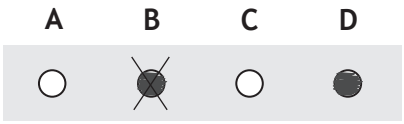
D filtration.

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

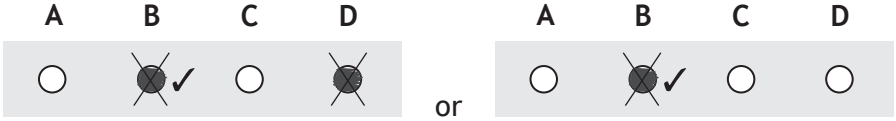


Changing an answer

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:



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You must record your answers to Section 1 questions on the answer grid on **page 03** of your **answer booklet.**

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SECTION 2 — 75 marks

Attempt ALL questions

1. A decomposition reaction occurs when one reactant breaks down to form two or more products.

(a) The equation for the decomposition of hydrogen peroxide is shown.

$$H_2O_2 \rightarrow H_2O + O_2$$

(i) Balance the above equation. **1**

(ii) The rate of this reaction can be increased by the addition of manganese(IV) oxide.

The manganese(IV) oxide can be recovered unchanged at the end of the reaction.

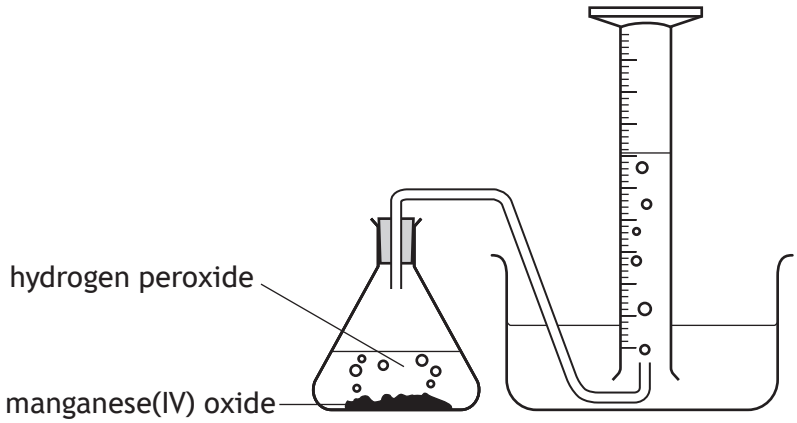
State the role of manganese(IV) oxide in this reaction. **1**

[Turn over

1. (a) (continued)

(iii) A student was asked to calculate the average rate of reaction for the decomposition of hydrogen peroxide using manganese(IV) oxide.

The equipment shown was used to collect and measure the volume of gas produced.



(A) State the property of oxygen gas that allows it to be collected by this method. **1**

(B) The student calculated the average rate of reaction to be 1.2 $cm^3 s^{-1}$ for the first 30 seconds of the reaction.

Calculate the volume of gas, in cm^3, collected in the measuring cylinder after 30 seconds. **2**

(C) Predict the average rate of reaction, in $cm^3 s^{-1}$, for this experiment between 60 and 90 seconds. **1**

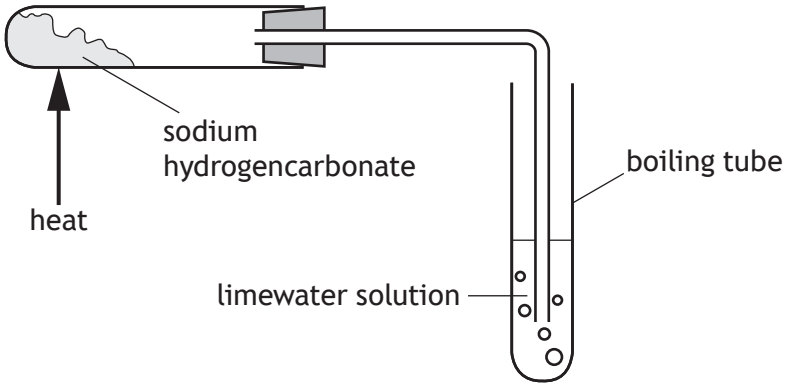
1. **(continued)**

(b) Sodium hydrogencarbonate, $NaHCO_3$, decomposes when heated above 80 °C.

The equation for this reaction is

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(\ell) + CO_2(g)$$

A teacher set up the following experiment to demonstrate the reaction to a class.



(i) Describe the change that would be observed as the gas produced is bubbled through the solution in the boiling tube. **1**

(ii) Sodium hydrogencarbonate can also react with citric acid in a chemical reaction that takes in heat energy.

State the term used to describe all chemical reactions that take in heat energy. **1**

[Turn over

2. Ammonia, NH_3, is a widely used compound.

(a) (i) State the term used to describe the shape of the ammonia molecule. **1**

(ii) Draw a diagram, showing **all** outer electrons, to represent a molecule of ammonia, NH_3. **1**

(b) Ammonia is a reactant in the Ostwald process.

Name the product made by the Ostwald process. **1**

2. (continued)

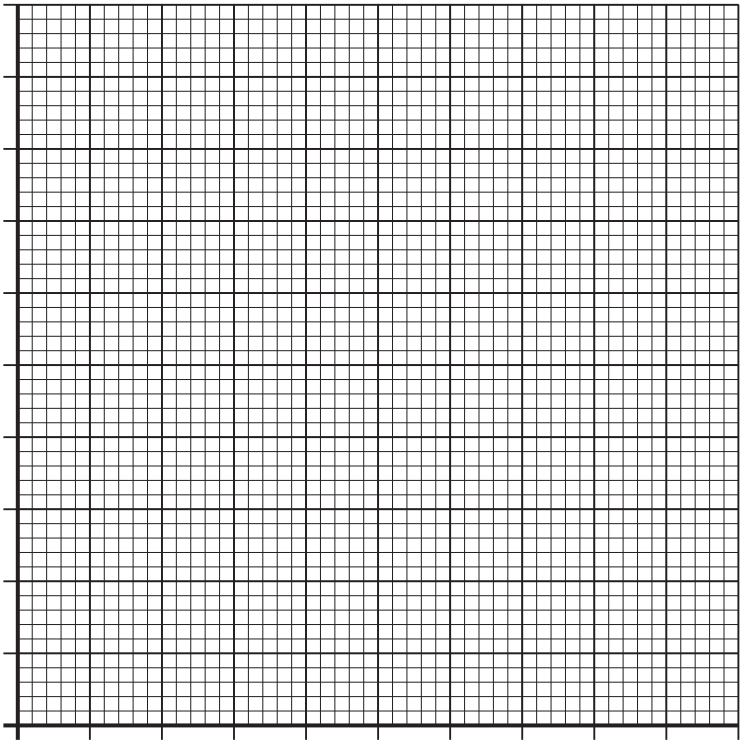
(c) Ammonia is a greenhouse gas that is released from animal waste and fertilisers.

The table shows some sources of ammonia.

Source of ammonia	Percentage (%)
Poultry	15
Fertiliser use	23
Beef cattle	20
Dairy cattle	28
Other	14

Draw a graph showing the information in the table. **4**

(Additional graph paper, if required, can be found on *page 32*.)

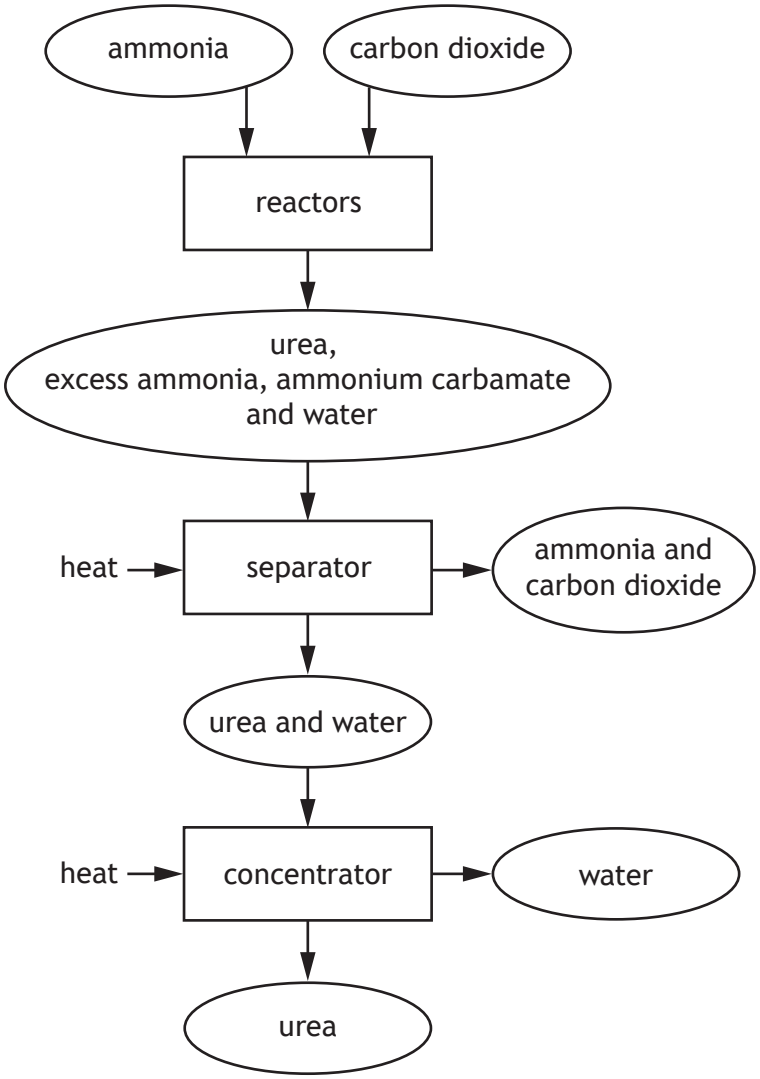


[Turn over

2. (continued)

(d) Ammonia can also be used to make the fertiliser urea, as shown in the flow diagram below.

On the flow diagram, draw an arrow to show how the process could be made more economical. **1**



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3. Read the passage and answer the questions that follow.

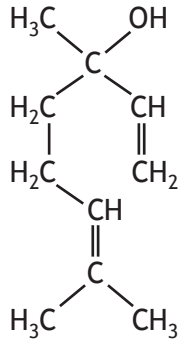
Lavender oils

There are many types of lavender oil that can be extracted from lavender plants. These oils are known as essential oils.

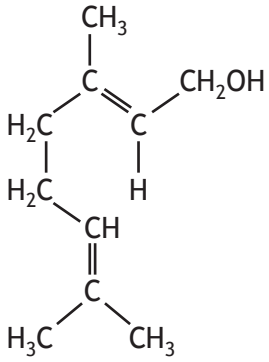
Lavender flower oil is colourless and insoluble in water. It has a density of 0.885 g cm^{-3} and a boiling point of 204 °C. It smells sweet and is used in perfume.

Lavender spike oil is pale yellow and soluble in water. It has a density of 0.905 g cm^{-3} and a boiling point of 183 °C. It has a sharp smell and is used as a solvent for paints.

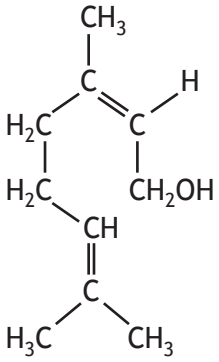
Essential oils are complex mixtures of chemicals. The structures of three chemicals found in lavender oils are shown with their boiling point, density and gram formula mass, *GFM*.



linalool
198 °C
0.900 g cm^{-3}
GFM = 154



geraniol
230 °C
0.889 g cm^{-3}
GFM = 154



nerol
225 °C
0.881 g cm^{-3}
GFM = 154

(a) State the term used to describe oils such as lavender oil. **1**

(b) Complete the table for the two types of lavender oil. **2**

	Lavender flower oil	Lavender spike oil
Density (g cm^{-3})		
Boiling point (°C)		

3. (continued)

(c) State the type of lavender oil that could be sold as an aqueous solution. **1**

(d) Describe the chemical test, including the result, to show that linalool, geraniol and nerol are all unsaturated. **1**

(e) Explain why geraniol has a higher boiling point than linalool and nerol. **2**

(f) The relationship used to calculate mass from density and volume is

$$\text{mass (g)} = \text{density (g cm}^{-3}\text{)} \times \text{volume (cm}^3\text{)}$$

Calculate the mass, in grams, of 3 cm^3 of nerol. **2**

Show your working clearly.

[Turn over

4. Alcohols are a family of compounds.

(a) State the term used to describe a family of compounds that share a general formula and have similar chemical properties. **1**

(b) The boiling points of some alcohols are given in the table.

Name	Boiling point (°C)
Methanol	65
Ethanol	78
Propan-1-ol	97
Butan-1-ol	118
Pentan-1-ol	

(i) Predict the boiling point, in °C, for pentan-1-ol. **1**

(ii) Describe the relationship shown by the data in the table. **1**

4. (continued)

(c) Alcohols can react with acidified potassium dichromate to form carboxylic acids.

(i) Circle the correct words to complete the sentence.

When alcohols react with acidified potassium dichromate the functional group changes from {hydroxyl / carboxyl} to {hydroxyl / carboxyl}. **1**

(ii) An example of this type of reaction is shown.

propan-1-ol → propanoic acid

Draw a structure for the carboxylic acid produced when butan-1-ol reacts with acidified potassium dichromate. **1**

(iii) Write the formula for potassium dichromate, showing the charge on both ions. **1**

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

[Turn over

5. Dmitri Mendeleev produced a Periodic Table of the Elements in 1869.

Using your knowledge of chemistry, comment on how the elements are positioned in the Periodic Table. **3**

6. Copper is a metal found in the Periodic Table.

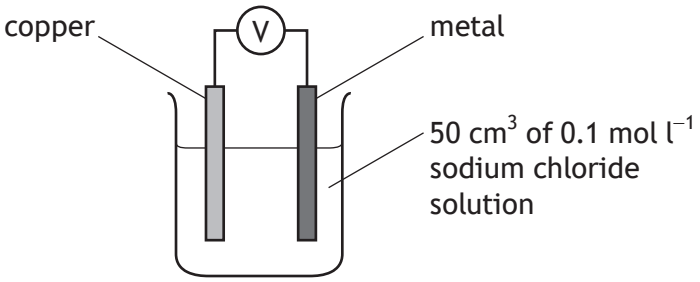
(a) State why the bonding in metal elements, like copper, allows them to conduct electricity. **1**

(b) Suggest how copper can be extracted from its ore. **1**

[Turn over

6. (continued)

(c) The apparatus shown can be used to investigate the size of the voltage produced when copper is paired with different metals in a cell.



The size of the voltage and the direction of electron flow when copper is paired with four different metals is shown in the table.

Metal	Voltage (V)	Direction of electron flow
A	0.6	metal **A** → copper
B	0.2	copper → metal **B**
C	0.9	metal **C** → copper
D	0.1	copper → metal **D**

(i) Using the information in the table arrange **copper** and the metals **A**, **B**, **C**, **D** into an electrochemical series. **2**

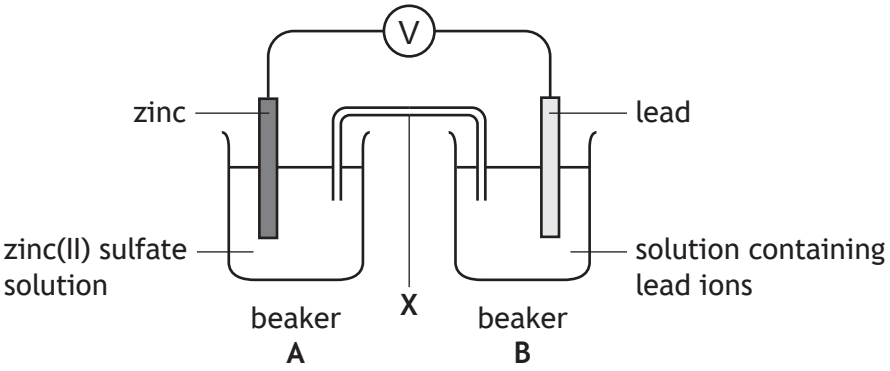
(An additional table, if required, can be found on *page 32*.)

Order in the electrochemical series	Metal
highest ↓ lowest	

6. (c) (continued)

(ii) Explain why glucose solution, $C_6H_{12}O_6$, **cannot** be used instead of sodium chloride solution in the cell. **1**

(d) Another way of producing a voltage is to use two half-cells as shown.



(i) Name the piece of apparatus labelled **X**. **1**

(ii) Suggest a name for a suitable compound that could be used in beaker **B**. **1**

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

[Turn over

7. Read the passage and answer the questions that follow.

Cleaning water — from ground to tap

Water needs to be cleaned before it is safe for drinking. One of the chemicals used to clean water is ozone, O_3, because it kills bacteria and viruses present in the water.

The machine used to produce the ozone operates at a very high voltage and contains multiple electrodes, which produce controlled lightning. This lightning turns oxygen, O_2, into ozone, O_3.

The ozone is added to the water in a tank where it takes around seven minutes to clean the water. Excess ozone is converted back to oxygen, using heat, to prevent it being released into the atmosphere. Ozone is also removed from the water by adding the chemical sodium hydrogensulfite.

One of the final stages in cleaning water is the addition of chlorine to prevent the growth of disease-causing viruses and bacteria. When chlorine is added to water, hypochlorous acid, HOCl, and hydrochloric acid, HCl, are formed.

(a) State why ozone is used to clean water. **1**

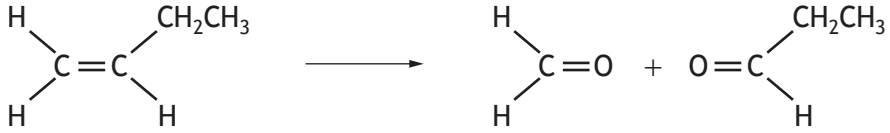
(b) Name the elements found in the chemical added to remove ozone. **1**

(c) Write an equation, using symbols and formulae, to show the reaction that prevents the growth of disease-causing viruses and bacteria. **1**

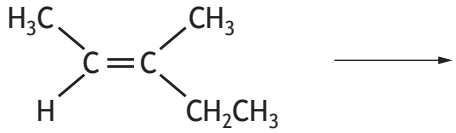
There is no need to balance this equation.

7. (continued)

(d) Alkenes react with ozone, O_3, to make two products as shown.



Draw **both** of the products formed from the reaction of the following alkene. **1**



[Turn over

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8. A primary standard is a chemical that can be used to make a standard solution.

Standard solutions can be used to find the concentration of other chemicals.

(a) Silver nitrate is a primary standard that is used to find the concentration of chloride ions in a sodium chloride solution.

An equation for the reaction of silver nitrate and sodium chloride is shown.

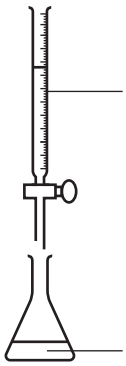
$$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow Ag^+Cl^-(s) + Na^+(aq) + NO_3^-(aq)$$

(i) Write the equation with the spectator ions removed. **1**

(ii) State the type of chemical reaction that takes place between silver nitrate solution and sodium chloride solution. **1**

(b) Oxalic acid, $H_2C_2O_4$, is another primary standard. It can be used to determine the concentration of a sodium hydroxide solution in a titration.

The results of a titration experiment are shown.



	1st titre	2nd titre	3rd titre
Initial burette reading (cm^3)	0.0	16.4	31.9
Final burette reading (cm^3)	16.4	31.9	47.6
Volume used (cm^3)	16.4	15.5	15.7

(i) Name the most appropriate piece of apparatus to measure the 10 cm^3 of sodium hydroxide solution. **1**

(ii) The average volume of oxalic acid that should be used to calculate the sodium hydroxide concentration is 15.6 cm^3.

Explain why only the results of 2nd and 3rd titre are used to calculate this average. **1**

8. (b) (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(iii) The equation for the reaction is

$$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$$

oxalic acid

Using the average volume of oxalic acid as 15.6 cm^3, calculate the concentration, in mol l^{-1}, of the sodium hydroxide solution. **3**

Show your working clearly.

(iv) The indicator used in this titration is called phenolphthalein.

The table below shows some information about the colour of phenolphthalein in different conditions.

Phenolphthalein indicator		
Colour in acidic solutions	**Colour in neutral solutions**	**Colour in alkaline solutions**
colourless	colourless	pink

State the colour change, including **initial and final** colour, that indicates the end point of the titration. **1**

[Turn over

9. A student carried out an experiment to prepare nickel(II) sulfate crystals.

(a) The first step in the experiment was to prepare a nickel(II) sulfate solution by completely neutralising 25 cm^3 of sulfuric acid. This was done by adding an excess of nickel(II) carbonate powder. A gas was also produced.

(i) Suggest how the student would know when the acid was completely neutralised. **1**

(ii) Name the compound that is produced in all neutralisation reactions. **1**

(iii) State the term used to describe a substance, such as nickel(II) carbonate, that neutralises an acid. **1**

(iv) The sulfuric acid used had a concentration of 1 mol l^{-1}.

Calculate the number of moles in 25 cm^3 of sulfuric acid with a concentration of 1 mol l^{-1}. **1**

(b) The second step in the experiment was to remove excess nickel(II) carbonate from the nickel(II) sulfate solution.

Name this experimental technique. **1**

9. (continued)

(c) The final step in the experiment was to leave the nickel(II) sulfate solution for a few days to evaporate, leaving solid nickel(II) sulfate crystals.

Suggest how the student could have carried out this step in a much shorter time. **1**

(d) Calculate the percentage by mass of nickel in nickel(II) sulfate, $NiSO_4$. **3**

Show your working clearly.

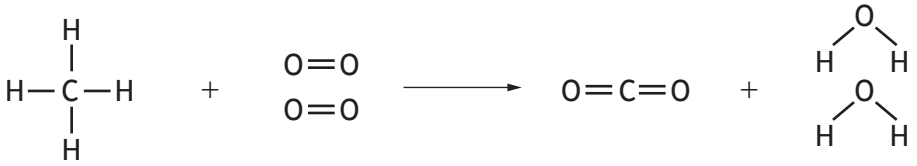
[Turn over

10. Alkanes, alkenes and cycloalkanes are all families of hydrocarbons.

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

(b) The energy released when a hydrocarbon is burned can be calculated by working out the difference between the total energy needed when all of the bonds in the reactants are **broken** and the total energy released when all of the bonds in the products are **made**.

The burning of methane can be represented by the following equation.



bonds being **broken** in the reactants bonds being **made** in the products

The total energy needed for all of the bonds in the reactants to be **broken** is calculated as shown.

Bond	Bond energy (kJ)	Number of bonds broken	Total energy needed (kJ)
C–H	412	4	$4 \times 412 = 1648$
O=O	498	2	$2 \times 498 = 996$
Total energy to **break** all the bonds in the reactants =			$1648 + 996 =$ **2644**

10. (b) (continued)

(i) Complete the table below to calculate the total energy released when all of the bonds in the products are **made**. **2**

(An additional table, if required, can be found on *page 33*.)

Bond	Bond energy (kJ)	Number of bonds made	Total energy released (kJ)
C=O	804		
O–H	463		
Total energy to **make** all the bonds in the products =			

(ii) Using the total energy to **break** all of the bonds in the reactants, your answer to (b) (i) and the relationship shown below, calculate the energy change, in kJ, for the combustion of methane. **1**

Energy change = total energy to **break** all the bonds in the reactants − total energy to **make** all the bonds in the products

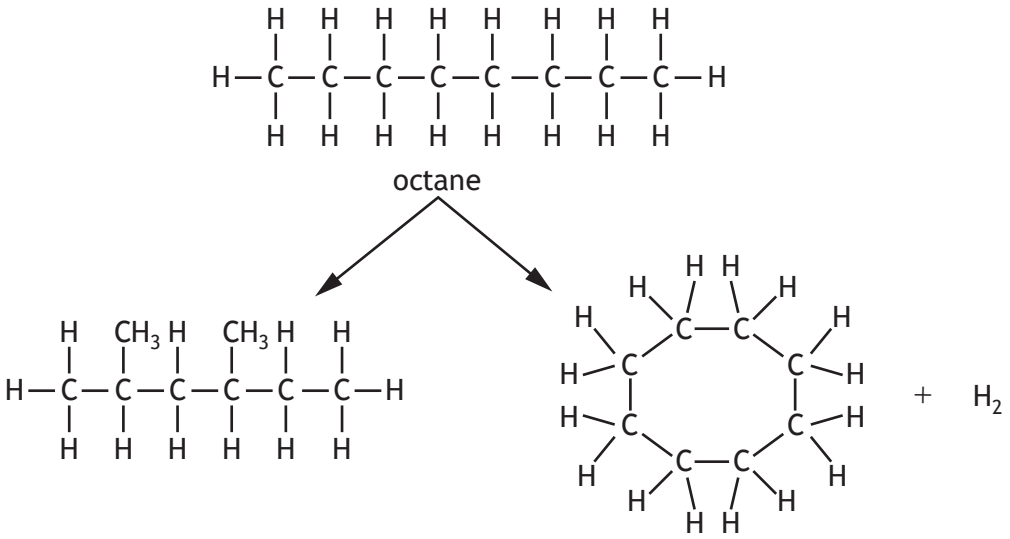
[Turn over

10. (continued)

(c) Branched chain alkanes and cycloalkanes can be made by a process known as reforming.

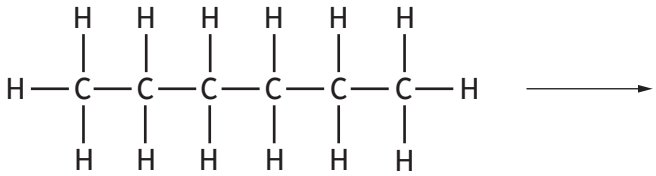
Reforming is a chemical reaction that changes the arrangement of carbon atoms without changing the number of carbon atoms.

An example of reforming octane is shown.



(i) Name the branched alkane produced by the reforming of octane. **1**

(ii) Draw a structure for a cycloalkane that can be produced by the reforming of **hexane**. **1**



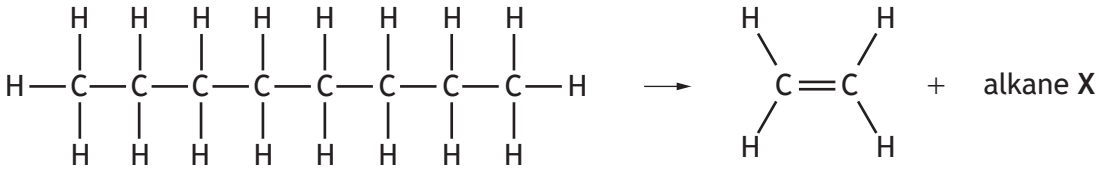
10. (continued)

(d) Alkanes can be used to make unsaturated hydrocarbons in a reaction called cracking.

These unsaturated hydrocarbons can then be used to make other chemicals, such as alcohols and polymers.

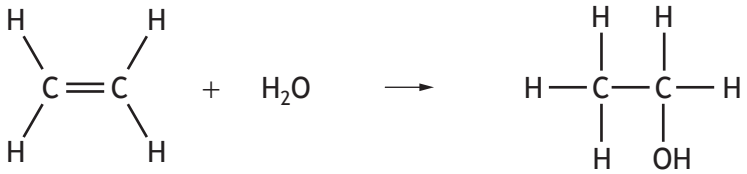
(i) (A) A cracking reaction can break an alkane into an alkene and a smaller alkane.

An example of this reaction is shown.



Write the molecular formula for alkane **X**. **1**

(B) Ethene can be reacted with water, in an addition reaction, to produce ethanol for hand sanitisers.

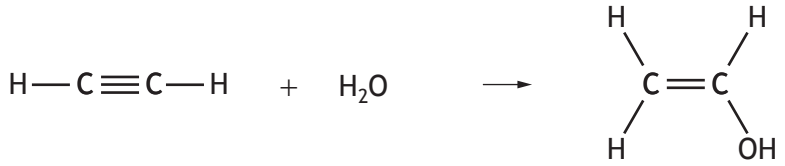


Name the type of addition reaction taking place when ethene reacts with water. **1**

[Turn over

10. (d) (continued)

(ii) Ethyne, another unsaturated hydrocarbon with a carbon to carbon triple bond, can react with water to produce ethenol.



ethyne ethenol

(A) Name the polymer made from ethenol. **1**

(B) Draw the repeating unit of the polymer made from ethenol. **1**

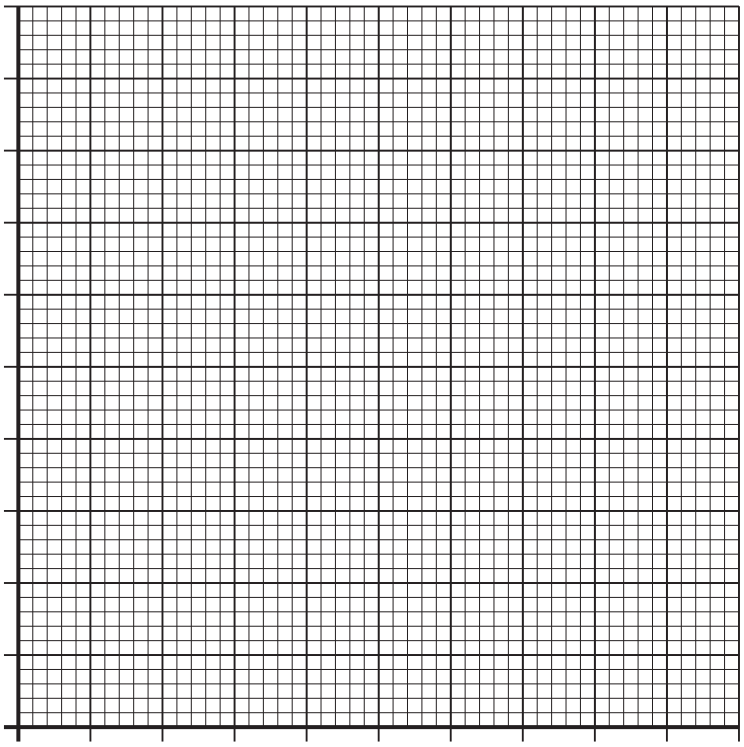
11. Radioactive decay involves changes in the nuclei of atoms.

Using your knowledge of chemistry, comment on radioactive decay. **3**

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 2 (c)



Additional table for question 6 (c) (i)

Order in the electrochemical series	Metal
highest ↓ lowest	

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional table for question 10 (b) (i)

Bond	Bond energy (kJ)	Number of bonds made	Total energy released (kJ)
C=O	804		
O–H	463		
Total energy to **make** all the bonds in the products =			

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

X8137501 34

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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