FOR OFFICIAL USE

N5

National Qualifications 2022

Mark

X813/75/01

Chemistry
Section 1 — Answer grid and Section 2

FRIDAY, 29 APRIL
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:

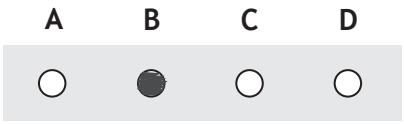
A fractional distillation

B chromatography

C fractional crystallisation

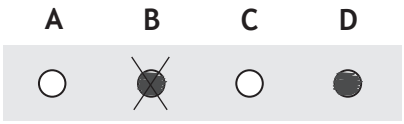
D filtration.

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

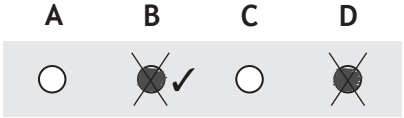


Changing an answer

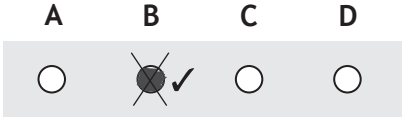
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



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:



or



SECTION 1 — Answer grid

0BJ25AD1

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

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[Turn over for next question

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SECTION 2 — 75 marks

Attempt ALL questions

1. Research shows that if nuclear power reactors are not constantly monitored and maintained, radioisotopes can be released into the environment.

Three such radioisotopes are xenon-133, iodine-131 and caesium-137.

(a) The equation for the decay of iodine-131 is

$$^{131}_{53}\mathrm{I} \rightarrow {}^{0}_{-1}\mathrm{e} + \mathbf{Y}$$

(i) Name the **type** of radiation emitted by the iodine-131 radioisotope. **1**

(ii) Name element **Y**. **1**

(b) The half-life of the three radioisotopes is shown in the table.

Radioisotope	xenon-133	iodine-131	caesium-137
Half-life	5 days	8 days	30 years

(i) Calculate the length of time taken for the radioactivity of xenon-133 to fall to $\frac{1}{8}$ of its original value. **2**

Show your working clearly.

1. (b) (continued)

(ii) Suggest which of the radioisotopes from the table would be responsible for long term radiation, if released into the environment. 1

[Turn over

2. Calcium reacts with water as shown in the equation.

$$Ca(s) + 2H_2O(\ell) \rightarrow Ca(OH)_2(aq) + H_2(g)$$

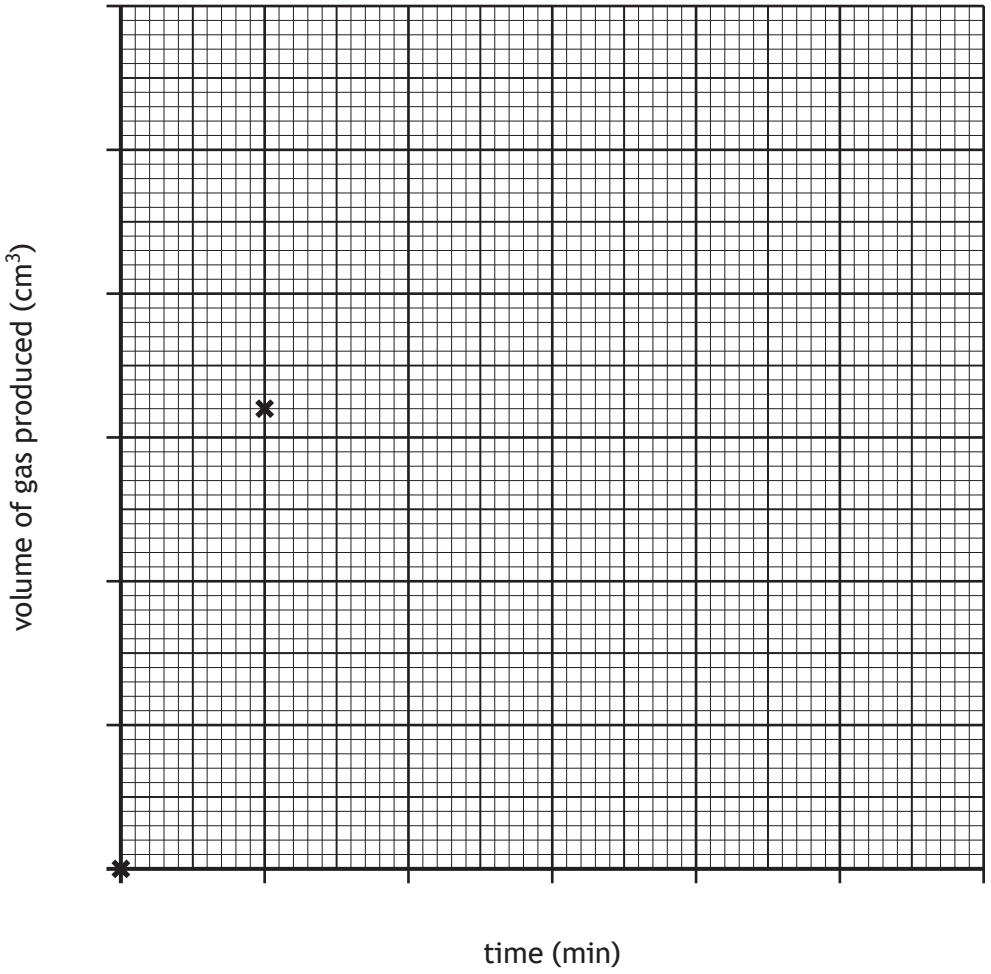
In an experiment, the progress of a reaction was monitored by measuring the volume of hydrogen gas produced.

Time (min)	0	1	2	3	4	5
Volume of gas produced (cm^3)	0	32	40	46	48	48

(a) Complete the graph to show the volume of gas produced against time. **2**

The first two points have been plotted for you.

(Additional graph paper, if required, can be found on *page 31*.)



2. (continued)

(b) Calculate the average rate of reaction, in $cm^3\,min^{-1}$, between 1 and 4 minutes. **2**

Show your working clearly.

(c) Suggest a different measurement that could be used to follow the progress of this chemical reaction. **1**

(d) A student repeated the experiment at a higher temperature, using the same mass of calcium and the same volume of water.

Predict the final volume of gas, in cm^3, produced in this experiment. **1**

[Turn over

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

Diesel Exhaust Fluid

Diesel Exhaust Fluid, DEF, is a chemical that can be added to diesel cars to lower pollution.

DEF is a solution that consists of urea and water only; 32.5% of the mass of this solution is urea.

When DEF is heated in the exhaust system, urea reacts with water to make ammonia and carbon dioxide. The ammonia then reacts with two of the harmful gases in the exhaust fumes, nitrogen monoxide and nitrogen dioxide, to produce two harmless substances, water and nitrogen.

DEF is preferred to solutions of ammonia because it is not considered a dangerous chemical; it is not toxic or flammable making it safer and easier to store.

(a) State the name of the two products formed when DEF is heated in the exhaust system. **1**

(b) Calculate the mass of urea, in kg, used to make 5 kg of DEF. **1**

(c) Circle the words to complete the sentence. **1**

The harmful gases in the exhaust fumes, if released, can dissolve in water to form a solution which contains more {hydrogen / hydroxide} ions than {hydrogen / hydroxide} ions.

3. (continued)

(d) State a reason why DEF is not considered a dangerous substance. **1**

(e) Another use of urea, $CO(NH_2)_2$, is as a fertiliser.

Urea is known as a 'single nutrient' fertiliser because it contains only one of the elements essential for healthy plant growth.

(i) Diammonium hydrogen phosphate, $(NH_4)_2HPO_4$, is another common fertiliser.

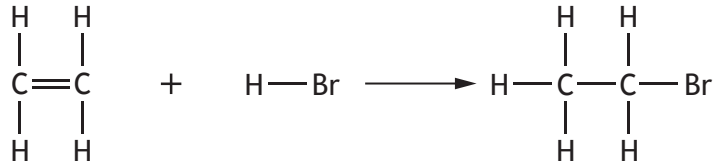
Explain why diammonium hydrogen phosphate, $(NH_4)_2HPO_4$, is not classified as a 'single nutrient' fertiliser. **1**

(ii) Calculate the percentage by mass of nitrogen in diammonium hydrogen phosphate, $(NH_4)_2HPO_4$. **3**

[Turn over

4. Haloalkanes are alkane molecules in which one or more hydrogen atoms have been replaced by an atom of a group 7 element.

(a) Haloalkanes are produced by the reaction of an alkene with a hydrogen halide, such as hydrogen bromide.



ethene + hydrogen bromide → bromoethane

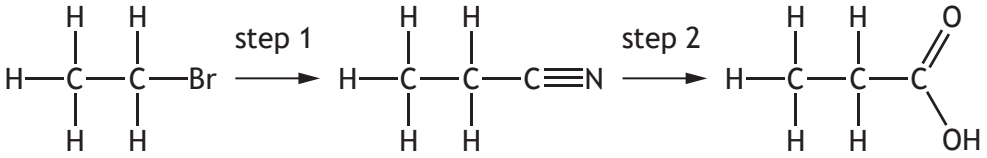
(i) Name the type of chemical reaction taking place when ethene reacts with hydrogen bromide. **1**

(ii) Draw a diagram, showing **all** the outer electrons, for a molecule of hydrogen bromide, HBr. **1**

(iii) Name the chemical that can be reacted with ethene to make chloroethane. **1**

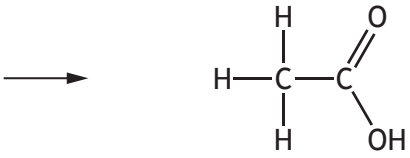
4. (continued)

(b) Haloalkanes can be used to produce carboxylic acids in a two-step process.



propanoic acid

(i) Draw a structure for the haloalkane used in **step 1** that would react in this way to produce ethanoic acid. **1**



ethanoic acid

(ii) A dilute solution of ethanoic acid is often used in food and household cleaning products.

State the name given to a dilute solution of ethanoic acid. **1**

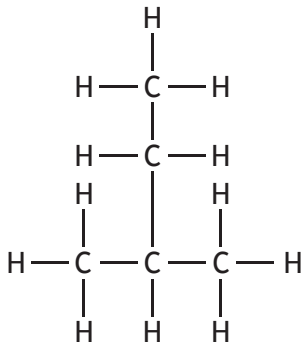
[Turn over

5. Indigestion is caused by excess stomach acid and is treated using indigestion tablets, a medicine containing chemicals such as calcium carbonate, that neutralise the excess stomach acid.

A group of students were given two brands of indigestion tablet and asked to carry out an experiment to determine which of the two brands is the most effective at neutralising an acid.

Using your knowledge of chemistry, comment on how the students could determine experimentally which tablet is the most effective. **3**

6. Isopentane is an alkane.



isopentane

(a) State the systematic name for isopentane. **1**

(b) Isopentane will react with oxygen in a combustion reaction to release heat energy.

(i) State the term used to describe a substance that burns to release heat energy in a combustion reaction. **1**

(ii) The equation for the combustion reaction of isopentane is shown.

$$C_5H_{12} + O_2 \rightarrow CO_2 + H_2O$$

Balance this equation. **1**

[Turn over

6. (b) (continued)

(iii) A chemist calculated the energy absorbed by water when isopentane is burned. The chemist recorded the following data.

Initial mass of isopentane (g)	275.6
Final mass of isopentane (g)	274.8
Mass of water heated (g)	200
Initial temperature of water (°C)	23
Final temperature of water (°C)	35

Calculate the energy, in kJ, absorbed by the water in the chemist's experiment. **3**

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

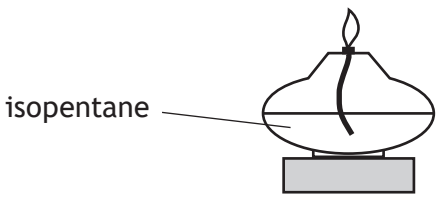
Show your working clearly.

6. (b) (continued)

(iv) Complete the diagram to show an experimental setup that could be used to determine the quantity of heat energy absorbed by water when isopentane burns.

You **must** label your diagram. **2**

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



7. A student carried out an investigation to find out how concentration affects the boiling point of a sodium chloride solution.

(a) Before the investigation was carried out the student prepared 500 cm^3 of a sodium chloride solution.

This solution had an accurate concentration of 1.5 mol l^{-1}.

(i) Calculate the mass, in grams, of solid sodium chloride, NaCl, required to prepare 500 cm^3 of 1.5 mol l^{-1} solution. **3**

(ii) Name the piece of apparatus which should be used to accurately measure the mass of solid sodium chloride required to make the 1.5 mol l^{-1} solution. **1**

7. (continued)

(b) The student heated three samples of the 1.5 mol l^{-1} sodium chloride solution until they boiled and measured the temperature each time.

The boiling points were 105 °C, 107 °C and 108 °C.

(i) Calculate the student's average boiling point, in °C, for the 1.5 mol l^{-1} sodium chloride solution. **1**

(ii) The student measured the boiling points for two more concentrations of sodium chloride solution.

The average boiling point for 0.5 mol l^{-1} was 101.3 °C and the average boiling point for 1.0 mol l^{-1} was 104.0 °C.

Present these results and your answer to (b) (i) in a table. **2**

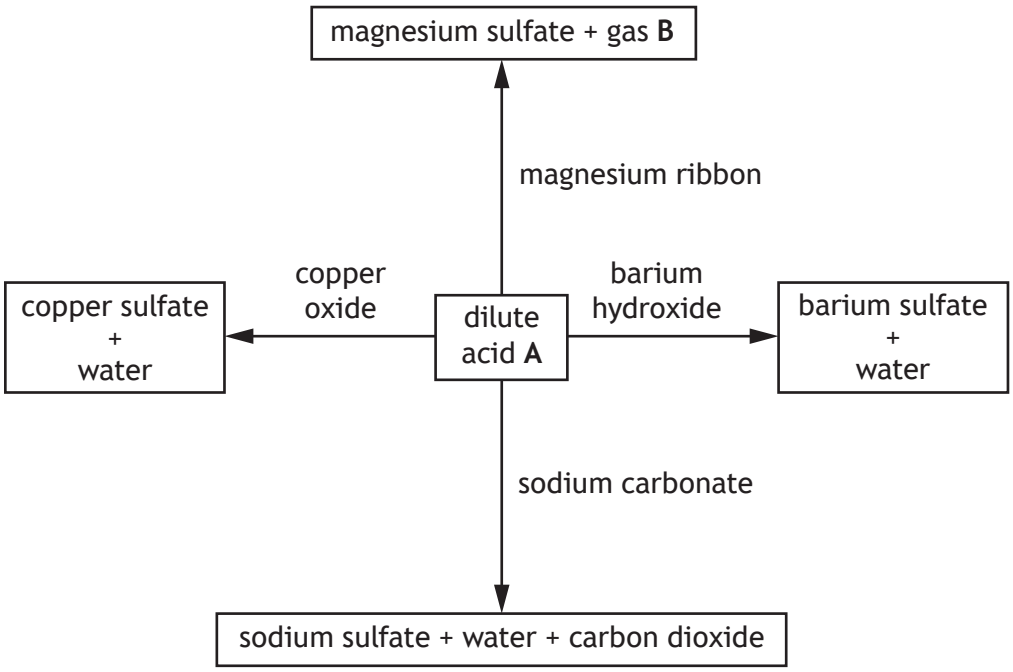
(c) State the **type** of graph the student should draw to present these results. **1**

(d) The student's aim was to find out how the concentration of a sodium chloride solution affects its boiling point.

Suggest a conclusion for the experiment based on the student's results. **1**

[Turn over

8. A student carried out four reactions with dilute acid **A** as shown in the diagram.



(a) Name dilute acid **A**. **1**

(b) Name gas **B**. **1**

(c) Sodium carbonate is added to dilute acid **A** until the reaction is finished.

Other than measuring the pH, suggest how the student would know when to stop adding sodium carbonate. **1**

8. (continued)

(d) In all of these reactions a salt is produced.

State which of these salts would be produced as a precipitate. **1**

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

(e) Unlike the other reactions in the diagram, the reaction between magnesium and dilute acid **A** cannot be classified as a neutralisation reaction.

State what is meant by a neutralisation reaction. **1**

[Turn over

9. Xenon is an element found in group 0 of the periodic table.

(a) A number of isotopes of xenon exist.

State what is meant by the term isotope. **1**

(b) The elements in group 0 are known as the noble gases and are all very unreactive.

Explain why the noble gases are unreactive. **1**

(c) Under certain conditions xenon can form compounds.

Xenon hexafluoride, XeF_6, is made by reacting xenon difluoride with fluorine using nickel(II) fluoride as a catalyst.

(i) Write a chemical equation, using symbols and formulae, to show the reaction.

There is no need to balance this equation. **1**

(ii) Xenon hexafluoride is a solid at room temperature with a melting point of 49 °C.

State the term used to describe the structure of xenon hexafluoride. **1**

9. (c) (continued)

(iii) When making a sample of xenon hexafluoride, 35 g of nickel(II) fluoride is required to catalyse the reaction.

(A) Suggest what mass of nickel(II) fluoride, in grams, should be present at the end of the reaction. **1**

(B) Calculate the cost, in £, of purchasing the required mass of nickel(II) fluoride if nickel(II) fluoride can only be bought as a 10 g tub for £69.40. **1**

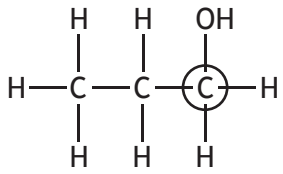
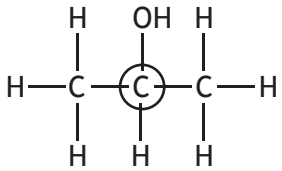
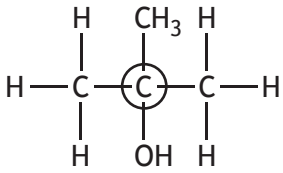
[Turn over

10. Alcohols are a homologous series used for a variety of purposes in everyday life.

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

(b) Alcohols can be classified depending on how many hydrogen atoms are attached to the carbon atom bonded to the functional group.

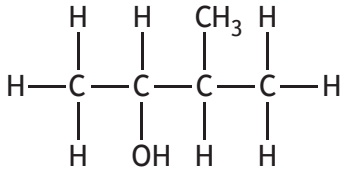
This carbon atom is circled in the examples shown.

Number of hydrogen atoms attached to carbon bonded to the functional group	Example	Alcohol classification
2		primary
1		secondary
0		tertiary

(i) Name the functional group present in all alcohols. **1**

10. (b) (continued)

(ii) The structure for 3-methylbutan-2-ol is shown.



Identify the alcohol classification of 3-methylbutan-2-ol. **1**

(iii) Draw an isomer of 3-methylbutan-2-ol which has a different alcohol classification. **1**

[Turn over

11. The 'Screaming Jelly Baby' is a popular chemistry demonstration where the sugars in a jelly baby reacts with oxygen.

(a) In the demonstration, potassium chlorate, $KClO_3$, is first heated in a boiling tube until it decomposes, producing oxygen gas.

$$2KClO_3 \rightarrow 2KCl + 3O_2$$

(i) Describe how you could test for the presence of oxygen. **1**

(ii) Write the formula for potassium chlorate, $KClO_3$, showing the charge on both ions. **1**

(b) The jelly baby is then added to the reaction mixture.

The sugars in the jelly baby undergo an exothermic reaction with oxygen.

(i) State what is meant by the term exothermic. **1**

(ii) During the demonstration, brightly coloured flames are produced.

Suggest why the flames are lilac coloured. **1**

11. (continued)

(c) The equation for the reaction of the sugar, glucose, is shown.

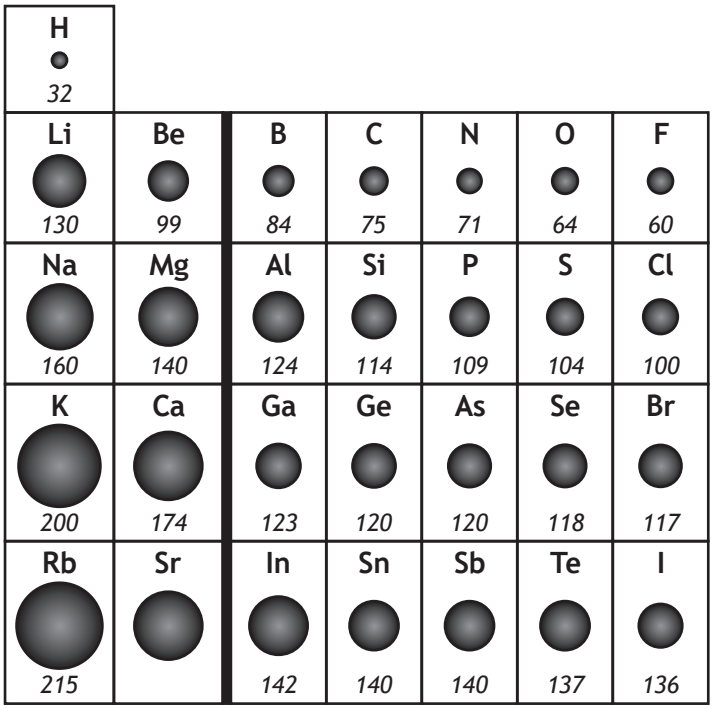
$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

glucose

Calculate the mass, in grams, of oxygen required to react completely with 2.25 g of glucose, $C_6H_{12}O_6$. **3**

12. The covalent radius is a measurement used to indicate the size of an atom.

The diagram below shows the covalent radius for elements in groups 1 to 7 of the periodic table.



covalent radius (picometres)

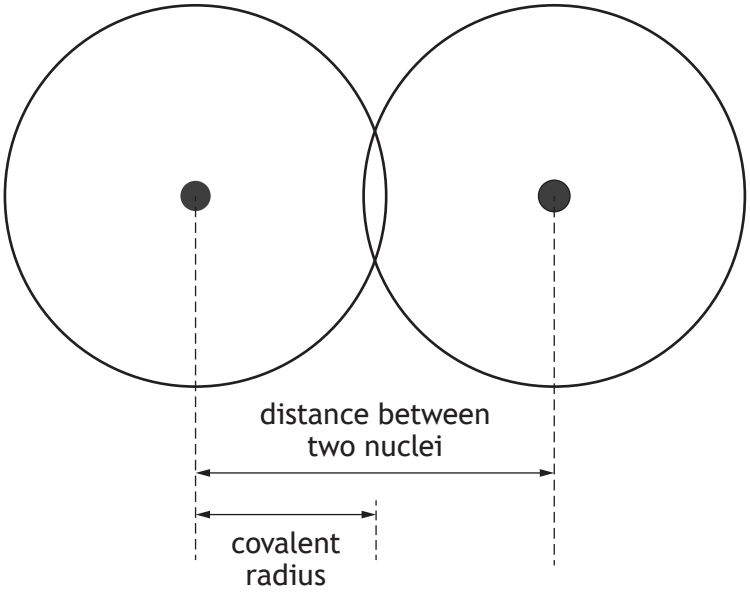
(a) (i) Describe the trend in covalent radius going from sodium to chlorine. **1**

(ii) Describe the **general** trend in covalent radius going down a group in the periodic table. **1**

(iii) Predict a value, in picometres, for the covalent radius of strontium. **1**

12. (continued)

(b) The covalent radius is defined as being 'half the distance between two bonded nuclei'.



Calculate the distance, in picometres, between the nuclei in bromine, Br_2. **1**

(c) The radius of the sodium ion, Na^+, is smaller than the radius of the sodium atom.

(i) Write the electron arrangement for the sodium ion, Na^+. **1**

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

(ii) Suggest why the radius of a Na^+ ion is smaller than the radius of the sodium atom. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

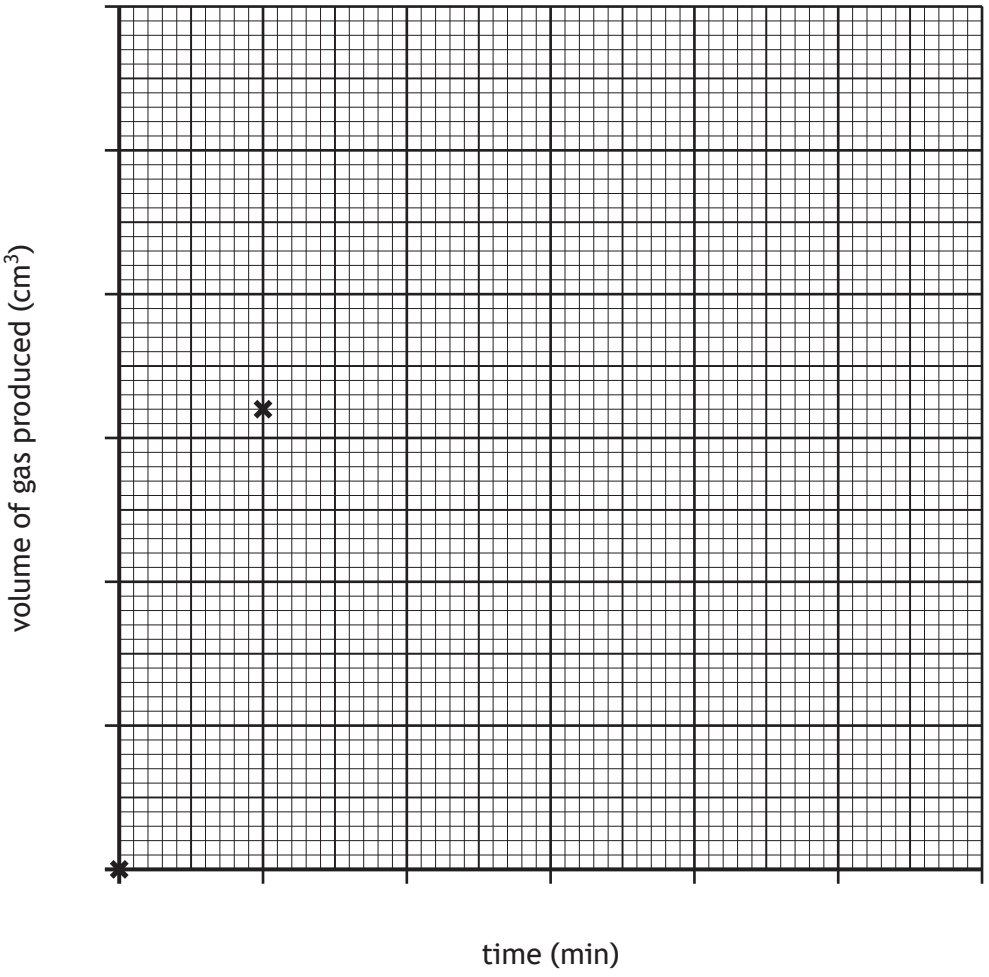
13. Redox reactions involve both an oxidation and reduction reaction.

Using your knowledge of chemistry, comment on the chemistry of redox reactions. **3**

[END OF QUESTION PAPER]

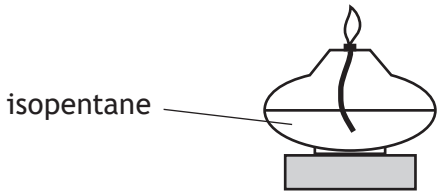
ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 2 (a)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional diagram for question 6 (b) (iv)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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