# National 5 Chemistry Past Papers 2021-2023

**September 2023**

## 1. About this study aid...

This document has been designed to make revision and self-marking easy for students studying National 5 chemistry in Scotland.

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## 2. How to use...

The following two pages contain tables which cross-reference the course topics with SQA question numbers for the years 2021-23.

The first table is for multiple choice questions; the second accesses Section 2 questions. Each question number is hyperlinked to the SQA question and clicking it will take you there. The question pages have further hyperlinks taking you back to the topic grid (top) or to the SQA marking instructions (bottom).

Of course, you can always just treat it as a succession of question papers with marking instructions. This will be useful for end-of-course timed revision.

**Updated to 2021-2023 by Mr Shepherd, St. Ambrose High School**

Full credit goes to Mr Sinclair, Vale of Leven Academy for making the original 2015-2019 hyper-linked question paper.

| N5 Chem Past Papers - Section 1 Multiple Choice Qs | | | | | | |
|---|---|---|---|---|---|---|
| | **Topic** | **2021** | **2022** | **2023** | | |
| **Unit 1** | Rate of Reaction | 10 | | 1 | | |
| | Atomic Structure and Bonding | 1 2 3 | 1 2 3 5 | 2 3 4 | | |
| | Formulae and Re-acting Quantities | 4 5 6 | | 5 6 | | |
| | Acids and Bases | 7 8 9 18 | 8 | 7 8 9 | | |
| **Unit 2** | Homologous Series | 11 13 14 16 | 13 14 | 10 11 12 15 | | |
| | Everyday Consumer Products | 12 17 | 11 12 | 13 14 16 | | |
| | Energy from Fuels | | 10 | | | |
| **Unit 3** | Metals | 21 22 | 15 17 18 19 20 | 17 18 19 20 | | |
| | Plastics | | | | | |
| | Fertilisers | 24 | 9 22 | 21 | | |
| | Nuclear Chemistry | 23 | 23 24 | 22 | | |
| | Chemical Analysis | 19 | 4 7 25 | 23 25 | | |
| | Problem Solving | 15 20 25 | 6 16 | 24 | | |

| N5 Chem Past Papers - Section 2 Qs | | | | | | |
|---|---|---|---|---|---|---|
| | **Topic** | **2021** | **2022** | **2023** | | |
| **Unit 1** | Rate of Reaction | 2 3a | 2 9ciiiA | 4b | | |
| | Atomic Structure and Bonding | 1 4b | 9a-b 9cii 12c | 1 7d-e 11a | | |
| | Formulae and Reacting Quantities | 3ci 4c 7cii 8aiii 10b 12c | 3eii 4aii 6bii 9ci 11aii 11c | 3bi 4c 7f 8b 8d 11bi | | |
| | Acids and Bases | 2ciii 7aii 7bi | 3c 8 | 11bii | | |
| **Unit 2** | Homologous Series | 4eii 4f 8aii 12a-b | 4ai 4aiii 6a 10a | 2a-ci 7a-c | | |
| | Everyday Consumer Products | 4d 4ei 7ai | 4bii 10b | 6ai | | |
| | Energy from Fuels | 8b | 6b 11bi | 2cii 9a | | |
| **Unit 3** | Metals | 9b | | 3 10a 11c | | |
| | Plastics | 6ai 6b | | 6aii-iii | | |
| | Fertilisers | 3b | 3ei | 8c | | |
| | Nuclear Chemistry | 11 | 1 | 10b | | |
| | Open-ended | 5 13 | 5 13 | 5 12 | | |
| | Chemical Analysis | 8ai 3cii 7bii 7ci | 7a 7b-d 11ai 11bii | 6ci 8e | | |
| | Problem Solving | 4a 6aii 9a 10a 10c-d 12d | 3a-b 3d 4bi 9ciiiB 12a-b | 4a 6b 6cii 8a 8f 9b | | |

N5 National Qualifications

**X813/75/02**

# Chemistry
# Section 1 — Questions

Duration — 2 hours 30 minutes

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/75/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

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

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

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*X813750 2*

Go to Topic Grid

**SECTION 1 — 25 marks**

**Attempt ALL questions**

**1.** Identify the element with similar chemical properties to fluorine.

A Neon

B Chlorine

C Nitrogen

D Hydrogen

**2.** An atom has an atomic number of 15 and a mass number of 31.

The atom has

A 15 protons and 15 electrons

B 15 protons and 16 electrons

C 16 protons and 15 electrons

D 16 protons and 16 electrons.

**3.** Which of the following molecules has a trigonal pyramidal shape?

A $HCl$

B $CO_2$

C $NCl_3$

D $CHCl_3$

**4.** When sulfur dioxide gas dissolves in water, a solution containing hydrogen ions and sulfite ions is formed.

In which of the following equations are all of the state symbols correctly shown?

A $SO_2(s) + H_2O(\ell) \rightarrow 2H^+(\ell) + SO_3^{2-}(\ell)$

B $SO_2(g) + H_2O(\ell) \rightarrow 2H^+(aq) + SO_3^{2-}(aq)$

C $SO_2(g) + H_2O(aq) \rightarrow 2H^+(aq) + SO_3^{2-}(aq)$

D $SO_2(\ell) + H_2O(aq) \rightarrow 2H^+(aq) + SO_3^{2-}(aq)$

Go to Answers

Go to Topic Grid

**5.** 0·2 mol of potassium hydroxide was dissolved in water and the solution made up to 250 $cm^3$.

What is the concentration, in $mol\,l^{-1}$, of the potassium hydroxide solution?

A 0·0008

B 0·05

C 0·8

D 50

**6.** Which substance exists as diatomic molecules?

A Nitrogen monoxide

B Nitrogen dioxide

C Dinitrogen monoxide

D Dinitrogen tetraoxide

**7.** Which of the following compounds is a base?

A Magnesium nitrate

B Magnesium sulfate

C Magnesium chloride

D Magnesium carbonate

**8.** Which line in the table correctly describes what happens to a dilute solution of hydrochloric acid when water is added to it?

| | **pH** | **$H^+$ (aq) concentration** |
|---|---|---|
| A | increases | increases |
| B | decreases | decreases |
| C | increases | decreases |
| D | decreases | increases |

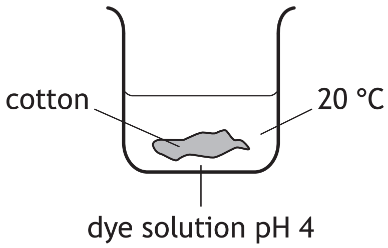
**[Turn over**

Go to Answers

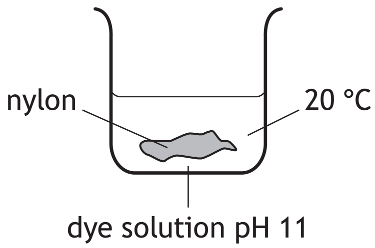
Go to Topic Grid

Questions **9** and **10** refer to the diagrams below.

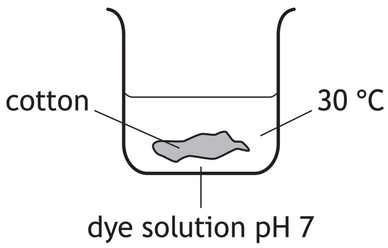
experiment 1



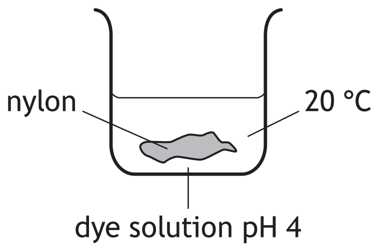

experiment 2




experiment 3




experiment 4




**9.** Which of the following statements correctly describes the dye solution in **experiment 2**?

It contains

A only hydrogen ions

B only hydroxide ions

C more hydrogen ions than hydroxide ions

D more hydroxide ions than hydrogen ions.

**10.** Identify the **two** experiments that should be used to compare the effect of pH on the dyeing of cloth.

A Experiments 1 and 4

B Experiments 2 and 4

C Experiments 1 and 3

D Experiments 3 and 4

Go to Answers

Go to Topic Grid

**11.** A straight chain molecule has the chemical formula $C_{16}H_{28}$ and contains only single or double bonds between carbon atoms.

How many carbon to carbon double bonds must the molecule contain?

A 1

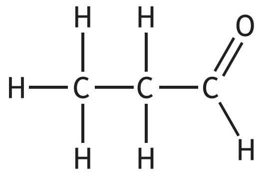
B 2

C 3

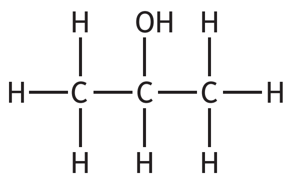
D 4

**12.** Which of the following compounds does **not** belong to a family with the general formula $C_nH_{2n+2}O$?

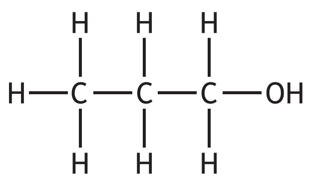
A



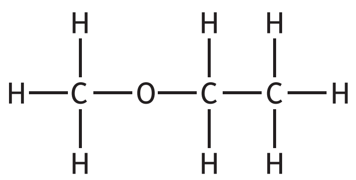
B



C



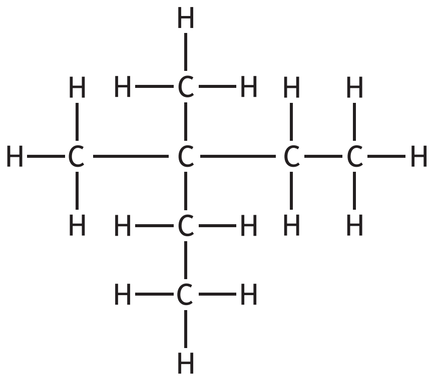
D



**[Turn over**

Go to Answers

**13.**



The shortened structural formula for this compound is

A $CH_3CH_2CH_2CH_2CH_2CH_2CH_3$

B $CH_3CH_2CH(CH_3)CH_2CH_2CH_3$

C $CH_3CH_2C(CH_3)_2CH_2CH_3$

D $CH_3C(CH_3)_2CH_2CH_2CH_3$

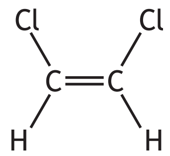
**14.** **1,2-dichloroethene** has two possible structures known as **cis** and **trans.**

The **cis** structure has the chlorine atoms on the same side of the double bond.

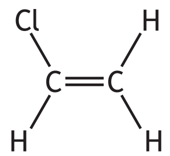
The **trans** structure has the chlorine atoms on the opposite side of the double bond.

Which of the following is the **cis** structure of **1,2-dichloroethene**?

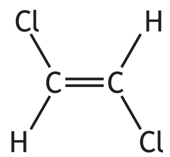
A



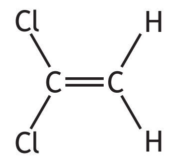
B



C



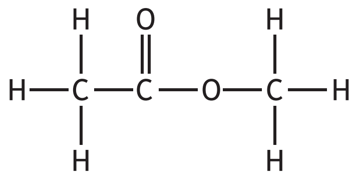
D



Go to Answers

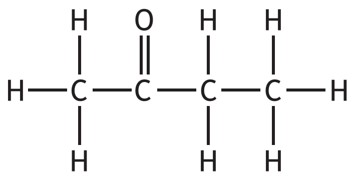
Go to Topic Grid

**15.** The structure shown is a member of a family of compounds known as esters.

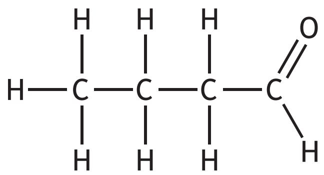


Which of the following is also an ester?

A



B



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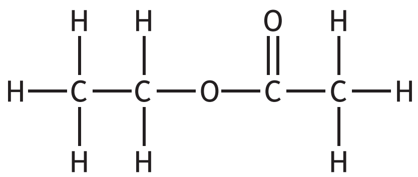

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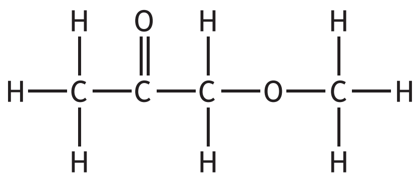


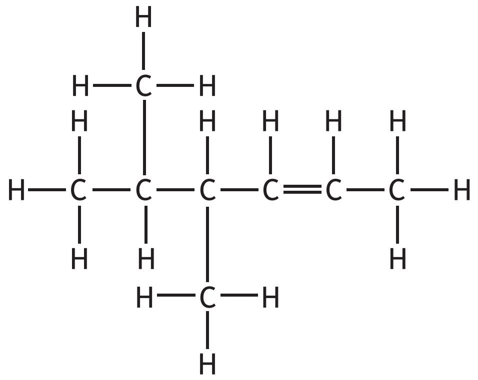
**[Turn over**

Go to Answers

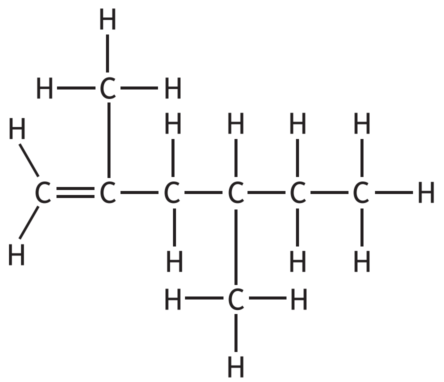
Go to Topic Grid

**16.** The correct structural formula for 2,4-dimethylhex-2-ene is

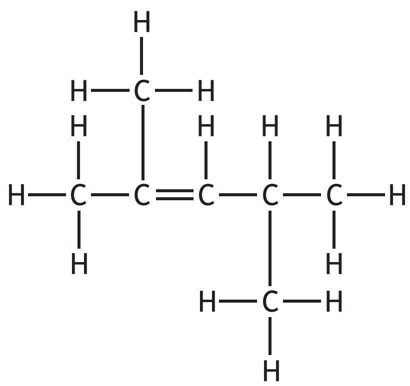
A



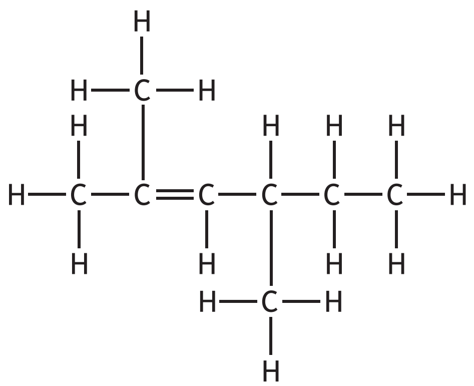
B



C



D



Go to Answers

Go to Topic Grid

**17.** Ethanoic acid has a higher boiling point than methanoic acid because

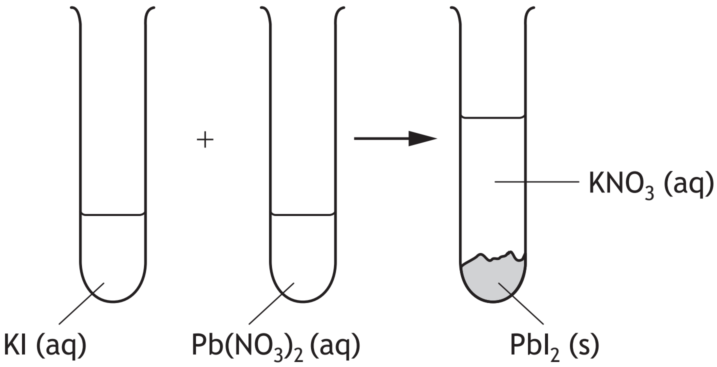
A the covalent bonds are stronger in methanoic acid

B the intermolecular forces of attraction are stronger in methanoic acid

C the covalent bonds are stronger in ethanoic acid

D the intermolecular forces of attraction are stronger in ethanoic acid.

Questions **18** and **19** refer to the reaction below.




**18.** The spectator ions in the reaction above are

A $Pb^{2+}$ and $NO_3^-$

B $K^+$ and $NO_3^-$

C $K^+$ and $I^-$

D $Pb^{2+}$ and $I^-$

**19.** The type of reaction shown above is

A oxidation

B reduction

C neutralisation

D precipitation.

[Turn over

Go to Answers

Go to Topic Grid

**20.** The table shows the names of some common ions and their colours in solution.

| Ion | Colour in solution |
|---|---|
| copper | blue |
| potassium | colourless |
| chromate | yellow |
| sulfate | colourless |

Which of the following compounds would be colourless in solution?

A Potassium sulfate

B Potassium chromate

C Copper sulfate

D Copper chromate

**21.** In which of the following reactions is a positive ion oxidised?

A iodide ion → iodine

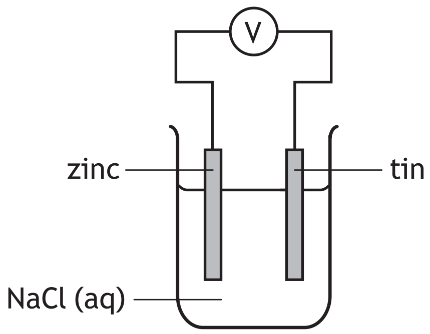
B nickel(II) ion → nickel(III) ion

C cobalt(III) ion → cobalt(II) ion

D sulfate ion → sulfite ion

**22.** Which line in the table is correct for this cell.

You may wish to use the data booklet.




| | Change in mass of zinc | Direction of electron flow |
|---|---|---|
| A | decrease | tin to zinc |
| B | decrease | zinc to tin |
| C | increase | tin to zinc |
| D | increase | zinc to tin |

Go to Answers

Go to Topic Grid

**23.** Which line in the table shows the materials that will stop $\alpha$, $\beta$ and $\gamma$ radiation?

| | **Material that will stop** | | |
|---|---|---|---|
| | **$\alpha$ radiation** | **$\beta$ radiation** | **$\gamma$ radiation** |
| A | thick concrete | thin metal foil | sheet of paper |
| B | thin metal foil | sheet of paper | thick concrete |
| C | sheet of paper | thin metal foil | thick concrete |
| D | sheet of paper | thick concrete | thin metal foil |

**24.** Which line in the table shows the correct name for the process and catalyst used for the reaction shown?

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

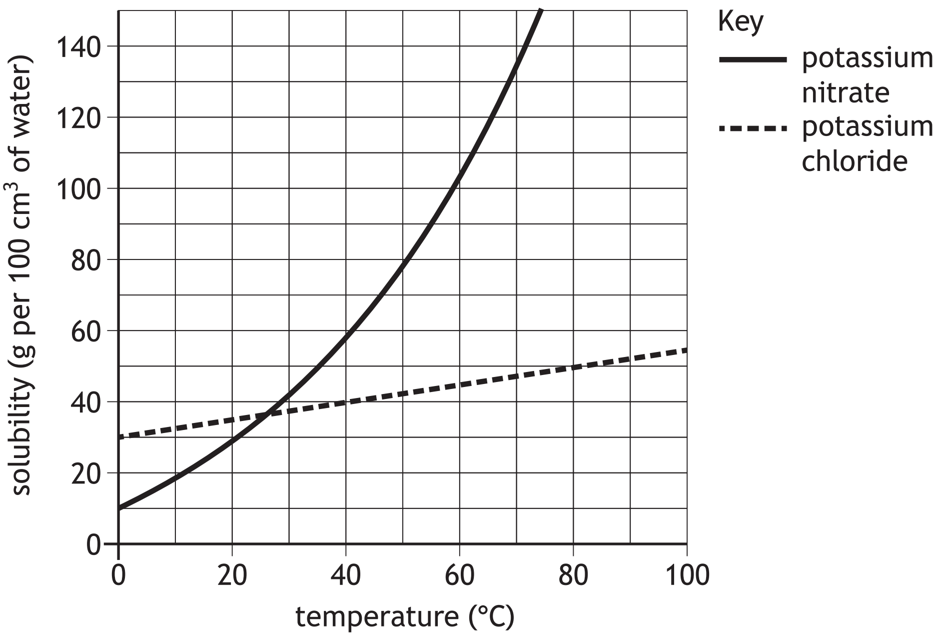
| | **Name of process** | **Catalyst used** |
|---|---|---|
| A | Ostwald | iron |
| B | Haber | platinum |
| C | Ostwald | platinum |
| D | Haber | iron |

**[Turn over**

Go to Answers

Go to Topic Grid

**25.** The graph shows the solubility of compounds at various temperatures.




A student added different compounds to beakers each containing 100 $cm^3$ of water at 40 °C.

The student added 50 g of potassium nitrate to one beaker and 50 g of potassium chloride to another beaker.

From the information in the graph which of the following statements is correct?

A Both compounds completely dissolved at 40 °C.

B Neither compound completely dissolved at 40 °C.

C Only potassium chloride completely dissolved at 40 °C.

D Only potassium nitrate completely dissolved 40 °C.

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]**

Go to Answers

FOR OFFICIAL USE

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |

N5

National Qualifications

Mark

# X813/75/01

# Chemistry
# Section 1 — Answer grid and Section 2

Duration — 2 hours 30 minutes

*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.

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Go to Topic Grid

MARKS DO NOT WRITE IN THIS MARGIN

**SECTION 2 — 75 marks**

**Attempt ALL questions**

**1.** The element tin has the chemical symbol Sn.

(a) A sample of tin contains three different isotopes. The nuclide notation for each is shown.

$$^{116}_{50}\text{Sn} \qquad ^{118}_{50}\text{Sn} \qquad ^{120}_{50}\text{Sn}$$

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

(ii) This sample of tin has an average atomic mass of 119·4.

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

(b) Another isotope of tin exists with 74 neutrons.

Write the nuclide notation for this isotope of tin. **1**

(c) Tin(IV) chloride can be formed by reacting tin with chlorine.

Some properties of tin(IV) chloride are shown in the table.

| | |
|---|---|
| **Melting point** | –33 °C |
| **Boiling point** | 114 °C |
| **Electrical conductivity as a solid** | Does not conduct |
| **Electrical conductivity as a liquid** | Does not conduct |

Using the information in the table, state the **type of bonding** present in tin(IV) chloride. **1**

[Turn over

Go to Answers

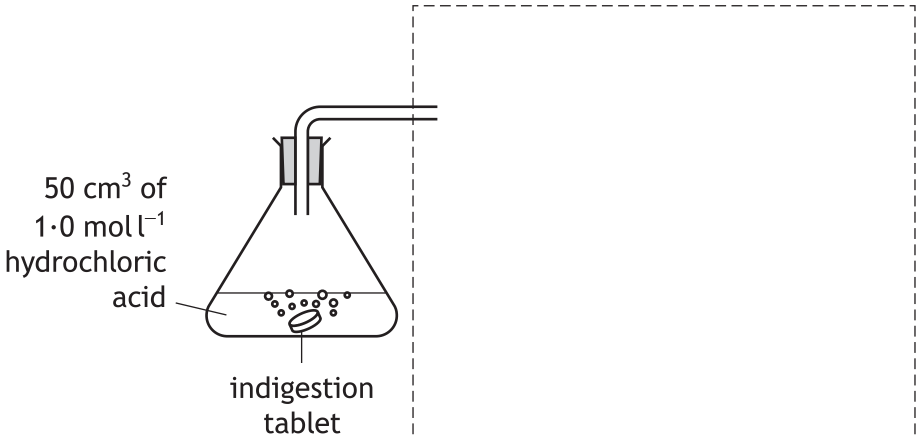
MARKS | DO NOT WRITE IN THIS MARGIN

**2.** A student carried out an investigation into reaction rates using dilute hydrochloric acid and indigestion tablets which contain calcium carbonate.

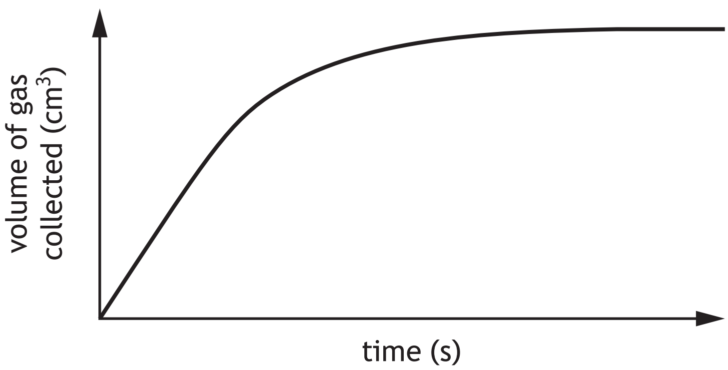
$$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(\ell) + CO_2(g)$$

(a) Complete the diagram to show the apparatus required to **collect** and **measure** the volume of gas produced. **1**

(An additional diagram, if required, can be found on *page 29*.)




(b) The student recorded the volume of gas produced over a period of time. A graph of the results of this experiment is shown.




(i) **Add a curve to the graph** to show the results that would be expected if the experiment was repeated using a crushed indigestion tablet. **1**

(An additional diagram, if required, can be found on *page 29*.)

(ii) As these reactions proceed the rate of reaction decreases.

Suggest a reason why the rate of reaction decreases. **1**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**2. (continued)**

(c) The student carried out another three experiments, recording the time taken for 50 $cm^3$ of gas to be collected at different temperatures.

The results are shown.

| Experiment | Temperature of acid (°C) | Time taken for 50 $cm^3$ of gas to be collected (s) |
|---|---|---|
| 1 | 15 | 230 |
| 2 | 25 | 145 |
| 3 | 35 | 76 |

(i) Calculate the average rate of reaction, in $cm^3\,s^{-1}$, for **experiment 1**. **2**

(ii) State the relationship between temperature of acid and time taken to collect 50 $cm^3$ of gas. **1**

(iii) **Experiment 1** was repeated using 1·0 mol $l^{-1}$ sulfuric acid, $H_2SO_4$(aq), instead of 1·0 mol $l^{-1}$ hydrochloric acid, HCl(aq).

The time taken to collect 50 $cm^3$ of gas decreased.

Explain why the time taken decreased. **1**

**[Turn over**

Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**3.** Ammonia is a starting material for the commercial production of nitric acid.

(a) A catalyst is used in the production of nitric acid.

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

(b) Ammonia and nitric acid react together to form ammonium nitrate.

Ammonium nitrate is commonly used as a fertiliser because it contains the element nitrogen, which is essential for healthy plant growth.

(i) Name another element essential for healthy plant growth. **1**

(ii) Describe another property of ammonium nitrate that makes it suitable for use as a fertiliser. **1**

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

(c) Another common fertiliser is urea, $(NH_2)_2CO$.

(i) Calculate the percentage by mass of nitrogen in urea, $(NH_2)_2CO$. **3**

**Show your working clearly.**

(ii) Urea dissolving in water is an endothermic process.

Suggest a piece of apparatus that could be used to confirm this process is endothermic. **1**



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

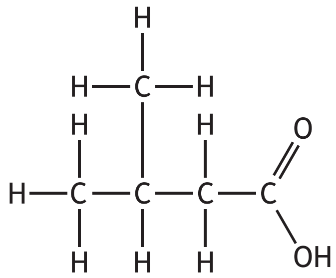
**4.** Read the passage below and answer the questions that follow.

### Air Fresheners

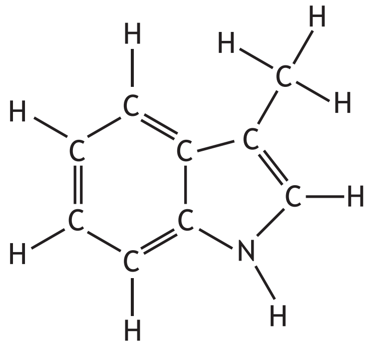
There are three ways an air freshener can remove an unpleasant smell. These are:

- Overpower it with a stronger smell
- Disguise it by mixing it with molecules to create a pleasant smell
- Absorb it

The following molecules are often found in unpleasant toilet smells.



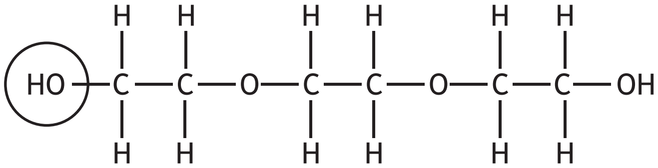
3-methylbutanoic acid



skatole

Some other molecules that make up these bad smells can contain sulfur atoms. For example, hydrogen sulfide ($H_2S$) is the gas associated with the smell of rotten eggs.

Air fresheners can contain molecules such as cyclodextrins that can absorb bad smells. Another molecule which is added for the same purpose is triethylene glycol.



triethylene glycol

*Adapted from an article by John Emsley*
*in* Education in Chemistry, *September 2007*

(a) Cyclodextrin molecules absorb bad smells.

Name another molecule added to air fresheners to absorb bad smells. **1**



Go to Answers

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MARKS | DO NOT WRITE IN THIS MARGIN

4. **(continued)**

(b) Draw a diagram, showing all outer electrons, of the molecule associated with the smell of rotten eggs. **1**

(c) Calculate the mass, in grams, of one mole of skatole. **1**

(d) Name the functional group circled on the triethylene glycol molecule. **1**

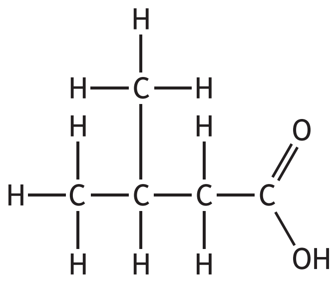
**[Turn over**

Go to Answers

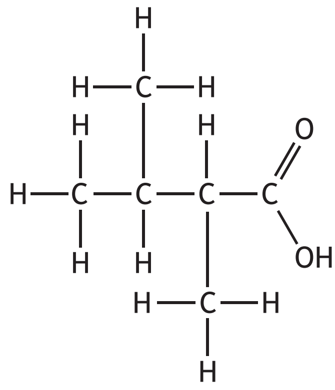
MARKS | DO NOT WRITE IN THIS MARGIN

**4. (continued)**

(e) Two branched carboxylic acid molecules are shown.



3-methylbutanoic acid



2,3-dimethylbutanoic acid

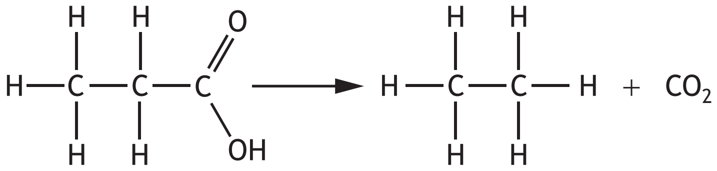
(i) Draw the structure of 2,4-dimethylpentanoic acid. **1**

Go to Topic Grid

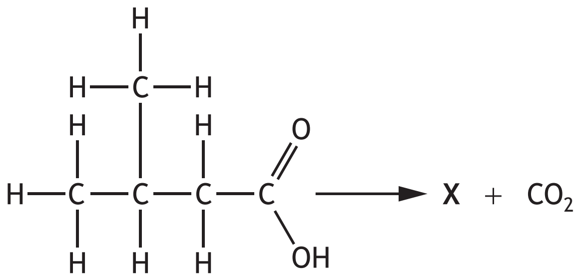
**4. (e) (continued)**

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) Carboxylic acids can be used to produce alkanes by a reaction that involves the loss of carbon dioxide.



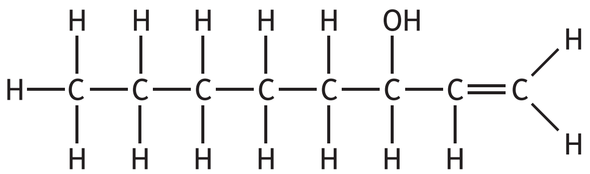
3-methylbutanoic acid produces alkane **X** as shown.



3-methylbutanoic acid

Draw the structure of alkane **X**. 1

(f) The molecule shown is associated with the smell of wet dogs. It will decolourise bromine solution quickly.



State the term used to describe molecules that decolourise bromine solution quickly. 1

**[Turn over**

*X813750113*

Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**5.** Metal elements make up over three-quarters of the periodic table.

**Using your knowledge of chemistry**, comment on the chemical reactions and properties of metals. **3**



Go to Answers

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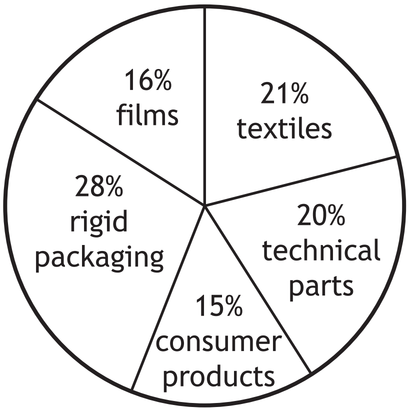
MARKS DO NOT WRITE IN THIS MARGIN

6. Poly(propene) is an addition polymer with many uses.

(a) (i) Draw the monomer used to make poly(propene). 1

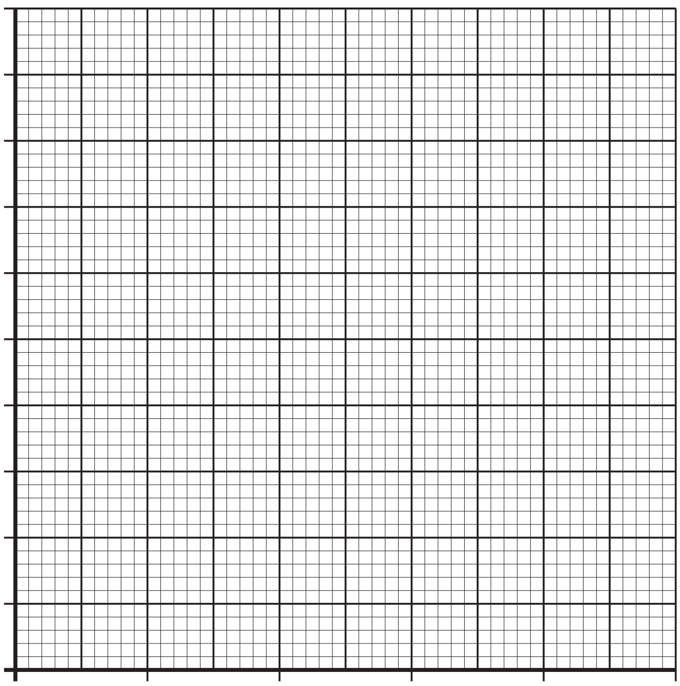
(ii) Poly(propene) is one of the most widely used polymers.

Uses of poly(propene)




Draw a graph showing the information in the pie chart. 4

(Additional graph paper, if required, can be found on *page 30*.)





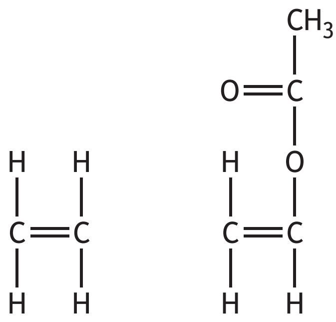
Go to Answers

Go to Topic Grid



**6. (continued)**

(b) Co-polymers are polymers made using more than one type of monomer. Poly(ethylene-vinyl acetate) is a co-polymer used to make shower curtains and football studs. The monomers used to make it are shown.



monomer A monomer B

(i) These monomer units join together by addition polymerisation.

State why these monomers can take part in addition polymerisation. **1**

(ii) Draw the repeating unit formed when one molecule of **monomer A** joins with one molecule of **monomer B**. **1**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**7.** When an acid and a base react together, water and a salt are formed.

(a) Acids and bases can be classified as strong or weak.

The salts formed, if soluble, will have a pH that depends on the strength of the acid and base used.

strong acid + strong base → neutral salt + water

strong acid + weak base → acidic salt + water

weak acid + strong base → alkaline salt + water

Examples of strong and weak acids and bases are shown in the tables.

| Acids | |
|---|---|
| **Strong acid** | **Weak acid** |
| hydrochloric acid | methanoic acid |

| Bases | |
|---|---|
| **Strong base** | **Weak base** |
| sodium hydroxide | ammonium hydroxide |

(i) Methanoic acid reacts with sodium hydroxide.

Name the salt formed. **1**

(ii) Predict the pH of the salt solution formed when hydrochloric acid reacts with ammonium hydroxide. **1**

**[Turn over**



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**7. (continued)**

(b) (i) The volume of an acid required to neutralise an accurately measured volume of a base can be measured as follows.

1. Pipette 10 $cm^3$ of a base into a conical flask
2. Add 3 drops of indicator solution
3. Add 0·1 $mol\,l^{-1}$ of an acid from a burette until the indicator changes colour

State the name of this technique. **1**

(ii) To determine the concentration of a base, the titre volumes must be concordant.

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

(c) Salts have a wide variety of uses.

(i) The salt strontium chloride is used in fireworks.

State the colour of the flame that would be seen when a firework containing the salt strontium chloride is burned. **1**

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

(ii) Another salt, barium sulfate, is used in some medical procedures.

Write the formula, showing the charge on each ion, for barium sulfate. **1**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**8.** Camping gas contains a mixture of the hydrocarbons propane and butane. When propane and butane are burned, carbon dioxide and water are produced.

(a) (i) Name the chemical used to confirm that carbon dioxide has been produced. **1**

(ii) Propane and butane are members of the alkane homologous series.

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

(iii) Balance the equation for the combustion of butane. **1**

$$C_4H_{10} \quad + \quad O_2 \quad \rightarrow \quad CO_2 \quad + \quad H_2O$$

(b) During a camping trip a can of baked beans was heated by burning camping gas.

| | |
|---|---|
| **Specific heat capacity of baked beans** | 3·6 kJ kg$^{-1}$ °C$^{-1}$ |
| **Energy absorbed by the baked beans** | 76·32 kJ |
| **Temperature of baked beans before being heated** | 17 °C |
| **Mass of baked beans** | 400 g |

Calculate the **final** temperature, in °C, of the baked beans using the information in the table. **4**

Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

9. Aluminium is a metal that cannot be extracted from its ore by heat alone.

(a) The first step in the extraction of aluminium is to obtain aluminium oxide from the ore bauxite.

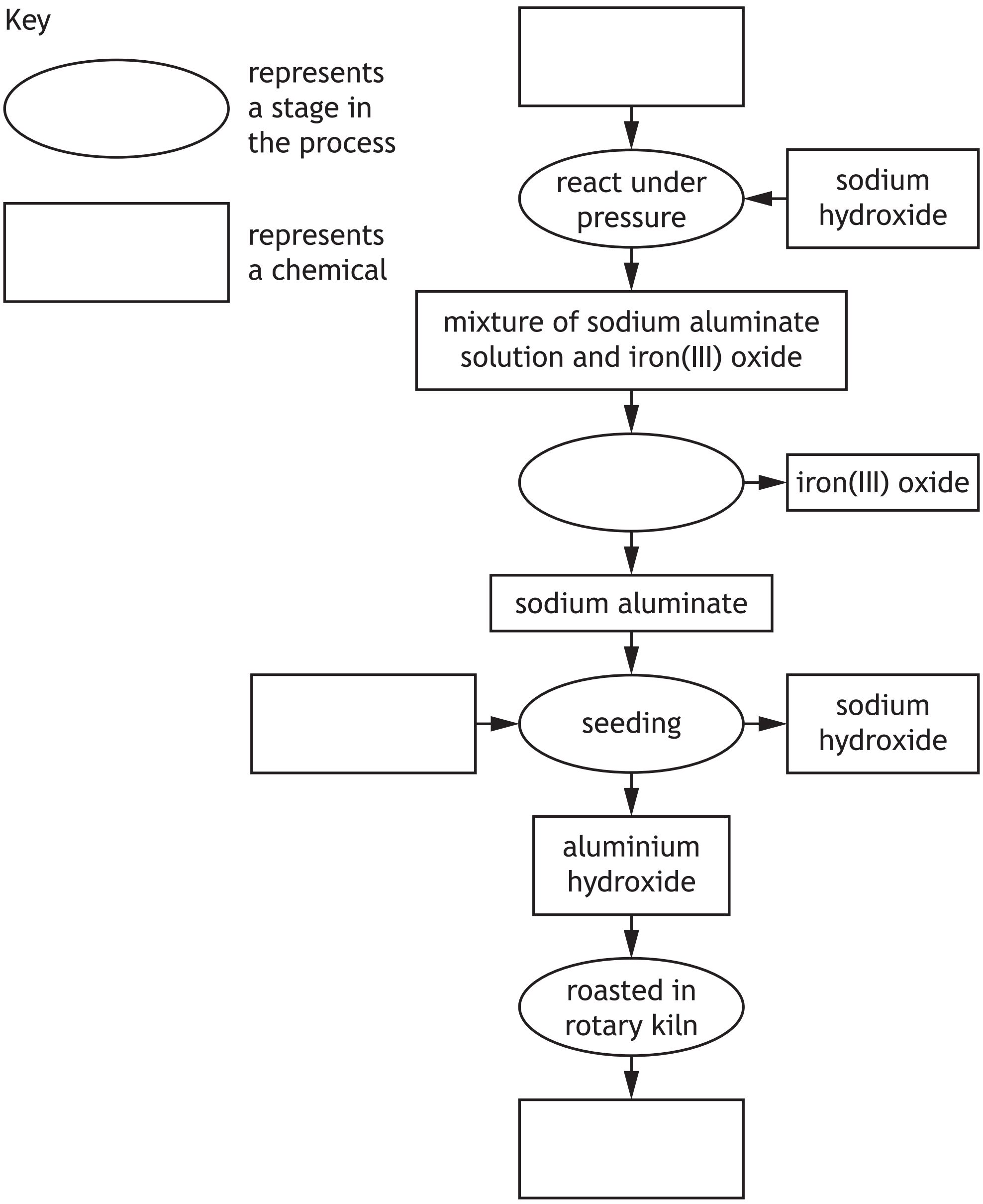
The ore is reacted with sodium hydroxide solution under pressure. This produces a mixture of sodium aluminate solution and the impurity iron(III) oxide which is removed by filtration.

A small amount of aluminium hydroxide is added to the filtrate to produce larger amounts of aluminium hydroxide in a process called 'seeding'. Sodium hydroxide solution is also formed.

The aluminium hydroxide then passes to a rotary kiln where it is roasted to form aluminium oxide.

(i) Complete the **flow diagram**, to summarise the production of aluminium oxide. **2**

(An additional diagram, if required, can be found on *page 31*.)




* X 8 1 3 7 5 0 1 2 0 *

Go to Answers

Go to Topic Grid

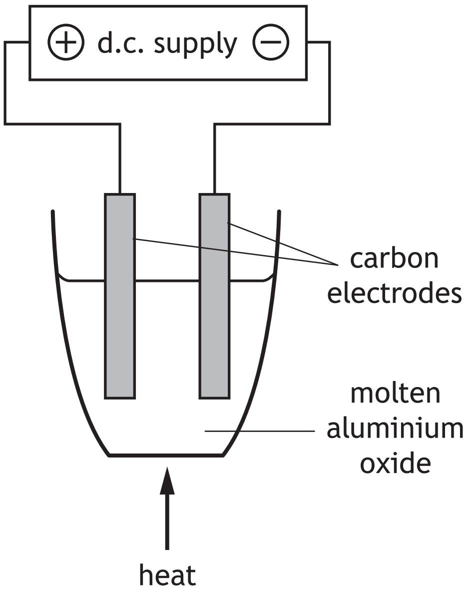
MARKS | DO NOT WRITE IN THIS MARGIN

**9. (a) (continued)**

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

(b) Aluminium can be extracted from aluminium oxide by electrolysis.

A simple electrolysis set up is shown.




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

(ii) Explain why a d.c. supply **must** be used. **1**

[Turn over

Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**9. (b) (continued)**

(iii) State why ionic compounds, like aluminium oxide, conduct electricity when molten. **1**

(iv) During electrolysis, the following reactions take place.

$$Al^{3+} + 3e^- \rightarrow Al$$

$$2O^{2-} \rightarrow O_2 + 4e^-$$

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

Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**10.** Read the passage and answer the questions that follow.

**Tungsten carbide**

Tungsten has the chemical symbol W. It can be traced back to the 18th century when it was first extracted from the ore wolframite. Tungsten has a very high melting point of 3422 °C.

Tungsten carbide, a compound of tungsten, was accidentally made by chemist Henri Moissan in 1896. In an attempt to make artificial diamond, he heated sugar and tungsten(III) oxide in a furnace. The sugar reacted with the tungsten oxide to produce liquid tungsten carbide.

Tungsten carbide has a melting point of 2870 °C and a boiling point of 6000 °C and is three and a half times as dense as titanium.

*Adapted from*
https://eic.rsc.org/magnificent-molecules/tungsten-carbide/3008556.article

(a) State the name of the ore from which tungsten was first extracted. **1**

(b) Write the formula for the compound that was heated with sugar, in a furnace, to produce tungsten carbide. **1**

(c) Suggest a temperature, in °C, that Henri Moissan's furnace could have been operating at when tungsten carbide was accidentally made. **1**

(d) Calculate the density of tungsten carbide, in $g\,cm^{-3}$. **2**

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

[Turn over

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**11.** Carbon-14 is an isotope of carbon that can be used to determine the age of materials.

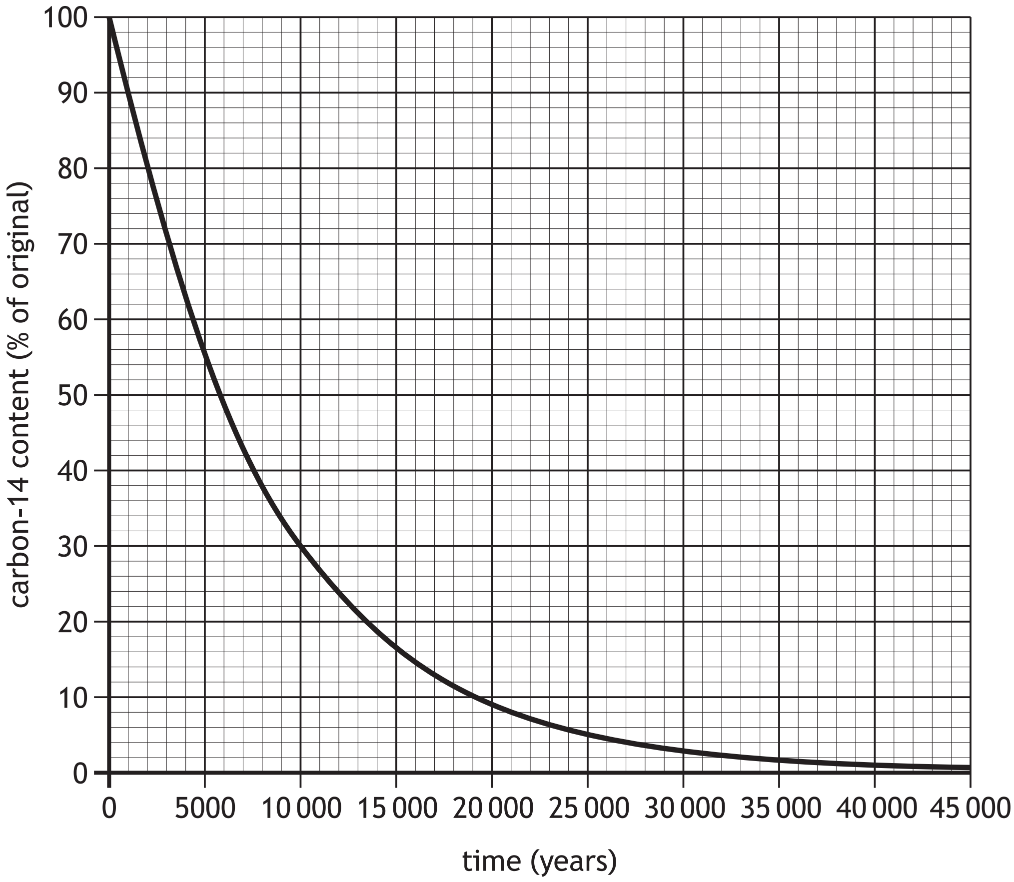
(a) When a neutron is absorbed by a nitrogen-14 nucleus, a carbon-14 isotope is produced along with one other particle, **X**.

An equation for this is shown

$$^{14}_{7}\text{N} + {}^{1}_{0}\text{n} \rightarrow {}^{14}_{6}\text{C} + \mathbf{X}$$

Name particle **X**. **1**

(b) The graph shows how the percentage of carbon-14 in a sample changes over a period of time.




(i) Use the graph to calculate the half-life, in years, of carbon-14. **1**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**11. (b) (continued)**

(ii) Use your answer to part (b) (i) to calculate the age, in years, of a bone found to contain $\frac{1}{16}$ of the original carbon-14 content. **2**

(iii) Another bone, believed to be over 100 000 years old, cannot be dated using levels of carbon-14.

Suggest why carbon-14 is unsuitable for dating this bone. **1**

[Turn over

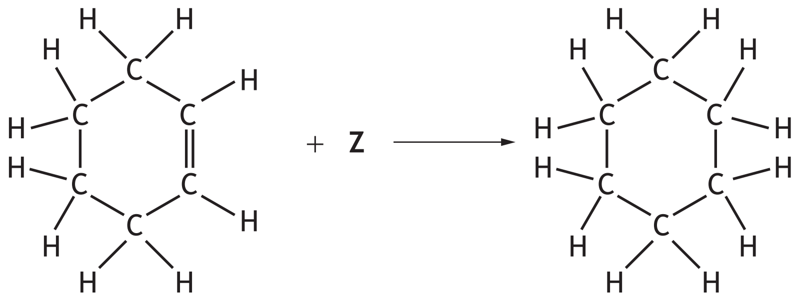
Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**12.** Cycloalkanes are an important family of hydrocarbons found in jet fuels.

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

(b) Cycloalkanes can be made in a number of ways. One method is shown.




cyclohexene    compound **Y**

(i) Name the type of addition reaction taking place when cyclohexene reacts with **Z**. **1**

(ii) Draw an isomer of compound **Y** that belongs to a different homologous series to compound **Y**. **1**

Go to Topic Grid

**12. (continued)** MARKS | DO NOT WRITE IN THIS MARGIN

(c) Another method for making cycloalkanes is shown.

| $C_5H_{10}Br_2$ | $+$ | 2Na | $\rightarrow$ | $C_5H_{10}$ | $+$ | 2NaBr |
|---|---|---|---|---|---|---|
| 1,5-dibromopentane | | sodium | | cyclopentane | | sodium bromide |

Calculate the mass, in grams, of sodium required to produce 175 g of cyclopentane. **3**

(d) Cycloalkanes can experience ring strain within their rings. The ring strain of some cycloalkanes is shown.

| Cycloalkane | Total ring strain (kJ) |
|---|---|
| cyclopropane | 132 |
| cyclopentane | 25 |
| cycloheptane | 28 |

$$\text{Ring strain per carbon} = \frac{\text{total ring strain}}{\text{number of carbons in the cycloalkane}}$$

Calculate the ring strain per carbon, in kJ, for cycloheptane. **1**

[Turn over

Go to Topic Grid

MARKS DO NOT WRITE IN THIS MARGIN

**13.** Vinegar is a solution of ethanoic acid in water. Different types of vinegar can contain different concentrations of ethanoic acid.

**Using your knowledge of chemistry**, suggest how a student could determine which type of vinegar had the highest concentration of ethanoic acid. **3**

**[END OF QUESTION PAPER]**

National Qualifications

# X813/75/02 Chemistry

## Marking Instructions

**Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.**

©

Go to Topic Grid

Marking instructions for each question

Section 1

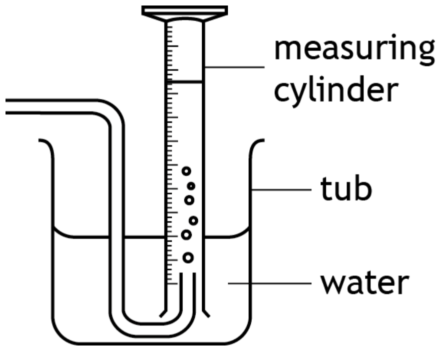
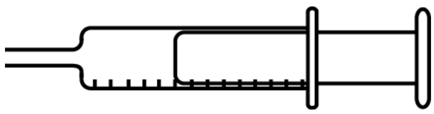
| Question | Answer | Mark |
| --- | --- | --- |
| 1. | B | 1 |
| 2. | A | 1 |
| 3. | C | 1 |
| 4. | B | 1 |
| 5. | C | 1 |
| 6. | A | 1 |
| 7. | D | 1 |
| 8. | C | 1 |
| 9. | D | 1 |
| 10. | B | 1 |
| 11. | C | 1 |
| 12. | A | 1 |
| 13. | C | 1 |
| 14. | A | 1 |
| 15. | C | 1 |
| 16. | D | 1 |
| 17. | D | 1 |
| 18. | B | 1 |
| 19. | D | 1 |
| 20. | A | 1 |
| 21. | B | 1 |
| 22. | B | 1 |
| 23. | C | 1 |
| 24. | D | 1 |
| 25. | D | 1 |

Go to Topic Grid

Section 2

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 1. | (a) | (i) | Same atomic number/protons AND different mass number/mass/ number of neutrons<br><br>**Atoms of** the same element with different mass number/mass/ number of neutrons<br><br>Candidate must specify either same atomic number or number of protons/positive charges or atoms of the same element AND different mass number/mass/number of neutrons | 1 | If electrons mentioned this does **not** negate a correct answer<br><br>Do **not** accept<br>Particles, molecules or same atoms with …<br>Same element with different mass number |
| | | (ii) | 120<br>**OR**<br>$^{120}_{50}Sn$<br>**OR**<br>$^{120}Sn$<br>**OR**<br>Sn-120<br>**OR**<br>tin-120. | 1 | Accept amu or g if stated. |
| | (b) | | $^{124}_{50}Sn$ | 1 | |
| | (c) | | Covalent | 1 | Accept covalent molecular.<br><br>Molecular on its own is not acceptable.<br><br>Any mention of network or lattice or ionic or metallic negates a correct answer. |

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **2.** | (a) | | Correctly drawn apparatus for either:<br><br>Upturned measuring cylinder in water<br><br>**OR**<br><br>Gas syringe<br><br>**Graduation marks must be shown.** | **1** | A graduated test tube would be acceptable.<br><br>The apparatus set-up must work; delivery tube cannot enter measuring cylinder through side wall.<br><br>Gas syringe must not be closed by bi-secting line.<br><br>See additional exemplification guidance. |
| | (b) | (i) | Curve should be steeper and should plateau at same height. | **1** | |
| | | (ii) | Reactants are being used up. | **1** | |
| | (c) | (i) | 0·2174/0·217/0·22/0·2 **(2 marks)**<br><br>Partial marking:<br><br>**1 mark awarded for concept of change in volume/change in time.**<br><br>50/230 with an incorrect answer<br>**OR**<br>50/145 = 0·345 or 0·34<br>**OR**<br>50/76 = 0·658 or 0·66 | **2** | If working is shown then it must demonstrate the concept of change in volume over time.<br><br>If wrong concept of change in time divided by change is volume is used, zero marks are awarded.<br>e.g. 230/50 |

Go To Additional Exemplification Guidance

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **2.** | (c) | (ii) | As the temperature (of acid) increases the time taken decreases.<br>**OR**<br>As the temperature (of the acid) decreases the time taken increases.<br>**OR**<br>The time taken increases as the temperature decreases.<br>**OR**<br>The time taken decreases as the temperature increases. | **1** | Must have correct cause and effect.<br><br>e.g. As the time decreases, the temperature increases.<br>-Zero marks would be awarded.<br><br>As temperature increases, rate increases.<br>-Zero marks would be awarded. |
| | | (iii) | Greater number/concentration/ moles of hydrogen ions/$H^+$<br>**OR**<br>more $H^+$ ions.<br>**OR**<br>$H_2SO_4$ is diprotic. | **1** | Award zero marks for 'more hydrogen'/more hydrogen atoms/ more 'H'/more acid/more moles of acid.<br><br>Award zero marks for mention of stronger/weaker acid but this does not negate a correct answer. |

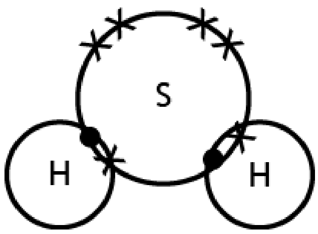
Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 3. | (a) | | Catalysts are substances that speed up chemical reactions (but can be recovered chemically unchanged at the end of the reaction). | 1 | |
| | (b) | (i) | Phosphorus/P<br>**OR**<br>Potassium/K | 1 | |
| | (b) | (ii) | Soluble | 1 | |
| | (c) | (i) | 46·67/46·7/47 (%) **(3 marks)**<br><br>Partial marking:<br><br>GFM = 60 **(1 mark)**<br><br>$\frac{28}{\text{candidate's GFM}} \times 100$ **(1 mark)**<br><br>This step on its own is worth 2 marks if the candidate's GFM is 60.<br><br>Calculation of **final answer** using the relationship<br><br>% by mass = $\frac{m}{\text{GFM}} \times 100$ **(1 mark)** | 3 | No units required but a maximum of two marks can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.<br><br>Maximum 2 marks<br>**(working must be shown)**<br><br>Incorrectly calculated GFM-allow follow through using the mass of nitrogen from working<br><br>**OR**<br><br>Using total mass of N as 14-<br><br>14/60 × 100 = 23·3%<br><br>The mark for the final answer can only be awarded if the correct relationship between total mass of element present divided by GFM × 100 is **shown with working.**<br><br>**An incorrect GFM of urea must be supported by working.**<br><br>See additional exemplification guidance. |
| | | (ii) | Thermometer/temperature probe | 1 | |

Go To Additional Exemplification Guidance

Go to Topic Grid

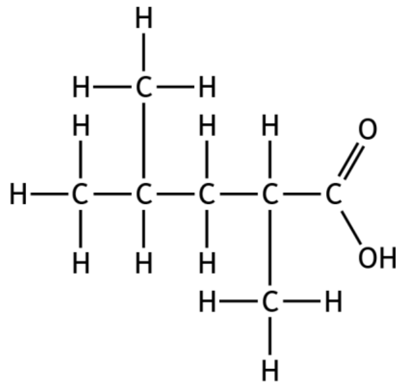
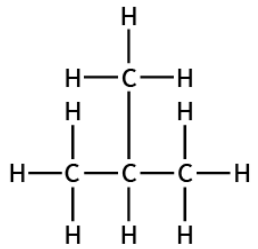
Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 4. | (a) | | Triethylene glycol | 1 | |
| | (b) | | Diagram showing sulfur with two hydrogen atoms: each of the two overlap areas must have two electrons in or on overlap area.<br><br>Either the sulfur or both hydrogen symbols must be shown.<br><br> | 1 | The diagram does not need to show the angular shape.<br><br>Accept cross or dot or e or e- to represent electrons or a mixture of these.<br><br>Accept petal diagram. The non-bonding electrons in sulfur must be shown but do not need to be together/shown as two pairs.<br><br>Bonding electrons MUST be on the line or in the overlapping area.<br><br>If inner electrons on sulfur are shown they must be correct ie 2,8.<br><br>See additional exemplification guidance. |
| | (c) | | 131 | 1 | |
| | (d) | | hydroxyl | 1 | OH is not acceptable, but does not negate the correct answer.<br>Hydroxide is not acceptable. |

Go To Additional Exemplification Guidance

Go to Topic Grid

Go to Topic Grid

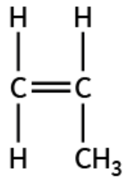
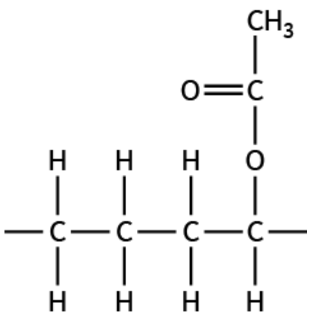
| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 4. | (e) | (i) | A correct shortened or full structural formula for 2,4-dimethylpentanoic acid.<br><br>eg $CH_3CH(CH_3)CH_2CH(CH_3)COOH$<br><br>$HOOCCH(CH_3)CH_2CH(CH_3)CH_3$<br><br><br>Or mirror images. | 1 | Accept $CH_3$ for branch in a full structural formula.<br><br>See additional exemplification guidance. |
| | | (ii) | A correct shortened or full structural formula for 2-methylpropane.<br><br> | 1 | 2-methylpropane (0 marks)<br>$CH_3CH(CH_3)CH_3$ would be acceptable.<br><br>See additional exemplification guidance for Question 4(e)(i) |
| | (f) | | Unsaturated | 1 | Carbon to carbon double bond or alkene 0 marks. |

Go To Additional Exemplification Guidance

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 5. | | | This is an open ended question.<br><br>**1 mark:** The candidate has demonstrated a limited understanding of the chemistry involved. The candidate has made a/some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.<br><br>**2 marks:** The candidate has demonstrated a reasonable understanding of the chemistry involved. The candidate has made a/some statement(s) that is/are relevant to the situation, showing that the problem is understood.<br><br>**3 marks:** The candidate has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one. | 3 | **0 marks**: The candidate has demonstrated no understanding of the chemistry involved.<br><br>There is no evidence that the candidate has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle.<br><br>This mark would also be given when the candidate merely restates the chemistry given in the question. |

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 6. | (a) | (i) |  | 1 | Accept full or shortened structural formula.<br><br>See additional exemplification guidance. |
| | | (ii) | For appropriate format: bars (not points) **(1 mark)**<br><br>The ‘percentage’ axis of the graph has a suitable scale. For the graph paper provided within the question paper, the selection of a suitable scale will result in a graph (plotted bars) that occupies greater than half of the width and half of the height of the graph paper. **(1 mark)**<br><br>The axes of the graph have suitable labels and units. **(1 mark)**<br><br>All bars are plotted accurately (within a half box tolerance).<br>**This mark can only be accessed if a linear scale for the y-axis has been provided. (1 mark)** | 4 | If a scatter/line graph is drawn a maximum of 3 marks can be awarded.<br>Bars should be separate, however mark would still be awarded if bars are drawn together.<br><br>The last bar must finish beyond the mid-point of the graph paper.<br><br>If the scale is non-linear then the mark for accurate plotting can only be accessed if the error occurs out with the data-set.<br><br>See additional exemplification guidance. |
| | (b) | (i) | They are unsaturated/contain a carbon to carbon double bond | 1 | If double bond is mentioned carbon to carbon must be included. |
| | | (ii) |  | 1 | Award mark if **one** end bond is missing.<br><br>Award mark if one end bond is shown with other end having a H in place of second end bond.<br><br>Allow dot or ~ to represent end bond.<br><br>Zero marks if **both** end bonds are missing/both ends have H/bond between two carbon missing. |

**Go To Additional Exemplification Guidance**

Go to Topic Grid

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 7. | (a) | (i) | Sodium methanoate | 1 | |
| | | (ii) | Any value less than 7 | 1 | |
| | (b) | (i) | Titration | 1 | |
| | | (ii) | Within 0·2 $cm^3$ (of each other)<br>**OR**<br>The same | 1 | |
| | (c) | (i) | Red | 1 | |
| | | (ii) | $Ba^{2+}SO_4^{2-}$ | 1 | Brackets, if included, must be in the correct place. |

Go to Topic Grid

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **8.** | (a) | (i) | Limewater | **1** | |
| | | (ii) | Same general formula<br>**AND**<br>Same/similar chemical properties | **1** | Award zero marks for - molecular formula - structural formula - chemical formula.<br><br>Award zero marks for - physical properties in place of chemical properties however, it does not negate if given in addition to chemical properties. |
| | | (iii) | $C_4H_{10} + 6{\cdot}5\ O_2 \rightarrow 4\ CO_2 + 5H_2O$ | **1** | Accept correct multiples |
| | (b) | | Final temperature<br>70 with no working **(4)**<br>---------------------------------<br>**Partial marking**<br>ΔT= correctly calculated<br>**53** =76·32/(0·4 x 3·6) **(3)**<br>----------------------------------<br>Using the correct concept of<br>ΔT=E/mc<br>With both c = 3·6 and Eh = 76·32 correctly substituted **(1)**<br><br>0·4 with or without concept **(1)**<br>**Calculation of** ΔT **(1)** provided concept mark has been awarded.<br><br>Calculation of final temperature T using incorrect ΔT **(1)** provided working is shown.<br>---------------------------------- | **4** | No units required but a maximum of three marks can be awarded if wrong unit is given. (Wrong units are only penalised once in any paper) 76320 and 3600 can be used to together in the calculation.<br><br>See additional exemplification guidance. |

**Go To Additional Exemplification Guidance**

Go to Topic Grid

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 9. | (a) | (i) | Ore/bauxite<br>filtration<br>aluminium hydroxide<br>aluminium oxide<br><br>**All 4 for both marks**<br>**3 or 2 correct for 1 mark** | **2** | Zero marks awarded for 1 correct entry. |
| | | (ii) | Arrow from bottom sodium hydroxide to top sodium hydroxide<br>**OR**<br>Arrow from lower aluminium hydroxide to upper aluminium hydroxide | **1** | See additional exemplification guidance. |
| | (b) | (i) | Decomposition/breaking apart of an ionic compound (into its elements) using electricity | **1** | |
| | | (ii) | Allows the product(s) to be identified.<br>**OR**<br>To make sure that only one product is produced at each electrode.<br>**OR**<br>To separate the aluminium from the oxygen. | **1** | Award zero marks for<br>• allows ions to separate<br>• so each electrode stays the same charge<br>• so the electricity/current goes in the one direction |
| | | (iii) | Ions are free to move. | **1** | Award zero marks for electrons/ molecules/charged particles in place of ions. |
| | | (iv) | $4Al^{3+} + 6O^{2-} \rightarrow 4Al + 3O_2$<br>(or correct multiples)<br>**All must be correct for 1 mark** | **1** | Zero marks awarded for any electrons shown in equation. Ignore state symbols if given. |

**Go To Additional Exemplification Guidance**

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **10.** | (a) | | Wolframite | **1** | |
| | (b) | | $W_2O_3$ | **1** | |
| | (c) | | Any temperature greater than or equal to 2870 °C and lower than 6000 °C | **1** | |
| | (d) | | 15·785/15·79/15·8/16 **(2 marks)**<br>..................................................................<br>**Partial Marks**<br>Density of titanium = 4·51 **(1 mark)** | **2** | Density of tungsten × 3·5<br>19·3 × 3.5 = 67·55 **(1 mark)** |

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **11.** | (a) | | proton/ $^{1}_{1}p$ / $^{1}_{1}H$ /H/hydrogen | **1** | Zero marks for $H_2$ |
| | (b) | (i) | 5500-6000 years | **1** | Unit is not required however if the wrong unit is given do **not** award mark.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | | (ii) | 4 x candidate's answer to (b) (i) **(2 marks)**<br>--------------------------------------<br>Partial marking:<br>1 mark can be awarded for **either**:<br>• 4 half-lives<br>**OR**<br>• number of years correctly calculated for an incorrect number of half-lives (provided the working supports the number of half-lives). | **2** | Allow follow through from (b) (i).<br><br>See additional exemplification guidance.<br><br>Unit is not required; however, a maximum of 1 mark can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | | (iii) | There would be no C-14 left in the bone/levels of C-14 too small to measure/Half-life is too short | **1** | 'It' refers to C-14 |
| **12.** | (a) | | Hydrocarbons are compounds containing only hydrogen and carbon (atoms). | **1** | Must contain **only**. |
| | (b) | (i) | Hydrogenation | **1** | |
| | | (ii) | Any acceptable alkene isomer. | **1** | See additional exemplification guidance. |

**Go To Additional Exemplification Guidance**

Go to Topic Grid

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 12. | (c) | | 115(g) **(3 marks)**<br>----------------------------------------<br>Partial marks<br><br>Both GFMs<br>ie 23 and 70 **(1 mark)**<br>**OR**<br>Moles of cyclopentane<br><br>ie (175÷70) = 2·5 mol **(1 mark)**<br>----------------------------------<br><br>1 concept mark for either:<br><br>$175 \times \frac{2 \times \text{candidate's GFM of sodium}}{\text{candidate's GFM of cyclopentane}}$<br><br>**(1 mark)**<br>**OR**<br>Moles of cyclopentane × (2 × candidate's GFM of sodium) **(1 mark)**<br>**OR**<br>Moles of cyclopentane × (1 × 23) **(1 mark)**<br>------------------------------------ -<br>Where the candidate has been awarded any concept mark, a further mark can be awarded for correct follow through to a final answer **(1 mark)** | 3 | No units required but a maximum of two marks can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.<br><br>**Award zero marks if the candidate's working does not use cyclopentane.**<br><br>A maximum of two marks can be awarded where the candidate has carried out the calculation using **cyclopentane** and 1,5-dibromopentane provided working is shown.<br><br>An incorrect GFM, with no working shown, cannot be used to gain the concept mark and therefore arithmetical follow through cannot be accessed.<br><br>See additional exemplification guidance. |
| | (d) | | 4 | 1 | Unit is not required; however, a maximum of 1 mark can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper. |

**Go To Additional Exemplification Guidance**

Go to Topic Grid

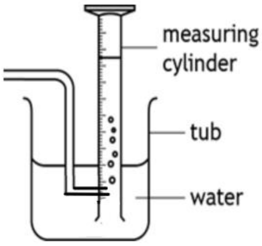
Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **13.** | | | This is an open ended question.<br><br>**1 mark:** The candidate has demonstrated a limited understanding of the chemistry involved. The candidate has made a/some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.<br><br>**2 marks:** The candidate has demonstrated a reasonable understanding of the chemistry involved. The candidate has made a/some statement(s) that is/are relevant to the situation, showing that the problem is understood.<br><br>**3 marks:** The candidate has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one. | **3** | **0 marks**: The candidate has demonstrated no understanding of the chemistry involved.<br><br>There is no evidence that the candidate has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle.<br><br>This mark would also be given when the candidate merely restates the chemistry given in the question. |

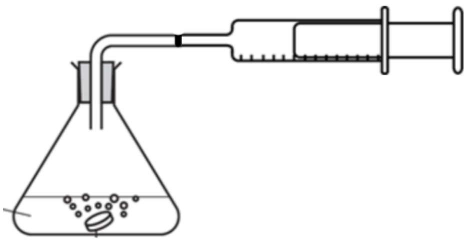
**[END OF MARKING INSTRUCTIONS]**

Go to Topic Grid

## Exemplification for Question 2(a)




Zero marks would be awarded as this experimental set up would not work.



Zero marks would be awarded as delivery tube is bi-sected.

## Exemplification of Question 3 (c) (i)

Example 1

GFM = 46

$\%N = \frac{28}{46} \times 100$

$= 60.9\%$

**2 marks**
0 mark for incorrect GFM
1 mark for $\frac{28}{\text{candidate's GFM}}$ x 100
1 mark for the final answer as they have used the relationship

$$\%\text{ by mass} = \frac{m}{GFM} \times 100$$

Example 2

$(NH_2)_2CO$
16
12
4
28

$\%N = (28/60) \times 100 = 46.6\%$

**2 marks**
1 mark for correct GFM

1 mark for $\frac{28}{\text{candidate's GFM}} \times 100$

0 mark for answer due to incorrect rounding

Example 3

$(NH_2)_2CO$

16
12
4
14
———
46

$\frac{14}{46} \times 100 = 30.4\%$

**2 marks**

0 marks for incorrect GFM

1 mark for $\frac{14}{46}$ x 100 as incorrect mass of N from GFM working has been used correctly

1 mark for final answer as concept correctly used.

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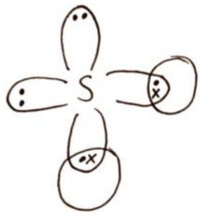
**Exemplification of Question 4(b)**

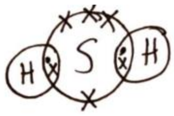

**1 mark.** Symbol is missing for sulfur, but as hydrogen atoms have symbols the mark can be awarded.


**0 marks.** Bonding electrons are out-with the overlap region and therefore the mark would not be awarded.

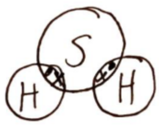

**1 mark.** Both pairs of bonding electrons are within the overlap region and the mark would therefore be awarded.




**1 mark.** Petal diagram is an acceptable format, and as symbol for one of the elements, sulfur, has been given.




**1 mark.** Non-bonding electrons are unpaired; this is acceptable.

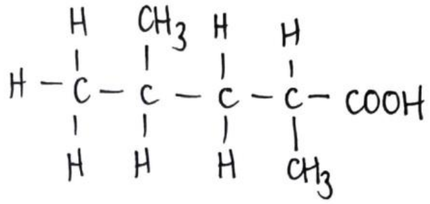



**0 marks**. Non-bonding electrons on sulfur have not been shown. No mark can be awarded.

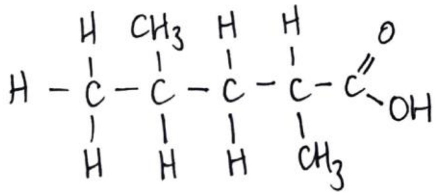

**0 marks.** Sulfur has an extra electron so mark cannot be awarded

Go to Topic Grid

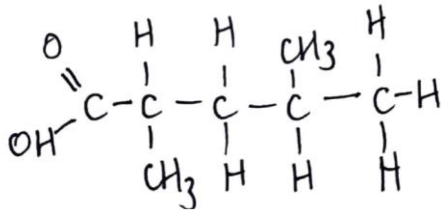
**Exemplification for Question 4 (e) (i)**



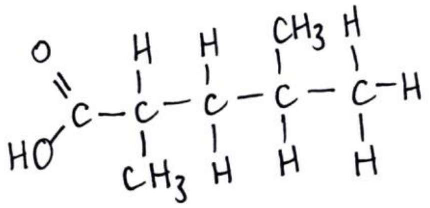
**1 mark.** A mixture of full and shortened structural formula is acceptable.



**0 marks.** The bond connectivity of the methyl group on carbon number 4 is incorrect and the mark would therefore not be awarded.



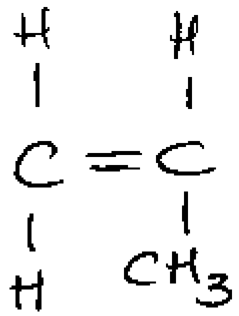
**0 marks.** The bond connectivity of the hydroxyl of the carboxyl group is incorrect.



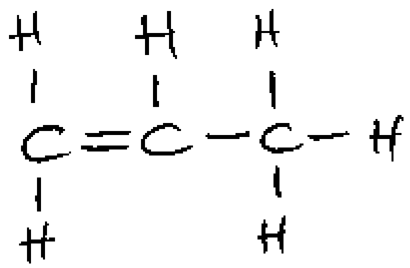
**0 marks.** The bond connectivity of the methyl group on carbon number 2 is questionable. It is closer to the hydrogen than the carbon.

Go to Topic Grid

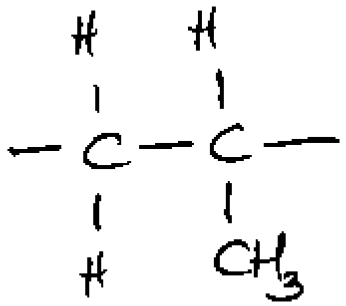
Exemplification of Question 6 (a) (i)



**0 marks.** Bond to $CH_3$ group not going to C of $CH_3$.



**1 mark**. Correctly drawn structure of propene although not in usual monomer format.



**0 marks**. A repeating unit is not acceptable. The monomer must be shown with the C=C.

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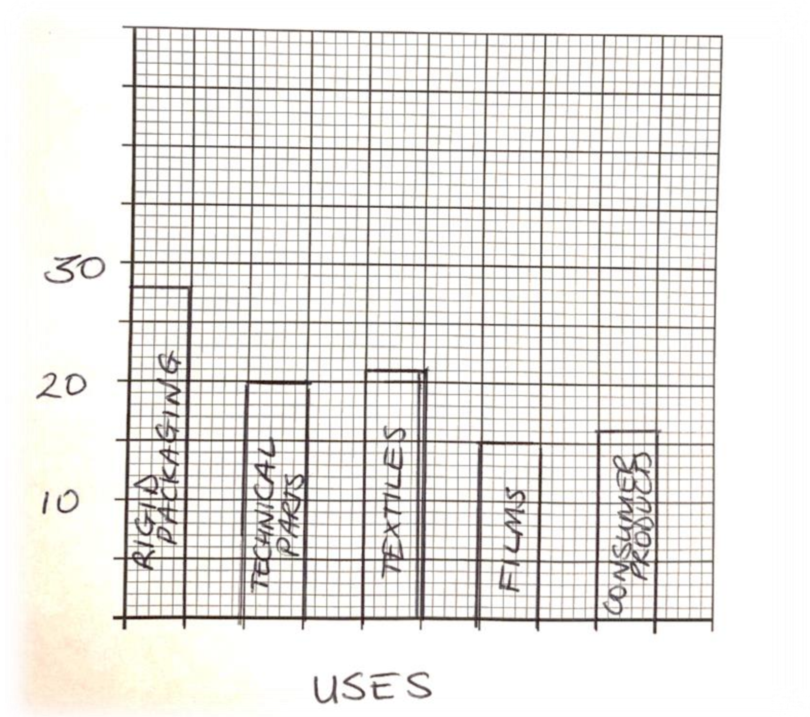
**Exemplification of Question 6 (a) (ii)**

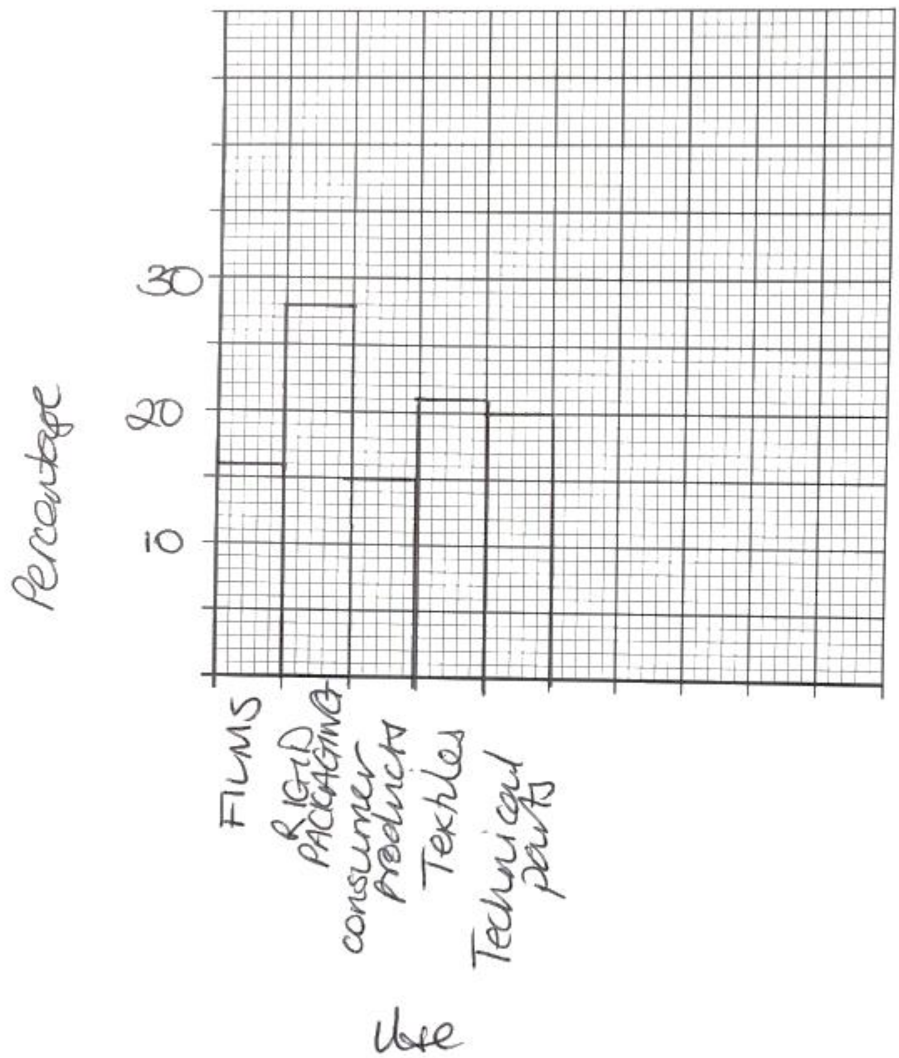
Graph 1




**2 marks**

1 mark for correct type – bars plotted.
1 mark for scales
0 mark for labels (missing y-axis label)
0 mark for plotting (films and consumer packaging wrongly plotted)

Graph 2

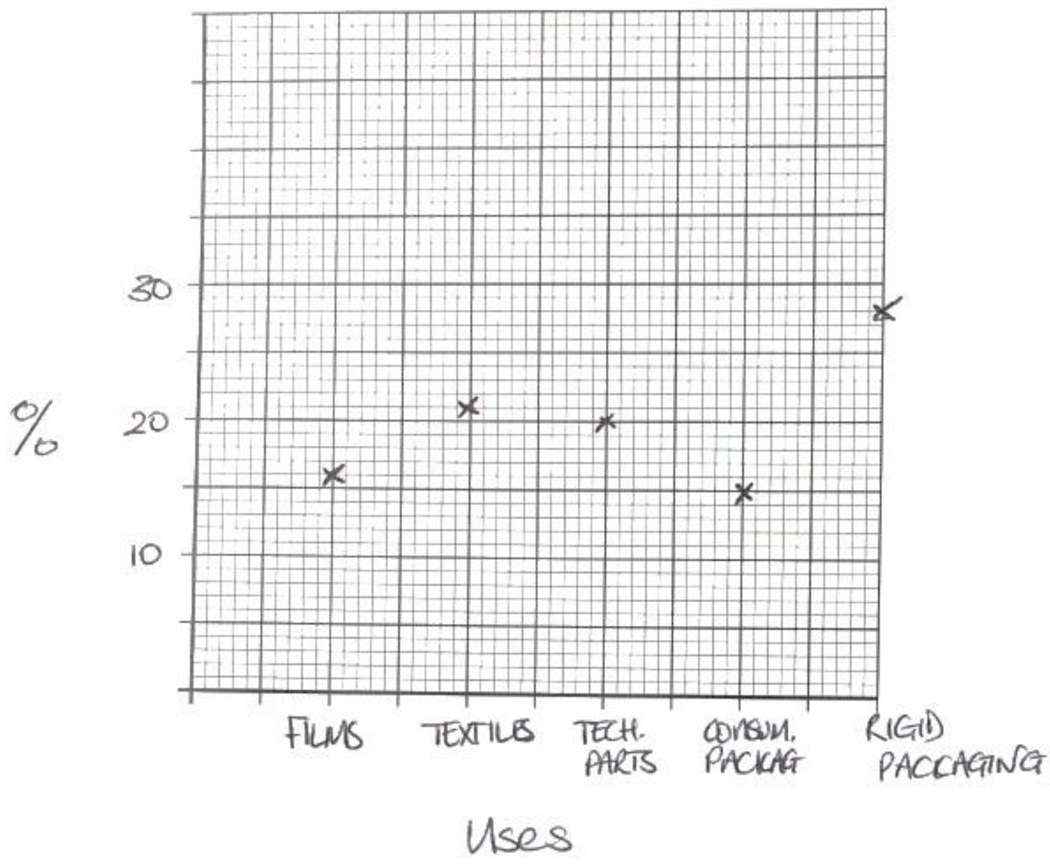



**3 marks**

1 mark for correct type – bars plotted.
0 mark for scales – last bar is not past the midway point of the graph paper
1 mark for labels
1 mark for plotting

Go to Topic Grid

Graph 3




**3 marks**

0 mark for correct type – points plotted rather than bars
1 mark for scales
1 mark for labels
1 mark for plotting

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**Exemplification of Question 8 (b)**

**Example 1**

$$\Delta T = \frac{76.32}{0.4 + 3.6}$$

$$= 53°$$

$$\text{Final temp} = 17 + 53°$$

$$= 70°$$

**3-marks.**

1 mark deducted for incorrect unit (applied once in paper)

**Example 2**

$$E_h = cm\Delta T \qquad m = \frac{400}{1000} = 0.4$$

$$\Delta T = \frac{mc}{E_h}$$

$$= \frac{0.4 \times 3.6}{76.32}$$

$$= 0.019$$

$$\Delta T = 17 + 0.019$$

$$= \underline{\underline{17.019°C}}$$

**2 marks.**

1 mark for correct mass in kg and 1 mark for correct final temperature calculation using incorrect delta T. Concept mark not awarded.

**Example 3**

$$E = mc\Delta T \qquad m = 0.4$$

$$c = 3.6$$

$$\Delta T = ?$$

$$E = 76.32$$

$$\Delta T = \frac{E}{mc}$$

$$= \frac{76.32}{3.6 \times 0.4}$$

$$= 41°C$$

$$\Delta T = 17°C + 41°C = 58°C$$

**3 marks.**

Correct mass, concept and correct final temperature calculation using incorrect $\Delta T$ value.

**Example 4**

$E = mc\Delta T$

$m = 0.4$
$c = 3.6$
$\Delta T = ?$
$E = 76.32$

$\Delta T = \frac{E}{mc}$

$= \frac{76.32}{0.4 \times 3.6}$

$= \frac{76.32}{1.44}$

$= \underline{53\,°C}$

**3 marks.**

Final temperature not calculated.

**Example 5**

$\Delta T = \frac{E}{mc}$

$= \frac{76.32}{0.4 \times 3.6}$

$= 53\,°C$

Final temp $= 17 + 53$

$= \underline{\underline{70\,°C}}$

**4 marks.**

**Example 6**

$\Delta T = \frac{E}{mc}$

$m = \frac{40}{1000}$

$= \frac{76.32}{0.04 \times 3.6}$

$= \frac{76.32}{0.144}$

$= 530$

$\Delta T = 530 + 17$

$= \underline{547\,°C}$

**3 marks.**

Incorrect mass used but concept and calculations are correct.

Go to Topic Grid

**Example 7**

$c = 3600\ \text{J kg}^{-1}\ {}^\circ\text{C}^{-1}$

$E = 76320\ \text{J}$

$m = \frac{400}{1000} = 0.4$

$\Delta T = \frac{E}{mc} = \frac{76320}{0.4 \times 3600}$

$\Delta T = \frac{76320}{1440} = 53\,^\circ\text{C}$

Final temp $= 17 + 53\,^\circ\text{C}$

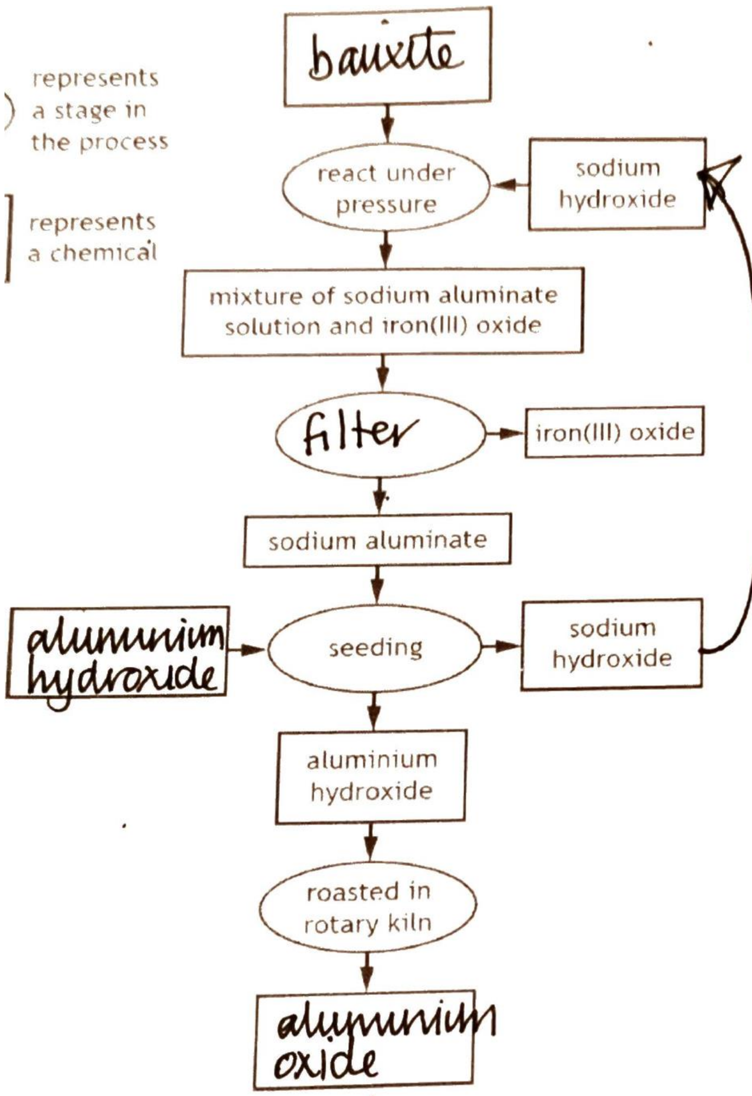
$= 60\,^\circ\text{C}$

**3 marks.**

Final temperature calculation incorrect.

## Exemplification of Question 9 (a) (ii)

**Example 1**




**1 mark.**

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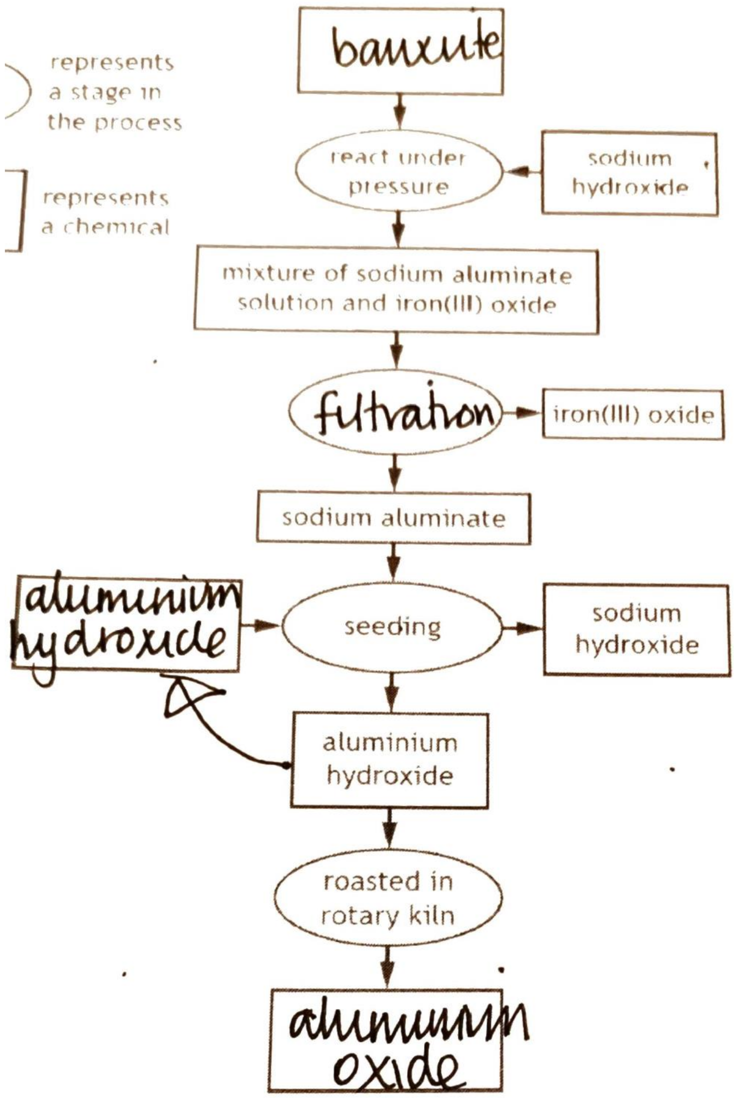
**Example 2**




**1 mark.**

**Exemplification of Question 11 (b) (i) and (ii)**

**Example 1**

**11(b) (i)**

5,000 years

**0 marks**

**11(b) (ii)**

$4 \times 5{,}000$
$= 20{,}000$

**2-marks.** Follow through of incorrect value with correct number of half-lives.

**Example 2**

1 2 3 4 5

$1 \quad \frac{1}{2} \quad \frac{1}{4} \quad \frac{1}{8} \quad \frac{1}{16}$

$= 5 \ \frac{1}{2}$ lives

$= 5 \times 5{,}700$

$= 28{,}500$

**1mark**. Incorrect number of half-lives used.

**Example 3**

11(b) (i)

5,000 years

11(b) (ii)

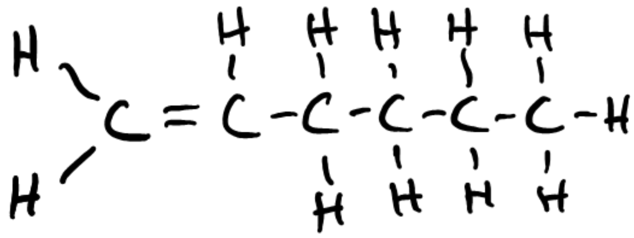
$\frac{1}{16} = 4 \times \frac{1}{2}$ life

$4 \times 4{,}000$

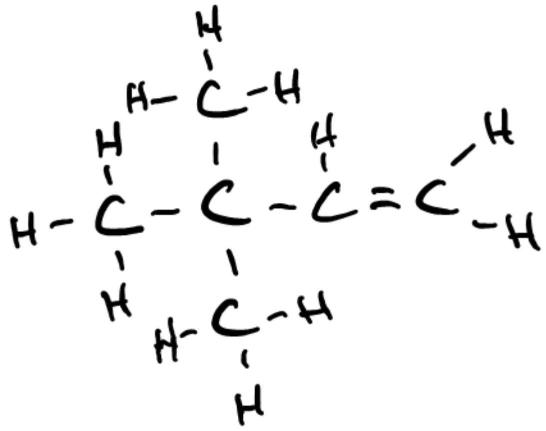
$= 16{,}000$

**1 mark.** Correct number of half lives, incorrect half-life used from b(i) should be 5,000.

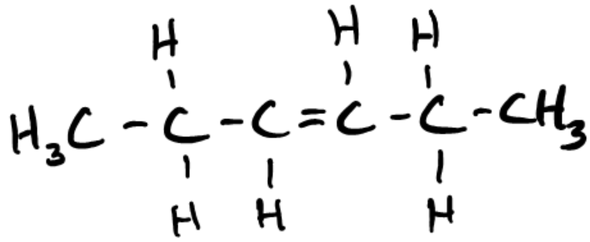
**Exemplification of Question 12 b (ii)**



1 mark



1 mark



1 mark

Go to Topic Grid

## Exemplification of Question 12 (c)

**Example 1**

$$\frac{175}{\text{gfm } C_5H_{10}} = \frac{175}{60}$$

$$= 2.92 \times 2$$

$$= 5.84 \text{ moles of sodium}$$

$$\text{mass of sodium} = n \times \text{gfm(RAM)}$$

$$= 5.84 \times 23$$

$$= 134.32\text{g}$$

**2-marks.** Incorrect GFM of cyclopentane used, all other calculations correct.

**Example 2**

$$\frac{175}{70} = 2.5 \text{ mols}$$

$$2.5 \times 23$$

$$= 57.5$$

**2-marks**. Number of moles and concept mark but 2:1 ratio of sodium:cyclopentane not used. Unit not required.

**Example 3**

$$2Na \longrightarrow C_5H_{10}$$

$$23 \longrightarrow 70$$

$$x \longrightarrow 170$$

$$23x = 70 \times 170$$

$$x = \frac{70 \times 170}{23}$$

$$= 517.39\text{g}$$

**1 mark.**

Correct GFMs used. Incorrect concept.

**Example 4**

$$2Na \longrightarrow C_5H_{10}$$

$$2 : 1$$

GFM 46 —— 70 - GFM

175g

115g

**3 marks.**

Go to Topic Grid

**Example 5**

| $2Na$ | $C_5H_{10}$ |
|---|---|
| 2 | 1 |
| 46 | 60 |
| .1 | $\frac{46}{60}$ |

$175 \times 0.77$
$= 134g$

**2 marks.**

Incorrect GFM for cyclopentane used.

Concept mark awarded for applying concept of 174 x (2 x candidates GFM Na / candidates incorrect GFM of cyclopentane.)

N5 National Qualifications 2022

**X813/75/02**

# Chemistry
# Section 1 — Questions

FRIDAY, 29 APRIL

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/75/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

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

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

SQA ©

*X8137502*

Go to Topic Grid

**SECTION 1 — 25 marks**

**Attempt ALL questions**

**1.** Which of the following is the atomic number of a metal?

A 1
B 33
C 45
D 86

**2.** An atom is neutral because:

A the number of protons equals the number of neutrons
B the number of electrons equals the number of protons
C the number of electrons equals the number of protons plus neutrons
D the number of neutrons equals the number of electrons plus protons.

**3.** When liquid water changes to steam:

A weak forces of attraction between the water molecules are broken
B strong forces of attraction between the water molecules are broken
C weak forces of attraction between the atoms in the water molecules are broken
D strong forces of attraction between the atoms in the water molecules are broken.

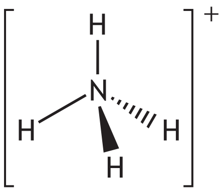
**4.** Which line in the table shows how the concentration of a solution changes when more solute or solvent is added?

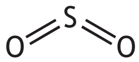
| | **Adding solute** | **Adding solvent** |
|---|---|---|
| A | concentration decreases | concentration increases |
| B | concentration decreases | concentration decreases |
| C | concentration increases | concentration decreases |
| D | concentration increases | concentration increases |

Go to Answers

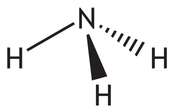
Go to Topic Grid

**5.** Which of the following structures would be described as angular?

A 

B 

C 

D 

[Turn over

Go to Answers

Go to Topic Grid

6. Electronegativity is a measure of the attraction a nucleus has for the shared pair of electrons in a covalent bond.

When two nuclei that have different electronegativity values are bonded together, the bond formed is described as ‘polar covalent’.

The bigger the difference in the electronegativity values the more polar the bond.

The table contains electronegativity values for some atoms.

| Atom | Electronegativity value |
|---|---|
| H | 2.2 |
| C | 2.6 |
| N | 3.0 |
| O | 3.4 |

Which of the following bonds would be the most polar?

A O–H

B N–H

C C–H

D C–O

7. Which line in the table shows what would be observed during the electrolysis of copper chloride, using a d.c. supply?

| | At the positive electrode | At the negative electrode |
|---|---|---|
| A | gas forms | solid forms |
| B | gas forms | gas forms |
| C | solid forms | gas forms |
| D | solid forms | solid forms |

Go to Answers

Go to Topic Grid

**8.** Which of the following compounds is a salt?

A Calcium oxide

B Hydrogen nitrate

C Sodium hydroxide

D Potassium ethanoate

**9.** The pH of the solution formed when ammonia is bubbled into water is most likely to be:

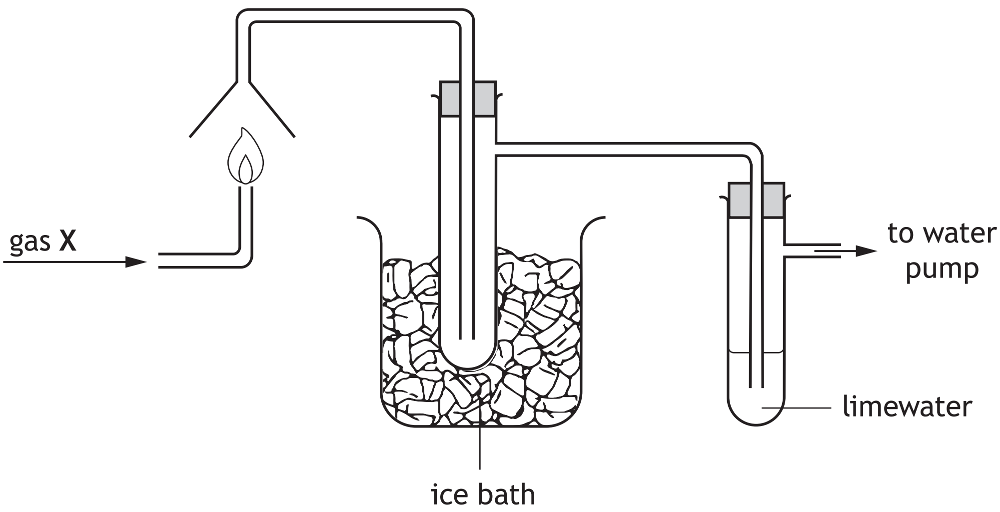
A 3

B 5

C 7

D 9.

**10.** The apparatus shown can be used to identify the products of combustion.




When gas **X** was burned, a colourless liquid collected in the cooled test tube but there was no change in the limewater.

Gas **X** could be:

A methane

B carbon monoxide

C hydrogen

D ethane.

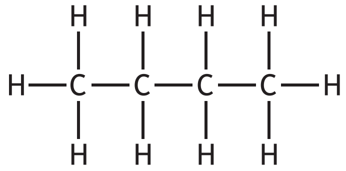
**[Turn over**

Go to Answers

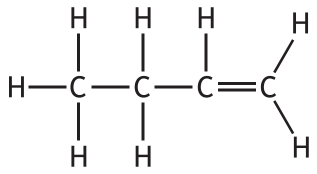
**11.** Which of the following compounds has the highest boiling point?

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

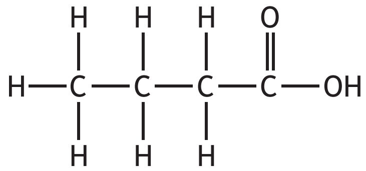
A



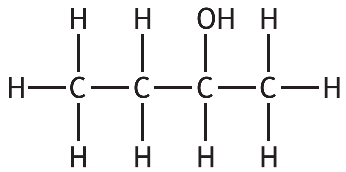
B



C



D

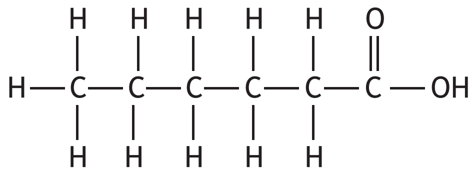


Go to Answers

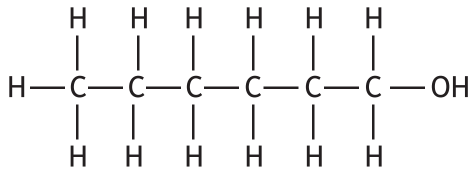
Go to Topic Grid

**12.** Which of the following molecules will decolourise bromine solution and also form an acidic solution when added to water?

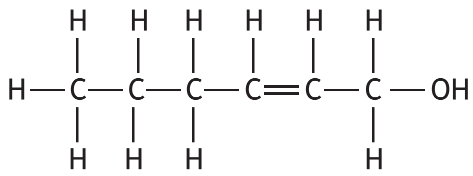
A



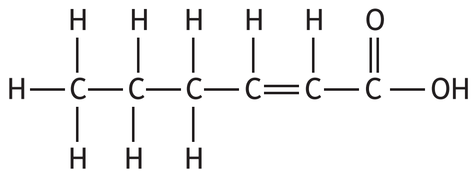
B



C



D

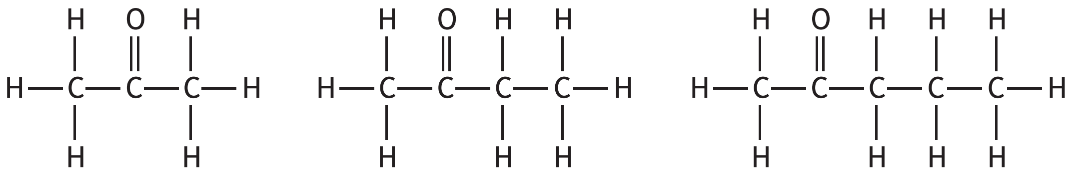


**[Turn over**

Go to Answers

Go to Topic Grid

**13.** The first three members of the alkanones are



The general formula for the alkanones is:

A $C_nH_{2n-2}O$

B $C_nH_{2n}O$

C $C_nH_{2n+1}O$

D $C_nH_{2n+2}O$

**14.** Which of the following could be the formula mass of a cycloalkane?

A 40

B 42

C 54

D 58

**15.** Metallic bonding is a force of attraction between:

A positive ions and delocalised electrons

B negative ions and delocalised electrons

C negative ions and positive ions

D a shared pair of electrons and two nuclei.

**16.** Metals used to make aircraft have a density of less than 3 $g\,cm^{-3}$ and have to withstand temperatures up to 600 °C.

Which line in the table gives the correct data for a metal used to make aircraft?

| | Melting point (°C) | Density ($g\,cm^{-3}$) |
|---|---|---|
| A | 98 | 0.97 |
| B | 660 | 2.70 |
| C | 1854 | 6.52 |
| D | 1085 | 8.96 |

Go to Answers

Go to Topic Grid

**17.** Which of these metals can only be extracted from its ore by electrolysis and forms an oxide that is insoluble in water?

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

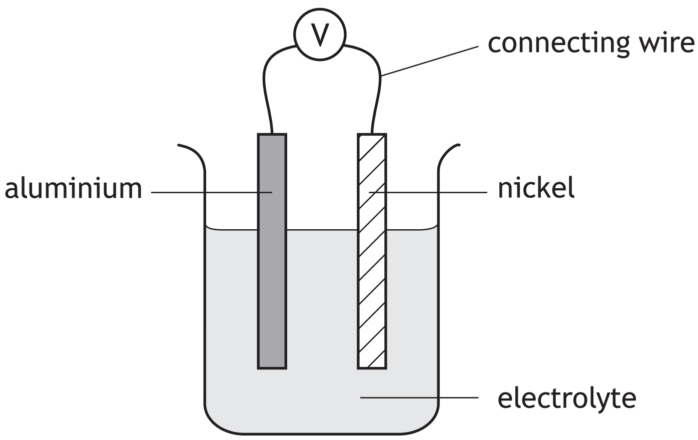
A Aluminium

B Calcium

C Copper

D Lead

**18.**




Which statement correctly describes the electron flow in the cell?

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

A Through the electrolyte from aluminium to nickel.

B Through the electrolyte from nickel to aluminium.

C Through the connecting wire from nickel to aluminium.

D Through the connecting wire from aluminium to nickel.

**19.** Which metal, when paired with magnesium in a cell, will produce the highest voltage?

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

A Iron

B Lead

C Tin

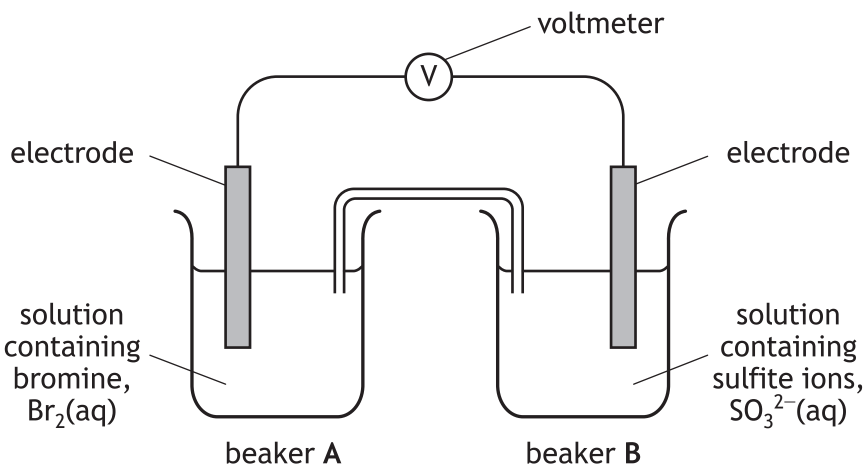
D Zinc

**[Turn over**

Go to Answers

Go to Topic Grid

**20.**




The reactions occurring at each electrode are:

Beaker **A** $Br_2(\ell) + 2e^- \rightarrow 2Br^-(aq)$

Beaker **B** $SO_3^{2-}(aq) + H_2O(\ell) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$

Which of the following equations is the overall redox reaction in the cell?

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

A $Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell) + 2e^- \rightarrow 2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$

B $2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq) \rightarrow Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell)$

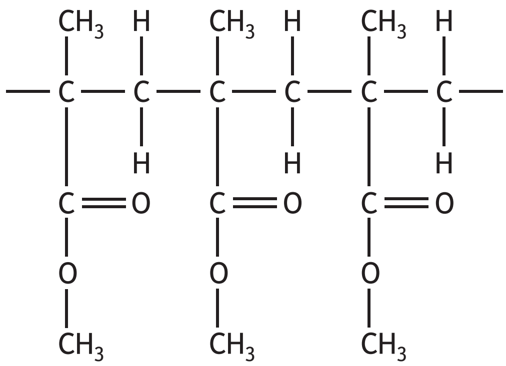
C $Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell) \rightarrow 2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq)$

D $2Br^-(aq) + SO_4^{2-}(aq) \rightarrow Br_2(\ell) + SO_3^{2-}(aq)$

Go to Answers

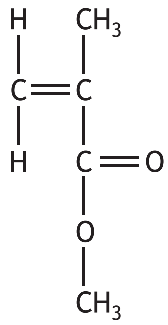
Go to Topic Grid

**21.** Polymethylmethacrylate is a polymer used in the manufacture of aircraft windows. A section of the polymer chain is drawn below.

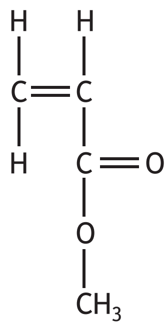


The monomer used to make this polymer is:

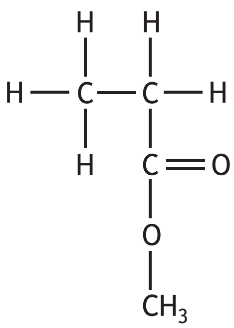
A



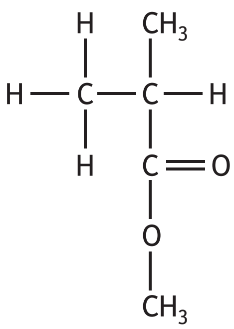
B



C



D



Go to Answers

Go to Topic Grid

**22.** Which line in the table is correct for the Ostwald process?

| | Product | Catalyst |
|---|---|---|
| A | $HNO_3$ | iron |
| B | $HNO_3$ | platinum |
| C | $NH_3$ | iron |
| D | $NH_3$ | platinum |

**23.** Radon-222 is a radioisotope present in the Earth's atmosphere. Plants can absorb radon-222 through their roots.

Compared with radon-222 in the atmosphere, the half-life of the radon-222 in the plant cells will be:

A shorter

B longer

C the same

D dependent on the size of the plant.

**24.** A radioisotope is used to monitor blood flow around the body. In order to prevent damage to the body the radiation emitted must be able to escape through the skin.

Which line in the table describes the type of radiation emitted and half-life that would make a radioisotope suitable for this use?

| | Type of radiation emitted | Half-life |
|---|---|---|
| A | alpha | long |
| B | beta | long |
| C | alpha | short |
| D | beta | short |

Go to Answers

Go to Topic Grid

**25.** A student measured 25 $cm^3$ of sodium hydroxide for a titration experiment using a 100 $cm^3$ measuring cylinder. Their teacher suggested that there was a more accurate piece of apparatus to measure this volume.

Which piece of apparatus should the student have used to more accurately measure out the 25 $cm^3$ volume of sodium hydroxide?

A 100 $cm^3$ beaker

B 25 $cm^3$ measuring cylinder

C 25 $cm^3$ pipette

D 100 $cm^3$ conical flask

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]**

Go to Answers

FOR OFFICIAL USE

| | | | | | |
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# N5

National Qualifications 2022

Mark

**X813/75/01**

**Chemistry Section 2**

FRIDAY, 29 APRIL

1:00 PM – 3:30 PM

* X 8 1 3 7 5 0 1 *

**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 ©

* X 8 1 3 7 5 0 1 0 1 *

Go to Topic Grid



## 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

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

(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.**



Go to Answers

Go to Topic Grid

MARKS DO NOT WRITE IN THIS MARGIN

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

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

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

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

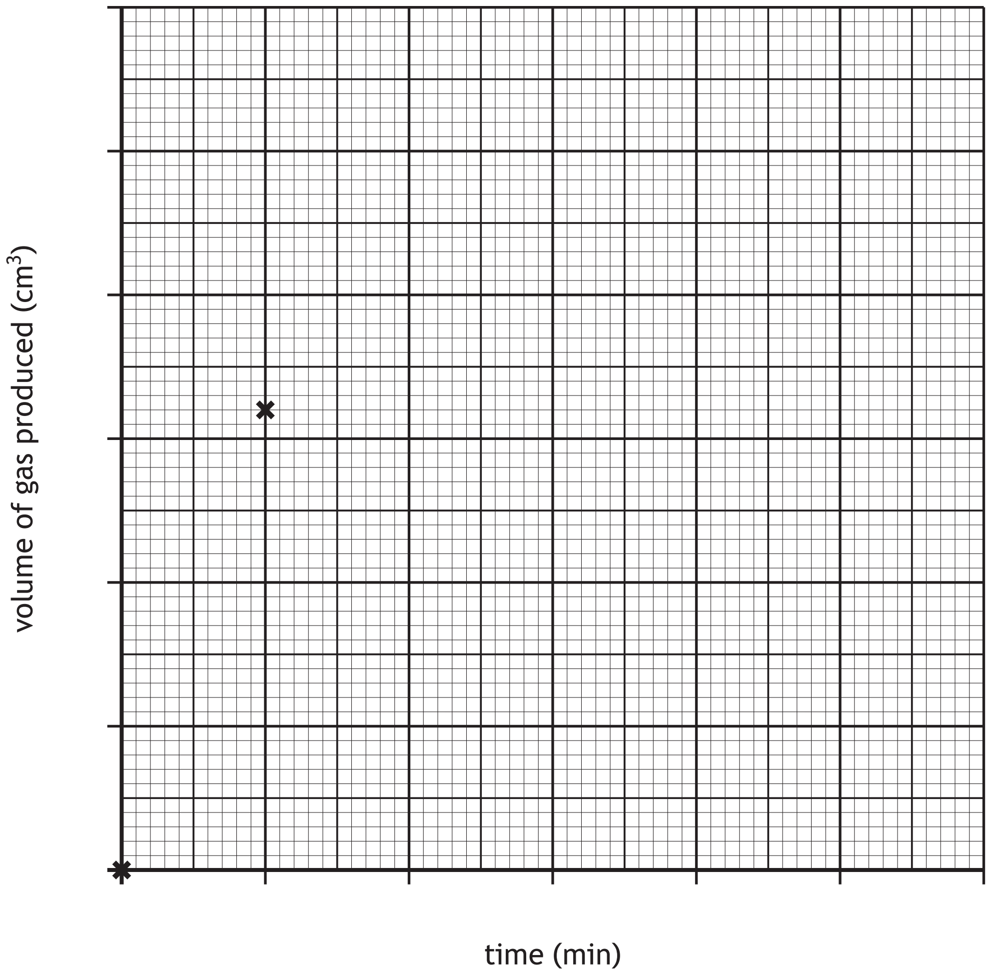
In an experiment, the progress of a reaction was monitored by measuring the volume of hydrogen gas produced.

| **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*.)




Go to Answers

Go to Topic Grid

MARKS DO NOT WRITE IN THIS MARGIN

**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**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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 $\left\{\begin{array}{c}\text{hydrogen}\\ \text{hydroxide}\end{array}\right\}$ ions than $\left\{\begin{array}{c}\text{hydrogen}\\ \text{hydroxide}\end{array}\right\}$ ions.



Go to Answers

Go to Topic Grid



**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



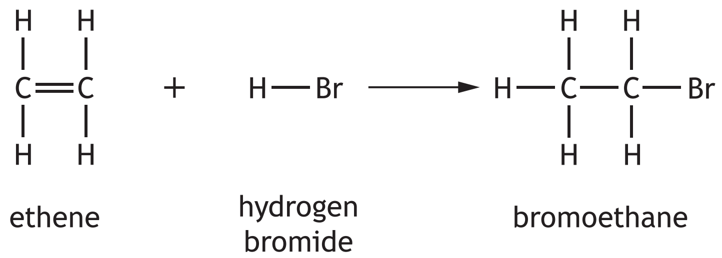
Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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.



(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**

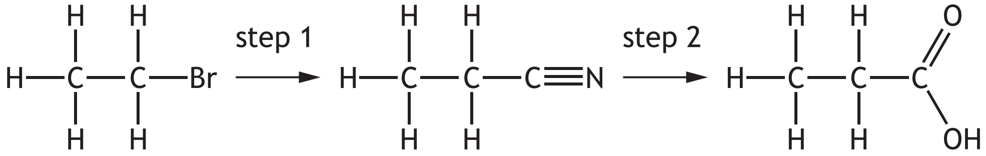
Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

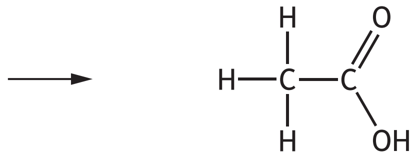
**4. (continued)**

(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



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

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**

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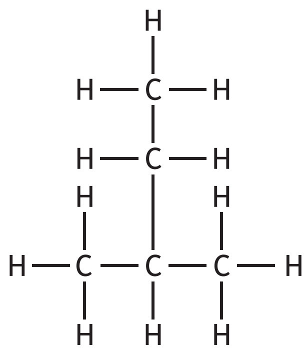
Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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.

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

Balance this equation. **1**

**[Turn over**



Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

**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.**

Go to Topic Grid

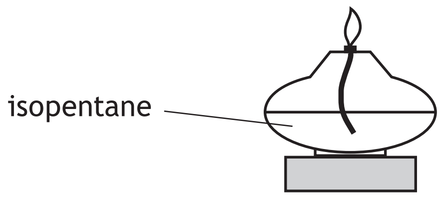
MARKS | DO NOT WRITE IN THIS MARGIN

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*.)




[Turn over



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

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**

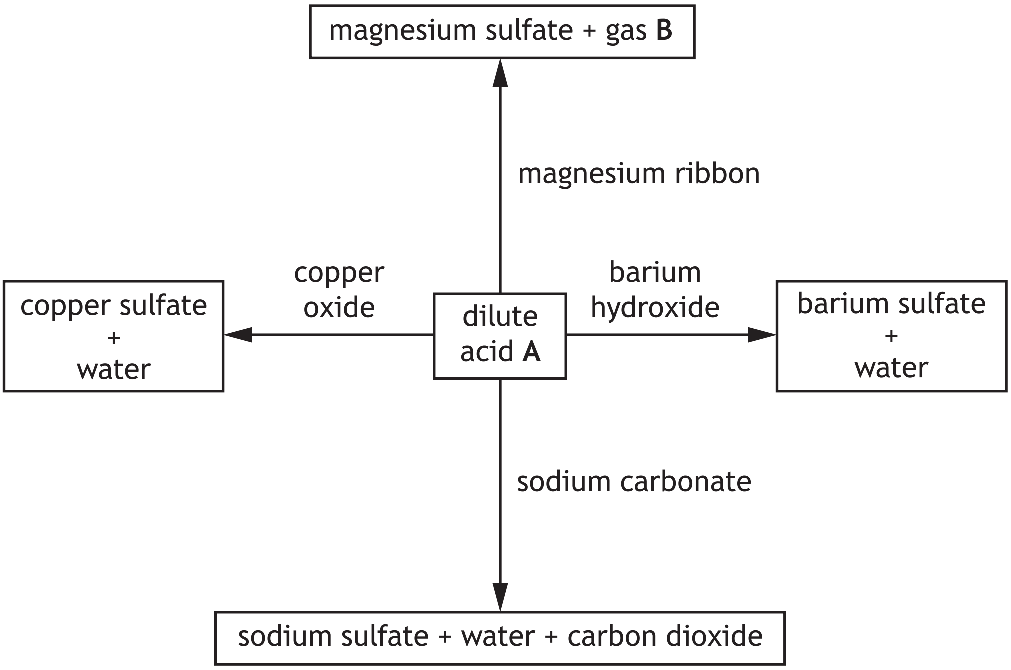
[Turn over

Go to Answers

Go to Topic Grid

MARKS DO NOT WRITE IN THIS MARGIN

**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**

MARKS DO NOT WRITE IN THIS MARGIN

**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

MARKS | DO NOT WRITE IN THIS MARGIN

**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**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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**



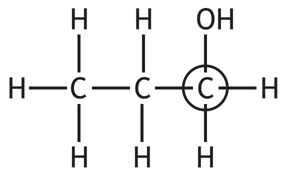
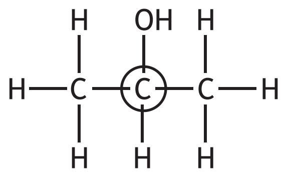
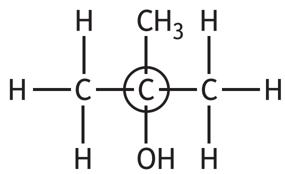
Go to Answers

**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 |

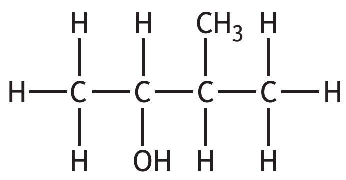
(i) Name the functional group present in all alcohols. **1**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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**



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**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**

Go to Answers

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MARKS DO NOT WRITE IN THIS MARGIN

**11. (continued)**

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

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

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

[Turn over

Go to Answers

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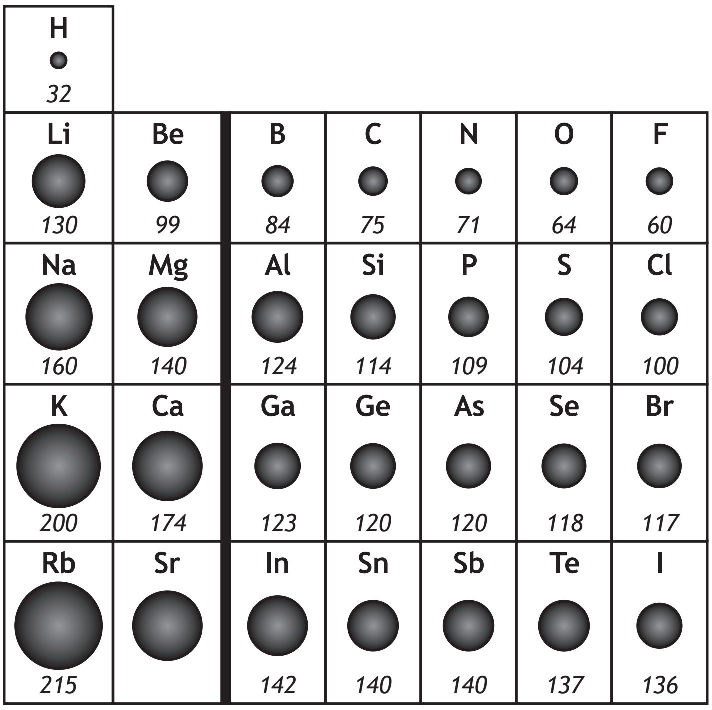
MARKS | DO NOT WRITE IN THIS MARGIN

**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**

*X813750128*

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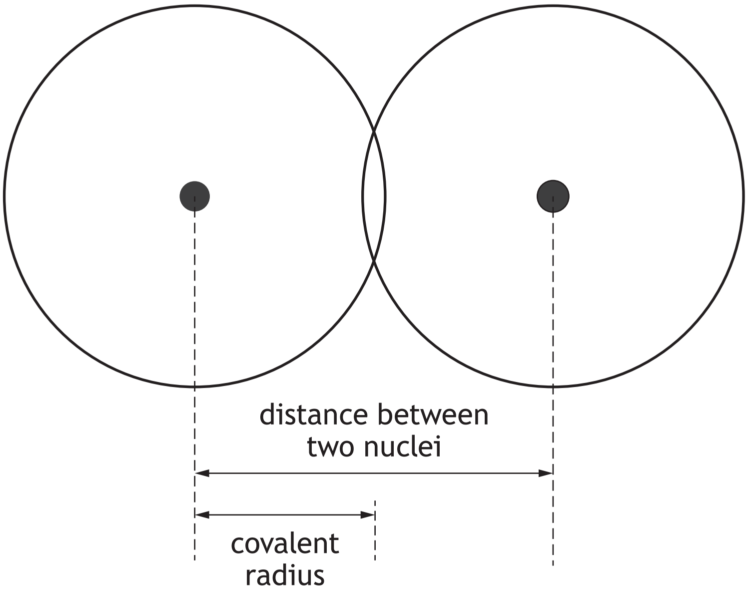
MARKS DO NOT WRITE IN THIS MARGIN

**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



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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]**



Go to Answers

National
Qualifications
2022

# 2022 Chemistry

# National 5

# Finalised Marking Instructions

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Marking instructions for each question

| Question | Answer | Mark |
|---|---|---|
| 1. | C | 1 |
| 2. | B | 1 |
| 3. | A | 1 |
| 4. | C | 1 |
| 5. | B | 1 |
| 6. | A | 1 |
| 7. | A | 1 |
| 8. | D | 1 |
| 9. | D | 1 |
| 10. | C | 1 |
| 11. | C | 1 |
| 12. | D | 1 |
| 13. | B | 1 |
| 14. | B | 1 |
| 15. | A | 1 |
| 16. | B | 1 |
| 17. | A | 1 |
| 18. | D | 1 |
| 19. | B | 1 |
| 20. | C | 1 |
| 21. | A | 1 |
| 22. | B | 1 |
| 23. | C | 1 |
| 24. | D | 1 |
| 25. | C | 1 |

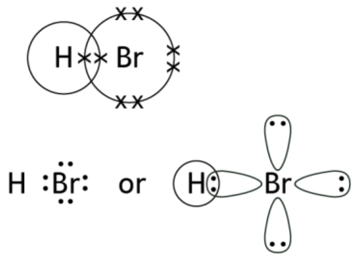
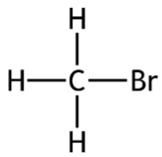
Go to Topic Grid

Section 2

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 1. | (a) | (i) | Beta/β | 1 | |
| | | (ii) | Xenon/Xe / $^{131}_{54}\text{Xe}$ / $^{131}\text{Xe}$ | 1 | If atomic/mass numbers are given they must be correct. |
| | (b) | (i) | 15 (days) **(2)**<br><br>Partial marking:<br><br>1 mark can be awarded for either:<br><br>3 half-lives<br><br>**OR**<br><br>Number of days correctly calculated for an incorrect number of half-lives (provided the working supports the number of half-lives).<br><br>**OR**<br><br>Time for 3 half lives for the wrong radioisotope.<br>i.e. 24 days for iodine or 90 years for caesium. (provided it is clear they have used the wrong half life). | 2 | Units not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | | (ii) | Caesium-137/Caesium /Cs/ $^{137}\text{Cs}$ | 1 | |

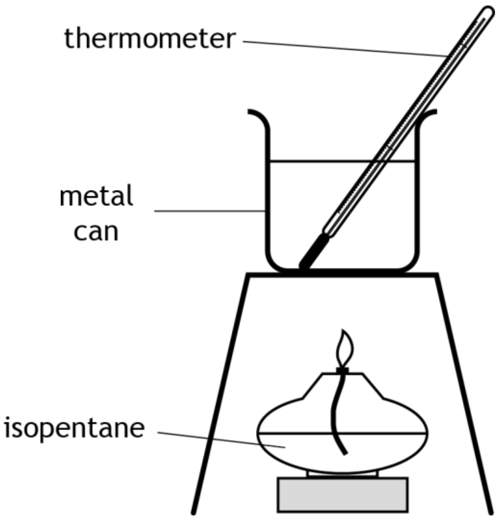
| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **2.** | (a) | | Correct scales **(1)**<br><br>Correct plotting and curve/line of best fit drawn **(1)** | **2** | |
| | (b) | | 5.33/5.3/5.0 (cm$^3$ min$^{-1}$) **(2)**<br>-------------------------------------------<br>Partial marking:<br><br>**1 mark awarded for concept of change in volume/change in time.**<br><br>(48-32) ÷ 3 **(1)**<br>**OR**<br>16 ÷ 3<br>with an incorrect answer | **2** | Unit is not required, however a maximum of 1 mark can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper.<br><br>The mark for a final answer can only be awarded if the concept of **change in** volume/**change in** time is correct i.e. incorrect values **from the table** used (subtractions must be shown and volumes chosen **must** correspond to chosen times). |
| | (c) | | Mass, pH, concentration, conductivity | **1** | If candidate mentions an incorrect direction of change for a correct alternative measurement this would negate the type of measurement. |
| | (d) | | 48 (cm$^3$) | **1** | Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **3.** | (a) | | Ammonia and carbon dioxide | **1** | Both required to award the mark. |
| | (b) | | 1.625 /1.63/1.6 (kg) | **1** | Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | (c) | | Hydrogen hydroxide | **1** | |
| | (d) | | Not toxic or flammable<br><br>OR<br><br>Not toxic<br>**OR**<br>Not flammable | **1** | |
| | (e) | (i) | It also contains phosphorus<br>**OR**<br>It contains nitrogen and phosphorus<br>**OR**<br>It contains two of the elements essential (for healthy plant growth) | **1** | |
| | | (ii) | 21.21/21.2/21 (%) **(3)**<br>------------------------------------------<br>Partial marking:<br><br>1 mark for correctly calculating the GFM of $(NH_4)_2HPO_4$ = 132 **(1)**<br><br>$\frac{28}{132} \times 100$<br><br>This step on its own is awarded 2 marks. **(2)**<br><br>Using the correct concept of:<br><br>$\frac{\text{candidate's mass of nitrogen in GFM}}{\text{candidate's GFM}} \times 100$ **(1)**<br><br>A further mark can be awarded for arithmetical follow through to the candidate's answer **only if the mark for the concept has been awarded.** | **3** | If no working of GFM is shown then mass of nitrogen must be 28.<br><br>Working **must** be shown to support an incorrect GFM to allow the concept mark to be awarded.<br><br>Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 4. | (a) | (i) | addition | 1 | |
| | | (ii) |    <br>**Either** the correct symbol for bromine **or** hydrogen **must** be shown. | 1 | The non-bonding electrons in bromine must be shown but do not need to be together/shown as a pair.<br><br>Bonding electrons **must** be on the line or in the overlapping area. If inner electrons on bromine are shown they must be correct i.e. 2, 8, 18. |
| | | (iii) | Hydrogen chloride/HCl/ hydrochloric acid | 1 | |
| | (b) | (i) |    <br>OR<br>$CH_3Br$<br>Accept any halogen in place of bromine. | 1 | If the candidate attempts to draw the nitrile as well as the haloalkane this should be ignored. |
| | | (ii) | vinegar | 1 | |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 5. | | | This is an open-ended question.<br><br>**1 mark**: The candidate has demonstrated a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.<br><br>**2 marks**: The candidate has demonstrated a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem.<br><br>**3 marks:** The maximum available mark would be awarded to a candidate who has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. | 3 | **Award 0 marks** where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award zero marks also if the candidate merely restates the chemistry given in the question. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **6.** | (a) | | (2-) methylbutane | **1** | Punctuation/spaces/omission of a hyphen should not be penalised.<br><br>2 is the only acceptable number. |
| | (b) | (i) | fuel | **1** | |
| | | (ii) | $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ | **1** | Accept correct multiples.<br><br>If equation is rewritten, **all** formulae must be correct and correct format.<br><br>If state symbols are given, they must be correct. |
| | | (iii) | 10/10.03/10.032 **(3)**<br>------------------------------------------<br>Partial marking:<br><br>Using *cm*Δ*T* with *c* = 4.18 **(1)**<br>To be awarded this concept mark, candidates do not specifically need to write *cm*Δ*T*. The concept mark is awarded for using this relationship with three values, one of which must be 4.18<br><br>For values 0.2 (kg) **and** 12 (°C) **(1)**<br><br>A further mark can be awarded for arithmetical follow through to the candidate's answer only if the mark for the *cm*Δ*T* concept has been awarded. **(1)** | **3** | No units required but a maximum of two marks can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.<br><br>10032 J can be awarded 3 marks if used with 4180 and the correct unit is given.<br><br>If candidate follows through to 12.54 kJ $g^{-1}$ then 3 marks can still be awarded provided working is shown to support this answer. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 6. | (b) | (iv) | 1 mark awarded for a workable, labelled method that allows the heat energy to be absorbed by the water.<br>(labelled diagram to include beaker/can/test-tube with water)<br>(water line is acceptable in place of a 'water' label).<br><br>1 mark for a labelled thermometer.<br><br> | 2 | Unsafe methods (such as including a Bunsen burner/heating isopentane) would be awarded zero marks.<br><br>Candidate cannot access the mark for labelled thermometer unless a workable diagram is given. |

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>7.</td><td>(a)</td><td>(i)</td><td>43.875/43.88/43.9/44<br><br>------------------------------------------<br><br>Partial marks can be awarded for a maximum of two of the following three steps:<br><br>1 mark for correctly calculating the number of moles of sodium chloride.<br>i.e. n = cV = 1.5 x 0.5 = 0.75 mol (1)<br><br>1 mark for correctly calculating the GFM of sodium chloride<br>i.e. GFM = 58.5 (1)<br><br>1 mark for calculating the mass of sodium chloride<br>i.e. m = n x GFM using candidate’s calculated moles of sodium chloride and candidate’s calculated GFM (1)</td><td>3</td><td>No units required but a maximum of two marks can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(mass) balance/scale(s) / measuring scale</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>106.67/106.7/107 (°C)</td><td>1</td><td>$106.\dot{6}$ is not acceptable.<br><br>Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><td>Concentration (mol $l^{-1}$)</td><td>(Average) Boiling Point (°C)</td></tr><tr><td>0.5</td><td>101.3</td></tr><tr><td>1.0</td><td>104</td></tr><tr><td>1.5</td><td>Candidate’s answer from (b)(i)</td></tr></table><br>1 mark for correct headings with units<br>1 mark for matching data</td><td>2</td><td>Units do not need to be in the headings but would need to be correctly shown for every entry in the table.<br><br>Units can be included in both the heading and entries.<br><br>A unit on its own is not sufficient to award the mark for a correct heading.</td></tr>
</table>

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| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **7.** | (c) | | Line graph/scatter graph | **1** | Accept "points" |
| | (d) | | As the concentration increases the boiling point increases.<br><br>OR<br><br>The boiling decreases as the concentration decreases. | **1** | If candidates answer to b(i) does not allow them to make a conclusion, then the candidate can state this for 1 mark.<br><br>Zero marks awarded for an incorrect cause and effect<br>e.g. the concentration increases as the boiling point increases. |

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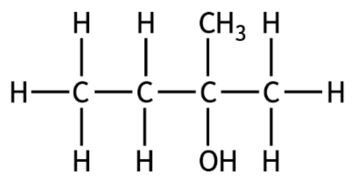
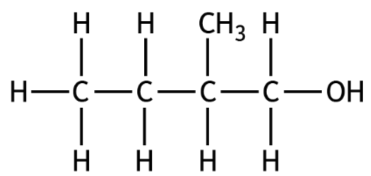
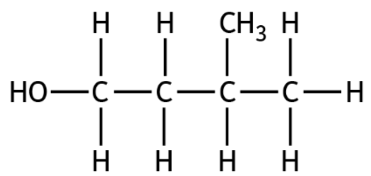
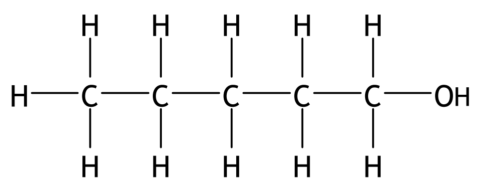
| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **8.** | (a) | | Sulfuric (acid) / $H_2SO_4$ / hydrogen sulfate | **1** | |
| | (b) | | Hydrogen / $H_2$ | **1** | |
| | (c) | | a gas/carbon dioxide is no longer produced no more fizzing/bubbling | **1** | Award zero marks for<br>- any mention of dissolving<br>- saturated solution<br>Both of these would negate a correct answer.<br><br>'until it no longer reacts' is awarded zero marks but does not negate a correct answer. |
| | (d) | | Barium sulfate | **1** | |
| | (e) | | The reaction of an acid with a base (to produce water). | **1** | If the candidate names the types of bases all three must be mentioned. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **9.** | (a) | | same atomic number/<br>number of protons but a different mass number/number of neutrons. | **1** | Mention of molecules/compounds negates. |
| | (b) | | It has a stable electron arrangement/<br>Noble gases have full/<br>stable outer shells | **1** | |
| | (c) | (i) | $XeF_2 + F_2 \longrightarrow XeF_6$ | **1** | Equation does not need to be balanced but if balanced it must be correct.<br><br>If a catalyst is included its formula must be correct and shown over/under the arrow.<br><br>Zero marks awarded for a word equation on its own but this does **not** negate a correct formulae equation.<br><br>Ignore state symbols |
| | | (ii) | (Covalent) Molecular / molecule | **1** | |
| | | (iii)<br>(A) | 35 (g) | **1** | Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | | (B) | (£)277.60 | **1** | Accept 27760p.<br>Do not accept “27760” on its own.<br><br>Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **10.** | (a) | | They have the same general formula<br>**AND**<br>similar/same chemical properties<br><br>Both required for **(1 mark)** | **1** | Award zero marks for<br>- molecular formula<br>- structural formula<br>- chemical formula<br><br>Award zero marks for<br>- physical properties in place of chemical properties however, it does not negate if given in addition to chemical properties. |
| | (b) | (i) | Hydroxyl | **1** | Zero marks awarded for OH/-OH/hydroxide/$OH^-$<br><br>General marking principle **(m)** does not apply in this question.<br>Zero marks awarded if hydroxide is given along with hydroxyl.<br><br>Refer to general marking principle **(g)** for guidance. |
| | | (ii) | secondary | **1** | |
| | | (iii) | Any correct full/shortened structural formula for a primary or tertiary isomer of 3-methylbutan-2-ol<br><br>eg<br><br><br><br> | **1** | |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **11.** | (a) | (i) | Relights a glowing splint | **1** | |
| | | (ii) | $K^+ ClO_3^-$ | **1** | |
| | (b) | (i) | (A reaction that) releases/gives off energy/heat/gets hotter. | **1** | |
| | | (ii) | Because there is potassium present<br>**OR**<br>Potassium chloride is present<br>**OR**<br>Potassium chlorate is present | **1** | |

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>11.</td><td>(c)</td><td></td><td>2.4/2 (g)<br>-------------------------------------------<br><br>Partial marks can be awarded for a maximum of two of the following three steps:<br><br><u>Method A</u><br><br>1 mark for correctly calculating the number of moles of glucose<br>i.e. n=m/GFM = 2.25/180 = 0.0125 mol (1)<br><br>1 mark for calculating the moles of oxygen by correctly<br>applying the molar ratio<br>i.e. 6 x candidate's calculated number of moles of glucose (1)<br><br>0.075 mol on its own (2)<br><br>1 mark for calculating the mass of oxygen<br>i.e. m = n x GFM using candidate's calculated moles of oxygen and candidate's calculated GFM (1)<br><br>-------------------------------------------<br><br><u>Method B</u><br><br>Both GFMs 180 and 32 (1)<br><br>180 → 192 This step on its own is worth 2 marks. (2)<br><br>Correct application of mole ratio to candidate's GFM of oxygen<br><br>$2.25 \leftrightarrow \frac{6 \text{ x candidate's GFM oxygen}}{\text{candidate's GFM glucose}} \text{ x } 2.25$<br><br>Where the candidate has been awarded the mark for correct proportionality, shown by GFM oxygen over GFM glucose with or without the mole ratio applied, a further mark can be awarded for correct follow through to a final answer.</td><td>3</td><td>Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper.<br><br>A maximum of two marks can be awarded where the candidate has carried out the calculation using glucose and one wrong chemical provided working is shown. i.e. if a candidate calculates the mass of $CO_2$ or $H_2O$ instead of oxygen a maximum of 2 marks can be awarded for 3.3 (g) for using $CO_2$ and 1.35 (g) for using $H_2O$ provided the GFM of each of these chemicals is correct.<br><br>$\frac{32}{180} \text{ x } 2.25 = 0.4$ is awarded 2 marks<br><br>Working must be shown to support an incorrect GFM to allow the concept mark to be awarded</td></tr>
</table>

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **12.** | (a) | (i) | decreases | **1** | |
| | | (ii) | increases | **1** | |
| | | (iii) | Between 175 and 214 (picometres). | **1** | Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | (b) | | 234 (picometres) | **1** | Unit is not required but if given must be correct.<br><br>This marking instruction must only be applied a maximum of once per paper. |
| | (c) | (i) | 2,8<br><br>Accept a correctly drawn electron arrangement diagram. | **1** | |
| | | (ii) | (it has) one fewer electron shell<br><br>'It' is assumed to refer to the sodium ion. | **1** | The use of 'outer shells' is acceptable in place of electron shells.<br><br>Zero mark awarded for it loses an electron but this does not negate a correct response.<br><br>Candidates can be awarded the mark if they explain why the sodium atom is larger than the sodium ion. It must be clear from the candidate's response they are referring to the sodium atom. |

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **13.** | | | This is an open-ended question.<br><br>**1 mark**: The candidate has demonstrated a limited understanding of the chemistry involved. They have made some statement(s) that are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.<br><br>**2 marks**: The candidate has demonstrated a reasonable understanding of the chemistry involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem.<br><br>**3 marks:** The maximum available mark would be awarded to a candidate who has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. | **3** | **Award 0 marks** where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award zero marks also if the candidate merely restates the chemistry given in the question. |

**[END OF MARKING INSTRUCTIONS]**

Go to Topic Grid

N5 National Qualifications 2023

X813/75/02

# Chemistry Section 1 — Questions

FRIDAY, 12 MAY

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/75/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

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

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

©

Go to Topic Grid

SECTION 1 — 25 marks

Attempt ALL questions

**1.** The average rate of a chemical reaction was calculated to be 5 $cm^3\,s^{-1}$ for the first 60 s of the reaction.

What volume of gas was collected in the first 60 s of the reaction?

A 0.08 $cm^3$

B 12 $cm^3$

C 55 $cm^3$

D 300 $cm^3$

**2.** Which line in the table correctly describes a proton?

| | Mass | Charge | Location |
|---|---|---|---|
| A | 1 | +1 | inside the nucleus |
| B | 0 | –1 | outside the nucleus |
| C | 1 | 0 | outside the nucleus |
| D | 0 | +1 | inside the nucleus |

**3.** Which of the following compounds forms molecules with an angular structure?

A $CCl_4$

B $NCl_3$

C $SCl_2$

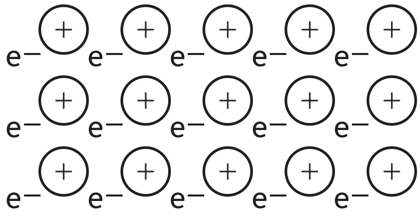
D $FCl$

Go to Answers

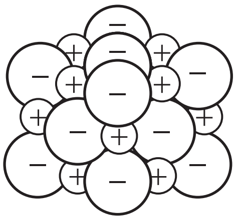
Go to Topic Grid

**4.** Which of the following diagrams could be used to represent the structure of lithium fluoride?

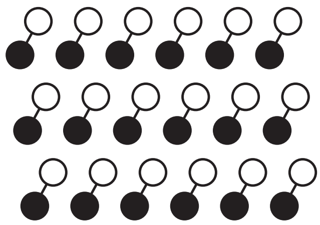
A



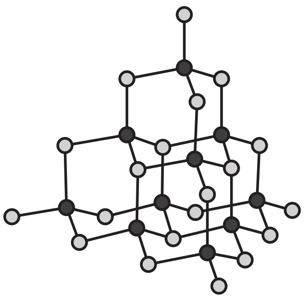

B




C



D



**5.** In which of the following compounds does the iron ion have a 3+ charge?

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

A $FeO$

B $FeP$

C $Fe(NO_3)_2$

D $Fe_3(PO_4)_2$

**[Turn over**

Go to Answers

Go to Topic Grid

**6.** Which solution contains the **least** number of moles of solute?

A $100\ cm^3$ of $1.00\ mol\,l^{-1}$

B $150\ cm^3$ of $0.75\ mol\,l^{-1}$

C $200\ cm^3$ of $0.60\ mol\,l^{-1}$

D $250\ cm^3$ of $0.25\ mol\,l^{-1}$

**7.** Which of the following substances, when shaken with water, would cause the pH of water to increase?

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

A Aluminium oxide

B Barium oxide

C Nitrogen oxide

D Hydrogen oxide

**8.** Nickel carbonate, nickel hydroxide and nickel metal all react with dilute sulfuric acid.

Which of the following statements is true for all three reactions?

A A gas is produced.

B Water is produced.

C Nickel sulfate is produced.

D A neutralisation reaction takes place.

**9.** Sodium carbonate can be used to neutralise hydrochloric acid.

$$(Na^+)_2CO_3^{2-}(aq) \quad + \quad 2H^+Cl^-(aq) \quad \rightarrow \quad 2Na^+Cl^-(aq) \quad + \quad H_2O(\ell) \quad + \quad CO_2(g)$$

The correct equation omitting the spectator ions is

A $H^+(aq) \quad + \quad OH^-(aq) \quad \rightarrow \quad H_2O(\ell)$

B $2H^+(aq) \quad + \quad CO_3^{2-}(aq) \quad \rightarrow \quad H_2O(\ell) \quad + \quad CO_2(g)$

C $2H^+(aq) \quad + \quad CO_3^{2-}(g) \quad \rightarrow \quad H_2O(\ell) \quad + \quad CO_2(g)$

D $Na^+(aq) \quad + \quad Cl^-(aq) \quad \rightarrow \quad Na^+Cl^-(aq)$

**10.** $CH_3CH(CH_3)CH_2C(CH_3)_2CH_3$

The name of the above compound is

A 2,2,4-trimethylpentane

B 2,4,4-trimethylpentane

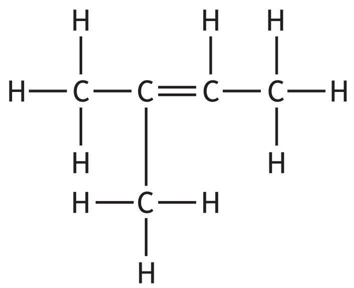
C 2,2,4-trimethylpentene

D 2,4,4-trimethylpentene.

Go to Answers

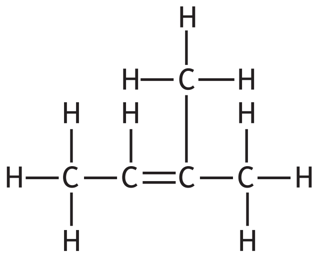
Go to Topic Grid

11. The structure of 2-methylbut-2-ene is

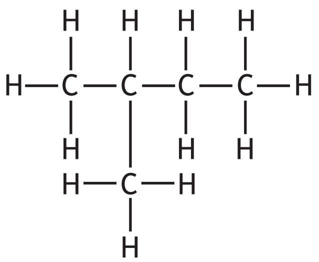


Which of the following represents an isomer of 2-methylbut-2-ene?

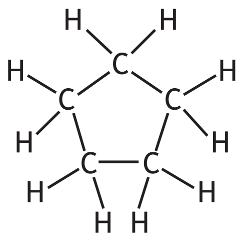
A



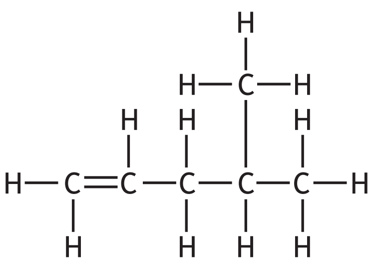
B



C



D



[Turn over

Go to Answers

Go to Topic Grid

**12.** Which of the following would **not** be produced by an addition reaction of but-2-ene?

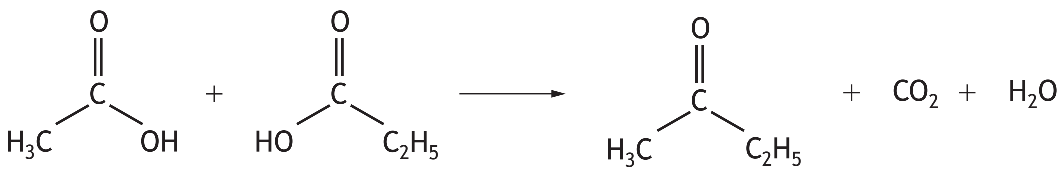
A $CH_3CH_2CH_2CH_3$

B $CH_3CH_2CH_2CH_2OH$

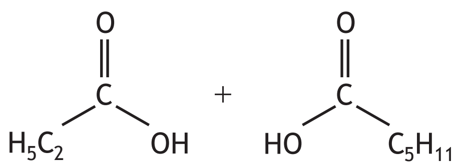
C $CH_3CH(OH)CH_2CH_3$

D $CH_3CHBrCHBrCH_3$

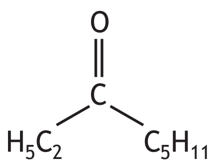
**13.** Carboxylic acids can react to form compounds known as ketones.



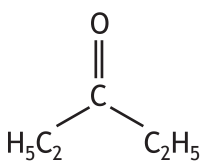

Identify the ketone that can be formed by reacting the two carboxylic acids below.



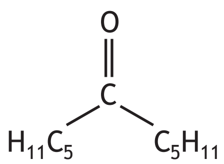

A



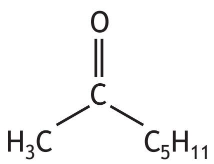

B




C




D




Go to Answers

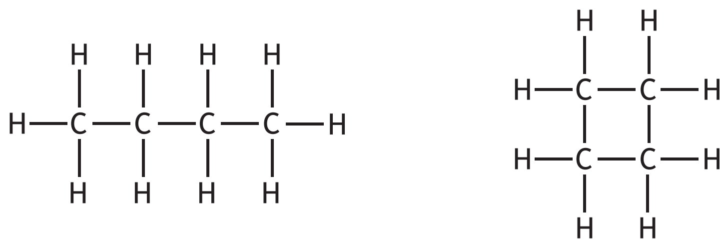
Go to Topic Grid

**14.** Which line in the table correctly describes methanol compared to octan-1-ol?

| | Formula mass | Solubility in water |
|---|---|---|
| A | higher | lower |
| B | lower | lower |
| C | higher | higher |
| D | lower | higher |

**15.** Which of the following is correct for **both** of the molecules shown below?

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



A They can be represented by the general formula $C_nH_{2n}$.

B They have the same melting point.

C They are soluble in water.

D They are saturated.

**16.** Sodium methanoate is produced in the reaction of

A sodium oxide and methanol

B sodium chloride and methanoic acid

C sodium oxide and methanoic acid

D sodium and methanol.

**[Turn over**

Go to Answers

Go to Topic Grid

**17.** Which line in the table shows the properties of a metal?

| | Melting point (°C) | Boiling point (°C) | Conducts electricity | |
|---|---|---|---|---|
| | | | Solid | Liquid |
| A | 30 | 2229 | yes | yes |
| B | –118 | 90 | no | no |
| C | 714 | 1412 | no | yes |
| D | 2077 | 4000 | no | no |

**18.** Information about the reactions of three different metals, **X**, **Y** and **Z** is given in the table.

| | Reaction with | | |
|---|---|---|---|
| **Metal** | **Oxygen** | **Dilute acid** | **Water** |
| **X** | reacts | reacts | no reaction |
| **Y** | reacts | no reaction | no reaction |
| **Z** | reacts | reacts | reacts |

Which of the following correctly shows the metals in order of **increasing** reactivity?

A X, Y, Z

B Y, X, Z

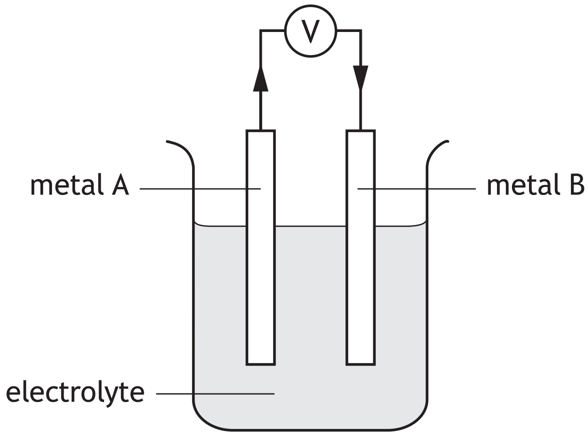
C Z, X, Y

D Z, Y, X

Go to Answers

Go to Topic Grid

**19.** An electrochemical cell was set up by joining two metals, **A** and **B**, in an electrolyte as shown.




The direction of electron flow is from metal **A** to metal **B**.

Which line in the table is correct for this cell?

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

| | Metal A | Metal B |
|---|---|---|
| A | nickel | zinc |
| B | zinc | aluminium |
| C | aluminium | magnesium |
| D | aluminium | nickel |

**20.** The ion-electron equations for the reduction of magnesium ions and silver(I) ions are

$$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$$
$$Ag^{+}(aq) + e^- \rightarrow Ag(s)$$

The redox equation for the overall reaction is

A $Mg(s) + 2Ag^{+}(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$

B $Mg^{2+}(aq) + 2Ag(s) \rightarrow Mg(s) + 2Ag^{+}(aq)$

C $Mg(s) + Ag^{+}(aq) + e^- \rightarrow Mg^{2+}(aq) + 2Ag(s) + 2e^-$

D $Mg^{2+}(aq) + 2Ag(s) + 2e^- \rightarrow Mg(s) + Ag^{+}(aq) + e^-$

**[Turn over**

Go to Answers

**21.** Which line in the table correctly identifies the reactant and product for the industrial process?

| | **Industrial process** | **Reactant** | **Product** |
|---|---|---|---|
| A | Haber | ammonia | nitric acid |
| B | Ostwald | ammonia | nitrogen |
| C | Haber | nitrogen | ammonia |
| D | Ostwald | nitric acid | ammonia |

**22.** An atom of $^{227}Th$ decays by a series of alpha emissions to form an atom of $^{211}Pb$.

How many alpha particles are released in this decay process?

A 2

B 3

C 4

D 5

**23.** Which salt **cannot** be prepared by a precipitation reaction?

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

A Barium sulfate

B Lead(II) sulfate

C Calcium chloride

D Silver chloride

Go to Topic Grid

**24.** The Benedict's test and the iodine test are commonly used to identify the presence of glucose and starch.

The results of these tests are shown.

| **Test** | **Result for glucose** | **Result for starch** |
|---|---|---|
| Benedict's test | blue to orange | no change |
| Iodine test | no change | brown to blue/black |

Flame tests can be used to identify the presence of some metal ions.

An unknown mixture was tested and the following results obtained.

| **Test** | **Result for unknown mixture** |
|---|---|
| Benedict's test | blue to orange |
| Iodine test | no change |
| Flame test | yellow flame |

Which of the following mixtures could give the results shown?

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

A Glucose and sodium chloride

B Starch and sodium chloride

C Glucose and strontium chloride

D Starch and strontium chloride

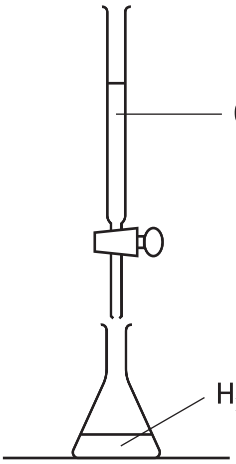
**[Turn over**

Go to Answers

Go to Topic Grid

**25.** A titration was carried out to neutralise 0.002 mol of sulfuric acid solution, $H_2SO_4$.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$




The number of moles of NaOH(aq) required to neutralise the acid is

A 0.05

B 0.004

C 0.002

D 0.001

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]**

Go to Answers

FOR OFFICIAL USE

| | | | | | |
|---|---|---|---|---|---|
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N5

National
Qualifications
2023

Mark

X813/75/01

# Chemistry
# Section 1 — Answer grid and Section 2

FRIDAY, 12 MAY

1:00 PM – 3:30 PM

* X 8 1 3 7 5 0 1 *

**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 ©

* X 8 1 3 7 5 0 1 0 1 *

Go to Topic Grid



## SECTION 2 — 75 marks

**Attempt ALL questions**

**1.** Chlorine is an element that exists as diatomic molecules.

(a) State the number of elements, including chlorine, that exist as diatomic molecules. **1**

(b) A sample of chlorine contains two isotopes with masses of 35 and 37. The average mass of this sample of chlorine is 35.5.

State the mass number of the most common isotope in this sample. **1**

(c) Name an element that has similar chemical properties to chlorine. **1**

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

(d) Magnesium chloride is an ionic compound containing magnesium ions and chloride ions. The nuclide notation for these two ions are shown.

Complete the table to show the number of electrons and neutrons in these ions. **2**

| | Electrons | Neutrons |
|---|---|---|
| ${}^{24}_{12}Mg^{2+}$ | | 12 |
| ${}^{37}_{17}Cl^{-}$ | 18 | |

[Turn over

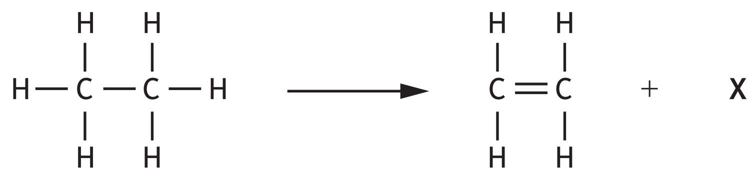
Go to Topic Grid



**2.** Ethane, ethene and ethyne are compounds that contain two carbon atoms. Hydrogen is the only other type of atom present in these compounds.

(a) State the term used to describe compounds that contain only carbon and hydrogen atoms. **1**

(b) Ethene can be produced from ethane as shown.



ethane ethene

(i) State the name of chemical **X** produced in the reaction. **1**

(ii) Describe the chemical test, including the result, to show that ethene is unsaturated. **1**



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**2. (continued)**

(c) (i) Ethyne contains a carbon-carbon triple bond.

Draw the full structural formula for ethyne. **1**

(ii) Ethyne can be used as a fuel.

(A) Name the products formed when ethyne is burned in a plentiful supply of oxygen. **1**

(B) The burning of a fuel is an exothermic reaction.

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

**[Turn over**

MARKS | DO NOT WRITE IN THIS MARGIN

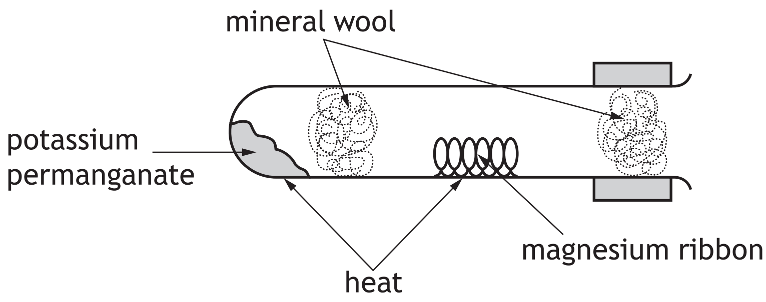
**3.** Metal elements make up approximately three quarters of the periodic table.

(a) The columns of elements in the periodic table are known as groups.

State a group number in which **all** the elements are metals. **1**

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

(b) Some metals react with oxygen. A common experimental set up for this reaction is shown.




(i) Write the formula for potassium permanganate. **1**

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

(ii) The observations for this reaction with four different metals were recorded.

| Metal | Observation |
|---|---|
| Copper | dull red glow |
| Iron | red glow with a few sparks |
| **X** | bright light |
| Magnesium | blinding white light |

Suggest a name for metal **X**, based on these observations. **1**

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

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

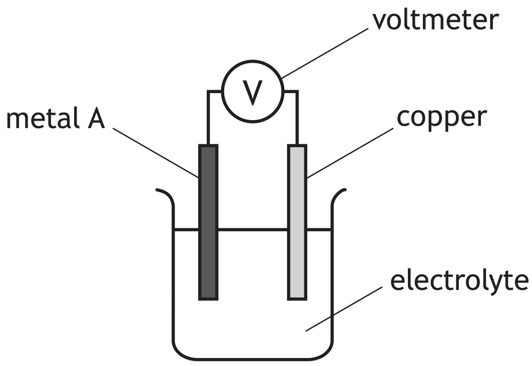
**3. (continued)**

(c) Some metals react with dilute hydrochloric acid to produce a gas.

Complete the table naming this gas and the test, including the result, used to identify it. **2**

| Gas produced | Test and result |
|---|---|
| | |

(d) Metals can be used to produce a voltage using a simple cell as shown.




The results are shown in the table.

| Metal A | Voltage (V) |
|---|---|
| Magnesium | 2.7 |
| Tin | 0.5 |
| Iron | |

(i) **Complete the table** to suggest a value for the voltage produced by the cell when metal **A** is iron. **1**

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

(ii) State what is meant by the term electrolyte. **1**

(iii) Suggest **one** factor that should be kept constant to make the experiment fair. **1**



Go to Answers

Go to Topic Grid



**4.** Read the passage and answer the questions that follow.

**Carbon dioxide catalysis making jet fuel**

A new catalyst for turning carbon dioxide into jet fuel has been developed. This development could lead to an industrial-scale method of extracting carbon dioxide gas from the air and using it in jet engines.

The new catalyst is made from iron, manganese and potassium, and can produce long-chain molecules from carbon dioxide in a single step. The catalyst converts carbon dioxide into molecules that are suitable for use in jet fuel.

Ultimately, 4700 g of atmospheric carbon dioxide could be turned into one litre of jet fuel using the new catalyst.

(a) State where the carbon dioxide for this industrial-scale method would be extracted from. **1**

(b) An advantage of using catalysts is that they speed up chemical reactions.

State **another** advantage of using catalysts. **1**

(c) Calculate the number of moles of carbon dioxide required to produce 5 litres of jet fuel using the new catalyst. **2**



Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

5. Nitrogen gas makes up nearly 80% of the air and is found in many compounds.

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

[Turn over

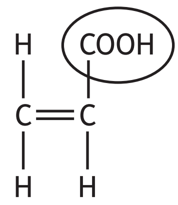


Go to Answers

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**6.** Propenoic acid is a monomer used to make the polymer poly(propenoic acid).



propenoic acid

(a) (i) Name the functional group circled in the diagram above. **1**

(ii) State the type of reaction that takes place when monomers join to form a polymer. **1**

(iii) Draw a section of poly(propenoic acid) showing three monomer units joined together. **1**



Go to Answers

Go to Topic Grid

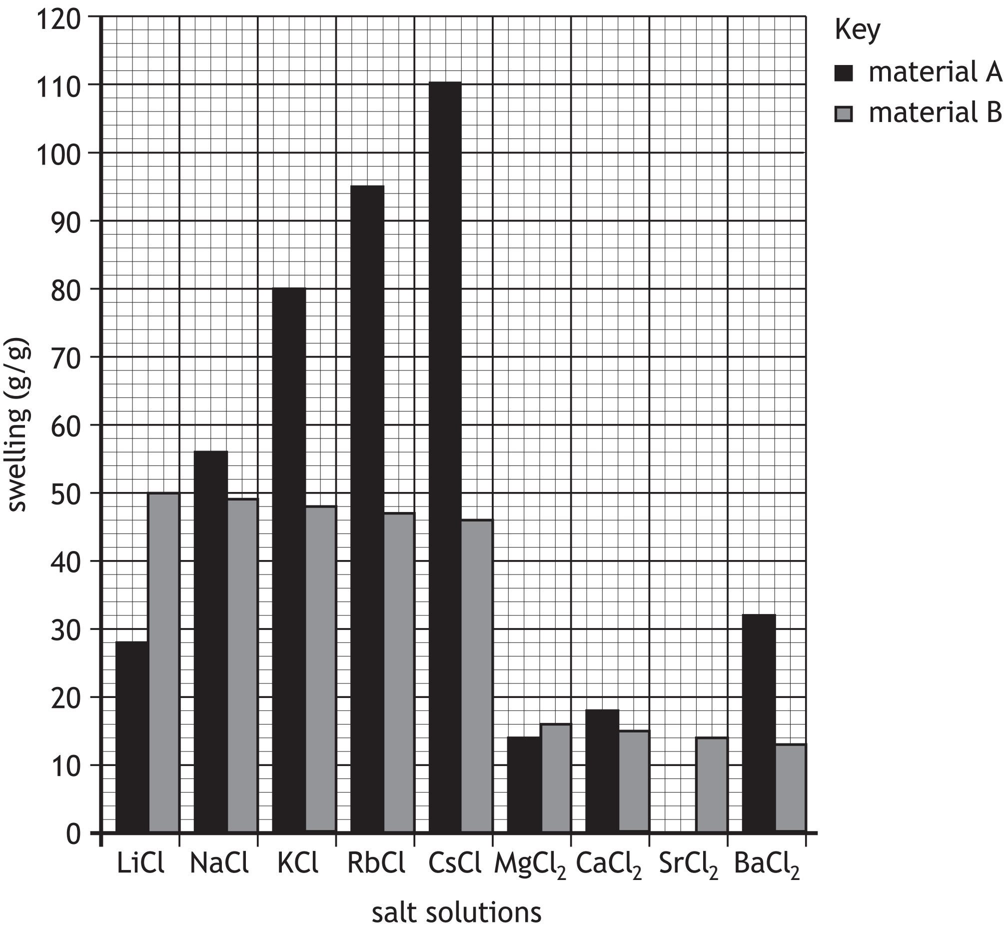
MARKS | DO NOT WRITE IN THIS MARGIN

**6. (continued)**

(b) Polymers such as poly(propenoic acid) are used to make materials that have the ability to swell by absorbing water.

The amount of swelling is affected by salts dissolved in the water.

Experimental data for materials **A** and **B**, with a variety of different chloride salt solutions is shown.




(i) Using the graph, identify the combination of material **and** salt solution that results in the most swelling. **1**

(ii) Draw a bar on the graph to show the expected swelling for material **A** in a salt solution of strontium chloride, $\mathbf{SrCl_2}$. **1**

(An additional graph, if required, can be found on *page 26*.)

**[Turn over**

Go to Answers

**6. (continued)**



(c) A student investigated the time taken for different masses of another material to absorb 100 $cm^3$ of water.

(i) The student used a beaker to measure the 100 $cm^3$ of water.

Suggest a more appropriate piece of apparatus to measure the volume of water. **1**

(ii) The student's results are shown.

| Mass of material (g) | Time taken to absorb 100 $cm^3$ of water (s) |
|---|---|
| 0.1 | 180 |
| 0.2 | 160 |
| 0.5 | 90 |
| 0.7 | 50 |
| 1.0 | 30 |

Draw a graph of these results. **4**

(Additional graph paper, if required, can be found on *page 27*.)

Go to Topic Grid



**7.** Silanes are a homologous series containing atoms of silicon and hydrogen only.

The table shows data for some silanes.

| Compound name | Formula | Boiling point (°C) |
|---|---|---|
| Monosilane | $SiH_4$ | −112 |
| Disilane | $Si_2H_6$ | −15 |
| | $Si_3H_8$ | 53 |
| Tetrasilane | $Si_4H_{10}$ | 108 |
| Pentasilane | | 153 |
| Hexasilane | $Si_6H_{14}$ | |

(a) Name the third member of the silane family, $Si_3H_8$. **1**

(b) Calculate the number of hydrogen atoms present in a molecule of pentasilane. **1**

(c) Predict the boiling point, in °C, of hexasilane. **1**



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MARKS | DO NOT WRITE IN THIS MARGIN

**7. (continued)**

(d) Draw a diagram, showing all the outer electrons, for a molecule of monosilane, $SiH_4$. **1**

(e) Explain why pentasilane has a higher boiling point than tetrasilane. **2**

(f) Disilane, $Si_2H_6$, can be produced in the following reaction.

$$7Mg + 2SiO_2 + 14HCl \rightarrow \underset{\text{disilane}}{Si_2H_6} + 7MgCl_2 + 4H_2O$$

Calculate the mass of disilane, in grams, that would be produced from the reaction of 6 g of silicon dioxide, $SiO_2$. **3**

[Turn over

Go to Answers

Go to Topic Grid

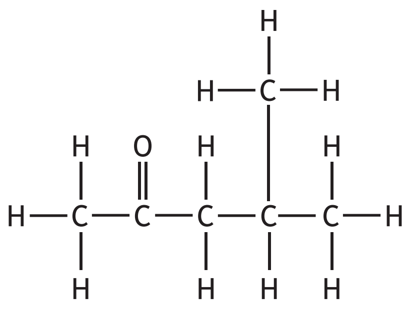
MARKS | DO NOT WRITE IN THIS MARGIN

**8.** Read the passage and answer the questions that follow.

**Phosphoric acid**

Fluorapatite, a compound found in some rocks, can be used to produce phosphoric acid.

The phosphoric acid is purified using 4-methylpentan-2-one as shown below.



4-methylpentan-2-one

The salts of phosphoric acid have many uses. For example, the salt ammonium dihydrogenphosphate, $NH_4H_2PO_4$, more commonly known as ADP, can be used as a fertiliser. Another salt, sodium phosphate, $Na_3PO_4$, is used in the manufacture of pharmaceuticals, cheese and toothpastes.

Solid calcium sulfate is also produced along with liquid phosphoric acid as an impurity from fluorapatite. Calcium sulfate can exist in two common forms: 'hemihydrate', $CaSO_4.\frac{1}{2}H_2O$, and 'dihydrate', $CaSO_4.2H_2O$. The 'dihydrate' form, $CaSO_4.2H_2O$, has two moles of water present for every one mole of calcium sulfate.

(a) State the name of the compound found in some rocks, from which phosphoric acid can be produced. **1**

(b) Write the molecular formula for the chemical used to purify phosphoric acid. **1**

Go to Topic Grid

**8. (continued)** MARKS DO NOT WRITE IN THIS MARGIN

(c) (i) The chemical known as ADP contains phosphorus, an element essential for healthy plant growth.

Name the **other** element present in ADP that is essential for healthy plant growth. **1**

(ii) Sodium phosphate can also be used as a fertiliser as it contains phosphorus.

Suggest a property of sodium phosphate that would make it suitable for use as a fertiliser. **1**

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

(d) Calculate the percentage by mass of phosphorus in phosphoric acid, $H_3PO_4$. **3**

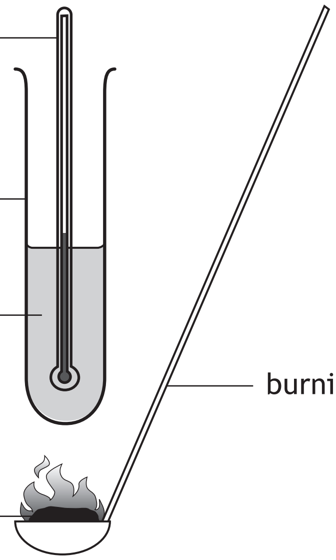
**Show your working clearly.**

(e) Name the technique that could be used to separate the calcium sulfate from the phosphoric acid. **1**

(f) State the number of moles of water present for every one mole of calcium sulfate in the 'hemihydrate' form. **1**

[Turn over

**9.** The energy stored in foods can be determined using the experiment shown.




(a) A student burned a single crisp using this apparatus and recorded the following results.

| | |
|---|---|
| **Mass of single crisp** | 1 g |
| **Mass of water** | 10 g |
| **Initial temperature of water** | 19 °C |
| **Final temperature of water** | 34 °C |

(i) Calculate the energy, in kJ, absorbed by the water in this experiment. **3**

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MARKS | DO NOT WRITE IN THIS MARGIN

**9. (a) (continued)**

(ii) In the experiment, the amount of energy absorbed by the water is lower than the expected value.

Suggest why the value in the experiment is **lower** than expected. **1**

(b) The energy stored in food is more often referred to in kilocalories, where 1 kilocalorie is equal to 4.18 kJ.

A food testing laboratory measured the energy absorbed by water when burning 1 g of a biscuit to be 20.9 kJ.

Calculate the energy, in kilocalories, that would be found in a **30 g** biscuit. **2**

**[Turn over**

Go to Topic Grid

MARKS | DO NOT WRITE IN THIS MARGIN

**10.** Caesium is a highly reactive metal that was first extracted from an ore in the late 1800s.

(a) (i) Suggest a method used to extract caesium metal from its ore. **1**

(ii) During the extraction of caesium from its ore, the caesium ions are changed to caesium atoms.

Name this type of chemical reaction. **1**

(b) Caesium-137 is a radioactive isotope of caesium that decays by emitting beta particles.

(i) Write the nuclide notation for a beta particle. **1**

(ii) Caesium-137 is used in industry to measure the thickness of materials, such as paper and sheets of metal.

Suggest a reason why an alpha particle emitting radioactive isotope is not suitable for this purpose. **1**

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MARKS | DO NOT WRITE IN THIS MARGIN

**10. (b) (continued)**

(iii) The half-life of caesium-137 is 30 years.

(A) State what is meant by the term half-life. **1**

(B) Calculate the fraction of caesium-137 that will have **decayed** after 120 years. **3**

**[Turn over**



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MARKS | DO NOT WRITE IN THIS MARGIN

**11.** Tungsten(VI) fluoride is used in the electronics industry.

(a) Tungsten(VI) fluoride is a toxic, colourless gas at room temperature.

Circle the correct words to complete the sentence. **1**

Tungsten(VI) fluoride has $\left\{\begin{array}{c}\text{covalent}\\ \text{ionic}\\ \text{metallic}\end{array}\right\}$ bonding and a $\left\{\begin{array}{c}\text{lattice}\\ \text{molecular}\\ \text{network}\end{array}\right\}$ structure.

(b) Tungsten(VI) fluoride reacts with water to form hydrofluoric acid, HF.

The equation for this reaction is shown.

$$WF_6 \quad + \quad H_2O \quad \rightarrow \quad WO_3 \quad + \quad HF$$

(i) Balance this equation. **1**

(ii) Describe the relationship between the concentration of hydrogen ions and the concentration of hydroxide ions in a solution of hydrofluoric acid. **1**

(c) Tungsten(VI) fluoride can react to form tungsten(IV) fluoride.

Complete the ion-electron equation for the reaction of tungsten(VI) ions to form tungsten(IV) ions by **adding electrons**. **1**

$$W^{6+} \qquad \longrightarrow \qquad W^{4+}$$



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MARKS | DO NOT WRITE IN THIS MARGIN

**12.** Dilute hydrochloric acid, $HCl(aq)$, will react with marble chips, which contain calcium carbonate, $CaCO_3(s)$.

The rate of this reaction can be easily changed and measured.

**Using your knowledge of chemistry**, describe how a student could investigate one factor that affects the rate of a chemical reaction. **3**

**[END OF QUESTION PAPER]**



Go to Answers

National
Qualifications
2023

# 2023 Chemistry

# National 5

# Finalised Marking Instructions

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**Marking instructions for each question**

| Question | Answer | Mark |
|---|---|---|
| 1. | D | **1** |
| 2. | A | **1** |
| 3. | C | **1** |
| 4. | B | **1** |
| 5. | B | **1** |
| 6. | D | **1** |
| 7. | B | **1** |
| 8. | C | **1** |
| 9. | B | **1** |
| 10. | A | **1** |
| 11. | C | **1** |
| 12. | B | **1** |
| 13. | A | **1** |
| 14. | D | **1** |
| 15. | D | **1** |
| 16. | C | **1** |
| 17. | A | **1** |
| 18. | B | **1** |
| 19. | D | **1** |
| 20. | A | **1** |
| 21. | C | **1** |
| 22. | C | **1** |
| 23. | C | **1** |
| 24. | A | **1** |
| 25. | B | **1** |

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Section 2

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 1. | (a) | | 7 | 1 | |
| | (b) | | 35/Chlorine-35/ $^{35}Cl$ / $^{35}_{17}Cl$ | 1 | Accept $Cl^{35}$ or $Cl^{35}_{17}$ |
| | (c) | | Fluorine/$F_2$<br>**OR**<br>Bromine/$Br_2$<br>**OR**<br>Any other group 7 element. | | Do not accept F/Br/I. |
| | (d) | | <table><tr><th></th><th>Electrons</th><th>Neutrons</th></tr><tr><td>$^{24}_{12}Mg^{2+}$</td><td>10</td><td></td></tr><tr><td>$^{37}_{17}Cl^{-}$</td><td></td><td>20</td></tr></table> | 2 | |

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| Question | | | Expected response | Max mark | Additional guidance |
| --- | --- | --- | --- | --- | --- |
| **2.** | (a) | | Hydrocarbon | **1** | |
| | (b) | (i) | Hydrogen/$H_2$ | **1** | Do not accept H |
| | | (ii) | Bromine/$Br_2$ decolourised (by ethene.)<br>**OR**<br>Bromine/$Br_2$ goes colourless (in ethene.) | **1** | Accept bromine/bromine water/ bromine solution but do not accept bromide or Br.<br><br>Zero marks awarded for 'goes clear' however if given in addition to a correct answer it does not negate.<br><br>If starting colour is given it must be correct eg orange/yellow/orange-brown/red-brown or brown. |
| | (c) | (i) | $H—C\equiv C—H$ | **1** | |
| | | (ii) (A) | Carbon dioxide and water.<br><br>Both required for **1 mark** | **1** | Accept correct formulae. |
| | | (ii) (B) | (A reaction that) produces/ releases energy/heat. | **1** | |

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<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>3.</td><td>(a)</td><td></td><td>Group 1/Column 1<br>OR<br>Group 2/Column 2</td><td>1</td><td>Accept correct group names in place of number.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>$KMnO_4$</td><td>1</td><td>If charges are included, both need to be present and correct.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Aluminium/Al<br>OR<br>Zinc/Zn<br>OR<br>Beryllium/Be</td><td>1</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td><table><tr><th>Gas produced</th><th>Test and result</th></tr><tr><td>hydrogen</td><td>burns with a pop</td></tr></table><br>Both required for 2 marks.<br><br>Incorrect gas with correct test for that gas. (1 mark)<br><br>Correct gas but incorrect test/result. (1 mark)</td><td>2</td><td>Award one mark if no gas is identified but a correct test and result is given for hydrogen gas.</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>Voltage higher than 0.5 but lower than 2.7 (volts/V).</td><td>1</td><td>No unit is required but an incorrect unit negates. This marking principle is only applied once per paper.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(Electrically conducting) solutions/ melts containing ions/ionic solution.</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td>Volume/type/concentration of electrolyte/solution.<br><br>Depth of immersion of metals/ electrodes.<br><br>Size/mass of metals/electrodes.<br><br>Separation of metals/electrodes.<br><br>Temperature.<br><br>Use of copper each time.</td><td>1</td><td>Zero marks awarded for amount of electrolyte/time/metal.</td></tr>
</table>

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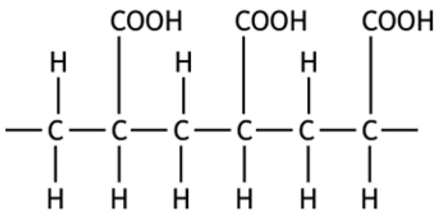
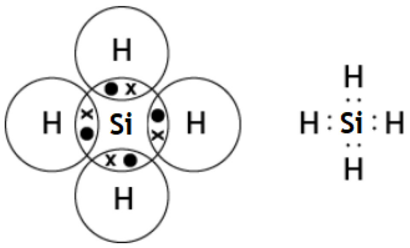
| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 4. | (a) | | (The) air/atmosphere. | 1 | |
| | (b) | | It doesn't get used up/can be recovered, chemically unchanged, at the end of the reaction/can be reused<br><br>**OR**<br><br>Allows the reaction to be carried out at a lower temperature. | 1 | |
| | (c) | | 534/534.1/534.09 (moles)<br><br>---------------------------------------------<br>Partial Marking:<br><br>$n = \frac{4700}{44}$ = 106.82/106.8/107 (moles) **(1 mark)**<br><br>**OR**<br><br>(m = 4700 × 5 =) 23 500 **(g)** **(1 mark)**<br><br>**OR**<br><br>Candidates' calculated number of moles multiplied by 5 **(1 mark)**<br><br>**OR**<br><br>$\frac{4700}{44}$ × 5 with incorrect answer **(1 mark)** | 2 | Unit is not required but if included must be correct. This marking instruction must only be applied a maximum of once per paper.<br><br>Where the candidate has only carried out one of the two steps and their final answer includes a unit, one mark can be awarded for; **106.8 moles** or **23500 g**<br><br>Working must be shown for calculated number of moles |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| 5. | | | This is an open ended question.<br><br>**1 mark**: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the context is understood.<br><br>**2 marks**: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) that is/are relevant to the situation, showing that the context is understood.<br><br>**3 marks**: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the context. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one. | 3 | |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **6.** | (a) | (i) | Carboxyl | **1** | Award zero marks for carboxylic (acid) or COOH. |
| | | (ii) | (Addition) polymerisation | **1** | |
| | | (iii) |  | **1** | Mark can still be awarded if one end bond is missing or if one H atom is shown on an end bond.<br><br>Allow dot or ~ to represent end bond.<br><br>Connectivity to the carboxyl group must be to the carbon.<br><br>Zero marks awarded if<br>• both end bonds are missing<br>• both ends have a hydrogen atom<br>• less than or more than three monomers shown<br>• a bond between two carbons is missing. |
| | (b) | (i) | (Material) A<br><br>**AND**<br><br>CsCl | **1** | |
| | | (ii) | Bar above $SrCl_2$ greater than 18 and less than 32. | **1** | Ignore any shading of the bar. |
| | (c) | (i) | Measuring cylinder/Burette/Pipette. | **1** | |
| | | (ii) | For appropriate format: points (not bars). **(1 mark)**<br><br>The axis/axes of the graph has/have suitable scale(s).<br>For the graph paper provided within the question paper, the selection of suitable scales will result in a graph that occupies at least half of the width and half of the height of the graph paper. **(1 mark)**<br><br>The axes of the graph have suitable labels and units. **(1 mark)**<br><br>All data points plotted accurately with a line of best fit (smooth curve/straight line) drawn. **(1 mark)** | **4** | Where the candidate has drawn a bar graph the format mark is not awarded, but the remaining three marks can still be accessed.<br><br>Spelling mistakes or the use of abbreviations should not be penalised if the meaning of an axis label may be clearly understood.<br><br>Where the candidate has drawn a bar graph, the mark for accurate plotting can be awarded if the heights of bars are plotted accurately but in this case no line of best fit should be used.<br><br>If the scale is non-linear then the mark for accurate plotting can only be accessed if the error occurs out with the data-set. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **7.** | (a) | | Trisilane | **1** | Marker should only refer to answers in the table if no answer has been provided in the space beneath the question. |
| | (b) | | 12 /$Si_5H_{12}$/ $H_{12}$ | **1** | Marker should only refer to answers in the table if no answer has been provided in the space beneath the question |
| | (c) | | 180 – 195 (°C) | **1** | Unit is not required but if included must be correct. This marking instruction must only be applied a maximum of once per paper.<br>Marker should only refer to answers in the table if no answer has been provided in the space beneath the question. |
| | (d) | | Diagram showing carbon with four hydrogen atoms: each of the four overlap areas must have two electrons in or on overlap area (cross, dot, petal diagram) eg<br> | **1** | Accept cross or dot or e or e⁻ to represent electrons or a mixture of these.<br>Bonding electrons **MUST** be on the line or in the overlapping area.<br><br>The diagram does not need to show tetrahedral shape.<br><br>The symbols must be shown for either the silicon atom **or** all four hydrogen atoms.<br><br>If inner electrons are shown then these must be correct. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| | (e) | | Pentasilane/it has bigger/stronger/ more forces (of attraction). **(1 mark)**<br><br>Between molecules **or** mention of intermolecular attractions. **(1 mark)**<br><br>If neither of these two points are given, a maximum of 1 mark can be awarded for pentasilane/it is bigger/ has more (silicon or hydrogen) atoms/longer silicon chain. | **2** | The term bond is only acceptable if it is specifically identified as between the molecules or used with the term intermolecular.<br><br>Mention of breaking bonds/bonds within molecule or chain/breaking silicon to silicon or silicon to hydrogen bonds or more bonds cannot gain the second mark but does not negate the first mark.<br><br>If the candidate uses carbon in place of silicon this would negate the awarding of one of the marks.<br><br>Candidates can be awarded the full/partial marks if they correctly explain why tetrasilane has a lower melting point but tetrasilane **must** be stated in their answer.<br><br>More bonds in the compound is not sufficient to imply a larger molecule but does not negate. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| | (f) | | 3.1 (g) **(3 marks)**<br><br>Partial marks can be awarded for a maximum of two of the following three steps.<br><br>**<u>Method A</u>**<br><br>1 mark for correctly calculating the number of moles of silicon dioxide.<br>ie n = m/GFM = 6/60 = 0.1 mol **(1)**<br><br>1 mark for calculating the moles of disilane by correctly applying the molar ratio<br>ie 0.5 × candidate's calculated moles of silicon dioxide. **(1)**<br><br>0.05 (mol) on its own. **(2)**<br><br>1 mark for calculating the mass of disilane ie m = n × GFM using candidates calculated moles of silicon dioxide and candidate's calculated GFM of disilane.<br><br>**<u>Method B</u>**<br><br>Both GFMs 60 and 62 **(1)**<br><br>120 ↔ 62 This step on its own is worth 2 marks. **(2)**<br><br>Correct application of mole ratio to candidate's GFM of disilane ie<br><br>$\frac{\text{candidate's GFM of disilane}}{\text{2 x candidate's GFM of silicon dioxide}} \times 6$<br><br>Where the candidate has been awarded the mark for correct proportionality, shown by GFM of disilane over GFM of silicon dioxide with or without the mole ratio applied, a further mark can be awarded for correct follow through to a final answer. | 3 | Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit.<br><br>This marking instruction must only be applied a maximum of once per paper.<br><br>A maximum of two marks can be awarded where the candidate has carried out the calculation **using silicon dioxide** and one wrong chemical provided working is shown.<br><br>ie if a candidate calculates the mass of $MgCl_2$ or $H_2O$ instead of disilane, a maximum of 2 marks can be awarded for 33.25 (g) for using $MgCl_2$ or 8.4 (g) for using Mg or 3.6 (g) for using $H_2O$ provided the GFM of each of these chemicals is correct.<br><br>Award zero marks if candidate's working does not use silicon dioxide.<br><br>Award 2 marks for<br>$\frac{62}{60} \times 6 = 6.2$<br><br>Award 1 mark for<br>$\frac{\text{candidate's GFM of disilane}}{\text{candidate's GFM of silicon dioxide}} \times 6$<br><br>Working **must** be shown to support an incorrect GFM to allow the concept mark to be awarded. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **8.** | (a) | | Fluorapatite | **1** | |
| | (b) | | $C_6H_{12}O$ | **1** | Accept $C_5H_{12}CO$<br>Symbols can be in any order |
| | (c) | (i) | Nitrogen/N/$N_2$ | **1** | Any mention of potassium negates a correct answer. |
| | | (ii) | It is (very) soluble. | **1** | |
| | (d) | | 31.63/31.6/32 (%) **(3 marks)**<br>------------------------------------------<br>Partial marking:<br>GFM = 98 **(1 mark)**<br>$\frac{\text{candidate's mass of phosphorus}}{\text{candidate's GFM}} \times 100$ **(1 mark)**<br>This step on its own is worth 2 marks if the candidate's GFM is 98.<br>Calculation of final answer using the relationship<br>% by mass = m/GFM × 100 **(1 mark)** | **3** | Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit.<br>This marking instruction must only be applied a maximum of once per paper.<br>Maximum 2 marks if candidate correctly calculates percentage of hydrogen (3/3.1/3.06 %) or oxygen (65/65.3/65.31 %) rather than phosphorus but **working must be shown.**<br>Working **must** be shown to support an incorrect GFM to allow the concept mark to be awarded. The value used for m in the concept must be used in the working for the candidate's calculated GFM.<br>The mark for the final answer can only be awarded if the correct relationship between total mass of element present divided by GFM × 100 is shown with working. |
| | (e) | | Filtration | **1** | |
| | (f) | | ½ or 0.5 or half | **1** | |

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<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>9.</td><td>(a)</td><td>(i)</td><td>0.627/0.63/0.6 (kJ) (3 marks)<br>-------------------------------------------<br>Partial Marking<br><br>using the correct concept of cmΔT with c = 4·18 (1 mark)<br><br>To be awarded this concept mark, candidates do not specifically need to write cmΔT. The concept mark is awarded for using this relationship with three values, one of which must be 4.18<br><br>For values<br>0.01 and 15 (1 mark)<br><br>A further mark can be awarded for arithmetical follow through to the candidate's answer only if the mark for the concept has been awarded. (1 mark)</td><td>3</td><td>No units required but a maximum of two marks can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.<br><br>627 J can be awarded 3 marks if used with 4180 and the correct unit is given.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Heat loss to the surroundings.<br>OR<br>Glass is a poor conductor of heat.<br>OR<br>Incomplete combustion.</td><td>1</td><td>Answer must describe the reason why the value is lower, simply providing an improvement is not sufficient but does not negate.</td></tr>
<tr><td></td><td>(b)</td><td></td><td>150 (kilocalories)<br><br>Partial Marks<br><br>627 (30 × 20.9) (1 mark)<br>OR<br>5 (20.9/4.18) (1 mark)<br>OR<br>(20.9 × 30)/4.18 with incorrect answer (1 mark)</td><td>2</td><td>No units required but a maximum of one mark can be awarded if an incorrect unit is given. This marking instruction must only be applied a maximum of once per paper.</td></tr>
</table>

Go to Topic Grid

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **10.** | (a) | (i) | Electrolysis | **1** | |
| | | (ii) | Reduction | **1** | |
| | (b) | (i) | ${}^{0}_{-1}e$ **OR** ${}^{0}_{-1}\beta$ | **1** | |
| | | (ii) | (Alpha particles) they<br>• cannot penetrate/pass through (the paper/metal)<br>• are stopped (by the paper/metal)<br>• are absorbed (by the paper/metal)<br>• can only pass through air | **1** | Award zero marks for<br>• they do not travel far<br>• they cannot reach the detector<br>• air absorbs alpha particles.<br><br>However, they do not negate a correct answer. |
| | | (iii) (A) | Time for half of the nuclei to decay.<br>**OR**<br>Time taken for the (radio)activity to half | **1** | Time taken for mass to half is not accepted. |

| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| | | (iii) (B) | $\frac{15}{16}$ /93.75/93.8/94 (%) **(3 marks)**<br>----------------------------------<br>**Partial marking**<br>4 half-lives. **(1 mark)**<br>**OR**<br>Correct percentage or fraction left for a correct number of half-lives. **(2 marks)**<br>**OR**<br>Correct percentage or fraction left for an incorrect number of half-lives. Working must be shown. **(1 mark)**<br>**OR**<br>Correct percentage or fraction decayed with incorrect number of half-lives. Working must be shown. **(2 marks)** | **3** | Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit.<br><br>If a candidate does not demonstrate the application of half-lives they cannot access the final mark for calculating the percentage/fraction remaining. |

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| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **11.** | (a) | | Covalent molecular. | **1** | |
| | (b) | (i) | $WF_6$ + **3**$H_2O$ $\rightarrow$ $WO_3$ + **6**HF | **1** | Accept correct multiples. |
| | | (ii) | More hydrogen ions/$H^+$ than hydroxide ions/$OH^-$ | **1** | |
| | (c) | | $W^{6+} + 2e^- \rightarrow W^{4+}$ | **1** | |

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| Question | | | Expected response | Max mark | Additional guidance |
|---|---|---|---|---|---|
| **12.** | | | This is an open ended question.<br><br>**1 mark**: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) that is/are relevant to the situation, showing that at least a little of the chemistry within the context is understood.<br><br>**2 marks**: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) that is/are relevant to the situation, showing that the context is understood.<br><br>**3 marks**: The maximum available mark would be awarded to a student who has demonstrated a good understanding of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the context. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one. | **3** | |

**[END OF MARKING INSTRUCTIONS]**

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