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.

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

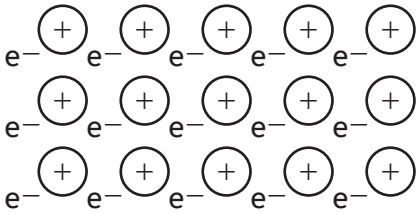
B NCl_3

C SCl_2

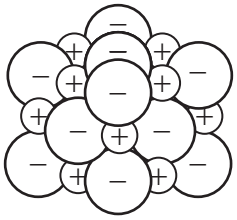
D FCl

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

A



B



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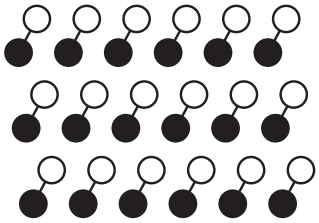

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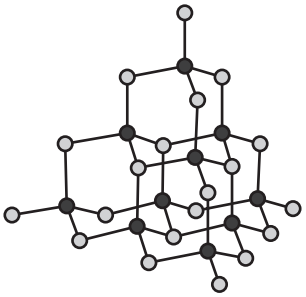


5. In which of the following compounds does the iron ion have a 3+ charge?

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

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.

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

The correct equation omitting the spectator ions is

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

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

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

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

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

The name of the above compound is

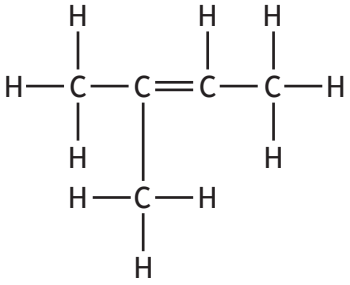
A 2,2,4-trimethylpentane

B 2,4,4-trimethylpentane

C 2,2,4-trimethylpentene

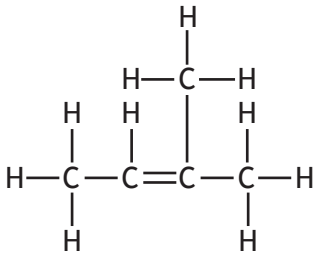
D 2,4,4-trimethylpentene.

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



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

A



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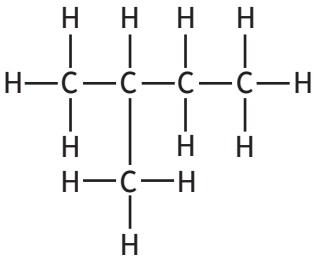

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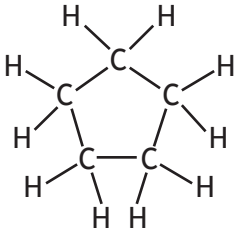

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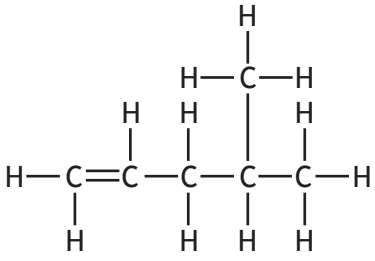


[Turn over

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

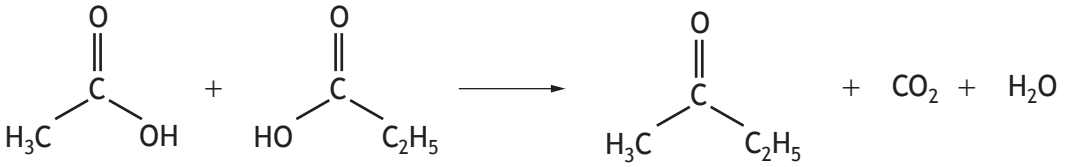
A $CH_3CH_2CH_2CH_3$

B $CH_3CH_2CH_2CH_2OH$

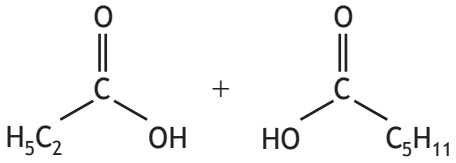
C $CH_3CH(OH)CH_2CH_3$

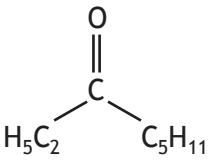
D $CH_3CHBrCHBrCH_3$

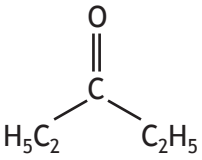
13. Carboxylic acids can react to form compounds known as ketones.

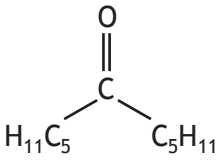


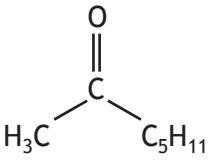
Identify the ketone that can be formed by reacting the two carboxylic acids below.



A 

B 

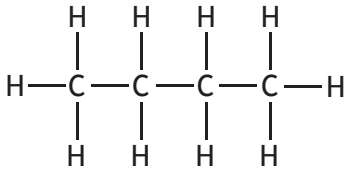
C 

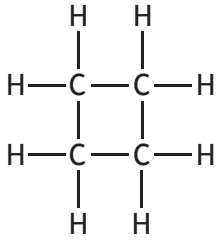
D 

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

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?

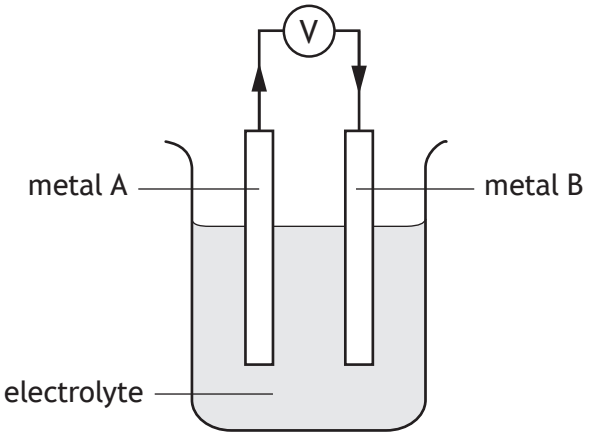
A X, Y, Z

B Y, X, Z

C Z, X, Y

D Z, Y, X

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

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

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

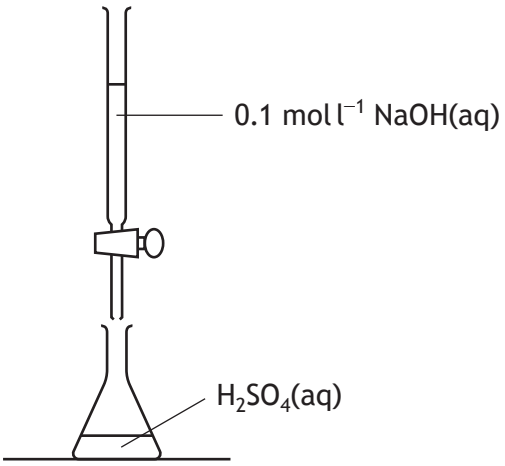
C Glucose and strontium chloride

D Starch and strontium chloride

[Turn over

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]

FOR OFFICIAL USE

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

X8137501

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day | Month | Year

Scottish candidate number

Total marks — 100

SECTION 1 — 25 marks

Attempt ALL questions.

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

SECTION 2 — 75 marks

Attempt ALL questions.

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

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

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

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

SQA ©

X8137501 01

MARKS | DO NOT WRITE IN THIS MARGIN

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**

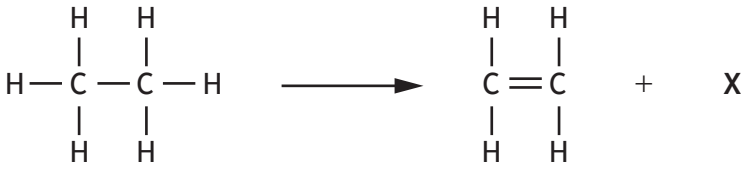
	Electrons	Neutrons
$^{24}_{12}Mg^{2+}$		12
$^{37}_{17}Cl^{-}$	18	

[Turn over

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**

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

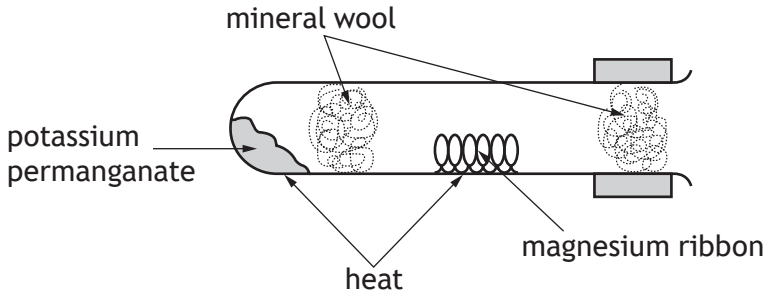
3. Metal elements make up approximately three quarters of the periodic table.

(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.

MARKS

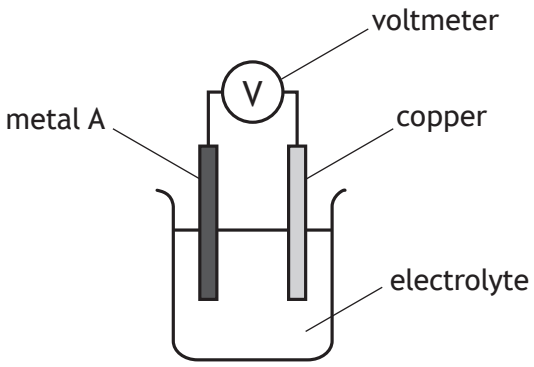
DO NOT WRITE IN THIS MARGIN

(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**

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**

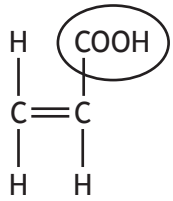
(c) Calculate the number of moles of carbon dioxide required to produce 5 litres of jet fuel using the new catalyst. **2**

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

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**

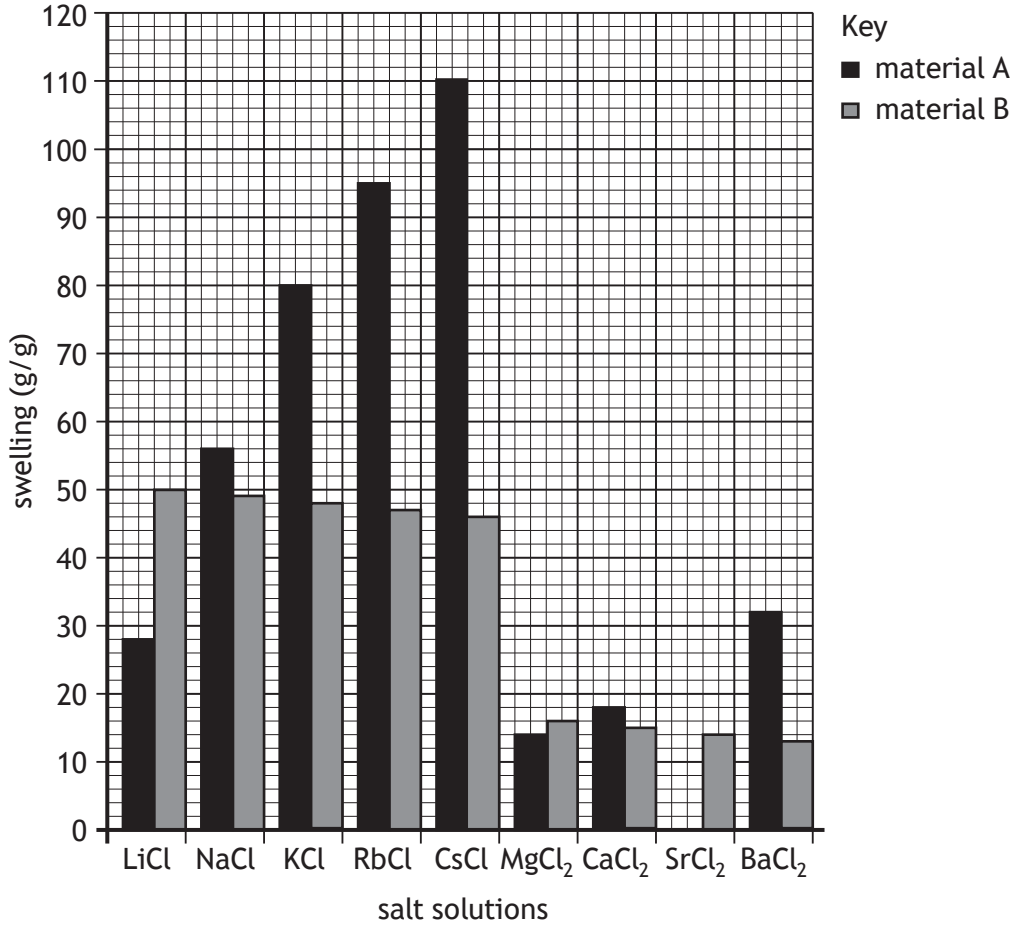
(iii) Draw a section of poly(propenoic acid) showing three monomer units joined together. **1**

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, **$SrCl_2$**. **1**

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

[Turn over

6. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(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.

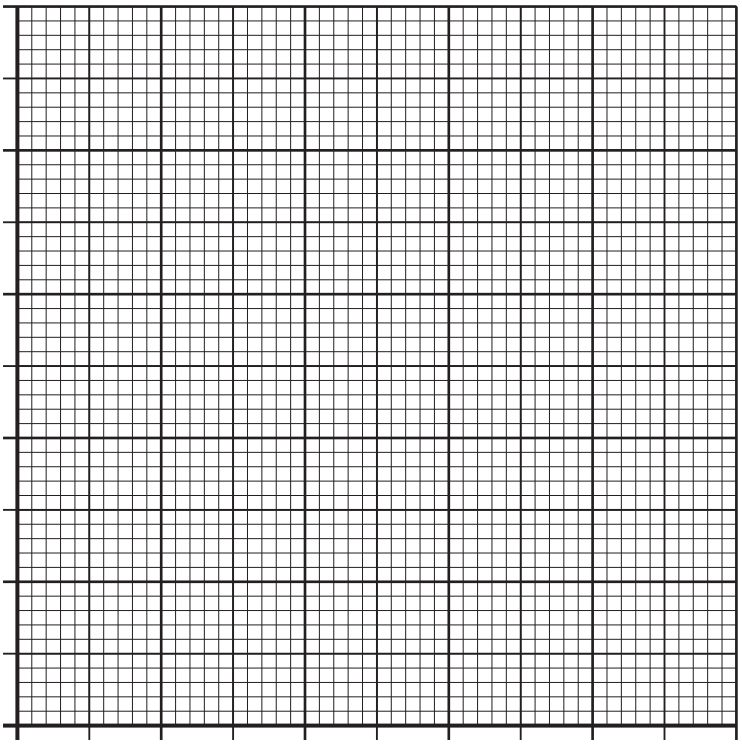
Suggest a more appropriate piece of apparatus to measure the volume of water. **1**

(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*.)



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**

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**

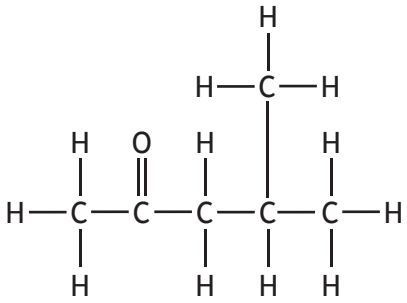
[Turn over

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**

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**

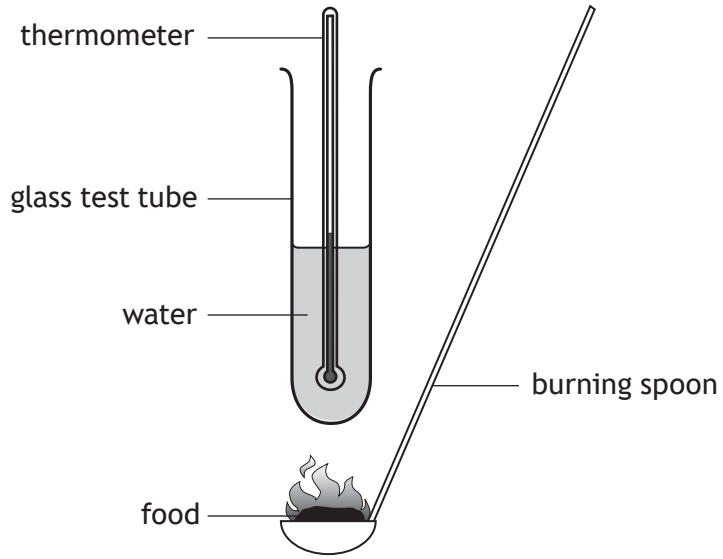
Show your working clearly.

(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**

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

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**

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

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 { covalent / ionic / metallic } bonding and a { lattice / molecular / network } 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**

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

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]