National 5 Chemistry Past Papers

September 2020

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.

2 How to use...

The following two pages contain tables which cross-reference the course topics with SQA question numbers for the years 2015-19.

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).
The Nat 5 course has been revised over this time period and some questions in the 2015, 2016 and 2017 papers have since been removed from the course. These questions refer to esters and condensation polymers and you should ignore these questions. I have omitted their question numbers from the tables.

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.

Mr Sinclair, Vale of Leven Academy

N5 Chem Past Papers - Multiple Choice Qs						
	Topic	2015	2016	2017	2018	2019
Unit 1	Rate of Reaction		2	1	1	1 2
	Atomic Structure and Bonding	1 2 3 5 7	3 5 6 7	2	2 3 4 5 6 7	3 4 6 7 8
	Formulae and Reacting Quantities	6 8	1	3 6 7 9		10
	Acids and Bases	10 11	8	5	8 9	11 12
Unit 2	Homologous Series	12 13 14	10 11 12	10 11	10 11	13 14 15
	Everyday Consumer Products			13	12 13 14	17
	Energy from Fuels		9	12 14		
Unit 3	Metals	15 16 18	4 15	15 16	17 18 19 23	18 19
	Plastics	17				20
	Fertilisers			17 18	20 21	
	Nuclear Chemistry		17 18 19		22	
	Chemical Analysis	4 19	14 20	19 20	15 24 25	9 21 22 23 24 25
	Problem Solving	9 20		4 8	16	5 16

N5 Chem Past Papers - Section 2 Qs						
	Topic	2015	2016	2017	2018	2019
Unit 1	Rate of Reaction	1	3b		1b 1c	
	Atomic Structure and Bonding	4a 9bii 14aii	1 11c 11d	1 3	6 7 10b	1 3a 8e
	Formulae and Reacting Quantities	6b 7b	3cii 4b 6b 12d	10b 12c	3b 13aii 14biii 16c	1c 5ci 11a 12aii 12biv
	Acids and Bases	4b-c 15a 15b	3ci	11a	1a	3b 11b-d
Unit 2	Homologous Series	12		9	4 9a 16a	5a 5bi&ii 5cii 7a&b
	Everyday Consumer Products	3 13a	12a	7 12a 14ai	13ai	2a
	Energy from Fuels	6c 8b	3a 9c	14b	9b	9
Unit 3	Metals	9a 9bi 9c	10	4b 8 10a	11	8d 10
	Plastics		2	13bi	2	5biii
	Fertilisers	5	1cii 6aii		10	
	Nuclear Chemistry	2		5	12	4
	Open-ended	10 16	7 13	6 15	8 17	6 13
	Chemical Analysis	7a 14b	8b 9a 12c		14bi&ii	12a 12b
	Problem Solving	5c-d 6a 8a 11 12c 14ai 14c	4a 5 6a 8a 8c 9b 11 12b	2 4a 9c 11b 13a 13c 14aii	3a 4d 5 13b&c 14a 15 16b	2 3c 3d 7c 8 9c

National Qualifications 2015

X713/75/02

Chemistry
Section 1—Questions

THURSDAY, 28 MAY

9:00 AM – 11:00 AM

Instructions for the completion of Section 1 are given on *Page two* of your question and answer booklet X713/75/01.

Record your answers on the answer grid on *Page three* of your question and answer booklet.

Necessary data will be found in 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.

X7137502

Go to Topic Grid

SECTION 1

1. An atom has 26 protons, 26 electrons and 30 neutrons.

The atom has

A atomic number 26, mass number 56

B atomic number 56, mass number 30

C atomic number 30, mass number 26

D atomic number 52, mass number 56.

2. The table shows the numbers of protons, electrons and neutrons in four particles, **W**, **X**, **Y** and **Z**.

Particle	*Protons*	*Electrons*	*Neutrons*
W	17	17	18
X	11	11	12
Y	17	17	20
Z	18	18	18

Which pair of particles are isotopes?

A **W** and **X**

B **W** and **Y**

C **X** and **Y**

D **Y** and **Z**

3. Which of the following particles contains a different number of electrons from the others?

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

A Cl^-

B S^{2-}

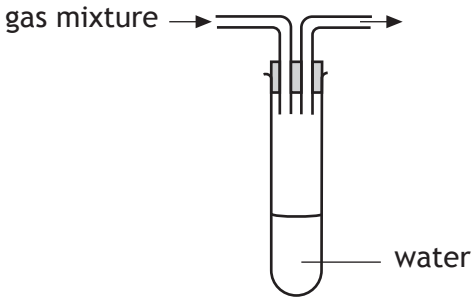
C Ar

D Na^+

Go to Answers

4. Which of the following diagrams shows the apparatus which would allow a soluble gas to be removed from a mixture of gases?

A



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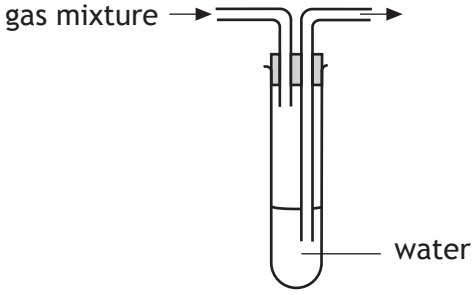

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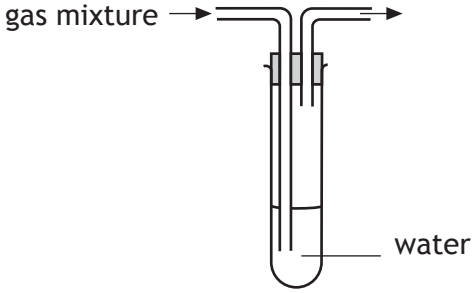

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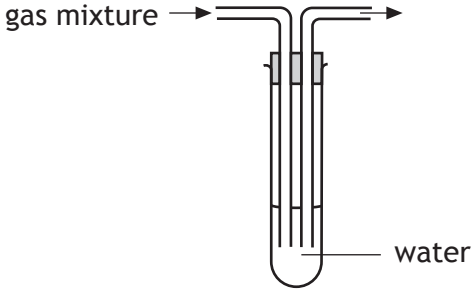
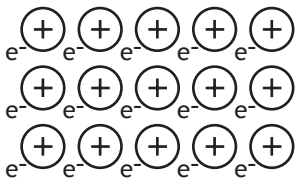


[Turn over

Go to Topic Grid

5. Which of the following diagrams could be used to represent the structure of a covalent network?

A



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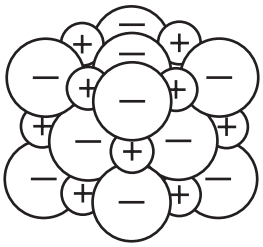

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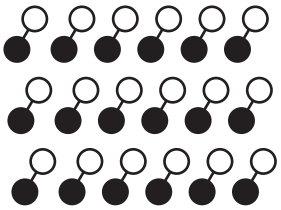

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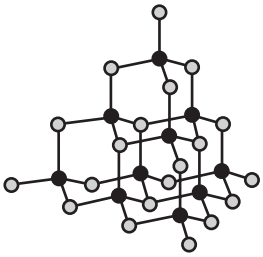


6. What is the charge on the chromium ion in $CrCl_3$?

A 1+

B 1−

C 3+

D 3−

Go to Answers

Go to Topic Grid

7. The table contains information about calcium and calcium chloride.

	Melting point (°C)	*Density* ($g\,cm^{-3}$)
Calcium	842	1·54
Calcium chloride	772	2·15

When molten calcium chloride is electrolysed at 800 °C the calcium appears as a

A solid at the bottom of the molten calcium chloride

B liquid at the bottom of the molten calcium chloride

C solid on the surface of the molten calcium chloride

D liquid on the surface of the molten calcium chloride.

8. $\boldsymbol{x}\,Al(s) + \boldsymbol{y}\,Br_2(\ell) \rightarrow \boldsymbol{z}\,AlBr_3(s)$

This equation will be balanced when

A $\boldsymbol{x} = 1$, $\boldsymbol{y} = 2$ and $\boldsymbol{z} = 1$

B $\boldsymbol{x} = 2$, $\boldsymbol{y} = 3$ and $\boldsymbol{z} = 2$

C $\boldsymbol{x} = 3$, $\boldsymbol{y} = 2$ and $\boldsymbol{z} = 3$

D $\boldsymbol{x} = 4$, $\boldsymbol{y} = 3$ and $\boldsymbol{z} = 4$.

9. 0·2 mol of a gas has a mass of 12·8 g.

Which of the following could be the molecular formula for the gas?

A SO_2

B CO

C CO_2

D NH_3

[Turn over

Go to Answers

Go to Topic Grid

10. Which of the following oxides, when shaken with water, would leave the pH unchanged? You may wish to use the data booklet to help you.

A Carbon dioxide

B Copper oxide

C Sodium oxide

D Sulfur dioxide

11. Which compound would **not** neutralise hydrochloric acid?

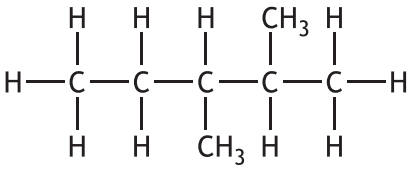
A Sodium carbonate

B Sodium chloride

C Sodium hydroxide

D Sodium oxide

12.



The name of the above compound is

A 2,3-dimethylpropane

B 3,4-dimethylpropane

C 2,3-dimethylpentane

D 3,4-dimethylpentane.

Go to Answers

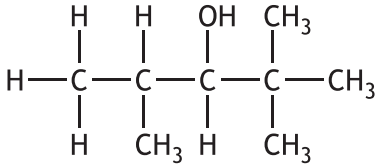
Go to Topic Grid

13. The shortened structural formula for an organic compound is

$CH_3CH(CH_3)CH(OH)C(CH_3)_3$

Which of the following is another way of representing this structure?

A



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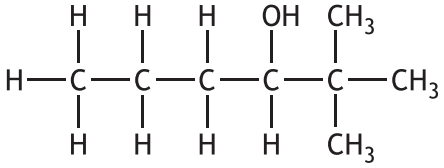

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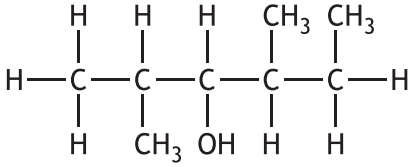

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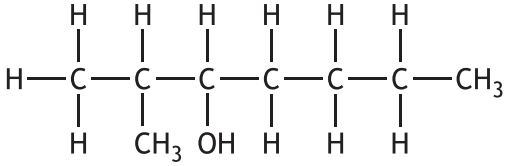

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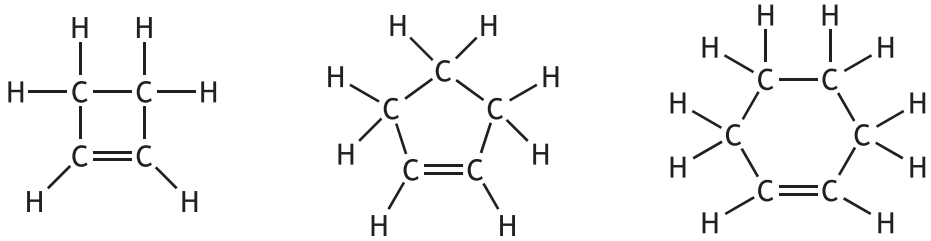
Go to Answers

Go to Topic Grid

14. Three members of the cycloalkene homologous series are



Which of the following is the general formula for this homologous series?

A C_nH_{2n-4}

B C_nH_{2n+2}

C C_nH_{2n}

D C_nH_{2n-2}

15. Metallic bonding is a force of attraction between

A negative ions and positive ions

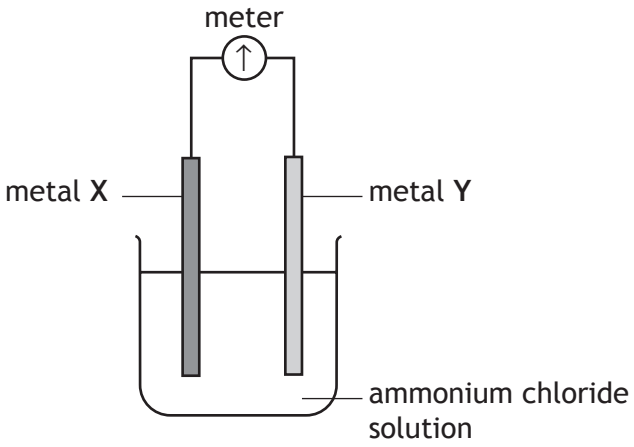
B a shared pair of electrons and two nuclei

C positive ions and delocalised electrons

D negative ions and delocalised electrons.

Go to Answers

16. Which pair of metals, when connected in a cell, would give the highest voltage and a flow of electrons from **X** to **Y**?



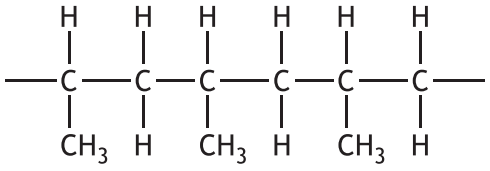
You may wish to use the data booklet to help you.

	Metal X	*Metal Y*
A	zinc	tin
B	tin	zinc
C	copper	magnesium
D	magnesium	copper

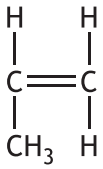
[Turn over

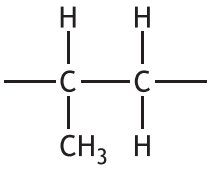
Go to Topic Grid

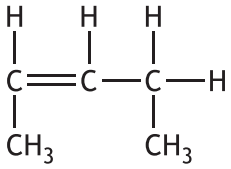
17. Part of the structure of a polymer is drawn below.

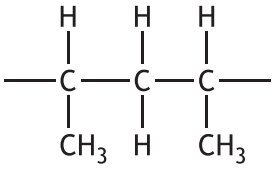


The monomer used to make this polymer is

A 

B 

C 

D 

Go to Answers

18. Sodium sulfate solution reacts with barium chloride solution.

$$Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$$

The spectator ions present in this reaction are

A Na^+ and Cl^-

B Na^+ and SO_4^{2-}

C Ba^{2+} and Cl^-

D Ba^{2+} and SO_4^{2-}.

19. Which of the following solutions would produce a precipitate when mixed together? You may wish to use the data booklet to help you.

A Ammonium chloride and potassium nitrate

B Zinc nitrate and magnesium sulfate

C Calcium nitrate and nickel chloride

D Sodium iodide and silver nitrate

[Turn over for Question 20 on *Page twelve*

20. The table shows the colours of some ionic compounds in solution.

Compound	*Colour*
copper sulfate	blue
copper chromate	green
potassium chloride	colourless
potassium chromate	yellow

The colour of the chromate ion is

A blue

B green

C colourless

D yellow.

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

Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2—60 marks

Attempt ALL questions

1. Ethyne is the first member of the alkyne family.

It can be produced by the reaction of calcium carbide with water.

The equation for this reaction is

$$CaC_2(s) + 2H_2O(\ell) \longrightarrow C_2H_2(g) + Ca(OH)_2(aq)$$

(a) The table shows the results obtained in an experiment carried out to measure the volume of ethyne gas produced.

Time (s)	0	30	60	90	120	150	180	210
Volume of ethyne (cm^3)	0	60	96	120	140	148	152	152

Calculate the average rate of reaction between 60 and 90 seconds.

Your answer must include the appropriate unit. **3**

Show your working clearly.

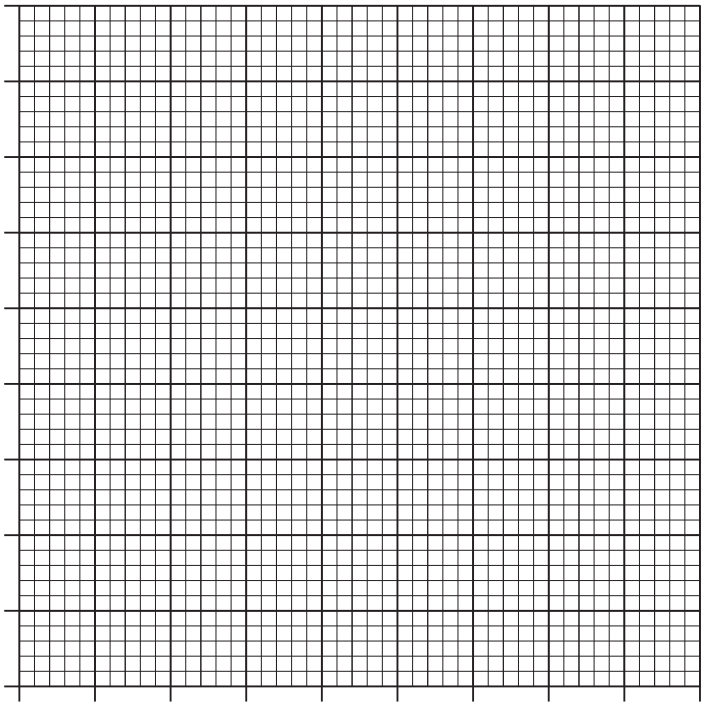
MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(b) Draw a line graph of the results. **3**

Use appropriate scales to fill most of the graph paper.

(Additional graph paper, if required, will be found on *Page twenty-seven*.)



[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

2. Americium-241, a radioisotope used in smoke detectors, has a half-life of 432 years.

(a) The equation for the decay of americium-241 is

$$^{241}_{95}\text{Am} \longrightarrow {}^{4}_{2}\text{He} + \mathbf{X}$$

Name element **X**. **1**

(b) Name the **type** of radiation emitted by the americium-241 radioisotope. **1**

(c) Another radioisotope of americium exists which has an atomic mass of 242.

Americium-242 has a half-life of 16 hours.

(i) A sample of americium-242 has a mass of 8 g.

Calculate the mass, in grams, of americium-242 that would be left after 48 hours. **2**

Show your working clearly.

(ii) Suggest why americium-241, and not americium-242, is the radioisotope used in smoke detectors. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

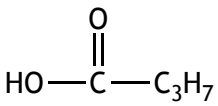
3. Butter contains different triglyceride molecules.

(a) A triglyceride molecule is made when the alcohol glycerol reacts with carboxylic acids.

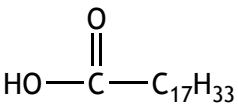
(i) Name the functional group present in glycerol. **1**

(ii) Name the family to which triglycerides belong. **1**

(b) When butter goes off, a triglyceride molecule is broken down, producing compounds **X** and **Y**.



X



Y

(i) Name compound **X**. **1**

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

MARKS | DO NOT WRITE IN THIS MARGIN

4. Some sources of methane gas contain hydrogen sulfide, H_2S.

(a) Draw a diagram, showing all outer electrons, to represent a molecule of hydrogen sulfide, H_2S. **1**

(b) If hydrogen sulfide is not removed before methane gas is burned, sulfur dioxide is formed.

When sulfur dioxide dissolves in water in the atmosphere, acid rain is produced.

(Circle) the correct words to complete the sentence.

Acid rain contains more { hydrogen / hydroxide } ions than { hydrogen / hydroxide } ions. **1**

(c) In industry, calcium oxide is reacted with sulfur dioxide to reduce the volume of sulfur dioxide released into the atmosphere.

Explain why calcium oxide is able to reduce the volume of sulfur dioxide gas released. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

5. A researcher investigated the conditions for producing ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Name the catalyst used in the production of ammonia. **1**

(b) In her first experiment she measured how the percentage yield of ammonia varied with pressure at a constant temperature of 500 °C.

Pressure (atmospheres)	100	200	300	400	500
Percentage yield (%)	10	18	26	32	40

Predict the percentage yield of ammonia at 700 atmospheres. **1**

(c) In a second experiment the researcher kept the pressure constant, at 200 atmospheres, and changed the temperature as shown.

Temperature (°C)	200	300	400	500
Percentage yield (%)	89	67	39	18

Describe how the percentage yield varies with temperature. **1**

(d) **Using the information in both tables**, suggest the combination of temperature and pressure that would produce the highest percentage yield of ammonia. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

6. Read the passage below and answer the questions that follow.

Clean coal technology comes a step closer

It is claimed a process called Coal-Direct Chemical Looping (CDCL) is able to release energy from coal while capturing 99% of the carbon dioxide emitted. CDCL works by extracting the energy from coal using a reaction other than combustion.

A mixture of powdered coal and beads of iron(III) oxide is heated inside a metal cylinder. Carbon in the coal and oxygen from the beads react to form carbon dioxide which can be captured for recycling or stored.

This reaction gives off heat energy that could be used to heat water in order to drive electricity-producing steam turbines.

Adapted from *Focus: Science and Technology*, April 2013

(a) The CDCL process produced 300 tonnes of carbon dioxide.

Calculate the mass, in tonnes, of carbon dioxide released into the atmosphere. **1**

(b) Write the ionic formula for the iron compound used in CDCL. **1**

(c) State the term used to describe all chemical reactions that release heat energy. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

7. A student was asked to carry out an experiment to determine the concentration of a copper(II) sulfate solution.

Part of the work card used is shown.

> Determination of the Concentration of Copper(II) Sulfate Solution
>
> 1. Weigh an empty crucible
> 2. Add 100 cm^3 copper(II) sulfate solution
> 3. Evaporate the solution to dryness
> 4. Weigh the crucible containing dry copper(II) sulfate

(a) Suggest how the student could have evaporated the solution to dryness. **1**

(b) The student found that the 100 cm^3 solution contained 3·19 g of copper(II) sulfate, $CuSO_4$.

Calculate the concentration of the solution in mol l^{-1}. **2**

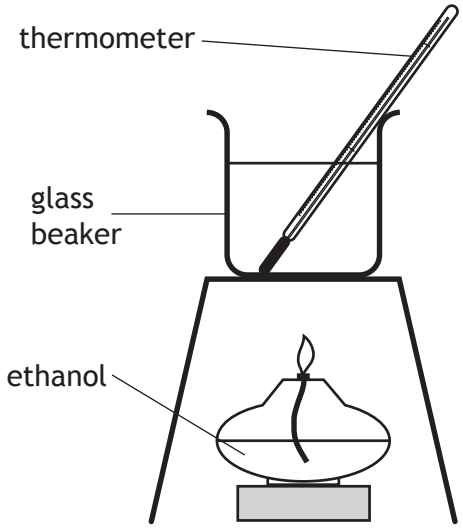
Show your working clearly.

[Turn over

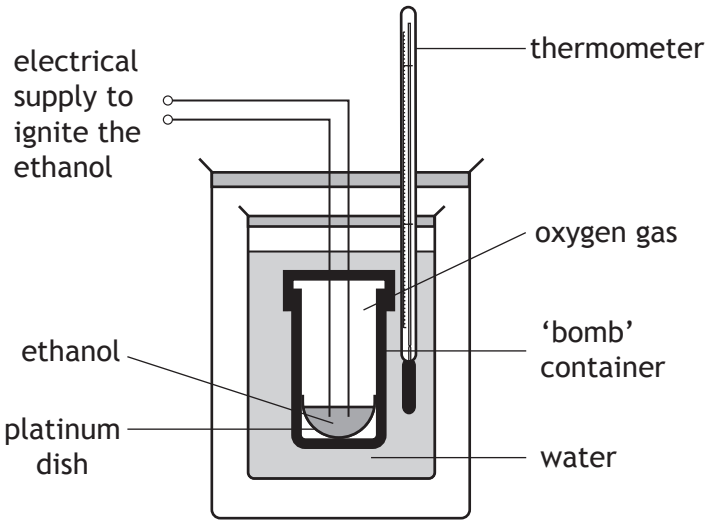
MARKS DO NOT WRITE IN THIS MARGIN

8. A student calculated the energy absorbed by water when ethanol is burned using two different methods.

Method A



Method B



The student recorded the following data.

	Method	
	A	**B**
Mass of ethanol burned (g)	0·5	0·5
Mass of water heated (g)	100	100
Initial temperature of water (°C)	24	24
Final temperature of water (°C)	32	58

(a) The final temperature of water in method **B** is higher than in method **A**.
Suggest why there is a difference in the energy absorbed by the water. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

8. (continued)

(b) Calculate the energy, in kJ, absorbed by the water in method **B**. **3**

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

Show your working clearly.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. Aluminium can be extracted from naturally occurring metal compounds such as bauxite.

(a) State the term used to describe naturally occurring metal compounds such as bauxite. **1**

(b) Bauxite is refined to produce aluminium oxide.

Electrolysis of molten aluminium oxide produces aluminium and oxygen gas.

The ion-electron equations taking place during the electrolysis of aluminium oxide are

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

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

(i) Write the redox equation for the overall reaction. **1**

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

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(c) Bauxite contains impurities such as silicon dioxide.

Silicon can be extracted from silicon dioxide as shown.

$$SiO_2 + 2Mg \longrightarrow Si + 2MgO$$

Identify the reducing agent in this reaction. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

10. A group of students were given strips of aluminium, iron, tin and zinc.

Using your knowledge of chemistry, suggest how the students could identify each of the four metals. **3**

MARKS | DO NOT WRITE IN THIS MARGIN

11. Electrons can be removed from all atoms.

The energy required to do this is called the ionisation energy.

The first ionisation energy for an element is defined as the energy required to remove one mole of electrons from one mole of atoms, in the gaseous state.

The equation for the first ionisation energy of chlorine is

$$Cl(g) \longrightarrow Cl^{+}(g) + e^{-}$$

(a) State the electron arrangement for the Cl^{+} ion. **1**

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

(b) Write the equation for the first ionisation energy of magnesium. **1**

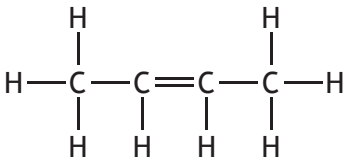
(c) Information on the first ionisation energy of some elements is given in the table.

Element	*First ionisation energy* ($kJ\,mol^{-1}$)
lithium	526
fluorine	1690
sodium	502
chlorine	1260
potassium	425
bromine	1150

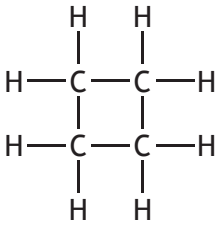
Describe the trend in the first ionisation energy going down a group in the Periodic Table. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

12. The structural formulae of two hydrocarbons are shown.



A



B

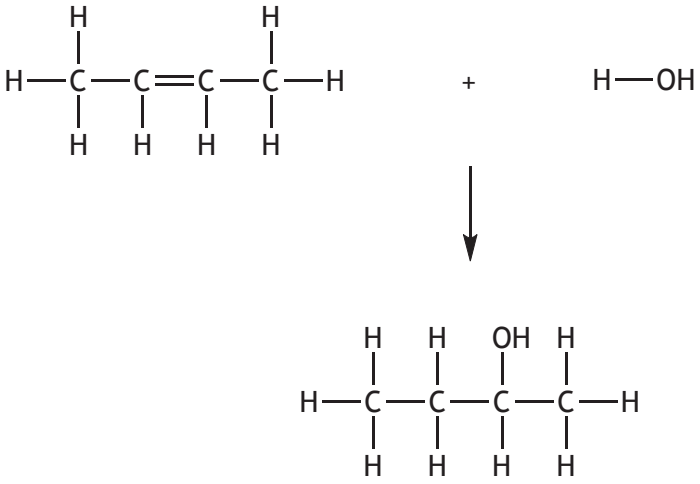
(a) Name hydrocarbon **A**. **1**

(b) Hydrocarbons **A** and **B** can be described as isomers.
State what is meant by the term isomer. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

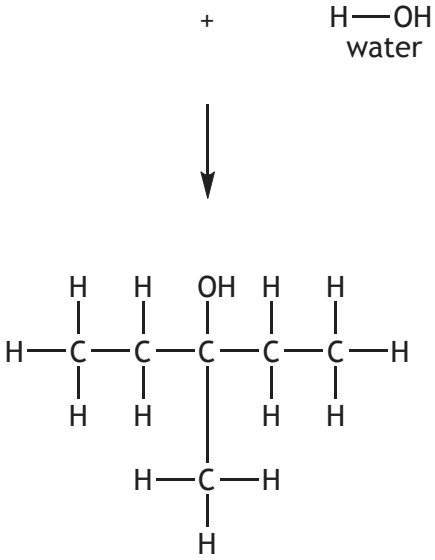
12. (continued)

(c) Hydrocarbon **A** can undergo an addition reaction with water to form butan-2-ol as shown.



A similar reaction can be used to produce 3-methylpentan-3-ol.

Draw a structural formula for the hydrocarbon used to form this molecule. **1**

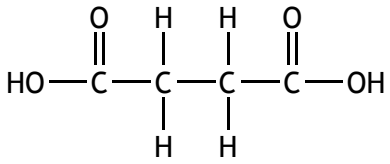


3-methylpentan-3-ol

MARKS | DO NOT WRITE IN THIS MARGIN

13. Succinic acid is a natural antibiotic.

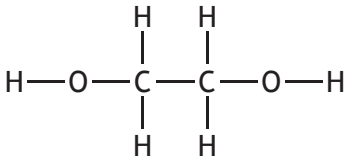
The structure of succinic acid is shown.



(a) Name the functional group present in succinic acid. **1**

(b) Succinic acid can form a polymer with ethane-1,2-diol.

The structure of ethane-1,2-diol is shown.



(i) Name the type of polymerisation which would take place between succinic acid and ethane-1,2-diol. **1**

(ii) Draw the repeating unit of the polymer formed between succinic acid and ethane-1,2-diol. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

14. Titanium is the tenth most commonly occurring element in the Earth's crust.

(a) The first step in the extraction of titanium from impure titanium oxide involves the conversion of titanium oxide into titanium(IV) chloride.

$$TiO_2 + 2Cl_2 + 2C \longrightarrow TiCl_4 + 2X$$

(i) Identify **X**. **1**

(ii) Titanium(IV) chloride is a liquid at room temperature and does not conduct electricity.

Suggest the type of bonding that is present in titanium(IV) chloride. **1**

(b) The next step involves separating pure titanium(IV) chloride from other liquid impurities that are also produced during the first step.

Suggest a name for this process. **1**

(c) The equation for the final step in the extraction of titanium is

$$TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$$

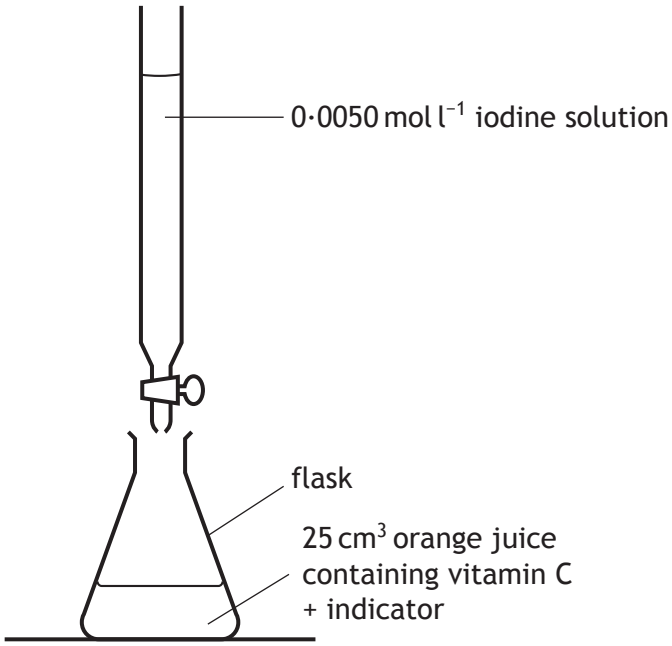
The sodium chloride produced can be electrolysed.

Suggest how this could make the extraction of titanium from titanium oxide more economical. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

15. Vitamin C is found in fruits and vegetables.

Using iodine solution, a student carried out titrations to determine the concentration of vitamin C in orange juice.



The results of the titration are given in the table.

Titration	*Initial burette reading* (cm^3)	*Final burette reading* (cm^3)	*Titre* (cm^3)
1	1·2	18·0	16·8
2	18·0	33·9	15·9
3	0·5	16·6	16·1

(a) Calculate the average volume, in cm^3, that should be used in calculating the concentration of vitamin C. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

15. (continued)

(b) The equation for the reaction is

$$\underset{\text{vitamin C}}{C_6H_8O_6(aq)} + I_2(aq) \longrightarrow C_6H_6O_6(aq) + 2HI(aq)$$

Calculate the concentration, in mol l^{-1}, of vitamin C in the orange juice. **3**

Show your working clearly.

[Turn over for Question 16 on *Page twenty-six*

MARKS | DO NOT WRITE IN THIS MARGIN

16. A student is given three different compounds each containing carbon.

Using your knowledge of chemistry, describe how the student could identify the compounds. **3**

[END OF QUESTION PAPER]

National
Qualifications
2015

2015 Chemistry

National 5

Finalised Marking Instructions

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Detailed Marking Instructions for each question

Section 1

Question	Answer	Max Mark
1.	A	**1**
2.	B	**1**
3.	D	**1**
4.	C	**1**
5.	D	**1**
6.	C	**1**
7.	C	**1**
8.	B	**1**
9.	A	**1**
10.	B	**1**
11.	B	**1**
12.	C	**1**
13.	A	**1**
14.	D	**1**
15.	C	**1**
16.	D	**1**
17.	A	**1**
18.	A	**1**
19.	D	**1**
20.	D	**1**

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Section 2

Question			Answer	Max Mark	Additional Guidance
1.	(a)		$0{\cdot}8\ cm^3\ s^{-1}$ or $0{\cdot}8\ cm^3/s$ with no working (3) For partial marking **Maximum 2 marks for calculation.** **Final mark is awarded for the correct unit.** $\frac{120-96}{90-60}$ or $\frac{96-120}{60-90}$ or $24/30$ (1) $0{\cdot}8$ (1) (this answer without working 2 marks) The mark for the correct unit, $cm^3\ s^{-1}$ **or** cm^3/s **or** cubic centimetres per second **or** cm^3 per second, **is independent of the other marks.** (1)	**3**	Please note that the unit mark is independent of the other marks. Correct method (i.e. change in volume/change in time) but incorrect arithmetic using correct values from table. 1 mark for calculation Correct method but incorrect values **from the table** used (subtractions must be shown). 1 mark for calculation If correct method is used but values used are **not** in the table. 0 marks for calculation If incorrect method used (i.e. change in time/change in volume). 0 marks for calculation Do not accept cm^3/s^{-1} **or** $cm^{3\ s-1}$ **or** cm3s-1 etc. 's' is the only acceptable abbreviation of second. Refer to General Marking Principle **(j)** for guidance.

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Question			Answer	Max Mark	Additional Guidance
	(b)		Both axes labelled with units (1) Both scales (1) Graph drawn accurately (1) (points must be plotted correctly and line drawn, either by joining the dots or by a smooth curve or curve of best fit) The line must be drawn from the origin.	**3**	Accept volume of ethyne (cm^3), volume of C_2H_2 (cm^3), volume of gas (cm^3), volume (cm^3), as label. Accept 0/0 or a common zero on the axis. The zero does not have to be shown on the scale. Accept time on the x axis and volume on the y axis or vice versa. Allow 1 plotting error. Line not drawn to the origin does not count as a plotting error i.e. if the line is not drawn to the origin a maximum of two marks can be awarded. Allow ½ box tolerance Bar graph maximum 2 marks Max 2 marks if the graph plotted takes up less than half of the graph paper for either axis.

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Question			Answer	Max Mark	Additional Guidance
2.	(a)		Neptunium or Np **or** ^{237}Np $^{237}_{93}$Np $_{93}$Np	**1**	If mass **or** atomic number are given incorrectly e.g. ^{236}Np ^{93}Np 0 marks Do not penalise if the atomic number/mass number is written on the right hand side of the symbol. NP **or** np **or** nP are awarded zero marks and negates (cancels) the correct name.
	(b)		Alpha **or** α **or** $^{4}_{2}\alpha$	**1**	$^{4}_{2}\mathrm{He}$ **or** $^{4}_{2}\mathrm{He}^{2+}$ on their own they are **not** acceptable but if given with a correct answer they do not negate the correct answer. Any mention of beta **or** gamma negates the correct answer eg Alpha β award 0 marks

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Question			Answer	Max Mark	Additional Guidance
	(c)	(i)	1 with no working (2) Partial marking Three half-lives stated **or** correct working shown (1) Final answer = 1 (1) (this step on its own 2 marks)	**2**	If number of half-lives is incorrect allow follow through to second step - maximum 1 mark can be awarded. Unit is not required however if the wrong unit is given a maximum of 1 mark out of 2 can be awarded. A correct answer clearly derived from incorrect working is awarded zero marks.
		(ii)	(It/Americium 241/Am-241) has a long/longer half life **or** will not need to be replaced as often **or** words to this effect **or** (It/Americium 241/Am-241) emits alpha radiation (particles) which has a low penetrating power/doesn't travel far/stopped by the smoke particles.	**1**	If candidate states -shorter/short/lower half-life/needs replaced more often/does not last as long/**only** has a half-life of 16 hours it **must** be stated that they are referring to **americium -242** Zero marks awarded for It/Am-241 has a half-life of 432 years **or** Am-242 has a half-life of 16 hours. Socio-economical answers **or** answers relating to safety are not accepted but do not negate the correct answer. Refer to General Marking Principle **(p)** for guidance.

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Question			Answer	Max Mark	Additional Guidance
3.	(a)	(i)	Hydroxyl **or** OH **or** -OH	**1**	Zero marks awarded for hydroxide/OH^- Refer to General Marking Principle **(m)** for guidance. Zero marks awarded if hydroxide is given along with hydroxyl. Refer to General Marking Principle **(g)** for guidance.
		(ii)	Ester **or** esters **or** fats **or** oils	**1**	

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Question			Answer	Max Mark	Additional Guidance
	(b)	(i)	Butanoic acid **or** methylpropanoic acid **or** 2-methylpropanoic acid **or** butyric acid	**1**	Spelling must be correct **and** the word acid must be included. If candidate draws a structure that is incorrect then this does not negate. Refer to General Marking Principles **(b)** and **(f)** for guidance.
		(ii)	Bromine/Br_2 decolourised/discolourised **or** bromine/Br_2 goes colourless	**1**	Accept bromine/bromine water/bromine solution but do **not** accept bromide or Br. Zero marks awarded for 'goes clear' however if given in addition to a correct answer it does not negate. Award zero marks if candidate explicitly states compound **Y** is decolourised **or** the unsaturated compound is decolourised. If starting colour is given it must be correct e.g. orange/yellow/red-brown or brown. If candidate states correct answer followed by incorrect statement such as because it has a carbon to carbon single bond zero marks are awarded. Refer to General Marking Principle (**g**) for guidance.

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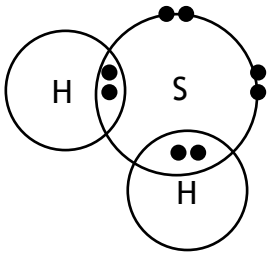
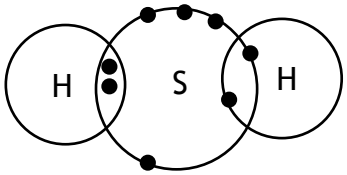
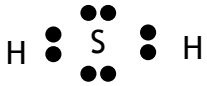
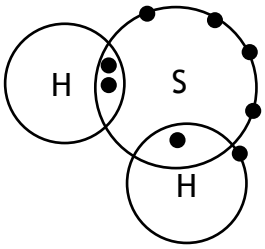
Question			Answer	Max Mark	Additional Guidance
4	(a)		Diagram showing two hydrogen atoms and one sulfur atom with two pairs of bonding electrons and two non-bonding pair of electrons in sulfur e.g.    	1	**All symbols must be shown.** Accept cross **or** dot **or** e to represent electrons or a mixture of these. Accept petal diagram for sulfur but **not** for hydrogen. The non-bonding electrons in sulfur must be shown but do **not** need to be shown as a pair **or** be together **or** be on the line. Bonding electrons **MUST** be on the line or in the overlapping area. The example below is awarded 0 marks.  If inner electrons on sulfur are shown they must be correct ie 2,8
	(b)		1st = hydrogen 2nd = hydroxide **Both required for 1 mark**	1	Accept corrects words underlined/highlighted rather than circled.
	(c)		It/calcium oxide is a base **or** forms an alkaline solution (alkali) when dissolved in water. For the mention of alkali the candidate must explicitly state the calcium oxide is in solution/dissolved in water (1) Mention of it neutralising sulfur dioxide/it neutralises it/**or** a neutralisation reaction takes place. (1)	2	Calcium is a base **or** alkali is **not** acceptable for the first mark. The two marks are **independent** of each other. e.g. a candidate who **only** states 'it neutralises it' would be awarded 1 mark out of a possible two. A candidate who states that calcium oxide is a base and reacts with sulfur dioxide would be awarded 1 mark out of a possible two.

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Question			Answer	Max Mark	Additional Guidance
5.	(a)		Iron **or** Fe	**1**	Refer to General Marking Principle **(m)** for guidance.
	(b)		Any value from 52 - 56 inclusive	**1**	
	(c)		As temperature increases the yield decreases. **or** As temperature decreases the yield increases. **or** The yield increases as the temperature decreases. **or** The yield decreases as the temperature increases. Accept percentage in place of yield.	**1**	**Cause** and **effect** must be stated correctly**.** Zero marks awarded for The temperature increases as the yield decreases. **or** As the yield increases the temperature decreases. Accept alternatives to increases e.g. goes up/gets higher decreases e.g. goes down/gets lower/gets less
	(d)		temperature 200 °C **or** a value **below** 200 °C **and** pressure 500 atmospheres **or** a value **greater** than 500 atmospheres **Both required for 1 mark**	**1**	Do **not** accept correct values without either unit **or** label. eg temperature 200 and 500 atmospheres is awarded 1 mark; 200 °C and pressure of 500 is awarded 1 mark. The candidate must link each value given to the correct condition. eg 500 and 200 - 0 marks; 500 atmospheres and 200 - 0 marks

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Question			Answer	Max Mark	Additional Guidance
6	(a)		3	**1**	Unit is not required however if the wrong unit is given do **not** award the mark. 0 marks are awarded for 3.03 Accept abbreviations for unit that convey the meaning.
	(b)		$(Fe^{3+})_2(O^{2-})_3$ **or** $Fe^{3+}{}_2\ O^{2-}{}_3$ **or** $(Fe^{3+})_2\ O^{2-}{}_3$ **or** $Fe^{3+}{}_2(O^{2-})_3$ **or** $Fe_2{}^{3+}\ O_3{}^{2-}$	**1**	Refer to General Marking Principle **(n)** for guidance. Both charges **must** be shown and correct Award zero marks for Fe_2O_3 $Fe^{3+}{}_2O_3$ $Fe_2O^{2-}{}_3$ $2Fe^{3+}(O^{2-})_3$
	(c)		Exothermic or exothermal	**1**	Any mention of endothermic negates the correct answer. Refer General Marking Principle **(f)** for guidance.

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Question			Answer	Max Mark	Additional Guidance
7.	(a)		Boil it **or** boil off the water **or** heat it **or** leave it for some time/overnight/next lesson **or** leave it on the window ledge **or** use Bunsen (burner) **or** appropriate diagram	**1**	Any mention of filtering negates the correct answer. Refer to General Marking Principle **(g)** for guidance. Award zero marks for leave it with no indication of appropriate time or do nothing. Award zero marks awarded for mention of burn **or** burning. This negates the correct answer.
	(b)		0·2 with no working (2) Partial marking 3·19/159·5 = 0·02 (1) 0·02/0·1 = 0·2 (1) (this step on its own 2 marks) or (3·19 in 100 cm^3) 31·9 in 1000 cm^3 or 1 litre (1) 31·9/159·5 = 0·2 (1) (this step on its own 2 marks)	**2**	Allow follow through from step 1 Award 1 mark for 0·1 --> 3·19 1 --> 31·9 Zero marks are awarded for **only** showing c=n/v where the answer is not 0·2 Unit is not required however if the wrong unit is given a maximum of 1 mark out of 2 can be awarded. Accept mol l^{-1} or mol/l ('L' in place of 'l') Do not accept mol/l^{-1} or mol^{-1} or mol l

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Question			Answer	Max Mark	Additional Guidance
8.	(a)		<u>Method B (it)</u> Complete combustion/more oxygen/pure oxygen Less/no heat loss (to surroundings) Better insulation Metal/platinum is a better conductor **or** <u>Method A</u> Incomplete combustion Less oxygen (More) heat loss to surroundings No draught shield/no insulation Glass is a poor conductor Flame too far away from beaker **or** Any other reasonable answer	**1**	If answer relates to method A it must be clear that it is method A they are referring to. If the method is not identified in the candidates answer as method A or method B then assume that the answer refers to method B. Award zero marks for the beaker is made from glass without the effect **or** the walls are thick without the effect **or** the water evaporates.

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Question	Answer	Max Mark	Additional Guidance
(b)	14 /14·2/14·21/14·212 with no working (3) Partial marking using concept cmΔT with c = 4·18 To be awarded the concept mark candidates do not specifically need to write cmΔT. The concept mark is awarded for using this relationship with values - three values, one of which must be 4·18 (1) using data correctly i.e. both 0·1 **and** 34 °C (1) final answer 14/14·2/14·21/14·212 (1) If awarding partial marks, the mark for the final answer can only be awarded if the concept mark has been awarded.	**3**	4·18 x 0·5 x 34 = 71·06 would be awarded 2 marks (concept mark and follow through) 4·18 x 0·5 x 58 = 121·22 would be awarded 2 marks (concept mark and follow through) If **Method A** data is used i.e. 0·1 x 8, a maximum of 2 marks can be awarded (1 for concept mark and 1 for final answer 3·344). If **Method A** data is used and **no working shown** award **zero marks** (for answer 3·344 with no working). Ignore negative sign if present. Unit is not required however if the wrong unit is given do **not** award mark for final answer e.g. kJ^{-1} or kg is incorrect Accept kj, kJ, Kj or KJ. 4.18 x 100 x 34 = 14212(KJ) is worth 2 marks as it contains wrong data. The answer in joules is accepted but the units must be given. e.g. 14212 J is acceptable and would be awarded 3 marks. 14212 on its own is **not** acceptable without working.

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Question			Answer	Max Mark	Additional Guidance
9.	(a)		(Metal) ore/ores	**1**	Zero marks awarded for mineral/alloy These also negate the correct answer. Refer to General Marking Principle **(f)** for guidance.
	(b)	(i)	$4Al^{3+} + 6O^{2-} \longrightarrow 4Al + 3O_2$ (or correct multiples) **All must be correct for 1 mark**	**1**	Zero marks awarded for any electrons shown in equation. Ignore state symbols if given.
		(ii)	Ions free to move **or** ions able to move **or** ions mobile	**1**	Any mention of electrons negates the correct answer. Refer to General Marking Principle **(g)** for guidance. The word 'ion' **must** be mentioned. Zero marks awarded for they can move **or** (charged) particles **or** molecules **or** electrons can move.
	(c)		Mg **or** magnesium **or** 2Mg **or** Mg circled/highlighted/underlined in equation.	**1**	Any other substance indicated, in addition to Mg, negates the correct answer. Refer General Marking Principle **(g)** for guidance.

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Question			Answer	Max Mark	Additional Guidance
10.			This is an open ended question **1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	

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Question			Answer	Max Mark	Additional Guidance
11.	(a)		2,8,6 **or** a correct target diagram	1	Punctuation between numbers is not required. Zero marks awarded for values in the wrong order eg 6.8.2
	(b)		$Mg_{(g)} \rightarrow Mg^{+}_{(g)} + e^{-}$ $Mg \rightarrow Mg^{+} + e$ $Mg_{(g)} \rightarrow Mg^{+} + e^{-}$ $Mg \rightarrow Mg^{+}_{(g)} + e$ or $Mg_{(g)} - e^{-} \rightarrow Mg^{+}_{(g)}$ etc.	1	State symbols are not required, however if shown they must be correct ie (g) Negative charge on electron is not needed.
	(c)		Decreases **or** As you go from lithium to potassium (alkali metals) it (ionisation energy) decreases. **or** As you go from fluorine to bromine (halogens) it (ionisation energy) decreases. **or** as the atomic number in the group increases it decreases	1	Accept alternatives to decreases e.g. goes down, gets less, gets lower If answer states trend is for going across a period **or** specific elements not in a group award zero marks. Zero marks awarded for as you go from potassium to lithium it decreases. Zero marks awarded for relating ionisation energy to reactivity. If candidate answers the question in terms of going up a group this is acceptable as long as they state both the direction (going up a group) and the trend (increases).

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Question			Answer	Max Mark	Additional Guidance
12.	(a)		But-2-ene **or** 2-butene	**1**	Refer to General Marking Principle **(b)** for guidance. Zero marks awarded for butene **or** but-2-ane **or** butan-2-ene
	(b)		(Molecules/compounds /hydrocarbons/alkenes) with same molecular/chemical formula but a different structural formula	**1**	The same number of carbons and hydrogens but different structure or atoms are arranged differently is acceptable. Different **shape** is **not** acceptable. Zero marks awarded for 'general formula' instead of 'molecular formula'. Zero marks awarded for **elements** with.....

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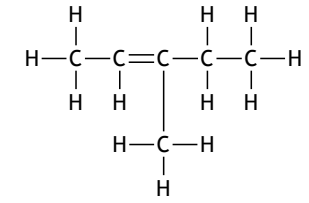
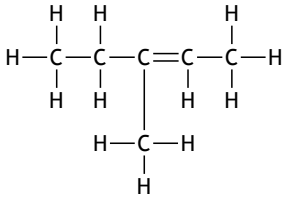
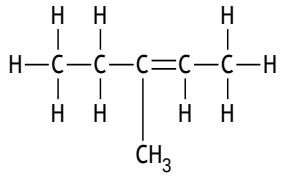
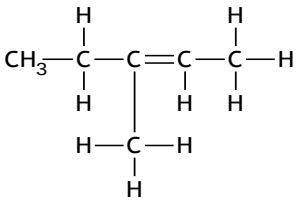
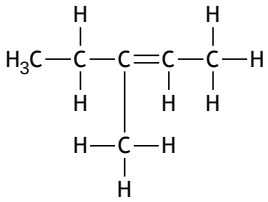
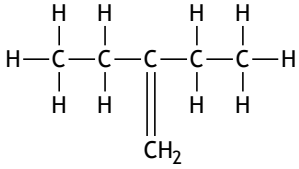
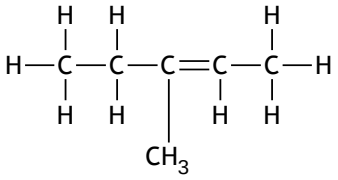
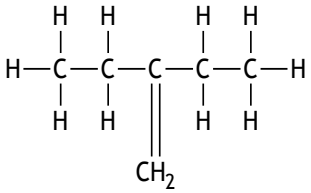
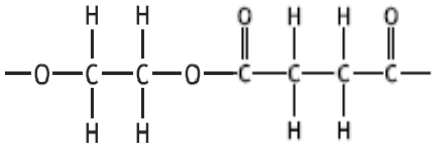
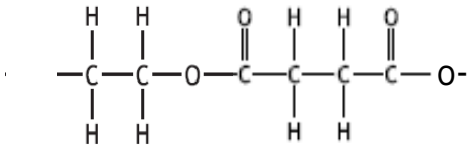
Question			Answer	Max Mark	Additional Guidance
	(c)		Correct structural formula for 3-methylpent-2-ene or 2 ethyl but-1-ene eg       or mirror images or correct shortened structural formula e.g. $CH_3CHC(CH_3)CH_2CH_3$	1	Accept shortened structural formula or full structural formula or combination of both Allow one H bonded to a carbon to be missing as long as bond from carbon is shown. Allow one bond between a carbon and a hydrogen to be missing as long as hydrogen is shown. Refer to General Marking Principle (l) for guidance. As the vertical bond is not to the carbon, award zero marks for  

Go to Topic Grid

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
13.	(a)		Carboxyl	**1**	Zero marks awarded for carboxylic (acid). Zero marks awarded for –COOH circled or drawn but this does not negate the correct answer 'carboxyl'. Refer to General Marking Principle **(h)** for guidance.
	(b)	(i)	Condensation (polymerisation)	**1**	Any mention of 'addition' or any other reaction type negates the correct answer. Refer to General Marking Principle **(g)** for guidance.
		(ii)	  or mirror images Accept full or shortened structural formula or combination of both.	**1**	Allow dot or ~ to represent end bond. Ignore brackets or n written outside the bracket at side of repeating unit. Allow one end bond to be missing without penalty. Allow **one** hydrogen bonded to a carbon to be missing as long as bond from carbon is shown. Allow **one** bond between a carbon and a hydrogen to be missing as long as hydrogen is shown. Refer to General Marking Principle **(l)** for guidance. Zero marks awarded if **both** end bonds are missing **or** both/either end has a H **or** both ends have an O **or** bond between carbon and oxygen or another carbon is missing.

Go to Topic Grid

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
14.	(a)	(i)	Carbon monoxide **or** CO/2CO	**1**	Zero marks awarded for Co or cO
		(ii)	Covalent	**1**	Ignore the mention of single or double bonds. Refer to General Marking Principle **(h)** for guidance. Accept covalent molecular/ covalent discrete/covalent discrete molecular. Do not accept molecular on its own. Do **not** accept covalent network The mention of ionic negates the correct answer. Refer to General Marking Principle **(g)** for guidance.
	(b)		Distillation/distilling	**1**	Zero marks awarded for fractional on its own, however it does not negate the correct answer. Zero marks awarded for 'evaporation then condensation'.
	(c)		The sodium **or** chlorine or products can be recycled/reused **or** Chlorine can be used in the first step **or** Sodium can be used in final step	**1**	Award zero marks for sodium **or** chlorine **or** products could be sold etc. However, this does not negate a correct answer. A statement about recycling or reusing for anything outwith this process on its own should be awarded zero marks but does not negate a correct answer. Any mention of 'will not pollute' etc. is awarded zero marks on its own but does not negate a correct answer. Zero marks awarded for '**it** can be recycled' as 'it' refers to sodium chloride.

Go to Topic Grid

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
15.	(a)		16	**1**	Unit is not required however if the wrong unit is given do **not** award mark.

Go to Topic Grid

Go to Topic Grid

Question	Answer	Max Mark	Additional Guidance
(b)	$0{\cdot}0032/3{\cdot}2 \times 10^{-3}$ with no working or correctly rounded answer (3) ..... Partial marking $0{\cdot}0050 \times 0{\cdot}016 = 0{\cdot}00008$ mol I_2 (1) 0·00008 mol of Vit C (1) (this step on its own gets 2 marks) $0{\cdot}00008/0{\cdot}025 = 0{\cdot}0032/3{\cdot}2 \times 10^{-3}$ (1) (this step on its own gets 3 marks) **or** $0{\cdot}0050 \times 16 = 0{\cdot}08$ mol I_2 (1) 0·08 mol of Vit C (1) (this step on its own gets 2 marks) $0{\cdot}08/25 = 0{\cdot}0032/3{\cdot}2 \times 10^{-3}$ (1) (this step on its own gets 3 marks) or $\frac{C_1 \times 25}{1} = \frac{0{\cdot}0050 \times 16}{1}$ (1) (1) $C_1 \times 25 = 0{\cdot}08$ (this step on its own gets 2 marks) $C_1 = 0{\cdot}0032/3{\cdot}2 \times 10^{-3}$ (1) (this step on its own gets 3 marks) or $\frac{C_1 \times 0.025}{1} = \frac{0{\cdot}0050 \times 0.016}{1}$ (1) (1) $C_1 \times 0.025 = 0{\cdot}00008$ (this step on its own gets 2 marks) $C_1 = 0{\cdot}0032/3{\cdot}2 \times 10^{-3}$ (1) (this step on its own gets 3 marks) OR ANY OTHER ACCEPTABLE METHOD	**3**	Allow follow through from part 15(a). Refer to General Marking Principle **(k)** for guidance. Candidates should not be penalised if 16 (or volume from part a) **and** 25 (volume of vitamin C solution) are both expressed in cm^3. If candidate expresses one volume in cm^3 and the other in litres then a maximum of two marks can be awarded. If candidate **only** calculates number of moles of iodine the volume must be in litres to be awarded 1 mark i.e. $0{\cdot}0050 \times 16 = 0{\cdot}08$ mol I_2 on its own with no further working is awarded zero marks. Zero marks are awarded if values for C, V and n are given but not used in an appropriate method. For method using relationship shown in the data book 1 mark is awarded for the correct pairings of volume (in the same unit) and concentration. 1 mark is awarded for the correct mole ratio being applied. 1 mark is awarded for the correct arithmetic. This mark can only be awarded if an appropriate method has been used. Unit is not required however if the wrong unit is given then the final mark cannot be awarded. Accept mol l^{-1} or mol/l but **not** mol/l^{-1} or mol^{-1} or mol l

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Question			Answer	Max Mark	Additional Guidance
16.			**1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. 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]

Go to Topic Grid

National Qualifications 2016

X713/75/02

Chemistry
Section 1 — Questions

WEDNESDAY, 18 MAY

1:00 PM – 3:00 PM

Instructions for the completion of Section 1 are given on *Page 02* of your question and answer booklet X713/75/01.

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

Necessary data will be found in 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

1. When solid sodium chloride dissolves in water, a solution containing sodium ions and chloride ions is formed.

Which of the following equations correctly shows the state symbols for this process?

A $NaCl(s) + H_2O(\ell) \longrightarrow Na^+(\ell) + Cl^-(\ell)$

B $NaCl(s) + H_2O(aq) \longrightarrow Na^+(aq) + Cl^-(aq)$

C $NaCl(aq) + H_2O(\ell) \longrightarrow Na^+(aq) + Cl^-(aq)$

D $NaCl(s) + H_2O(\ell) \longrightarrow Na^+(aq) + Cl^-(aq)$

2. The table shows the times taken for 0·5 g of magnesium to react completely with acid under different conditions.

Acid concentration (mol l^{-1})	*Temperature* (°C)	*Reaction time* (s)
0·1	20	80
0·1	25	60
0·2	30	20
0·2	40	10

The time for 0·5 g of magnesium to react completely with 0·2 mol l^{-1} acid at 25 °C will be

A less than 10 s

B between 10 s and 20 s

C between 20 s and 60 s

D more than 80 s.

3. When an atom **X** of an element in Group 1 reacts to become $\mathbf{X}^+$

A the mass number of **X** decreases

B the atomic number of **X** increases

C the charge of the nucleus increases

D the number of occupied energy levels decreases.

4. Which of the following does **not** contain covalent bonds?

A Sulfur

B Copper

C Oxygen

D Hydrogen

Go to Answers

Go to Topic Grid

5. Which of the following structures is **never** found in compounds?

A Ionic
B Monatomic
C Covalent network
D Covalent molecular

6. Which line in the table shows the properties of an ionic substance?

			Conducts electricity	
	Melting point (°C)	*Boiling point* (°C)	*Solid*	*Liquid*
A	19	80	no	no
B	655	1425	no	no
C	1450	1740	no	yes
D	1495	2927	yes	yes

7. What is the name of the compound with the formula Ag_2O?

A Silver(I) oxide
B Silver(II) oxide
C Silver(III) oxide
D Silver(IV) oxide

8. An element was burned in air. The product was added to water, producing a solution with a pH less than 7. The element could be

A tin
B zinc
C sulfur
D sodium.

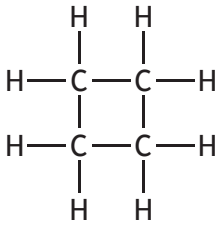
9. When methane burns in a plentiful supply of air, the products are

A carbon and water
B carbon dioxide and water
C carbon monoxide and water
D carbon dioxide and hydrogen.

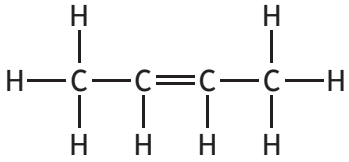
Go to Answers

10. Which of the following compounds belongs to the same homologous series as the compound with the molecular formula C_3H_8?

A



B



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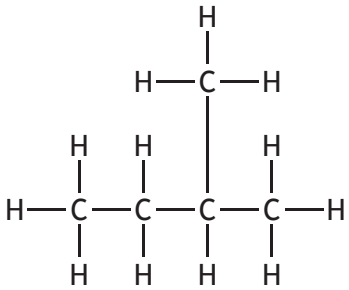
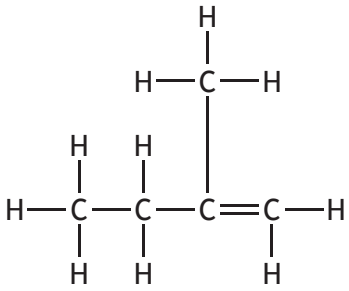
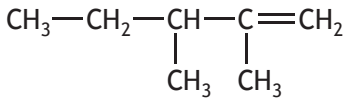


D



Go to Answers

11. 

The systematic name for the structure shown is

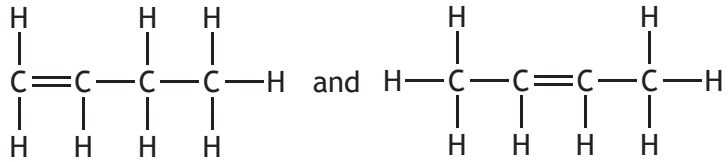
A 1,2-dimethylpent-1-ene

B 2,3-dimethylpent-1-ene

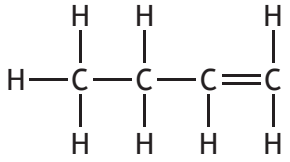
C 3,4-dimethylpent-4-ene

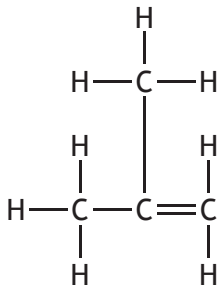
D 3,4-dimethylpent-1-ene.

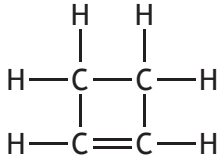
12. Two isomers of butene are

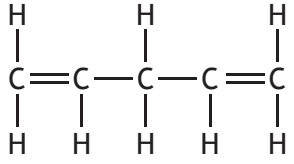


Which of the following structures represents a third isomer of butene?

A 

B 

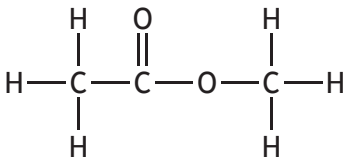
C 

D 

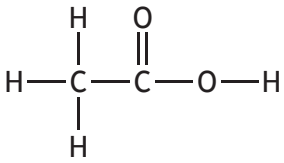
Go to Answers

13. Which of the following structures represents an ester?

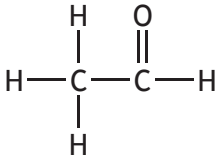
A



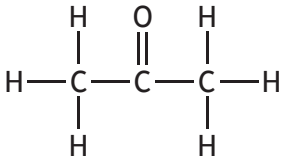
B



C



D



14. The lowest temperature at which a hydrocarbon ignites is called its flash point.

Hydrocarbon	*Formula*	*Boiling point* (°C)	*Flash point* (°C)
hexene	C_6H_{12}	63	−25
hexane	C_6H_{14}	69	−23
cyclohexane	C_6H_{12}	81	−20
heptane	C_7H_{16}	98	−1
octane	C_8H_{18}	126	15

Using information in the table, identify the correct statement.

A Octane will ignite at 0 °C.

B Hydrocarbons with the same molecular mass have the same flash point.

C The flash point of a hydrocarbon increases as the boiling point increases.

D In a homologous series the flash point decreases as the number of carbon atoms increases.

Go to Answers

15. Which of the following metals can be obtained from its ore by heating with carbon monoxide?

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

A Magnesium

B Aluminium

C Calcium

D Nickel

16. Polyesters are always made from monomers

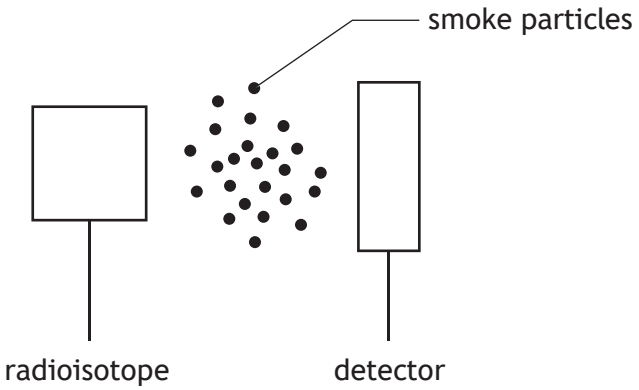
A which are the same

B which are unsaturated

C with one functional group per molecule

D with two functional groups per molecule.

17. Some smoke detectors make use of radiation which is very easily stopped by tiny smoke particles moving between the radioactive source and the detector.



The most suitable type of radioisotope for a smoke detector would be

A an alpha-emitter with a long half-life

B a gamma-emitter with a short half-life

C an alpha-emitter with a short half-life

D a gamma-emitter with a long half-life.

[Turn over for next question

Go to Answers

Go to Topic Grid

18. Which particle will be formed when an atom of $^{234}_{90}Th$ emits a β-particle?

A $^{234}_{91}Pa$

B $^{230}_{88}Ra$

C $^{234}_{89}Ac$

D $^{238}_{92}U$

19. ^{14}C has a half life of 5600 years. An analysis of charcoal from a wood fire shows that its ^{14}C content is 25 % of that in living wood.

How many years have passed since the wood for the fire was cut?

A 1400

B 4200

C 11 200

D 16 800

20. A solution of potassium carbonate, made up using tap water, was found to be cloudy. This could result from the tap water containing

A lithium ions

B calcium ions

C sodium ions

D ammonium ions.

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

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

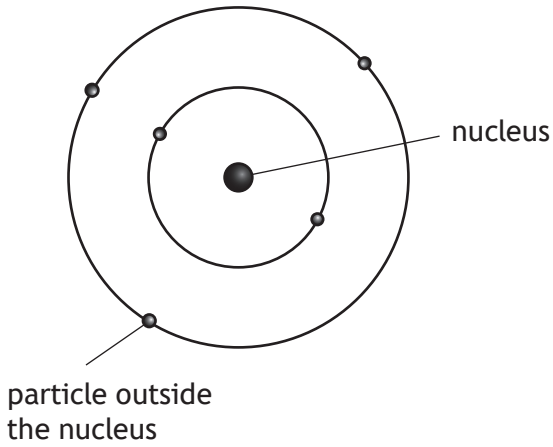
Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2—60 marks

Attempt ALL questions

1. Elements are made up of atoms.



(a) Complete the tables to show the missing information.

(i)

In the Nucleus		
Particle	*Relative Mass*	*Charge*
proton		+1
neutron	1	

1

(ii)

Outside the Nucleus		
Particle	*Relative Mass*	*Charge*
	almost zero	

1

(b) A sample of nitrogen was found to contain equal amounts of two isotopes. One isotope has mass number 14 and the other has mass number 15.

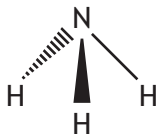
What is the relative atomic mass of this sample of nitrogen? 1

MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(c) Nitrogen can form bonds with other elements.

The diagram shows the shape of a molecule of ammonia (NH_3).



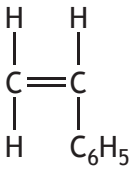
(i) State the name used to describe the shape of a molecule of ammonia. **1**

(ii) Name the industrial process used to manufacture ammonia. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

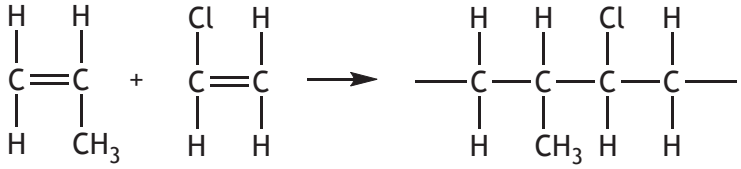
2. The monomer used to produce polystyrene has the following structure.



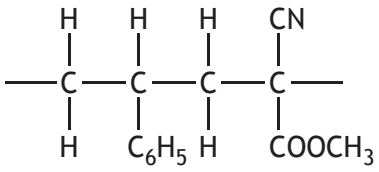
styrene

(a) Draw a section of polystyrene, showing three monomer units joined together. **1**

(b) When two different monomers polymerise, a copolymer is formed as shown.



Another copolymer can be made from styrene and acrylonitrile monomers. A section of this copolymer is shown below.



Draw the structure of the acrylonitrile monomer. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

3. Hydrogen gas can be produced in the laboratory by adding a metal to dilute acid. Heat energy is also produced in the reaction.

(a) State the term used to describe all chemical reactions that release heat energy. **1**

(b) A student measured the volume of hydrogen gas produced when zinc lumps were added to dilute hydrochloric acid.

Time (s)	0	10	20	30	40	50	60	70
Volume of hydrogen (cm^3)	0	12	21	29	34	36	37	37

(i) Calculate the average rate of reaction, in $cm^3\,s^{-1}$, between 10 and 30 seconds. **2**

Show your working clearly.

(ii) Estimate the time taken, in seconds, for the reaction to finish. **1**

(iii) The student repeated the experiment using the same mass of zinc.

State the effect on the rate of the reaction if zinc powder was used instead of lumps. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

3. (continued)

(c) Another student reacted aluminium with dilute nitric acid.

$$2Al(s) + 6HNO_3(aq) \longrightarrow 2Al(NO_3)_3(aq) + 3H_2(g)$$

(i) Circle the formula for the salt in the above equation. **1**

(ii) 1 mole of hydrogen gas has a volume of 24 litres.

Calculate the volume of hydrogen gas, in litres, produced when 0·01 moles of aluminium react with dilute nitric acid. **2**

Show your working clearly.

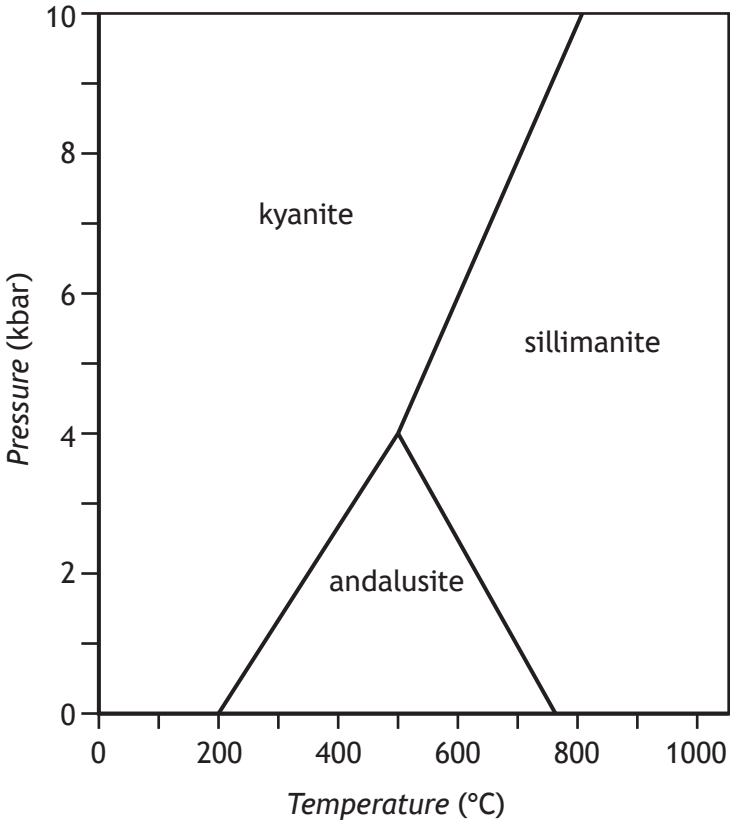
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

4. Some rocks contain the mineral with the formula Al_2SiO_5.

This mineral exists in three different forms, andalusite, sillimanite, and kyanite. The form depends on the temperature and pressure.

The diagram shows this relationship.



(a) (i) Name the **two** forms which could exist at 400 °C. **1**

(ii) Complete the table to show the temperature and pressure at which all three forms would exist. **1**

Temperature (°C)	
Pressure (kbar)	

MARKS | DO NOT WRITE IN THIS MARGIN

4. (continued)

(b) Calculate the percentage mass of silicon in andalusite, Al_2SiO_5. **3**

Show your working clearly.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

Gold — a very useful metal

Gold has been associated with wealth since before the first gold coins were minted in Lydia (modern Turkey) about 550 BC. It does not react with water, air, alkalis and almost all acids. Gold only has one naturally occurring isotope with mass 197.

As an element it has many uses in the modern world. 1 gram of gold can be beaten into a gold film covering one square metre and thin coatings of gold are used as lubricants in aerospace applications. Gold electroplating can be used to coat electrical connectors and printed circuit boards.

Chemists have recently discovered that gold nanoparticles make superb catalysts for many reactions such as the conversion of alcohols into aldehydes and ketones. It can also be used as a catalyst for removing trace carbon monoxide from gases. In this reaction carbon monoxide reacts with oxygen to form carbon dioxide.

Gold nanorods can be grown from a dilute solution of auric acid and are used in the treatment of some forms of cancer.

Adapted from *Education in Chemistry*, Volume 45, November 2008

(a) Suggest a reason why gold was used in the first coins minted. **1**

(b) Calculate the number of neutrons present in the naturally occurring isotope of gold. **1**

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

MARKS | DO NOT WRITE IN THIS MARGIN

5. (continued)

(c) (i) Write an equation, using symbols and formulae, to show the reaction for removing trace carbon monoxide from gases.

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

(ii) State the role of gold in this reaction. **1**

(d) Circle the correct words to complete the sentence. **1**

Gold nanorods can be grown from a solution which contains

more { hydroxide / hydrogen } ions than { hydroxide / hydrogen } ions.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

6. (a) A fertiliser for tomato plants contains compounds of phosphorus and potassium.

(i) Suggest an experimental test, including the result, to show that potassium is present in the fertiliser. **1**

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

(ii) Ammonium citrate is included in the fertiliser because some phosphorus compounds are more soluble in ammonium citrate solution than they are in water.

Suggest another reason why ammonium citrate is added to the fertiliser. **1**

(b) In the production of the fertiliser ammonium phosphate, phosphoric acid (H_3PO_4) reacts with ammonium hydroxide as shown.

$$H_3PO_4(aq) + NH_4OH(aq) \longrightarrow (NH_4)_3PO_4(aq) + H_2O(\ell)$$

Balance this equation. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

7. The element strontium was discovered in 1790 in the village of Strontian in Scotland.

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

MARKS | DO NOT WRITE IN THIS MARGIN

8. Essential oils can be extracted from plants and used in perfumes and food flavourings.

(a) Essential oils contain compounds called terpenes.

A terpene is a chemical made up of a number of isoprene molecules joined together.

The shortened structural formula of isoprene is $CH_2C(CH_3)CHCH_2$.

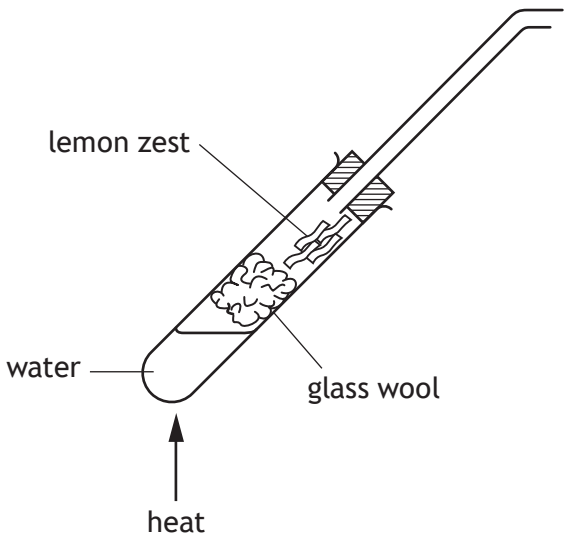
Draw the full structural formula for isoprene. **1**

(b) Essential oils can be extracted from the zest of lemons in the laboratory by steam distillation.

The process involves heating up water in a boiling tube until it boils. The steam produced then passes over the lemon zest which is separated from the water by glass wool. As the steam passes over the lemon zest it carries the essential oils into a delivery tube. The condensed liquids (essential oils and water) are collected in a test tube placed in a cold water bath.

Complete the diagram to show the apparatus required to collect the essential oils. **1**

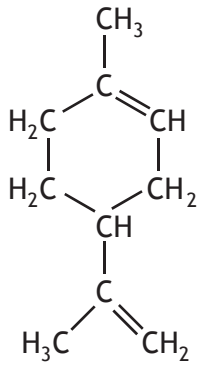
(An additional diagram, if required, can be found on Page 29.)



MARKS | DO NOT WRITE IN THIS MARGIN

8. (continued)

(c) Limonene, $C_{10}H_{16}$, is an essential oil which is added to some cleaning products to give them a lemon scent.



The concentration of limonene present in a cleaning product can be determined by titrating with bromine solution.

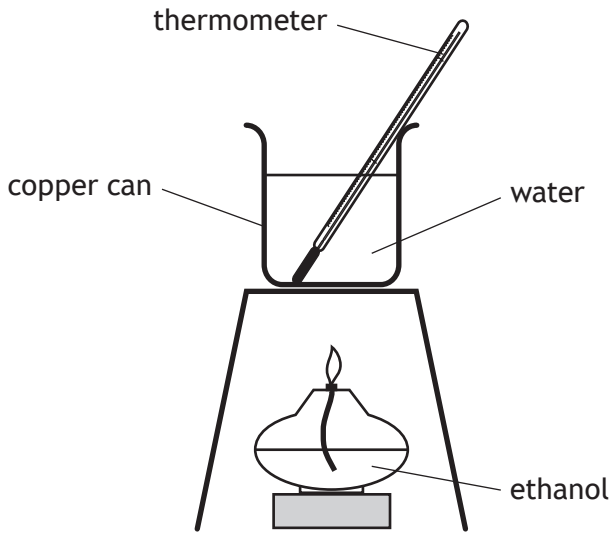
(i) Name the type of chemical reaction taking place when limonene reacts with bromine solution. **1**

(ii) Write the molecular formula for the product formed when limonene, $C_{10}H_{16}$, reacts completely with bromine solution. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

9. Ethanol can be used as an alternative fuel for cars.

(a) A student considered two methods to confirm the amount of energy released when ethanol burns.



Method ***A***	*Method* ***B***
1. Record the initial temperature of the water.	1. Record the initial temperature of the water.
2. Weigh the burner containing the fuel.	2. Weigh the burner containing the fuel.
3. Place the burner under the copper can and then light the burner.	3. Light the burner and then place it under the copper can.
4. Extinguish the flame after 2 minutes.	4. Extinguish the flame after 2 minutes.
5. Record the final temperature and reweigh the burner.	5. Record the final temperature and reweigh the burner.

Explain which method would give a more accurate result. **2**

MARKS DO NOT WRITE IN THIS MARGIN

9. (continued)

(b) The table gives information about the amount of energy released when 1 mole of some alcohols are burned.

Name of alcohol	*Energy released when one mole of alcohol is burned* (kJ)
propan-1-ol	2021
propan-2-ol	2005
butan-1-ol	2676
butan-2-ol	2661
pentan-1-ol	3329
pentan-2-ol	3315
hexan-1-ol	3984

(i) Write a statement linking the amount of energy released to the position of the functional group in an alcohol molecule. **1**

(ii) Predict the amount of energy released, in kJ, when 1 mole of hexan-2-ol is burned. **1**

(c) Ethanol can also be used in portable camping stoves.

The chemical reaction in a camping stove releases 23 kJ of energy. If 100 g of water is heated using this stove, calculate the rise in temperature of the water, in °C. **3**

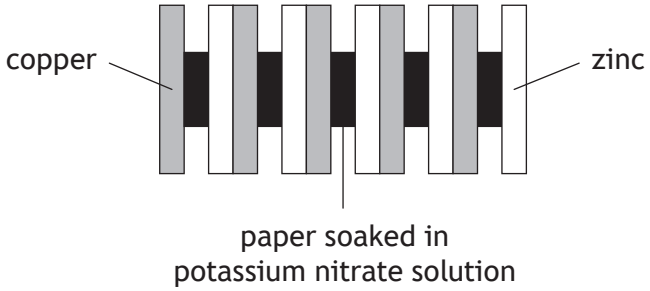
You may wish to use the data booklet to help you.

Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

10. A battery is a number of cells joined together.

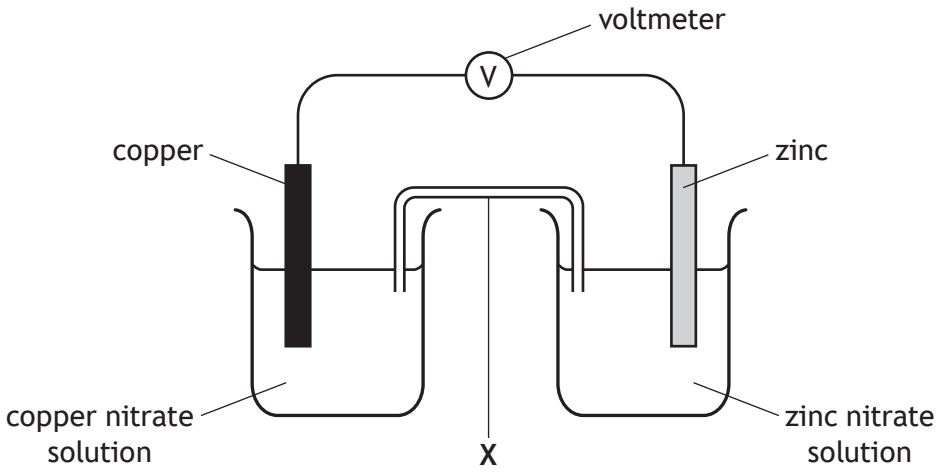
(a) The diagram shows a simple battery made from copper and zinc discs separated by paper soaked in potassium nitrate solution.



The purpose of the potassium nitrate solution is to complete the circuit.

State the **term** used to describe an ionic compound which is used for this purpose. **1**

(b) A student set up a cell using the same metals as those used in the battery.



(i) **On the diagram**, draw an arrow to show the path and direction of electron flow. **1**

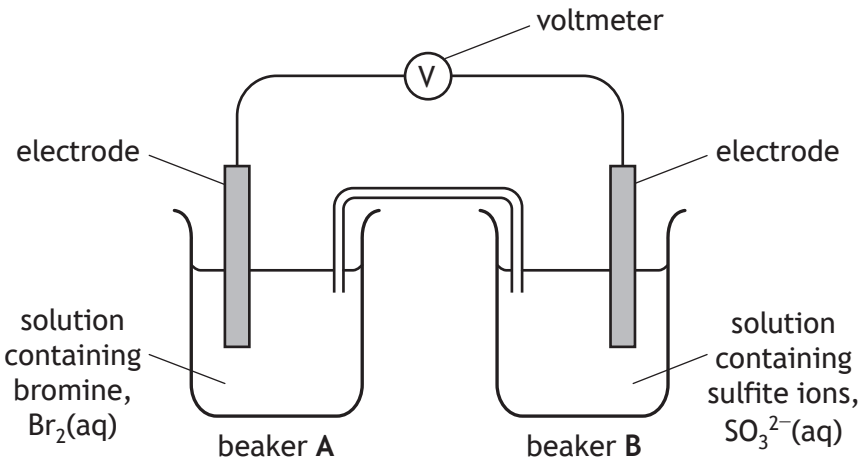
You may wish to use the data booklet to help you.

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

MARKS | DO NOT WRITE IN THIS MARGIN

10. (continued)

(c) Electricity can also be produced in a cell containing non-metals.



The reactions occurring at each electrode are

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

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

(i) Name the type of chemical reaction taking place in beaker **B**. **1**

(ii) Write the redox equation for the overall reaction. **1**

(iii) Name a non-metal element which is suitable for use as the electrodes. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

11. Ethers are a group of compounds containing carbon, hydrogen and oxygen.

Name of ether	*Structural formula*	*Boiling point* (°C)
methoxyethane	$CH_3-O-CH_2CH_3$	7
ethoxyethane	$CH_3CH_2-O-CH_2CH_3$	35
X	$CH_3-O-CH_2CH_2CH_3$	39
propoxybutane	$CH_3CH_2CH_2-O-CH_2CH_2CH_2CH_3$	117

(a) Name ether **X**. **1**

(b) Suggest a general formula for this homologous series. **1**

(c) Methoxyethane is a covalent molecular substance. It has a low boiling point and is a gas at room temperature.

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

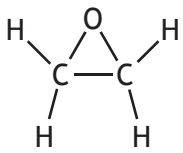
The bonds between the molecules are { weak / strong } and the bonds within the molecule are { weak / strong }.

MARKS | DO NOT WRITE IN THIS MARGIN

11. (continued)

(d) Epoxides are a family of cyclic ethers.

The full structural formula for the first member of this family is shown.



(i) Epoxides can be produced by reacting an alkene with oxygen.

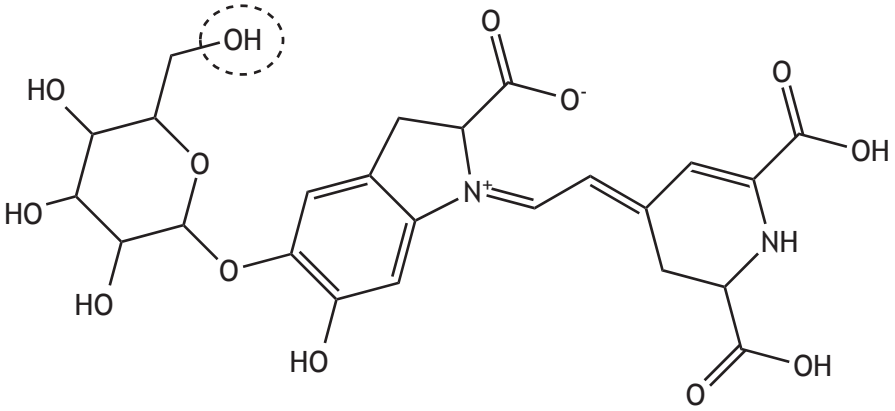
Name the alkene which would be used to produce the epoxide shown. **1**

(ii) Epoxides have three atoms in a ring, one of which is oxygen.

Draw a structural formula for the epoxide with the chemical formula C_3H_6O. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

12. Betanin is responsible for the red colour in beetroot and can be used as a food colouring.



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

(b) Betanin can be used as an indicator in a neutralisation reaction.

The pH range at which some indicators change colour is shown.

Indicator	*pH range of colour change*
methyl orange	3·2 to 4·4
litmus	5·0 to 8·0
phenolphthalein	8·2 to 10·0
betanin	9·0 to 10·0

The indicator used in a neutralisation reaction depends on the pH at the end point.

The table below shows the end point of neutralisation reactions using different types of acid and base.

Type of acid	*Type of base*	*pH at the end point*
strong	strong	7
strong	weak	below 7
weak	strong	above 7

Betanin can be used to indicate the end point in the reaction between oxalic acid and sodium hydroxide solution.

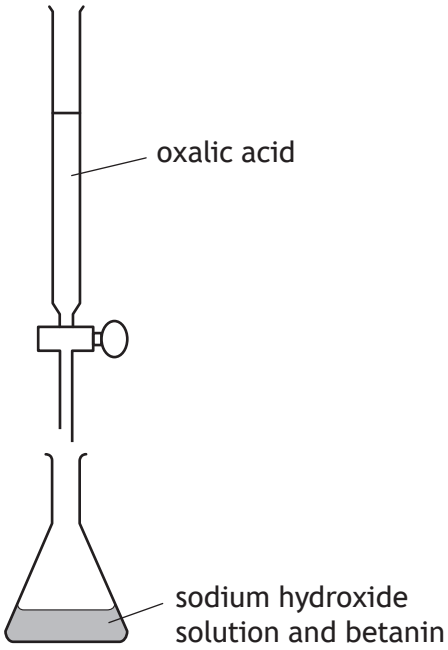
State the type of acid **and** the type of base used in this reaction. **1**

12. (continued)

MARKS

DO NOT WRITE IN THIS MARGIN

(c) A student carried out a titration experiment to determine the concentration of a sodium hydroxide solution.



	Initial burette reading (cm^3)	*Final burette reading* (cm^3)	*Volume used* (cm^3)
Rough titre	0·0	15·6	15·6
1st titre	15·6	30·5	14·9
2nd titre	30·5	45·6	15·1

Using the results in the table, calculate the average volume, in cm^3, of oxalic acid required to neutralise the sodium hydroxide solution. **1**

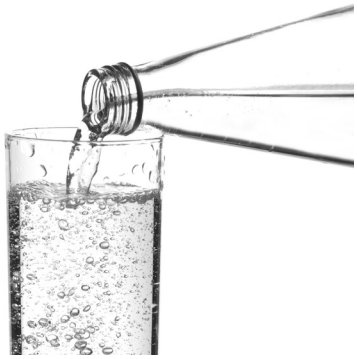
(d) Oxalic acid is found naturally in rhubarb. A piece of rhubarb was found to contain 1·8 g of oxalic acid.

Calculate the number of moles of oxalic acid contained in the piece of rhubarb. **1**

(Formula mass of oxalic acid = 90)

MARKS | DO NOT WRITE IN THIS MARGIN

13. Carbonated water, also known as sparkling water, is water into which carbon dioxide gas has been dissolved. This process is called carbonating.



A group of students are given two brands of carbonated water and asked to determine which brand contains more dissolved carbon dioxide.

Using your knowledge of chemistry, describe how the students could determine which brand of carbonated water contains more dissolved carbon dioxide. **3**

[END OF QUESTION PAPER]

National Qualifications 2016

2016 Chemistry

National 5

Finalised Marking Instructions

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Part Two: Marking Instructions for each question

Section 1

Question	Answer	Max Mark
1.	D	**1**
2.	C	**1**
3.	D	**1**
4.	B	**1**
5.	B	**1**
6.	C	**1**
7.	A	**1**
8.	C	**1**
9.	B	**1**
10.	C	**1**
11.	B	**1**
12.	B	**1**
13.	A	**1**
14.	C	**1**
15.	D	**1**
16.	D	**1**
17.	A	**1**
18.	A	**1**
19.	C	**1**
20.	B	**1**

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Section 2

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>1.</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><td colspan="3">In the Nucleus</td></tr>
<tr><td>Particle</td><td>Relative Mass</td><td>Charge</td></tr>
<tr><td>Proton</td><td>1</td><td></td></tr>
<tr><td>Neutron</td><td></td><td>0
neutral
no charge</td></tr>
</table>
BOTH REQUIRED
</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>
<table>
<tr><td colspan="3">Outside the Nucleus</td></tr>
<tr><td>Particle</td><td>Relative Mass</td><td>Charge</td></tr>
<tr><td>ELECTRON</td><td></td><td>–
–1
negative</td></tr>
</table>
BOTH REQUIRED
</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>14·5</td><td>1</td><td>Accept 14·5 g or 14·5 amu.</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>Pyramidal

OR

Trigonal pyramidal</td><td>1</td><td>Zero marks awarded for trigonal on its own.

Zero marks awarded for ‘pyramid’.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Haber</td><td>1</td><td></td></tr>
</table>

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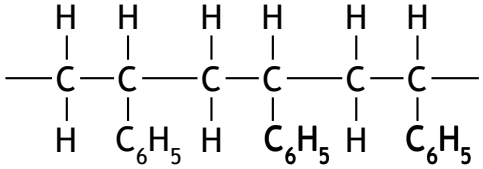
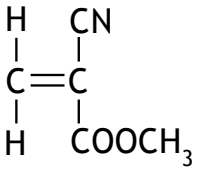
Question			Answer	Max Mark	Additional Guidance
2.	(a)		 With or without brackets	1	Do **not** deduct mark if one end bond is missing. Do **not** deduct mark if one end bond is shown with other end having an H in place of second end bond. Allow dot or ~ to represent end bond. Zero marks awarded if **both** end bonds are missing/both ends have H/less than or more than three monomers shown/bond between two carbons missing.
	(b)			1	Zero marks awarded if candidate draws **both monomers**, unless they have clearly identified the acrylonitrile monomer.

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Question			Answer	Max Mark	Additional Guidance
3.	(a)		Exothermic **OR** exothermal	**1**	Zero marks awarded for 'combustion'. This also negates a correct answer.
	(b)	(i)	0·85 with no working 2 marks $\frac{29-12}{30-10}$ or $\frac{12-29}{10-30}$ **OR** 17/20 **(1)** 0·85 **(1)**	**2**	1 mark awarded for – correct method (ie change in volume/change in time) but incorrect arithmetic using correct values from table. 1 mark awarded for – correct method but incorrect values **from the table** used (subtractions must be shown and volumes chosen **must** correspond to chosen times). Award zero marks awarded if correct method is used but values are **not** in the table. Unit is not required however if the wrong unit is given do **not** award second mark. Acceptable units are $cm^3 s^{-1}$ **or** cm^3/s **or** cubic centimetres per second **or** cm^3 per second. Do not accept cm^3/s^{-1} **or** $cm^{3\ s-1}$ **or** cm3s–1 etc. 's' is the only acceptable abbreviation of second.
		(ii)	Any value greater than 50 and less than or equal to 60.	**1**	Zero marks awarded if correct answer given with incorrect unit of time (eg minutes). 's' is the only acceptable abbreviation of second.

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Question			Answer	Max Mark	Additional Guidance
3.	(b)	(iii)	Faster / quicker / increase /speed up	**1**	Zero marks awarded for less time, but does **not** negate. Zero marks awarded for "fast" reaction without comparison. Incorrect explanation negates eg the reaction speeds up due to increase in particle size.
	(c)	(i)	$Al(NO_3)_3$ circled, underlined etc	**1**	
		(ii)	0·36 with no working 2 marks 0·01 moles gives 0·015 moles **(1)** 0·015 × 24 = 0·36 **(1)** **This step on its own 2 marks**	**2**	If correct mole ratio (2:3) applied **and** answer of 36 eg 1·5 x 24 given award max 1 mark (working must be shown). If candidate shows mass of aluminium accept 54g to 72l or 27g to 36l for 1 mark Zero marks awarded for 0·01 × 24 = 0·24 Unit is not required however if the wrong unit is given do **not** award final mark.

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>4.</td><td>(a)</td><td>(i)</td><td>Andalusite and kyanite

BOTH REQUIRED</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><td>Temperature (°C)</td><td>490 – 510</td></tr><tr><td>Pressure (kbar)</td><td>3·9 – 4·1</td></tr></table>
BOTH REQUIRED</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>17 or 17·28 or 17·3
with no working 3 marks

GFM 162 (1)

28/162 × 100 (concept mark) (1)
This step on its own 2 marks

1 mark for correct arithmetic to give final answer (this mark can only be awarded if the concept mark has been awarded).</td><td>3</td><td>Maximum 2 marks if candidate correctly calculates percentage of aluminium (33 or 33·3 %) or oxygen (49 or 49·38 or 49·4 %) rather than silicon but working must be shown.

Maximum 2 marks if atomic numbers are used (17·5 % of silicon) but working must be shown.

If candidate incorrectly rounds to 17·2 then a maximum of 2 marks can be awarded only if working is shown.

If value divided by 162 does not correspond to an element in the compound award a maximum of 1 mark.

Unit is not required however if the wrong unit is given do not award final mark.</td></tr>
</table>

Question			Answer	Max Mark	Additional Guidance
5.	(a)		Unreactive **OR** does not react with water/air/alkalis/ (almost all) acids **OR** Can be beaten into shape **OR** Found uncombined	**1**	Zero marks awarded for phrases like "associated with wealth" on their own but do **not** negate correct answer. Zero marks awarded for soft on its own but does **not** negate.
	(b)		118	**1**	
	(c)	(i)	$CO + O_2 \longrightarrow CO_2$ **ALL CORRECT FOR 1 MARK** **OR** $CO + O_2 \xrightarrow{Au} CO_2$	**1**	If equation is balanced then it needs to be correct eg $2CO + O_2 \longrightarrow 2CO_2$ $CO + \frac{1}{2}O_2 \longrightarrow CO_2$ Zero marks awarded for $CO + O_2 = CO_2$ $CO + O_2 + Au \longrightarrow CO_2 + Au$ State symbols should be ignored. Zero marks awarded for a word equation on its own but this does **not** negate a correct formulae equation.
		(ii)	Catalyst **OR** catalysis **OR** speeds up the reaction **OR** allows less energy/heat to be used for the reaction **OR** lowers activation energy	**1**	Zero marks awarded for spectator ion and this negates correct answer.
	(d)		hydroxide hydrogen hydroxide hydrogen **BOTH REQUIRED**	**1**	

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Question			Answer	Max Mark	Additional Guidance
6.	(a)	(i)	Flame test or correct description e.g. burn it/fertiliser/potassium, put in Bunsen flame etc. **AND** purple/lilac **Both required**	**1**	Mention of burning the plant negates correct answer.
		(ii)	To add/provide/supply nitrogen or it contains nitrogen. Any wording that implies that plants need nitrogen.	**1**	Zero marks awarded for 'essential/key element' on its own but does **not** negate correct answer. Zero marks awarded for 'to make plants grow better' on its own but does **not** negate correct answer.
	(b)		$H_3PO_4 + \mathbf{3}NH_4OH \longrightarrow (NH_4)_3PO_4 + \mathbf{3}H_2O$ If rewritten accept $H_3PO_4 + \mathbf{3}NH_4OH \downarrow (NH_4)_3PO_4 + \mathbf{3}H_2O$	**1**	Accept correct multiples If equation is rewritten, **all** formulae must be correct and correct format see marking instructions for Question 10c(ii). If state symbols are given they must be correct.

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Question			Answer	Max Mark	Additional Guidance
7.	(a)		This is an open ended question **1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	

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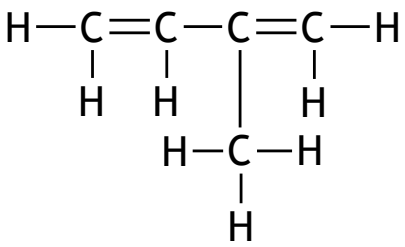
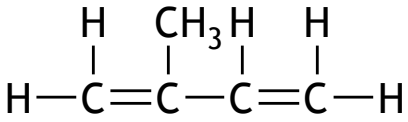
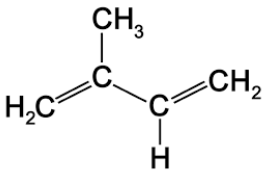
Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
8.	(a)		The correct structural formula for isoprene eg  OR  However if CH_3 is used the bond must be going to the carbon	**1**	Zero marks awarded for 
	(b)		Diagram showing delivery tube passing into a test tube which is placed in a water/ice bath. Delivery tube must extend close enough to the neck of the test tube to ensure the vapour can enter the test tube.	**1**	Do not penalise if boiling tube/measuring cylinder etc has been used in place of test tube. Diagram does **not** need to be labelled. Delivery tube must be open and no lines drawn across it. Ignore a stopper as long as it does **not** close off the delivery tube.

Go to Topic Grid

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Question			Answer	Max Mark	Additional Guidance
8.	(c)	(i)	Addition / additional **OR** bromination	**1**	Zero marks awarded for 'add.' Zero marks awarded for 'Addition' followed by incorrect answer eg 'polymerisation', 'distillation', 'combustion' etc.
		(ii)	$C_{10}H_{16}Br_4$	**1**	Symbols can be in any order. Numbers must be smaller than symbol or subscript Symbols must be correct Zero marks awarded for: C10 H16 Br4 $C_{10}H_{16}br_4$ $C_{10}H_{16}BR_4$ $C_{10}H_{16} + Br_4$

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Question			Answer	Max Mark	Additional Guidance
9.	(a)		1 mark for **Method A** *The second mark for the explanation **cannot** be awarded if the first mark is not gained.* 1 mark for explanation of accuracy of **A** (or inaccuracy of **B**) based on • Heat loss • Heat transfer • Mass loss (due to ethanol being combusted/used up) eg - **Method A** because more heat is transferred to water - **Method B** because less heat is transferred to water - **B** releases more heat to the surroundings	**2**	Explanation is assumed to be for chosen method unless otherwise stated. The explanation mark **cannot** be awarded for restating or describing Step 3 eg • the fuel in **A** doesn't start to burn until it is under the (copper) can / water • the fuel in **B** starts to burn before it is under the (copper) can /water Zero marks awarded for an explanation in terms of evaporation of ethanol but does not negate a correct explanation.

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Question			Answer	Max Mark	Additional Guidance
	(b)	(i)	A statement that identifies the effect of changing the position on the energy released. eg If the alcohol is 2-ol then less energy is released compared with 1-ol or vice versa. **OR** As you move from one to two (carbon/position) then the energy decreases or vice versa. **OR** As it (the position of the functional group) increases/gets higher, the energy released decreases or vice versa **OR** Functional group (or it/hydroxyl/–OH) on (position) 1/end carbon/first carbon – energy released is greater/higher/bigger/increases **OR** Functional group (or it/hydroxyl/–OH) on position 2/not on the end carbon energy released is smaller/lower/decreases **OR** As it/functional group goes further along/further down/further up the lower the energy or vice versa.	**1**	Award zero marks for as the number of carbons increase/alcohol gets bigger the energy released also increases or vice versa.
		(ii)	3967 – 3971	**1**	Unit is not required however if the wrong unit is given do **not** award mark. Accept kj, kJ, Kj or KJ. Also accept kJ mol^{-1}or kJ/mol or kilo Joules per mole in words.

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Question			Answer	Max Mark	Additional Guidance
	(c)		55 or 55·02 with no working 3 marks 1 mark for using the correct concept of $\Delta T = Eh / cm$ with **both 4·18 and 23** correctly substituted 1 mark for 0·1 with or without concept 1 mark for correct arithmetic **(this mark can only be awarded if the concept mark has been awarded).**	**3**	Unit is not required however if the wrong unit is given do **not** award final mark. Do not accept ° on its own. 1 mark awarded if **23000 and 4180** are both used together in correct concept. If a mass of 100 is used then 23000 **and** 4·18 must be used to access all 3 marks.

Go to Topic Grid

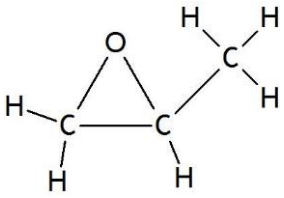
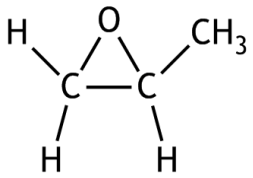
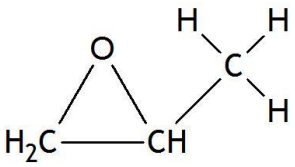
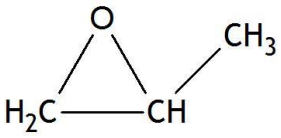
Question			Answer	Max Mark	Additional Guidance
10.	(a)		Electrolyte	**1**	
	(b)	(i)	From zinc to copper on or near the wire/voltmeter	**1**	Zero marks awarded if – arrow goes into solution – arrow is drawn on wire and ion bridge – arrow is drawn closer to the ion bridge than the wire / voltmeter
		(ii)	Ion bridge **OR** Salt bridge	**1**	Correct description of an ion bridge eg filter paper soaked in an electrolyte.
	(c)	(i)	Oxidation	**1**	Zero marks awarded for redox.
		(ii)	$Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell) \longrightarrow 2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq)$ **OR** $Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell)$ $\downarrow$ $2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq)$ **1** State symbols are not required but if included must be correct. Zero marks awarded for any electrons shown in equation, unless clearly scored out. Zero marks awarded for $Br_2(\ell) + SO_3^{2-}(aq) + H_2O(\ell) \longrightarrow$ $2Br^-(aq) + SO_4^{2-}(aq) + 2H^+(aq)$		
		(iii)	Carbon or graphite	**1**	Zero marks awarded for hydrogen, diamond or charcoal and these negate a correct answer.

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
11.	(a)		Methoxypropane (**spelling must be correct**)	1	Zero marks awarded for propoxymethane.
	(b)		$C_nH_{2n+2}O$ **OR** $C_nH_{2n+2}O_1$ OR $C_nH_{n2+2}O$	1	Symbols can be in any order eg $H_{2n+2}OC_n$ Accept another letter in place of n eg $C_xH_{2x+2}O$ Zero marks awarded for CnH2n+2O C_nH_{2n+2} + O $C_nH_{2n+2}O_n$ Award zero marks for $C_nH_{2n+1}OH$, $C_nH_{2n+1}OC_nH_{2n+1}$
	(c)		**WEAK** strong weak **STRONG** **BOTH REQUIRED**	1	
	(d)	(i)	Ethene / Eth-1-ene OR Ethylene	1	Accept a correct molecular or structural formula for ethene. Incorrect formulae in addition to ethene negates. Mention of any other substance negates.

Go to Topic Grid

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
		(ii)	Any acceptable full, shortened or abbreviated structural formula e.g.    	1	Allow one carbon to hydrogen bond to be missing provided the hydrogen is shown. Allow one hydrogen to be missing provided the carbon to hydrogen bond is shown.

Go to Topic Grid

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Question			Answer	Max Mark	Additional Guidance
12.	(a)		hydroxyl	**1**	Zero marks awarded for OH however this does **not** negate hydroxyl. Zero marks awarded for hydroxide and this negates correct answer.
	(b)		Weak acid, strong base/alkali **BOTH REQUIRED**	**1**	Zero marks awarded for mention of weak and strong without stating acid or base.
	(c)		15·0	**1**	Unit is not required however if the wrong unit is given do **not** award mark. If more than two numbers have been averaged the mark cannot be awarded even if the candidate has the correct answer.
	(d)		0·02	**1**	Zero marks awarded for 0·02 mol^{-1} or 0·02 mol l^{-1} etc.

Go to Topic Grid

Go to Topic Grid

Question			Answer	Max Mark	Additional Guidance
13.			This is an open ended question **1 mark**: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 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 student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

[END OF MARKING INSTRUCTIONS]

Go to Topic Grid

National Qualifications 2017

X713/75/02

Chemistry
Section 1 — Questions

MONDAY, 8 MAY

1:00 PM – 3:00 PM

Instructions for the completion of Section 1 are given on *Page 02* of your question and answer booklet X713/75/01.

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

1. In a reaction, the mass lost in 30 seconds was 2 g.

What is the average rate of reaction, in $g\,s^{-1}$, over this time?

A $\frac{1}{30}$

B $\frac{30}{2}$

C $\frac{1}{2}$

D $\frac{2}{30}$

2. An atom has 21 protons, 21 electrons and 24 neutrons.

The atom has

A atomic number 24 and mass number 42

B atomic number 45 and mass number 21

C atomic number 21 and mass number 45

D atomic number 24 and mass number 45.

3. What is the charge on the zinc ion in zinc dichromate, $ZnCr_2O_7$?

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

A 2+

B 2–

C 1+

D 1–

4. The table contains information about magnesium and magnesium chloride.

	Melting Point (°C)	*Density* ($g\,cm^{-3}$)
Magnesium	650	1·74
Magnesium chloride	714	2·32

When molten magnesium chloride is electrolysed at 730 °C the magnesium appears as a

A solid on the surface of the molten magnesium chloride

B solid at the bottom of the molten magnesium chloride

C liquid at the bottom of the molten magnesium chloride

D liquid on the surface of the molten magnesium chloride.

Go to Answers

5. Which of the following compounds is a base?

A Sodium carbonate
B Sodium chloride
C Sodium nitrate
D Sodium sulfate

6. $AgNO_3(aq) + KCl(aq) \longrightarrow AgCl(s) + KNO_3(aq)$
Which of the following are the spectator ions in this reaction?

A Ag^+ and Cl^-
B K^+ and NO_3^-
C Ag^+ and NO_3^-
D K^+ and Cl^-

7. $x\ H_2O_2 \longrightarrow y\ H_2O + z\ O_2$
This equation will be balanced when

A $\mathbf{x} = 1$, $\mathbf{y} = 2$ and $\mathbf{z} = 2$
B $\mathbf{x} = 1$, $\mathbf{y} = 1$ and $\mathbf{z} = 2$
C $\mathbf{x} = 2$, $\mathbf{y} = 2$ and $\mathbf{z} = 1$
D $\mathbf{x} = 2$, $\mathbf{y} = 2$ and $\mathbf{z} = 2$.

8. 0·25 moles of a gas has a mass of 7 g.
Which of the following could be the molecular formula for the gas?

A C_2H_6
B C_2H_4
C C_3H_8
D C_3H_6

9. Which of the following solutions contains the **least** number of moles of solute?

A 100 cm^3 of 0·4 mol l^{-1} solution
B 200 cm^3 of 0·3 mol l^{-1} solution
C 300 cm^3 of 1·0 mol l^{-1} solution
D 400 cm^3 of 0·5 mol l^{-1} solution

[Turn over

Go to Answers

Go to Topic Grid

10. Which of the following could be the molecular formula for an alkane?

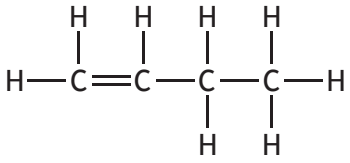
A C_7H_{16}

B C_7H_{14}

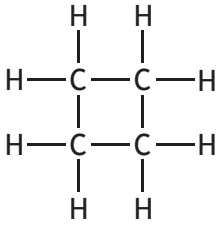
C C_7H_{12}

D C_7H_{10}

11. A student added bromine solution to compound **X** and compound **Y**.



Compound **X**



Compound **Y**

Which line in the table is correct?

	Decolourises bromine solution immediately	
	Compound **X**	Compound **Y**
A	no	no
B	no	yes
C	yes	yes
D	yes	no

12. A compound burns in air. The only products of the reaction are carbon dioxide, sulfur dioxide and water.

The compound **must** contain

A carbon and sulfur only

B carbon and hydrogen only

C carbon, hydrogen and sulfur

D carbon, hydrogen, sulfur and oxygen.

13. Vinegar is a solution of

A ethanol

B methanol

C ethanoic acid

D methanoic acid.

Go to Answers

Go to Topic Grid

14. A reaction is exothermic if

A energy is absorbed from the surroundings

B energy is released to the surroundings

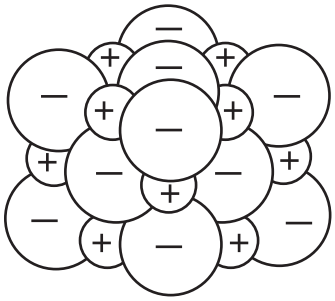
C energy is required to start the reaction

D there is no energy change.

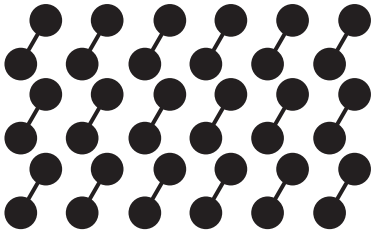
15. Which of the following diagrams could be used to represent the structure of copper?

A

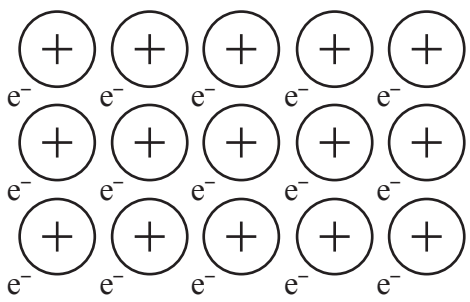
B



C



D



Go to Answers

Go to Topic Grid

16. Which of the following metals is found uncombined in the Earth's crust?
You may wish to use the data booklet to help you.

A Tin
B Magnesium
C Gold
D Sodium

17. Which of the following is **not** an essential element for healthy plant growth?

A Oxygen
B Nitrogen
C Potassium
D Phosphorus

18. The Haber process is the industrial process for the manufacture of

A nitric acid
B ammonia
C alkenes
D esters.

19. Which of the following salts can be prepared by a precipitation reaction?
You may wish to use the data booklet to help you.

A Barium sulfate
B Lithium nitrate
C Calcium chloride
D Ammonium phosphate

20. A solution of accurately known concentration is more commonly known as a

A correct solution
B precise solution
C standard solution
D prepared solution.

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

Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2 —60 marks

Attempt ALL questions

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

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

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

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

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

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

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

Hydrogen Storage

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

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

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

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

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

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

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

Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

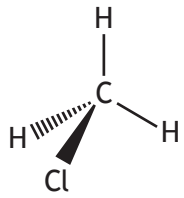
3. Chlorine can form covalent and ionic bonds.

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

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

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

The structure of a chloromethane molecule is shown.



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

MARKS DO NOT WRITE IN THIS MARGIN

3. (continued)

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

A chloride ion has a stable electron arrangement.

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

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

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

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

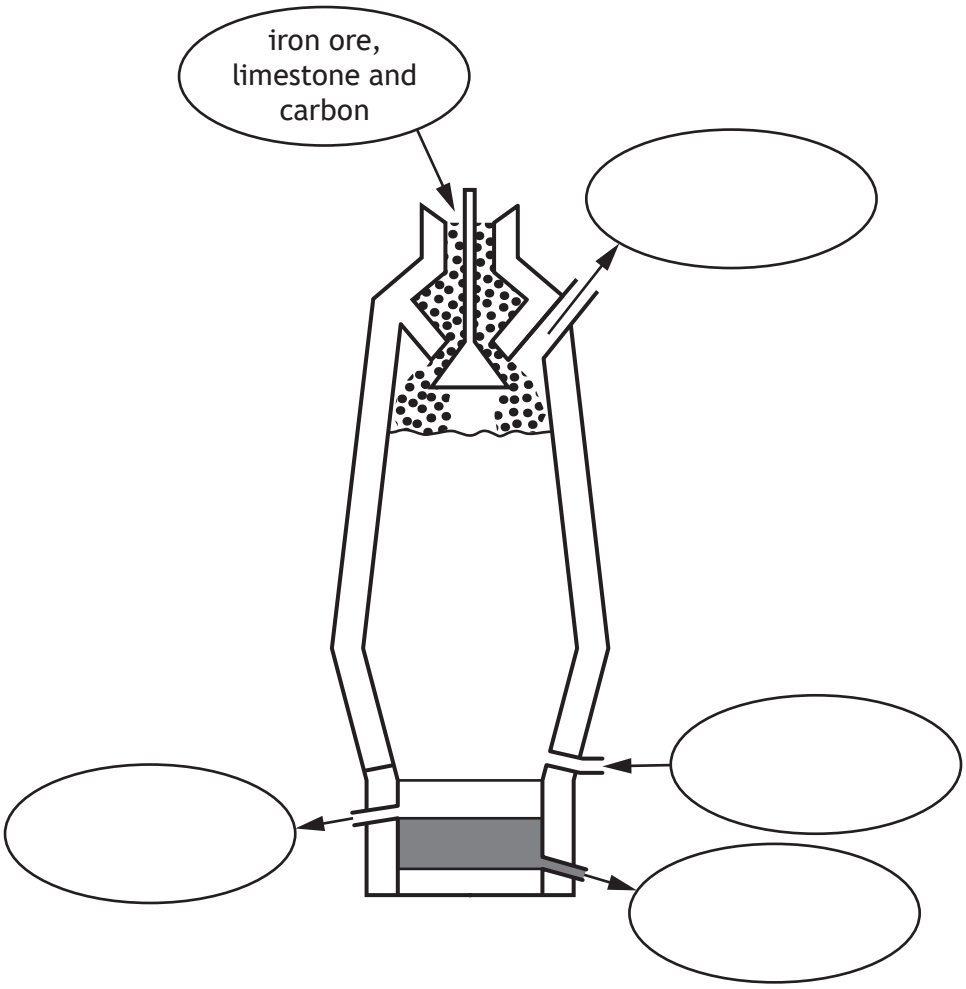
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

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

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



MARKS | DO NOT WRITE IN THIS MARGIN

4. (a) (continued)

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

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

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

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

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

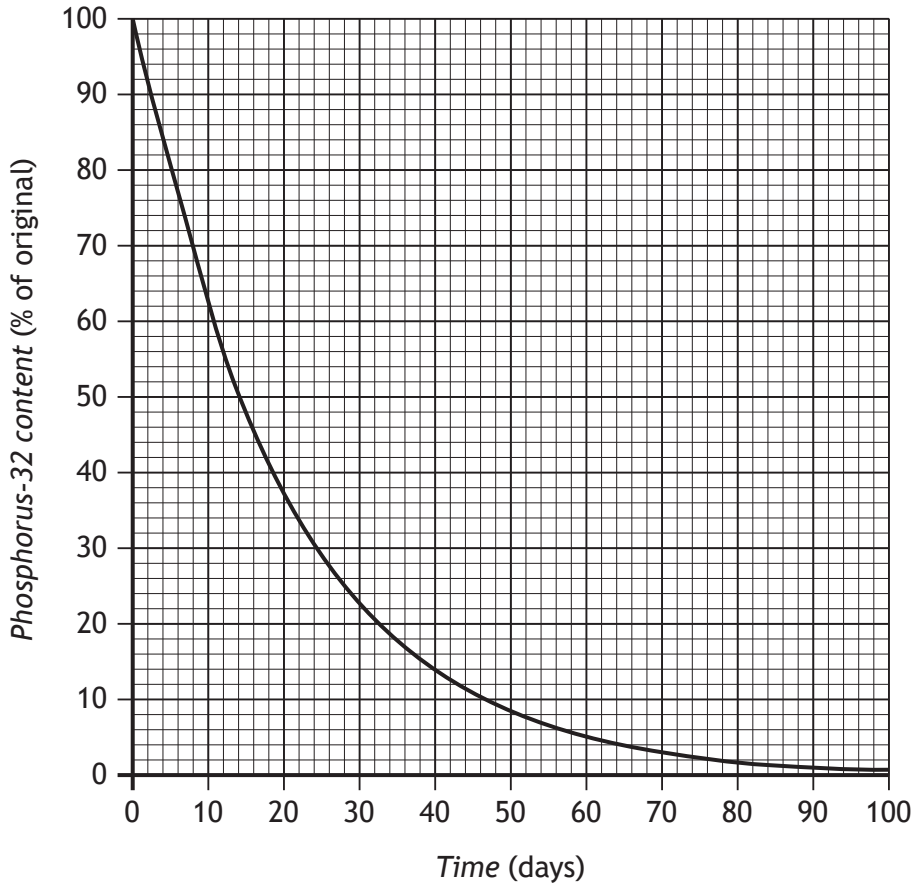
You may wish to use the data booklet to help you.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

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



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

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

(b) Phosphorus-32 decays by emitting radiation.

During this decay the atomic number increases by 1.

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

MARKS | DO NOT WRITE IN THIS MARGIN

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

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

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

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

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

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

The table gives information about propanoic acid and butanoic acid.

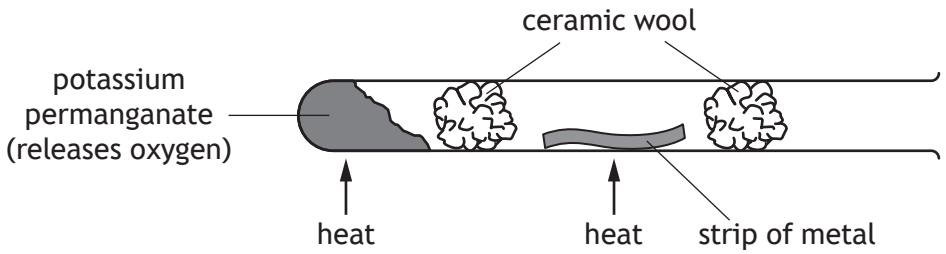
Carboxylic acid	*Melting point* (°C)
propanoic acid	–21
butanoic acid	–5

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

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

MARKS | DO NOT WRITE IN THIS MARGIN

8. A teacher demonstrated the following experiment.



The results are shown in the table.

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

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

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

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

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

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

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

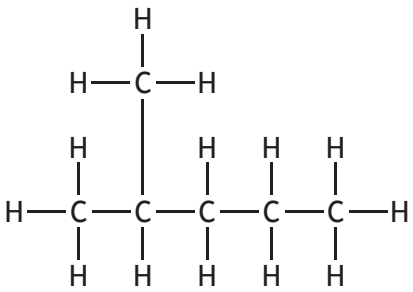
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

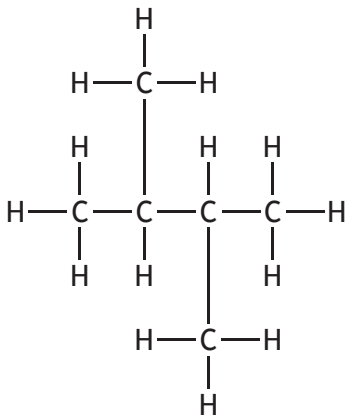
9. The alkanes are a homologous series of saturated hydrocarbons.

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

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



2-methylpentane



2,3-dimethylbutane

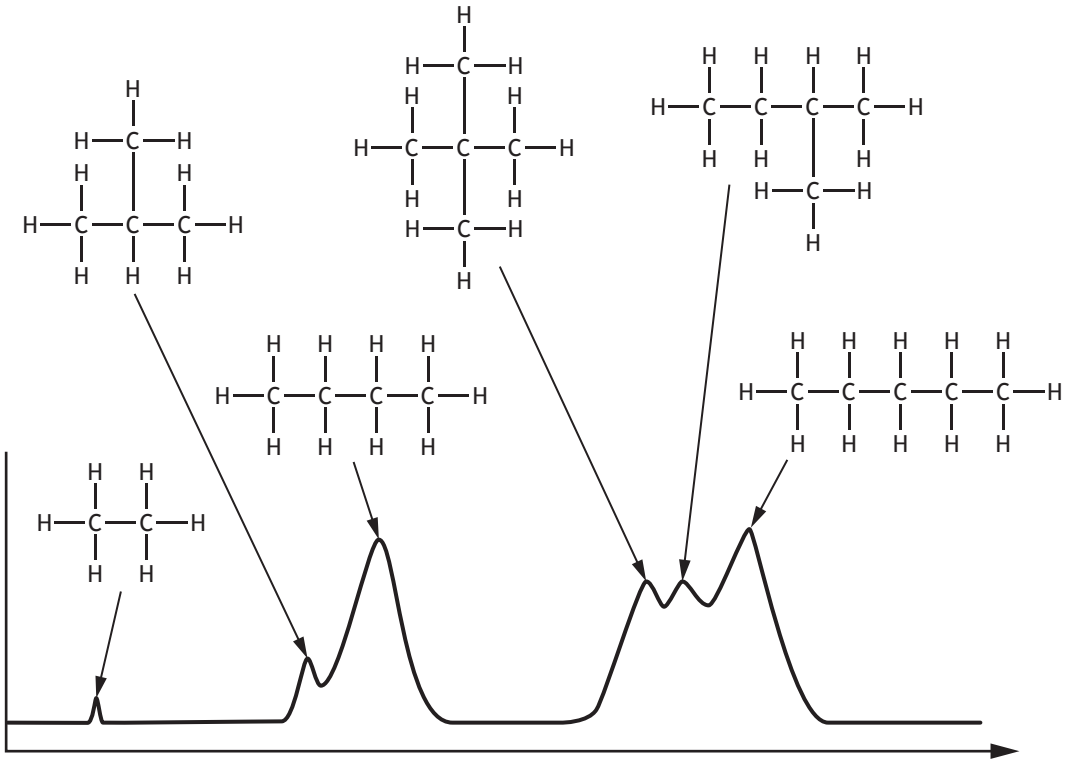
State the term used to describe a pair of alkanes such as 2-methylpentane and 2,3-dimethylbutane. **1**

9. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

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

The results are shown.



Time taken to pass through the column

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

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

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

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

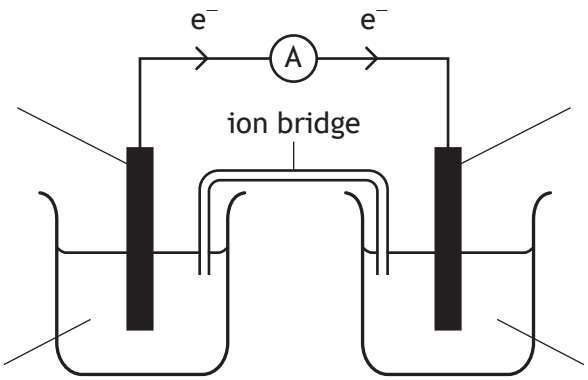
MARKS | DO NOT WRITE IN THIS MARGIN

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

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

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

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



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

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

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

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

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

Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

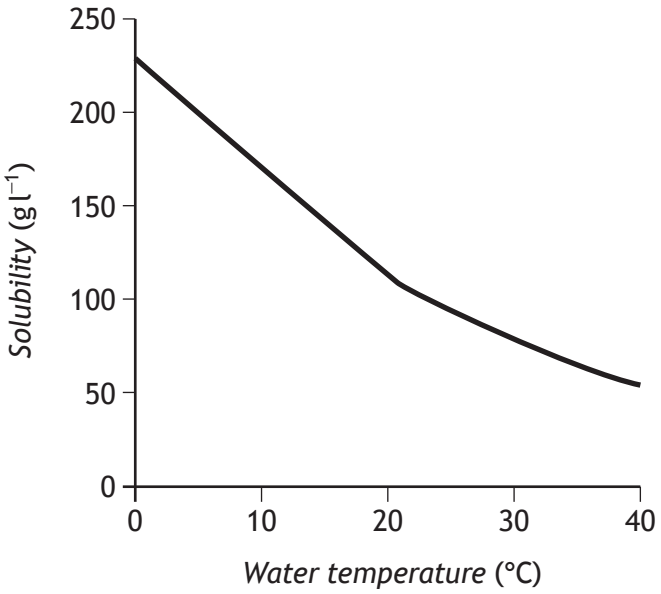
11. Sulfur dioxide is an important industrial chemical.

Sulfur dioxide dissolves in water to produce sulfurous acid.

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

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

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

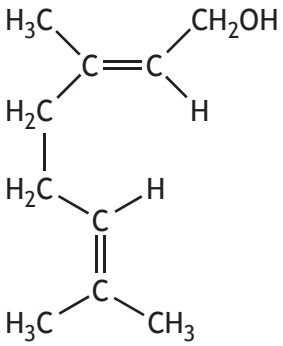


Describe the general trend in solubility as the temperature of the water increases. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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



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

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

MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

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

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

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

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

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

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

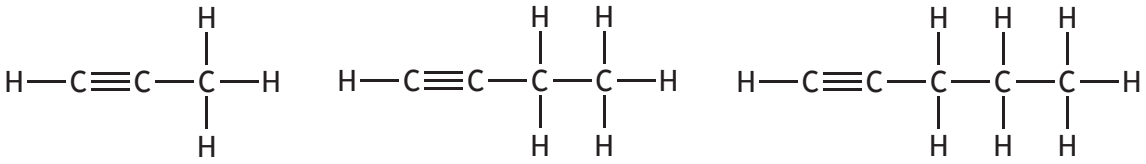
Calculate the mass, in grams, of geranyl propanoate which would be produced. **3**

Show your working clearly.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

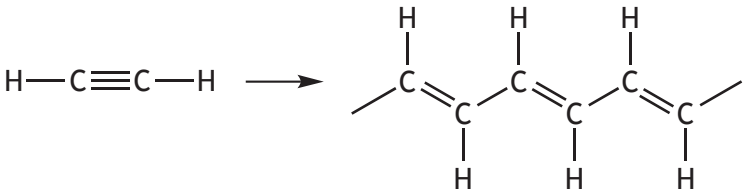
13. The alkynes are a family of hydrocarbons which contain a carbon to carbon triple bond. Three members of this family are shown.



propyne but-1-yne pent-1-yne

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

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

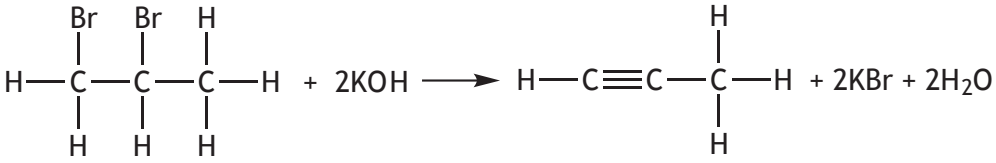


(i) Draw the repeating unit in the polymer poly(ethyne). **1**

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

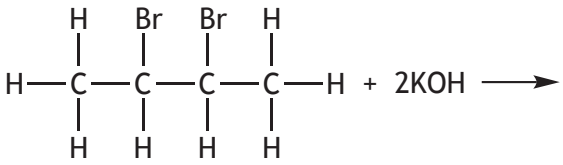
13. (continued) **MARKS** DO NOT WRITE IN THIS MARGIN

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



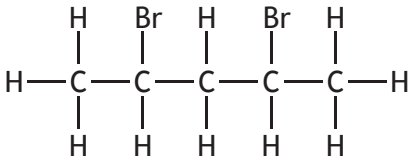
1,2-dibromopropane propyne

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



2,3-dibromobutane

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



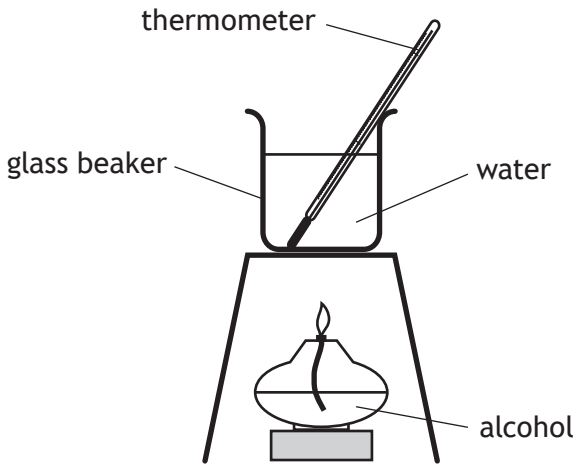
2,4-dibromopentane

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

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

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



The results are shown.

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

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

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

MARKS | DO NOT WRITE IN THIS MARGIN

14. (continued)

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

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

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

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

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

Show your working clearly.

[Turn over for next question

MARKS | DO NOT WRITE IN THIS MARGIN

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

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

[END OF QUESTION PAPER]

National Qualifications 2017

2017 Chemistry

National 5

Finalised Marking Instructions

SQA ©

Go to Topic Grid

Marking Instructions for each question

Section 1

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

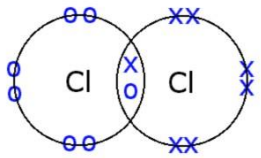
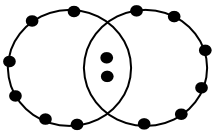
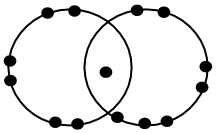
Go to Topic Grid

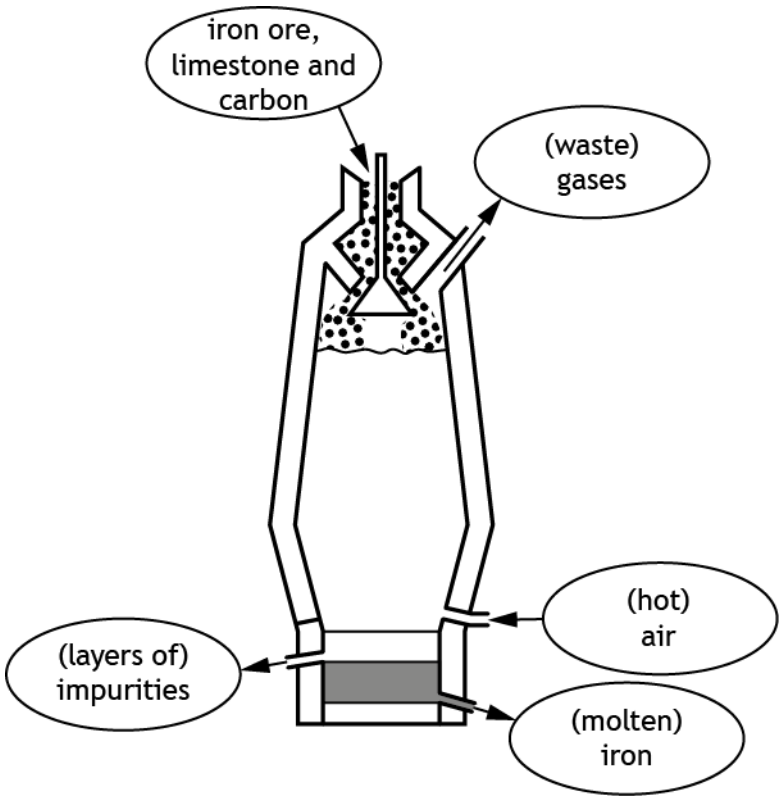
Detailed marking instruction for each question

Section 2

Question			Answer	Max mark	Additional guidance
1.	(a)		Isotope(s)	**1**	
	(b)		Different numbers of neutrons **or** the atoms have 18, 20 or 22 neutrons	**1**	Award zero marks for -different mass in the nucleus -different number of particles in the nucleus
	(c)		36 **or** $^{36}_{18}$Ar **or** ^{36}Ar	**1**	Accept amu or g if stated.

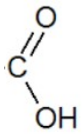
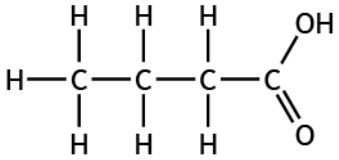
Question			Answer	Max mark	Additional guidance
2.	(a)		Carbon nanotube **or** Nanotube	**1**	Award zero marks for -carbon on its own -graphene nanotubes -graphite nanotubes
	(b)		Lithium or Li	**1**	
	(c)		20·5 with no working **(2)** 21 with correct working **(2)** Partial marking Demonstration of the correct use of the relationship concept. ie 41/2. **(1)** **or** 41/1 = 41 **(1)** Working must be shown	**2**	Accept mol l^{-1} or mol/l Zero marks awarded for - 41 without working.

Question			Answer	Max mark	Additional guidance
3.	(a)		Must show **all** outer electrons   	1	Accept cross or dot or e or e- to represent electrons or a mixture of these. Accept petal diagram. The non-bonding electrons in each chlorine atom must be shown but do **not** need to be together/shown as a pair. Bonding electrons **MUST** be on the line or in the overlapping area. The example below is awarded zero marks.  If inner electrons are shown they must be correct ie 2,8
	(b)		Tetrahedral / tetrahedron	1	
	(c)		Gains an electron (from sodium) **or** Indication that the electron arrangement increases by 1 eg electron arrangement goes from 2.8.7 to 2.8.8, outer electron number goes from 7 to 8.	1	Accept - sodium gives an electron - chlorine takes an electron Award zero marks for - implying that chlorine gains more than one electron - a chloride ion gains an electron
	(d)		**low no 1 mark** **high no 1 mark** 1 mark for **both** correct **properties** for **chloromethane gas** 1 mark for **both** correct **properties** for **solid sodium chloride**	2	

Question			Answer	Max mark	Additional guidance
4.	(a)	(i)		2	All 4 correct – 2 marks 2/3 correct – 1 mark 0/1 correct – 0 marks
		(ii)	Iron would not melt/ be molten/liquid or able to flow **or** Iron would be solid **or** Iron needs to be molten/liquid/flowing	1	Award zero marks for: -it is the melting point of iron however, this does not negate a correct answer.
	(b)		$Fe^{2+} \rightarrow Fe^{3+} + e^-$ **or** $Fe^{2+} - e \rightarrow Fe^{3+}$	1	State symbols are not required however, if given they must be correct

Question			Answer	Max mark	Additional guidance
5.	(a)	(i)	14 (days)	**1**	No units required but no mark is awarded if wrong unit is given. (Wrong units are only penalised once in any paper).
		(ii)	42 (days) **(2)** Partial marking 3 half-lives **(1)** **or** Correct number of days for an incorrect number of half-lives-working must be shown. **(1)**	**2**	Allow follow through from part (a)(i) to allow the candidate to access both marks No units required but maximum of 1 mark is awarded if wrong unit is given. (Wrong units are only penalised once in any paper).
	(b)		beta **or** β **or** $^{0}_{-1}\beta$ **or** $^{0}_{-1}e$ **or** $^{0}_{-1}e^{-}$	**1**	

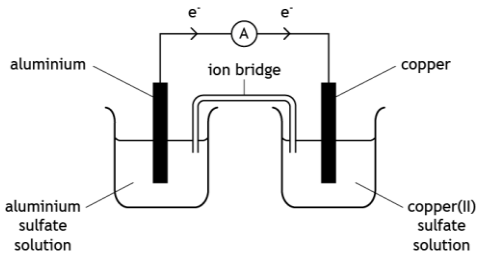
Question			Answer	Max mark	Additional guidance
6.			**1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	3	

Question			Answer	Max mark	Additional guidance
7.	(a)		Carboxyl **or**  **or** COOH	**1**	
	(b)	(i)	Any acceptable structural formula for butanoic acid eg $CH_3CH_2CH_2COOH$ $CH_3(CH_2)_2COOH$ 	**1**	Accept mixture of shortened and full structural formula Ignore - the omission of one H atom (from a carbon atom) in full structural formula provided the bond is shown **or** - one carbon to hydrogen bond missing provided the hydrogen is shown. Award zero marks for C_3H_7COOH

Question			Answer	Max mark	Additional guidance
7.	(b)	(ii)	Butanoic acid or it has bigger / stronger / more forces (of attraction) **(1)** Between molecules **or** mention of intermolecular attractions **(1)**	2	The term bond is only acceptable if it is specifically identified as between the molecules or used with the term intermolecular. Mention of breaking bonds /bonds within molecule or chain / breaking carbon to carbon or carbon to hydrogen bonds or more bonds cannot gain the second mark but does not negate the first mark. Candidates can be awarded the full/partial marks if they correctly explain why propanoic acid has a lower melting point but propanoic acid **must** be stated in their answer.
			If neither of these two points are given, a maximum of 1 mark can be awarded for - butanoic acid or it is bigger has more carbons or hydrogens or atoms longer carbon chain		More bonds in the compound is not sufficient to imply a larger molecule but does not negate.

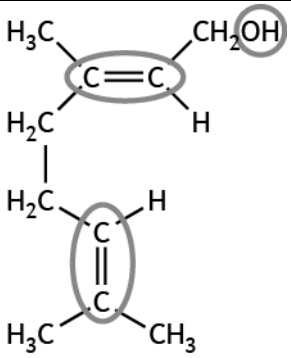
Question			Answer	Max mark	Additional guidance
8.	(a)	(i)	Glowed brighter/more brightly than zinc **or** Glowed most brightly/very brightly/white light	**1**	
		(ii)	Faster/higher/speed up/increase	**1**	Award zero marks for -takes less time on its own but does not negate correct answer.
	(b)		Magnesium **or** Mg	**1**	Can be circled, highlighted etc

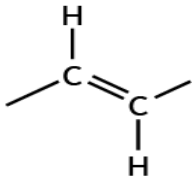
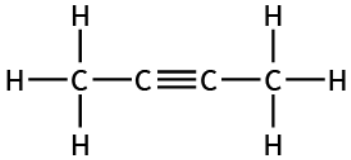
Question			Answer	Max mark	Additional guidance
9.	(a)		They have the same general formula **AND** similar/same chemical properties **Both required for 1 mark**	**1**	Award zero marks for -molecular formula -structural formula -chemical formula Award zero marks for - physical properties in place of chemical properties however, it does not negate
	(b)		Isomer(s)	**1**	
	(c)	(i)	Increasing carbon chain length/ number of carbons takes more time (longer, slower) **or** Decreasing carbon chain length/ number of carbons takes less time (faster, quicker) **or** Straight chain takes more time (longer, slower) than branched chain **or** Branched chain takes less time (faster, quicker) than straight chain	**1**	
		(ii)	Indication that the expected position occurs anywhere on the horizontal line between ethene and 2-methylpropane.	**1**	

Question			Answer	Max mark	Additional guidance
10.	(a)	(i)	 ALL REQUIRED FOR 1 MARK	**1**	Accept - copper sulfate instead of copper(II) sulfate - name of solution without (aq) or solution.
		(ii)	$3Cu^{2+} + 2Al \longrightarrow 3Cu + 2Al^{3+}$	**1**	Accept correct multiples Zero marks awarded for -electrons shown in equation, unless clearly scored out. State symbols are not required however if given they must be correct

Question			Answer	Max mark	Additional guidance
10.	(b)		15·79 or 15·8 or 16 (%) **(3)** Partial marking GFM = 342 **(1)** 54/342 x 100 (concept mark) **(1)** **This step on its own 2 marks** Calculation of final answer using the correct relationship **(1)**	**3**	Maximum 2 marks **(working must be shown)** Incorrectly calculated GFM- allow follow through using the mass of aluminium from working **or** Using mass of Al as 27- 27/342 x 100 = 7·89 or 7·9 or 8 **or** Using atomic numbers- 26/170 x 100 = 15 or 15·29 or 15·3 **or** Candidate correctly calculates percentage of sulfur (28 or 28·1%) or oxygen (56 or 56·1%) rather than aluminium Maximum of 1 mark - **working must be shown for** value divided by 342 does not correspond to an element in the compound, award a maximum of 1 mark. No units required but maximum of 2 marks can be awarded if wrong unit is given. (Wrong units would only be penalised once in any paper)

Question			Answer	Max mark	Additional guidance
11.	(a)		pH of solution goes down / decreases / goes below 7 / goes to a value less than 7 from 7 **because** the H^+ ion / hydrogen ion concentration increases /goes up or more H^+ than OH^- / $H^+ > OH$ **(2)** Partial marking pH of solution goes down/ decreases/goes below 7/ goes to a value less than 7 from 7 **(1)** **or** H^+ ion / hydrogen ion concentration increases/goes up / more H^+ than OH^- / $H^+ > OH^-$ **(1)**	**2**	Award zero marks for - it gets more acidic - sulfur dioxide is a non-metal /acidic oxide These two do **not** negate a correct answer. Award zero marks for any mention of pH being above 7. If the candidate states the pH increases/goes up/goes above 7, the mark for the description of more H^+ cannot be awarded.
	(b)		Decreases /goes down /gets lower	**1**	If the candidate mentions temperature **and** solubility in their answer the cause and effect must be given ie - as the temperature increases the solubility decreases **or** the solubility decreases as the temperature increases Award zero marks for - as the solubility decreases the temperature increases or - the temperature increases as the solubility decreases

Question			Answer	Max mark	Additional guidance
12.	(a)			1	Circling of either C=C or OH. Award zero marks for 
	(b)		Ester(s)	1	
	(c)		21 (g) **(3)** --- Partial marks 1 mark for **either**: Both GFMs ie 154 and 210 **or** Moles of geraniol ie (15·4 / 154) = 0·1 mol --- 1 concept mark for **either:** $15{\cdot}4 \times \frac{\text{GFM of ester}}{\text{GFM of geraniol}}$ ie 15.4 x (210 / 154) **or** Moles of geraniol x GFM of ester ie 0·1 x 210 **(Either of these two steps on their own with all correct substitutions 2 marks)** 1 mark for calculated final answer **provided the concept mark** has been awarded.	3	No units required but a maximum of two marks can be awarded if wrong unit is given. (Wrong units are only penalised once in any paper)

Question			Answer	Max mark	Additional guidance
13.	(a)		C_nH_{2n-2} **or** C_nH_{n2-2} **or** $C_nH_{2(n-1)}$	1	Accept **x** etc in place of **n**
	(b)	(i)			Allow one end bond to be missing.
		(ii)	Addition / additional	1	Award zero marks for - add
	(c)	(i)		1	Ignore - the omission of one H atom (from a carbon atom) in full structural formula provided the bond is shown **or** - one carbon to hydrogen bond missing provided the hydrogen is shown.
		(ii)	The two bromine atoms are not next to one another. **or** The two bromines are separated by a hydrogen. **or** The two bromine branches are not next to one another.	1	Award zero marks for -bromide -bromine molecules. Accept words/phrases that imply not together or not next to each other.

Question			Answer	Max mark	Additional guidance
14.	(a)	(i)	Any correct shortened or full structural formula for hexan-1-ol	**1**	Bond to the hydroxyl group **must** be to the O of the OH. Ignore the omission of one H atom (from a carbon atom) in full structural formula provided the bond is shown **or** ignore one carbon to hydrogen bond missing provided the hydrogen is shown.
		(ii)	188 (kJ)	**1**	No units required but no mark is awarded if wrong unit is given. (Wrong units are only penalised once in any paper).
	(b)		3·9 or 3·91 or 4 (kJ kg^{-1} $°C^{-1}$) **(3)** Partial marking Using the correct concept of $c = E_h / m\,\Delta T$ with E_h = 13·3 **(1)** 0·1 **and** 34 **(1)** A further mark can be awarded for the candidate's calculated answer **only** if the mark for the concept has been awarded. **(1)**	**3**	No units required but a maximum of two marks can be awarded if wrong unit is given. (Wrong units are only penalised once in any paper) 13300 and 100 can be used if the calculation is carried out in J/g. (The final answer would be 3·9 and the unit is correct if given as J g^{-1} $°C^{-1}$. or as kJ kg^{-1} $°C^{-1}$) Alternatively -13300 and 0·1 can be used but the final answer should be 3912 J kg^{-1} $°C^{-1}$ (units must be shown and correct for 3 marks to be awarded). If no unit, or the unit given in question is used then 2 marks are awarded as the mark for the final calculated answer is not awarded. Or alternatively - the answer, 3912, can be divided by 1000 to give the correct answer in kJ kg^{-1} $°C^{-1}$.

Go to Topic Grid

Question			Answer	Max mark	Additional guidance
15.			**1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. 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]

Go to Topic Grid

National Qualifications 2018

X813/75/02

Chemistry
Section 1 — Questions

MONDAY, 21 MAY

1:00 PM – 3:30 PM

Instructions for 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.

X8137502

Go to Topic Grid

SECTION 1 — 25 marks

Attempt ALL questions

1. Which of the following changes would **not** speed up a chemical reaction?

A Increasing the particle size

B Increasing the temperature

C Increasing the concentration

D Addition of a catalyst

2. Which line in the table identifies the correct location of a proton and an electron in an atom?

	Proton	*Electron*
A	inside the nucleus	inside the nucleus
B	inside the nucleus	outside the nucleus
C	outside the nucleus	outside the nucleus
D	outside the nucleus	inside the nucleus

3. Which of the following elements does **not** exist as diatomic molecules?

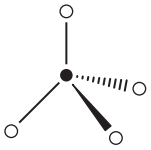
A Oxygen

B Helium

C Bromine

D Hydrogen

4. The shapes of some molecules are shown below.



tetrahedral

trigonal pyramidal

angular

linear

The shape of a molecule of hydrogen bromide is likely to be

A tetrahedral

B trigonal pyramidal

C angular

D linear.

Go to Answers

Go to Topic Grid

5. Which of the following elements forms an ion with a single positive charge and an electron arrangement of 2,8?

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

A Sodium

B Magnesium

C Fluorine

D Neon

6. Which line in the table shows the properties of a covalent network compound?

	Melting point (°C)	*Boiling point* (°C)	*Conducts electricity*	
			Solid	*Liquid*
A	−127	−100	no	no
B	795	1410	no	yes
C	30	2204	yes	yes
D	2700	3350	no	no

7. 0·1 mol of sodium hydroxide was dissolved in water and the solution made up to 250 cm^3.

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

A 0·0004

B 0·025

C 0·4

D 2·5

8. An alkaline solution contains

A only hydroxide ions

B more hydroxide ions than hydrogen ions

C more hydrogen ions than hydroxide ions

D equal numbers of hydrogen ions and hydroxide ions.

[Turn over

Go to Answers

9. A student made some statements about the effect of adding water to an acidic solution. Identify the correct statement.

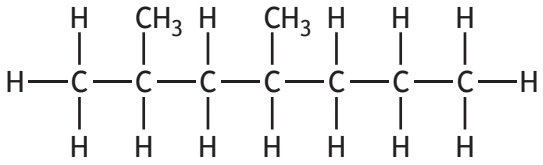
A The pH of the solution will remain the same.
B The pH of the solution will decrease.
C The hydrogen ion concentration will decrease.
D The hydrogen ion concentration will increase.

10. The shortened structural formula for a compound is

$$CH_3CH_2CH(CH_3)CH(CH_3)CH_2CH_2CH_3$$

Which of the following is another way of representing this structure?

A



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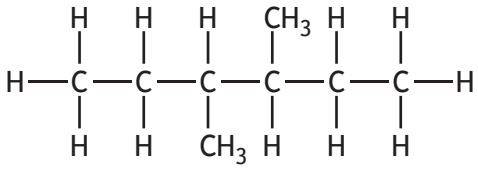

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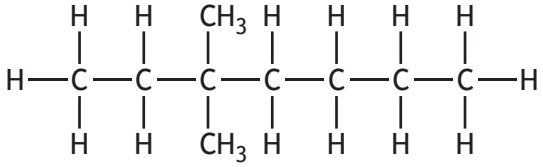
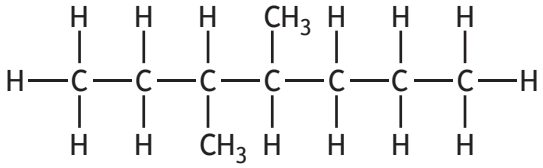
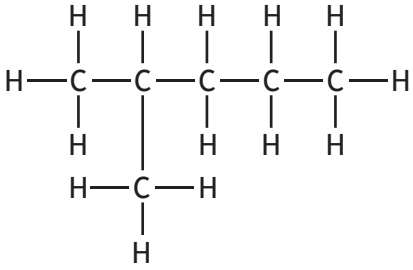


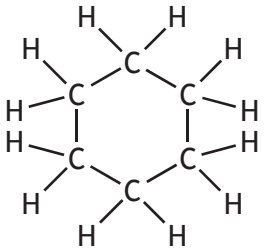
D

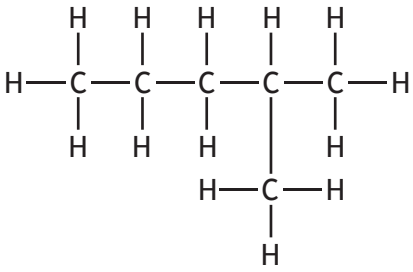


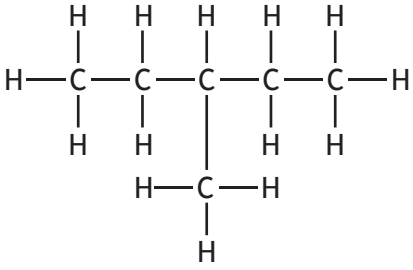
Go to Answers

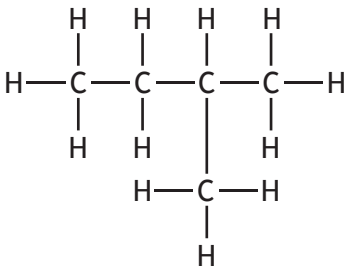
11. Identify which of the following is an isomer of



A 

B 

C 

D 

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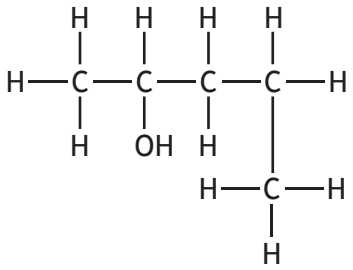
Go to Answers

12. Which of the following reactions takes place when an alcohol is formed from an alkene?

A Hydrogenation
B Combustion
C Hydration
D Reduction

13.



The systematic name for the above compound is

A pentan-2-ol
B pentan-4-ol
C 1-methylbutan-3-ol
D 4-methylbutan-2-ol.

14. Which of the following alcohols is the least soluble in water?

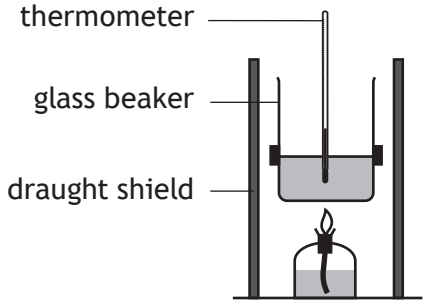
A Butan-1-ol
B Hexan-1-ol
C Pentan-1-ol
D Propan-1-ol

Go to Answers

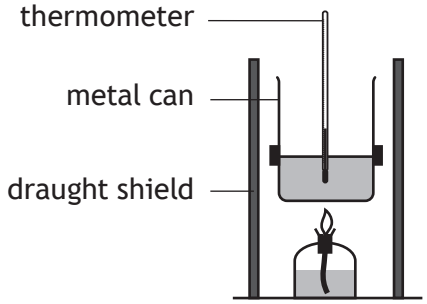
15. A student set up an experiment to determine the quantity of energy released when a hydrocarbon burns.

Which of the following diagrams shows the apparatus which would produce the most accurate result?

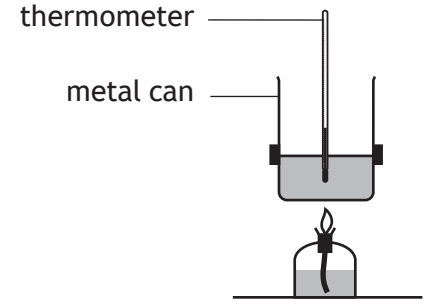
A



B



C



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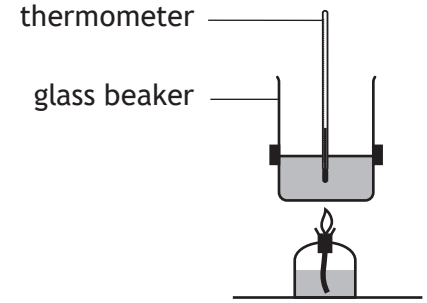

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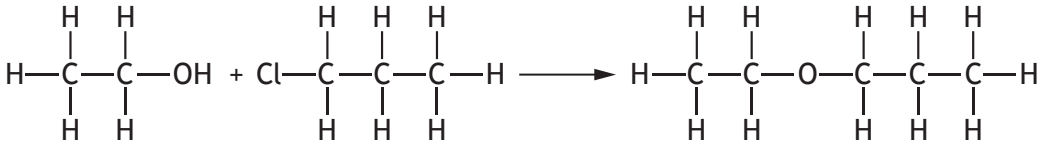
Go to Answers

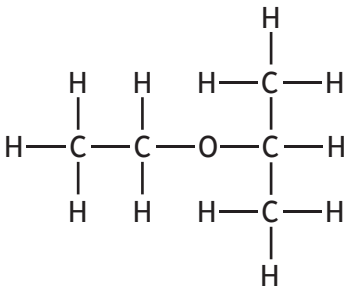
Go to Topic Grid

16. The ether, 1-ethoxypropane, can be made by the Williamson reaction.



ethanol **1-chloropropane** **1-ethoxypropane**

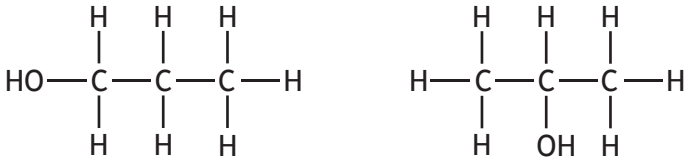
The structural formula for another ether is shown below.



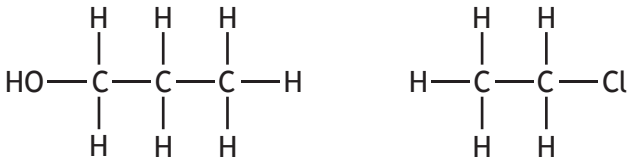
2-ethoxypropane

Which of the following pairs of compounds would react together to produce 2-ethoxypropane?

A



B



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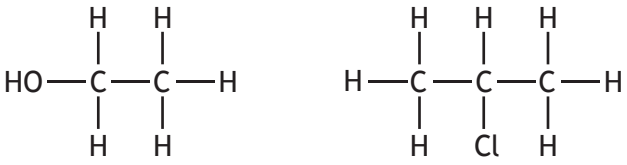
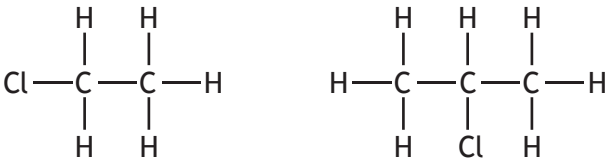


D



Go to Answers

17. Information about the reactions of four different metals, **W**, **X**, **Y** and **Z** is given in the table.

Metal	*Reaction with dilute acid*	*Reaction with water*
W	moderate reaction	no reaction
X	fast reaction	slow reaction
Y	slow reaction	no reaction
Z	fast reaction	no reaction

The order of reactivity of the metals, starting with the most reactive is

A X, Z, W, Y
B Y, W, Z, X
C Z, X, W, Y
D Y, W, X, Z.

18. The ion-electron equations for the oxidation and reduction steps in the reaction between hydrogen and oxygen are given below.

$$H_2(g) \rightarrow 2H^+(aq) + 2e^-$$

$$2H_2O(\ell) + O_2(g) + 4e^- \rightarrow 4OH^-(aq)$$

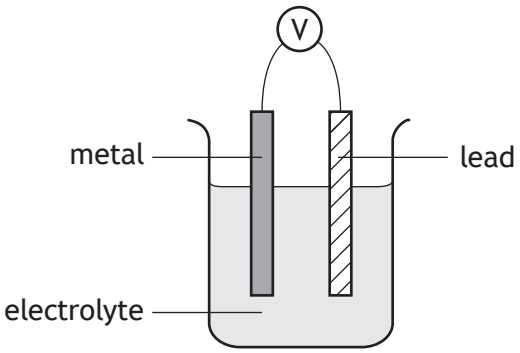
The redox equation for the overall reaction is

A $H_2(g) + 2H_2O(\ell) + O_2(g) + 4e^- \rightarrow 2H^+(aq) + 4OH^-(aq) + 2e^-$
B $2H_2(g) + 2H_2O(\ell) + O_2(g) \rightarrow 4H^+(aq) + 4OH^-(aq)$
C $H_2(g) + 2H_2O(\ell) + O_2(g) \rightarrow 2H^+(aq) + 4OH^-(aq)$
D $2H_2(g) + 2H_2O(\ell) + O_2(g) + 4e^- \rightarrow 4H^+(aq) + 4OH^-(aq) + 4e^-$

[Turn over

19. Which of the following metals, when connected to lead in a cell, would produce the highest reading on the voltmeter?

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



A Zinc

B Tin

C Nickel

D Lead

20. Which of the following salts would **not** be used as a fertiliser?

A Ammonium chloride

B Ammonium phosphate

C Sodium chloride

D Sodium phosphate

Go to Answers

21. Which metal is used as the catalyst in the industrial manufacture of ammonia?

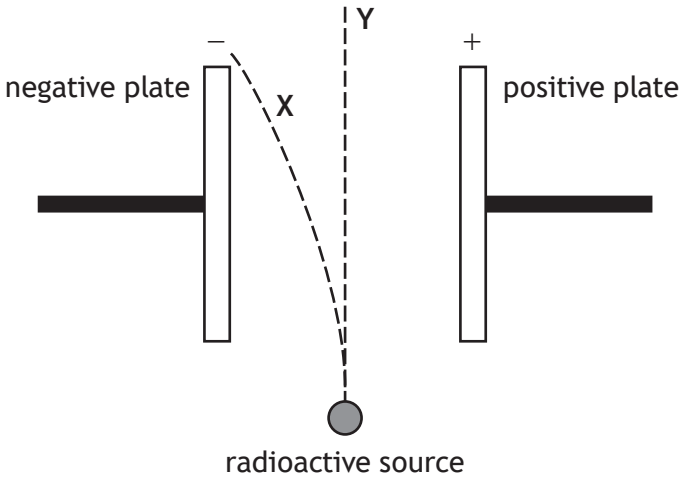
A Nickel

B Platinum

C Iron

D Rhodium

22. The diagram shows the path of two different types of radiation as they pass through an electric field.



Which line in the table correctly identifies the types of radiation which follow paths **X** and **Y**?

	Path **X**	*Path* **Y**
A	alpha	beta
B	beta	alpha
C	beta	gamma
D	alpha	gamma

23. Metallic bonding is a force of attraction between

A a shared pair of electrons and two nuclei

B negative ions and delocalised electrons

C negative ions and positive ions

D positive ions and delocalised electrons.

[Turn over

Go to Answers

Go to Topic Grid

24. $2K^+(aq) + 2I^-(aq) + Pb^{2+}(aq) + 2NO_3^-(aq) \rightarrow PbI_2(s) + 2K^+(aq) + 2NO_3^-(aq)$

The type of reaction represented by this equation is

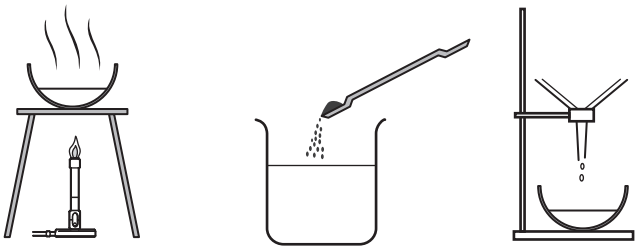
A neutralisation

B precipitation

C addition

D redox.

25. A student prepared a sample of copper sulfate crystals by reacting excess copper carbonate with acid.



X **Y** **Z**

Which line in the table shows the correct order in which this experiment would be carried out?

A Y, X, Z

B X, Y, Z

C Z, Y, X

D Y, Z, X

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

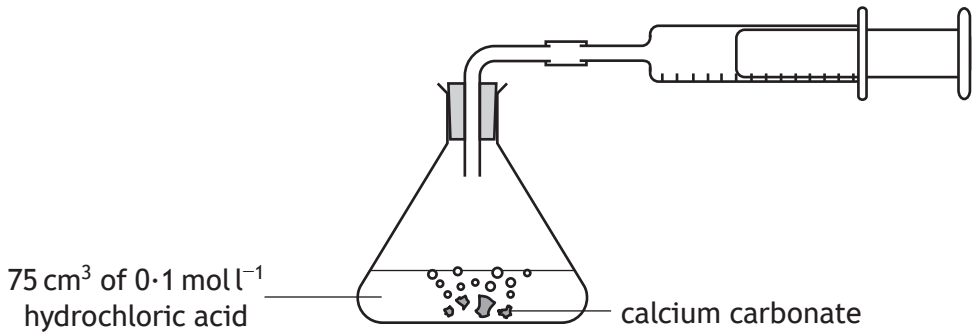
Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2 — 75 marks

Attempt ALL questions

1. A student monitored the rate of reaction between excess calcium carbonate and dilute hydrochloric acid, HCl, using a gas syringe to collect the gas produced.



(a) Name the gas produced in this reaction. **1**

(b) The student obtained the results shown.

Time (s)	0	10	20	40	50	60	70	80
Volume of gas (cm^3)	0	48	62	74	77	79	80	80

(i) Calculate the average rate of reaction between 20 and 50 seconds. **3**

Your answer must include the appropriate unit.

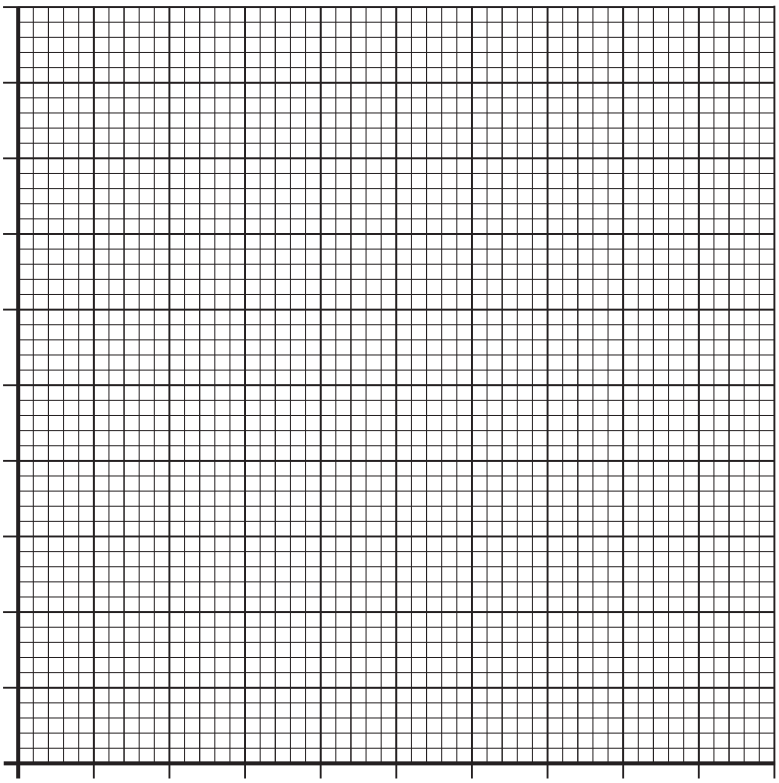
Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

1. (b) (continued)

(ii) Draw a graph of the student's results. **4**

(Additional graph paper, if required, can be found on *page 33*).



(iii) **Using your graph**, estimate the volume of gas, in cm^3, produced at 30 seconds. **1**

(c) The student carried out a similar experiment using 75 cm^3 of 0·1 mol l^{-1} sulfuric acid, $H_2SO_4(aq)$.

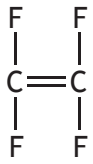
The total volume of gas collected was 160 cm^3.

Explain why there was a greater volume of gas produced. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

2. The retractable roof on Centre Court at Wimbledon Tennis Club is made of the polymer poly(tetrafluoroethene), PTFE.

(a) The monomer used to produce PTFE has the following structure.



tetrafluoroethene

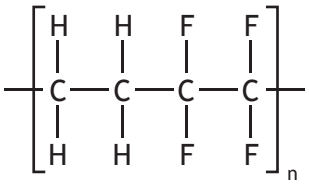
(i) Name the type of polymerisation used to produce PTFE. **1**

(ii) Draw a section of poly(tetrafluoroethene) showing three monomer units joined together. **1**

(b) The roof of the O_2 Arena in London is made from a co-polymer.

A co-polymer is formed when two different monomers polymerise.

The repeating unit of the co-polymer is shown.



One of the monomers in this co-polymer is tetrafluoroethene.

Draw the full structural formula for the other monomer. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

3. Coal is a fuel that contains carbon. Different types of coal contain different percentages of carbon.

Heat content is a measure of how much heat energy is released when coal is burned.

(a) The table gives information about types of coal.

Type of coal	*Percentage of carbon*	*Average heat content* ($kJ\,kg^{-1}$)
Anthracite	86 - 98	32 500
Bituminous	45 - 85	27 850
Sub-bituminous	35 - 44	25 550
Lignite	25 - 34	13 950

Describe how the percentage of carbon in coal affects the average heat content. **1**

(b) Iron pyrite, FeS_2, is an impurity found in coal.

Calculate the percentage of iron in iron pyrite. **3**

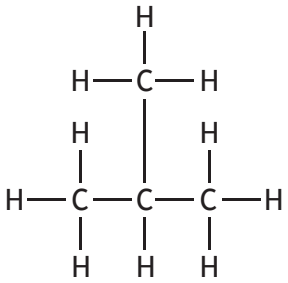
Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

4. During the FIFA World Cup, referees will spray foam onto the pitch to ensure players stand the correct distance from the ball when a free kick is taken. The foam contains a hydrocarbon mixture of isobutane, butane and propane.

(a) Name the elements present in a hydrocarbon. **1**

(b) The full structural formula for isobutane is



Write the systematic name for isobutane. **1**

(c) Alkanes have different physical properties.

The table gives some information about isobutane and butane.

Alkane	*Boiling point* (°C)
isobutane	–12
butane	–1

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

Compared to isobutane, butane has a higher boiling point

as it contains { weaker / stronger } { covalent bonds / intermolecular forces }.

MARKS | DO NOT WRITE IN THIS MARGIN

4. (continued)

(d) The table shows the boiling points of some alkanes.

Alkane	*Boiling point* (°C)
pentane	36
hexane	69
heptane	98
octane	126
nonane	

Predict the boiling point, in °C, of nonane, C_9H_{20}. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

The Chemistry within Airbags

Airbags, an important safety feature in cars, inflate rapidly on collision. Inside the airbag is a gas generator containing a mixture of sodium azide (NaN_3), potassium nitrate and silicon dioxide.

When a car is involved in a collision, a series of three chemical reactions takes place.

In the first reaction, electrical energy causes sodium azide to decompose producing sodium metal and nitrogen gas. The nitrogen gas that is generated fills the airbag.

In the second reaction, the sodium reacts with potassium nitrate producing more nitrogen gas, sodium oxide and potassium oxide.

In the final reaction, the metal oxides react with silicon dioxide to produce silicate fibres, which are harmless and stable.

This process, from the initial impact of the crash to full inflation of the airbag, takes a fraction of a second.

(a) Name the three chemicals found inside the gas generator before any chemical reactions take place. **1**

(b) Name the compound produced in the second reaction which would give a lilac flame colour. **1**

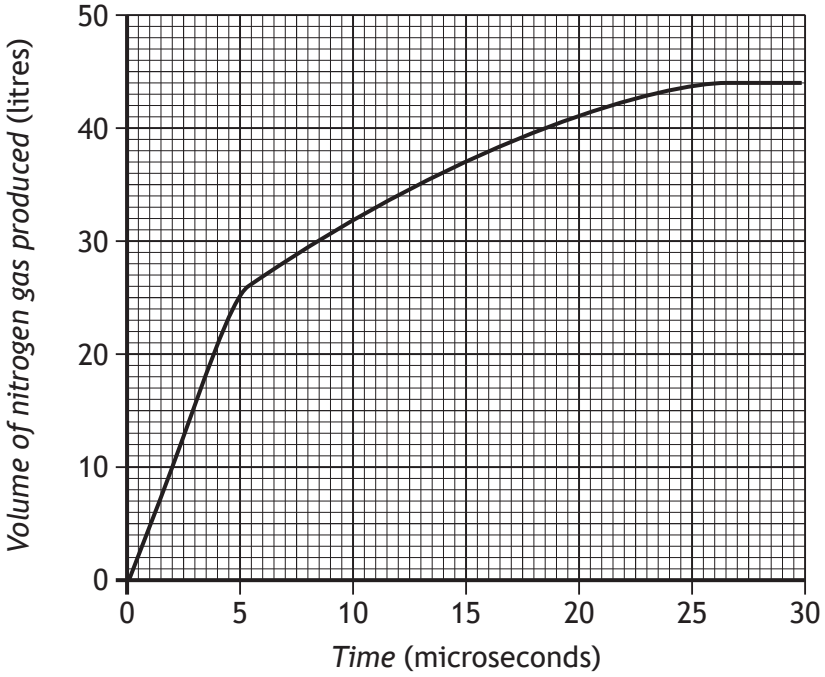
You may wish to use the data booklet to help you.

(c) Write the formula for the compound which reacts with the metal oxides in the final reaction. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

5. (continued)

(d) The graph below gives information on the volume of nitrogen gas produced by the gas generator.



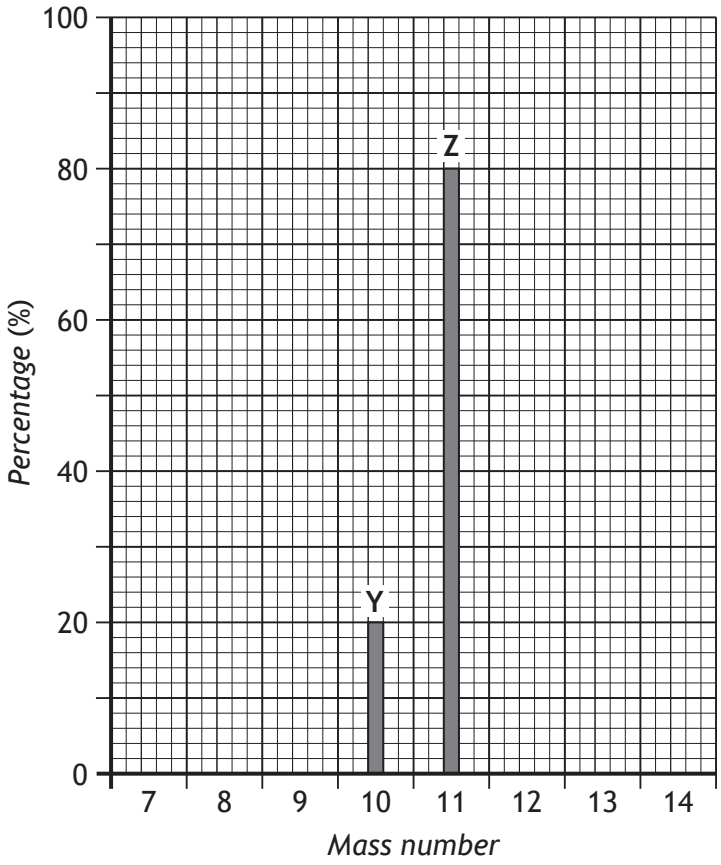
State the total volume, in litres, of nitrogen gas produced. **1**

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

6. Scientists use an instrument called a mass spectrometer to determine the number of isotopes and the percentage of each isotope in a sample of an element.

(a) When a sample of boron is passed through a mass spectrometer the following graph is obtained.



(i) State the number of isotopes present in this sample of boron. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

6. (a) (continued)

(ii) The relative atomic mass can be calculated using:

$$\frac{(\text{mass of isotope } \mathbf{Y} \times \% \text{ of } \mathbf{Y}) + (\text{mass of isotope } \mathbf{Z} \times \% \text{ of } \mathbf{Z})}{100}$$

Using the information from the graph, calculate the relative atomic mass of the sample of boron. **2**

Show your working clearly.

(b) Carbon also has more than one isotope.

The nuclide notation for an isotope of carbon can be represented as

$$^{12}_{6}C$$

Write the nuclide notation for the isotope of carbon with 8 neutrons. **1**

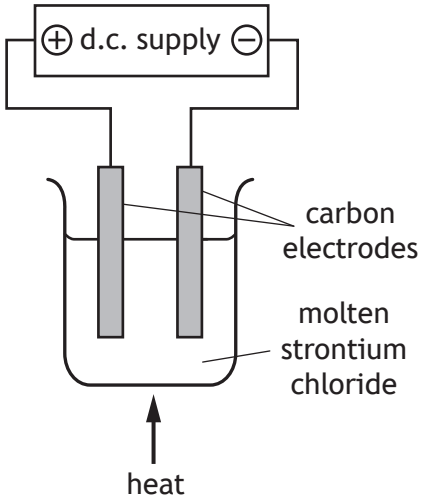
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

7. Strontium chloride, which is an ionic compound, is used in toothpaste to reduce tooth sensitivity.

(a) State the term used to describe the structure of solid strontium chloride. **1**

(b) A sample of strontium chloride was electrolysed.



(i) State why ionic compounds, like strontium chloride, conduct electricity when molten. **1**

(ii) During electrolysis, chloride ions lose electrons to form chlorine gas.

Name the type of chemical reaction taking place. **1**

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

MARKS | DO NOT WRITE IN THIS MARGIN

8. Water is one of the most versatile of all chemicals and features in many chemical reactions and processes.

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

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. Olive oil, which can be used in cooking, is a mixture of unsaturated molecules.

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

(ii) Describe the chemical test, including the result, that can be used to show that olive oil is unsaturated. **1**

(b) When frying food, it is recommended that the oil is heated before food is added.

The table gives information about olive oil used to fry food.

Specific heat capacity of olive oil	$1{\cdot}97\ kJ\ kg^{-1}\ °C^{-1}$
Initial temperature of olive oil	20 °C
Mass of olive oil heated	1500 g

Calculate the energy, in kJ, required to increase the temperature of the olive oil to 180 °C. **3**

Show your working clearly

MARKS | DO NOT WRITE IN THIS MARGIN

10. Ammonia is made industrially by reacting nitrogen with hydrogen.

(a) The equation for this reaction is

$$N_2 \quad + \quad H_2 \quad \rightleftharpoons \quad NH_3$$

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

(ii) In the equation the symbol $\rightleftharpoons$ is used.

State what this indicates about the reaction. **1**

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

(c) In industry, ammonia can be converted into nitric acid.

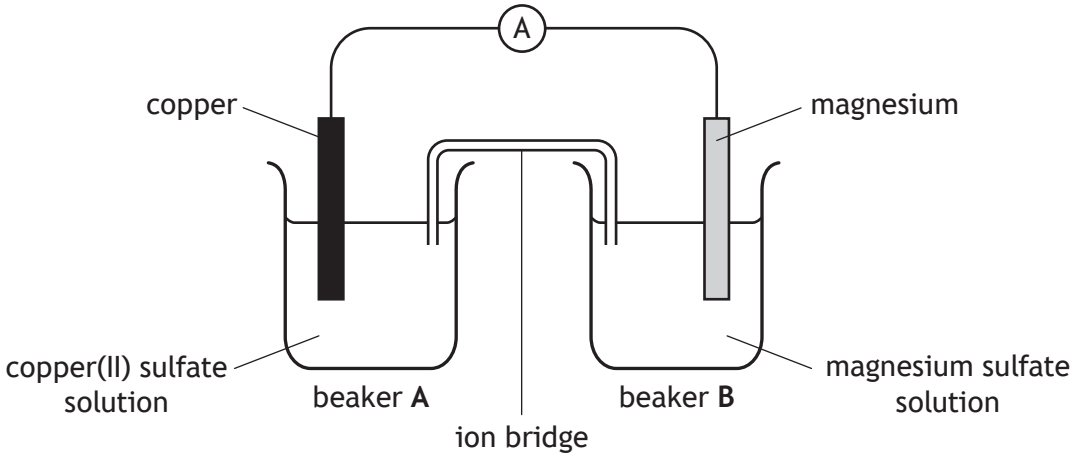
Name this industrial process. **1**

(d) Ammonia reacts with nitric acid to produce a salt.

Name the salt produced in this reaction. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

11. A student set up the following cell.



(a) **On the diagram**, draw an arrow to show the path and direction of electron flow. **1**

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

(b) Explain why an ion bridge is used to link the beakers. **1**

(c) In this reaction, the copper ions are reduced.

Write the ion-electron equation for the reduction of copper(II) ions. **1**

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

MARKS | DO NOT WRITE IN THIS MARGIN

11. (continued)

(d) Other magnesium compounds could be used in place of magnesium sulfate when making this type of cell.

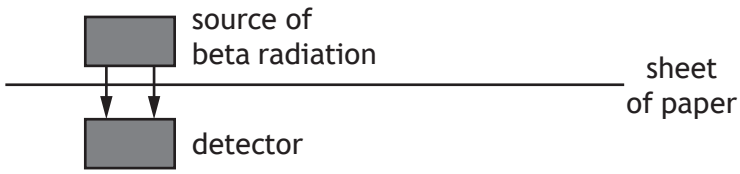
Suggest why magnesium phosphate would **not** be suitable. **1**

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

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. Thallium-204 decays by emitting beta particles and can be used in industry to measure the thickness of paper.



(a) Suggest a reason why a radioisotope which emits alpha particles is not suitable for this purpose. **1**

(b) A paper manufacturer found a thallium-204 source had only $\frac{1}{16}$ of its original activity.

The half-life of thallium-204 is 3·7 years.

Calculate the age, in years, of the source. **2**

Show your working clearly.

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

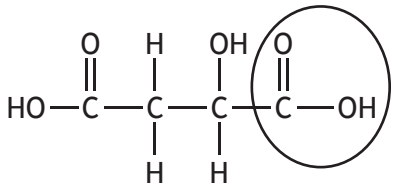
When an atom emits a beta particle,

the atomic number of the atom { increases / decreases / stays the same } and

the mass number { increases / decreases / stays the same }.

MARKS | DO NOT WRITE IN THIS MARGIN

13. Malic acid is a carboxylic acid found in some fruits.



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

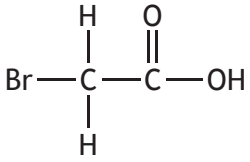
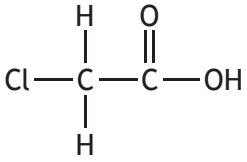
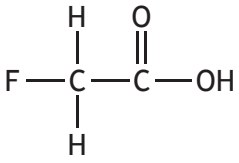
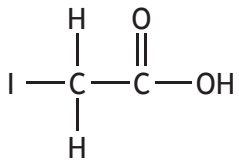
(ii) Calculate the mass, in grams, of 1 mole of malic acid. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

13. (continued)

(b) Carboxylic acids can contain a halogen atom. The pH of 1 mol l^{-1} solutions of some of these acids are given in the table.

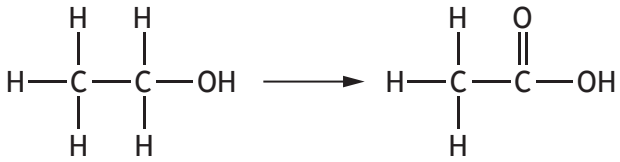
Carboxylic acid	*pH*
	1·45
	1·42
	1·33
	1·55

Describe how the acidity of the carboxylic acid is related to the position of the halogen in group 7 of the periodic table. **1**

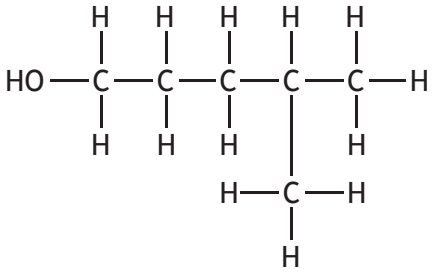
MARKS | DO NOT WRITE IN THIS MARGIN

13. (continued)

(c) The Jones oxidation reaction can be used to convert alcohols to carboxylic acids.



The following alcohol can also be converted to a carboxylic acid by the Jones oxidation reaction.



Draw a structural formula for the carboxylic acid produced in this reaction. **1**

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

14. Chloride ion concentrations greater than $0{\cdot}25\,g\,l^{-1}$ can cause a noticeable taste in drinking water.

The table gives information about the chloride ion concentration in drinking water from different sources.

Source	*Chloride ion concentration* ($g\,l^{-1}$)
A	0·26
B	0·28
C	0·24

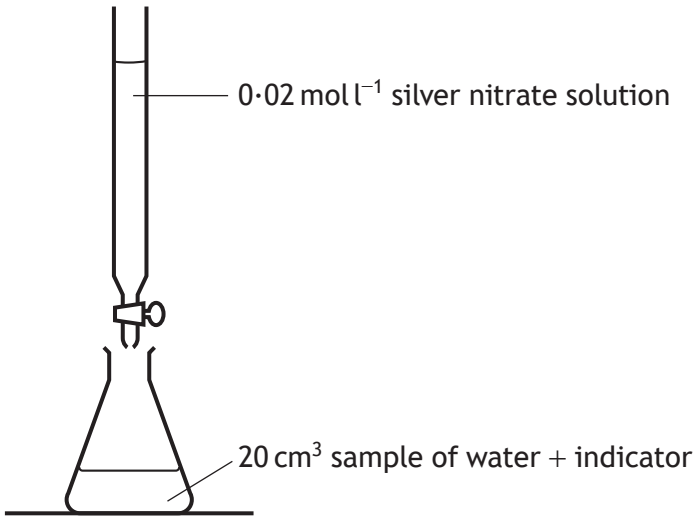
(a) One of the sources provides drinking water that does **not** have a noticeable taste.

Identify this source. **1**

(b) A student investigated the concentration of chloride ions in drinking water from another source.

Samples of water were titrated with silver nitrate solution.

An indicator was used to show when the end-point was reached.



Titration	*Volume of silver nitrate added* (cm^3)
1	9·6
2	8·0
3	8·5
4	8·1

MARKS | DO NOT WRITE IN THIS MARGIN

14. (b) (continued)

(i) Name the most appropriate piece of apparatus to measure 20 cm^3 samples of water into the flask. **1**

(ii) The average volume of silver nitrate that should be used to calculate the chloride ion concentration is 8·05 cm^3.

Explain why only the results of titration **2** and titration **4** are used to calculate this average. **1**

(iii) Calculate the number of moles of silver nitrate in 8·05 cm^3. **1**

Show your working clearly.

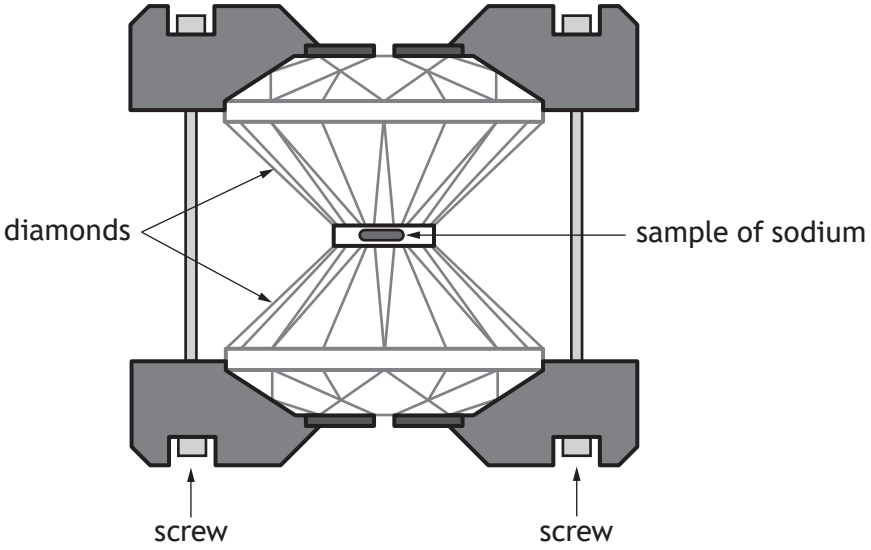
[Turn over

DO NOT WRITE IN THIS MARGIN

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

The bizarre world of high pressure chemistry

What would happen if you put some sodium, normally a soft grey metal, under extremely high pressure?



Researchers investigated this using a piece of apparatus called a diamond anvil cell. The diamond anvil cell contains two diamonds and as the screws are tightened, high pressure is created. The pressure between the diamonds can reach 1000 gigapascals, which is a pressure of 10 million atmospheres.

When sodium is squeezed to 190 gigapascals it loses an important property of metals and becomes an insulator. This shows that there is a change in the structure and bonding of sodium.

The diamond anvil cell also allows scientists to create new materials, including superconductors.

Scientists are studying what happens to the materials thought to be deep inside the Earth, where high pressure occurs naturally.

Using this technique to mirror what may happen to materials deep in the Earth, iron(III) oxide is found to decompose, releasing oxygen, and forming the very unusual Fe_5O_7.

Adapted from *The Catalyst*, Volume 27, Number 1, October 2016

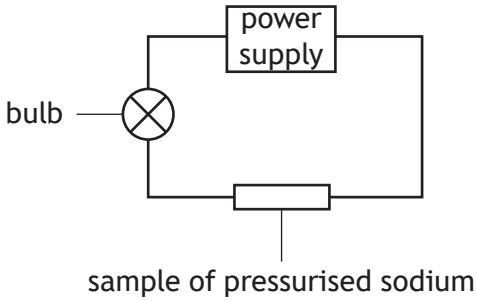
MARKS | DO NOT WRITE IN THIS MARGIN

15. (continued)

(a) Name the piece of apparatus used by researchers to create high pressure. **1**

(b) (i) Calculate the pressure, in atmospheres, when sodium is squeezed at 190 gigapascals. **1**

(ii) Suggest what would be observed if this pressurised sodium was placed in the circuit below. **1**

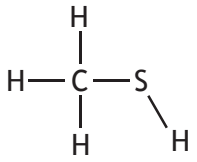
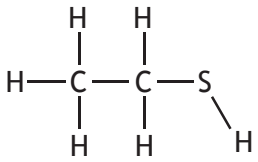
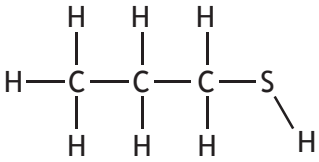


(c) Write an equation, using symbols and formulae, to show the decomposition of iron(III) oxide, at high pressure. **1**

There is no need to balance this equation.

MARKS | DO NOT WRITE IN THIS MARGIN

16. The thiols are a family of compounds containing carbon, hydrogen and sulfur.

Name	*Full structural formula*
methanethiol	
ethanethiol	
propanethiol	

(a) Thiols have the same general formula and similar chemical properties.

(i) State the term used to describe a family of compounds such as the thiols. **1**

(ii) Suggest a general formula for this family. **1**

(b) Ethanethiol can react with oxygen as shown.

ethanethiol + oxygen → carbon dioxide + water + **Y**

Identify **Y**. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

16. (continued)

(c) Methanethiol, which smells like rotting cabbage, is added to natural gas to allow gas leaks to be detected.

It is prepared industrially by the reaction of methanol with hydrogen sulfide gas.

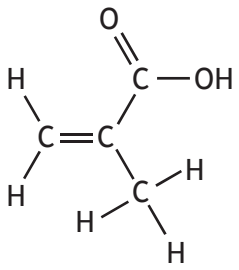
$$CH_3OH + H_2S \longrightarrow CH_3SH + H_2O$$

Calculate the mass of methanethiol, in grams, produced when 640 grams of methanol reacts completely with hydrogen sulfide. **3**

Show your working clearly.

MARKS | DO NOT WRITE IN THIS MARGIN

17. Methacrylic acid is used to make methacrylates which are used in Shellac nail polish.



methacrylic acid

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

[END OF QUESTION PAPER]

National Qualifications 2018

2018 Chemistry

National 5

Finalised Marking Instructions

SQA ©

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Marking instructions for each question

Section 1

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

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Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)		Carbon dioxide	**1**	Accept correct formula CO_2. Do not accept CO2, CO^2.
	(b)	(i)	0·5 or ½ $cm^3 s^{-1}$ **(3 marks)** Partial marking: 0·5 with no unit/incorrect unit **(2 marks)** **OR** **1 mark awarded for concept of change in volume/change in time.** $\frac{77-62}{50-20}$ or $\frac{15}{30}$ or $\frac{62-77}{20-50}$ **(1 mark)** --- Correct unit $cm^3 s^{-1}$ **(1 mark)** **This mark is independent of the calculated value.**	**3**	Accept cm^3/s or unit in words. Do not accept cm^3/s^{-1} or sec. The mark for a final answer can only be awarded if the concept of **change in** volume/**change in** time is correct ie incorrect values **from the table** used (subtractions must be shown and volumes chosen **must** correspond to chosen times).
		(ii)	One mark is awarded for a graph which shows points plotted rather than bars. **(1 mark)** The axis/axes of the graph has/have suitable scale(s). For the graph paper provided within the question paper, the selection of suitable scales will result in a graph (plotted points) that occupies at least half of the width and half of the height of the graph paper. **(1 mark)** The axes of the graph have suitable labels and units. **(1 mark)** All data points plotted accurately (within a half box tolerance) with either a line of best fit drawn or plots joined. **This mark can only be accessed if linear scales for both axes have been provided.** **(1 mark)**	**4**	Where the candidate has drawn a bar graph the mark for the correct type of graph is not awarded, but the remaining three marks can still be accessed. For bar graphs, this mark is awarded for the selection of a suitable scale. Spelling mistakes or the use of abbreviations should not be penalised if the meaning of an axis label may be clearly understood. 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 is required.

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Question			Expected response	Max mark	Additional guidance
1.	(b)	(iii)	Answer must be correct for the candidate's graph (within a half box tolerance). If no graph drawn, 68 ± 1.	**1**	Unit is not required; however zero marks are awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.
	(c)		Greater number /concentration / moles of hydrogen ions / H^+ **OR** more H^+ ions.	**1**	Award zero marks for 'more hydrogen'/more hydrogen atoms/more 'H'/more acid/more moles of acid. Award zero marks for mention of stronger/weaker acid but this does not negate a correct answer.

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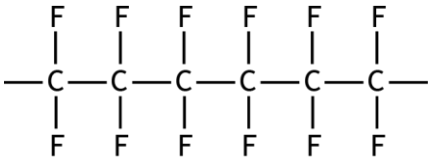
Question			Expected response	Max mark	Additional guidance
2.	(a)	(i)	Addition	**1**	Award one mark for 'additional'.
		(ii)		**1**	Mark can still be awarded if one end bond is missing. Allow dot or ~ to represent end bond. Ignore the omission of one F atom provided the bond is shown or one carbon to fluorine bond missing provided the fluorine is shown. Zero marks awarded if • **both** end bonds are missing • less than or more than three monomers shown • a bond between two carbons is missing.
	(b)		Correctly drawn **full** structural formula for ethene.	**1**	Do not accept the word ethene on its own but it does not negate a correct answer.

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Question			Expected response	Max mark	Additional guidance
3.	(a)		As the percentage of carbon increases the heat content also increases. **OR** As the percentage of carbon decreases the heat content also decreases. **OR** The heat content increases as the percentage of carbon increases. **OR** The heat content decreases as the percentage of carbon decreases.	**1**	Zero marks awarded for an incorrect cause and effect eg as the heat content increases the percentage of carbon increases. Zero marks awarded if the candidate uses the word coal instead of carbon.
	(b)		46·67 / 46·7 / 47 (%) **(3 marks)** --- Partial marking: *GFM* = 120 **(1 mark)** $\frac{56}{candidate's\ GFM} \times 100$ **(1 mark)** This step on its own is worth 2 marks if the candidate's gfm is 120. Calculation of final answer using the relationship $\%\ by\ mass = \frac{m}{GFM} \times 100$ **(1 mark)**	**3**	Award zero marks for 46/46·6 (%) with no working shown. Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper. The mark for the final answer can only be awarded if the correct relationship between total mass of element present divided by gfm x 100 is **shown with working**.

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Question			Expected response	Max mark	Additional guidance
4.	(a)		Hydrogen and carbon.	**1**	Accept H/H_2/C
	(b)		Methylpropane **OR** 2-methylpropane	**1**	Omission of a hyphen should not be penalised.
	(c)		Stronger and intermolecular forces.	**1**	Both phrases correctly circled.
	(d)		150 to 154°C inclusive.	**1**	Unit is not required; however zero marks are awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.

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Question			Expected response	Max mark	Additional guidance
5.	(a)		Sodium azide, potassium nitrate and silicon dioxide.	**1**	Correct formulae accepted.
	(b)		Potassium oxide.	**1**	Correct formula accepted.
	(c)		SiO_2	**1**	Do not accept Si_2O_4.
	(d)		44 (litres)	**1**	Unit is not required; however zero marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.

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Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	Two	**1**	
		(ii)	10·8 **(2 marks)** 11 with working **(2 marks)** --- Partial marking: $\frac{(10\times 20)+(11\times 80)}{100}$ **(1 mark)** **OR** $\frac{10 \text{ x } 20\% + 11 \text{ x } 80\%}{100}$ **(1 mark)**	**2**	Award zero marks for 11 on its own. Accept amu/g Unit is not required; however a maximum of 1 mark can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.
	(b)		${}^{14}_{6}C$	**1**	

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Question			Expected response	Max mark	Additional guidance
7.	(a)		(Ionic) Lattice	**1**	Any mention of covalent/network/ metallic negates Award zero marks for crystal on its own but it does not negate the correct answer.
	(b)	(i)	Ions are free to move.	**1**	Award zero marks for electrons/ molecules/charged particles in place of ions.
		(ii)	Oxidation	**1**	
		(iii)	Allows the product(s) to be identified. **OR** To make sure that only one product is produced at each electrode. **OR** To separate the strontium from the chlorine.	**1**	Award zero marks for • allows ions to separate • so each electrode stays the same charge • so the electricity/current goes in the one direction.

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Question			Expected response	Max mark	Additional guidance
8.			This is an open ended question. **1 mark**: The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks**: The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	

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Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	(A molecule that contains) carbon to carbon double bond. **OR** C=C	**1**	Award zero marks for a double bond without mention of carbon. Award zero marks for alkene but does not negate a correct answer. Accept carbon to carbon triple bond. If the candidate draws the structure of an unsaturated molecule they must highlight the carbon to carbon double/triple bond.
		(ii)	Bromine (solution)(water)/Br_2 decolourised/discolourised/goes colourless.	**1**	Award zero marks for bromide or Br or Br^-. Award zero marks for 'goes clear' however if given in addition to a correct answer it does not negate. If starting colour is given it must be correct eg orange/yellow/red-brown or brown. Award zero marks if the candidate implies it is the olive oil that is being decolourised. Ignore any mention of time frame.
	(b)		472·8 / 473 (kJ) **(3 marks)** --- Partial marking: Using $cm\Delta T$ with c = 1·97 **(1 mark)** To be awarded this concept mark, candidates do not specifically need to write $cm\Delta T$. The concept mark is awarded for using this relationship with three values, one of which must be 1·97. For values 1·5 (kg) **and** 160 (°C) **(1 mark)** A further mark can be awarded for arithmetical follow through to the candidate's answer **only if the mark for the $cm\Delta T$ concept has been awarded.** **(1 mark)**	**3**	3 marks can be awarded for 472800 or 473000 J. **However the unit (Joules / J) must be given.** Unit is not required if answer given in kilojoules, however a maximum of 2 marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper. **If the candidate uses the values of 1·97 and 4·18 the concept mark cannot be awarded. A maximum of 1 mark can be awarded for the values of 1·5 and 160.**

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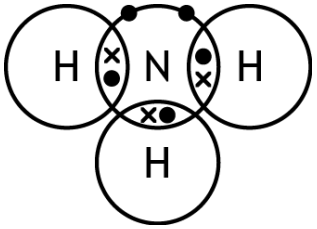
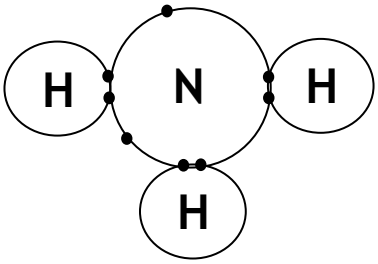
Question			Expected response	Max mark	Additional guidance
10.	(a)	(i)	N_2 + $3H_2$ ⇌ $2NH_3$	**1**	Accept correct multiples.
		(ii)	The reaction (it) is reversible **OR** the reaction (it) occurs in both directions **OR** the reaction (it) reaches (or is at) equilibrium.	**1**	
	(b)		Diagram showing nitrogen with three hydrogen atoms: each of the three overlap areas must have two electrons in or on overlap area. Either the nitrogen or all three hydrogen symbols must be shown.    	**1**	The diagram does **not** need to show trigonal pyramidal shape. Accept cross or dot or e or e- to represent electrons or a mixture of these. Accept petal diagram. The non-bonding electrons in nitrogen **must** be shown but do **not** need to be together/shown as a pair. Bonding electrons **MUST** be on the line or in the overlapping area. If inner electrons on nitrogen are shown they must be correct ie 2.
	(c)		Ostwald	**1**	Award zero marks for catalytic oxidation but does not negate a correct answer.
	(d)		Ammonium nitrate	**1**	Accept the correct formula.

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Question			Expected response	Max mark	Additional guidance
11.	(a)		From Mg to Cu through meter/wire.	**1**	Award zero marks for • arrow goes into solution • arrow is drawn on wire and ion bridge • arrow is drawn closer to the ion bridge than the wire/ammeter.
	(b)		Completes the circuit/cell **OR** allows ions to flow/move/transfer (between the two beakers) **OR** provide ions to complete the circuit /cell.	**1**	Award zero marks for allows electrons to flow and this negates a correct answer. Award zero marks for allows the current to flow but this does not negate a correct answer.
	(c)		$Cu^{2+}(aq) + 2e^{-} \longrightarrow Cu(s)$	**1**	State symbols are not required, however if given they must be correct.
	(d)		Insoluble **OR** Solubility less than 1 g l^{-1}	**1**	Award zero marks for "phosphate is insoluble".

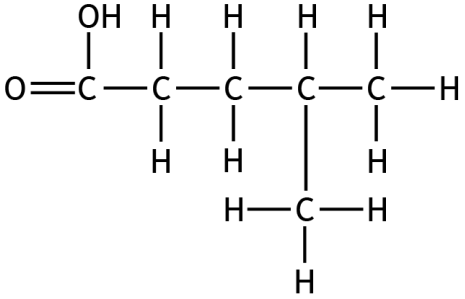
Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
12.	(a)		(Alpha particles) they • cannot penetrate the paper • cannot pass through paper • are stopped by the paper • are absorbed by the paper • can **only** pass through air.	**1**	Award zero marks for • they do not travel far • they cannot reach the detector • air absorbs alpha particles. However they do not negate a correct answer.
	(b)		14·8 (years) **(2 marks)** --- Partial marking: 1 mark can be awarded for **either**: • 4 half-lives **OR** • number of years correctly calculated for an incorrect number of half-lives (provided the working supports the number of half-lives).	**2**	Unit is not required; however a maximum of 1 mark can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.
	(c)		Increases Stays the same	**1**	Both required for 1 mark.

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
13.	(a)	(i)	Carboxyl	**1**	Award zero marks for carboxylic (acid).
		(ii)	134(g)	**1**	Unit is not required; however 0 marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.
	(b)		Any correct statement linking acidity to the position of the halogen. eg The acidity (of the carboxylic acids) decreases going down the group. **OR** As you go (up) from iodine to fluorine the acidity increases. **OR** The one at the top (of the group) has the highest acidity. **OR** The one that has the lowest acidity is at the bottom (of the group).	**1**	Award zero marks for an explanation in terms of pH only rather than acidity however this does not negate a correct answer. Award zero marks for stronger/weaker acid but does not negate a correct answer. The term increase/decrease on its own does not clearly indicate the position of halogen in the group.
	(c)		A correct shortened or full structural formula for 4-methylpentanoic acid eg $CH_3CH(CH_3)CH_2CH_2COOH$ $HOOCCH_2CH_2CH(CH_3)CH_3$  **OR** mirror images.	**1**	Accept CH_3 for branch in a full structural formula.

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
14.	(a)		C **OR** 0·24	**1**	Accept C or 0·24 identified in table.
	(b)	(i)	Pipette	**1**	
		(ii)	(2 and 4) They are concordant. **OR** They are within 0·2 (cm^3). **OR** They are within 0·1 / 0·1 apart. **OR** Titration 1 and 3 or the other two are not concordant or not within 0·2 of each other.	**1**	Award zero marks for any of the following on their own but these answers do not negate a correct answer. • They are the most accurate/consistent. • They are really close together. • They are the closest to each other. • They are the closest to 8·05. • Those are the two that gives the average. • Titrations 1 and 3 are rough.
		(iii)	0·000161 (mol / mole / moles) **OR** $1{\cdot}61 \times 10^{-4}$	**1**	Unit is not required; however 0 marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
15.	(a)		Diamond(s) anvil cell	**1**	
	(b)	(i)	1·9 million (atmospheres) **OR** 1 900 000 (atmospheres) **OR** $1{\cdot}9 \times 10^6$	**1**	Unit is not required; however 0 marks can be awarded for the correct value with incorrect unit. This marking instruction must only be applied a maximum of once per paper.
		(ii)	The bulb would not light/would turn off.	**1**	Award zero marks for • electricity does not flow • does not conduct electricity. However, they do not negate the correct answer. Additional incorrect chemistry negates a correct answer eg metals don't conduct electricity when solid.
	(c)		$Fe_2O_3 \longrightarrow O_2 + Fe_5O_7$	**1**	Does not require to be balanced. If balanced it must be correct ie $5Fe_2O_3 \rightarrow \frac{1}{2} O_2 + 2Fe_5O_7$ or correct multiples. Ignore state symbols if given. Award zero marks for an equals sign in place of an arrow.

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
16.	(a)	(i)	Homologous (series)	**1**	Award zero marks for homogeneous.
		(ii)	$C_nH_{2n+1}SH$ / $C_nH_{2n+1}HS$ **OR** C_nSH_{2n+2} **OR** $C_nH_{2n+2}S$ **OR** $C_nH_{2(n+1)}S$	**1**	Accept n or x Award zero marks for $C_nH_{2n+1}S + H$ $C_nH_{2n+}1SH$ $C_nH_{2n+1}SH_n$.
	(b)		Sulfur (mon)oxide Sulfur dioxide Sulfur trioxide	**1**	Accept a correct formula.

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
16.	(c)		960 (g) **(3 marks)** --- Partial marking: Both *GFM*s 32 and 48 **(1 mark)** **OR** **correct number of moles of methanol (20 moles).** **(1 mark)** --- Correct application of the relationship between moles and mass. **(1 mark)** This could be shown by: **Method A** $moles\ CH_3SH \times candidate's\ GFM\ CH_3SH$ **OR** **Method B** by working showing correct proportionality. $640 \leftrightarrow \frac{candidate\ GFM\ CH_3SH}{candidate\ GFM\ CH_3OH} \times 640$ Where the candidate has been awarded the mark for the correct application of the relationship between moles and mass, a further mark can be awarded for correct follow through to a final answer. **(1 mark)** **OR** Any other valid method accepted.	**3**	Unit is not required, however a maximum of 2 marks can be awarded for the correct value with incorrect unit. A maximum of two marks can be awarded where the candidate has carried out the calculation **using methanol** and one wrong chemical provided working is shown. ie if a candidate calculates the mass of H_2S or H_2O instead of methanethiol a maximum of 2 marks can be awarded for 680 (g) for using H_2S and 360 (g) for using H_2O provided the gfm of each of these chemicals is correct. **Award zero marks if candidate's working does not use methanol.**

Go to Topic Grid

Go to Topic Grid

Question			Expected response	Max mark	Additional guidance
17.			**1 mark:** The student has demonstrated a limited understanding of the chemistry involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **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 problem. This does not mean the answer has to be what might be termed an "excellent".	3	

[END OF MARKING INSTRUCTIONS]

Go to Topic Grid

National Qualifications 2019

X813/75/02

Chemistry
Section 1 — Questions

FRIDAY, 10 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

Questions 1 and 2 refer to an experiment to investigate the rate of a reaction.

The volume of gas collected in 2 minutes was 5 cm^3.

1. What was the average rate of reaction over this time?

A 0·2

B 0·4

C 2·5

D 5·0

2. The unit for the average rate of this reaction is

A cm^3/min^{-1}

B $cm^3\,min^{-1}$

C min/cm^3

D $min\,cm^{-3}$

3. Tennessine is a newly discovered element with a predicted electron arrangement of 2,8,18,32,32,18,7.

In which group of the periodic table should Tennessine be placed?

A 1

B 2

C 7

D 8

Go to Answers

4. Which of the following is a positively charged ion?

	Protons	Neutrons	Electrons
A	9	10	10
B	10	9	10
C	11	12	11
D	12	13	10

5. To turn a gas into a liquid it must be cooled below a temperature known as its critical temperature.

Gas	Formula	Relative formula mass	Critical temperature (°C)
hydrogen	H_2	2	–240
helium	He	4	–268
ammonia	NH_3	17	133
oxygen	O_2	32	–119
carbon dioxide	CO_2	44	31

Identify the true statement based on the information in this table.

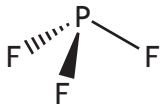
A Carbon dioxide can be a liquid at 40 °C

B Compounds have higher critical temperatures than elements

C Critical temperature increases as relative formula mass increases

D Diatomic elements have lower critical temperatures than Noble gases

6. A molecule of phosphorus trifluoride is shown.



Which term can be used to describe the shape of a phosphorus trifluoride molecule?

A Linear

B Angular

C Tetrahedral

D Trigonal pyramidal

[Turn over

Go to Answers

7. In which of the following compounds do the ions have the same electron arrangement? You may wish to use the data booklet to help you.

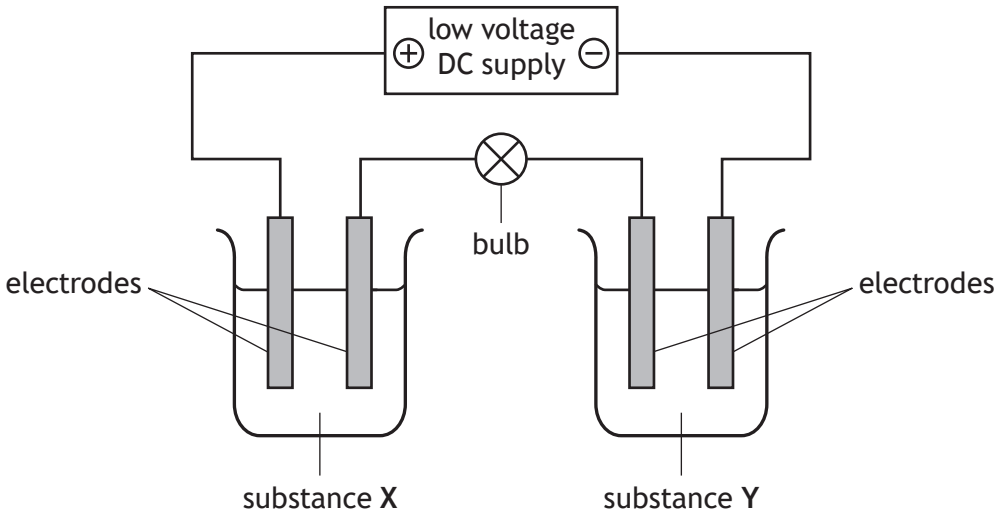
A Na_2O

B LiF

C KBr

D $MgCl_2$

8. Several conductivity experiments were carried out using the apparatus below.



Identify the experiment in which the bulb would light.

	Substance X	Substance Y
A	solid copper sulfate	liquid mercury
B	copper chloride solution	molten sodium chloride
C	solid potassium nitrate	nickel bromide solution
D	sodium chloride solution	liquid hexane

Go to Answers

Go to Topic Grid

9. Limewater can be made by dissolving calcium hydroxide in water.
Which of the following terms correctly describes calcium hydroxide?

A Solute
B Solvent
C Solution
D Insoluble

10. Ammonium nitrate, NH_4NO_3, has a gram formula mass of 80.
The percentage by mass of nitrogen in ammonium nitrate is equal to

A $\frac{14}{80} \times 100$
B $\frac{28}{80} \times 100$
C $\frac{28}{100} \times 80$
D $\frac{80}{28} \times 100$.

11. As an alkaline solution is diluted with water

A the pH increases
B the pH stays the same
C the concentration of hydroxide ions increases
D the concentration of hydroxide ions decreases.

12. Which of the following compounds is a base?

A Sodium oxide
B Calcium chloride
C Potassium nitrate
D Ammonium sulfate

[Turn over

Go to Answers

Go to Topic Grid

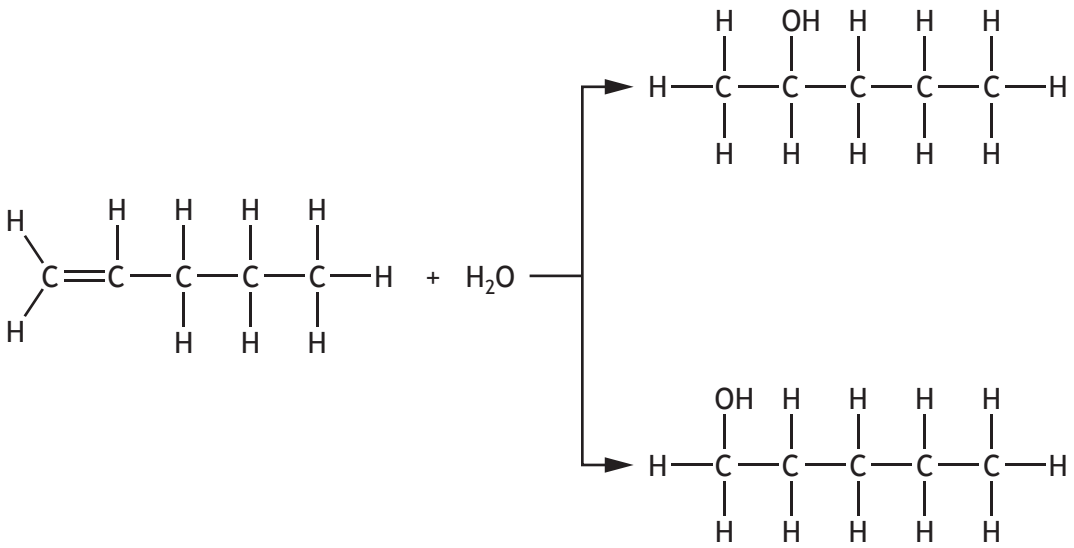
13. Which of the following compounds does **not** have an isomer?

A Cyclopropane
B But-1-ene
C Pentane
D Ethene

14. The systematic name for $CH_3CH_2C(CH_3)CHCH_3$ is

A 3-methylpentane
B 2-methylpentane
C 3-methylpent-2-ene
D 2-methylpent-3-ene.

15. When pent-1-ene undergoes an addition reaction with water, two products are formed.

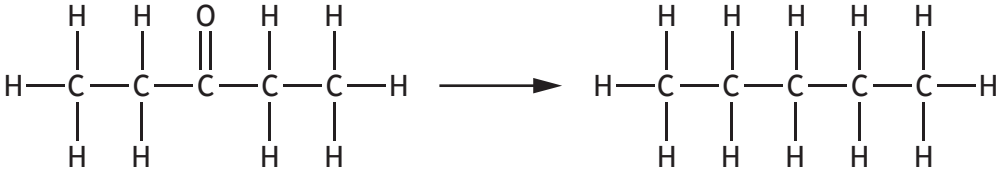


Which of the following alkenes will also produce two products when it undergoes an addition reaction with water?

A Oct-2-ene
B Hex-3-ene
C But-2-ene
D Ethene

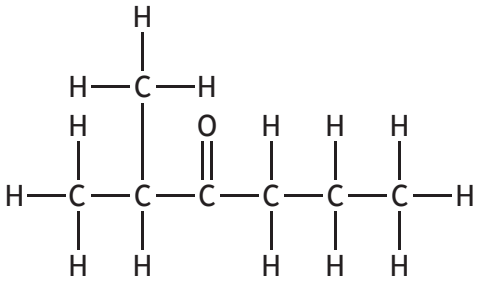
Go to Answers

16. In the Clemmensen reaction, ketones can be converted to alkanes as shown.

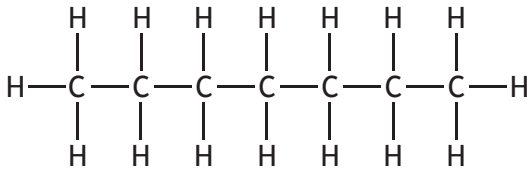
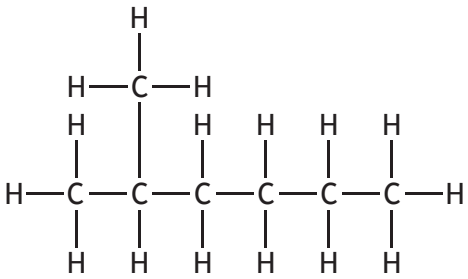
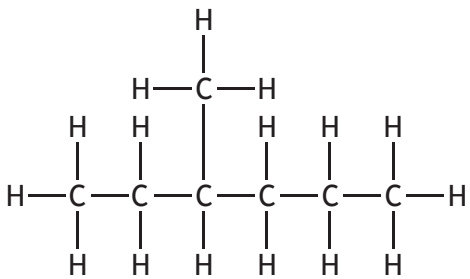
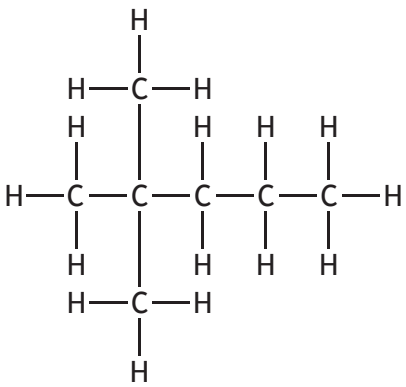


ketone alkane

Identify the alkane produced if the following ketone was used in this reaction?



ketone

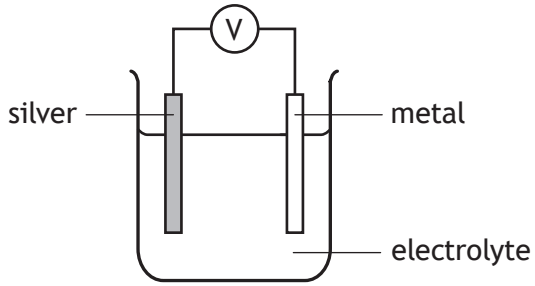
A 	B 
C 	D 

17. Which line in the table correctly describes the trends going from hexanoic acid to butanoic acid?

	Formula mass	Solubility in water
A	increasing	decreasing
B	decreasing	increasing
C	decreasing	decreasing
D	increasing	increasing

18. Four cells were made by joining silver to different metals.

The cells produced the following voltages 2·7 V, 1·1 V, 0·9 V and 0·5 V.



The metals used were copper, zinc, iron and magnesium.

Which voltage was produced in the cell containing silver and copper?

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

A 2·7 V

B 1·1 V

C 0·9 V

D 0·5 V

Go to Answers

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

Metal	Reaction with dilute acid	Reaction with water
X	reacts	no reaction
Y	no reaction	no reaction
Z	reacts	reacts

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

A Y, Z, X

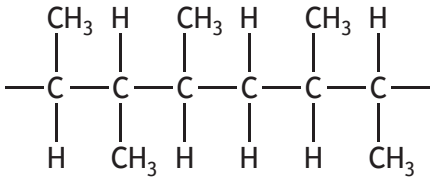
B Z, X, Y

C Y, X, Z

D X, Y, Z

20. A co-polymer is formed when two different monomers polymerise.

Part of the structure of a co-polymer, showing three monomer units, is given below.



One of the monomers used is propene.

Identify the other monomer.

A Pent-2-ene

B Pent-1-ene

C But-2-ene

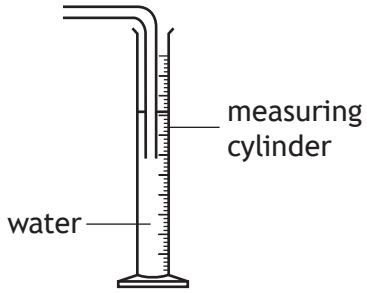
D But-1-ene

[Turn over

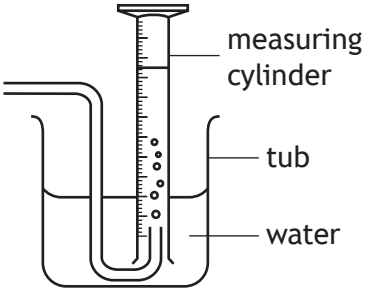
21. Nitrogen dioxide is a brown coloured gas that is soluble in water and more dense than air.

Which of the following diagrams shows the most appropriate method for collecting and measuring the volume of nitrogen dioxide?

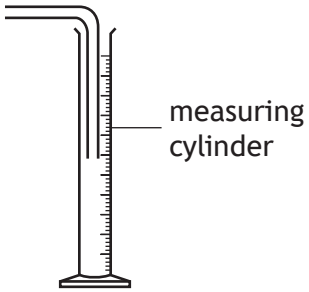
A



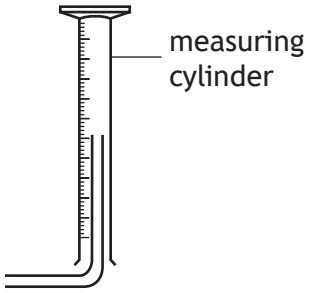
B



C



D



Go to Answers

22. A solution of a metal chloride burns with a green flame.
Which of the following metal ions could be present in the metal chloride?
You may wish to use the data booklet to help you.

A Ba^{2+}
B Ca^{2+}
C K^{+}
D Na^{+}

23. Identify the gas that turns limewater cloudy.

A Oxygen
B Nitrogen
C Hydrogen
D Carbon dioxide

Questions **24** and **25** refer to the equation shown.

$$AgNO_3(aq) + NaBr(aq) \rightarrow NaNO_3(aq) + AgBr(s)$$

24. The reaction shown by the equation is an example of

A addition
B combustion
C precipitation
D neutralisation.

25. Which of the following ions are spectator ions in the reaction?

A Ag^{+} and NO_3^{-}
B Na^{+} and NO_3^{-}
C Ag^{+} and Br^{-}
D Na^{+} and Br^{-}

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

Go to Answers

MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2 — 75 marks

Attempt ALL questions

1. There are many different types of glass.

Glass is made from the chemical silica, SiO_2, which is obtained from sand.

(a) Silica has a melting point of 1713 °C.

State the term used to describe the structure of silica. **1**

(b) Borosilicate glass is a type of glass that also contains the element boron.

A sample of boron contains two different types of atom.

$^{10}_{5}B$ $^{11}_{5}B$

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

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

(iii) The relative atomic mass of boron is 10·8.

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

MARKS | DO NOT WRITE IN THIS MARGIN

1. (continued)

(c) Glass that contains a minimum of 24% lead oxide is known as crystal glass.

Calculate the mass, in grams, of lead oxide in a sample of crystal glass weighing 500 g. **1**

[Turn over

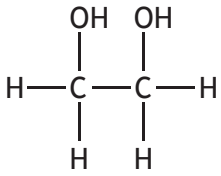
MARKS | DO NOT WRITE IN THIS MARGIN

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

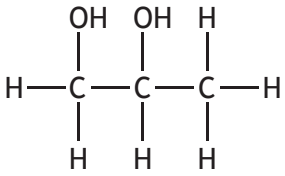
Antifreeze

Antifreeze lowers the freezing point of water. When diluted, antifreeze is used in car engines to prevent water-based liquids from freezing.

Different brands of antifreeze can contain either ethane-1,2-diol or propane-1,2-diol.

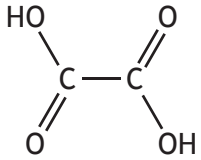


ethane-1,2-diol



propane-1,2-diol

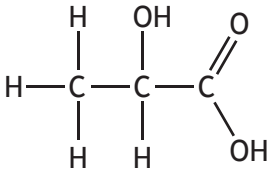
Ethane-1,2-diol is toxic if swallowed. In the liver, an enzyme converts ethane-1,2-diol into oxalic acid.



oxalic acid

The oxalic acid then reacts with calcium in the body to form calcium oxalate. Calcium oxalate is the main component of kidney stones, which can cause extreme pain.

Propane-1,2-diol is not regarded as toxic because the body breaks down the molecule to harmless lactic acid, which is also produced naturally in the body during exercise.



lactic acid

Adapted from *Education in Chemistry, May 2008, Volume 45 Number 3*

MARKS | DO NOT WRITE IN THIS MARGIN

2. (continued)

(a) Name the functional group found in both ethane-1,2-diol and propane-1,2-diol. **1**

(b) Name the type of substance used to convert ethane-1,2-diol into oxalic acid. **1**

(c) Name the salt mentioned in the passage. **1**

(d) Calculate the mass, in grams, of 1 mole of the harmless product formed, in the body, from propane-1,2-diol. **1**

[Turn over

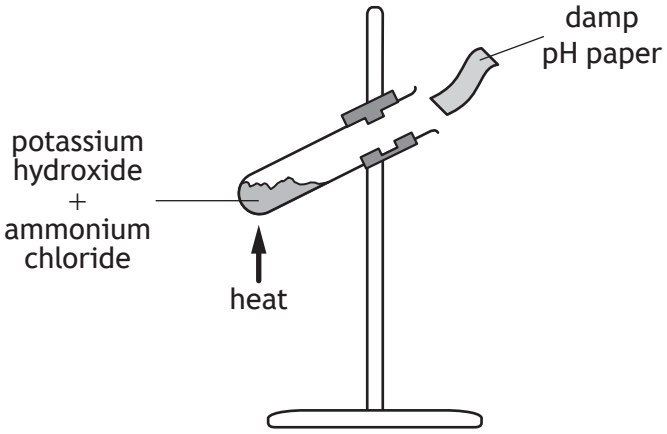
MARKS | DO NOT WRITE IN THIS MARGIN

3. Nitrogen and hydrogen react together to form ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) Draw a diagram, showing **all** outer electrons, to represent a molecule of nitrogen gas, N_2. **1**

(b) The following method can be used to prepare small quantities of ammonia in the laboratory.



Suggest what colour the damp pH paper would be after the mixture is heated. **1**

3. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(c) In industry, ammonia can be produced by the Haber process.

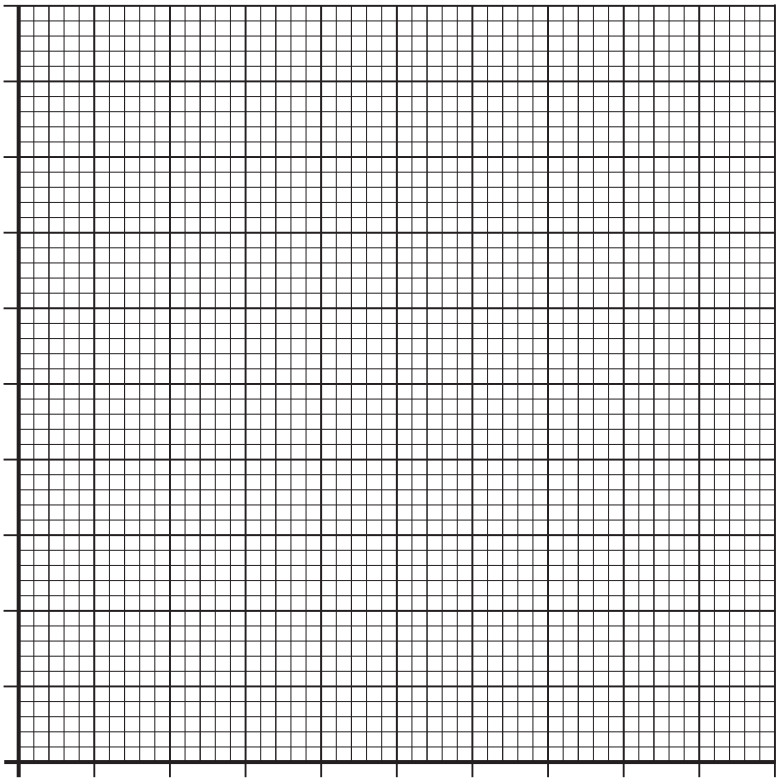
The table shows the yield of ammonia produced at different temperatures by this process.

Temperature (°C)	100	200	400	500	600	700
Percentage yield of ammonia (%)	97	87	46	28	17	10

(i) Describe the relationship between temperature and percentage yield of ammonia. **1**

(ii) Draw a graph of the percentage yield of ammonia against temperature. **4**

(Additional graph paper, if required, can be found on *page 33*.)



MARKS | DO NOT WRITE IN THIS MARGIN

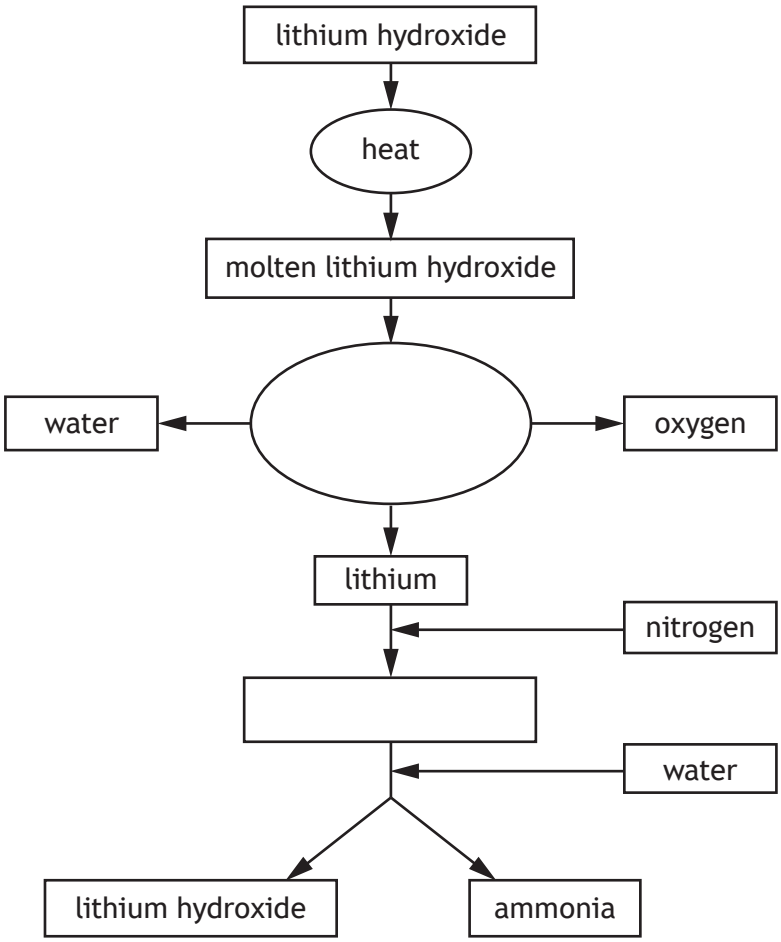
3. (continued)

(d) Scientists are developing an alternative industrial process to produce ammonia, which is more efficient than the Haber process.

This involves the electrolysis of molten lithium hydroxide to produce lithium, water and oxygen. Lithium is then reacted with nitrogen gas, which is obtained from air, to produce lithium nitride. Ammonia and lithium hydroxide are produced when lithium nitride reacts with water.

(i) Complete the flow diagram using the information above. **1**

(An additional diagram, if required, can be found on *page 34*.)



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

MARKS | DO NOT WRITE IN THIS MARGIN

4. Radioisotopes emit radiation to become more stable.

(a) State where the radioactive decay occurs in an atom. **1**

(b) Iodine-131 is a radioisotope with a half-life of 8 days and can be used in the treatment of thyroid cancer.

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

(ii) Calculate the percentage of iodine-131 that would have **decayed** after 24 days. **3**

(iii) Different concentrations of iodine-131 are used to treat different types of cancer.

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

When an iodine-131 solution is diluted,

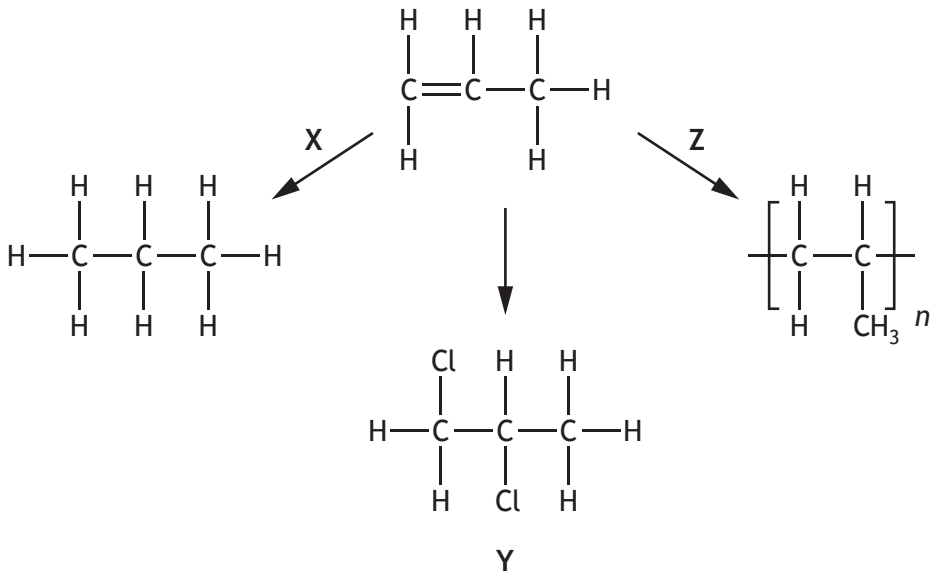
the half-life { gets longer / stays the same / gets shorter }.

MARKS | DO NOT WRITE IN THIS MARGIN

5. The alkenes are a family of unsaturated hydrocarbons.

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

(b) Propene is an alkene that can take part in a range of addition reactions.



Y

(i) Name the type of addition reaction taking place in reaction **X**. **1**

(ii) Name the chemical that reacts with propene to form compound **Y**. **1**

(iii) Name the polymer formed in reaction **Z**. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

5. (continued)

(c) The cycloalkenes are another family of unsaturated hydrocarbons.

(i) Cyclohexene can be made by reacting ethene with butadiene in a reaction called the Diels-Alder reaction as shown.

$$\underset{\text{ethene}}{C_2H_4} + \underset{\text{butadiene}}{C_4H_6} \rightarrow \underset{\text{cyclohexene}}{C_6H_{10}}$$

Calculate the mass, in grams, of ethene required to make 410 g of cyclohexene. **3**

Show your working clearly.

(ii) The table gives information about cyclopentene and cyclohexene.

Cycloalkene	Boiling point (°C)
cyclopentene	45
cyclohexene	83

Explain why cyclopentene has a lower boiling point than cyclohexene. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

6. An oxide is a compound that contains at least one oxygen atom and **only one** other element in its chemical formula.

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

MARKS | DO NOT WRITE IN THIS MARGIN

7. Paraffin wax is a mixture of hydrocarbon molecules that belong to the same homologous series.

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

(b) An example of one hydrocarbon contained in paraffin wax is $C_{25}H_{52}$.

(i) Name the homologous series to which this hydrocarbon belongs. **1**

(ii) Write the molecular formula for the molecule, containing 72 hydrogen atoms, that belongs to the same homologous series. **1**

MARKS DO NOT WRITE IN THIS MARGIN

7. (continued)

(c) The table contains information about some hydrocarbon molecules.

Number of carbon atoms	Boiling point (°C)
20	343
21	356
22	369
23	381

Predict the boiling point, in °C, of the hydrocarbon with 24 carbon atoms. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

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

Beryllium

Beryllium is a rare element in the universe. Unlike most elements it was not formed during the Big Bang or by stars. In fact, beryllium is only formed in supernova explosions.

Beryllium is found in the mineral Beryl, which has the chemical name beryllium aluminium silicate. Beryl makes up a range of glittering gemstones such as emerald and aquamarine.

In 1828 the metal beryllium was extracted from beryllium chloride ($BeCl_2$) by reacting this compound with potassium. Potassium chloride was also produced in this reaction.

In 1932 James Chadwick discovered when a sample of beryllium was bombarded with X-rays from radium, it emitted a new kind of sub-atomic particle that had mass but no charge. He called this new particle a neutron and was awarded the Nobel Prize for his work in 1935.

Adapted from *Education in Chemistry, November 2015, Volume 52, Issue 6*

(a) State where beryllium is formed. **1**

(b) Name the elements found in the mineral Beryl. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

8. (continued)

(c) Write an equation, using symbols and formulae, to show the reaction taking place when beryllium is extracted from beryllium chloride.

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

(d) During the extraction of beryllium, the beryllium ions are changed to beryllium atoms.

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

(e) Write the nuclide notation for the sub-atomic particle discovered by James Chadwick in 1932. **1**

[Turn over

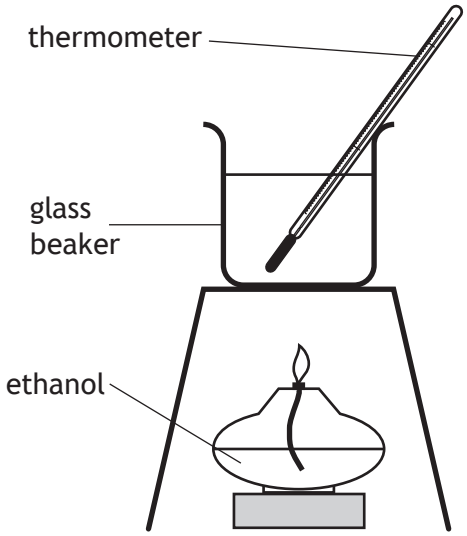
MARKS | DO NOT WRITE IN THIS MARGIN

9. Alcohols can take part in different types of chemical reaction.

(a) When alcohols are burned, heat energy is released.

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

(b) A student carried out the following experiment.



(i) When 0·8 g of ethanol was burned, 8·36 kJ of energy was absorbed by the water.

If the temperature of the water increased by 40 °C, calculate the mass, in kg, of water used by the student in this experiment. **3**

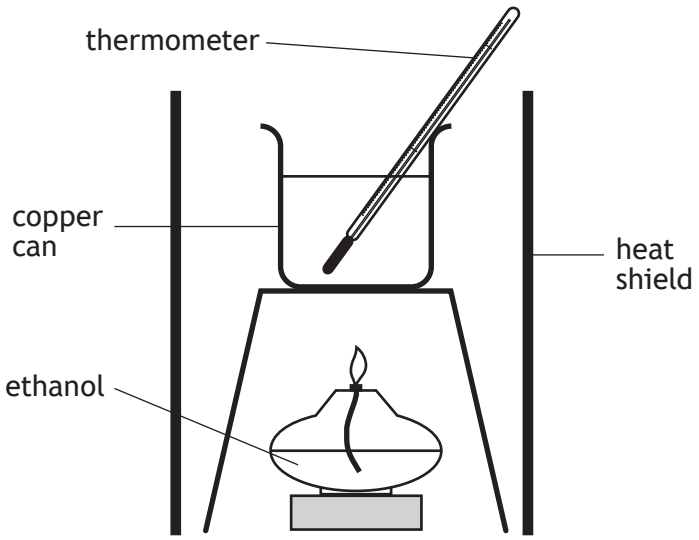
You may wish to use the data booklet to help you.

Show your working clearly.

MARKS DO NOT WRITE IN THIS MARGIN

9. (b) (continued)

(ii) The experiment was repeated, replacing the glass beaker with a copper can and using a heat shield.



Explain why these changes resulted in more heat energy being absorbed by the water. **2**

Improvement	Explanation
Use of a copper can	
Use of a heat shield	

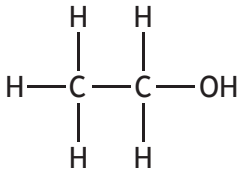
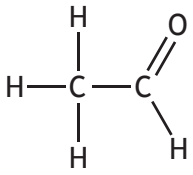
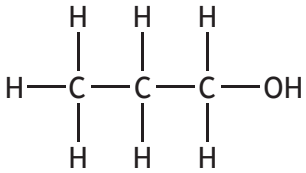
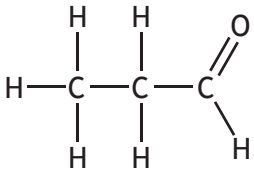
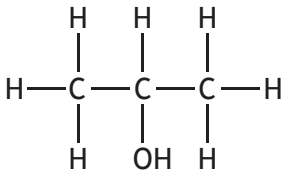
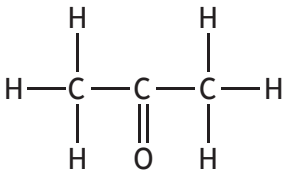
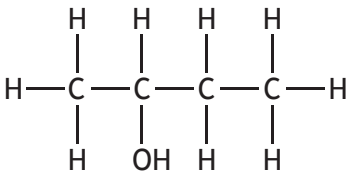
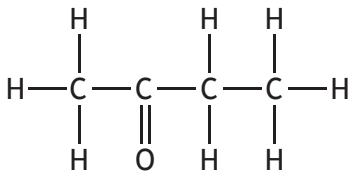
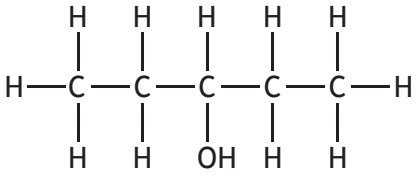
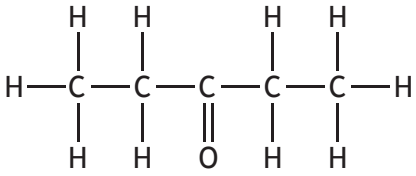
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(c) Alcohols can react with hot copper(II) oxide.

Depending on the structure of the alcohol used, the product will be either an aldehyde or a ketone.

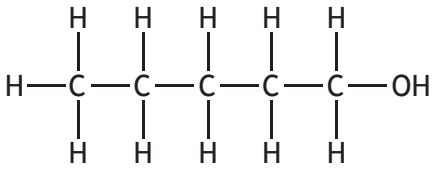
Structural formula of alcohol	Type of product	Structural formula of product
	aldehyde	
	aldehyde	
	ketone	
	ketone	
	ketone	

(i) Write a general statement linking the position of the functional group in an alcohol to the **type** of product formed. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

9. (c) (continued)

(ii) The following alcohol reacts with hot copper(II) oxide to produce an aldehyde.

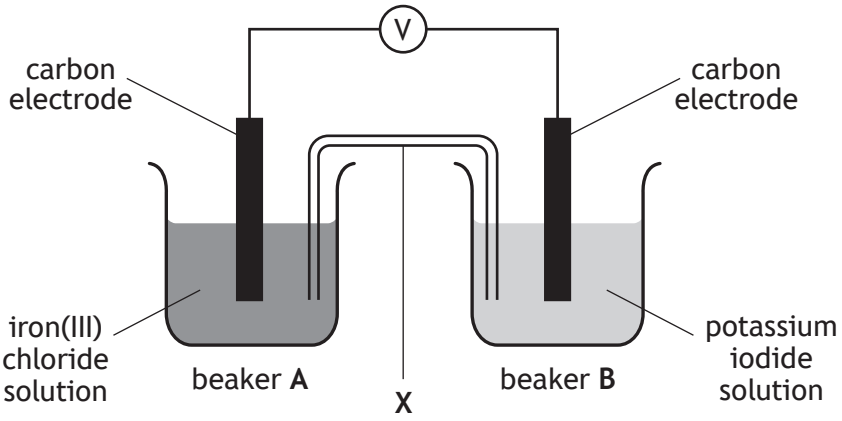


Draw the full structural formula for the aldehyde produced when this alcohol reacts with hot copper(II) oxide. **1**

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

10. A student set up an electrochemical cell using solutions of iron(III) chloride and potassium iodide.



The reactions taking place are

beaker **A** $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$

beaker **B** $2I^-(aq) \rightarrow I_2(\ell) + 2e^-$

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

(b) (i) **On the diagram**, draw an arrow to show the path and direction of electron flow. **1**

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

(ii) Name the type of chemical reaction taking place in beaker **B**. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

10. (b) (continued)

(iii) Write the redox equation for the overall reaction. **1**

(c) Carbon in the form of graphite is a suitable material for use as an electrode as it does not react with the solutions.

Suggest another reason why it is a suitable material. **1**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

11. A student was asked to prepare the soluble compound, calcium propanoate.

A section of the procedure used by the student is shown.

Preparation of calcium propanoate

Procedure

1. Using a measuring cylinder add 20 cm^3 of dilute acid to a beaker.
2. Add a spatulaful of calcium carbonate to the acid and stir the reaction mixture with a glass rod.
3. Continue adding the calcium carbonate until . . .

(a) Write the formula, showing the charge on each ion, for calcium carbonate. **1**

(b) Name the acid used to prepare calcium propanoate. **1**

(c) Complete the instruction for step 3 of the procedure. **1**

Continue adding the calcium carbonate until . . .

(d) After step 3 has been completed a further two techniques are carried out to prepare a dry sample of calcium propanoate.

Name the two techniques, in the correct order, that must be carried out. **1**

1st technique _____

2nd technique _____

MARKS | DO NOT WRITE IN THIS MARGIN

12. A student carried out a titration experiment to calculate the concentration of a solution of hydrochloric acid.

(a) Before the titration was carried out the student prepared a 200 cm^3 solution of sodium carbonate.

This solution had an accurate concentration of 1·0 mol l^{-1}.

(i) State the term given to a solution of accurately known concentration. **1**

(ii) Calculate the mass, in grams, of sodium carbonate, Na_2CO_3, required to prepare 200 cm^3 of 1·0 mol l^{-1} solution. **3**

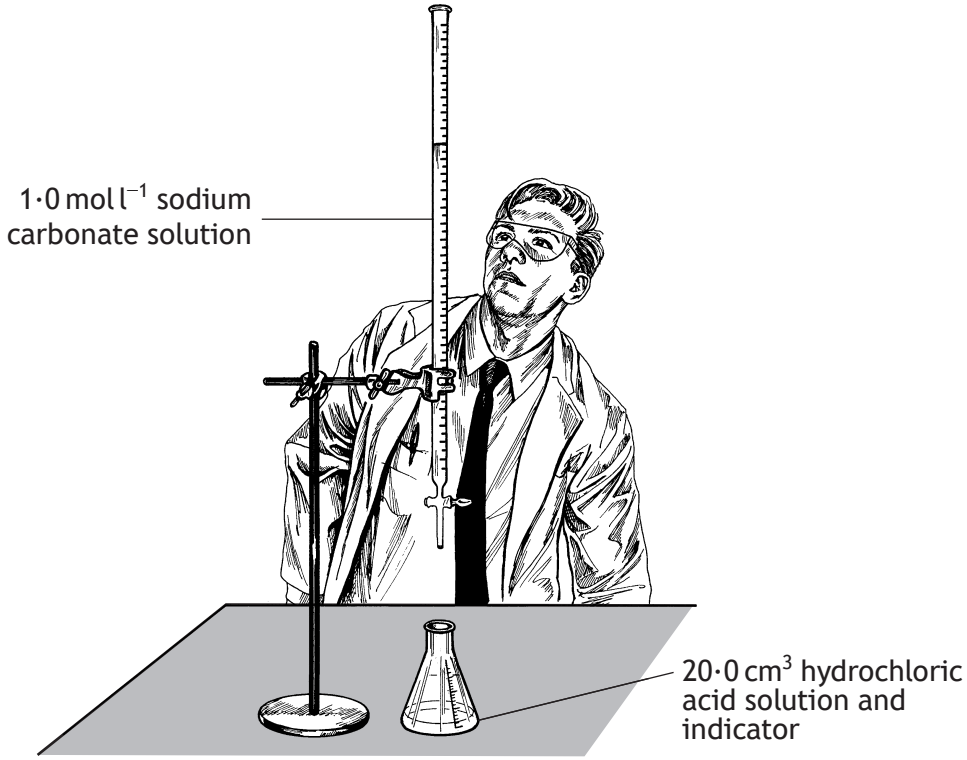
Show your working clearly.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

(b) The student performed the titration as shown.



(i) Suggest one improvement to the student's experimental technique. **1**

(ii) State why an indicator is used. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

12. (continued)

(iii) The average volume of sodium carbonate used was 15·0 cm^3.

To calculate the average volume of sodium carbonate used, the student only used titre volumes within 0·2 cm^3 of each other.

State the term used to describe these titre volumes. **1**

(iv) The equation for the reaction is

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(\ell) + CO_2(g)$$

Calculate the concentration, in mol l^{-1}, of the hydrochloric acid solution. **3**

Show your working clearly.

[Turn over for next question

MARKS | DO NOT WRITE IN THIS MARGIN

13. The force of attraction between oppositely charged particles is important in chemistry.

Using your knowledge of chemistry, explain why this force of attraction is important. **3**

[END OF QUESTION PAPER]

National Qualifications 2019

2019 Chemistry

National 5

Finalised Marking Instructions

These marking instructions have been prepared by examination teams for use by SQA appointed markers when marking external course assessments.

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Marking instructions for each question

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

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Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)		(Covalent) Network	**1**	Award zero marks for - covalent on its own.
	(b)	(i)	Isotope(s)	**1**	
		(ii)	Different number of neutrons **OR** One atom has 5 neutrons and one atom has 6 neutrons (both numbers must be given) **OR** More/less neutrons	**1**	Award zero marks for -different mass in the nucleus -different number of particles in the nucleus
		(iii)	11 / ^{11}B / $^{11}_{5}B$	**1**	
	(c)		120 (g)	**1**	Unit is not required however zero marks are awarded for the correct value with an incorrect unit. This marking instruction must only be applied a maximum of once per paper.
2.	(a)		Hydroxyl	**1**	Award zero marks for – OH however this does not negate the correct answer.
	(b)		Enzyme	**1**	Accept (Biological) Catalyst.
	(c)		Calcium oxalate	**1**	
	(d)		90 (g)	**1**	Unit is not required however zero marks are awarded for the correct value with an incorrect unit. This marking instruction must only be applied a maximum of once per paper.

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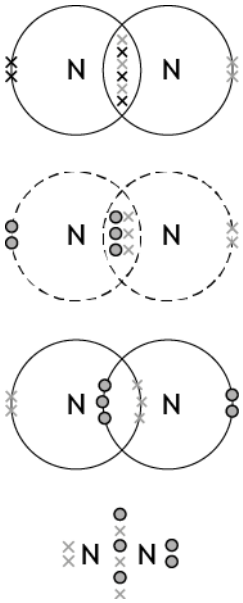
Question			Expected response	Max mark	Additional guidance
3.	(a)		Must show all outer electrons  	**1**	Accept cross or dot or e or e- to represent electrons or a mixture of these. Accept petal diagram. Bonding electrons MUST be on the line or in the overlapping area. Element symbols do not need to be shown. If inner electrons are shown they must be correct.
	(b)		Blue/purple	**1**	Any colour that clearly represents an alkaline pH is acceptable.
	(c)	(i)	As the temperature increases yield/% decreases. As the temperature decreases the yield/% increases. The yield/% increases as the temperature decreases. The yield/% decreases as the temperature increases.	**1**	Award zero marks for wrong cause and effect eg as yield of ammonia decreases, temperature gets higher etc.

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Question			Expected response	Max mark	Additional guidance
3.	(c)	(ii)	For appropriate format: points (not bars) **(1 mark)** The axis/axes of the graph has/have suitable scale(s). 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)** The axes of the graph have suitable labels and units **(1 mark)** 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. For bar graphs, this mark is awarded for the selection of a suitable scale for percentage yield of ammonia only. Spelling mistakes or the use of abbreviations should not be penalised if the meaning of an axis label may be clearly understood. 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. 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.
	(d)	(i)	Electrolysis and lithium nitride Both required for **(1 mark)**	**1**	

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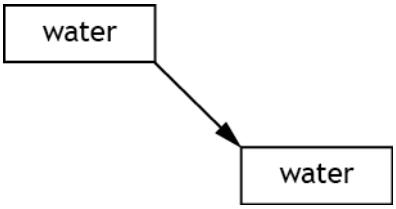
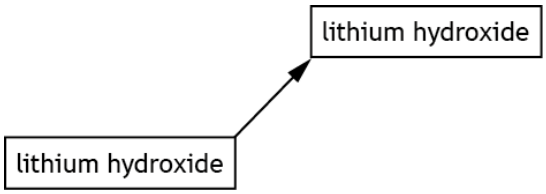
Question			Expected response	Max mark	Additional guidance
		(ii)	Arrow from water at top to water at bottom OR to the vertical line beneath the 'lithium nitride' box.  **OR** Arrow from lithium hydroxide at bottom to lithium hydroxide OR heat at top OR to the vertical line between lithium hydroxide and heat.  	**1**	Direction of arrow must be shown. Arrow to "molten lithium hydroxide" or the vertical line between "heat" and "molten lithium hydroxide" is awarded zero marks.

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Question			Expected response	Max mark	Additional guidance
4.	(a)		Nucleus	**1**	
	(b)	(i)	The time for half of the mass/ (radio)activity/nuclei to decay	**1**	Radiation acceptable in place of radioactivity. Any mention of reactivity – zero marks.
		(ii)	87·5% / 0·875 / $\frac{7}{8}$ **(3 marks)** --- Partial marking 3 half-lives **(1 mark)** **OR** Correct percentage or fraction left for a correct number of half-lives. **(2 mark)** **OR** Correct percentage or fraction left for an incorrect number of half-lives. Working must be shown. **(1 mark)** **OR** Correct percentage or fraction decayed with incorrect number of half-lives. Working must be shown. **(2 marks)**	**3**	If a candidate does not demonstrate the application of half-lives they cannot access the final mark for calculating the percentage/fraction decayed. eg $\frac{8}{24}$ x 100 = 33·3% 100 – 33·3 = 66·7% Zero marks.
		(iii)	When an iodine-131 solution is diluted, the half-life { gets longer / **stays the same** / gets shorter }	**1**	

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Question			Expected response	Max mark	Additional guidance
5.	(a)		Bromine/Br_2 decolourised **OR** bromine/Br_2 goes colourless	**1**	Accept bromine/bromine water/ bromine solution but do **not** accept bromide or Br. Zero marks awarded for 'goes clear' however if given in addition to a correct answer it does not negate. If starting colour is given it must be correct eg orange/yellow/red-brown or brown. If candidate states correct answer followed by incorrect statement such as because it has a carbon to carbon single bond zero marks are awarded.
	(b)	(i)	Hydrogenation	**1**	
		(ii)	Chlorine/Cl_2	**1**	Award zero marks for Cl or chloride
		(iii)	Polypropene/Poly(propene)	**1**	Accept polypropylene

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Question			Expected response	Max mark	Additional guidance
5.	(c)	(i)	140 (g) **(3 marks)** --- Partial marks Both GFMs ie 28 and 82 **(1 mark)** **OR** Moles of cyclohexene ie (410÷82) = 5 mol **(1 mark)** --- 1 concept mark for either: $410 \times \frac{\text{Candidate's GFM of ethene}}{\text{Candidate's GFM of cyclohexene}}$ **(1 mark)** **OR** Moles of cyclohexene × Candidate's GFM of ethene **(1 mark)** Where the candidate has been awarded either concept mark, a further mark can be awarded for correct follow through to a final answer **(1 mark)**	**3**	Rounding in intermediate steps does not negate the award of 3 marks but working must be shown. 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. **Award zero marks if the candidate's working does not use cyclohexene.** A maximum of two marks can be awarded where the candidate has carried out the calculation using **cyclohexene** and butadiene provided working is shown. An incorrect GFM, with no working shown, cannot be used to gain the concept mark and therefore arithmetical follow through cannot be accessed.

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Question			Expected response	Max mark	Additional guidance
5.	(c)	(ii)	(Cyclopentene) has smaller/weaker/ less forces (of attraction) **(1 mark)** Between molecules or mention of intermolecular attractions **(1 mark)** If neither of these two points are given, a maximum of 1 mark can be awarded for – cyclopentene is smaller/has fewer carbons or hydrogens or atoms/smaller carbon chain	**2**	The term bond is only acceptable if it is specifically identified as between the molecules or used with the term intermolecular. Mention of breaking: - (more) bonds - bonds within molecule/chain - carbon to carbon bonds - carbon to hydrogen bonds cannot gain the second mark but does not negate the first mark. Fewer bonds in the compound is not sufficient to imply a smaller molecule but does not negate. Candidates can be awarded the full/partial marks if they explain why the cyclohexene has a higher boiling point. It must be clear from the candidate's response that they are referring to cyclohexene.

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Question			Expected response	Max mark	Additional guidance
6.			This is an open ended question **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. **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. **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	

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Question			Expected response	Max mark	Additional guidance
7.	(a)		They have the same general formula **AND** similar/same chemical properties Both required for **(1 mark)**	**1**	Award zero marks for - molecular formula - structural formula - chemical formula Award zero marks for - physical properties in place of chemical properties however, it does not negate if given in addition to chemical properties.
	(b)	(i)	Alkane	**1**	
		(ii)	C_{35} H_{72}	**1**	Numbers must be smaller than symbol or subscript Symbols must be correct Zero marks awarded for: C35 H72 c_{35} H_{72} C35 h72 c35 h72
	(c)		Accept 391 to 394 inclusive.	**1**	Unit is not required; however zero marks are awarded for the correct value with an incorrect unit. This marking instruction must only be applied a maximum of once per paper.
8.	(a)		Supernova (explosions)	**1**	
	(b)		Beryllium, aluminium, silicon and oxygen Be/Al/Si/O All 4 required for **(1 mark)**	**1**	Accept O_2 and loose spelling of element names.
	(c)		$BeCl_2 + K \longrightarrow Be + KCl$	**1**	Equation does not need to be balanced but if balanced it must be correct: $BeCl_2 + 2K \rightarrow Be + 2KCl$
	(d)		Reduction	**1**	Redox not acceptable
	(e)		$^{1}_{0}\mathbf{n}$	**1**	Do not accept $^{1}_{0}N$, $^{1}\mathbf{n}$ $^{1}\mathbf{neutron}$

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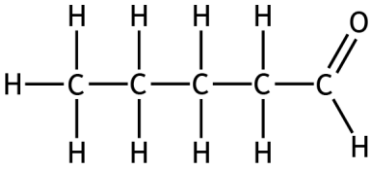
Question			Expected response	Max mark	Additional guidance
9.	(a)		Exothermic/exothermal	**1**	Do not accept combustion.
	(b)	(i)	0·05 (kg) **(3 marks)** --- Partial marking Using the correct concept of $m = \frac{E_h}{c\Delta T}$ with c=4·18 **(1 mark)** (To be awarded this concept mark candidates do not have to specifically write $m = \frac{E_h}{c\Delta T}$.) For values 8·36 **and** 40 **(1 mark)** 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)**	**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. 8360 and 4180 can be used to together in the calculation. 8360 and 40 can be awarded one mark provided c = 4180.
		(ii)	Copper can: copper is a better conductor (of heat) (than glass) **(1 mark)** Heat shield: prevent/less heat loss (to the surroundings) or insulate the experiment. **(1 mark)**	**2**	These two marks are independent of each other. A comparison of energy transfer to the water must be made however zero marks are awarded for a comparison in terms of easier/ quicker/faster. Link must be made to heat/energy.
	(c)	(i)	If the OH/functional group is at the end/start/carbon number 1 (of the alcohol), an aldehyde is produced. **OR** If the OH/functional group is not at the end/in the middle (of an alcohol), a ketone is produced.	**1**	
		(ii)		**1**	

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Question			Expected response	Max mark	Additional guidance
10.	(a)		Ion bridge/salt bridge	**1**	
	(b)	(i)	From right to left either on the wire or nearer the wire/voltmeter than the ion-bridge.	**1**	Zero marks awarded if – arrow goes into solution – arrow is drawn on wire and ion bridge – arrow is drawn closer to the ion bridge than the wire/voltmeter
		(ii)	Oxidation	**1**	
		(iii)	$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$	**1**	Accept correct multiples. Zero marks awarded for -electrons shown in the equation, unless clearly scored out. State symbols are not required and should be ignored.
	(c)		Conducts (electricity)	**1**	Additional correct properties do not negate. Accept a correct description of electrical conductivity eg electrons free to move or has delocalised electrons.

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Question			Expected response	Max mark	Additional guidance
11.	(a)		$Ca^{2+}CO_3^{2-}$	**1**	
	(b)		Propanoic acid.	**1**	Accept propaneoic or propionic acid.
	(c)		until… no more solid reacts/until it no longer reacts solid remains/is left (at the bottom of the beaker) a gas is no longer produced no more fizzing/bubbling no more calcium carbonate reacts/ calcium carbonate left (at the bottom) neutral/neutralised **with a description of testing pH**.	**1**	Award zero marks for - any mention of dissolving - saturated solution neutral/neutralised on its own – zero marks.
	(d)		1st technique - Filtration 2nd technique - Evaporation Both required in correct order for one mark.	**1**	Accept a correct description of filtration. Do not accept 'use filter paper' on its own as a description of filtration. Accept heat it/warm it/boil it/leave by a window/leave for some time/ distillation. The term 'dry' for the 2nd technique is awarded zero marks but does not negate a correct answer.

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Question			Expected response	Max mark	Additional guidance
12.	(a)	(i)	Standard (solution)	**1**	
		(ii)	21·2 or 21 (g) **(3 marks)** Partial Marks can be awarded for a maximum of two of the following three steps: 1 mark for correctly calculating the number of moles of sodium carbonate. ie n = CV = 1 x 0·2 = 0·2 mol **(1 mark)** 1 mark for correctly calculating the GFM of sodium carbonate ie GFM = 106 **(1 mark)** 1 mark for calculating the mass of sodium carbonate ie m = n x GFM using candidates calculated moles of sodium carbonate and candidates calculated GFM **(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. **An incorrect number of moles or GFM of sodium carbonate must be supported by working.**
	(b)	(i)	Any from: Move burette/sodium carbonate (reading) to eye level. Reduce distance between flask and burette Use white tile/paper Clamp the burette towards the centre.	**1**	Award zero marks for - repeat the experiment
		(ii)	To show the end-point/point of neutralisation/completion of the reaction	**1**	
		(iii)	Concordant	**1**	

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Question			Expected response	Max mark	Additional guidance
12.	(b)	(iv)	1·5 (mol l^{-1}) **(3 marks)** --- **Partial marks can be awarded for a maximum of two of the following three steps:** **<u>Method A</u>** 1 mark for the correct number of moles of sodium carbonate. ie n = CV = 1 × 0·015 = 0·015 mol **(1 mark)** 1 mark for calculating the moles of hydrochloric acid by correctly applying the molar ratio ie 2 x candidate's calculated number of moles of Na_2CO_3 **(1 mark)** 0·03 mol HCl on its own **(2 marks)** 1 mark for calculating the concentration of the hydrochloric acid. ie C = n/V using candidate's calculated number of moles of HCl and 0·02 **(1 mark)** --- **<u>Method B</u>** $\frac{C_1 \times 20}{2} = \frac{1 \times 15}{1}$ **(1 mark)** **(1 mark)** $C_1 \times 20 = 30$ or $C_1 \times 10 = 15$ (this step on its own gets 2 marks) **Or** $\frac{C_1 \times 0{\cdot}02}{2} = \frac{1 \times 0{\cdot}015}{1}$ **(1 mark)** **(1 mark)** C_1x 0·02 = 0·03 (this step on its own gets 2 marks)	**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. Accept mol l^{-1} or mol/l but not mol/l^{-1} or mol^{-1} or mol l **Award zero marks if the candidate's working makes it clear that they have not used sodium carbonate.** If candidate does not attempt to calculate the number of moles of Na_2CO_3 then partial marks can be awarded for applying the molar ratio using 1 mol of sodium carbonate requires 2 moles of hydrochloric acid and/or using 2 moles of hydrochloric acid and V=0·02. ie 1:2 (1 mark) 2/0·02 = 100 (1 mark) For method B using relationship shown in the data book 1 mark is awarded for the correct pairings of volume (in the same unit) and concentration. 1 mark is awarded for the correct mole ratio **being applied**. 1 mark is awarded for the correct arithmetic. This mark can only be awarded if an appropriate method has been used.

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Question			Expected response	Max mark	Additional guidance
13.			**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. **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. **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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