Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2244180806

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2022**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

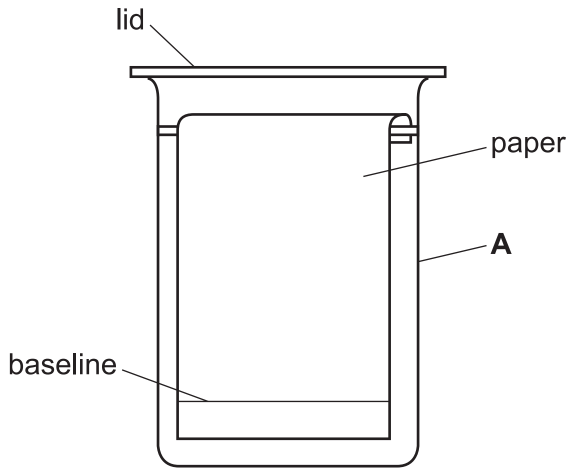
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

1 A mixture of three coloured compounds was separated using the apparatus shown in the diagram.



(a) Give the name of the item of apparatus labelled **A**.

.... [1]

(b) One drop of the mixture of coloured compounds was placed on the paper and some solvent was poured into **A**.

Draw **on the diagram**:

- a spot (●) to show where the drop of the mixture of coloured compounds should be placed on the paper at the start of the experiment
- a line to show the level of the solvent in **A** at the start of the experiment.

[2]

(c) Name an item of apparatus that should be used to place a drop of the mixture of coloured compounds onto the paper.

.... [1]

(d) State when the paper should be removed from the solvent in **A**.

.... [1]

(e) Name this method of separation of coloured compounds.

.... [1]

[Total: 6]

2 A student investigated the temperature change when two different aqueous solutions of sodium hydroxide, solution **G** and solution **H**, reacted with dilute hydrochloric acid.

Two experiments were done.

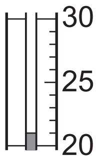
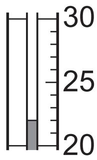
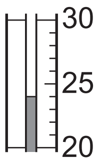
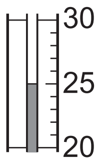
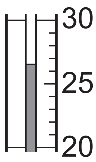
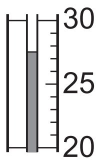
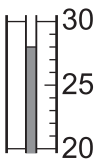
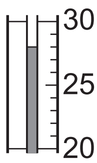
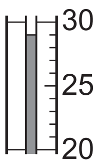
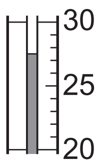
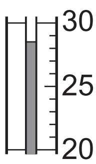
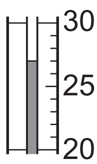
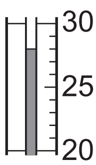
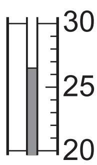
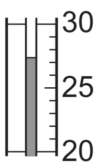
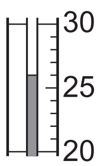
(a) *Experiment 1*

- A burette was rinsed with distilled water and then with dilute hydrochloric acid.
- The burette was filled with the dilute hydrochloric acid. The hydrochloric acid was then run out through the tap until the level was on the 0.00 cm^3 mark.
- A 50 cm^3 measuring cylinder was used to pour 20 cm^3 of solution **G** into a beaker.
- A thermometer was used to measure the initial temperature of solution **G**.
- 5 cm^3 of dilute hydrochloric acid was added from the burette into the beaker.
- The mixture in the beaker was stirred using the thermometer and the temperature of the mixture was measured.
- Another 5 cm^3 of dilute hydrochloric acid was added from the burette into the beaker.
- The mixture in the beaker was stirred using the thermometer and the temperature of the mixture was measured.
- 5 cm^3 portions of dilute hydrochloric acid continued to be added and the temperature measured until a total of 35 cm^3 of dilute hydrochloric acid had been added.

Experiment 2

- Experiment 1 was repeated using solution **H** instead of solution **G**.

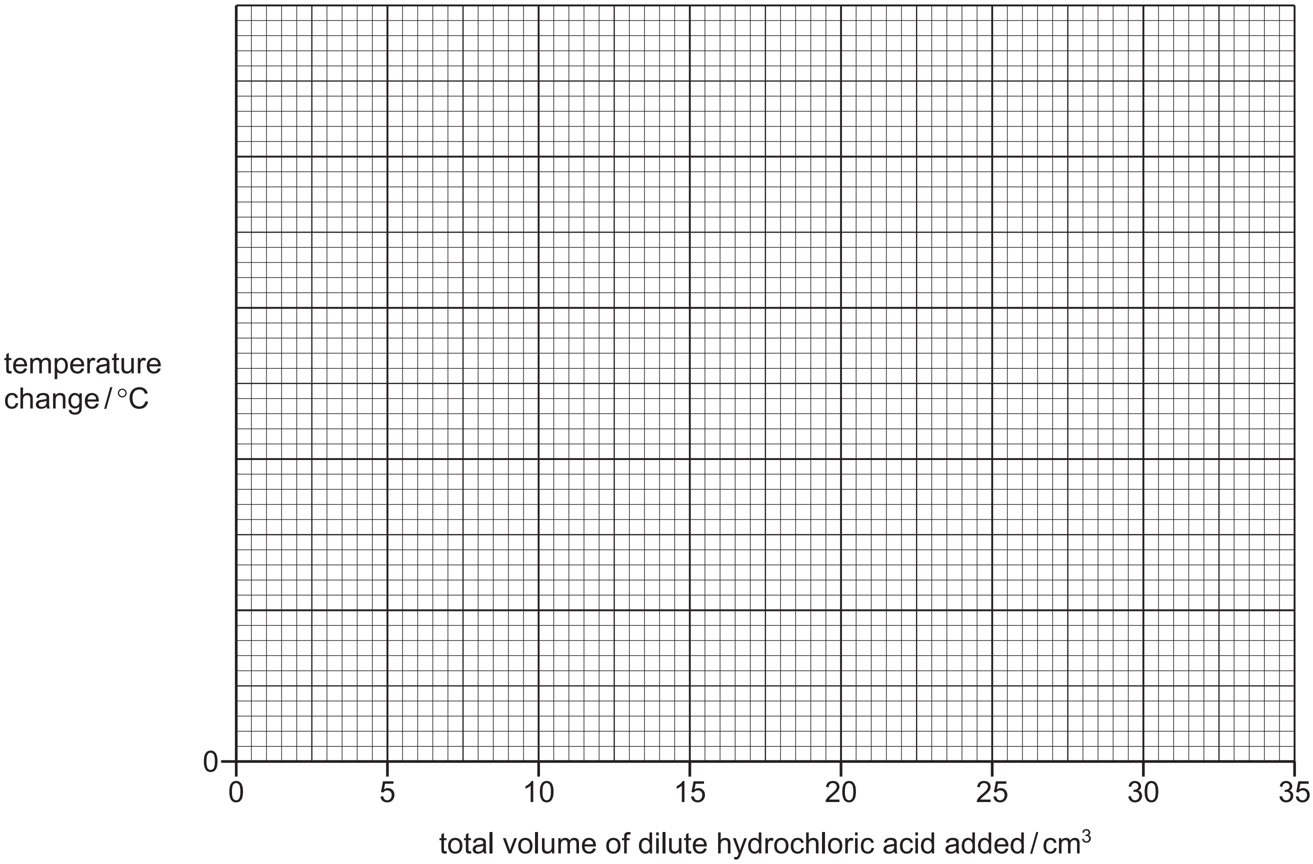
Use the thermometer diagrams to complete the table.

	Experiment 1 using solution **G**			Experiment 2 using solution **H**		
total volume of dilute hydrochloric acid added / cm^3	thermometer diagram	temperature / °C	temperature change since start / °C	thermometer diagram	temperature / °C	temperature change since start / °C
0						
5						
10						
15						
20						
25						
30						
35						

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 and 2 on the grid.

Draw two smooth line graphs. Both curves must start at (0,0). Clearly label your lines.



[5]

(c) **From your graph**, deduce the temperature change obtained when a total volume of 13 cm^3 of dilute hydrochloric acid is added in Experiment 1.

Show clearly **on the grid** how you worked out your answer.

temperature change = ... °C [2]

(d) Explain why the temperature change decreases towards the end of each experiment.

....

.... [1]

(e) Explain what conclusion about the concentrations of solution **G** and solution **H** can be made from the results of Experiments 1 and 2.

....

....

....

.... [2]

(f) Explain how the results obtained would be different if a polystyrene cup is used instead of the beaker.

....

....

....

.... [2]

(g) Give an advantage and a disadvantage of using a burette rather than a measuring cylinder to add the dilute hydrochloric acid to solution **G** and solution **H**.

advantage ....

....

disadvantage ....

....

[2]

[Total: 19]

3 Solid **I** and solid **J** were analysed.
Tests were done on each substance.

tests on solid I

tests	observations
test 1 Dilute hydrochloric acid was added to a boiling tube containing solid **I**. Any gas produced was tested.	effervescence was seen, the solid dissolved to form a colourless solution the gas turned limewater milky
test 2 A flame test was carried out on the solution formed in **test 1**.	a red flame was seen

(a) Identify the gas made in **test 1**.

.... [1]

(b) Identify solid **I**.

....

.... [2]

tests on solid J

Solid **J** was aluminium chloride.

Solid **J** was dissolved in water to form solution **J**. Solution **J** was divided into four approximately equal portions in four test-tubes.

(c) Aqueous sodium hydroxide was added dropwise and then in excess to the first portion of solution **J**.

observations ....

.... [2]

(d) Aqueous ammonia was added dropwise and then in excess to the second portion of solution **J**.

observations ....

.... [2]

(e) About 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the third portion of solution **J**.

observations .... [1]

(f) About 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the fourth portion of solution **J**.

observations .... [1]

[Total: 9]

4 Hydrogels are powders that absorb water to form hydrated solids. Hydrogels and the hydrated solids formed are insoluble in water.

Plan an investigation to find which hydrogel, **hydrogel A** or **hydrogel B**, is able to absorb the greater mass of water.

You are provided with samples of **hydrogel A**, **hydrogel B**, water and common laboratory apparatus.

[6]

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Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	beaker	**1**
1(b)	**M1** '•' shown anywhere on base line	**1**
	M2 horizontal line drawn between bottom of paper and baseline. Line must not touch spot drawn on baseline or the baseline	**1**
1(c)	(dropping / teat) pipette / capillary tube / glass rod	**1**
1(d)	when the solvent is near the top of the paper	**1**
1(e)	(paper) chromatography	**1**

Question	Answer	Marks
2(a)	**M1** all eight temperatures recorded for Experiment 1 correct (21.0, 24.0, 26.5, 28.0, 29.0, 28.5, 28.0, 27.5)	**1**
	M2 all eight temperatures recorded for Experiment 2 correct (22.0, 25.0, 27.5, 28.0, 27.5, 27.0, 26.5, 26.0)	**1**
	M3 all 7 temperature changes in Experiment 1 calculated correctly (3.0, 5.5, 7.0, 8.0, 7.5, 7.0, 6.5)	**1**
	M4 all 7 temperature changes in Experiment 2 calculated correctly (3.0, 5.5, 6.0, 5.5, 5.0, 4.5, 4.0)	**1**
	M5 all temperature changes recorded to one decimal place	**1**
2(b)	**M1** y-axis scale in linear with scale of 2 cm = 2 °C	**1**
	M2 all points for Experiment 1 plotted correctly. (0,0) not required	**1**
	M3 all points for Experiment 2 plotted correctly. (0,0) not required	**1**
	M4 two acceptable smooth curves drawn which are both extended to (0,0)	**1**
	M5 lines labelled or key	**1**

Question	Answer	Marks
2(c)	**M1** correct working shown on graph for 13 cm^3 of acid to Experiment 1 line	**1**
	M2 correct reading from their working shown on graph	**1**
2(d)	excess / too much (hydrochloric) acid **or** reaction over / stopped / finished / all NaOH / G / H has been used up	**1**
2(e)	**M1** solution **G** is more concentrated (than solution **H)**	**1**
	M2 as maximum temperature change higher in Experiment 1 OR **M2 (**maximum temperature change) needs more (hydrochloric acid) in Experiment 1	**1**
2(f)	**M1** temperature (changes) higher	**1**
	M2 as less heat lost / polystyrene is a (better) insulator	**1**
2(g)	**advantage:** (burette is) (more) accurate / precise	**1**
	disadvantage: slow / takes more time (to add) / can overshoot required volume	**1**

Question	Answer	Marks
3(a)	carbon dioxide / CO_2	**1**
3(b)	lithium / Li^+	**1**
	carbonate / CO_3^{2-}	**1**
3(c)	**M1** white precipitate	**1**
	M2 dissolves	**1**

Question	Answer	Marks
3(d)	**M1** white precipitate	**1**
	M2 remains / does not redissolve / no change	**1**
3(e)	no change / (remains) colourless	**1**
3(f)	white precipitate	**1**

Question	Answer	Marks
4	**any 6 from** mass increase method **MP1** known / stated / find mass of hydrogel **MP2** repeat experiment for second hydrogel **MP3** add **excess** water **MP4** stir / mix with water **MP5** filter (to obtain solid hydrogel / excess water) **MP6** weigh hydrogel **MP7** mass of water absorbed = final mass – initial mass **OR** add gradually method **MP1** known / stated / find mass of hydrogel **MP2** repeat experiment for second hydrogel **MP3** add water gradually to hydrogel **MP4** stir / mix **MP5** until no more absorbed **MP6** find mass of hydrated hydrogel **MP7** mass of water absorbed = final mass – initial mass **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4647823607

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2022**

1 hour

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No additional materials are needed.

INSTRUCTIONS

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- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

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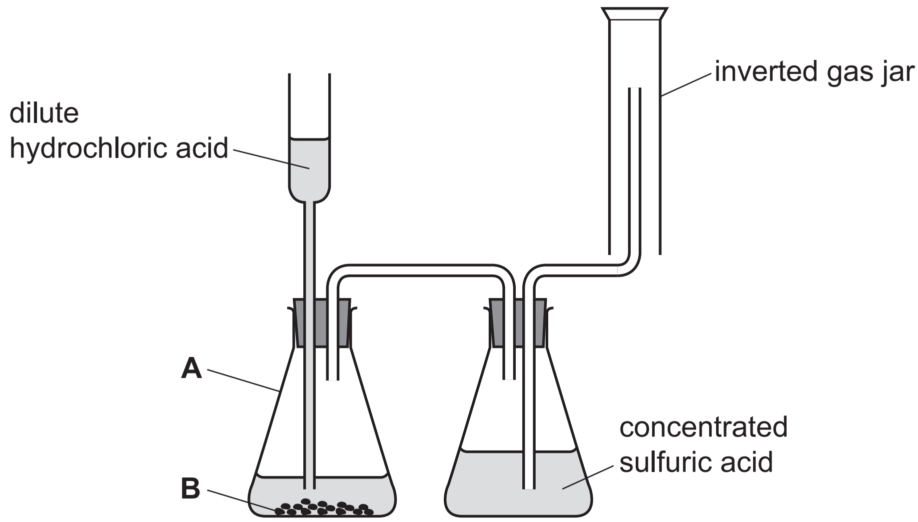
1 Sulfur dioxide gas is toxic, denser than air and soluble in water. Sulfur dioxide gas can be made by adding dilute hydrochloric acid to solid sodium sulfite and heating the mixture. The gas made can be dried by passing it through concentrated sulfuric acid.

The diagram shows the apparatus a student used to try and collect some dry sulfur dioxide gas. There are **two** errors in the way the apparatus has been set up.



(a) Indicate with an arrow **on the diagram** where heat should be applied. [1]

(b) Give the name of the item of apparatus labelled **A**.

.... [1]

(c) Give the name of the substance labelled **B**.

.... [1]

(d) Suggest why this experiment should be carried out in a fume cupboard.

....

.... [1]

(e) Identify the **two** errors in the way the apparatus has been set up.

1 ....

....

2 ....

.... [2]

[Total: 6]

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2 A student investigated how the solubility of sodium sulfate in water changes with temperature.

Eight experiments were done.

Experiment 1

- The mass of an empty evaporating basin was found.
- An excess of solid sodium sulfate was placed in a beaker.
- 100 cm^3 of cold water was added to the beaker.
- The mixture in the beaker was stirred and heated until it had reached a temperature of 15 °C. Some of the sodium sulfate had dissolved to form a saturated solution.
- A 25.0 cm^3 portion of the saturated solution was removed from the beaker and transferred to the evaporating basin.
- The evaporating basin was heated until no more steam could be seen and solid sodium sulfate remained in the evaporating basin.
- The mass of the evaporating basin and the solid sodium sulfate remaining was found.

Experiment 2

- Experiment 1 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 1.

Experiment 3

- Experiment 2 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 2.

Experiment 4

- Experiment 3 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 3.

Experiment 5

- Experiment 4 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 4.

Experiment 6

- Experiment 5 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 5.

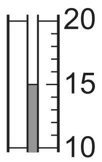
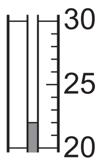
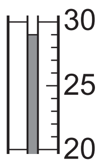
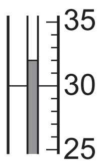
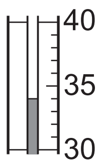
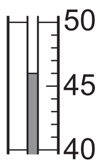
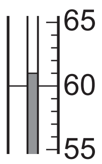
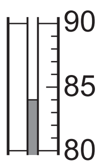
Experiment 7

- Experiment 6 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 6.

Experiment 8

- Experiment 7 was repeated but the mixture in the beaker was heated to a higher temperature than in Experiment 7.

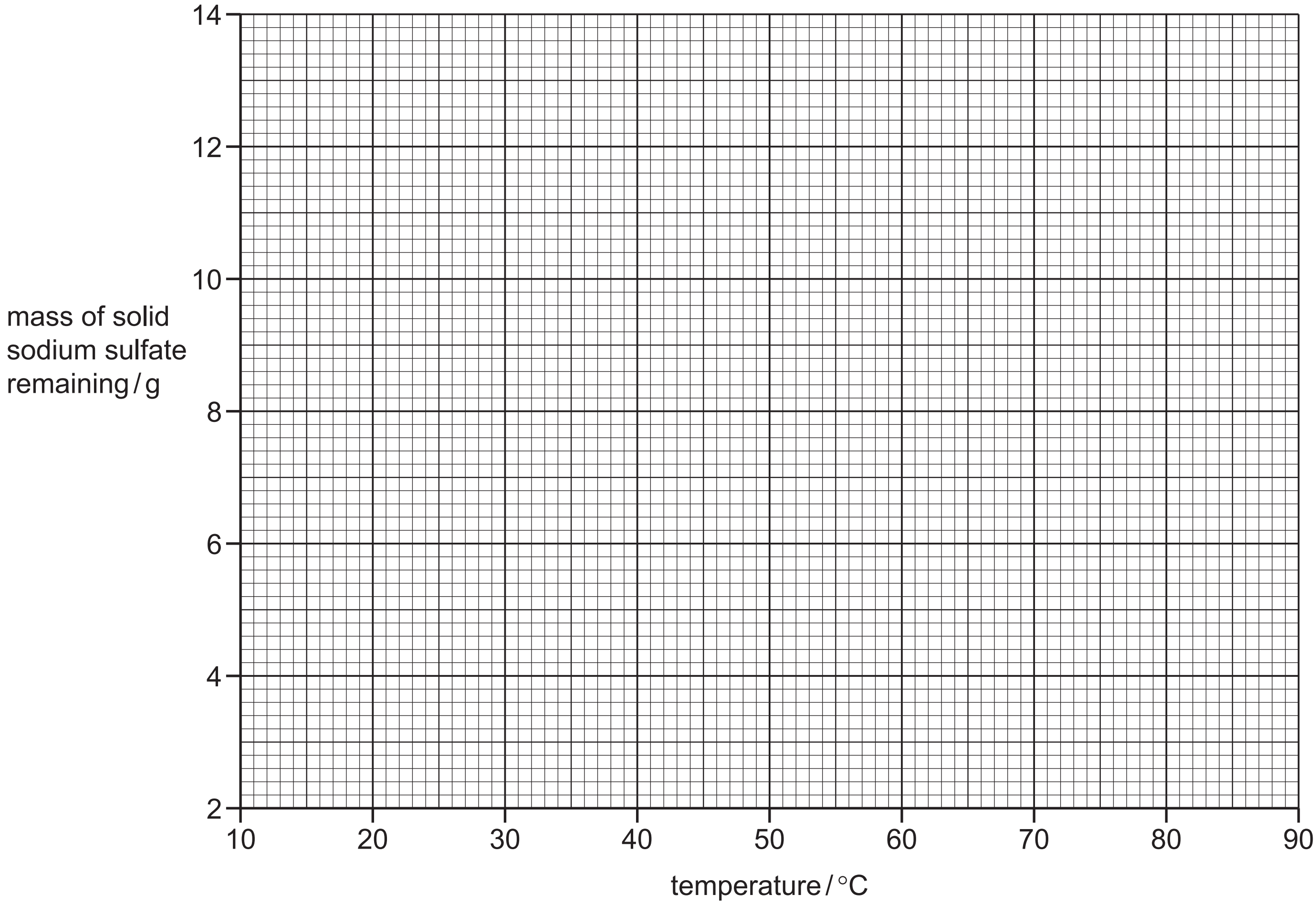
(a) Complete the table by using the thermometer diagrams and calculating the mass of solid sodium sulfate remaining in the evaporating basin at each temperature.

experiment	thermometer diagram	temperature / °C	mass of empty evaporating basin / g	mass of evaporating basin and solid sodium sulfate remaining / g	mass of solid sodium sulfate remaining / g
1		15	54.2	58.1	
2			56.3	62.2	
3			57.1	66.7	
4			58.0	69.7	
5			57.6	69.9	
6			56.4	68.1	
7			55.9	67.1	
8			57.6	68.4	

[4]

(b) Plot the results from Experiments 1 to 8 on the grid.

Draw two curves of best fit, one through the first four points and one through the second four points. Extend the two curves so that they cross.



[4]

(c) **(i)** **From your graph**, deduce the mass of solid sodium sulfate that remains in the evaporating basin when the mixture in the beaker is heated to 55 °C.

Show clearly **on the grid** how you worked out your answer.

mass of solid sodium sulfate remaining = ... g [2]

(ii) The mass of solid sodium sulfate remaining in **(c)(i)** is the mass of sodium sulfate that will dissolve in 25.0 cm^3 of solution at 55 °C.

Use your answer to **(c)(i)** to calculate the concentration, in g / dm^3, of saturated aqueous sodium sulfate at 55 °C.
(1 dm^3 = 1000 cm^3)

concentration = ... g / dm^3 [1]

(d) The student repeated the experiment and found 11.0 g of solid sodium sulfate remained in the evaporating basin.

Use your graph to deduce the **two** possible temperatures to which the mixture in the beaker may have been heated.

.... and .... [2]

(e) Name an item of apparatus that can be used to remove the 25.0 cm^3 portion of saturated solution from the beaker.

.... [1]

(f) **(i)** Suggest why it is important that an **excess** of sodium sulfate is added to the water in the beaker.

.... [1]

(ii) Suggest why the mixture in the beaker was stirred as it was heated.

.... [1]

(g) The saturated solution was heated until no more steam could be seen and solid sodium sulfate remained in the evaporating basin.

Suggest a better way of ensuring that **all** of the water has been evaporated.

....

....

.... [2]

(h) **Use your graph in (b)** to deduce what would be observed if a saturated solution of sodium sulfate at 80 °C is cooled to 50 °C.

....

.... [1]

[Total: 19]

3 Two substances, solid **W** and solid **X**, were analysed. Solid **W** was zinc bromide.

tests on solid W

Complete the expected observations.

Solid **W** was dissolved in water to form solution **W**. Solution **W** was divided into three equal portions.

(a) To the first portion of solution **W**, aqueous ammonia was added dropwise and then in excess.

observations ....

.... [2]

(b) To the second portion of solution **W**, 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added.

observations .... [1]

(c) To the third portion of solution **W**, 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added.

observations .... [1]

tests on solid X

tests	observations
test 1 About 1 g of solid **X** was placed in a boiling tube and heated strongly. A strip of filter paper soaked in acidified aqueous potassium manganate(VII) solution was held at the mouth of the boiling tube.	the acidified aqueous potassium manganate(VII) turned from purple to colourless
The remaining solid **X** was dissolved in water to form solution **X**. Solution **X** was divided into three equal portions. **test 2** 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the first portion of solution **X**.	no change
test 3 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the second portion of solution **X**.	a white precipitate formed
test 4 Aqueous sodium hydroxide was added dropwise and then in excess to the third portion of solution **X**.	a green precipitate formed and remained in excess

(d) **(i)** Name the gas given off in **test 1**.

.... [1]

(ii) Water vapour is also given off in **test 1**.

Give a chemical test for water and the expected observation if water is present.

substance used ....

observation ....
[2]

(e) Identify solid **X**.

....

.... [2]

[Total: 9]

4 The leaves of some trees contain coloured substances which can be used as pH indicators. These coloured substances are soluble in ethanol but insoluble in water.

You should assume that nothing else in the leaves is soluble in ethanol.

Plan an investigation to extract the coloured substances from some leaves and test them to see if they work as a pH indicator.

You are provided with leaves from a tree and common laboratory apparatus and chemicals.

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.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **8** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

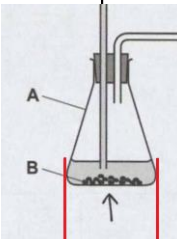
For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	arrow upward to bottom of left-hand flask – between lines shown 	**1**
1(b)	(conical) flask	**1**
1(c)	sodium sulf<u>ite</u>	**1**
1(d)	**sulfur dioxide / gas** is toxic	**1**
1(e)	**MP1** (tube linking flasks) should go into sulfuric acid / (tube from flask to gas jar) should not go into acid **MP2** gas jar should not be inverted	**2**

Question	Answer	Marks
2(a)	**M1** and **M2** all temperature readings correct ((15), 22, 29, 32, 34, 46, 61, 84)	**2**
	M3 and **M4** all final masses correct (3.9, 5.9, 9.6, 11.7, 12.3, 11.7, 11.2, 10.8)	**2**
2(b)	**M1** and **M2** all 8 points plotted correctly	**2**
	M3 two lines drawn, one for first four points and one for last four points	**1**
	M4 lines extrapolated so that they cross	**1**

Question	Answer	Marks
2(c)(i)	**M1** appropriate working from 55 °C on graph	**1**
	M2 correct value from their line (expected is 11.2 to 11.4)	**1**
2(c)(ii)	correct evaluation of answer to **c(i)** × 40	**1**
2(d)	**M1** two temperatures from graph at 11 g (expected are around 31 **and** 67)	**1**
	M2 °C	**1**
2(e)	(volumetric / graduated) pipette	**1**
2(f)(i)	to ensure a saturated solution is formed / so that it does **not** all dissolve	**1**
2(f)(ii)	to speed up dissolving	**1**
2(g)	**M1** reheat and reweigh	**1**
	M2 until mass stops changing	**1**
2(h)	no change / remains colourless	**1**

Question	Answer	Marks
3(a)	**M1** white precipitate	**1**
	M2 dissolves	**1**
3(b)	no change / (remains) colourless	**1**
3(c)	cream precipitate	**1**
3(d)(i)	sulfur dioxide	**1**

Question	Answer	Marks
3(d)(ii)	**M1** anhydrous cobalt(II) chloride (1) **M2** (changes from blue to) pink (1) **OR** **M1** anhydrous copper(II) sulfate (1) **M2** (changes from white to) blue (1)	**2**
3(e)	iron(II) / Fe^{2+}	**1**
	sulfate / SO_4^{2-}	**1**

Question	Answer	Marks
4	Any 6 from: **MP1** crush / grind leaves **MP2** using pestle / mortar **MP3** add ethanol to (ground up) leaves and stir / mix **MP4** filter (and split sample into two) **MP5** add named acid to one portion **MP6** add named alkali to second portion **MP7** samples colour will change / look for colour change **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME								
CENTRE NUMBER						CANDIDATE NUMBER		

* 3 7 2 2 9 1 3 4 3 4 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 Atoms and ions are made from small particles called electrons, neutrons and protons.

(a) Complete the table.

particle	relative charge	relative mass
electron	–1	$\frac{1}{1840}$
neutron		
proton		

[2]

(b) Information about atoms and ions, **A**, **B** and **C**, is shown in the table.

Complete the table.

atom or ion	number of electrons	number of neutrons	number of protons	symbol
A	18		20	${}^{42}_{20}Ca^{2+}$
B		18		${}^{35}_{17}Cl$
C	18	16	16	

[6]

[Total: 8]

2 The table shows the melting points, boiling points and electrical conductivities of six substances, **D**, **E**, **F**, **G**, **H** and **I**.

substance	melting point / °C	boiling point / °C	conducts electricity when solid	conducts electricity when liquid
D	1083	2567	yes	yes
E	–117	79	no	no
F	3550	4827	no	no
G	119	445	no	no
H	–210	–196	no	no
I	801	1413	no	yes

(a) Identify the substance, **D**, **E**, **F**, **G**, **H** or **I**, which is:

(i) a liquid at 25 °C .... [1]

(ii) a gas at 25 °C .... [1]

(iii) a solid consisting of simple molecules at 25 °C. .... [1]

(b) Identify the substance, **D**, **E**, **F**, **G**, **H** or **I**, which is a metal. Give a reason for your choice.

substance ....

reason ....

[2]

(c) Identify the substance, **D**, **E**, **F**, **G**, **H** or **I**, which has a macromolecular structure. Give **two** reasons for your choice.

substance ....

reason 1 ....

reason 2 ....

[3]

(d) Identify the substance, **D**, **E**, **F**, **G**, **H** or **I**, which is an ionic solid. Give a reason for your choice.

substance ....

reason ....

....

[2]

[Total: 10]

3 Aluminium is extracted from its ore by electrolysis.

(a) Name the ore of aluminium which consists mainly of aluminium oxide.

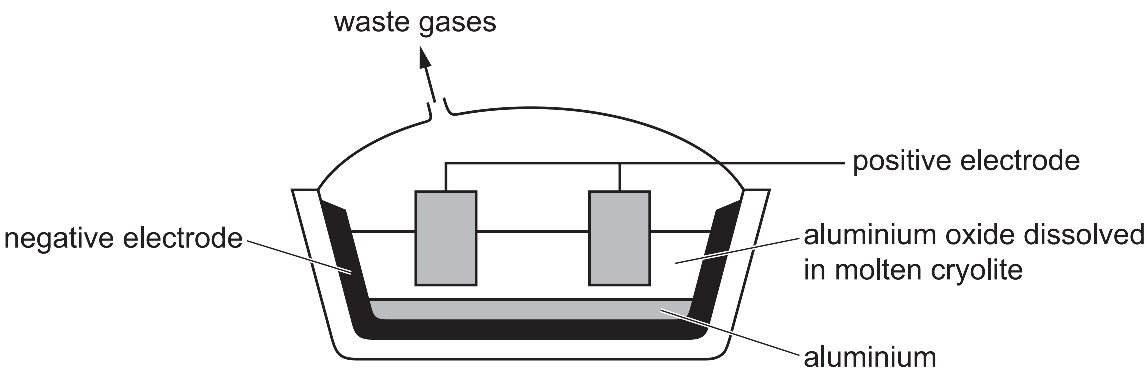
.... [1]

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

....

.... [2]

(c) Electrolysis is carried out on aluminium oxide dissolved in molten cryolite.



(i) Give **two** reasons why the electrolysis is carried out on aluminium oxide dissolved in molten cryolite instead of electrolysing molten aluminium oxide only.

1 ....

2 ....
[2]

(ii) Write the ionic half-equation for the reaction occurring at the negative electrode.

.... [2]

(iii) The positive electrodes are made of carbon.

Explain why the positive carbon electrodes are replaced regularly.

....

.... [2]

(d) Aluminium is more reactive than copper.

When aluminium is added to aqueous copper(II) sulfate, no immediate reaction is seen.

Explain why.

.... [1]

(e) Aluminium reacts with oxygen to form an amphoteric oxide.

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

....

.... [1]

(ii) The reaction between aluminium oxide and aqueous sodium hydroxide forms a salt containing the negative ion AlO_2^-. The only other product is water.

Write a chemical equation for the reaction between aluminium oxide and aqueous sodium hydroxide.

.... [2]

(f) Gallium is in the same group as aluminium and forms similar compounds.

Predict the formulae of:

gallium(III) chloride ....

gallium(III) sulfate. ....
[2]

[Total: 15]

4 This question is about compounds of phosphorus.

(a) Gaseous phosphorus(V) chloride decomposes into gaseous phosphorus(III) chloride and gaseous chlorine.

When the three gases are present in a closed container the system reaches equilibrium.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

(i) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield ($PCl_3(g)$ and $Cl_2(g)$)
increasing the temperature		increases
decreasing the pressure		
adding a catalyst		no change

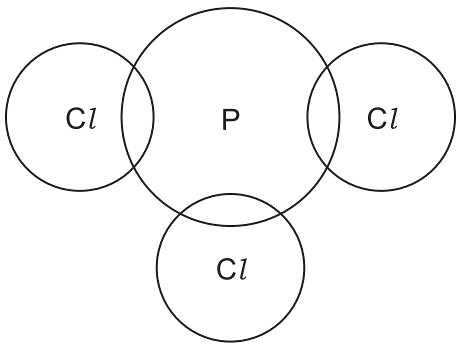
[4]

(ii) The table shows that when the temperature increases, the equilibrium yields of $PCl_3(g)$ and $Cl_2(g)$ increase.

State what conclusion can be made from this.

.... [1]

(b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of phosphorus(III) chloride, PCl_3. Show outer shell electrons only.



[2]

(c) Phosphorus oxychloride has the formula $POCl_3$.

Phosphorus oxychloride is the only product of the reaction between phosphorus(V) chloride, PCl_5, and phosphorus(V) oxide, P_4O_{10}.

Write a chemical equation for the reaction between phosphorus(V) chloride and phosphorus(V) oxide.

.... [2]

(d) Compound **X** has the following composition by mass.

H, 3.66%; P, 37.80%; O, 58.54%

Calculate the empirical formula of compound **X**.

empirical formula = ... [2]

(e) Compound **Y** has the empirical formula H_3PO_4 and a relative molecular mass of 98.

Deduce the molecular formula of compound **Y**.

molecular formula = ... [1]

[Total: 12]

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5 This question is about sulfuric acid, H_2SO_4, and salts that can be made from sulfuric acid.

(a) Sulfuric acid is manufactured by the Contact process.

stage 1 Molten sulfur burns in air to produce sulfur dioxide.

stage 2 Sulfur dioxide reacts with oxygen to form sulfur trioxide, SO_3.

stage 3 Sulfur trioxide reacts with concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

stage 4 Oleum is converted into sulfuric acid.

(i) The equation for the reaction in **stage 2** is shown.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

State the temperature and pressure used in **stage 2**.

Name the catalyst used in **stage 2**.

temperature .... °C

pressure .... atm

catalyst ....
[3]

(ii) Write the chemical equation for the reaction in **stage 3**.

.... [1]

(iii) Name the substance that reacts with oleum in **stage 4**.

.... [1]

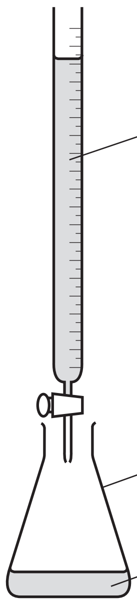
(b) Name the black solid that is produced when concentrated sulfuric acid is added to sugar, $C_{12}H_{22}O_{11}$.

.... [1]

(c) Dilute sulfuric acid and aqueous potassium hydroxide are used to make aqueous potassium sulfate.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

The method includes use of the following apparatus.



(i) Calculate the volume of 0.0625 mol / dm^3 dilute sulfuric acid, H_2SO_4, that completely reacts with 25.0 cm^3 of 0.100 mol / dm^3 potassium hydroxide, KOH, to produce aqueous potassium sulfate.

Use the following steps.

- Calculate the number of moles of KOH in 25.0 cm^3 of 0.100 mol / dm^3 KOH.

= .... mol

- Deduce the number of moles of H_2SO_4 that react with KOH.

= .... mol

- Calculate the volume of H_2SO_4 required.

volume = ... cm^3 [3]

(ii) The experiment is repeated using the same volume and concentration of potassium hydroxide and the same concentration of dilute sulfuric acid. In this second experiment, the product is aqueous potassium hydrogensulfate, $KHSO_4$.

$$H_2SO_4 + KOH \rightarrow KHSO_4 + H_2O$$

Use your answer to **(c)(i)** and the equation to deduce the volume of H_2SO_4 required.

volume = ... cm^3 [1]

(d) Aqueous potassium hydrogensulfate, $KHSO_4$(aq), contains the ions K^+(aq), H^+(aq) and SO_4^{2-}(aq).

Describe the observations in the following tests.

(i) A flame test is carried out on aqueous potassium hydrogensulfate.

.... [1]

(ii) Solid copper(II) carbonate is added to aqueous potassium hydrogensulfate.

....

.... [2]

(iii) An acidic solution containing aqueous barium ions, Ba^{2+}(aq), is added to aqueous potassium hydrogensulfate.

.... [1]

(e) Write the ionic equation for the reaction in **(d)(iii)**.

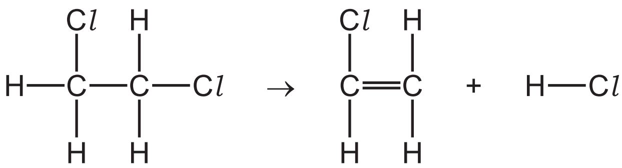
Include state symbols.

.... [3]

[Total: 17]

6 **(a)** Chloroethene ($CH_2{=}CHCl$) can be manufactured from 1,2-dichloroethane (CH_2ClCH_2Cl).

The equation can be represented as shown.



(i) Some bond energies are given.

bond	bond energy in kJ / mol
C–C	350
C=C	610
C–C*l*	340
C–H	410
H–C*l*	430

Use the bond energies in the table to calculate the energy change, in kJ / mol, of the reaction.

Use the following steps.

- Calculate the energy needed to break bonds.

energy = ... kJ

- Calculate the energy released when bonds form.

energy = ... kJ

- Calculate the energy change of the reaction.

energy change of the reaction = ... kJ / mol
[3]

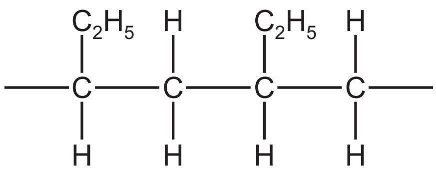
(ii) Deduce whether the energy change for this reaction is exothermic or endothermic.

Give a reason for your answer.

....

.... [1]

(b) Part of a synthetic polymer is shown.



(i) State the number of monomer units that are needed to make the part of the polymer shown.

.... [1]

(ii) Name and draw the structure of the monomer used to make this polymer. Show all of the atoms and all of the bonds.

name ....

structure

[3]

(iii) State the empirical formula of the polymer.

.... [1]

(c) Proteins are natural polymers.

Proteins are broken down into amino acids. The process is similar to how complex carbohydrates are broken down to give simple sugars.

(i) Name the type of reaction in which proteins are broken down into amino acids.

.... [1]

(ii) Name **two** types of substance that are used to break down proteins into amino acids.

1 ....

2 ....
[2]

(iii) Amino acids are colourless.

A sample containing a mixture of amino acids is separated. Each amino acid is detected and identified.

- Name the process used to separate the amino acids.

....

- Name the type of substance used to detect the amino acids.

....

- Give the symbol of the value used to determine the identity of each amino acid after separation and detection.

....
[3]

(d) Proteins are natural polymers. Proteins contain amide linkages.

Synthetic polyamides also contain amide linkages.

(i) Name a synthetic polyamide.

.... [1]

(ii) Identify the **two** functional groups present in the monomers used to produce synthetic polyamides.

1 ....

2 ....
[2]

[Total: 18]

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The Periodic Table of Elements

Key: atomic number / atomic symbol / name / relative atomic mass

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.).

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CHEMISTRY | **0620/43**

Paper 4 Theory (Extended) | **October/November 2022**

MARK SCHEME

Maximum Mark: 80

Published

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This document consists of **10** printed pages.

[Turn over

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>M1 relative charge</th><th>M2 relative mass</th></tr>
<tr><td>0</td><td>1</td></tr>
<tr><td>+1</td><td>1</td></tr>
</table>
1 mark for each correct column</td><td>2</td></tr>
<tr><td>1(b)</td><td>M1 22 (1)
M2 17 (1)
M3 17 (1)
M4 32 and 16 (1)
M5 S (1)
M6 2^{-} / $^{-}2$ / $^{--}$ (1)</td><td>6</td></tr>
</table>

Question	Answer	Marks
2(a)(i)	E	**1**
2(a)(ii)	H	**1**
2(a)(iii)	G	**1**
2(b)	**M1** D (1) **M2** conducts electricity **when solid** (1)	**2**

Question	Answer	Marks
2(c)	**M1** F (1) **M2** high melting point (1) **M3** non-conductor of electricity when solid **and** liquid (1)	**3**
2(d)	**M1** I (1) **M2** conducts electricity when liquid but not when solid / **ONLY** conducts when liquid (1)	**2**

Question	Answer	Marks
3(a)	bauxite	**1**
3(b)	**M1 breakdown** by (the passage of) **electricity** (1) **M2** of an **ionic compound** in **molten or aqueous** (state) (1)	**2**
3(c)(i)	**M1** improves conductivity of the electrolyte / makes the electrolyte a better conductor (1) **M2** low**er** operating temperature (1)	**2**
3(c)(ii)	$Al^{3+} + 3e^- \rightarrow Al$ **M1** only Al^{3+} + (3) e^- on the left (1) **M2** equation fully correct (1)	**2**
3(c)(iii)	**M1** anodes **or** carbon react(s) with oxygen (1) **M2** form carbon dioxide (1)	**2**
3(d)	unreactive coating of aluminium oxide (1)	**1**
3(e)(i)	neutralises both acids **AND** alkalis	**1**

Question	Answer	Marks
3(e)(ii)	$2NaOH + Al_2O_3 \rightarrow 2NaAlO_2 + H_2O$ **M1** $NaAlO_2$ on the right hand side (1) **M2** equation fully correct (1)	**2**
3(f)	**M1** $GaCl_3$ (1) **M2** $Ga_2(SO_4)_3$ (1)	**2**

Question	Answer	Marks
4(a)(i)	**M1** increases (1) | **M2** decreases (1) | **M3** increases (1) **M4** increases (1) |	**4**
4(a)(ii)	forward reaction is endothermic	**1**
4(b)	**M1** 3 **dot and cross** bonding pairs (1) **M2** All lone pairs correct. All octets should be complete AND dots and crosses should be different on P and all C*l* (1)	**2**
4(c)	$P_4O_{10} + 6PCl_5 \rightarrow 10POCl_3$ **M1** all formula correct and on the correct sides of the arrow (1) **M2** equation fully correct (1)	**2**

Question	Answer	Marks
4(d)	**M1** H 3.66 / 1 P 37.80 / 31 O 58.54 / 16 **OR** H = 3.66 P = 1.22 O = 3.66 **OR** H:P:O 3:1:3 (1) **M2** H_3PO_3 (1)	**2**
4(e)	H_3PO_4 (1)	**1**

Question	Answer	Marks
5(a)(i)	**M1** 450 (1) **M2** 1-2 (1) **M3** vanadium (V) oxide (1)	**3**
5(a)(ii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	**1**
5(a)(iii)	water	**1**
5(b)	carbon	**1**
5(c)(i)	**M1** 2.5×10^{-3} / 0.0025 (1) **M2** 1.25×10^{-3} / 0.00125 (1) **M3** 20 (1)	**3**
5(c)(ii)	40	**1**
5(d)(i)	lilac flame	**1**

Question	Answer	Marks
5(d)(ii)	**Any Two from** • solid disappears • blue solution • bubbles / effervescence / fizzing	**2**
5(d)(iii)	white precipitate	**1**
5(e)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **M1** $BaSO_4$ on the right (1) **M2 ONLY** Ba^{2+} and SO_4^{2-} on the left (1) **M3** state symbols (1)	**3**

Question	Answer	Marks
6(a)(i)	**M1** 2670 (1) **M2** 2610 (1) **M3** (+) 60 (1)	**3**
6(a)(ii)	endothermic **AND** energy released when bonds form is less than energy absorbed to break bonds **OR** endothermic **AND** overall energy change has a positive sign	**1**
6(b)(i)	2	**1**

Question	Answer	Marks
6(b)(ii)	**M1** but-1-ene (1) **M2** C=C (both C atoms should have 4 bonds) (1) **M3** Displayed formula of but-1-ene (1)	**3**
6(b)(iii)	CH_2	**1**
6(c)(i)	hydrolysis	**1**
6(c)(ii)	**M1** acids (1) **M2** enzymes (1)	**2**
6(c)(iii)	**M1** chromatography (1) **M2** locating agent (1) **M3** R_f (1)	**3**
6(d)(i)	nylon	**1**
6(d)(ii)	**M1** carboxylic acid (1) **M2** amine (1)	**2**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

4909270147

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 Diamond and graphite are different solid forms of carbon. The carbon atoms in diamond and graphite are arranged in different ways.

(a) State the number of covalent bonds each carbon atom has in diamond.

.... [1]

(b) State the term used to describe the structure of diamond.

.... [1]

(c) Name an oxide that has a similar structure to diamond.

.... [1]

(d) Describe the arrangement of atoms in graphite.

....

.... [2]

(e) Explain how graphite conducts electricity.

.... [1]

(f) Buckminsterfullerene is a simple molecular form of carbon.

The relative molecular mass of Buckminsterfullerene is 720.

Determine the number of carbon atoms in one molecule of Buckminsterfullerene.

.... [1]

(g) All forms of carbon burn to produce carbon dioxide.

Name the substance used to test for carbon dioxide.

.... [1]

[Total: 8]

2 Sodium is a reactive metal.

(a) Suggest why sodium is stored under oil.

.... [1]

(b) Sodium burns in air to form sodium oxide, Na_2O.

(i) State the term given to a reaction in which a substance burns.

.... [1]

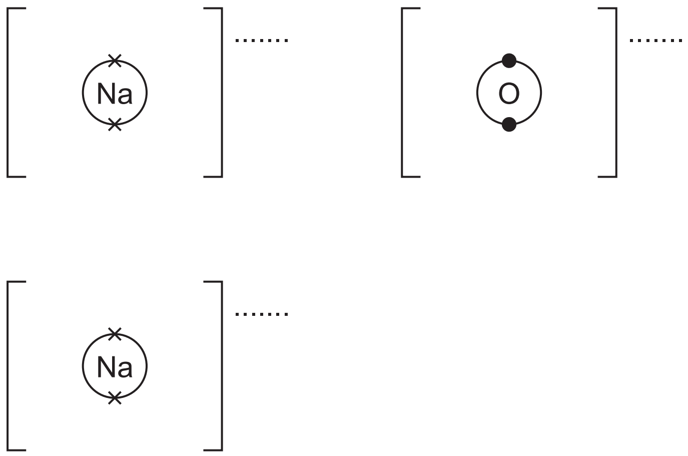
(ii) State the colour of the flame seen when sodium burns.

.... [1]

(iii) Write a chemical equation for the reaction which takes place when sodium burns in air to form sodium oxide.

.... [2]

(iv) Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in sodium oxide.



[3]

(c) Sodium reacts vigorously with water to form aqueous sodium hydroxide, NaOH, which is a strong base.

(i) Explain in terms of proton transfer what is meant by a base.

.... [1]

(ii) State a pH number that indicates the presence of a strong alkali.

.... [1]

(iii) State the colour of methyl orange in aqueous sodium hydroxide.

.... [1]

(iv) The equation for the reaction is shown.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Calculate the concentration of NaOH(aq) formed, in g/dm^3, when 0.345 g of sodium is added to 50.0 cm^3 of distilled water. Assume there is no change in volume.

Use the following steps.

- Calculate the number of moles of Na added.

= .... mol

- Determine the number of moles of NaOH formed.

= .... mol

- Calculate the concentration of NaOH in mol/dm^3.

concentration of NaOH = ... mol/dm^3

- Determine the M_r of NaOH and calculate the concentration of NaOH in g/dm^3.

concentration of NaOH = ... g/dm^3
[5]

(d) When NaOH(aq) is added to aqueous iron(III) chloride, $FeCl_3$(aq), a solid product is formed.

(i) Name the type of reaction where a solid is formed from two solutions.

.... [1]

(ii) State the colour of this solid product.

.... [1]

(iii) Name this solid product.

.... [1]

(iv) Write the ionic equation for the reaction. Include state symbols.

.... [3]

[Total: 22]

3 Sulfuric acid is manufactured by an industrial process. Sulfur is obtained from sulfur-containing metal ores.
The sulfur in the metal ore is converted to sulfur dioxide which is then oxidised to sulfur trioxide as shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(a) Name a metal ore which contains sulfur.

.... [1]

(b) Describe the process which converts metal ores to sulfur dioxide.

.... [1]

(c) Name the industrial process used to manufacture sulfuric acid.

.... [1]

(d) The reaction that produces sulfur trioxide is an equilibrium. The forward reaction is exothermic.

(i) State the temperature and pressure used to make sulfur trioxide.

temperature = ... °C

pressure = ... atm
[2]

(ii) Name the catalyst used.

.... [1]

(iii) Describe **two** features of an equilibrium.

1 ....

2 ....
[2]

(iv) State the effect, if any, on the position of equilibrium when the following changes are made.

Explain your answers.

temperature is increased ....

....

pressure is increased ....

....
[4]

(v) Explain, in terms of particles, what happens to the rate of reaction when the temperature is increased.

....

....

....

....

.... [3]

(e) Name the compound formed when sulfuric acid reacts with ammonia.

.... [1]

[Total: 16]

4 A student prepares magnesium sulfate crystals, $MgSO_4$, by adding excess magnesium to dilute sulfuric acid.

(a) Write the chemical equation for this reaction.

.... [1]

(b) Describe **two** observations which show the reaction has finished.

1 ....

2 ....
[2]

(c) The excess magnesium is removed by filtration.

State the general name given to a solid separated from a solution by filtration.

.... [1]

(d) The aqueous magnesium sulfate is heated until crystals begin to appear.

(i) Suggest the name for a solution in which no more solute can dissolve.

.... [1]

(ii) Suggest why more crystals of magnesium sulfate appear on cooling.

.... [1]

(e) Magnesium sulfate crystals have the formula, $MgSO_4{\bullet}xH_2O$, where *x* is a whole number of molecules of water.

The student heats the crystals to remove the molecules of water.

$$MgSO_4{\bullet}xH_2O(s) \rightarrow MgSO_4(s) + xH_2O(g)$$

(i) Name the term given to crystals containing molecules of water.

.... [1]

(ii) The student heats a sample of $MgSO_4{\bullet}xH_2O$ and finds it has lost 0.140 moles of H_2O and has 2.40 g of $MgSO_4$ remaining.

Determine the value of *x*. Use the following steps.

- Calculate the M_r of $MgSO_4$.

M_r = ...

- Determine the number of moles of $MgSO_4$ formed.

moles of $MgSO_4$ formed = ...

- Determine the value of *x* in $MgSO_4{\bullet}xH_2O$.

x = ...
[3]

(f) If the student uses dilute nitric acid instead of dilute sulfuric acid, the salt formed is magnesium nitrate, $Mg(NO_3)_2$.

Write the chemical equation for the reaction when solid magnesium nitrate is heated.

.... [2]

[Total: 12]

5 Ethane is an alkane which undergoes a photochemical reaction with chlorine as shown.

$$C_2H_6(g) + Cl_2(g) \rightarrow C_2H_5Cl(l) + HCl(g)$$

(a) Write the general formula of alkanes.

.... [1]

(b) State why this reaction is described as a photochemical reaction.

.... [1]

(c) In this reaction, an atom of hydrogen is replaced with a chlorine atom.

State the name of this type of organic reaction.

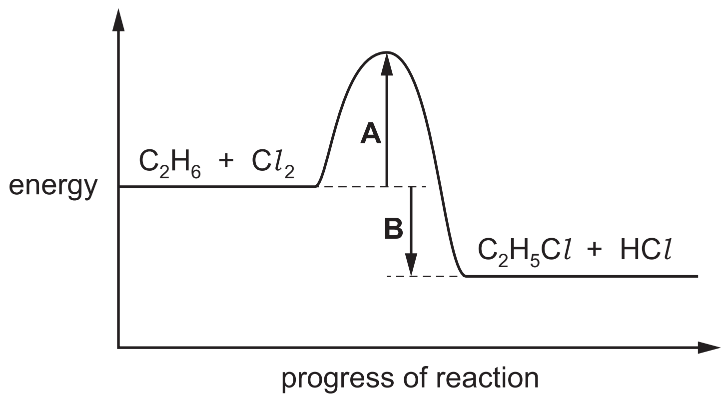
.... [1]

(d) In this reaction, one of the products is chloroethane.

Name the other product.

.... [1]

(e) The energy profile diagram of this reaction is shown.



(i) Name the energy change labelled **A**.

.... [1]

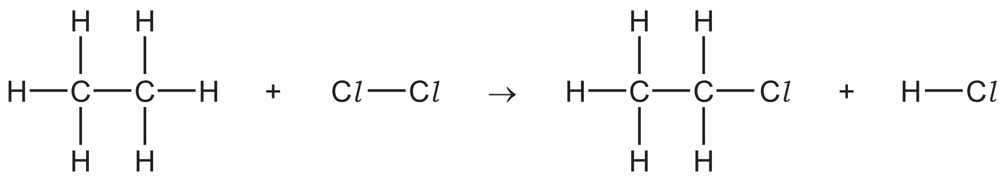
(ii) Name the energy change labelled **B**.

.... [1]

(iii) State how the energy profile diagram shows this is an exothermic reaction.

.... [1]

(f) The equation for the reaction can be represented as shown.



Some bond energies are given.

bond	bond energy / kJ mol
C–H	410
C–C	350
C*l*–C*l*	240
C–C*l*	340
H–C*l*	430

Use the bond energies in the table to calculate the energy change in this reaction.

Use the following steps.

- Calculate the energy needed to break bonds.

energy = ... kJ

- Calculate the energy released in making bonds.

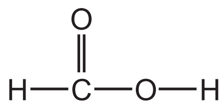
energy = ... kJ

- Determine the energy change in this reaction.

energy change in this reaction = ... kJ / mol
[3]

[Total: 10]

6 A carboxylic acid **Y** has the structure shown.



(a) State the general formula of carboxylic acids.

.... [1]

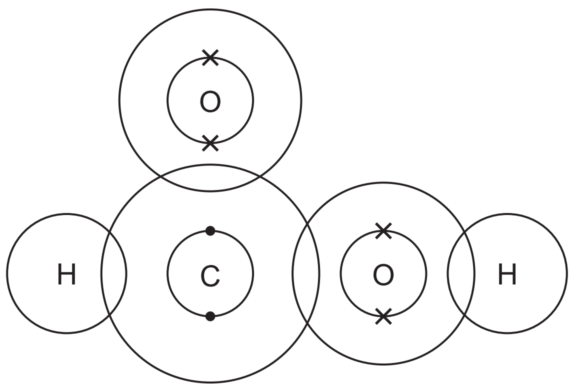
(b) Name carboxylic acid **Y**.

.... [1]

(c) Write the molecular formula of carboxylic acid **Y**.

.... [1]

(d) Complete the dot-and-cross diagram to show the arrangement of electrons in a molecule of carboxylic acid **Y**.



[3]

(e) Carboxylic acid **Y** will react with propan-1-ol, C_3H_7OH, to form ester **Z** and one other product.

(i) Name and draw the structure of ester **Z**.

Show all of the atoms and all of the bonds.

name ....

structure

[3]

(ii) Name the other product formed when carboxylic acid **Y** reacts with propan-1-ol.

.... [1]

(iii) Name:

- an ester which is a structural isomer of ester **Z**

....

- a carboxylic acid which is a structural isomer of ester **Z**.

....

[2]

[Total: 12]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge IGCSE™

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2022**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	4	**1**
1(b)	giant covalent	**1**
1(c)	silicon dioxide	**1**
1(d)	M1 layers M2 hexagon(al) (rings of carbon)	**2**
1(e)	mobile electrons	**1**
1(f)	60	**1**
1(g)	limewater	**1**

Question	Answer	Marks
2(a)(i)	to prevent contact with air / oxygen and / or water	**1**
2(b)(i)	combustion	**1**
2(b)(ii)	yellow	**1**
2(b)(iii)	$4Na + O_2 \rightarrow 2Na_2O$ **M1** species (1) **M2** balancing (1)	**2**
2(b)(iv)	**M1** eight crosses in second shell of both Na (1) **M2** six dots and two crosses in second shell of O (1) **M3** '+' charge on each Na ion on correct answer line **and** '2–' charge on O ion on correct answer line (1)	**3**
2(c)(i)	proton acceptor	**1**

Question	Answer	Marks
2(c)(ii)	pH 14	**1**
2(c)(iii)	yellow	**1**
2(c)(iv)	**M1** mol Na = 0.345 / 23 = 0.015(00) (1) **M2** mol NaOH = M1 = 0.015(00) (1) **M3** M2 × 1000 / 50 = 0.015(00) × 20 = 0.3(00) (1) **M4** M_r NaOH = 40(1) **M5** M4 × M3 = 40 x 0.3= 12.(0) (g / dm^3) (1)	**5**
2(d)(i)	precipitation	**1**
2(d)(ii)	red-brown	**1**
2(d)(iii)	iron(III) hydroxide	**1**
2(d)(iv)	$Fe^{3+}(aq) + 3OH^{-}(aq) \rightarrow Fe(OH)_3(s)$ **M1** $Fe(OH)_3$ (as only product) (1) **M2** Fe^{3+} and $3OH^{-}$ (as only reactants) (1) **M3** state symbols (1)	**3**

Question	Answer	Marks
3(a)	zinc blende	**1**
3(b)	strong heating in air / roasting in air	**1**
3(c)	contact	**1**
3(d)(i)	**M1** 450 (°C) (1) **M2** 1–2 (atm) (1)	**2**
3(d)(ii)	vanadium(V) oxide	**1**
3(d)(iii)	**M1** the rate of forward reaction equals (the rate of the) reverse reaction (1) **M2** concentrations of reactants and products are constant (1)	**2**
3(d)(iv)	*increased temperature:* **M1** (position of) equilibrium moves to left-hand side (1) **M2** reaction is exothermic (1) *increased pressure:* **M3** (position of) equilibrium moves to right-hand side (1) **M4** more (gaseous) moles / molecules on left-hand side (1)	**4**

Question	Answer	Marks
3(d)(v)	**M1** rate increases **and** particles have more energy (1) **M2** more collisions (between particles) occur per second / per unit time (1) **M3** more of the particles / collisions have energy equal to or above the activation energy (1) **or** more of the particles / collisions have sufficient energy to react **or** a higher percentage / proportion / fraction of collisions (of particles) are successful **/** have energy equal to or above activation energy	**3**
3(e)	ammonium sulfate	**1**

Question	Answer	Marks
4(a)	$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$	**1**
4(b)	**M1** no (more) fizzing (1) **M2** solid stops dissolving or a solid remains / is visible (in the mixture) (1)	**2**
4(c)	residue	**1**
4(d)(i)	saturated	**1**
4(d)(ii)	solubility (of $MgSO_4$ / solid) decreases (as temperature decreases)	**1**
4(e)(i)	hydrated	**1**

Question	Answer	Marks
4(e)(ii)	**M1** Mr $MgSO_4$ = 120 (1) **M2** mol $MgSO_4$ = 2.40 / M1 = 2.40 / 120 = 0.02(00) (1) **M3** 0.02(00) / 0.02(00) = 1 0.140 / 0.02(00) = 7 **and** x = 7 (1)	**3**
4(f)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ **M1** NO_2 + O_2 (1) **M2** equation completely correct (1)	**2**

Question	Answer	Marks
5(a)	C_nH_{2n+2}	**1**
5(b)	needs ultraviolet (light)	**1**
5(c)	substitution	**1**
5(d)	hydrogen chloride	**1**
5(e)(i)	activation energy	**1**
5(e)(ii)	energy (change) of reaction	**1**
5(e)(iii)	energy of products is lower than energy of reactants	**1**

Question	Answer	Marks
5(f)	**M1** energy needed to break bonds 6 × C–H + C–C + C*l*–C*l* = 6 × 410 + 350 + 240 = 3050 (kJ / mol) (1) **M2** energy released in making bonds 5 × C–H + C–C + C–C*l* + H–C*l* = 5 × 410 + 350 + 340 + 430 = 3170 (kJ / mol) (1) **M3** energy change M1 – M2 = –120 (kJ / mol) (1)	**3**

Question	Answer	Marks
6(a)	$C_nH_{2n+1}COOH$	**1**
6(b)	methanoic acid	**1**
6(c)	CH_2O_2	**1**
6(d)	**M1** all single bonding dot and cross pairs correct (1) **M2** double C=O bond dot and cross pairs are correct (1) **M3** four non-bonding cross electrons on each O atom (1)	**3**
6(e)(i)	**M1** propyl methanoate (1) **M2** ester linkage with all atoms and all bonds (1) **M3** correct structure of propyl methanoate (1)	**3**
6(e)(ii)	water	**1**
6(e)(iii)	**M1** methyl propanoate (1) **M2** butanoic acid (1)	**2**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5656332582

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

IB22 11_0620_41/2RP

1 The names of the elements of Period 2 of the Periodic Table are shown.

lithium beryllium boron carbon nitrogen oxygen fluorine neon

Answer the following questions about these elements.
Each element may be used once, more than once or not at all.

Identify the element which:

(a) is a product of photosynthesis

.... [1]

(b) has an oxide found in clean, dry air

.... [1]

(c) forms a basic oxide with the formula X_2O

.... [1]

(d) is a main component of fertilisers used to improve crop growth

.... [1]

(e) has the highest rate of diffusion at room temperature

.... [1]

(f) produces a red flame in a flame test

.... [1]

(g) has only 5 electrons in each of its atoms

.... [1]

(h) has an oxide responsible for acid rain.

.... [1]

[Total: 8]

2 Potassium is a Group I element.

(a) Name and describe the bonding in potassium.

name ....

description ....

....

....

.... [4]

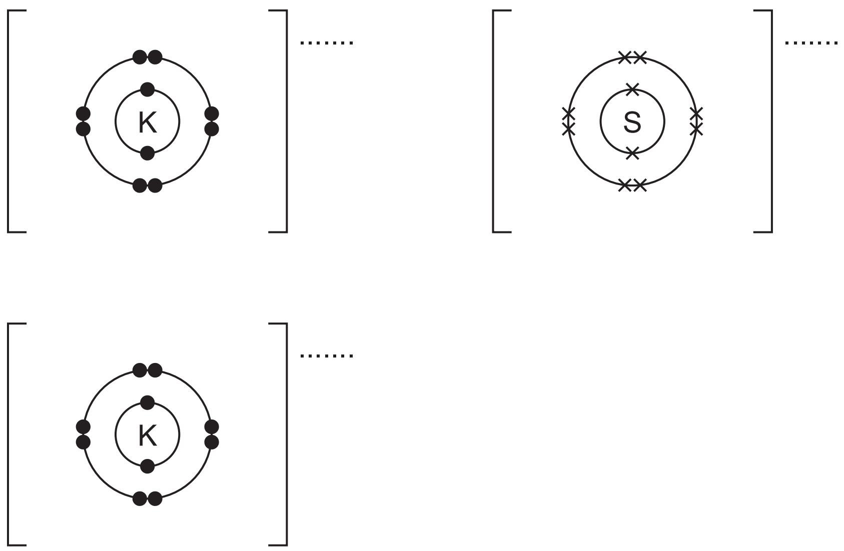
(b) Potassium combines with sulfur to form an ionic compound, potassium sulfide, K_2S.

(i) Give **two** physical properties of ionic compounds.

1 ....

2 .... [2]

(ii) Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in potassium sulfide.



[3]

(c) When potassium is added to water, it reacts vigorously and a coloured flame is seen. The equation for the reaction is shown.

$$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$$

(i) State the colour of the flame seen.

.... [1]

(ii) The solution formed is potassium hydroxide, a strong alkali.

State the formula of the ion responsible for alkalinity in a solution.

.... [1]

(iii) State the colour of litmus in a strong alkali.

.... [1]

(iv) Calculate the volume, in cm^3, of hydrogen gas formed when 2.34 g of potassium is added to excess water at room temperature and pressure.

Use the following steps.

- Calculate the number of moles of potassium added.

= .... mol

- Determine the number of moles of hydrogen gas formed.

= .... mol

- Calculate the volume of hydrogen gas formed.

volume = ... cm^3
[3]

(d) Aqueous potassium hydroxide reacts with a dilute acid to produce aqueous potassium chloride, $KCl(aq)$, which is a salt.

(i) Name the dilute acid used.

.... [1]

(ii) State the type of reaction taking place.

.... [1]

(iii) Name the experimental technique used when salts are made by reacting a dilute acid with an aqueous alkali.

.... [1]

(e) When aqueous silver nitrate, $AgNO_3(aq)$, is added to aqueous potassium chloride, a precipitate is formed.

(i) State the colour of the precipitate formed.

.... [1]

(ii) Name the precipitate formed.

.... [1]

(iii) Write the ionic equation for the reaction. Include state symbols.

.... [3]

[Total: 23]

3 Ammonia is made in an industrial process starting with nitrogen. The equation for the reaction is shown.

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

(a) Name the industrial process used to make ammonia.

.... [1]

(b) State the raw material from which nitrogen is obtained.

.... [1]

(c) State what is meant by the symbol $\rightleftharpoons$.

.... [1]

(d) State the temperature and pressure used in this industrial process.

temperature = ... °C

pressure = ... atm

[2]

(e) Name the catalyst used in this industrial process.

.... [1]

(f) The forward reaction is exothermic.

State the effect, if any, on the position of the equilibrium when the following changes are made. Explain your answers.

temperature is reduced

....

....

pressure is reduced

....

....

[4]

(g) Explain, in terms of particles, what happens to the rate of reaction when the temperature is reduced.

....

....

....

....

.... [3]

(h) Give the formula of the compound formed when sulfuric acid reacts with ammonia.

.... [1]

[Total: 14]

4 A student prepares calcium nitrate, $Ca(NO_3)_2$, by adding calcium carbonate to dilute nitric acid.

(a) Write the chemical equation for this reaction.

.... [2]

(b) Describe **two** observations during this reaction.

1 ....

2 ....
[2]

(c) The student continues to add calcium carbonate until it is in excess. The student then removes the excess calcium carbonate by filtration and collects the aqueous calcium nitrate.

State the general term given to a solution collected from filtration.

.... [1]

(d) The student gently heats the aqueous calcium nitrate until the solution is saturated.

(i) Suggest what is meant by the term *saturated solution*.

....

.... [2]

(ii) Describe how crystals are produced from a hot saturated solution.

.... [1]

(e) Calcium nitrate crystals are hydrated and have the formula $Ca(NO_3)_2•xH_2O$ where x is a whole number of molecules of water.

The student heats the crystals to remove the molecules of water.

$$Ca(NO_3)_2•xH_2O(s) \rightarrow Ca(NO_3)_2(s) + xH_2O(g)$$

(i) State the term used to describe the calcium nitrate after the molecules of water have been removed.

.... [1]

(ii) The student heats a sample of $Ca(NO_3)_2•xH_2O$ and forms 2.46 g of $Ca(NO_3)_2$ and 0.0600 moles of H_2O.

Determine the value of x. Use the following steps.

- Calculate the M_r of $Ca(NO_3)_2$.

M_r = ...

- Determine the number of moles of $Ca(NO_3)_2$ formed.

moles of $Ca(NO_3)_2$ formed = ...

- Determine the value of x in $Ca(NO_3)_2•xH_2O$.

x = ...
[3]

(f) Nitrates decompose on heating.

Write the chemical equation for the reaction when solid sodium nitrate is heated.

.... [2]

[Total: 14]

5 Ethene is an alkene which reacts with bromine as shown in the equation.

$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

(a) Write the general formula of alkenes.

.... [1]

(b) Describe the colour change seen when ethene is bubbled through aqueous bromine.

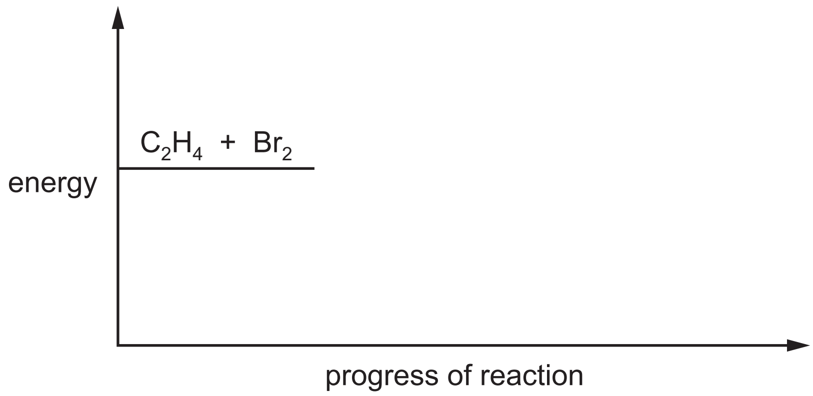
from .... to .... [1]

(c) In this reaction only one product is formed from two reactants.

Name this type of organic reaction.

.... [1]

(d) Part of the energy profile diagram of this reaction is shown.



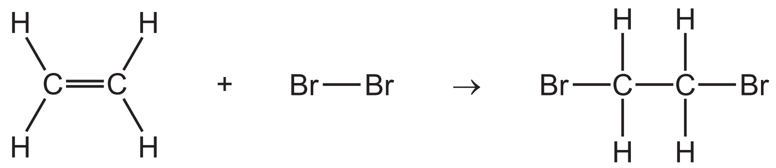
(i) The reaction is exothermic.

Complete the energy profile diagram for this reaction.
Include:

- the position of the products
- an arrow to show the activation energy, labelled as A
- an arrow to show the energy change for the reaction.

[3]

(ii) The chemical equation for the reaction can be represented as shown.



Some bond energies are given.

bond	bond energy / kJ mol
C–H	410
C=C	610
Br–Br	190
C–C	350
C–Br	290

Use the bond energies in the table to calculate the energy change in this reaction.

Use the following steps.

- Calculate the energy needed to break bonds.

energy = ... kJ

- Calculate the energy released in making bonds.

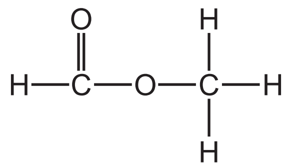
energy = ... kJ

- Determine the energy change in this reaction.

energy change in this reaction = ... kJ / mol
[3]

[Total: 9]

6 Ester **Y** has the structure shown.



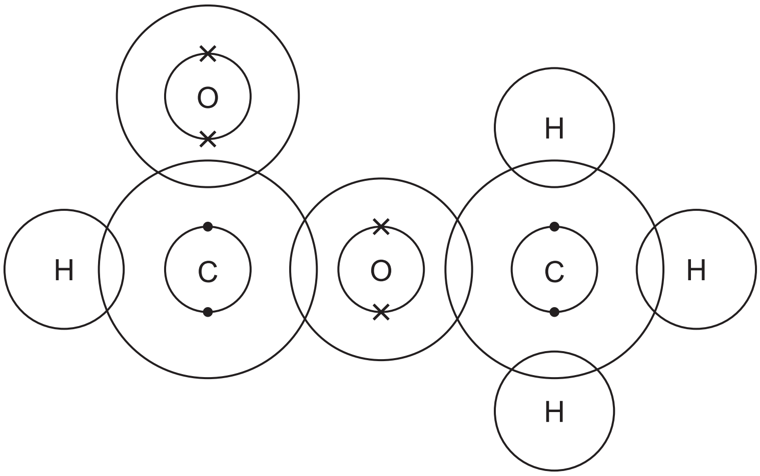
(a) (i) Name ester **Y**.

.... [1]

(ii) Deduce the empirical formula of ester **Y**.

.... [1]

(b) Complete the dot-and-cross diagram to show the arrangement of electrons in a molecule of ester **Y**.



[3]

(c) Ester **Y** can be made by reacting two organic compounds together.

Name the compounds and draw their structures.

Show all of the atoms and all of the bonds.

name ....

structure

name ....

structure

[4]

(d) **(i)** Describe what is meant by the term *structural isomer*.

....

.... [2]

(ii) Name a carboxylic acid which is a structural isomer of ester **Y**.

.... [1]

[Total: 12]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number atomic symbol name relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge IGCSE™

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2022**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **10** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states ‘show your working’. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	oxygen	**1**
1(b)	carbon	**1**
1(c)	lithium	**1**
1(d)	nitrogen	**1**
1(e)	neon	**1**
1f	lithium	**1**
1(g)	boron	**1**
1(h)	nitrogen	**1**

Question	Answer	Marks
2(a)	**M1** metallic (1) **M2** lattice of potassium ions (1) **M3** sea of electrons (1) **M4** attraction between potassium ions and electrons (1)	**4**
2(b)(i)	any two (one from each bullet point) • *physical constants*: high boiling point / melting point • *conductivity*: conduct electricity when aqueous / conduct electricity when molten • *solubility*: soluble in water	**2**

Question	Answer	Marks
2(b)(ii)	**M1** eight dots in third shell of both K (1) **M2** six crosses and two dots in third shell of S (1) **M3** ‘+’ charge on each K on correct answer line **and** ‘2–‘ charge on S ion on correct answer line (1)	**3**
2(c)(i)	lilac	**1**
2(c)(ii)	OH^-	**1**
2(c)(iii)	blue	**1**
2(c)(iv)	**M1** mol of K = 2.34 / 39 = 0.06(00) (1) **M2** mol of H_2 = 0.06 / 2 = 0.03(00) (1) **M3** volume of H_2 = 0.03 × 24 000 = 720 cm^3 (1)	**3**
2(d)(i)	hydrochloric (acid)	**1**
2(d)(ii)	neutralisation	**1**
2(d)(iii)	titration	**1**
2(e)(i)	white	**1**
2(e)(ii)	silver chloride	**1**
2(e)(iii)	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ **M1** AgCl (as *only* product) (1) **M2** Ag^+ and Cl^- (as *only* reactants) (1) **M3** state symbols (1)	**3**

Question	Answer	Marks
3(a)	Haber (process)	**1**
3(b)	air	**1**
3(c)	reversible	**1**
3(d)	450 (1) 200 (1)	**2**
3(e)	Iron / Fe	**1**
3(f)	reduced temperature: **M1** (position of) equilibrium moves to right-hand side (1) **M2** reaction is exothermic (1) reduced pressure: **M3** (position of) equilibrium moves to left-hand side (1) **M4** more (gaseous) moles on left hand side (1)	**4**
3(g)	**M1** rate decreases **and** particles have less energy (1) **M2** less collisions (between particles) occur per second / per unit time (1) **M3** less of the particles/collisions have energy equal to or above the activation energy (1) **or** less of the particles / collisions have sufficient energy to react **or** a lower percentage / proportion / fraction of collisions (of particles) • are successful or • have energy equal to or above activation energy	**3**
3(h)	$(NH_4)_2SO_4$	**1**

Question	Answer	Marks
4(a)	$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$ **M1** H_2O and CO_2 as product (1) **M2** rest of equation correct (1)	**2**
4(b)	**M1** fizzing / effervescence (1) **M2** solid disappears / dissolves (1)	**2**
4(c)	filtrate	**1**
4(d)(i)	**M1** a solution that can contain no more solute (1) **M2** at a given temperature (1)	**2**
4(d)(ii)	cool the solution	**1**
4(e)(i)	anhydrous	**1**
4(e)(ii)	**M1** M_r $Ca(NO_3)_2$ = 164 (1) **M2** mol $Ca(NO_3)_2$ = 2.46 / 164 = 0.015(00) (1) **M3** 0.015(00) / 0.015(00) = 1 0.0600 / 0.015(00) = 4 and x = 4 (1)	**3**
4(f)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ **M1** $NaNO_2$ on the right-hand side **M2** equation completely correct	**2**

Question	Answer	Marks
5(a)	C_nH_{2n}	**1**
5(b)	orange to colourless	**1**
5(c)	addition	**1**
5(d)(i)	**M1** horizontal line below energy level to right hand side of reactants line and labelled $C_2H_4Br_2$ (1) **M2** activation energy 'hump' with upward arrow **labelled A** from the reactants level (1) **M3** one downward arrow starting from the energy level of the reactants and finishing at the energy level of the products (1)	**3**
5(d)(ii)	**M1** energy needed to break bonds 4 × C–H + C=C + Br–Br = 4 × 410 + 610 + 190 = 2440 (kJ) (1) **M2** energy released in making bonds 4 × C–H + C–C + 2 × C–Br = 4 × 410 + 350 + 2 × 290 = 2570 (kJ) (1) **M3** energy change M1 – M2 = – 130 (kJ / mol) (1)	**3**

Question	Answer	Marks
6(a)(i)	methyl methanoate	**1**
6(a)(ii)	CH_2O	**1**
6(b)	**M1** all single bonding dot and cross pairs correct (1) **M2** double C=O bond dot and cross pairs are correct (1) **M3** complete diagram is correct (1)	**3**

Question	Answer	Marks
6(c)	**M1** methanoic acid (1) **M2** structure of methanoic acid (1) **M3** methanol (1) **M4** structure of methanol (1)	**4**
6(d)(i)	**M1** same (molecular) formula (1) **M2** different structural formula (1)	**2**
6(d)(ii)	ethanoic acid	**1**

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2022**

45 minutes

You must answer on the multiple choice answer sheet.

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You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
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- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

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- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

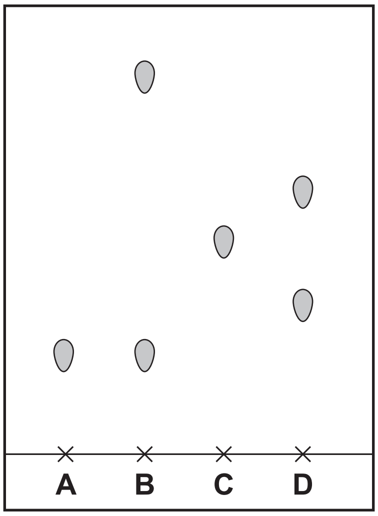
This document has **16** pages. Any blank pages are indicated.

1 Which gas diffuses the most slowly?

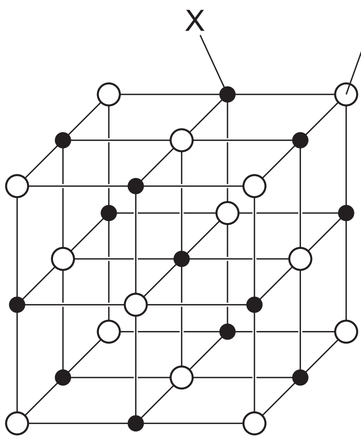
A CH_4 **B** CO_2 **C** H_2 **D** NH_3

2 The chromatogram from four different substances is shown.

Which pure substance has the largest R_f value?



3 The structure of sodium chloride can be represented as shown.



What are X and Y?

	X	Y
A	metal atom	non-metal atom
B	negative ion	electron
C	positive ion	negative ion
D	positive ion	electron

4 Which two particles have the same electronic structure?

A C and O^{2-}

B F^- and Na

C K^+ and S^{2-}

D Mg and Na^+

5 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

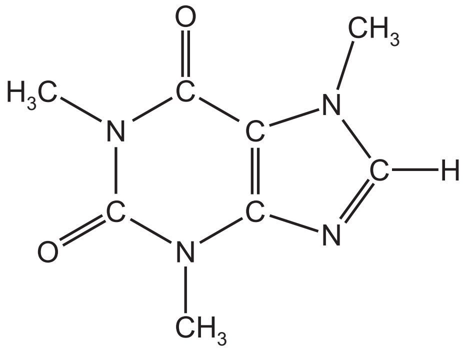
6 What is the total number of shared electrons in a molecule of methanol, CH_3OH?

A 4 **B** 5 **C** 8 **D** 10

7 Which row about the structures and uses of diamond and graphite is correct?

	structure	use
A	diamond has a giant covalent structure	diamond is used to make electrodes
B	diamond has a simple covalent structure	diamond is used to make cutting tools
C	graphite has a giant covalent structure	graphite is used as a lubricant
D	graphite has a simple covalent structure	graphite is used to make cutting tools

8 Caffeine is a stimulant found in coffee.



caffeine

Which formula represents caffeine?

A $C_7H_{10}N_4O_2$ **B** $C_8H_{10}N_3O_2$ **C** $C_8H_{10}N_4O_2$ **D** $C_8H_{11}N_4O_2$

9 The equation for the reaction between hydrogen sulfide, H_2S, and oxygen is shown.

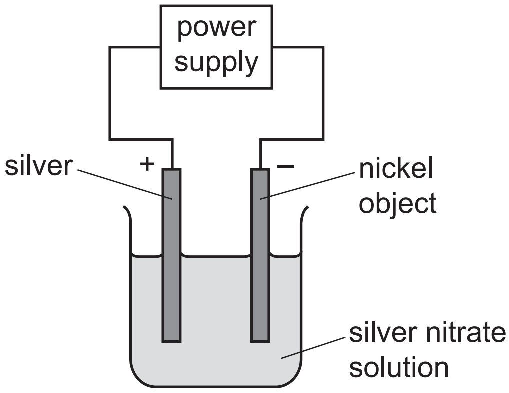
$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

Which mass of oxygen is required to react with 5.1 g of hydrogen sulfide?

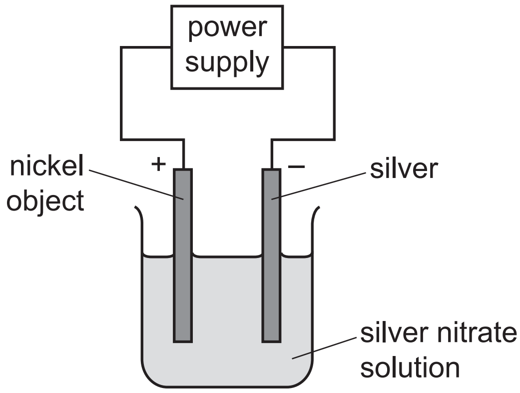
A 2.4 g **B** 4.8 g **C** 7.2 g **D** 14.4 g

10 Which apparatus is used to plate a nickel object with silver?

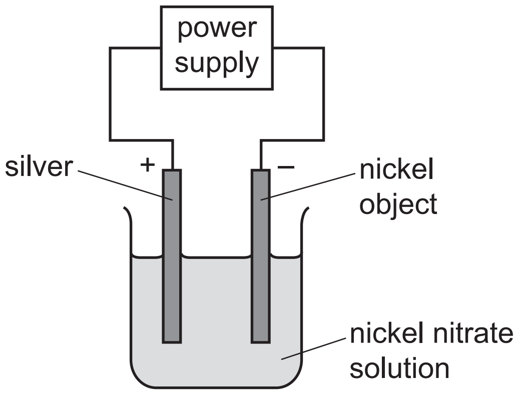
A



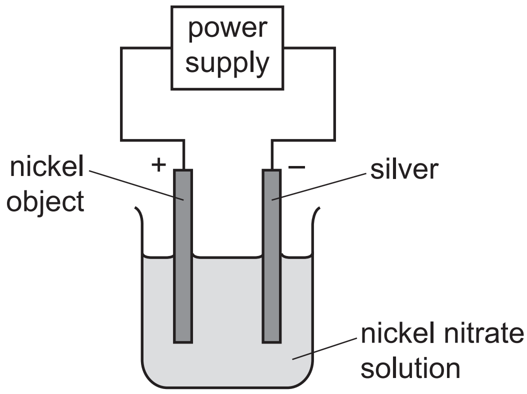
B



C



D



11 When an acid is added to an alkali, the temperature of the reaction mixture rises.

Which words describe this reaction?

A decomposition and endothermic

B decomposition and exothermic

C neutralisation and endothermic

D neutralisation and exothermic

12 Some properties of four fuels are shown.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

	fuel	formula	melting point / °C	boiling point / °C
A	hydrogen	H_2	–259	–253
B	methane	CH_4	–182	–164
C	octane	C_8H_{18}	–57	126
D	wax	$C_{31}H_{64}$	60	400

13 Dinitrogen tetroxide, N_2O_4, is converted into nitrogen dioxide, NO_2, in a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which conditions give the highest equilibrium yield of nitrogen dioxide?

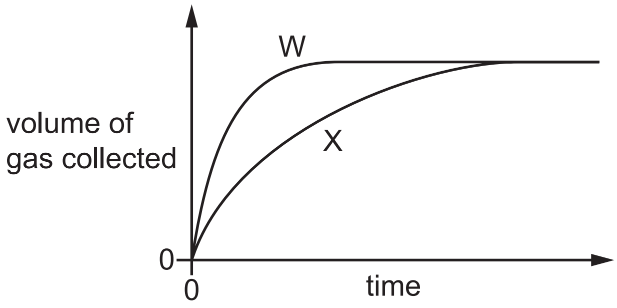
	pressure / atmospheres	temperature
A	2	high
B	2	low
C	50	high
D	50	low

14 Dilute hydrochloric acid is reacted with excess calcium carbonate and the total volume of gas is measured at regular intervals.

The results are shown by line W on the graph.

The experiment is repeated but with one change.

The results of the second experiment are shown by line X on the graph.



Which change is made in the second experiment?

A A catalyst is added.

B The calcium carbonate is broken into smaller pieces.

C The concentration of the dilute hydrochloric acid is increased.

D The temperature of the dilute hydrochloric acid is decreased.

15 When hydrated copper(II) sulfate is heated, it produces white copper(II) sulfate. When water is added, the white copper(II) sulfate turns blue.

Which type of reaction is shown by these observations?

A decomposition

B displacement

C redox

D reversible

16 When magnesium is heated with zinc oxide a reaction occurs.

The equation is shown.

$$Mg + ZnO \rightarrow MgO + Zn$$

Which substance is oxidised?

A magnesium

B magnesium oxide

C zinc

D zinc oxide

17 The equation for the reaction between ethene and hydrogen is shown.

$$CH_2{=}CH_2(g) + H_2(g) \rightarrow CH_3{-}CH_3(g)$$

The bond energies are shown.

bond	bond energy in kJ / mol
C=C	612
H–H	436
C–C	348
C–H	416

What is the overall energy change during this reaction?

A –284 kJ / mol

B –132 kJ / mol

C +132 kJ / mol

D +284 kJ / mol

18 Ethanoic acid reacts with water to produce an acidic solution.

Which row describes the roles of ethanoic acid and water in this reaction?

	ethanoic acid	water
A	accepts a proton	donates a proton
B	accepts an electron	donates an electron
C	donates a proton	accepts a proton
D	donates an electron	accepts an electron

19 Tests are done on an aqueous solution.

test	a few drops of aqueous sodium hydroxide are added	aqueous sodium hydroxide is added in excess
observation	white precipitate	precipitate dissolves to give a colourless solution

Which cations produce these observations?

1 aluminium, Al^{3+}

2 calcium, Ca^{2+}

3 zinc, Zn^{2+}

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

20 Ammonia, NH_3, dissolves in water to form a dilute solution of ammonium hydroxide, NH_4OH.

The reaction is reversible and exists as an equilibrium mixture.

$$NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Which statement about the mixture is correct?

A All of the ammonia and water molecules have turned into ions.

B The ammonia and water molecules have stopped changing into ions.

C The concentrations of the ammonia molecules and ammonium ions are always equal.

D The rate of the formation of ammonia molecules is equal to the rate of formation of the ammonium ions.

21 Elements E and F are in Group I of the Periodic Table.

E has a higher melting point than F.

Elements J and L are in Group VII of the Periodic Table.

J has a higher density than L.

Which elements have the highest atomic numbers in each group?

A E and J **B** E and L **C** F and J **D** F and L

22 Which metal forms ions with one oxidation state?

A aluminium

B chromium

C copper

D iron

23 How does the nature of the oxides change across Period 3 from sodium to chlorine?

A basic $\rightarrow$ amphoteric $\rightarrow$ acidic

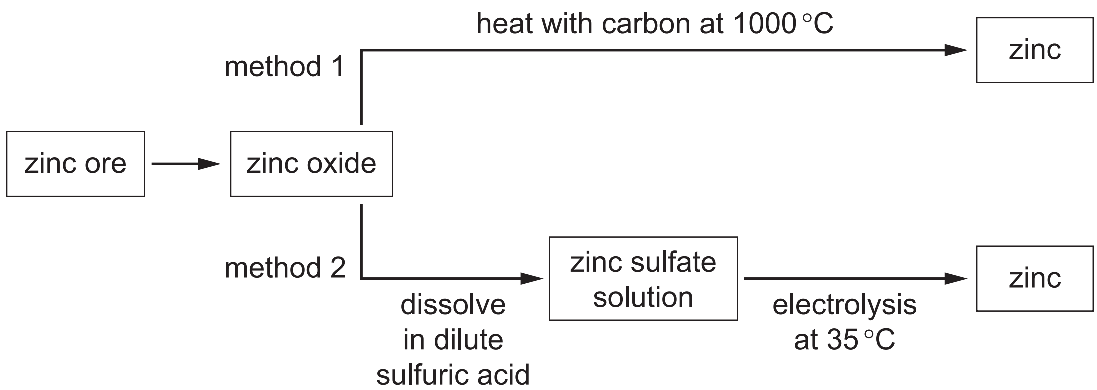
B basic $\rightarrow$ acidic $\rightarrow$ amphoteric

C amphoteric $\rightarrow$ basic $\rightarrow$ acidic

D acidic $\rightarrow$ amphoteric $\rightarrow$ basic

24 Zinc is a metal with a boiling point of 907 °C.

Two methods of making zinc are shown.



Which statement is correct?

A Carbon oxidises zinc oxide in method 1.

B Zinc vapour is produced in both methods.

C Zinc is produced at the anode in method 2.

D Zinc compounds are reduced in both methods.

25 Which statement about the reactions of metals is correct?

A Iron and carbon dioxide are produced when iron(III) oxide is heated with carbon.

B Magnesium reacts with dilute hydrochloric acid producing hydrogen and chlorine.

C Potassium reacts vigorously with water producing hydrogen and an acidic solution.

D Zinc reacts with dilute sulfuric acid producing sulfur dioxide.

26 12.4 g of copper(II) carbonate is heated in a test-tube. Only 50% is decomposed.

[M_r: $CuCO_3$, 124; CuO, 80]

What will be the final mass of the substances in the test-tube?

A 9.4 g **B** 9.8 g **C** 10.2 g **D** 10.6 g

27 Which statement about the manufacture of ammonia is correct?

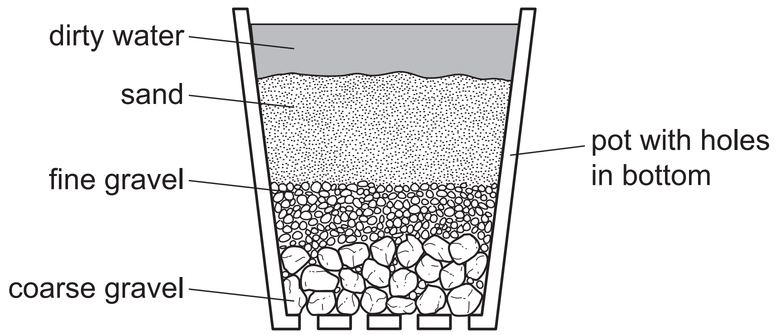
A Ammonia is manufactured by heating hydrogen and nitrogen at 50 °C and 1.0 atm.

B Ammonia is obtained by heating hydrogen and nitrogen in the Contact process.

C Hydrogen for the manufacture of ammonia is extracted from air.

D The reaction between hydrogen and nitrogen to form ammonia is reversible.

28 The diagram shows a stage in the purification of dirty water.



Which process does this apparatus show?

A chlorination

B condensation

C distillation

D filtration

29 Which substance in polluted air damages stonework and kills trees?

A carbon dioxide

B carbon monoxide

C lead compounds

D sulfur dioxide

30 Petrol-fuelled cars produce oxides of nitrogen.

Which statement explains how oxides of nitrogen are formed?

A In the catalytic converter, the elements nitrogen and oxygen combine.

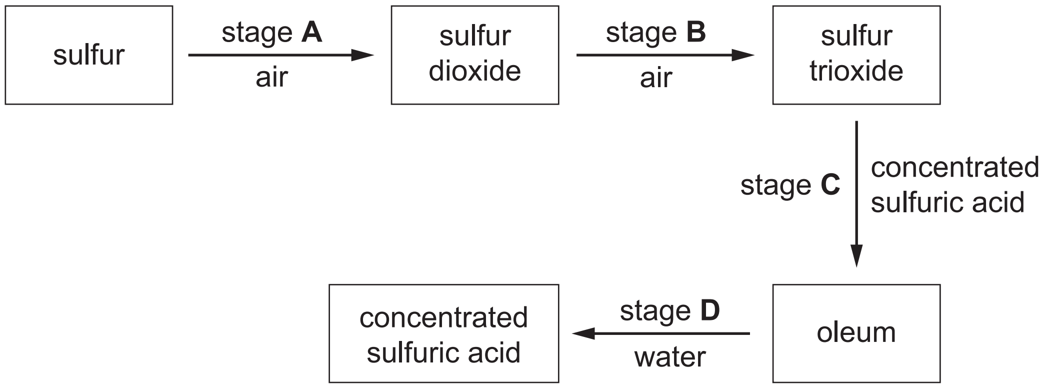
B Oxygen and nitrogen compounds in petrol combine in the car engine.

C The high temperatures in the engine provide oxygen and nitrogen with the activation energy needed to react.

D In the car engine, nitrogen compounds in petrol combine with oxygen.

31 The scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



32 Which element has an oxide that is used as a food preservative?

A helium

B hydrogen

C iron

D sulfur

33 Which substance gives off carbon dioxide on heating?

A lime

B limestone

C limewater

D slaked lime

34 Which formula represents ethyl butanoate?

A $CH_3CH_2CH_2COOCH_2CH_3$

B $CH_3COOCH_2CH_2CH_2CH_3$

C $CH_3CH_2CH_2CH_2COOCH_2CH_3$

D $CH_3CH_2COOCH_2CH_2CH_2CH_3$

35 Methanol, CH_3OH, is a member of the homologous series of alcohols.

What is the formula of the alcohol in the same homologous series which contains three carbon atoms?

A C_3H_5OH **B** C_3H_6OH **C** C_3H_7OH **D** C_3H_8OH

36 Which type of compound reacts with hydrogen in an addition reaction?

A alkanes

B alkenes

C alcohols

D carboxylic acids

37 The equation for the reaction between methane and chlorine is shown.

$$CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$$

Which type of reaction does methane undergo?

A substitution

B reduction

C condensation

D addition

38 Which functional groups form an amide linkage?

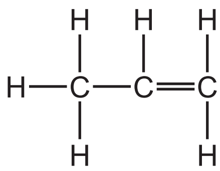
A $H_2N–$ and $–COOH$

B $H_2N–$ and $H_2N–$

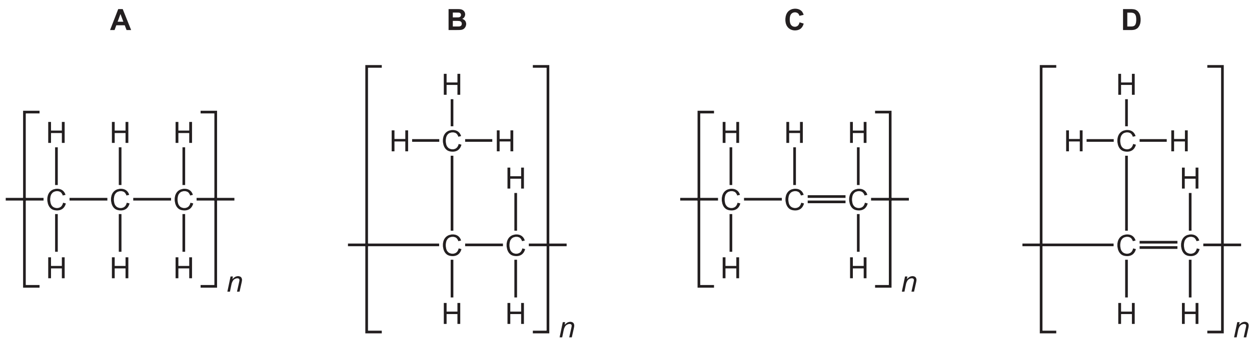
C $–OH$ and $–COOH$

D $–OH$ and $H_2N–$

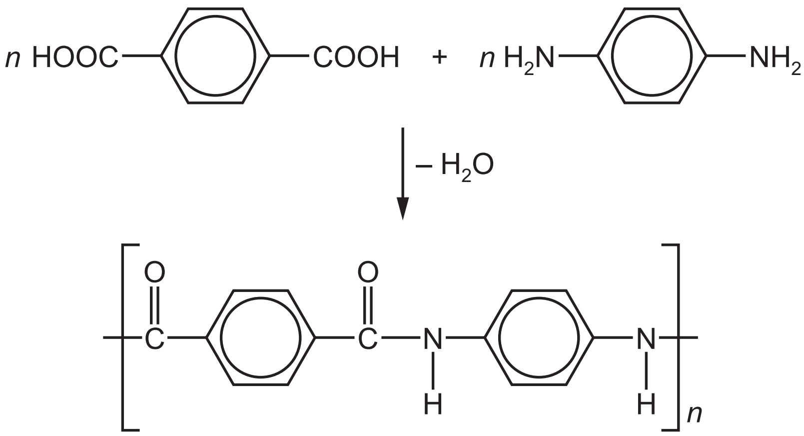
39 The structure of propene is shown.



Which diagram represents poly(propene)?



40 The equation shows the formation of a polymer called *Kevlar*.



Which row describes *Kevlar*?

	how the polymer is formed	type of polymer
A	addition polymerisation	polyamide
B	addition polymerisation	polyester
C	condensation polymerisation	polyamide
D	condensation polymerisation	polyester

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **3** printed pages.

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

Question	Answer	Marks
29	D	**1**
30	C	**1**
31	B	**1**
32	D	**1**
33	B	**1**
34	A	**1**
35	C	**1**
36	B	**1**
37	A	**1**
38	A	**1**
39	B	**1**
40	C	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2022**

45 minutes

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1 The rate of diffusion of three gases, ammonia, carbon dioxide and methane, is measured.

What is the order of the rate of diffusion of the gases from slowest to fastest?

A $CO_2 \rightarrow NH_3 \rightarrow CH_4$

B $CO_2 \rightarrow CH_4 \rightarrow NH_3$

C $CH_4 \rightarrow NH_3 \rightarrow CO_2$

D $NH_3 \rightarrow CH_4 \rightarrow CO_2$

2 Which description of Brownian motion is correct?

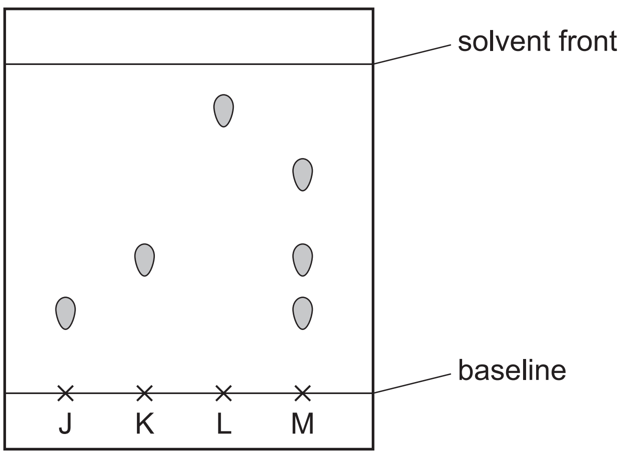
A random movement of particles due to bombardment by larger particles

B random movement of particles due to bombardment by smaller particles

C random movement of particles from a high concentration to a low concentration

D random movement of particles from a low concentration to a high concentration

3 The chromatogram obtained using four substances, J, K, L and M, is shown.



Which statement about M is correct?

A It is a mixture of J and K only.

B It is a pure substance.

C It is a mixture of J, K and L.

D It is a mixture of J, K and an unknown substance.

4 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

5 Which statement about solid magnesium oxide is correct?

A It is a giant structure made up of magnesium and oxygen atoms bonded covalently.

B It is an electrical conductor with mobile magnesium ions and oxygen ions.

C Magnesium loses electrons and these electrons move freely through a lattice.

D Oxygen ions and magnesium ions are attracted to each other in a giant lattice.

6 Which molecule contains only three shared pairs of electrons?

A CH_3OH **B** Cl_2 **C** H_2O **D** N_2

7 Which particles are present in the structure of metals?

1 positive ions

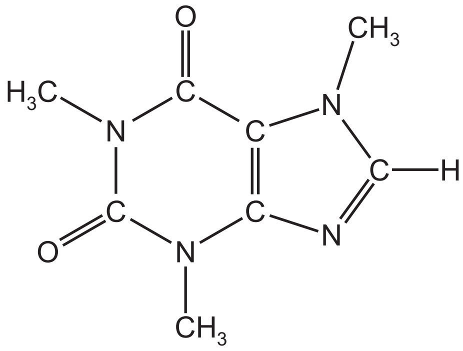
2 negative ions

3 shared pairs of electrons

4 mobile electrons

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

8 Caffeine is a stimulant found in coffee.



caffeine

Which formula represents caffeine?

A $C_7H_{10}N_4O_2$ **B** $C_8H_{10}N_3O_2$ **C** $C_8H_{10}N_4O_2$ **D** $C_8H_{11}N_4O_2$

9 Which sample does **not** contain a number of atoms equal to the Avogadro constant?

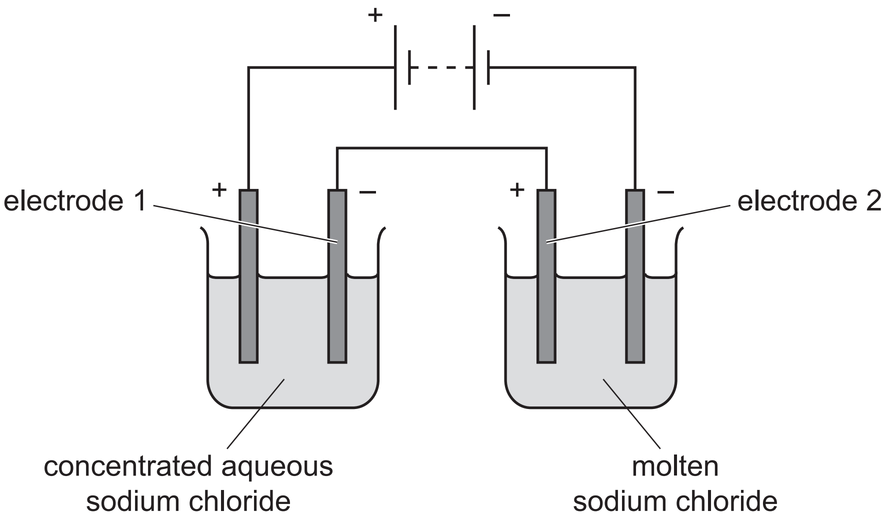
A 14 g of nitrogen, N_2

B 6 g of water, H_2O

C 4 g of helium, He

D 28 g of carbon monoxide, CO

10 The electrolysis of concentrated aqueous sodium chloride and molten sodium chloride is shown.



What are the products at electrodes 1 and 2?

	electrode 1	electrode 2
A	chlorine	chlorine
B	hydrogen	chlorine
C	hydrogen	sodium
D	sodium	sodium

11 When an acid is added to an alkali, the temperature of the reaction mixture rises.

Which words describe this reaction?

A decomposition and endothermic

B decomposition and exothermic

C neutralisation and endothermic

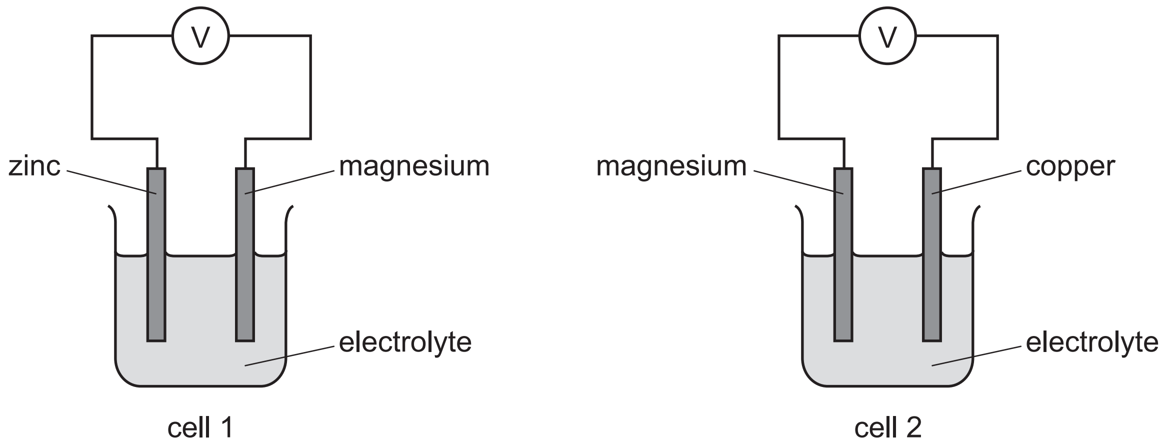
D neutralisation and exothermic

12 Some properties of four fuels are shown.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

	fuel	formula	melting point / °C	boiling point / °C
A	hydrogen	H_2	–259	–253
B	methane	CH_4	–182	–164
C	octane	C_8H_{18}	–57	126
D	wax	$C_{31}H_{64}$	60	400

13 The electrical energy, or voltage, of two simple cells is measured.



statement 1 The voltage of cell 1 is greater than cell 2.

statement 2 Zinc is more reactive than copper.

statement 3 Magnesium is oxidised in both cells.

statement 4 Magnesium atoms lose electrons to form magnesium ions.

Which option is correct?

A All the statements are correct.

B Only statements 1 and 3 are correct.

C Statement 2 is correct and explains statement 1.

D Statement 4 is correct and explains statement 3.

14 Dilute aqueous sodium chloride is electrolysed using carbon electrodes.

What is the product at the anode?

A carbon dioxide

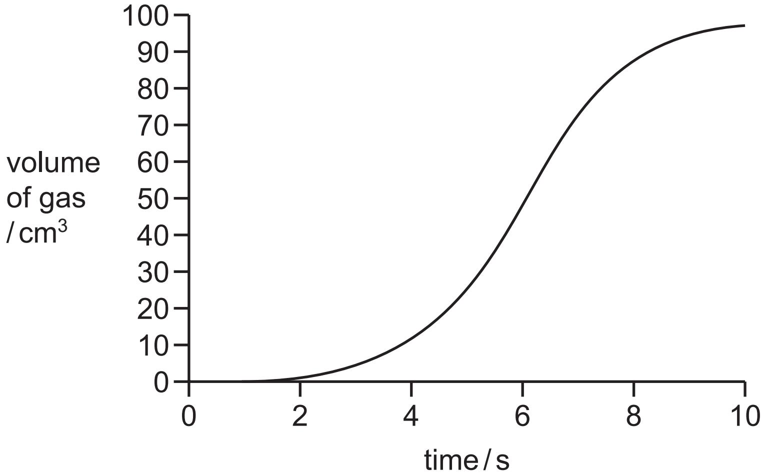
B hydrogen

C oxygen

D sodium

15 The volume of gas given off in a chemical reaction is measured over time.

The results are shown.



At which time is the rate of reaction greatest?

A 0 s **B** 4 s **C** 6 s **D** 10 s

16 Dinitrogen tetroxide, N_2O_4, is converted into nitrogen dioxide, NO_2, in a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which conditions give the highest equilibrium yield of nitrogen dioxide?

	pressure / atmospheres	temperature
A	2	high
B	2	low
C	50	high
D	50	low

[Turn over

17 When magnesium is heated with zinc oxide a reaction occurs.

The equation is shown.

$$Mg + ZnO \rightarrow MgO + Zn$$

Which substance is oxidised?

A magnesium

B magnesium oxide

C zinc

D zinc oxide

18 X and Y are oxides of two different elements.

- X reacts with water to produce aqueous solution Z.
- Z turns universal indicator paper blue.
- An aqueous solution of Y reacts with sodium carbonate to produce carbon dioxide gas.

Which statement is correct?

A X and Y are both the oxides of metals.

B X and Y are both the oxides of non-metals.

C X is the oxide of a metal and Y is the oxide of a non-metal.

D X is the oxide of a non-metal and Y is the oxide of a metal.

19 Ethanoic acid reacts with water to produce an acidic solution.

Which row describes the roles of ethanoic acid and water in this reaction?

	ethanoic acid	water
A	accepts a proton	donates a proton
B	accepts an electron	donates an electron
C	donates a proton	accepts a proton
D	donates an electron	accepts an electron

20 Copper(II) sulfate is a soluble salt.

Calcium sulfate is an insoluble salt.

Which row shows suitable reactants for preparing a pure sample of the named salt?

	salt	reactants
A	calcium sulfate	calcium carbonate + dilute sulfuric acid
B	calcium sulfate	aqueous calcium chloride and aqueous sodium sulfate
C	copper(II) sulfate	copper + dilute sulfuric acid
D	copper(II) sulfate	aqueous copper(II) chloride and aqueous sodium sulfate

21 Strontium displaces magnesium from molten magnesium chloride.

Bromine displaces iodine from aqueous potassium iodide.

Which row describes the change in reactivity down both Group II and Group VII of the Periodic Table?

	reactivity down the group	
	Group II	Group VII
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

22 Elements J and K are in the same period in the Periodic Table.

J reacts with acids to produce a salt and hydrogen.

K reacts with sodium to form an ionic compound.

Which statement about J and K is correct?

A An atom of J has more electrons than an atom of K.

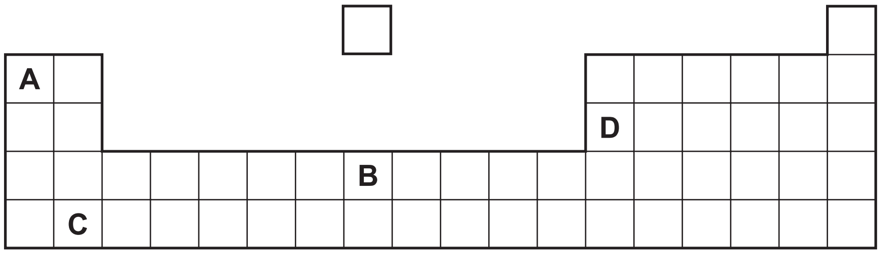
B J and K are both metals.

C J and K are both non-metals.

D J is to the left of K in the Periodic Table.

23 Part of the Periodic Table is shown.

Which element has a high density, a high melting point and forms a brown oxide?



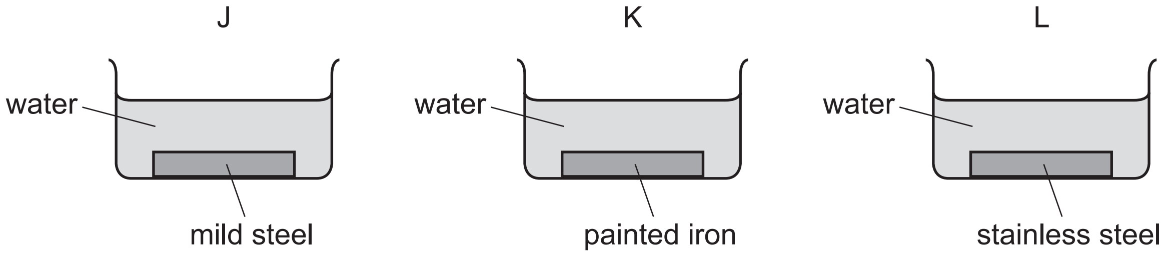
24 The reactions of four metals, W, X, Y and Z, are listed.

- Metal W displaces metal X from the oxide of metal X.
- Metal Y has a greater tendency to form positive ions than metal W.
- Aqueous ions of metal Z are reduced by metal X.

What is the order of reactivity of the metals?

	least reactive	→		most reactive
A	Y	W	X	Z
B	Y	X	W	Z
C	Z	W	X	Y
D	Z	X	W	Y

25 Three experiments, J, K and L, are set up to investigate rusting.



In which experiments does rusting occur?

	J	K	L
A	✗	✓	✓
B	✗	✓	✗
C	✓	✗	✗
D	✓	✗	✓

key
✓ = yes
✗ = no

26 Silver is below copper in the reactivity series.

Which row describes the reactions of silver?

	reaction with steam	reaction with dilute hydrochloric acid
A	no reaction	no reaction
B	no reaction	reacts to produce hydrogen gas
C	reacts to produce hydrogen gas	no reaction
D	reacts to produce hydrogen gas	reacts to produce hydrogen gas

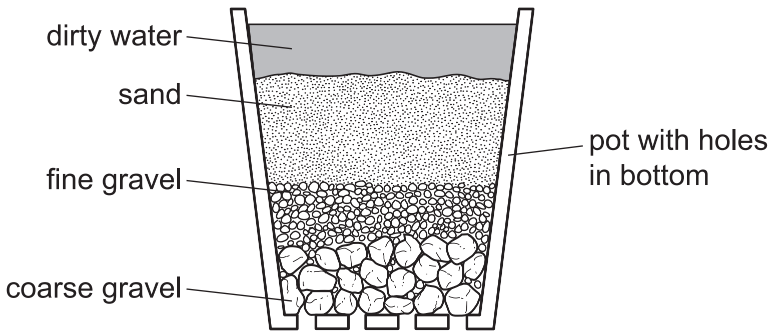
27 Iron is galvanised by coating it in zinc.

Brass is made by mixing copper with zinc.

Which row gives the reasons for each of these uses of zinc?

	reason for galvanising iron	reason for making brass
A	prevents corrosion	produces a softer metal
B	prevents corrosion	produces a harder metal
C	produces a harder metal	produces a softer metal
D	produces a harder metal	produces a harder metal

28 The diagram shows a stage in the purification of dirty water.



Which process does this apparatus show?

A chlorination

B condensation

C distillation

D filtration

[Turn over

29 Which substance in polluted air damages stonework and kills trees?

A carbon dioxide

B carbon monoxide

C lead compounds

D sulfur dioxide

30 Ammonium nitrate, NH_4NO_3, is a fertiliser and is added to fields to help crops grow.

Slaked lime, $Ca(OH)_2$, is an alkali and is added to fields to reduce the acidity of the soil.

Ammonium nitrate and slaked lime should not be added to a field at the same time because they react with each other to form a gas, Z.

What is Z?

A ammonia

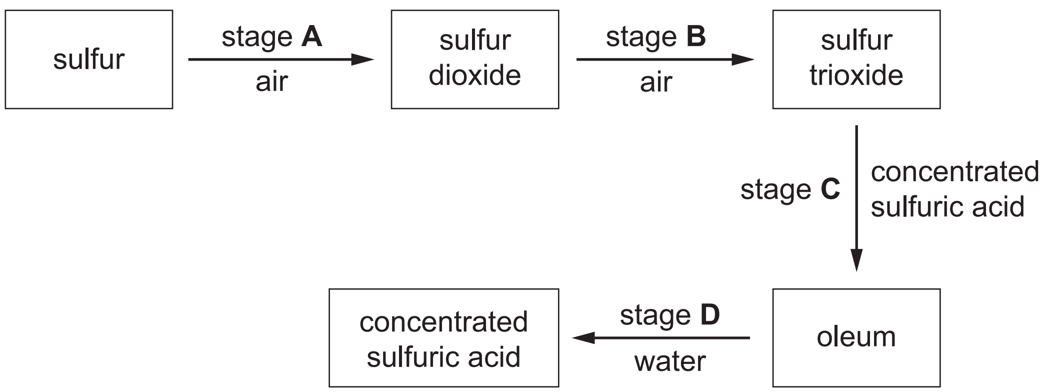
B hydrogen

C nitrogen

D oxygen

31 The scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



32 Which element has an oxide that is used as a food preservative?

A helium

B hydrogen

C iron

D sulfur

33 Which substance gives off carbon dioxide on heating?

A lime

B limestone

C limewater

D slaked lime

34 Which compound has the most $–CH_2–$ groups in one molecule?

A butane

B butanoic acid

C butan-1-ol

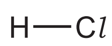
D but-1-ene

35 Methane reacts with chlorine in the presence of ultraviolet light.

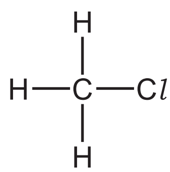
Which substance is **not** produced in this reaction?

A

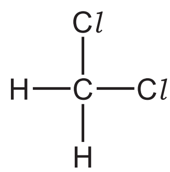
B



C



D



36 Ethene reacts with both hydrogen and steam.

Which row about these reactions is correct?

	reactant with ethene	type of reaction	catalyst used
A	hydrogen	substitution	phosphoric acid
B	hydrogen	addition	nickel
C	steam	substitution	phosphoric acid
D	steam	addition	nickel

37 Which type of reaction occurs when ethanol is converted to ethanoic acid?

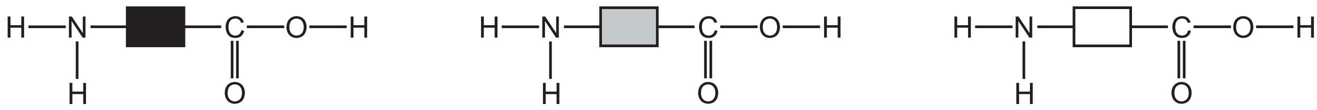
A combustion

B decomposition

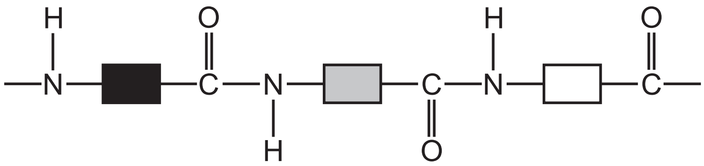
C neutralisation

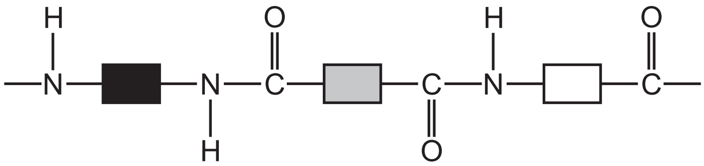
D oxidation

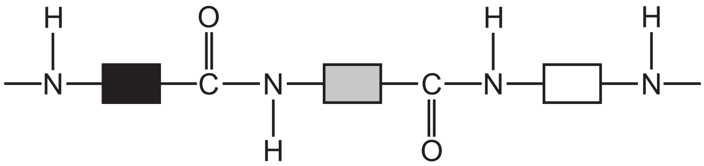
38 Hydrolysis of polymer P produces the three compounds shown.

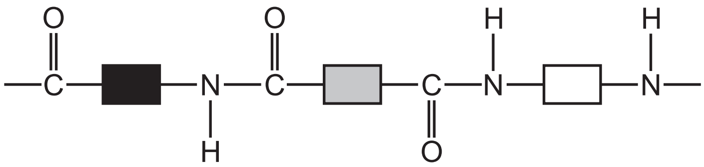


What is the structure of polymer P?

A 

B 

C 

D 

39 Which statement about unsaturated hydrocarbons is correct?

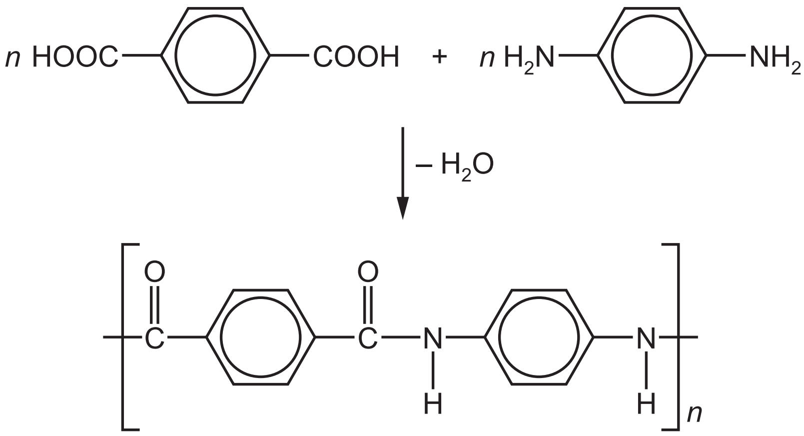
A $CH_3CH_2CH{=}CHCH_3$ is an unsaturated hydrocarbon.

B Ethene has more hydrogen atoms per molecule than ethane.

C Unsaturated hydrocarbons have double bonds between carbon and hydrogen atoms.

D Unsaturated hydrocarbons turn aqueous bromine from colourless to brown.

40 The equation shows the formation of a polymer called *Kevlar*.



Which row describes *Kevlar*?

	how the polymer is formed	type of polymer
A	addition polymerisation	polyamide
B	addition polymerisation	polyester
C	condensation polymerisation	polyamide
D	condensation polymerisation	polyester

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		**Key** atomic number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge IGCSE™

CHEMISTRY	**0620/22**
Paper 2 Multiple Choice (Extended)	**October/November 2022**
MARK SCHEME	
Maximum Mark: 40	

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

Question	Answer	Marks
29	D	**1**
30	A	**1**
31	B	**1**
32	D	**1**
33	B	**1**
34	C	**1**
35	A	**1**
36	B	**1**
37	D	**1**
38	A	**1**
39	A	**1**
40	C	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2022**

45 minutes

You must answer on the multiple choice answer sheet.

6240325308

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 The diagram shows the changes of state between a solid, a liquid and a gas.

$$\text{solid} \underset{3}{\overset{1}{\rightleftarrows}} \text{liquid} \underset{4}{\overset{2}{\rightleftarrows}} \text{gas}$$

In which changes of state is energy being given out?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

2 A coloured dye is separated by chromatography.

One component of the dye moves a distance of 13 cm and has an R_f value of 0.86.

Which distance did the solvent front move?

A 6.6 cm **B** 11.9 cm **C** 15.1 cm **D** 21.6 cm

3 A mixture contains salt, sand and sulfur.

Salt dissolves in water but not in xylene.

Sulfur dissolves in xylene but not in water.

Sand does not dissolve in water or xylene.

What is the order of the processes used to separate the salt, the sand and the sulfur from the mixture?

A add water → filter → add xylene to the filtrate → filter

B add water → filter → add xylene to the residue → filter

C add xylene → filter → add water to the filtrate → filter

D add xylene → filter → add xylene to the residue → filter

4 Which statements about isotopes of the same element are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different numbers of protons.

3 They are atoms which have the same number of electrons and protons but different numbers of neutrons.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

5 Which type of structure and bonding is present in an element that is malleable and conducts electricity?

A covalent molecular

B ionic lattice

C covalent macromolecular

D metallic lattice

6 Which statements about potassium bromide are correct?

1 It has a high melting point.

2 It dissolves in water.

3 It conducts electricity when solid.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 only

7 Which substance has a similar structure to silicon(IV) oxide?

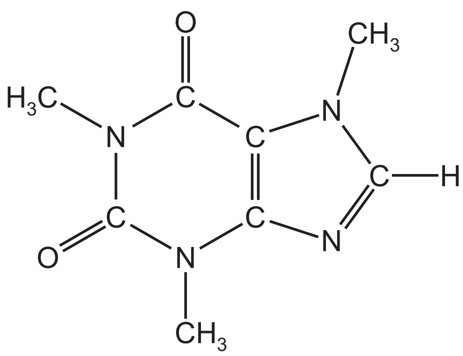
A carbon dioxide

B diamond

C graphite

D sodium oxide

8 Caffeine is a stimulant found in coffee.



caffeine

Which formula represents caffeine?

A $C_7H_{10}N_4O_2$ **B** $C_8H_{10}N_3O_2$ **C** $C_8H_{10}N_4O_2$ **D** $C_8H_{11}N_4O_2$

9 4.55 g of zinc is reacted with 50 cm^3 of 2.25 mol / dm^3 dilute hydrochloric acid.

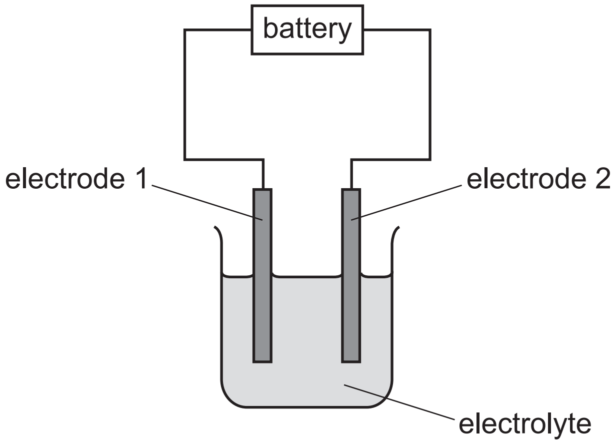
The equation for the reaction is shown.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Which volume of hydrogen gas, at room temperature and pressure, is produced in the reaction?

A 1.35 dm^3 **B** 1.67 dm^3 **C** 2.70 dm^3 **D** 3.34 dm^3

10 In the electrolysis diagram, oxidation is occurring at electrode 1 and reduction at electrode 2.



Which row shows the directions of movement of the electrons in the external circuit and of the positive ions in the electrolyte?

	direction of movement of electrons in external circuit	direction of movement of positive ions in electrolyte
A	1 → 2	1 → 2
B	1 → 2	2 → 1
C	2 → 1	1 → 2
D	2 → 1	2 → 1

11 When an acid is added to an alkali, the temperature of the reaction mixture rises.

Which words describe this reaction?

A decomposition and endothermic

B decomposition and exothermic

C neutralisation and endothermic

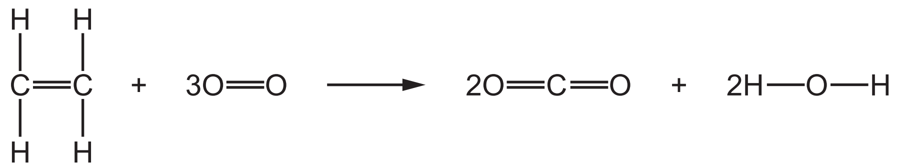
D neutralisation and exothermic

12 Some properties of four fuels are shown.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

	fuel	formula	melting point / °C	boiling point / °C
A	hydrogen	H_2	–259	–253
B	methane	CH_4	–182	–164
C	octane	C_8H_{18}	–57	126
D	wax	$C_{31}H_{64}$	60	400

13 Ethene can undergo complete combustion, as shown.



Some bond energies are given in the table.

bond	bond energy in kJ / mol
C=C	612
C–H	412
O–H	463
O=O	496

The energy change of the reaction is –1408 kJ / mol.

What is the bond energy of the C=O bond in CO_2?

A 454 kJ / mol **B** 673 kJ / mol **C** 826 kJ / mol **D** 1619 kJ / mol

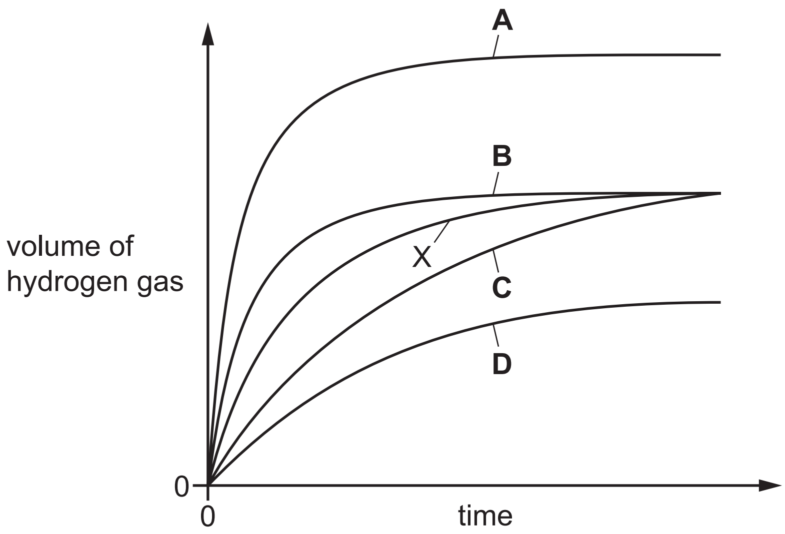
14 A student adds excess zinc to dilute hydrochloric acid at 25 °C.

The hydrogen gas produced is collected and measured at room temperature and pressure.

The results are plotted and labelled as curve X on the graph.

The experiment is repeated at 50 °C with all other conditions remaining the same.

Which graph shows the results at 50 °C?



15 Dinitrogen tetroxide, N_2O_4, is converted into nitrogen dioxide, NO_2, in a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which conditions give the highest equilibrium yield of nitrogen dioxide?

	pressure / atmospheres	temperature
A	2	high
B	2	low
C	50	high
D	50	low

16 When magnesium is heated with zinc oxide a reaction occurs.

The equation is shown.

$$Mg + ZnO \rightarrow MgO + Zn$$

Which substance is oxidised?

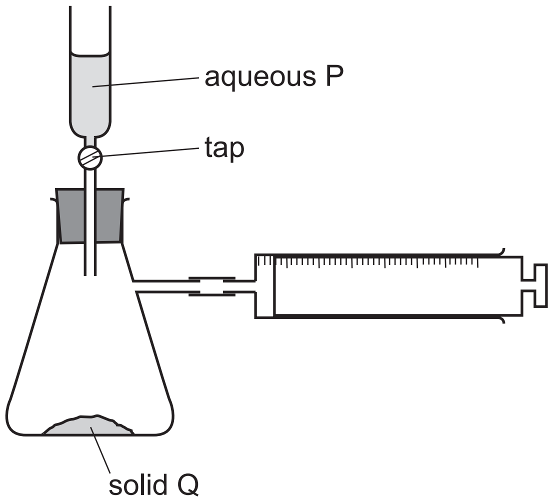
A magnesium

B magnesium oxide

C zinc

D zinc oxide

17 The diagram shows an experiment.



A small volume of aqueous P is poured on to solid Q and the tap of the funnel closed.

Which pairs of substances cause the syringe to fill with gas?

	HNO_3 and Mg	HCl and Cu	H_2SO_4 and Na_2CO_3
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

18 Ethanoic acid reacts with water to produce an acidic solution.

Which row describes the roles of ethanoic acid and water in this reaction?

	ethanoic acid	water
A	accepts a proton	donates a proton
B	accepts an electron	donates an electron
C	donates a proton	accepts a proton
D	donates an electron	accepts an electron

19 Aqueous ammonium sulfate is made by reacting aqueous ammonia with dilute sulfuric acid.

How is solid ammonium sulfate obtained from the resulting solution?

A crystallisation

B distillation

C filtration

D solvent extraction

20 Carbon forms two oxides: carbon monoxide, CO, and carbon dioxide, CO_2.

Which row describes these two oxides?

	CO	CO_2
A	acidic	acidic
B	acidic	neutral
C	neutral	acidic
D	neutral	neutral

21 Group II elements show the same trends as Group I elements.

Which statement about elements in Group II is correct?

A The melting point of barium is higher than the melting point of calcium.

B Barium is more reactive than beryllium.

C Strontium would not react with oxygen.

D Magnesium is more dense than barium.

22 Some information about properties of Group I elements is shown.

element	melting point / °C	density in g/cm^3
lithium	181	0.53
sodium	98	0.97
potassium	X	
rubidium	Y	Z

What are the values for X, Y and Z?

	X	Y	Z
A	63	252	0.26
B	63	39	0.26
C	39	63	1.53
D	63	39	1.53

23 Which statements describe properties of transition elements?

1 They form coloured compounds.

2 They have variable oxidation states.

3 They have low densities.

4 They are volatile.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

24 Which statement about the extraction of aluminium by electrolysis is correct?

A Aluminium is extracted from its ore, cryolite.

B Aluminium is formed at the positive electrode.

C Bauxite is used to lower the temperature of the extraction process.

D Graphite is used for both the positive and negative electrodes.

25 Copper(II) nitrate and zinc carbonate are heated strongly in separate test-tubes.

Which row identifies the gases produced?

	copper(II) nitrate	zinc carbonate
A	oxygen and nitrogen dioxide	carbon dioxide only
B	oxygen and nitrogen dioxide	carbon dioxide and oxygen
C	nitrogen dioxide only	carbon dioxide and oxygen
D	nitrogen dioxide only	carbon dioxide only

26 Iron from a blast furnace can be converted to steel.

Which statements about steel are correct?

1 Steel contains more carbon than the iron obtained from the blast furnace.

2 Steel is produced by blowing oxygen through the iron.

3 Calcium oxide is added to molten iron to remove basic oxides.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 only

27 Which metal is used to galvanise steel?

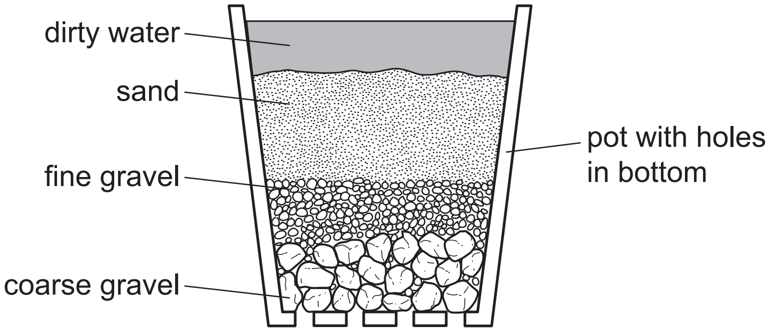
A copper

B lead

C tin

D zinc

28 The diagram shows a stage in the purification of dirty water.



Which process does this apparatus show?

A chlorination

B condensation

C distillation

D filtration

29 Which substance in polluted air damages stonework and kills trees?

A carbon dioxide

B carbon monoxide

C lead compounds

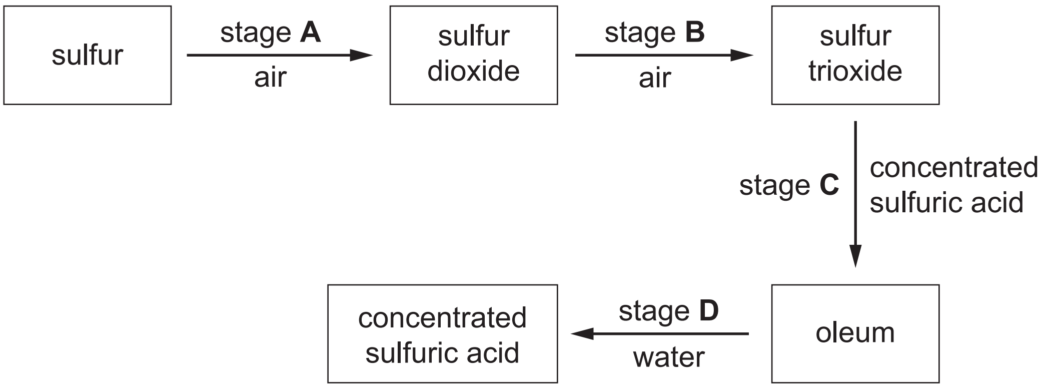
D sulfur dioxide

30 Which row explains why a high temperature and an iron catalyst are used in the manufacture of ammonia by the Haber process?

	high temperature	iron catalyst
A	increases the rate of the reaction	increases the equilibrium yield of ammonia
B	increases the rate of the reaction	increases the rate of the reaction
C	increases the equilibrium yield of ammonia	increases the equilibrium yield of ammonia
D	increases the equilibrium yield of ammonia	increases the rate of the reaction

31 The scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



32 Which element has an oxide that is used as a food preservative?

A helium

B hydrogen

C iron

D sulfur

33 Which substance gives off carbon dioxide on heating?

A lime

B limestone

C limewater

D slaked lime

34 Which formula represents ethanol?

A CH_3CH_3 **B** CH_2CH_2 **C** CH_3CH_2OH **D** CH_3COOH

35 Which statement about structural isomers is correct?

A They have the same structure but different reactivity.

B They have the same general formula but a different number of carbon atoms in their molecules.

C They have the same structure but different relative molecular masses.

D They have different structures but the same numbers of each type of atom.

36 Which formula is the same in methanol, ethanol and propanol?

- **A** empirical formula
- **B** general formula
- **C** molecular formula
- **D** structural formula

37 Ethene reacts with water under suitable conditions.

Which statement about this reaction is correct?

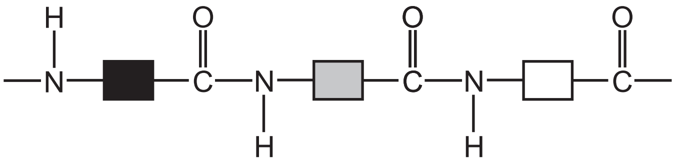
- **A** The product of this reaction has an M_r of 46.
- **B** The reaction produces two different products.
- **C** The reaction occurs when ethene gas is bubbled into cold water in the presence of an acid catalyst.
- **D** The reaction is a redox reaction.

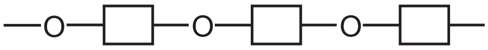
38 Ethanoic acid is made by reacting ethanol with acidified potassium manganate(VII).

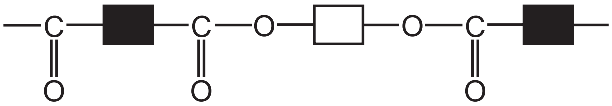
Which type of reaction occurs when ethanol reacts with acidified potassium manganate(VII)?

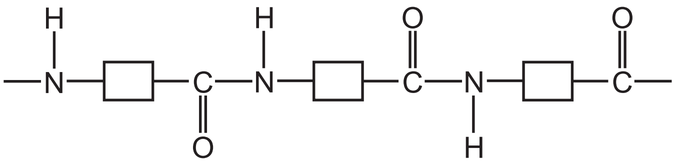
- **A** displacement
- **B** fermentation
- **C** oxidation
- **D** neutralisation

39 Which structure represents *Terylene*?

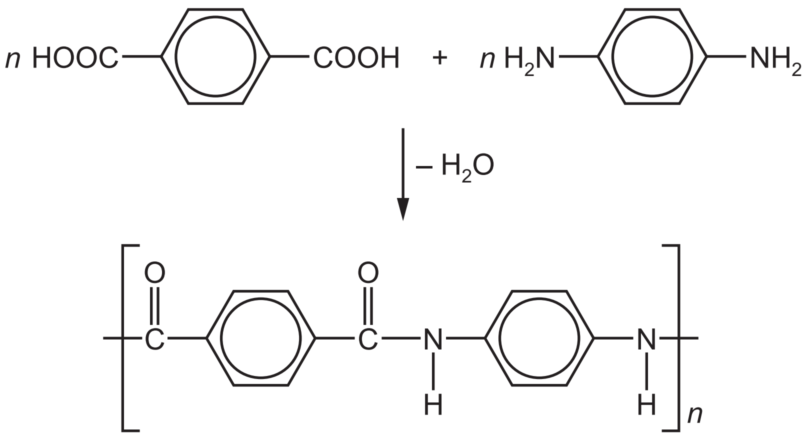
A 

B 

C 

D 

40 The equation shows the formation of a polymer called *Kevlar*.



Which row describes *Kevlar*?

	how the polymer is formed	type of polymer
A	addition polymerisation	polyamide
B	addition polymerisation	polyester
C	condensation polymerisation	polyamide
D	condensation polymerisation	polyester

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is $24\,dm^3$ at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **3** printed pages.

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

Question	Answer	Marks
29	D	**1**
30	B	**1**
31	B	**1**
32	D	**1**
33	B	**1**
34	C	**1**
35	D	**1**
36	B	**1**
37	A	**1**
38	C	**1**
39	C	**1**
40	C	**1**

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Cambridge IGCSE™

CANDIDATE NAME					
CENTRE NUMBER					
CANDIDATE NUMBER					

* 3 6 1 6 3 7 9 9 2 6 *

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2022**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

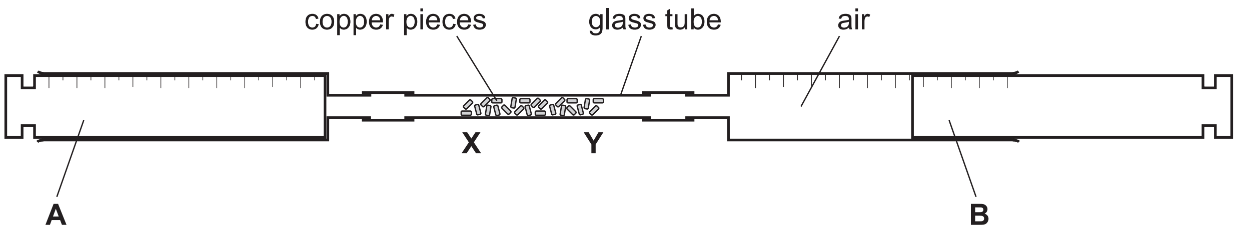
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

IB22 06_0620_63/3RP

1 The apparatus shown was used to determine the percentage of oxygen in a sample of air.



The glass tube was heated strongly at **X** while the sample of air was passed backwards and forwards over the copper pieces in the tube. The source of heat was gradually moved along the tube from **X** to **Y**.
During the experiment the copper pieces in the glass tube reacted with oxygen in the sample of air.

(a) Name the item of apparatus labelled **B**.

.... [1]

(b) Name the item of laboratory equipment that could be used to heat the glass tube strongly.

.... [1]

(c) The copper pieces at **Y** did not change colour when they were heated.

Suggest why the copper pieces at **Y** did **not** change colour.

....

.... [1]

(d) (i) The table shows the volume of air in each part of the apparatus at the start of the experiment.

part of apparatus	volume of air at start / cm^3
A	0
glass tube	8
B	94

Calculate the total volume of air in the apparatus at the start of the experiment.

total volume of air at start = ... cm^3 [1]

(ii) The table shows the volume of gas in each part of the apparatus at the end of the experiment.

part of apparatus	volume of gas at end / cm^3
A	0
glass tube	8
B	75

Calculate the percentage of oxygen in the sample of air.

percentage of oxygen = ... [1]

[Total: 5]

2 A student investigated the reaction between aqueous sodium hydroxide and two different solutions of dilute hydrochloric acid with different concentrations, labelled **Q** and **R**, using two different indicators.

Three experiments were done.

(a) *Experiment 1*

- A burette was filled with dilute hydrochloric acid **Q**. Some of the dilute hydrochloric acid was run out of the burette so that the level of the dilute hydrochloric acid was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of aqueous sodium hydroxide was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Dilute hydrochloric acid was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.

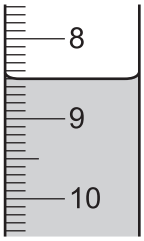
initial reading　　　　final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid **Q** added / cm^3	

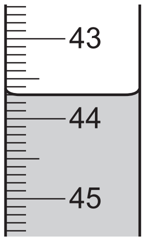
Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was rinsed with distilled water and then with dilute hydrochloric acid **R**.
- Experiment 1 was repeated using dilute hydrochloric acid **R** instead of dilute hydrochloric acid **Q**.

Use the burette diagrams to complete the table for Experiment 2.



initial reading



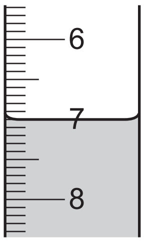
final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid **R** added / cm^3	

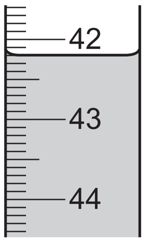
Experiment 3

- The conical flask was emptied and rinsed with distilled water.
- Experiment 2 was repeated using thymolphthalein indicator instead of methyl orange indicator.

Use the burette diagrams to complete the table for Experiment 3.



initial reading



final reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid **R** added / cm^3	

[5]

(b) Determine the simplest whole number ratio of the volumes of dilute hydrochloric acid **R** used in Experiment 2 and Experiment 3.

.... [1]

(c) Deduce the volume of dilute hydrochloric acid **Q** needed when Experiment 1 is repeated using thymolphthalein indicator instead of methyl orange indicator.

volume of hydrochloric acid **Q** = ... [2]

(d) Compare the concentration of dilute hydrochloric acid **Q** used in Experiment 1 to the concentration of dilute hydrochloric acid **R** used in Experiment 2.
Explain your answer.

....

....

....

.... [3]

(e) State how the results change, if at all, if the aqueous sodium hydroxide is warmed before adding the dilute hydrochloric acid.
Give a reason for your answer.

effect on results ....

reason ....
[2]

(f) State the advantage of using a pipette instead of the measuring cylinder in these experiments.

.... [1]

(g) Explain why a white tile is used in these experiments.

.... [1]

(h) At the start of Experiment 2 the burette was rinsed with distilled water and then with dilute hydrochloric acid **R**.

(i) State what was removed from the burette when it was rinsed with distilled water.

.... [1]

(ii) State what was removed from the burette when it was rinsed with dilute hydrochloric acid **R**.

....

.... [1]

(iii) Explain why the burette does **not** need to be rinsed at the start of Experiment 3.

.... [1]

(i) After the burette was filled with dilute hydrochloric acid at the start of Experiment 1, some of the acid was run out of the burette.

One reason for running the acid out of the burette is to make sure the level of the hydrochloric acid is on the scale.

Give one **other** reason why it is important to run some acid out of the burette after it has been filled for the first time in an experiment.

....

.... [1]

[Total: 19]

3 Solid **S** and solution **Y** were analysed. Solid **S** was anhydrous copper(II) sulfate.
Tests were done on each substance.

tests on solid S

Complete the expected observations.

(a) A flame test was carried out on solid **S**.

observations .... [1]

The remaining solid **S** was dissolved in about 10 cm^3 of distilled water to form solution **T**. Solution **T** was divided into two approximately equal portions in two test-tubes.

(b) State the colour change that occurred when water was added to solid **S** to form solution **T**.

from solid **S** .... to solution **T** .... [1]

(c) To the first portion of solution **T**, about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate were added.

observations .... [1]

(d) To the second portion of solution **T**, aqueous ammonia was added dropwise and then in excess.

observations ....

....

.... [3]

tests on solution Y

tests	observations
test 1 A flame test was carried out on solution **Y**.	the flame became lilac
Solution **Y** was divided into three approximately equal portions in one boiling tube and two test-tubes. **test 2** Dilute hydrochloric acid was added to the portion of solution **Y** in a boiling tube. The mixture was warmed. A strip of filter paper soaked in acidified aqueous potassium manganate(VII) was held at the mouth of the boiling tube.	the acidified aqueous potassium manganate(VII) remained purple
test 3 About 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the second portion of solution **Y**.	yellow precipitate
test 4 Aqueous ammonia was added dropwise and then in excess to the third portion of solution **Y**.	a white precipitate formed which dissolved in excess to give a colourless solution

(e) Name the gas tested for in **test 2**.

.... [1]

(f) Identify the **three** ions in solution **Y**.

....

.... [3]

[Total: 10]

4 When solution **A** and solution **B** are mixed they react slowly to form iodine.
Starch solution is added to the mixture to act as an indicator.
When a certain amount of iodine is made there is a sudden colour change to blue-black.

Plan an investigation to find the effect of temperature on the rate of the reaction between solution **A** and solution **B**.

You are provided with solution **A**, solution **B**, starch solution and common laboratory apparatus.

.... [6]

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	(gas) syringe	**1**
1(b)	Bunsen (burner)	**1**
1(c)	all oxygen used up (so copper does not react)	**1**
1(d)(i)	102	**1**
1(d)(ii)	18.6(27451)%	**1**

Question	Answer	Marks
2(a)	all 6 burette readings correct (20.3 ,2.7,43.7, 8.5,42.2, 7(.0))	**2**
	burette readings recorded in correct row in each table	**1**
	all readings / volumes in all tables given to 1 dp or better and are to a consistent number of dp.	**1**
	all three values for volume added are correct (17.6, 35.2, 35.2)	**1**
2(b)	1 : 1	**1**
2(c)	17.6	**1**
	cm^3	**1**
2(d)	**Q** is more concentrated than **R**	**1**
	as smaller volume of **Q** is required	**1**
	answer is quantitative. **Either** Q is twice the concentration of R **OR** the volume of Q is half the volume of R	**1**

Question	Answer	Marks
2(e)	none	**1**
	does not change amount / concentration / moles of sodium hydroxide	
2(f)	(more) accurate (volume of aqueous sodium hydroxide)	**1**
2(g)	so colour change can be seen clearly / easily	**1**
2(h)(i)	(acid) Q	**1**
2(h)(ii)	water	**1**
2(h)(iii)	same acid used	**1**
2(h)(iv)	to fill tap / to fill part of burette below tap / to fill all of the burette / to fill the jet	**1**

Question	Answer	Marks
3(a)	blue green (flame)	**1**
3(b)	solid S: white (solid) solution T: blue (solution)	**1**
3(c)	white precipitate	**1**
3(d)	(light/pale) blue precipitate	**1**
	dissolves / forms a solution	**1**
	deep(er) blue	**1**
3(e)	sulfur dioxide	**1**

Question	Answer	Marks
3(f)	potassium / K^+	**1**
	iodide / I^-	**1**
	zinc / Zn^{2+}	**1**

Question	Answer	Marks
4	any 6 from: • known volumes of aqueous solution A **and** solution B • suitable apparatus for measuring volumes of solutions • measure temperature • mix solutions together (with starch solution) • time until blue black colour seen • repeat at a different temperature • solutions warmed **before** they are mixed.	**6**

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9457558127

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2022**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

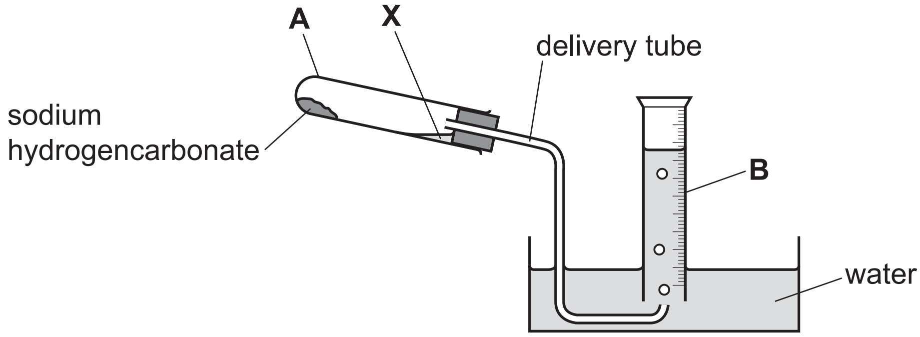
INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

1 Sodium hydrogencarbonate decomposes when heated. The products are solid sodium carbonate, water and carbon dioxide.

A student decomposed a sample of sodium hydrogencarbonate using the apparatus shown.



(a) Name the items of apparatus labelled **A** and **B**.

A ....

B ....
[2]

(b) When the sodium hydrogencarbonate was heated, a colourless liquid collected at the point marked **X**.

Suggest the identity of the colourless liquid.

.... [1]

(c) **On the diagram** draw one arrow to show where the apparatus should be heated during the experiment. [1]

(d) State an observation that would indicate the sodium hydrogencarbonate had stopped reacting.

....

.... [1]

(e) Explain why it is important to remove the delivery tube from the water as soon as heating is stopped.

....

....

.... [2]

[Total: 7]

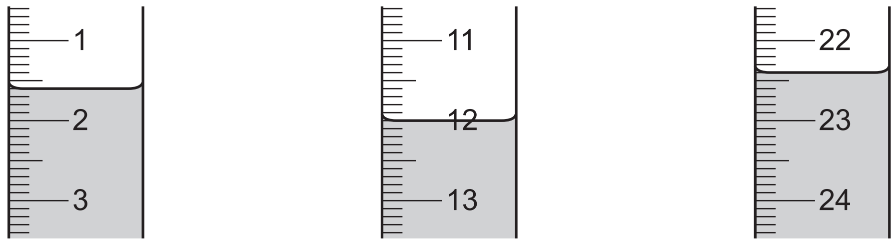
2 A student investigated the reaction between two different solutions of aqueous sodium carbonate, solution **K** and solution **L**, and dilute hydrochloric acid using two different indicators.

Two experiments were done.

Experiment 1

- A burette was rinsed with water and then with the dilute hydrochloric acid.
- The burette was filled with dilute hydrochloric acid. Some of the dilute hydrochloric acid was run out of the burette so that the level of the dilute hydrochloric acid was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of solution **K** was poured into a conical flask.
- Five drops of methyl orange indicator **and** five drops of thymolphthalein indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Dilute hydrochloric acid was added slowly from the burette to the conical flask, while the flask was swirled, until the solution turned yellow. This is the first colour change.
- More dilute hydrochloric acid from the burette was added to the conical flask, while swirling the flask, until the solution changed colour again. This is the second colour change.

(a) Use the burette diagrams to complete the table for Experiment 1.



initial burette reading | burette reading at first colour change | burette reading at second colour change

	Experiment 1
burette reading at first colour change / cm^3	
final burette reading at second colour change / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid added for first colour change / cm^3	
total volume of dilute hydrochloric acid added for second colour change / cm^3	

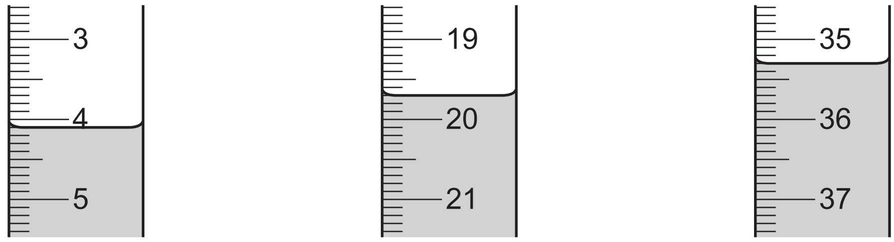
[3]

[Turn over

(b) *Experiment 2*

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution **L** instead of solution **K**.

Use the burette diagrams to complete the table for Experiment 2.



initial burette reading | burette reading at first colour change | burette reading at second colour change

	Experiment 2
burette reading at first colour change / cm^3	
final burette reading at second colour change / cm^3	
initial burette reading / cm^3	
volume of dilute hydrochloric acid added for first colour change / cm^3	
total volume of dilute hydrochloric acid added for second colour change / cm^3	

[3]

(c) State the colour change observed at the end-point when dilute hydrochloric acid is added to methyl orange in an alkaline solution.

from .... to .... [1]

(d) For Experiment 1, compare the volume of dilute hydrochloric acid needed for the first colour change with the volume of dilute hydrochloric acid for the second colour change.

....

.... [2]

(e) Compare the concentration of solution **K** used in Experiment 1 to the concentration of solution **L** used in Experiment 2.
Explain your answer.

....

....

.... [3]

(f) **(i)** Deduce the volume of dilute hydrochloric acid needed for the second colour change when Experiment 2 is repeated using 50 cm^3 of solution **L**.

.... [2]

(ii) State why using 50 cm^3 of solution **L** would cause a problem.

....

.... [1]

(g) State the advantage of using a pipette instead of the measuring cylinder in these experiments.

.... [1]

(h) Explain why the conical flask was swirled as the dilute hydrochloric acid was added from the burette.

....

.... [1]

(i) At the start of Experiment 1, the burette was rinsed with water and then with dilute hydrochloric acid.
At the start of Experiment 2, the conical flask was rinsed with water but **not** with solution **L**.

(i) Explain why the conical flask was rinsed with water.

....

.... [1]

(ii) Explain why the conical flask was **not** rinsed with solution **L** in Experiment 2.

....

.... [1]

[Total: 19]

3 Solid **M** and solid **N** were analysed. Solid **M** was iron(III) nitrate.
Tests were done on each substance.

tests on solid M

Complete the expected observations.

Solid **M** was dissolved in water to form solution **M**. Solution **M** was divided into two approximately equal portions in two test-tubes.

(a) To the first portion of solution **M**, aqueous sodium hydroxide was added gradually until in excess. The product was kept for **(b)**.

observations ....

.... [2]

(b) **(i)** The product from **(a)** was transferred to a boiling tube. A piece of aluminium foil was added and the mixture warmed gently. Any gas produced was tested.

observations ....

.... [1]

(ii) Identify the gas made in **(i)**.

.... [1]

(c) To the second portion of solution **M**, about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate were added.

observations .... [1]

tests on solid N

tests	observations
test 1 A flame test was carried out on solid **N**.	the flame became red
Solid **N** was dissolved in water to form solution **N**. Solution **N** was divided equally into one test-tube and one boiling tube. **test 2** About 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the first portion of solution **N** in a test-tube.	no visible change
test 3 About 2 cm depth of dilute hydrochloric acid was added to the second portion of solution **N**. The mixture was warmed and any gas produced was tested.	acidified aqueous potassium manganate(VII) changed from purple to colourless

(d) Identify the gas produced in **test 3**.

.... [1]

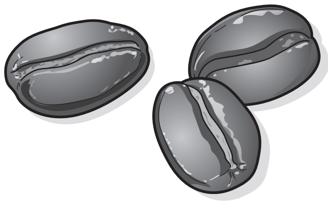
(e) Identify solid **N**.

....

.... [2]

[Total: 8]

4 The diagram shows some coffee beans.



Caffeine occurs naturally in coffee beans. Caffeine is a white crystalline solid. It is very soluble in hot water but much less soluble in cold water.

Plan an investigation to obtain a pure crystalline sample of caffeine from coffee beans.

Assume that all other soluble substances in coffee beans are very soluble in both hot and cold water.

You are provided with coffee beans and common laboratory apparatus.

....

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.... [6]

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

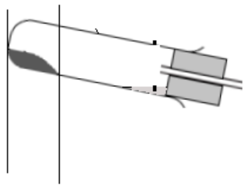
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	Guidance for chemical equations Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	**A** boiling tube / test-tube	**1**
	B measuring cylinder	**1**
1(b)	water / H_2O	**1**
1(c)	arrow to show heating must have head pointing towards the tube and the arrowhead must be between the two lines shown 	**1**
1(d)	no more bubbles / volume of gas stops changing	**1**
1(e)	test-tube / boiling tube breaks / cracks	**1**
	suck back / water goes into tube	**1**

Question	Answer	Marks
2(a)	all values in (a) to 1 dp or better and to a consistent number of dp	**1**
	all burette reading correct (12.0/12, 22.4, 1.6)	**1**
	both titres correct (10.4, 20.8)	**1**
2(b)	all burette readings correct (19.7 35.3, 4.1)	**1**
	all readings in the correct cells (initial reading is the smallest and second colour change is the largest)	**1**
	both titres correct (15.6, 31.2)	**1**

Question	Answer	Marks
2(c)	(from) yellow (to) orange	**1**
2(d)	a greater volume is required to reach the second end point	**1**
	double	**1**
2(e)	smaller volume (of acid) is required for **K** (experiment 1) **OR** larger volume (of acid) is required for **L** (Experiment 2)	**1**
	(so) **L** (Experiment 2) is more concentrated than **K** (Experiment 1) **OR** (so) **K** (Experiment 1) is less concentrated than **L** (Experiment 2)	**1**
	answer is quantitative. **Either** L is 1.5 × concentration of K **OR** the volume of acid for **L** is 1.5 × the volume of acid for **K**	**1**
2(f)(i)	numerical answer which is 2 × answer for second colour change in results table for Experiment 2	**1**
	cm^3	**1**
2(f)(ii)	more than can fit into burette	**1**
2(g)	(more) accurate	**1**
2(h)(i)	to mix the solutions	**1**
2(h)(ii)	to clean / remove residues (of Experiment 1 from the flask)	**1**
2(h)(iii)	it would add an unknown volume of solution **L**	**1**

Question	Answer	Marks
3(a)	brown precipitate or red-brown precipitate	**1**
	remains / does not (re)dissolve (in excess)	**1**

Question	Answer	Marks
3(b)(i)	(red) litmus turns blue	**1**
3(b)(ii)	ammonia / NH_3	**1**
3(c)	no change / no precipitate / no reaction	**1**
3(d)	sulfur dioxide / SO_2	**1**
3(e)	lithium sulfite / Li_2SO_3	**2**

Question	Answer	Marks
4	any 6 from: • grind / crush / powder coffee beans • using pestle / mortar • add water **and** stir / mix • heat / hot (water) (to dissolve) • filter • leave (filtrate) to cool **or** leave to form crystals • wash / rinse (crystals / residue / caffeine)	**6**

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

4234628191

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2022**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

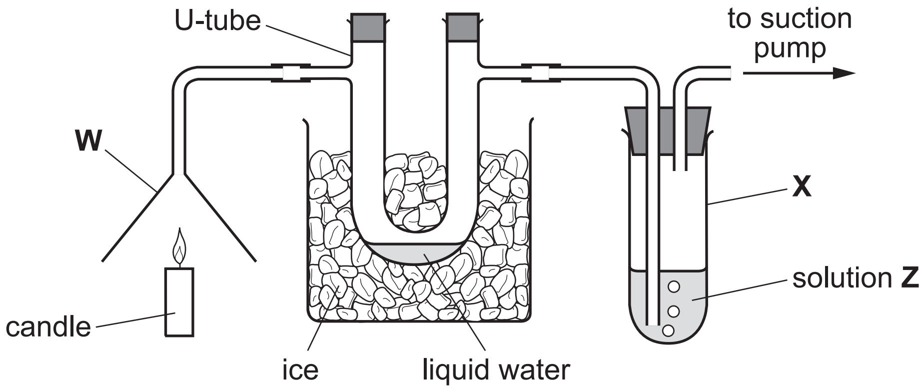
INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

IB22 06_0620_61/3RP

1 The apparatus in the diagram was used to show that when a candle is burned both water and carbon dioxide are formed. The gases produced when the candle burns are passed through the apparatus using a suction pump.



(a) Name the items of apparatus labelled **W** and **X**.

W ....

X ....
[2]

(b) Suggest why ice is placed around the U-tube.

....

.... [1]

(c) Describe how to test the liquid collected in the U-tube to show it is water.

....

.... [1]

(d) Solution **Z** is used to show that carbon dioxide is produced.

Identify solution **Z**.

.... [1]

(e) Both water and carbon dioxide were made.

Identify **one** element that must be in the compound that makes up the candle.

.... [1]

(f) Describe how the apparatus could be changed to see if sulfur dioxide is made.
Give the observations if sulfur dioxide is made.

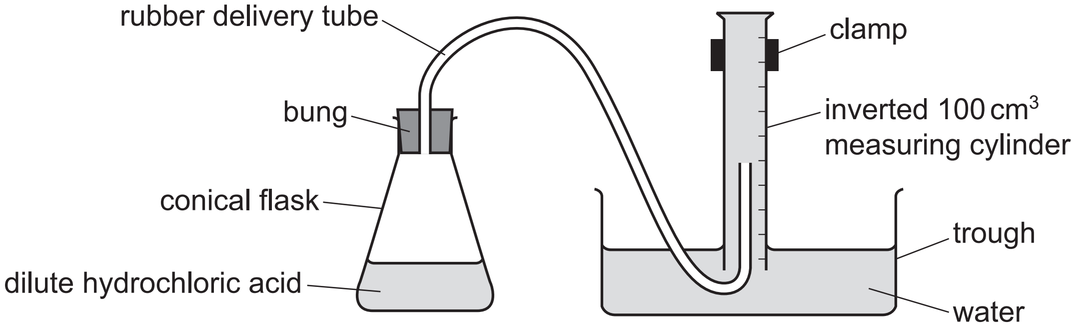
change ....

observation ....
[2]

[Total: 8]

2 A student investigated the rate at which hydrogen gas is made when magnesium reacts with two different solutions of dilute hydrochloric acid, **C** and **D**, with different concentrations. The dilute hydrochloric acid was in excess in both experiments.

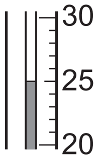
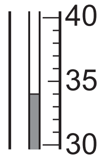
Two experiments were done using the apparatus shown.

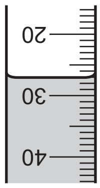
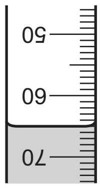
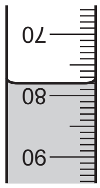
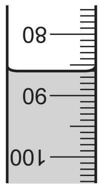
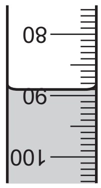
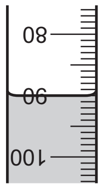
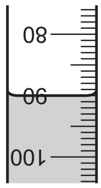


Experiment 1

- A measuring cylinder was used to pour 50 cm^3 of dilute hydrochloric acid **C** into a conical flask.
- The initial temperature of the dilute hydrochloric acid was measured using a thermometer.
- The apparatus was set up as shown in the diagram.
- The bung was removed from the conical flask and a coiled 5 cm length of magnesium ribbon was added to the flask. The bung was replaced immediately and a timer started.
- The volume of gas collected in the inverted measuring cylinder was recorded every 20 seconds for 160 seconds.
- The final temperature of the dilute hydrochloric acid in the flask was measured using a thermometer.

(a) Use the thermometer diagrams and the diagrams of inverted measuring cylinders to complete the tables.

initial		final	
thermometer diagram	temperature / °C	thermometer diagram	temperature / °C
			

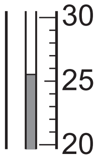
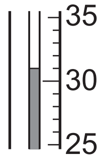
time / s	20	40	60	80	100	120	140	160
diagrams of inverted measuring cylinder								
volume of gas collected / cm^3								

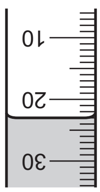
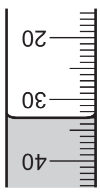
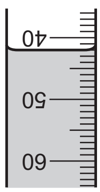
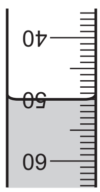
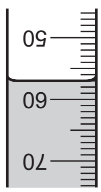
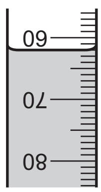
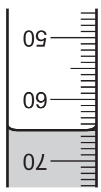
[2]

(b) *Experiment 2*

- Experiment 1 was repeated using 50 cm^3 of dilute hydrochloric acid **D** instead of dilute hydrochloric acid **C**.

Use the thermometer diagrams and the diagrams of inverted measuring cylinders to complete the tables.

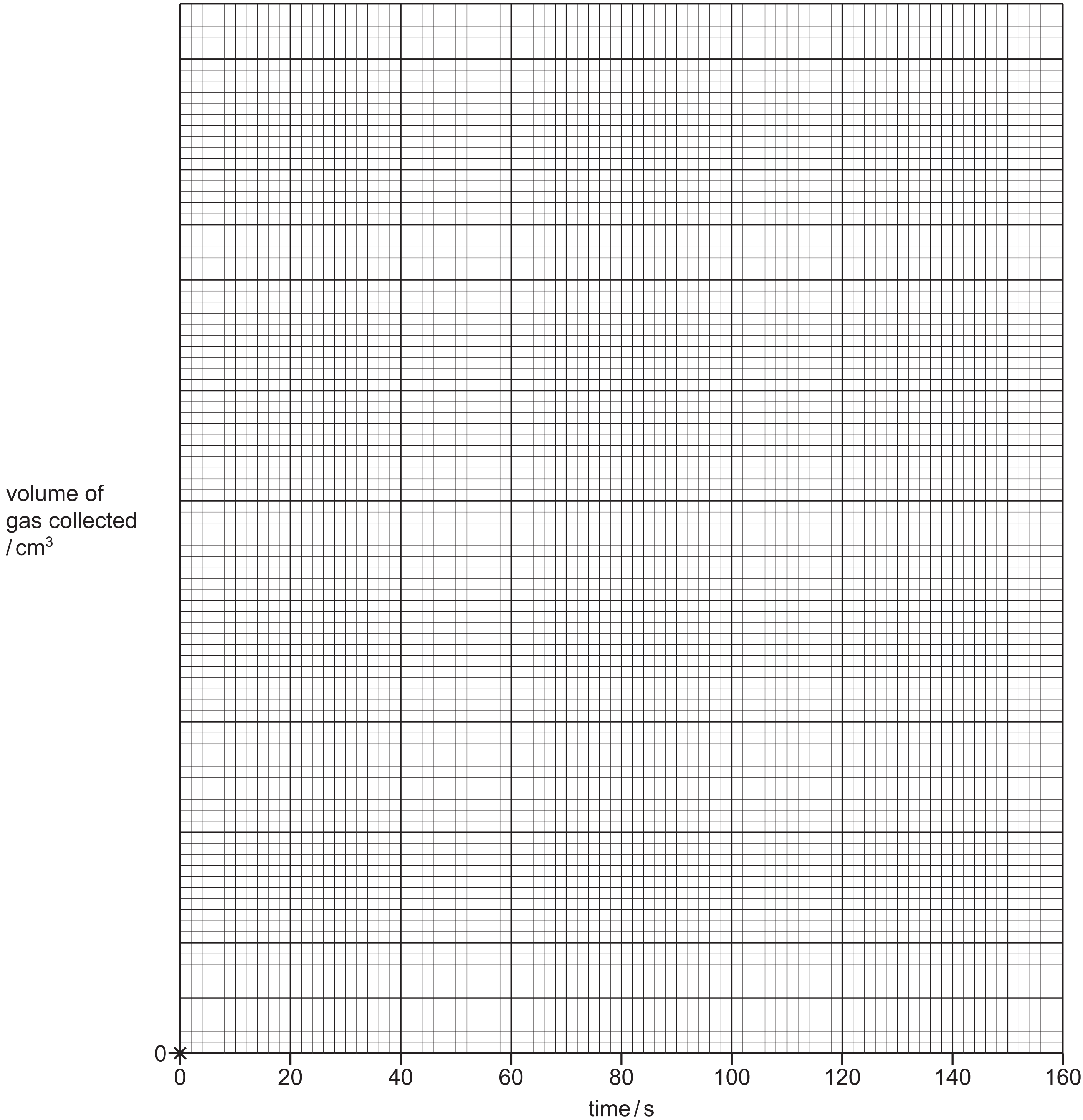
initial		final	
thermometer diagram	temperature / °C	thermometer diagram	temperature / °C
			

time / s	20	40	60	80	100	120	140	160
diagrams of inverted measuring cylinder								
volume of gas collected / cm^3								

[3]

(c) Complete a suitable scale on the *y*-axis and plot your results from Experiments 1 and 2 on the grid.

Draw **two** smooth line graphs. The lines must pass through (0,0). Clearly label your lines.



[5]

(d) **From your graph**, deduce the volume of gas that was collected after 50 seconds in Experiment 2.

Show clearly **on the grid** how you worked out your answer.

volume of gas = ... [3]

(e) Explain what can be deduced about the concentrations of dilute hydrochloric acid **C** and dilute hydrochloric acid **D**.

....

....

....

.... [2]

(f) **(i)** State what happens to the temperature of the dilute hydrochloric acid during Experiment 1.

.... [1]

(ii) State what effect this temperature change has on the total volume of gas made when the reaction has finished.

.... [1]

(iii) Describe a change that can be made to the apparatus or reagents to reduce the temperature change of the acid in Experiment 1.

.... [1]

(g) Suggest why it is important to replace the bung in the conical flask immediately after adding the magnesium ribbon.

....

.... [1]

(h) State the advantage of measuring the volume of gas collected every 10 seconds rather than every 20 seconds.

.... [1]

[Total: 20]

3 Solid **E** and solution **F** were analysed. Solid **E** was ammonium sulfate.
Tests were done on each substance.

tests on solid E

Complete the expected observations.

Solid **E** was dissolved in water to form solution **E**. Solution **E** was divided into three approximately equal portions in one boiling tube and two test-tubes.

(a) Aqueous sodium hydroxide was added to the first portion of solution **E** in a boiling tube. The mixture formed was warmed. Any gas produced was tested.

observations ....

....

identity of gas .... [2]

(b) To the second portion of solution **E**, about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate were added.

observations .... [1]

(c) To the third portion of solution **E**, about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate were added.

observations .... [1]

tests on solution F

tests	observations
Solution **F** was divided into two equal portions in two test-tubes. **test 1** A strip of universal indicator paper was placed in the first portion of solution **F**.	the universal indicator paper turned orange
test 2 The second portion of solution **F** was added to solid sodium carbonate in a boiling tube. Any gas made was tested.	effervescence and the solid disappeared limewater turned milky

(d) Deduce the pH of solution **F**.

.... [1]

(e) Identify the positive ion in solution **F**.

.... [1]

[Total: 6]

4 A sample of muddy river water contains water, dissolved solids and insoluble solid mud.

Plan an investigation to find the concentration of dissolved solids, in g/dm^3, in the river water.

In your answer state how you will work out the concentration of the dissolved solids in g/dm^3.

You are provided with a small sample (less than $1\,dm^3$) of muddy river water and common laboratory apparatus.
($1\,dm^3 = 1000\,cm^3$)

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.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY | **0620/61**

Paper 6 Alternative to Practical | **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	Guidance for chemical equations Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	**W** (filter) funnel	**1**
	X test-tube / boiling tube	**1**
1(b)	to cool (the steam to form water) / to turn steam to water / to condense (the steam) / so water condenses	**1**
1(c)	measure boiling point = 100 (°C) **or** measure freezing point = 0 (°C)	**1**
1(d)	limewater / calcium hydroxide (solution)	**1**
1(e)	contains carbon **or** hydrogen	**1**
1(f)	use (acidified) potassium manganate(VII)	**1**
	changes from purple to colourless	**1**

Question	Answer	Marks
2(a)	both temperatures recorded correctly (25.0, 34.0)	**1**
	all eight measuring cylinder volumes correct (27, 48, 65, 78, 86, 89, 90, 90)	**1**
2(b)	both temperatures recorded correctly (25.5, 31.0)	**1**
	both temperatures recorded 1 dp in **(b)**	**1**
	all eight measuring cylinder volumes correct (12, 23, 33, 42, 50, 57, 62, 65)	**1**

Question	Answer	Marks
2(c)	y-axis scale in linear and points extend over halfway up scale	**1**
	all points for Experiment 1 and 2 plotted correctly	**2**
	two best fit curves	**1**
	lines both extended to (0,0) and are labelled	**1**
2(d)	correct working shown on graph	**1**
	correct reading from their working shown on graph.	**1**
	cm^3	**1**
2(e)	solution **C** is more concentrated than solution **D**	**1**
	as reaction is faster	**1**
2(f)(i)	increases	**1**
2(f)(ii)	none / stays the same	**1**
2(f)(iii)	use a water bath	**1**
2(g)	minimise gas loss / escape	**1**
2(h)	(more points / data so) better / smoother graph / curve / line	**1**

Question	Answer	Marks
3(a)	(red) litmus becomes blue	**1**
	ammonia / NH_3	**1**
3(b)	no change / (remains) colourless	**1**

Question	Answer	Marks
3(c)	white precipitate	**1**
3(d)	any in range 2–6	**1**
3(e)	hydrogen / H^+	**1**

Question	Answer	Marks
4	• filter the water (1) **and any five from:** • specified volume of water / filtrate • placed in a suitable container and heated in this container (evaporating basin / beaker) • heat/warm (to evaporate water) • (heat) until all water gone / to dryness / to constant mass • find mass of solid left • concentration = mass × 1000 ÷ volume used	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME										
CENTRE NUMBER							CANDIDATE NUMBER			

3760474789

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 A list of substances is shown.

aluminium oxide	**carbon dioxide**	**carbon monoxide**	**chlorine**	**copper**
glucose	**iron(III) oxide**	**limestone**	**nitrogen**	**oxygen**

Answer the questions using the substances in the list.

Each substance may be used once, more than once or not at all.

State which substance is:

(a) a product of respiration

.... [1]

(b) the main constituent of hematite

.... [1]

(c) an element which has a sulfate that is used to test for water

.... [1]

(d) a colourless toxic gas

.... [1]

(e) a reactant in fermentation

.... [1]

(f) a reducing agent in the extraction of iron

.... [1]

(g) a conductor of electricity when solid

.... [1]

(h) a gas that is approximately 21% of clean, dry air.

.... [1]

[Total: 8]

2 **(a)** $^{32}_{16}S$ and $^{33}_{16}S$ are isotopes of sulfur.

Use your knowledge of protons, neutrons and electrons to answer the following questions.

(i) Describe how these isotopes of sulfur are the same and how they are different.

same ....

....

different ....

....

[3]

(ii) Explain why each of these isotopes have an overall charge of zero.

....

.... [1]

(iii) Explain why both isotopes have the same chemical properties.

....

.... [1]

(b) Sulfide ions, S^{2-}, have the electronic structure 2,8,8.

(i) Explain why sulfide ions have a charge of 2–.

....

.... [1]

(ii) Give the formula of:

- an anion which has the same electronic structure as S^{2-}

....

- a cation which has the same electronic structure as S^{2-}.

....

[2]

[Total: 8]

3 This question is about nitrogen and compounds of nitrogen.

(a) Nitrogen molecules have the formula N_2.

Some properties of nitrogen are shown:

- melting point of –210 °C
- boiling point of –196 °C
- non-conductor of electricity when solid
- insoluble in water.

(i) Name the type of bonding between the atoms in an N_2 molecule.

.... [1]

(ii) Explain, in terms of attractive forces between particles, why nitrogen has a low melting point.

....

.... [1]

(iii) Explain why nitrogen does **not** conduct electricity.

....

.... [1]

(b) Nitrogen reacts with hydrogen to form ammonia, NH_3, in the Haber process.

State the essential conditions in the Haber process. Write an equation for the chemical reaction.

....

....

....

....

.... [4]

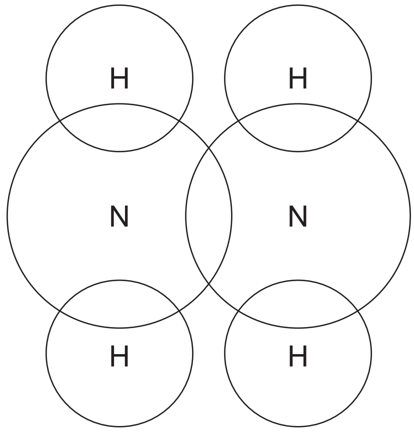
(c) Ammonia is made in the laboratory by heating ammonium chloride with calcium hydroxide.

Balance the chemical equation for the reaction.

$$.....NH_4Cl + Ca(OH)_2 \rightarrow .....NH_3 + CaCl_2 + ...H_2O$$ [1]

(d) Hydrazine, N_2H_4, is another compound that contains nitrogen and hydrogen.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrazine. Show outer electrons only.



[2]

(e) Ammonia and hydrazine are weak bases.

The chemical equation for the reaction between one molecule of ammonia and one molecule of water is shown.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

(i) State the meaning of the term *base*.

.... [1]

(ii) Write a chemical equation for the reaction between one molecule of hydrazine, N_2H_4, and one molecule of water.

.... [1]

[Total: 12]

4 Ethanol is made industrially by the reaction of ethene with steam. The reaction occurs at a temperature of 300 °C and a pressure of 60 atmospheres.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

A catalyst is used in this reaction.

The forward reaction is exothermic.

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

....

.... [2]

(b) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield of $C_2H_5OH(g)$
increasing the temperature		
decreasing the pressure		

[4]

(c) Ethanol is a member of the alcohol homologous series.

Members of the same homologous series have the same general formula.

(i) State the general formula of alcohols.

.... [1]

(ii) State two **general** characteristics, other than the same general formula, of all homologous series.

1 ....

2 ....
[2]

(iii) One alcohol containing three carbon atoms is propan-1-ol.

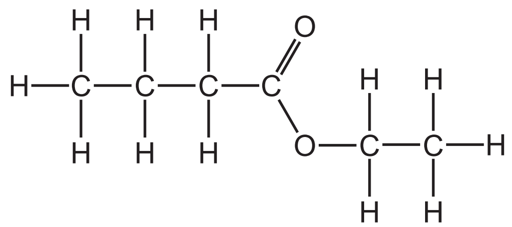
Draw the structure of one **other** alcohol containing three carbon atoms. Show all of the atoms and all of the bonds.

Name the alcohol you have drawn.

name ....
[2]

(d) When alcohols react with carboxylic acids, esters are produced.

(i) The structure of ester **X** is shown.



Name ester **X**.

.... [1]

(ii) Give the name of the alcohol and the carboxylic acid that react together to produce ester **X**.

alcohol ....

carboxylic acid ....
[2]

(e) Ester **Y** has the following composition by mass:

C, 58.82%; H, 9.80%; O, 31.37%.

Calculate the empirical formula of ester **Y**.

empirical formula = ... [3]

(f) Ester **Z** has the empirical formula C_3H_6O and a relative molecular mass of 116.

Calculate the molecular formula of ester **Z**.

molecular formula = ... [1]

[Total: 18]

5 This question is about copper and its compounds.

(a) Describe the bonding in a metallic element such as copper.

You may include a diagram as part of your answer.

....

....

.... [3]

(b) A metal spoon is electroplated with copper.

State what is used as:

the positive electrode (anode) ....

the negative electrode (cathode) ....

the electrolyte. ....
[3]

(c) The formula for crystals of hydrated copper(II) sulfate is $CuSO_4{\bullet}5H_2O$.

Hydrated copper(II) sulfate is made by reacting copper(II) oxide with dilute sulfuric acid.

The overall equation is shown.

$$CuO + H_2SO_4 + 4H_2O \rightarrow CuSO_4{\bullet}5H_2O$$

The crystals are made using the following steps:

step 1 50.0 cm^3 of 0.200 mol/dm^3 dilute sulfuric acid is heated in a beaker. Powdered copper(II) oxide is added until the copper(II) oxide is in excess. Aqueous copper(II) sulfate is formed.

step 2 The excess copper(II) oxide is separated from the aqueous copper(II) sulfate.

step 3 The aqueous copper(II) sulfate is heated until a saturated solution is formed.

step 4 The saturated solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

Calculate the maximum mass of copper(II) sulfate crystals, $CuSO_4{\bullet}5H_2O$, that can form using the following steps.

- Calculate the number of moles of H_2SO_4 in 50.0 cm^3 of 0.200 mol/dm^3 H_2SO_4.

.... mol

- Deduce the number of moles of $CuSO_4{\bullet}5H_2O$ that can form.

.... mol

- The M_r of $CuSO_4{\bullet}5H_2O$ is 250.

  Calculate the maximum mass of $CuSO_4{\bullet}5H_2O$ that can form.

.... g

[3]

(d) State **one** observation that indicates the copper(II) oxide is in excess in **step 1**.

.... [1]

(e) **Step 1** is repeated without heating the dilute sulfuric acid.

All other conditions are kept the same.

The rate of reaction decreases.

Give a reason why the rate of reaction decreases. Explain your answer in terms of particles.

....

....

....

....

.... [3]

(f) Name a substance, other than copper(II) oxide, that can be added to dilute sulfuric acid to produce copper(II) sulfate in **step 1**.

.... [1]

(g) Name the process used to separate excess copper(II) oxide from aqueous copper(II) sulfate in **step 2**.

.... [1]

(h) Suggest what is meant by the term *saturated solution* in **step 3**.

....

....

.... [2]

(i) The phrase 'heating to dryness' means heating until no more water is given off.

Explain why aqueous copper(II) sulfate is **not** heated to dryness in **step 3**.

....

.... [1]

[Total: 18]

6 The Periodic Table can be used to classify elements.

(a) The Group I metals react with cold water. Transition elements do not react with cold water.

(i) Describe two **other** differences in the **chemical** properties between Group I metals and transition elements.

1 ....

2 ....
[2]

(ii) Describe the observations when potassium is added to cold water. Write a balanced equation for the reaction. Include state symbols.

observations ....

....

....

....

equation ....
[5]

(b) Transition elements are stronger than Group I metals.

Describe two **other** differences in the **physical** properties of Group I metals and transition elements.

1 ....

2 ....
[2]

(c) Some Group VII elements react with aqueous solutions containing halide ions.

When aqueous bromine is added to aqueous potassium iodide a reaction occurs.

The ionic half-equations for the reaction are shown.

$$Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$$

$$2I^-(aq) \rightarrow I_2(aq) + 2e^-$$

(i) Describe the colour change of the solution.

original colour of potassium iodide solution ....

final colour of reaction mixture ....
[2]

(ii) State the name of the general term given to the type of reaction in which electrons are transferred from one species to another.

.... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

oxidising agent ....

reason ....
[2]

(d) Use the key to complete the table to show the results of adding aqueous halogens to aqueous solutions of halides. One has been completed for you.

		halides		
		KCl(aq)	KBr(aq)	KI(aq)
halogens	Cl_2(aq)			
	Br_2(aq)			✓
	I_2(aq)			

key
✓ = reaction
✗ = no reaction

[2]

[Total: 16]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2022**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **11** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Examples of how to apply the list rule
State **three** reasons…. [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B
(4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C
(4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D
(4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E
(4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F
(4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G
(5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I
(4 responses)

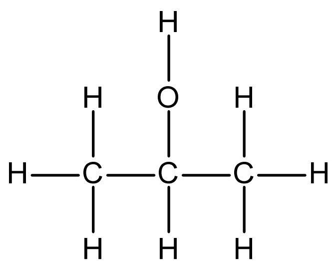
1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1(a)	carbon dioxide	**1**
1(b)	iron(III) oxide	**1**
1(c)	copper	**1**
1(d)	carbon monoxide	**1**
1(e)	glucose	**1**
1(f)	carbon monoxide	**1**
1(g)	copper	**1**
1(h)	oxygen	**1**

Question	Answer	Marks
2(a)(i)	number of protons (are the same) / 16 protons (1) number of electrons (are the same) / 16 electrons (1) number of neutrons (are different) / 16,17 neutrons (1)	**3**
2(a)(ii)	**number** of protons is the same as (the number of) electrons	**1**
2(a)(iii)	same **number** of (outer shell) electrons	**1**
2(b)(i)	(they have) **two** more electrons than protons	**1**
2(b)(ii)	P^{3-} **OR** Cl^{-} (1) K^{+} **OR** Ca^{2+} (1)	**2**

Question	Answer	Marks
3(a)(i)	covalent	**1**
3(a)(ii)	weak force(s) of attraction between **molecules**	**1**
3(a)(iii)	no ions OR no mobile electrons	**1**
3(b)	450 °C (1) 200 atmospheres (1) iron (catalyst) (1) $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (1)	**4**
3(c)	$\mathbf{2}NH_4Cl + Ca(OH)_2 \rightarrow \mathbf{2}NH_3 + CaCl_2 + \mathbf{2}H_2O$	**1**
3(d)	all 4 NH dot and cross bonds (1) single bonding pair between N's **and** two non-bonding electrons on each N **and** no non-bonding e on H and nitrogen octet complete (1)	**2**
3(e)(i)	proton acceptor	**1**
3(e)(ii)	$N_2H_4 + H_2O \rightleftharpoons N_2H_5^+ + OH^-$	**1**

Question	Answer	Marks
4(a)	(a substance which) increases the rate of a reaction remains unchanged or unaffected or without changing mass	**2**
4(b)	<table><tr><td>increases (1)</td><td>decreases (1)</td></tr><tr><td>decreases (1)</td><td>decreases (1)</td></tr></table>	**4**

Question	Answer	Marks
4(c)(i)	$C_nH_{2n+1}OH$	**1**
4(c)(ii)	any 2 from: • same or **similar** chemical properties or reactions • (contain) the same functional group • (consecutive members) differ by CH_2 • physical properties vary in predictable manner / show trends / gradually change	**2**
4(c)(iii)	 (1) propan-2-ol (1)	**2**
4(d)(i)	ethyl butanoate	**1**
4(d)(ii)	ethanol (1) butanoic acid (1)	**2**
4(e)	C 58.82 / 12 H 9.80 / 1 O 31.37 / 16 **OR** 4.90:9.80:1.96 (1) 2.5:5:1 **OR** 5:10:2 (1) $C_5H_{10}O_2$(1)	**3**

Question	Answer	Marks
4(f)	$C_6H_{12}O_2$	**1**

Question	Answer	Marks
5(a)	(lattice of) positive ions (1) sea of / delocalised / mobile electrons (1) attraction between positive ions and electrons (1)	**3**
5(b)	copper (1) spoon (1) (aqueous or solution) of named copper salt (1)	**3**
5(c)	$(0.2 \times 50 / 1000) = 0.01$ (1) 0.01 (1) $(250 \times 0.01) = 2.5$ (1)	**3**
5(d)	solid undissolved	**1**
5(e)	particles have less energy fewer collisions (between particles) occur per second / per unit time a smaller percentage / proportion / fraction of collisions (of particles) are successful / have energy above activation energy / have energy equal to activation energy	**3**
5(f)	copper(II) carbonate **OR** copper(II) hydroxide	**1**
5(g)	filtration	**1**

Question	Answer	Marks
5(h)	(a solution that) can dissolve no more solute at a given temperature	**2**
5(i)	forms anhydrous (copper sulfate) OR forms (white) powder	**1**

Question	Answer	Marks
6(a)(i)	Group 1 metals do not show catalytic behaviour Group 1 have fixed oxidation states	**2**
6(a)(ii)	any 2 observations from: • moves / floats • dissolves / disappears • bubbles / effervescence / fizzes • lilac flame • explodes • melts / forms a spherical shape $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$ KOH or H_2 product (1) in equation fully correct equation (1) state symbols (1)	**5**
6(b)	transition elements have high(er) melting point (1) transition elements have high(er) density (1)	**2**
6(c)(i)	colourless (1) brown (1)	**2**

Question	Answer	Marks
6(c)(ii)	redox	**1**
6(c)(iii)	Br_2 (1) (bromine) is reduced (1)	**2**
6(d)	two ticks in first row (1) three crosses in the other three boxes (1)	**2**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

* 6 1 4 8 5 9 4 1 8 3 *

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 The symbols of the elements of Period 3 of the Periodic Table are shown.

Na	Mg	Al	Si	P	S	Cl	Ar

Answer the following questions about these elements.
Each symbol may be used once, more than once or not at all.

Write the symbol of the element which:

(a) forms a stable ion with a 2+ charge .... [1]

(b) is the least reactive in the period .... [1]

(c) is used in water treatment .... [1]

(d) forms an oxide which is the main impurity in iron ore .... [1]

(e) is an important component of fertilisers .... [1]

(f) is stored under oil .... [1]

(g) is used in food containers .... [1]

(h) is found in the ore zinc blende. .... [1]

[Total: 8]

Question 2 starts on the next page.

2 Calcium hydroxide, $Ca(OH)_2$, is slightly soluble in water.

(a) Calcium hydroxide can be made by the reaction of calcium with water.

(i) Write the chemical equation for this reaction.

.... [2]

(ii) Name another substance that reacts with water to form calcium hydroxide.

.... [1]

(b) When calcium hydroxide dissolves in water, it dissociates into ions and forms a weakly alkaline solution.

(i) Suggest the pH of aqueous calcium hydroxide.

.... [1]

(ii) Give the formula of the ion responsible for making the solution alkaline.

.... [1]

(c) Limewater is a saturated solution of calcium hydroxide, $Ca(OH)_2(aq)$.

(i) Name the gas limewater is used to test for.

.... [1]

(ii) Suggest what is meant by the term *saturated solution*.

....

.... [2]

(iii) Describe how you would make a sample of limewater starting with solid calcium hydroxide.

....

....

.... [2]

(iv) Describe how you would test for the presence of calcium ions in a sample of limewater.

test ....

observations ....

....

[3]

(d) A 25.0 cm^3 sample of limewater is placed in a conical flask. The concentration of $Ca(OH)_2$ in the limewater is determined by titration with dilute hydrochloric acid, HCl.

(i) Name the item of apparatus used to measure the volume of acid in this titration.

.... [1]

(ii) State the type of reaction which takes place.

.... [1]

(iii) As well as limewater and dilute hydrochloric acid, state what other type of substance must be added to the conical flask.

.... [1]

(iv) The equation for the reaction is shown.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

20.0 cm^3 of 0.0500 mol / dm^3 HCl reacts with the 25.0 cm^3 of $Ca(OH)_2$.

Determine the concentration of $Ca(OH)_2$ in g / dm^3. Use the following steps.

- Calculate the number of moles in 20.0 cm^3 of 0.0500 mol / dm^3 HCl.

.... mol

- Determine the number of moles of $Ca(OH)_2$ in 25.0 cm^3 of the limewater.

.... mol

- Calculate the concentration of $Ca(OH)_2$ in mol / dm^3.

.... mol / dm^3

- Determine the concentration of $Ca(OH)_2$ in g / dm^3.

.... g / dm^3
[5]

[Total: 21]

3 Transition elements are found in the middle block of the Periodic Table.

(a) Chromium has several isotopes. Manganese has only one isotope.

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

....

.... [2]

(ii) State the nucleon number of manganese.

.... [1]

(iii) Complete the table to show the number of protons, neutrons and electrons in a $^{52}_{24}Cr^{3+}$ ion.

protons	neutrons	electrons

[3]

(b) One chemical property of transition elements is that they form coloured compounds.

(i) Give the colours of the following hydrated salts.

- hydrated copper(II) sulfate ....
- hydrated cobalt(II) chloride ....

[2]

(ii) State two **other** chemical properties of transition elements.

1 ....

2 ....

[2]

(c) Transition elements and Group I elements are metals. They share many physical properties including the ability to:

- conduct electricity
- be hammered into shape.

(i) Explain why transition elements and Group I elements conduct electricity.

.... [1]

(ii) State the property that describes a material which can be hammered into shape.

.... [1]

(d) Transition elements and Group I elements differ in other physical properties. Transition elements are harder and stronger than Group I elements.

Describe two **other** ways in which the physical properties of transition elements differ from Group I elements.

1 ....

2 ....
[2]

[Total: 14]

4 Fluorine and chlorine are halogens.

(a) Suggest the appearance of fluorine.

.... [1]

(b) Fluorine reacts with sulfur to form a compound which has 25.2% sulfur by mass and a relative molecular mass of 254.

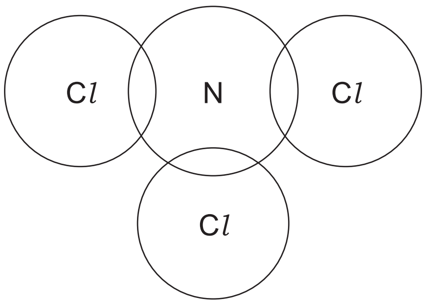
Determine the molecular formula of this compound.

molecular formula = ... [3]

(c) Nitrogen trichloride, NCl_3, is a covalent compound.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NCl_3.

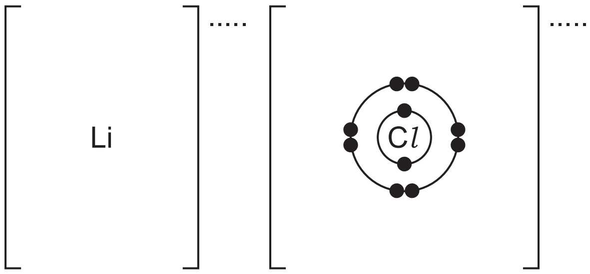
Show outer electrons only.



[3]

(d) Lithium chloride, LiCl, is an ionic compound.

Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in lithium chloride.



[3]

(e) Explain, in terms of attractive forces between particles, why LiCl is a solid at room temperature but NCl_3 is a liquid with a relatively low boiling point.

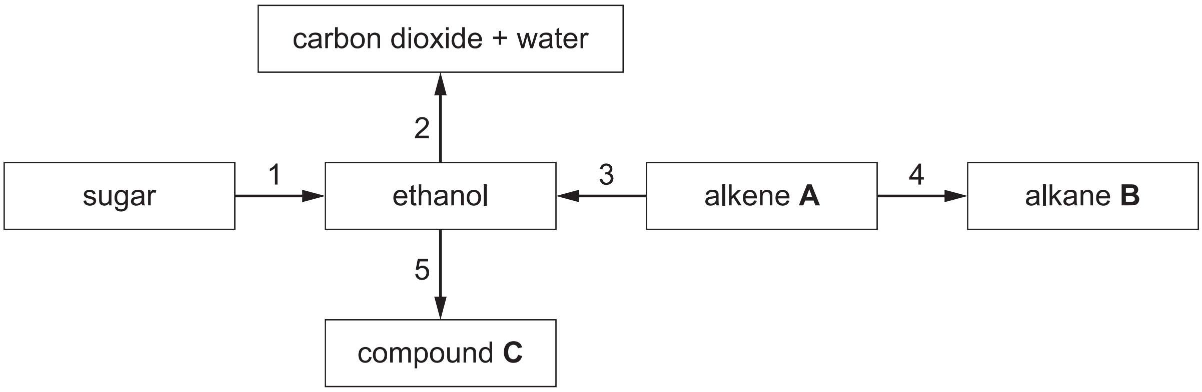
....

....

.... [3]

[Total: 13]

5 The reaction scheme shows five organic reactions, numbered 1 to 5.



(a) Name reaction 1.

.... [1]

(b) Name reaction 2 and write the chemical equation for this reaction.

name ....

equation ....
[3]

(c) Reaction 3 forms ethanol from alkene **A**.

(i) Identify alkene **A**.

.... [1]

(ii) State the type of reaction that occurs during reaction 3.

.... [1]

(iii) State the reagents and conditions needed for reaction 3.

....

.... [2]

(d) Alkene **A** is converted into alkane **B** in reaction 4.

(i) State the reagent and conditions for reaction 4.

....

.... [3]

(ii) State the general formula of alkanes.

.... [1]

(e) Ethanol is oxidised in reaction 5 by heating it with dilute sulfuric acid and one other reagent.

(i) Identify the other reagent in reaction 5.

.... [1]

(ii) Name the homologous series compound **C** belongs to.

.... [1]

(iii) Draw the structure of compound **C**.

Show all of the atoms and all of the bonds.

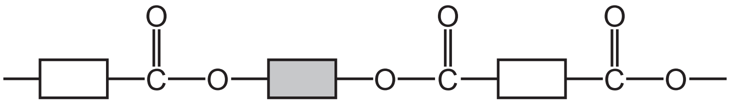
[1]

[Total: 15]

6 This question is about polymers.

(a) Polymer **X** is a condensation polymer.

Part of the structure of polymer **X** is shown.



(i) How many molecules of water are produced when this part of polymer **X** is formed from its monomers?

.... [1]

(ii) Complete the structures of the **two** monomers used to make polymer **X**.

Show all of the atoms and all of the bonds in the functional groups.

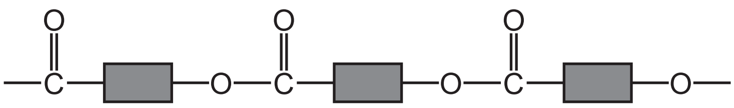
and

[2]

(iii) What type of condensation polymer is **X**?

.... [1]

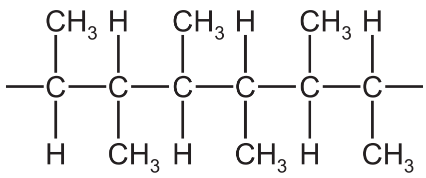
(b) Part of polymer **Y** has the structure shown.



State the number of different types of monomer needed to make polymer **Y**.

.... [1]

(c) Part of polymer **Z** has the structure shown.



(i) Draw and name the structure of the monomer which forms polymer **Z**.

Show all of the atoms and all of the bonds.

name ....

[3]

(ii) Name the chemical process used to make the monomer that forms polymer **Z**.

.... [1]

[Total: 9]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 T*l* thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 F*l* flerovium –		116 Lv livermorium –		

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actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2022**

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Published

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	Mg	**1**
1(b)	Ar	**1**
1(c)	C*l*	**1**
1(d)	Si	**1**
1(e)	P	**1**
1(f)	Na	**1**
1(g)	A*l*	**1**
1(h)	S	**1**

Question	Answer	Marks
2(a)(i)	$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ M1 H_2 as product M2 Fully correct equation	**2**
2(a)(ii)	calcium oxide	**1**
2(b)(i)	$7 < pH \leqslant 12$	**1**
2(b)(ii)	OH^-	**1**
2(c)(i)	carbon dioxide	**1**
2(c)(ii)	(a solution that) can dissolve no more solute at a given temperature	**2**

Question	Answer	Marks
2(c)(iii)	add excess (solid) calcium hydroxide (to water) filter	**2**
2(c)(iv)	(aqueous) sodium hydroxide	**1**
	white ppt insoluble / remains in excess	**2**
2(d)(i)	burette	**1**
2(d)(ii)	neutralisation	**1**
2(d)(iii)	indicator	**1**
2(d)(iv)	M1 Mol HC*l* = 0.0500 × 20.0 / 1000 = 0.001(00) M2 Mol $Ca(OH)_2$ = M1 / 2 = 0.00100 / 2 = 0.0005(00) M3 M2 × 1000 / 25 = 0.0005(00) × 40 = 0.02(00) M4 M_r $Ca(OH)_2$ = 74 M5 M4 × M3 = 74 × 0.02 = 1.48 (g / dm^3)	**5**

Question	Answer	Marks
3(a)(i)	**atom(s)** of the same element with different number of neutrons	**2**
3(a)(ii)	55	**1**
3(a)(iii)	24 protons; 28 neutrons; 21 electrons	**3**

Question	Answer	Marks
3(b)(i)	blue pink	**2**
3(b)(ii)	(act as) catalysts variable oxidation state	**2**
3(c)(i)	mobile electrons	**1**
3(c)(ii)	malleability / malleable	**1**
3(d)	high(er) density high(er) melting points	**2**

Question	Answer	Marks
4(a)	(pale) yellow **and** gas	**1**
4(b)	**Method 1** M1 S 25.2 / 32 **or** 0.78/0.79 … **and** F 74.8 / 19 **or** 3.93 / 3.94… M2 ÷ both by 0.7875 = 1 : 5 **or** SF_5 M3 (254 ÷ 127 = 2 and) S_2F_{10} **Method 2** M1 254 × 25.2/100 **and** 254 × 74.8 / 100 **OR** ‘64’ **and** ‘190’ M2 64 / 32 **and** 190 / 19 M3 (2 and 10) to give S_2F_{10}	**3**

Question	Answer	Marks
4(c)	N with 1 dot-cross bonding pair with each C*l* 2 non-bonding dots for N 6 non-bonding crosses for C*l*	**3**
4(d)	two crosses in first shell of Li 7 dots and 1 cross in third shell of C*l* '+' charge on Li on correct answer line **and** '–' charge on C*l* ion on correct answer line	**3**
4(e)	ionic bonds in LiC*l* attraction between molecules in NCl_3 weaker attraction (between particles) in NCl_3 ORA	**3**

Question	Answer	Marks
5(a)	fermentation	**1**
5(b)	(complete) combustion $C_2H_5OH + 3O_2 \rightarrow 3H_2O + 2CO_2$ reactant species fully correct equation	**3**
5(c)(i)	ethene	**1**
5(c)(ii)	addition	**1**
5(c)(iii)	steam catalyst + 60 atm **or** catalyst + 300 °C	**2**
5(d)(i)	hydrogen catalyst high temperature	**3**

Question	Answer	Marks
5(d)(ii)	CnH_{2n+2}	**1**
5(e)(i)	potassium manganate(VII)	**1**
5(e)(ii)	carboxylic acids	1
5(e)(iii)	fully displayed formula of ethanoic acid	1

Question	Answer	Marks
6(a)(i)	3	**1**
6(a)(ii)	diagram of dioic acid showing two fully displayed carboxylic acid groups on unshaded block diagram of diol showing two fully displayed hydroxyl groups on shaded block	**2**
6(a)(iii)	polyester	**1**
6(b)	one	**1**
6(c)(i)	any hydrocarbon with one C=C bond (with both C atoms having 4 bonds) (1) structure of but-2-ene (1) but-2-ene	**3**
6(c)(ii)	cracking	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8032813939

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 A list of substances is shown.

aluminium oxide	**carbon dioxide**	**chlorine**	**diamond**	**ethanol**
glucose	**iron(III) oxide**	**limestone**	**nitrogen**	**oxygen**

Answer the questions using the list of substances.

Each substance may be used once, more than once or not at all.

State which of the substances:

(a) is a reactant in photosynthesis

.... [1]

(b) is the main constituent of bauxite

.... [1]

(c) are **two** products of fermentation

.... and .... [2]

(d) is used as a fuel

.... [1]

(e) is a gas used to convert iron into steel

.... [1]

(f) is a greenhouse gas

.... [1]

(g) is a gas that is approximately 78% of clean, dry air

.... [1]

(h) is a form of carbon.

.... [1]

[Total: 9]

2 **(a)** Atoms are made of protons, neutrons and electrons. Atoms of the same element are known as isotopes.

(i) Complete the table.

particle	relative charge	relative mass
electron		$\frac{1}{1840}$
neutron		
proton	+1	

[2]

(ii) ${}^{24}_{12}Mg$ and ${}^{25}_{12}Mg$ are isotopes of magnesium.

Complete the table to show the numbers of electrons, neutrons and protons in these isotopes of magnesium.

isotope	number of electrons	number of neutrons	number of protons
${}^{24}_{12}Mg$			
${}^{25}_{12}Mg$			

[2]

(iii) Explain why magnesium ions have a charge of 2+.

....

.... [1]

(b) Mg^{2+} ions have the electronic structure 2,8.

Give the formula of the following particles which have the same electronic structure as Mg^{2+} ions.

- a cation (positive ion)

....

- an anion (negative ion)

....

- an atom

....

[3]

[Total: 8]

3 This question is about sodium and compounds of sodium.

(a) **(i)** Describe the bonding in a metallic element such as sodium.

You may include a diagram as part of your answer.

....

....

.... [3]

(ii) Describe how solid sodium conducts electricity.

.... [1]

(b) Some properties of sodium chloride are shown:

- melting point of 801 °C
- non-conductor of electricity when solid
- conductor of electricity when molten
- soluble in water.

(i) Name the type of bonding in sodium chloride.

.... [1]

(ii) Explain why sodium chloride conducts electricity when molten.

....

.... [1]

(c) A student determines the concentration of a solution of dilute sulfuric acid, H_2SO_4, by titration with aqueous sodium hydroxide, NaOH.

step 1 25.0 cm^3 of 0.200 mol/dm^3 NaOH is transferred into a conical flask.

step 2 Three drops of methyl orange indicator are added to the conical flask.

step 3 A burette is filled with H_2SO_4.

step 4 The acid in the burette is added to the conical flask until the indicator changes colour. The volume of acid is recorded. This process is known as titration.

step 5 The titration is repeated several times until a suitable number of results is obtained.

(i) Name the piece of apparatus used to measure exactly 25.0 cm^3 of 0.200 mol/dm^3 NaOH in **step 1**.

.... [1]

(ii) State the colour change of the methyl orange indicator in **step 4**.

from .... to .... [1]

(iii) State how the student decides that a suitable number of results have been obtained.

....

.... [1]

(iv) 20.0 cm^3 of H_2SO_4 reacts with 25.0 cm^3 of 0.200 mol/dm^3 NaOH.

The equation for the reaction is shown.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of H_2SO_4 using the following steps.

- Calculate the number of moles in 25.0 cm^3 of 0.200 mol/dm^3 NaOH.

.... mol

- Determine the number of moles of H_2SO_4 that react with the NaOH.

.... mol

- Calculate the concentration of H_2SO_4.

.... mol/dm^3
[3]

[Total: 12]

4 This question is about compounds of sulfur.

(a) Sulfuric acid, H_2SO_4, is manufactured using the Contact process. This manufacture involves four stages.

stage 1 Molten sulfur burns in air to produce sulfur dioxide.

stage 2 Sulfur dioxide reacts with oxygen to form sulfur trioxide.

stage 3 Sulfur trioxide combines with concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

stage 4 Oleum reacts to form concentrated sulfuric acid.

(i) Write a chemical equation for the reaction occurring in **stage 1**.

.... [1]

(ii) State the essential conditions that are necessary for **stage 2**. Write an equation for the chemical reaction that occurs.

....

....

....

.... [4]

(iii) Write a chemical equation for the reaction occurring in **stage 3**.

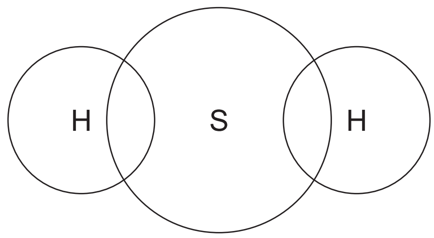
.... [1]

(iv) Name the substance that reacts with oleum in **stage 4**.

.... [1]

(b) Hydrogen sulfide has the formula H_2S.

(i) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen sulfide. Show outer shell electrons only.



[2]

(ii) Balance the chemical equation for the reaction of hydrogen sulfide with sulfur dioxide shown.

$$.....H_2S + SO_2 \rightarrow .....S + ...H_2O$$ [1]

[Total: 10]

5 Ethanoic acid is manufactured by the reaction of methanol with carbon monoxide.

An equilibrium mixture is produced.

$$CH_3OH(g) + CO(g) \rightleftharpoons CH_3COOH(g)$$

(a) State **two** characteristics of an equilibrium.

1 ....

2 ....
[2]

(b) The purpose of the industrial process is to produce a high yield of ethanoic acid at a high rate of reaction.

The manufacture is carried out at a temperature of 300 °C.

The forward reaction is exothermic.

Use this information to state why the manufacture is **not** carried out at temperatures:

- **below** 300 °C

....

- **above** 300 °C.

....
[2]

(c) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield of $CH_3COOH(g)$
adding a catalyst		no change
decreasing the pressure		

[3]

(d) Suggest which of the following metals is a suitable catalyst for the reaction. Give a reason for your answer.

aluminium **calcium** **cobalt** **magnesium** **potassium**

suitable catalyst ....

reason ....
[2]

(e) Ethanoic acid is a member of the homologous series of carboxylic acids.

State the general formula of this homologous series.

.... [1]

(f) Draw the structure of the carboxylic acid containing three carbon atoms. Show all of the atoms and all of the bonds.

[2]

(g) When carboxylic acids react with alcohols, esters are produced.

The formula of ester **X** is $CH_3CH_2CH_2COOCH_3$.

(i) Name ester **X**.

.... [1]

(ii) Give the name of the carboxylic acid and the alcohol that react together to produce ester **X**.

carboxylic acid ....

alcohol ....
[2]

(h) Ester **Y** has the following composition by mass:

C, 48.65%; H, 8.11%; O, 43.24%.

Calculate the empirical formula of ester **Y**.

empirical formula = ... [3]

(i) Ester **Z** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Determine the molecular formula of ester **Z**.

molecular formula = ... [1]

[Total: 19]

6 This question is about zinc and its compounds.

(a) Zinc is extracted from its ore which is mainly zinc sulfide, ZnS.

The steps for this extraction are shown.

step 1 Zinc sulfide is converted into zinc oxide.

step 2 The zinc oxide is then reduced to zinc in a furnace. The zinc formed becomes a gas.

step 3 The zinc gas is cooled to form molten zinc.

(i) Name the ore of zinc, which is mainly zinc sulfide.

.... [1]

(ii) Describe how zinc sulfide is converted into zinc oxide in **step 1**.

....

.... [1]

(iii) Name the reducing agent used in **step 2**.

.... [1]

(iv) Explain why the zinc forms a gas in **step 2** inside the furnace.

.... [1]

(v) State the name of the physical change occurring when zinc gas is converted into molten zinc.

.... [1]

(b) Zinc sulfate crystals, $ZnSO_4•7H_2O$, are hydrated.

Zinc sulfate crystals are made by reacting zinc carbonate with dilute sulfuric acid.

The equation for the overall process is shown.

$$ZnCO_3 + H_2SO_4 + 6H_2O \rightarrow ZnSO_4•7H_2O + CO_2$$

step 1 Large pieces of solid zinc carbonate are added to dilute sulfuric acid until the zinc carbonate is in excess. This forms aqueous zinc sulfate.

step 2 The excess zinc carbonate is separated from the aqueous zinc sulfate.

step 3 The aqueous zinc sulfate is heated until a saturated solution is formed.

step 4 The saturated solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

(i) In **step 1**, zinc carbonate is in excess when no more zinc carbonate dissolves.

State one **other** observation that indicates the zinc carbonate is in excess in **step 1**.

.... [1]

(ii) Name a different substance, other than zinc carbonate, that can be added to dilute sulfuric acid to produce aqueous zinc sulfate in **step 1**.

.... [1]

(iii) **Step 1** is repeated using powdered zinc carbonate instead of large pieces.

All other conditions are kept the same.

The rate of reaction increases.

Give a reason why the rate of reaction increases. Explain your answer in terms of particles.

....

....

.... [2]

(iv) Suggest what is observed when the solution is saturated in **step 3**.

....

....

.... [1]

(v) The formula of zinc sulfate crystals is $ZnSO_4 \bullet 7H_2O$.

Give the formula of the solid formed if the crystals are heated to dryness in **step 3**.

.... [1]

[Total: 11]

7 The Periodic Table can be used to classify elements.

(a) Group I elements react with cold water to form alkaline solutions.

(i) Place the Group I elements caesium, lithium, potassium, rubidium and sodium in their order of reactivity with water.

Put the most reactive element first.

most reactive ⟶ least reactive

[1]

(ii) Name the alkaline solution formed when caesium reacts with cold water.

.... [1]

(b) Group I elements have lower melting points than transition elements.

Describe one **other** difference in the **physical** properties of Group I elements and transition elements.

.... [1]

(c) Group VII elements are known as the halogens.

Astatine is below iodine in Group VII.

Predict the physical state of astatine at room temperature and pressure.

.... [1]

(d) Some Group VII elements react with aqueous solutions containing halide ions.

When aqueous chlorine is added to aqueous potassium bromide a reaction occurs.

The ionic half-equations for the reaction are shown.

$$Cl_2(aq) + 2e^- \rightarrow 2Cl^-(aq)$$

$$2Br^-(aq) \rightarrow Br_2(aq) + 2e^-$$

(i) Describe the colour change of the solution.

original colour of potassium bromide solution ....

final colour of reaction mixture ....
[2]

(ii) Identify the species that is oxidised.

Explain your decision.

species oxidised ....

explanation ....

[2]

(e) Bromine monochloride, $BrCl$, is made by the reaction between bromine and chlorine. The chemical equation is shown.

$$Br_2(g) + Cl_2(g) \rightarrow 2BrCl(g)$$

bond	bond energy in kJ / mol
Br–Br	190
Cl–Cl	242
Br–Cl	218

Calculate the overall energy change for the reaction using bond energies.

Use the following steps.

- Calculate the total amount of energy required to break the bonds in 1 mole of $Br_2(g)$ and 1 mole of $Cl_2(g)$.

.... kJ

- Calculate the total amount of energy released when the bonds in 2 moles of $BrCl(g)$ are formed.

.... kJ

- Calculate the overall energy change for the reaction.

.... kJ / mol

[3]

[Total: 11]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2022**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **12** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

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5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	carbon dioxide	**1**
1(b)	aluminium oxide	**1**
1(c)	ethanol (1) carbon dioxide (1)	**2**
1(d)	ethanol	**1**
1(e)	oxygen	**1**
1(f)	carbon dioxide	**1**
1(g)	nitrogen	**1**
1(h)	diamond	**1**

Question	Answer	Marks
2(a)(i)	<table><tr><td>charge</td><td>relative mass</td></tr><tr><td>–1</td><td></td></tr><tr><td>0</td><td>1</td></tr><tr><td></td><td>1</td></tr></table>**(1)** **(1)** **Mark by column**	**2**

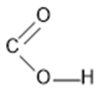
Question	Answer	Marks
2(a)(ii)	**12** | **12** | **12 (1)** **12** | **13** | **12 (1)** **Mark by row**	**2**
2(a)(iii)	(they have) 2 more protons than electrons **OR** (they have) 2 fewer electrons than protons **OR** (they have) 12 protons and 10 electrons	**1**
2(b)	Na^{+} **or** Al^{3+} (1) F^{-} or O^{2-} or N^{3-} (1) Ne (1)	**3**

Question	Answer	Marks
3(a)(i)	positive ions / cations (1) sea of electrons / mobile electrons / delocalised electrons (1) attraction between positive ions and electrons (1)	**3**
3(a)(ii)	**electrons** move / **electrons** mobile / **electrons** flow	**1**
3(b)(i)	ionic	**1**

Question	Answer	Marks
3(b)(ii)	**ions** move / **ions** are mobile / **ions** flow	**1**
3(c)(i)	pipette	**1**
3(c)(ii)	yellow to orange	**1**
3(c)(iii)	at least two results are within 0.2 cm^3 or less	**1**
3(c)(iv)	0.005 / 5×10^{-3} (1) 0.0025 / 2.5×10^{-3} (1) 0.125 (1)	**3**

Question	Answer	Marks
4(a)(i)	$S + O_2 \rightarrow SO_2$	**1**
4(a)(ii)	(temperature) 450 °C (1) (pressure) 1–2 atmosphere(s) (1) vanadium(V) oxide catalyst (1) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (1)	**4**
4(a)(iii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	**1**
4(a)(iv)	water	**1**
4(b)(i)	2 bonding pairs as **one dot and cross** each (1) 2 lone pairs on S (and no additional electrons on Hs) to complete the outer shell on S and both Hs (1)	**2**
4(b)(ii)	$\mathbf{2}H_2S + SO_2 \rightarrow \mathbf{3}S + \mathbf{2}H_2O$	**1**

Question	Answer	Marks
5(a)	the **rate** of forward reaction equals the rate of the reverse reaction (1) **concentrations** of reactants and products are constant (1)	**2**
5(b)	reaction too slow (1) yield of ethanoic acid too low (1)	**2**
5(c)	<table><tr><td>increases (1)</td><td></td></tr><tr><td>decreases (1)</td><td>decreases (1)</td></tr></table>	**3**

Question	Answer	Marks
5(d)	cobalt (1) transition element (1)	**2**
5(e)	$C_nH_{2n+1}COOH$	**1**
5(f)	COOH fully displayed (1)  whole molecule completely correct (1)	**2**
5(g)(i)	methyl butanoate	**1**
5(g)(ii)	butanoic acid (1) methanol (1)	**2**

Question	Answer	Marks
5(h)	C 48.65 / 12 H 8.11 / 1 O 43.24 / 16 **OR** 4.05:8.11:2.70 (1) fractions shown dividing all by smallest **OR** 1.5:3:1 **OR** 3:6:2 (1) $C_3H_6O_2$ (1)	**3**
5(i)	$C_4H_8O_2$	**1**

Question	Answer	Marks
6(a)(i)	zinc blende	**1**
6(a)(ii)	heat(zinc sulfide) strongly in air / roast in air	**1**
6(a)(iii)	carbon **or** carbon monoxide	**1**
6(a)(iv)	the temperature in the furnace is above **or** higher than the boiling point of zinc **OR** the boiling point of zinc is below **or** less than the temperature of the furnace	**1**
6(a)(v)	condensation / condensing / condense	**1**
6(b)(i)	no bubbles **or** no fizzing **or** no effervescence	**1**

Question	Answer	Marks
6(b)(ii)	zinc / zinc oxide / zinc hydroxide	**1**
6(b)(iii)	(powder has) larg**er** surface area **OR** lumps have small**er** surface area (1) (powder has) more collisions per unit time / more collision frequency **OR** **lumps** have fewer collisions per unit time / less collision frequency (1)	**2**
6(b)(iv)	crystals (form on glass rod or microscope slide)	**1**
6(b)(v)	$ZnSO_4$	**1**

Question	Answer	Marks
7(a)(i)	from left to right caesium → rubidium→ potassium →sodium → lithium	**1**
7(a)(ii)	caesium hydroxide	**1**
7(b)	Group I element is less strong / not strong **ORA** **OR** Group I element has low(er) density **ORA** **OR** Group I element is soft(er) **ORA**	**1**
7(c)	solid	**1**
7(d)(i)	colourless (1) orange / brown / yellow (1)	**2**

Question	Answer	Marks
7(d)(ii)	Br^- (1) loses electron(s) (1)	**2**
7(e)	432(1) 436(1) – 4(1)	**3**

Cambridge Assessment International Education

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2022**

45 minutes

You must answer on the multiple choice answer sheet.

* 3 9 8 1 9 7 4 9 5 1 *

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

IB22 06_0620_23/RP

1 Which two gases will diffuse at the same rate, at the same temperature?

A carbon monoxide and carbon dioxide

B carbon monoxide and nitrogen

C chlorine and fluorine

D nitrogen and oxygen

2 A student measures the time taken for 2.0 g of magnesium to dissolve in 50 cm^3 of dilute sulfuric acid.

Which apparatus is essential to complete the experiment?

1 stop-clock

2 measuring cylinder

3 thermometer

4 balance

A 1, 2 and 4 **B** 1 and 2 only **C** 1 and 4 only **D** 2, 3 and 4

3 Which statement describes the properties of both diamond and silicon(IV) oxide?

A They are brittle, with a low melting point, and are insoluble in water.

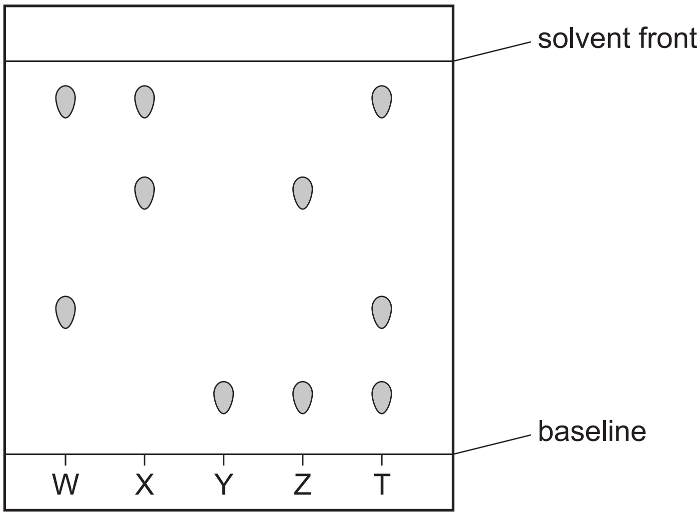
B They are hard, with a high melting point, and are electrical insulators.

C They are malleable, with a high melting point, and are electrical conductors.

D They are soft, with a low melting point, and are electrical insulators.

4 Paper chromatography is used to separate four different coloured inks, W, X, Y and Z, and an unknown ink T.

The chromatogram is shown.



Which inks are present in ink T?

A W and X **B** W and Y **C** X and Z **D** Y and Z

5 Particle P has an atomic number of 18, a mass number of 40 and no overall charge.

Particle Q has an atomic number of 19, a mass number of 40 and a single positive charge.

Which statement is correct?

A They are isotopes of the same element.

B They are both ions.

C Q has more neutrons than P.

D They have the same number of electrons in their outer shell.

6 Which statement about the properties of metals is correct?

A Metals are malleable because the layers of positive ions can slide over each other.

B Metals conduct electricity when solid because the positive ions move freely through the metal.

C Metals conduct electricity because there is a strong force of attraction between the positive ions and the delocalised electrons.

D Metals have a high melting point because the positive ions attract each other strongly.

7 The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

8 A 0.5 g sample of calcium carbonate is reacted with excess dilute hydrochloric acid.

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

Which volume of CO_2 is produced at r.t.p.?

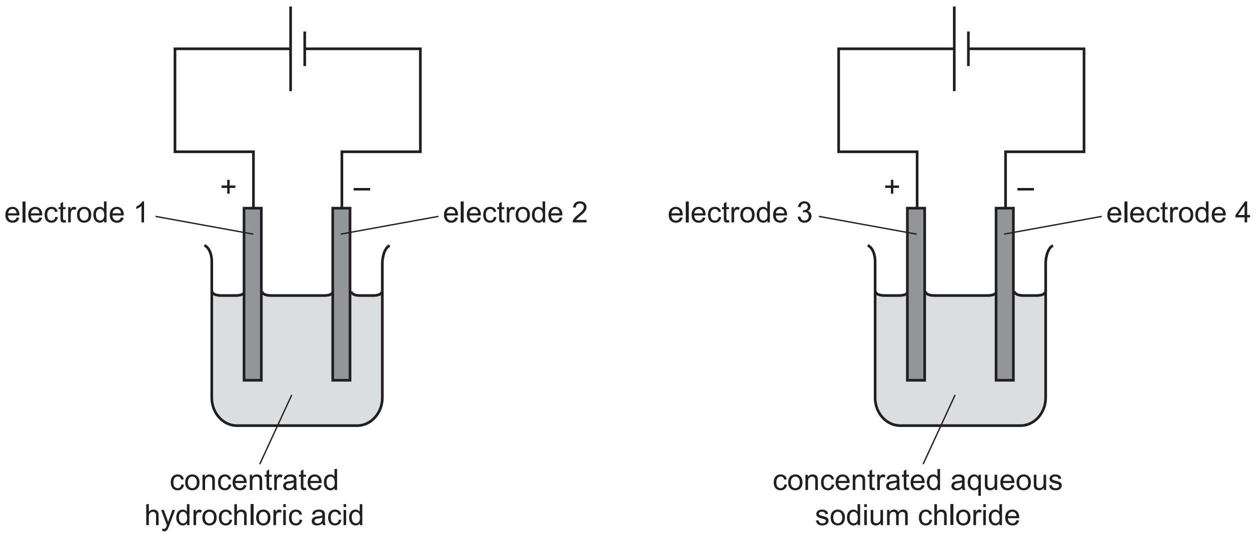
A 0.12 dm^3 **B** 0.18 dm^3 **C** 0.24 dm^3 **D** 12 dm^3

9 Aluminium is manufactured from aluminium oxide by electrolysis.

Which row shows the ionic half-equations at each electrode and describes the role of cryolite in the process?

	reaction at anode	reaction at cathode	role of cryolite
A	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow 3Al$	catalyst
B	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	solvent for aluminium oxide
C	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$	solvent for aluminium oxide
D	$Al^{3+} + 3e^- \rightarrow 3Al$	$2O^{2-} \rightarrow O_2 + 4e^-$	catalyst

10 The diagram shows the electrolysis of concentrated hydrochloric acid and concentrated aqueous sodium chloride using carbon electrodes.



At which electrodes is hydrogen produced?

A electrode 1 only

B electrodes 1 and 3

C electrode 2 only

D electrodes 2 and 4

11 Which statement about fuels is correct?

A Coal and ethanol are examples of non-renewable energy sources.

B Hydrogen and oxygen can be reacted to produce an electric current.

C Large amounts of energy are taken in by a fuel when it burns.

D Radioactive isotopes are burned to produce heat.

12 Which row identifies a chemical change and a physical change?

	chemical change	physical change
A	boiling ethanol	burning ethanol
B	burning ethanol	evaporating ethanol
C	dissolving ethanol in water	burning ethanol
D	evaporating ethanol	dissolving ethanol in water

13 Metal M reacts with steam and produces gas G.

Which row identifies gas G and the type of reaction when metal M reacts with steam?

	gas G	type of reaction
A	hydrogen	redox
B	hydrogen	neutralisation
C	oxygen	redox
D	oxygen	neutralisation

14 Which statement explains why increasing the concentration of a reactant increases the rate of the reaction?

A A greater proportion of the particles have the activation energy so there are more successful collisions.

B Particles have more energy so there are more frequent collisions.

C There are more particles in the same volume so there are more frequent collisions.

D The particles move more quickly so there are more frequent collisions.

15 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

A The copper(II) sulfate turns blue and the solution formed gets colder.

B The copper(II) sulfate turns blue and the solution formed gets hotter.

C The copper(II) sulfate turns white and the solution formed gets colder.

D The copper(II) sulfate turns white and the solution formed gets hotter.

16 Which statement explains why lime is added to soil?

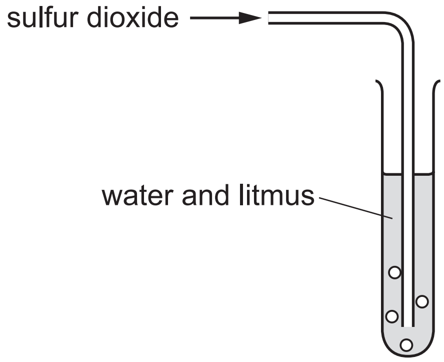
A to decrease the pH of acidic soil

B to decrease the pH of alkaline soil

C to increase the pH of acidic soil

D to increase the pH of alkaline soil

17 Sulfur dioxide is bubbled through water containing litmus.



Which row describes and explains what happens to the litmus?

	observation	explanation
A	it turns blue	sulfur dioxide is a basic oxide
B	it turns blue	sulfur dioxide is an acidic oxide
C	it turns red	sulfur dioxide is an acidic oxide
D	it turns red	sulfur dioxide is a basic oxide

18 The oxides of two elements, X and Y, are separately dissolved in water and the pH of each solution tested.

oxide tested	pH of solution
X	1
Y	13

Which information about X and Y is correct?

	oxide is acidic	oxide is basic	metal	non-metal
A	X	Y	X	Y
B	X	Y	Y	X
C	Y	X	X	Y
D	Y	X	Y	X

19 An acid is neutralised by adding an excess of an insoluble solid base.

A soluble salt is formed.

How is the pure salt obtained from the reaction mixture?

A crystallisation → evaporation → filtration

B evaporation → crystallisation → filtration

C filtration → crystallisation → evaporation

D filtration → evaporation → crystallisation

20 Which ion forms a precipitate that dissolves in excess with both aqueous ammonia and with aqueous sodium hydroxide?

A calcium ion, Ca^{2+}

B copper(II) ion, Cu^{2+}

C iron(III) ion, Fe^{3+}

D zinc ion, Zn^{2+}

21 Elements in Group IV of the Periodic Table are shown.

carbon

silicon

germanium

tin

lead

What does **not** occur in Group IV as it is descended?

A The proton number of the elements increases.

B The elements become more metallic.

C The elements have more electrons in their outer shell.

D The elements have more electron shells.

22 W, X, Y and Z are elements in Period 3 of the Periodic Table.

The numbers of outer-shell electrons in an atom of each element are shown.

element	number of outer-shell electrons
W	1
X	2
Y	7
Z	8

Which elements are non-metals?

A W, X and Y **B** W and X only **C** Y and Z **D** Z only

23 Selenium is an element in Group VI.

Group VI elements follow similar trends to Group VII elements.

Which statement about selenium is correct?

A It has a higher density than sulfur.

B It has a lower melting point than sulfur.

C It has six electron shells.

D It is a monoatomic element.

24 Which row describes the properties of a typical transition element?

	melting point	density	used as catalyst
A	high	high	yes
B	high	low	no
C	low	high	yes
D	low	low	no

25 Which row describes an atom of a noble gas?

	number of protons	number of neutrons	number of electrons
A	2	2	0
B	2	2	2
C	8	8	8
D	8	8	10

26 Some properties of four elements, P, Q, R and S, are shown.

Solid P reacts with dilute hydrochloric acid to give hydrogen.

Solid Q does not conduct electricity.

Solid R is used to make saucepans because it is a good conductor of heat.

Solid S reacts with oxygen to form a compound where atoms of S share electrons with atoms of oxygen.

Which elements are metals?

A P and R **B** P and S **C** Q and R **D** Q and S

27 Which substance is used to reduce zinc oxide in the manufacture of zinc?

A carbon

B carbon dioxide

C hydrogen

D sulfur dioxide

28 Three metal compounds, J, K and L, are heated using a Bunsen burner.

The results are shown.

J colourless gas produced, which relights a glowing splint

K colourless gas produced, which turns limewater milky

L no reaction

Which row identifies J, K and L?

	J	K	L
A	magnesium carbonate	potassium carbonate	potassium nitrate
B	magnesium carbonate	potassium nitrate	potassium carbonate
C	potassium nitrate	magnesium carbonate	potassium carbonate
D	potassium nitrate	potassium carbonate	magnesium carbonate

29 Nitrogen oxide, NO, is formed in the engine of petrol-powered cars.

One constituent of petrol is octane, C_8H_{18}.

Nitrogen oxide is removed from exhaust fumes by catalytic converters.

Which row identifies the reactants that produce nitrogen oxide and a reaction that removes it in a catalytic converter?

	reactants that produce NO	reaction that removes NO
A	octane + one gas found in air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
B	octane + one gas found in air	$NO + CO_2 \rightarrow NO_2 + CO$
C	two gases found in air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
D	two gases found in air	$NO + CO_2 \rightarrow NO_2 + CO$

30 A magnesium block is attached to iron to prevent it from rusting.

Which statement about this method of rust prevention is correct?

A Magnesium corrodes instead of iron because it is more reactive.

B Magnesium prevents oxygen from reaching the iron.

C The iron does not rust because it has a greater tendency to form ions than magnesium.

D This method of rust prevention is called galvanising.

31 Fertilisers are used to provide three of the elements needed for plant growth.

Which two compounds would give a fertiliser containing all three of these elements?

A $Ca(NO_3)_2$ and $(NH_4)_2SO_4$

B $Ca(NO_3)_2$ and $(NH_4)_3PO_4$

C KNO_3 and $(NH_4)_2SO_4$

D KNO_3 and $(NH_4)_3PO_4$

32 Which processes increase the amount of carbon dioxide in the air?

1 combustion of hydrogen

2 combustion of methane

3 photosynthesis by plants

4 thermal decomposition of limestone

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

33 In the Contact process, sulfur dioxide is converted into sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What is the effect of lowering the pressure on the rate of formation and percentage yield of sulfur trioxide at equilibrium?

	rate of formation	percentage yield
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

34 What are the products when limestone (calcium carbonate) is heated strongly?

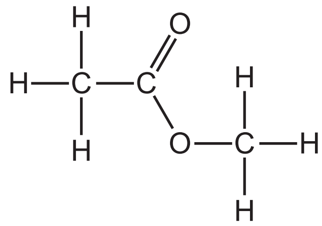
A calcium hydroxide and carbon dioxide

B calcium hydroxide and carbon monoxide

C calcium oxide and carbon dioxide

D calcium oxide and carbon monoxide

35 The structure of ester W is shown.



Which row gives the names of ester W and the carboxylic acid and alcohol from which it is made?

	name of ester W	carboxylic acid	alcohol
A	ethyl methanoate	ethanoic acid	methanol
B	ethyl methanoate	methanoic acid	ethanol
C	methyl ethanoate	ethanoic acid	methanol
D	methyl ethanoate	methanoic acid	ethanol

36 The equation for the reaction between butane, C_4H_{10}, and chlorine is shown.

$$C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$$

Which type of reaction does butane undergo when it reacts with chlorine?

A addition

B reduction

C acid–base

D substitution

37 Butene has three structural isomers which are alkenes.

Which statements about these isomers are correct?

1 They have the same molecular formula.

2 They have different numbers of bonds in the molecule.

3 They have a C=C bond in the structure.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

38 The hydrocarbon $C_{12}H_{26}$ is cracked to give X and Y, as shown.

$$C_{12}H_{26} \rightarrow X + Y$$

Which statement is correct?

A If X is C_6H_{12} then Y will react with aqueous bromine.

B If X is $C_{10}H_{22}$ then Y can be used to make a polymer.

C If X is a hydrogen molecule then Y is an alkane.

D X and Y could be structural isomers.

39 An ester, $C_4H_8O_2$, is made by reacting 0.06 mol of ethanol, C_2H_6O, and 0.05 mol of ethanoic acid, $C_2H_4O_2$.

$$C_2H_6O + C_2H_4O_2 \rightarrow C_4H_8O_2 + H_2O$$

0.0375 mol of the ester was made.

What is the percentage yield and the M_r of the ester?

	percentage yield / %	M_r
A	62.5	48
B	75.0	48
C	62.5	88
D	75.0	88

40 Which type of compound is made when a protein is hydrolysed?

A alkene

B amino acid

C carboxylic acid

D sugar

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Core) **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **3** printed pages.

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

Question	Answer	Marks
29	C	**1**
30	A	**1**
31	D	**1**
32	D	**1**
33	A	**1**
34	C	**1**
35	C	**1**
36	D	**1**
37	B	**1**
38	B	**1**
39	D	**1**
40	B	**1**

Cambridge Assessment International Education

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2022**

45 minutes

You must answer on the multiple choice answer sheet.

2772442771

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages.

1 Which two gases will diffuse at the same rate, at the same temperature?

A carbon monoxide and carbon dioxide

B carbon monoxide and nitrogen

C chlorine and fluorine

D nitrogen and oxygen

2 A student measures the time taken for 2.0 g of magnesium to dissolve in 50 cm^3 of dilute sulfuric acid.

Which apparatus is essential to complete the experiment?

1 stop-clock

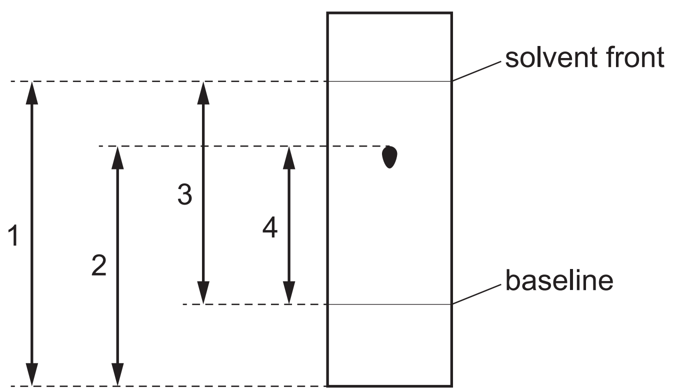
2 measuring cylinder

3 thermometer

4 balance

A 1, 2 and 4 **B** 1 and 2 only **C** 1 and 4 only **D** 2, 3 and 4

3 A chromatogram of a single substance T is shown.



Which measurements are used to find the R_f value of T?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

4 X and Y are two different elements.

X and Y have the same number of nucleons.

Which statement about X and Y is correct?

A They have the same physical properties.

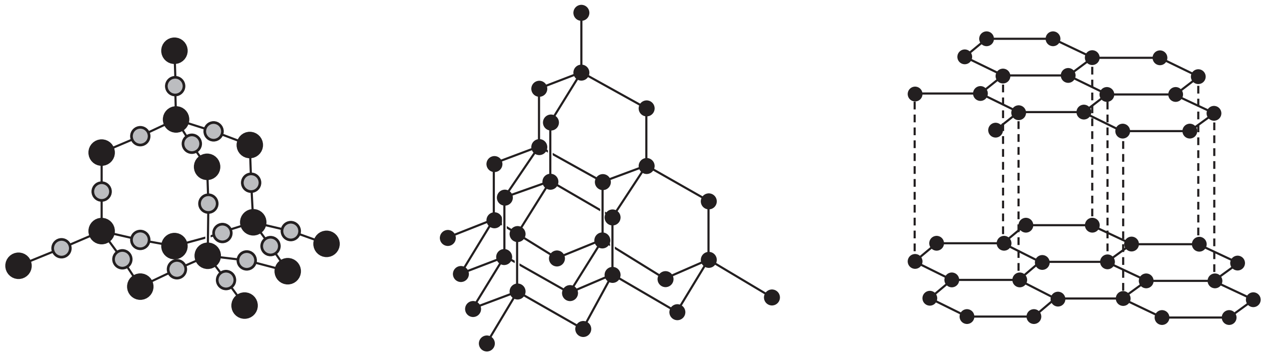
B Their atoms have the same number of electrons.

C They are in different groups of the Periodic Table.

D They have different relative masses.

5 The diagrams show the structures of three macromolecules P, Q and R.

P Q R

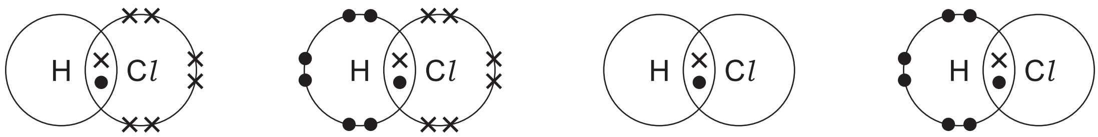


What are P, Q and R?

	P	Q	R
A	diamond	silicon(IV) oxide	graphite
B	graphite	diamond	silicon(IV) oxide
C	silicon(IV) oxide	diamond	graphite
D	silicon(IV) oxide	graphite	diamond

6 Which dot-and-cross diagram shows the arrangement of outer shell electrons in a molecule of hydrogen chloride?

A **B** **C** **D**



7 The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

8 Methane and steam react in the presence of a catalyst.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

0.5 mol of methane reacts completely with 0.5 mol of steam.

What is the volume of carbon monoxide and hydrogen produced, measured at room temperature and pressure?

	volume of CO / dm^3	volume of H_2 / dm^3
A	0.5	1.5
B	1.0	3.0
C	12.0	12.0
D	12.0	36.0

9 A compound of element X has the formula X_2O and a relative formula mass of 144.

What is element X?

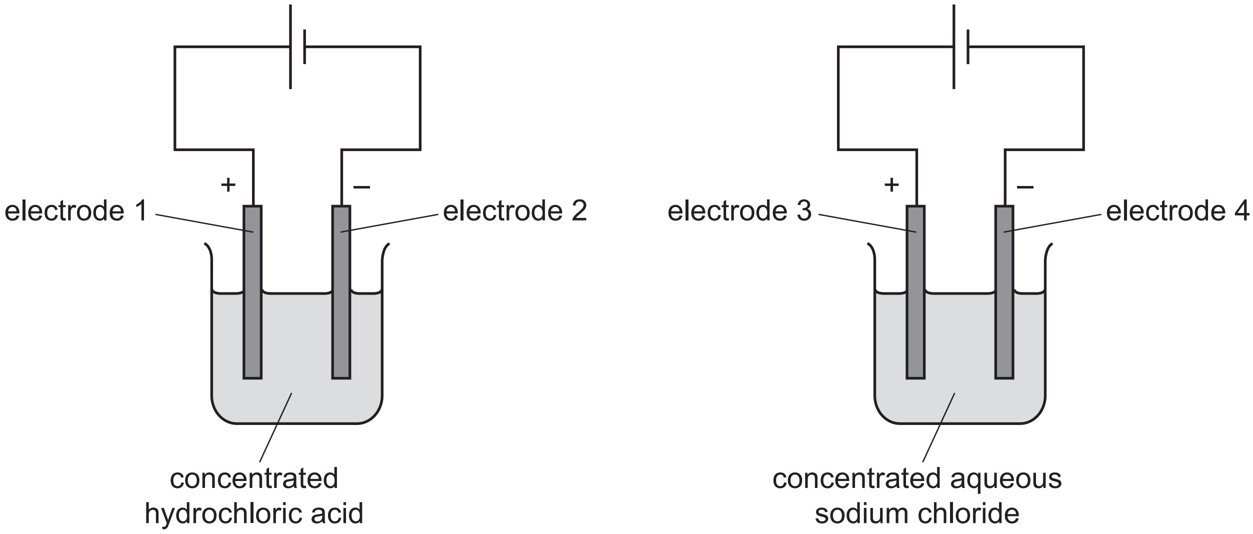
A copper, Cu

B gadolinium, Gd

C sulfur, S

D tellurium, Te

10 The diagram shows the electrolysis of concentrated hydrochloric acid and concentrated aqueous sodium chloride using carbon electrodes.



At which electrodes is hydrogen produced?

A electrode 1 only

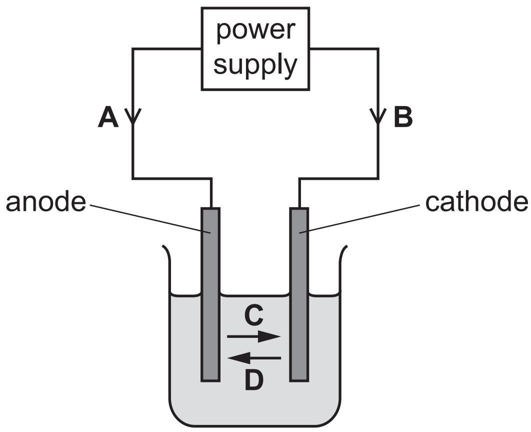
B electrodes 1 and 3

C electrode 2 only

D electrodes 2 and 4

11 The diagram shows the electrolysis of aqueous copper(II) sulfate using inert electrodes.

Which arrow shows the movement of electrons in the circuit?



12 Which row identifies a chemical change and a physical change?

	chemical change	physical change
A	boiling ethanol	burning ethanol
B	burning ethanol	evaporating ethanol
C	dissolving ethanol in water	burning ethanol
D	evaporating ethanol	dissolving ethanol in water

13 Which statements explain why increasing the concentration of a reactant increases the rate of reaction?

1 It increases the collision rate of particles.

2 It lowers the activation energy.

3 A greater proportion of the colliding molecules have the required activation energy.

4 There are more particles per unit volume.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

14 When the colourless gas N_2O_4 is heated, it forms the brown gas NO_2.

When the reaction mixture is cooled, the brown colour fades and turns back to colourless.

Which type of reaction is described by these observations?

A decomposition

B displacement

C reduction

D reversible

15 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

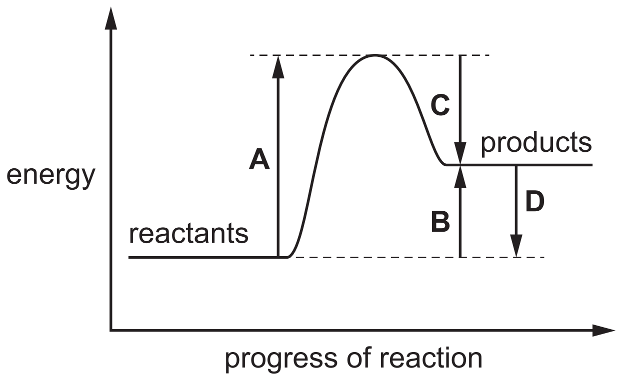
A The copper(II) sulfate turns blue and the solution formed gets colder.

B The copper(II) sulfate turns blue and the solution formed gets hotter.

C The copper(II) sulfate turns white and the solution formed gets colder.

D The copper(II) sulfate turns white and the solution formed gets hotter.

16 Which arrow on the energy level diagram shows the overall energy change for an endothermic reaction?



17 When a hydrogen–oxygen fuel cell is in operation, a different reaction happens at each electrode.

at the hydrogen electrode $H_2 \rightarrow 2H^+ + 2e^-$

at the oxygen electrode $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

The electrons that are lost at the hydrogen electrode travel through the external circuit to the oxygen electrode, where they are gained by the oxygen and water.

A hydrogen–oxygen fuel cell is operated for a period of time and four moles of oxygen molecules are consumed.

Which mass of hydrogen is consumed?

A 2.0 g **B** 4.0 g **C** 8.0 g **D** 16.0 g

18 The oxides of two elements, X and Y, are separately dissolved in water and the pH of each solution tested.

oxide tested	pH of solution
X	1
Y	13

Which information about X and Y is correct?

	oxide is acidic	oxide is basic	metal	non-metal
A	X	Y	X	Y
B	X	Y	Y	X
C	Y	X	X	Y
D	Y	X	Y	X

19 An acid is neutralised by adding an excess of an insoluble solid base.

A soluble salt is formed.

How is the pure salt obtained from the reaction mixture?

A crystallisation → evaporation → filtration

B evaporation → crystallisation → filtration

C filtration → crystallisation → evaporation

D filtration → evaporation → crystallisation

20 Substance J takes part in a redox reaction.

In the reaction, J gains electrons.

Which statement is correct?

A J is the oxidising agent and it is oxidised in the reaction.

B J is the oxidising agent and it is reduced in the reaction.

C J is the reducing agent and it is oxidised in the reaction.

D J is the reducing agent and it is reduced in the reaction.

21 Elements in Group IV of the Periodic Table are shown.

carbon

silicon

germanium

tin

lead

What does **not** occur in Group IV as it is descended?

A The proton number of the elements increases.

B The elements become more metallic.

C The elements have more electrons in their outer shell.

D The elements have more electron shells.

22 Which statement about acids is correct?

A Acids are proton acceptors.

B Acids transfer electrons to bases in aqueous solution.

C Hydrochloric acid reacts with ammonium hydroxide to produce ammonia.

D Ethanoic acid partially ionises in aqueous solution.

23 Which elements have both a high melting point and variable oxidation states?

A alkali metals

B transition elements

C halogens

D noble gases

24 Lithium, sodium and potassium are elements in Group I of the Periodic Table.

Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

Which row identifies the **least** dense of these elements in each group?

	Group I	Group VII
A	lithium	chlorine
B	lithium	iodine
C	potassium	chlorine
D	potassium	iodine

25 The reactions of metals P, Q, R and S are shown.

metal	reaction with water	reaction with hydrochloric acid	reduction of the metal oxide with carbon
P	no reaction	no reaction	reduced
Q	slow	vigorous	no reaction
R	vigorous	vigorous	no reaction
S	very slow	vigorous	reduced

What is the order of reactivity of the metals?

	least reactive	⟶		most reactive
A	P	S	Q	R
B	P	Q	S	R
C	R	S	Q	P
D	R	Q	S	P

26 The number of protons and the number of neutrons in the atoms of elements X, Y and Z are shown.

	number of protons	number of neutrons
X	6	6
Y	7	6
Z	8	10

Which statement about the elements is correct?

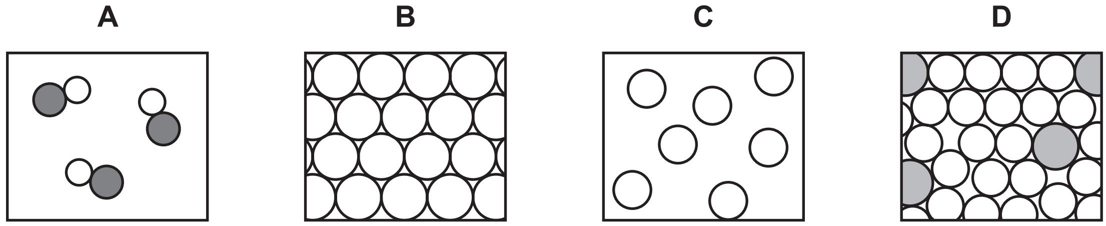
A X and Y are isotopes of the same element.

B Z forms an ion with a +2 charge.

C X and Z react together to form an ionic compound.

D X, Y and Z are non-metals.

27 Which diagram represents the arrangement of atoms in an alloy?



28 Three metal compounds, J, K and L, are heated using a Bunsen burner.

The results are shown.

J colourless gas produced, which relights a glowing splint

K colourless gas produced, which turns limewater milky

L no reaction

Which row identifies J, K and L?

	J	K	L
A	magnesium carbonate	potassium carbonate	potassium nitrate
B	magnesium carbonate	potassium nitrate	potassium carbonate
C	potassium nitrate	magnesium carbonate	potassium carbonate
D	potassium nitrate	potassium carbonate	magnesium carbonate

29 Processes involved in the extraction of zinc are listed.

1 Heat zinc oxide with carbon.

2 Condense zinc vapour.

3 Vaporise the zinc.

4 Roast zinc ore in air.

In which order are the processes carried out?

A $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$

B $4 \rightarrow 3 \rightarrow 1 \rightarrow 2$

C $4 \rightarrow 1 \rightarrow 3 \rightarrow 2$

D $1 \rightarrow 4 \rightarrow 3 \rightarrow 2$

30 Which process uses sacrificial protection to prevent steel from rusting?

A galvanising

B oiling

C copper plating

D painting

31 Fertilisers are used to provide three of the elements needed for plant growth.

Which two compounds would give a fertiliser containing all three of these elements?

A $Ca(NO_3)_2$ and $(NH_4)_2SO_4$

B $Ca(NO_3)_2$ and $(NH_4)_3PO_4$

C KNO_3 and $(NH_4)_2SO_4$

D KNO_3 and $(NH_4)_3PO_4$

32 Which processes produce carbon dioxide?

1 respiration

2 photosynthesis

3 fermentation

4 combustion of hydrogen

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

33 Which reaction in the Contact process requires the use of a catalyst?

A $S + O_2 \rightarrow SO_2$

B $2SO_2 + O_2 \rightarrow 2SO_3$

C $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$

D $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

34 What are the products when limestone (calcium carbonate) is heated strongly?

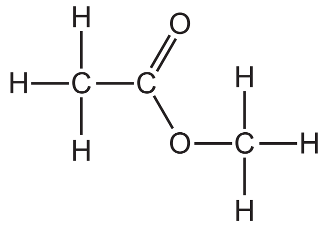
A calcium hydroxide and carbon dioxide

B calcium hydroxide and carbon monoxide

C calcium oxide and carbon dioxide

D calcium oxide and carbon monoxide

35 The structure of ester W is shown.



Which row gives the names of ester W and the carboxylic acid and alcohol from which it is made?

	name of ester W	carboxylic acid	alcohol
A	ethyl methanoate	ethanoic acid	methanol
B	ethyl methanoate	methanoic acid	ethanol
C	methyl ethanoate	ethanoic acid	methanol
D	methyl ethanoate	methanoic acid	ethanol

36 Ethene reacts with substance X to form ethanol.

What is X?

A ethanoic acid

B glucose

C hydrogen

D steam

37 Alkenes can be produced by cracking large hydrocarbon molecules to form smaller hydrocarbon molecules.

Which equations represent possible reactions when tetradecane, $C_{14}H_{30}$, is cracked?

1 $C_{14}H_{30} \rightarrow C_2H_6 + C_3H_6 + C_4H_8 + C_5H_{10}$

2 $C_{14}H_{30} \rightarrow H_2 + C_2H_4 + C_3H_6 + C_4H_8 + C_5H_{10}$

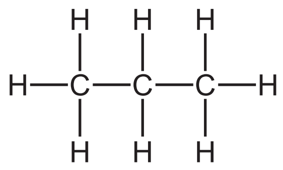
3 $C_{14}H_{30} \rightarrow C_2H_6 + 4C_3H_6$

4 $C_{14}H_{30} \rightarrow C_2H_6 + C_3H_8 + C_9H_{18}$

A 1 only **B** 1 and 4 **C** 1, 2 and 3 **D** 3 and 4

38 The structures of some hydrocarbons are shown.

1



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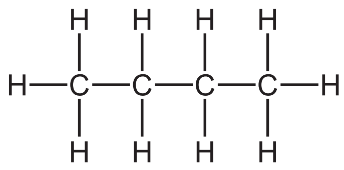

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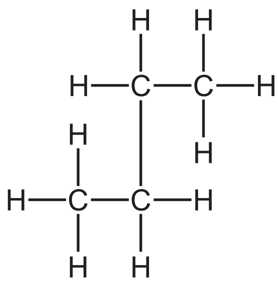

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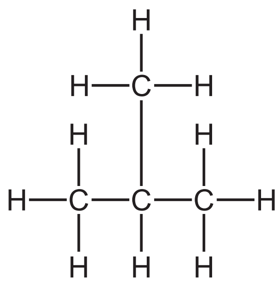


Which statement about the hydrocarbons is correct?

A 1 and 2 have a different general formula.

B 1 and 4 are in different homologous series.

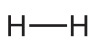
C 2 and 3 are structural isomers.

D 3 and 4 have the same empirical formula.

39 Ethane reacts with chlorine in the presence of ultraviolet light.

Which substances are produced in the reaction?

1



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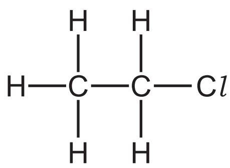

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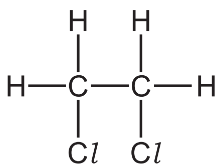

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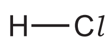
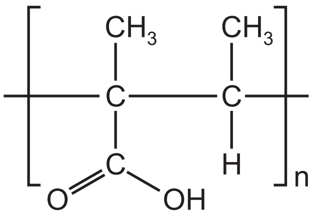


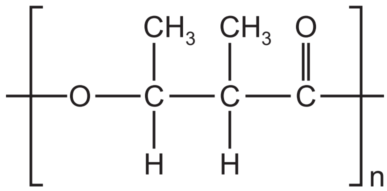
A 1, 2 and 3   **B** 1 and 3 only   **C** 2, 3 and 4   **D** 2 and 4 only

40 Which polymer structure has the same linkages as *Terylene*?

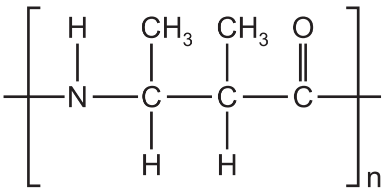
A



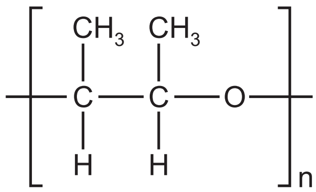
B



C



D



The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Core) **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

[Turn over

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

Question	Answer	Marks
29	C	**1**
30	A	**1**
31	D	**1**
32	A	**1**
33	B	**1**
34	C	**1**
35	C	**1**
36	D	**1**
37	C	**1**
38	D	**1**
39	C	**1**
40	B	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2022**

45 minutes

You must answer on the multiple choice answer sheet.

9070200185

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

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IB22 06_0620_21/RP

1 Which two gases will diffuse at the same rate, at the same temperature?

A carbon monoxide and carbon dioxide

B carbon monoxide and nitrogen

C chlorine and fluorine

D nitrogen and oxygen

2 A student measures the time taken for 2.0 g of magnesium to dissolve in 50 cm^3 of dilute sulfuric acid.

Which apparatus is essential to complete the experiment?

1 stop-clock

2 measuring cylinder

3 thermometer

4 balance

A 1, 2 and 4 **B** 1 and 2 only **C** 1 and 4 only **D** 2, 3 and 4

3 The numbers of protons and neutrons and the electronic structures of four particles, W, X, Y and Z, are shown.

	number of protons	number of neutrons	electronic structure
W	8	8	2,8
X	8	10	2,6
Y	8	8	2,6
Z	10	8	2,8

Which particles have the same chemical properties?

A W and Y **B** W and Z **C** X and Y **D** X and Z

4 Which substance should be pure for the intended use?

A a drug for curing disease

B limestone for iron extraction

C petroleum for fractional distillation

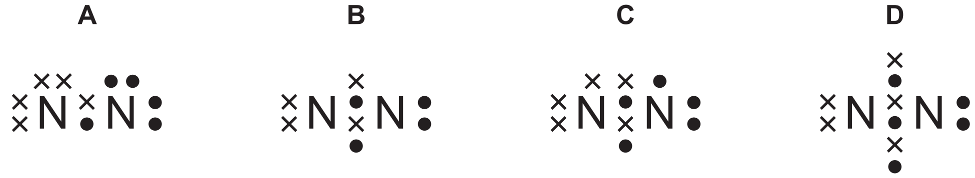
D water for washing a car

5 Metals and ionic compounds have similarities and differences in their structure and properties.

Which row about metals and ionic compounds is correct?

	similarity	difference
A	both contain positive ions	only ionic compounds contain anions
B	both contain positive ions	ionic compounds conduct using a 'sea of electrons'
C	both are malleable	only ionic compounds contain anions
D	both are malleable	ionic compounds conduct using a 'sea of electrons'

6 Which diagram represents the outer-shell electron arrangement in a nitrogen molecule?



7 The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

8 The relative atomic mass, A_r, of an element is determined by comparing the mass of one atom of the element with the mass of one atom of element Q.

What is Q?

A carbon

B chlorine

C hydrogen

D oxygen

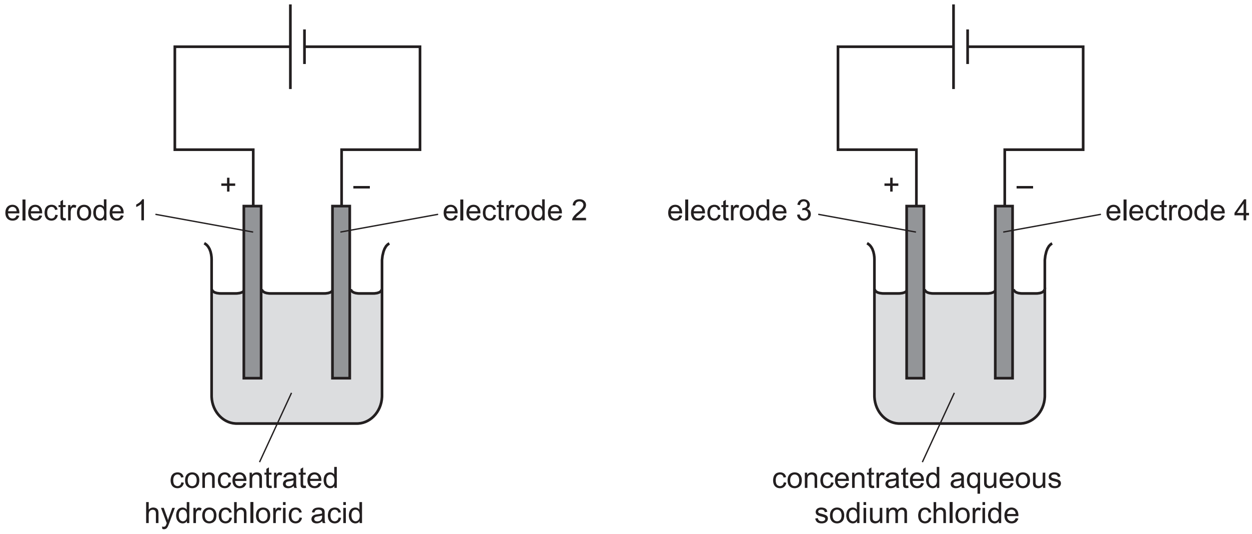
9 The equation for the reaction between aqueous lead(II) nitrate and aqueous sodium chloride is shown.

$$Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$$

If 100 cm^3 of aqueous lead(II) nitrate of concentration 0.1 mol / dm^3 is reacted with an excess of aqueous sodium chloride, which mass of lead(II) chloride is obtained?

A 1.16 g **B** 2.42 g **C** 2.78 g **D** 3.31 g

10 The diagram shows the electrolysis of concentrated hydrochloric acid and concentrated aqueous sodium chloride using carbon electrodes.



At which electrodes is hydrogen produced?

A electrode 1 only

B electrodes 1 and 3

C electrode 2 only

D electrodes 2 and 4

11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

What is the ionic half-equation for the reaction at the cathode?

A $Cu \rightarrow Cu^{2+} + 2e^-$

B $Cu^{2+} + 2e^- \rightarrow Cu$

C $2H^+ + 2e^- \rightarrow H_2$

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

12 Which row identifies a chemical change and a physical change?

	chemical change	physical change
A	boiling ethanol	burning ethanol
B	burning ethanol	evaporating ethanol
C	dissolving ethanol in water	burning ethanol
D	evaporating ethanol	dissolving ethanol in water

13 The equation for the reaction between gaseous hydrogen and gaseous iodine to form gaseous hydrogen iodide is shown.

$$H_2(g) + I_2(g) \rightarrow 2HI(g)$$

The reaction is exothermic.

Which statement explains why the reaction is exothermic?

A Energy is released when H–H and I–I bonds are broken.

B The bond energies of the reactants are larger than the bond energies of the products.

C The products are at a higher energy level than the reactants.

D More energy is released when two HI bonds are formed than is used when the H–H and I–I bonds are broken.

14 Acidified aqueous silver nitrate is added to a test-tube containing aqueous chloride ions.

The test-tube is then left in direct sunlight.

Which row describes the observations and explains what happens to the reaction mixture?

	observation on adding aqueous silver nitrate	observation after leaving in sunlight	explanation
A	yellow precipitate	precipitate dissolves	silver chloride forms
B	yellow precipitate	precipitate turns grey	silver ions are reduced
C	white precipitate	precipitate dissolves	silver chloride forms
D	white precipitate	precipitate turns grey	silver ions are reduced

15 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

A The copper(II) sulfate turns blue and the solution formed gets colder.

B The copper(II) sulfate turns blue and the solution formed gets hotter.

C The copper(II) sulfate turns white and the solution formed gets colder.

D The copper(II) sulfate turns white and the solution formed gets hotter.

16 Aqueous iron(III) chloride, $FeCl_3$, reacts with aqueous potassium iodide, KI.

$$v\text{FeC}l_3 + w\text{KI} \rightarrow x\text{FeC}l_2 + y\text{KC}l + \text{I}_2$$

Which statements are correct?

1 In the balanced equation, *v*, *w*, *x* and *y* have the same value.

2 Potassium iodide is an oxidising agent.

3 A dark brown solution is produced in the reaction.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 2 and 3

17 Which statement about acids is correct?

A A strong acid has a higher pH than a weak acid of the same concentration.

B A strong acid is a proton acceptor.

C A weak acid is a proton donor.

D A weak acid is fully ionised in aqueous solution.

18 The oxides of two elements, X and Y, are separately dissolved in water and the pH of each solution tested.

oxide tested	pH of solution
X	1
Y	13

Which information about X and Y is correct?

	oxide is acidic	oxide is basic	metal	non-metal
A	X	Y	X	Y
B	X	Y	Y	X
C	Y	X	X	Y
D	Y	X	Y	X

19 An acid is neutralised by adding an excess of an insoluble solid base.

A soluble salt is formed.

How is the pure salt obtained from the reaction mixture?

A crystallisation $\rightarrow$ evaporation $\rightarrow$ filtration

B evaporation $\rightarrow$ crystallisation $\rightarrow$ filtration

C filtration $\rightarrow$ crystallisation $\rightarrow$ evaporation

D filtration $\rightarrow$ evaporation $\rightarrow$ crystallisation

20 The electronic structure of element Z is 2,8,1.

Which statements about Z are correct?

1 It is a metal.

2 It has two outer-shell electrons.

3 It is in Period 3.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

21 Elements in Group IV of the Periodic Table are shown.

carbon

silicon

germanium

tin

lead

What does **not** occur in Group IV as it is descended?

A The proton number of the elements increases.

B The elements become more metallic.

C The elements have more electrons in their outer shell.

D The elements have more electron shells.

22 Element M forms both M^+ and M^{2+} ions.

In which part of the Periodic Table is M placed?

A Group I

B Group II

C Group III

D transition elements

23 In the extraction of aluminium by electrolysis, cryolite is added to the bauxite ore.

Which row describes the role of cryolite and gives the ionic half-equation at the cathode?

	role of cryolite	ionic half-equation at the cathode
A	catalyst	$Al^{3+} + 3e^- \rightarrow Al$
B	catalyst	$Al^{3+} + 3e^- \rightarrow 3Al$
C	lowers melting point of electrolyte	$Al^{3+} + 3e^- \rightarrow Al$
D	lowers melting point of electrolyte	$Al^{3+} + 3e^- \rightarrow 3Al$

24 Mild steel is galvanised to prevent corrosion of the iron.

Which statements about galvanising are correct?

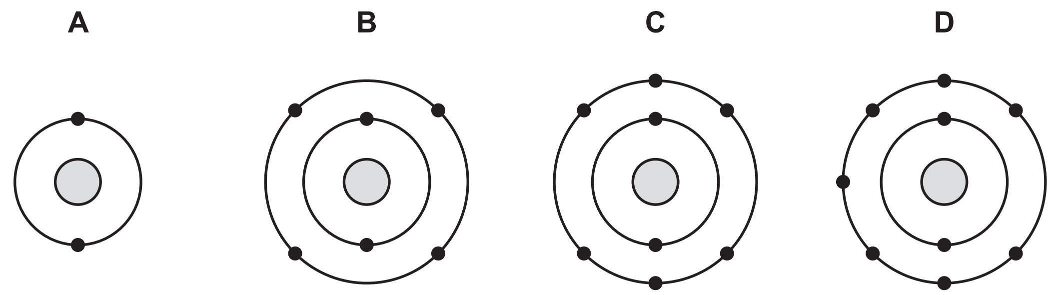
1 Galvanising prevents corrosion because the zinc forms an alloy.

2 If the coating is damaged, water and oxygen do not corrode the iron.

3 Zinc is a sacrificial metal and corrodes in preference to iron.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 2 and 3

25 Which diagram represents the arrangement of the outer-shell electrons of a noble gas?



26 Which statements about the general properties of metals are correct?

1 They are good conductors of heat and electricity.

2 They have low melting points.

3 They react with dilute acids to form a salt and water.

4 They react with oxygen to form basic oxides.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

27 Reactions of three metals and their oxides are shown.

metal	add dilute hydrochloric acid to metal	heat metal oxide with carbon
1	✓	✓
2	✓	✗
3	✗	✓

key
✓ = reacts
✗ = does not react

What is the order of reactivity of these metals, from most reactive to least reactive?

A $1 \rightarrow 2 \rightarrow 3$ **B** $1 \rightarrow 3 \rightarrow 2$ **C** $2 \rightarrow 1 \rightarrow 3$ **D** $2 \rightarrow 3 \rightarrow 1$

  [Turn over

28 Three metal compounds, J, K and L, are heated using a Bunsen burner.

The results are shown.

J colourless gas produced, which relights a glowing splint

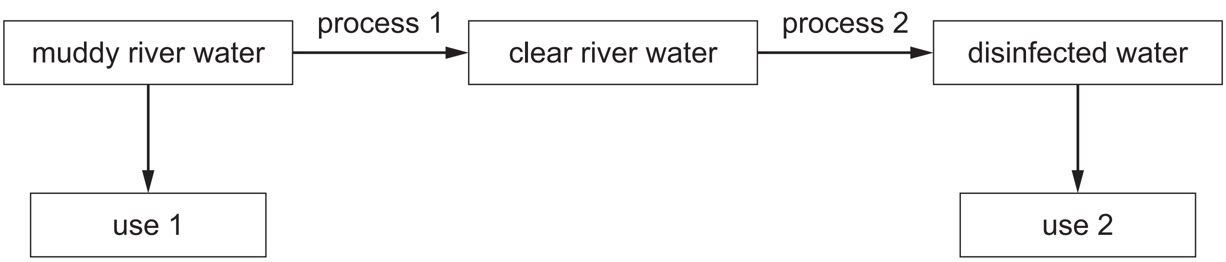
K colourless gas produced, which turns limewater milky

L no reaction

Which row identifies J, K and L?

	J	K	L
A	magnesium carbonate	potassium carbonate	potassium nitrate
B	magnesium carbonate	potassium nitrate	potassium carbonate
C	potassium nitrate	magnesium carbonate	potassium carbonate
D	potassium nitrate	potassium carbonate	magnesium carbonate

29 The diagram shows the uses and treatment processes of muddy river water.



Which row identifies uses 1 and 2 and processes 1 and 2?

	use 1	use 2	process 1	process 2
A	drinking	watering crops	chlorination	filtration
B	drinking	watering crops	filtration	chlorination
C	watering crops	drinking	chlorination	filtration
D	watering crops	drinking	filtration	chlorination

30 The equation for the manufacture of ammonia in the Haber process is shown.

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

The forward reaction is exothermic.

Which row describes the effect of the stated change on the reaction rate and the yield of ammonia?

	change	effect on reaction rate	effect on yield of ammonia
A	decrease pressure	increases	decreases
B	decrease temperature	decreases	increases
C	increase pressure	increases	decreases
D	increase temperature	increases	increases

31 Fertilisers are used to provide three of the elements needed for plant growth.

Which two compounds would give a fertiliser containing all three of these elements?

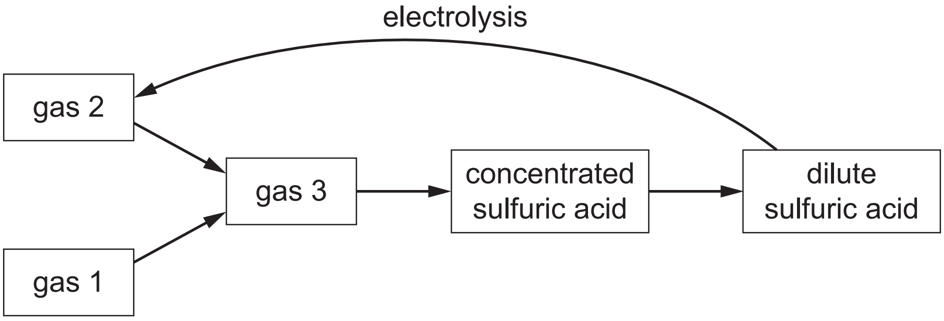
A $Ca(NO_3)_2$ and $(NH_4)_2SO_4$

B $Ca(NO_3)_2$ and $(NH_4)_3PO_4$

C KNO_3 and $(NH_4)_2SO_4$

D KNO_3 and $(NH_4)_3PO_4$

32 The flow chart shows part of the process for the manufacture of sulfuric acid and its electrolysis.



What are gases 1, 2 and 3?

	gas 1	gas 2	gas 3
A	sulfur dioxide	hydrogen	sulfur trioxide
B	sulfur dioxide	oxygen	sulfur trioxide
C	sulfur trioxide	hydrogen	sulfur dioxide
D	sulfur trioxide	oxygen	sulfur dioxide

33 Which statements about sulfur dioxide are correct?

1 Sulfur dioxide decolourises acidified potassium manganate(VII).

2 Sulfur dioxide forms when acids react with carbonates.

3 Sulfur dioxide is used as a bleach.

4 Sulfur dioxide is used to treat acidic soil.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

34 What are the products when limestone (calcium carbonate) is heated strongly?

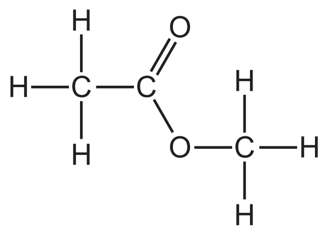
A calcium hydroxide and carbon dioxide

B calcium hydroxide and carbon monoxide

C calcium oxide and carbon dioxide

D calcium oxide and carbon monoxide

35 The structure of ester W is shown.



Which row gives the names of ester W and the carboxylic acid and alcohol from which it is made?

	name of ester W	carboxylic acid	alcohol
A	ethyl methanoate	ethanoic acid	methanol
B	ethyl methanoate	methanoic acid	ethanol
C	methyl ethanoate	ethanoic acid	methanol
D	methyl ethanoate	methanoic acid	ethanol

36 Ethanol is made industrially by the fermentation of glucose or by the catalytic addition of steam to ethene.

Which statement describes an advantage of fermentation compared to catalytic addition?

A Ethanol is the only product of fermentation.

B Fermentation uses a batch process but catalytic addition is continuous.

C Fermentation uses a higher temperature than catalytic addition.

D Fermentation uses a renewable resource.

37 Some properties of colourless liquid L are listed.

- It boils at 65 °C.
- When added to water, two layers form which do not mix.
- It does not react with sodium carbonate.
- It has no effect on bromine water.

What is L?

A ethanol

B hexane

C hexene

D ethanoic acid

38 A molecule of compound P contains two carbon atoms and four hydrogen atoms.

Which row represents P?

	name of compound	M_r	reacts with aqueous bromine
A	ethane	30	✗
B	ethene	16	✓
C	ethene	28	✓
D	ethene	28	✗

39 The reaction of ethanol with acidified potassium manganate(VII) is shown.

$$CH_3CH_2OH \xrightarrow[H^+]{KMnO_4} CH_3COOH$$

Which type of reaction is taking place?

A addition

B condensation

C hydrolysis

D oxidation

40 Which polymer is a synthetic polyamide?

A nylon

B poly(ethene)

C protein

D *Terylene*

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Core) **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **3** printed pages.

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

Question	Answer	Marks
29	D	**1**
30	B	**1**
31	D	**1**
32	B	**1**
33	A	**1**
34	C	**1**
35	C	**1**
36	D	**1**
37	B	**1**
38	C	**1**
39	D	**1**
40	A	**1**

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1831070697

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

IB22 03_0620_42/3RP

1 This question is about the first 30 elements in the Periodic Table.

Name the element which:

(a) is 78% of clean, dry air .... [1]

(b) has atoms with an electronic structure of 2,8,1 .... [1]

(c) is extracted from hematite .... [1]

(d) forms an oxide with a giant covalent structure .... [1]

(e) is the gas with the slowest rate of diffusion at room temperature

.... [1]

(f) has an anhydrous chloride which turns pink when water is added

.... [1]

(g) has aqueous ions which form a white precipitate when added to aqueous silver ions

.... [1]

(h) forms a blue hydroxide which dissolves in aqueous ammonia

....[1]

(i) is added to molten iron to remove impurities in the steel making process

.... [1]

(j) is used to galvanise iron. .... [1]

[Total: 10]

2 A student adds excess large pieces of magnesium carbonate, $MgCO_3$, to dilute hydrochloric acid, HCl, and measures the volume of carbon dioxide gas, CO_2, given off.

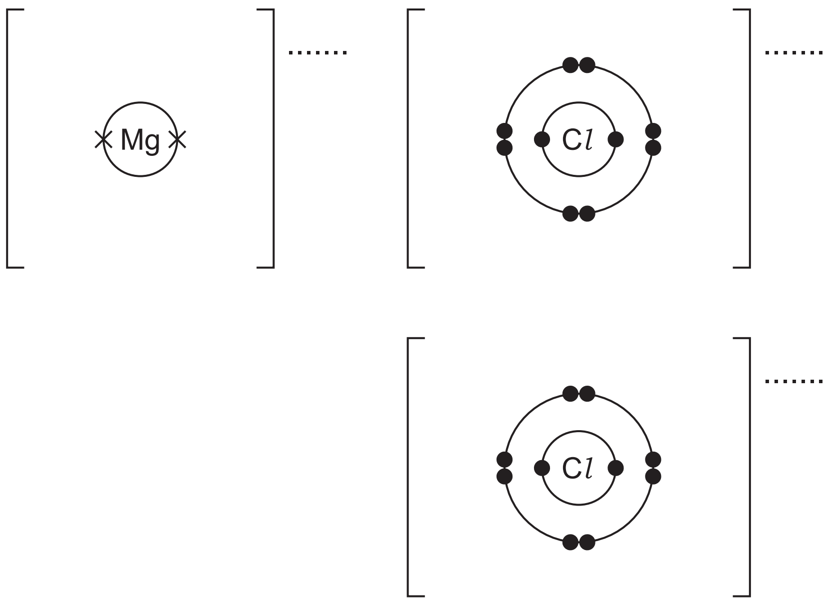
(a) Add the missing state symbols to the chemical equation for the reaction.

$$MgCO_3 \ ..... \ + \ 2HCl..... \ \rightarrow \ MgCl_2(aq) \ + \ H_2O \ ..... \ + \ CO_2 \ .....$$ [1]

(b) Complete the dot-and-cross diagram to show the electron arrangement of the ions in magnesium chloride.

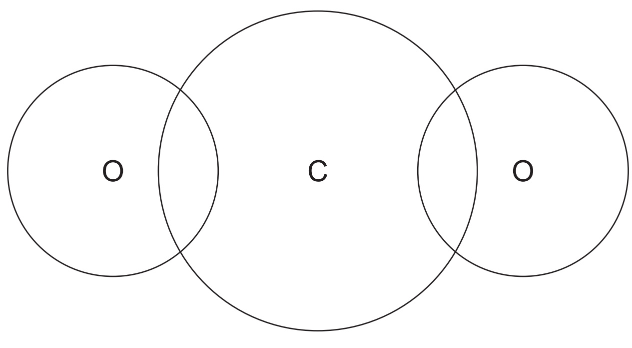
The inner shells have been drawn.

Give the charges on the ions.



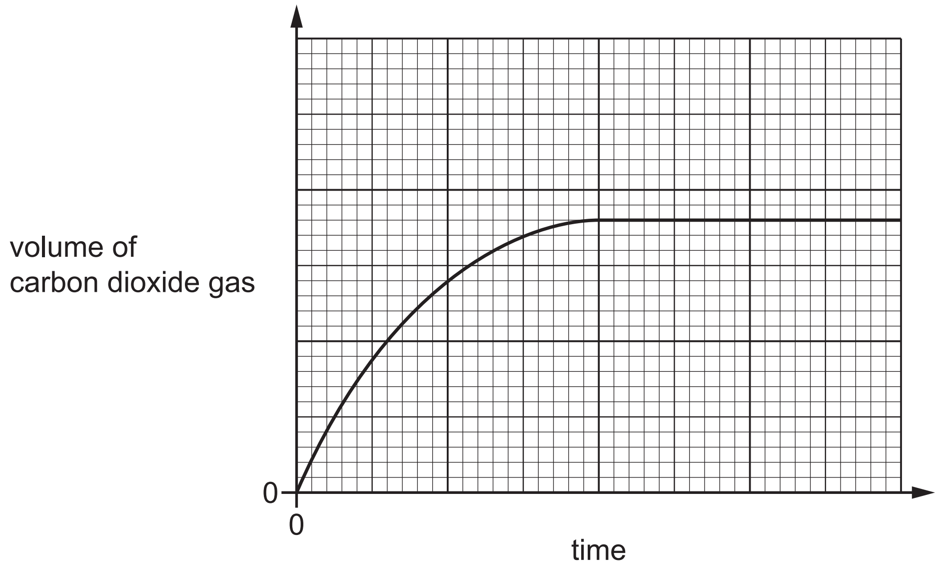
[3]

(c) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of carbon dioxide.
Show outer shell electrons only.



[2]

(d) The graph shows how the volume of carbon dioxide gas changes with time.



(i) Describe how the graph shows that the rate of this reaction decreases as time increases.

....

.... [1]

(ii) Explain, in terms of particles, why the rate of this reaction decreases as time increases.

....

.... [2]

(iii) The student repeats the experiment using powdered $MgCO_3$ instead of large pieces.

All other conditions stay the same.

On the grid, draw the line expected when powdered $MgCO_3$ is used instead of large pieces. [2]

(e) Determine the volume of CO_2 gas given off when excess $MgCO_3$ is added to 25.0 cm^3 of 0.400 mol / dm^3 HCl at room temperature and pressure.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$$

Use the following steps.

- Calculate the number of moles of HCl in 25.0 cm^3 of 0.400 mol / dm^3 of acid.

.... mol

- Determine the number of moles of CO_2 gas given off.

.... mol

- Calculate the volume of CO_2 gas given off in cm^3.

.... cm^3
[3]

[Total: 14]

3 Nitrogen dioxide, NO_2, is an atmospheric pollutant and is formed in car engines.

(a) Explain how nitrogen dioxide is formed in car engines.

....

.... [2]

(b) Nitrogen dioxide causes respiratory problems.

State one **other** adverse effect of nitrogen dioxide.

.... [1]

(c) Nitrogen dioxide emissions can be reduced by adding an aqueous solution of urea, $(NH_2)_2CO$, to car exhaust gases.

The heat of the exhaust gases breaks down the urea into simpler substances.

(i) Name the type of reaction which occurs when a substance is heated and breaks down into simpler substances.

.... [1]

(ii) One molecule of urea breaks down to form one molecule of ammonia and one other molecule.

Complete the chemical equation to show the formula of the other molecule formed in this reaction.

$$(NH_2)_2CO \rightarrow NH_3 + \text{.....................}$$ [1]

(iii) State the test for ammonia.

test ....

observations ....
[2]

(d) The ammonia formed reacts with nitrogen dioxide to form nitrogen and water.

(i) Balance the equation for this reaction.

$$\text{..........}NO_2 + \text{..........}NH_3 \rightarrow \text{..........}N_2 + 12H_2O$$ [2]

(ii) State how the equation shows that the nitrogen in nitrogen dioxide is reduced.

.... [1]

(iii) This reaction is a redox reaction.

State the meaning of the term *redox*.

.... [1]

(e) 135 moles of urea, $(NH_2)_2CO$, is stored in the tank of a car.

Calculate the mass, in kg, of the stored $(NH_2)_2CO$.

mass of $(NH_2)_2CO$ = ... kg
[2]

(f) Another oxide of nitrogen formed in car engines is nitrogen monoxide, NO. A catalytic converter removes NO by reacting it with a gas formed by incomplete combustion of the fuel. Two non-toxic gases are formed.

(i) Name the gas formed by incomplete combustion of the fuel.

.... [1]

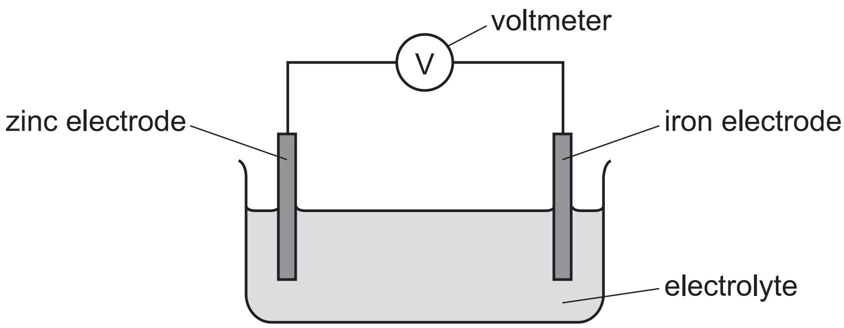
(ii) Name the **two** non-toxic gases formed.

.... and .... [1]

[Total: 15]

4 This question is about chemical reactions and electricity.

(a) The diagram shows the apparatus used in the production of electrical energy in a simple cell.



The zinc electrode dissolves in the electrolyte forming $Zn^{2+}(aq)$ ions.

(i) Draw an arrow on the diagram to show the direction of electron flow. [1]

(ii) Write the ionic half-equation for the reaction that occurs when the zinc electrode dissolves.

.... [2]

(b) The reading on the voltmeter can be increased if either zinc or iron is replaced by another metal.

(i) Name a metal that can replace zinc and increase the reading on the voltmeter.

.... [1]

(ii) Name a metal that can replace iron and increase the reading on the voltmeter.

.... [1]

(c) Fuel cells are used to generate electricity.

(i) Name the reactants in a fuel cell.

.... [1]

(ii) Name the waste product of a fuel cell.

.... [1]

(d) Electricity can be used to break down aqueous or molten ionic compounds.

(i) Name the process which uses electricity to break down aqueous or molten ionic compounds.

.... [1]

(ii) Explain why the ionic compound needs to be aqueous or molten.

.... [1]

(e) Brine is concentrated aqueous sodium chloride.

(i) Name **three** substances which are manufactured by passing electricity through brine.

1 ....

2 ....

3 ....
[3]

(ii) Name a different substance formed when molten sodium chloride is used instead of concentrated aqueous sodium chloride.

.... [1]

[Total: 13]

5 This question is about alkanes and alkenes.

(a) Short-chain alkanes and alkenes can be formed from long-chain alkanes in a chemical reaction.

(i) Name the type of chemical reaction which forms short-chain alkanes and alkenes from long-chain alkanes.

.... [1]

(ii) Decane has 10 carbon atoms. It forms ethane and ethene as the only products in this type of chemical reaction.

Write the chemical equation for this reaction.

.... [3]

(b) Ethane reacts with chlorine at room temperature to form chloroethane, C_2H_5Cl, and one other product.

(i) Name the other product formed.

.... [1]

(ii) State the condition needed for this reaction to take place.

.... [1]

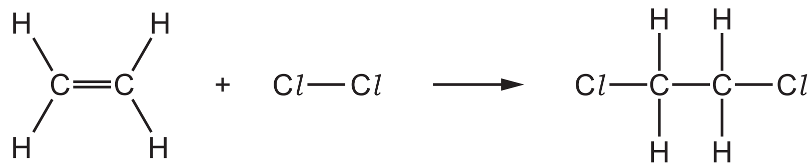
(c) Ethene reacts with chlorine at room temperature to form dichloroethane, $C_2H_4Cl_2$.

$$C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$$

(i) State why this is an addition reaction.

.... [1]

(ii) The chemical equation for this reaction can be represented as shown.



The energy change for the reaction is –180 kJ / mol.

Use the bond energies in the table to calculate the bond energy of a C–C*l* bond, in kJ / mol.

bond	C–H	C=C	C*l*–C*l*	C–C
bond energy in kJ / mol	410	610	240	350

Use the following steps.

step 1 Calculate the energy needed to break bonds.

energy needed to break bonds = ... kJ

step 2 Use your answer in **step 1** and the energy change for the reaction to determine the energy released when bonds are formed.

energy released when bonds form = ... kJ

step 3 Use your answer in **step 2** and bond energy values to determine the energy of a C–C*l* bond.

bond energy of a C–C*l* bond = ... kJ / mol
[4]

[Total: 11]

6 The names of four esters are listed.

methyl propanoate

ethyl propanoate

propyl propanoate

butyl propanoate

(a) Esters are a family of organic compounds with similar chemical properties. They can be represented by the formula $C_nH_{2n}O_2$.

(i) State the name given to a family of organic compounds with similar chemical properties.

.... [1]

(ii) Explain why members of a family of organic compounds have similar chemical properties.

.... [1]

(iii) State the name given to a formula such as $C_nH_{2n}O_2$.

.... [1]

(iv) Determine the value of '*n*' in butyl propanoate.

.... [1]

(b) All four of the esters in the list are liquids at room temperature.

Name the technique used to separate ethyl propanoate from a mixture of the four esters.

.... [2]

(c) All four esters can be made by reacting different alcohols with the same substance.

(i) Name this substance and draw its structure. Show all of the atoms and all of the bonds.

name ....

structure

[2]

(ii) Name the alcohol used to make methyl propanoate.

.... [1]

(d) Other esters, not in the list, have the same molecular formula as propyl propanoate, but different structures.

(i) State the term used to describe substances with the same molecular formula but different structures.

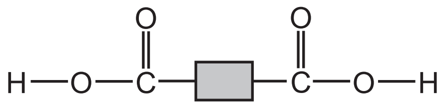
.... [1]

(ii) Name **two** esters with the same molecular formula as propyl propanoate.

1 ....

2 ....
[2]

(e) Polyesters can be made from the two different molecules shown.



and

(i) Complete the diagram to show a section of the polyester made from these two molecules. Include all of the atoms and all of the bonds in the linkages.

[3]

(ii) Name the type of polymerisation that takes place when this polymer forms.

.... [1]

(iii) Name a polyester.

.... [1]

[Total: 17]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMSITRY **0620/42**

Paper 4 Theory (Extended) **February/March 2022**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **9** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	nitrogen	**1**
1(b)	sodium	**1**
1(c)	iron	**1**
1(d)	silicon	**1**
1(e)	chlorine	**1**
1(f)	cobalt	**1**
1(g)	chlorine	**1**
1(h)	copper	**1**
1(i)	oxygen	**1**
1(j)	zinc	**1**

Question	Answer	Marks
2(a)	$MgCO_3\mathbf{(s)} + 2HCl\mathbf{(aq)} \rightarrow MgCl_2(q) + H_2O\mathbf{(l)} + CO_2\mathbf{(g)}$	**1**
2(b)	eight crosses in second shell of Mg 7 dots and 1 cross in third shell of both C*l* 2+ charge on Mg **and** – charge on both C*l* ions on correct answer line	**3**
2(c)	C atom double bonded to 2 O atoms 4 non-bonding e^- on each O and no non-bonding e^- on C and both octets complete	**2**
2(d)(i)	gradient (of line) decreases	**1**
2(d)(ii)	concentration of particles (of acid) decreases lower rate of collisions of particles	**2**

Question	Answer	Marks
2(d)(iii)	a new line steeper than printed line and starts at origin and levels off earlier than printed line levels off at the same volume	**2**
2(e)	M1 mol HCl = 0.400 × 25.0 / 1000 = 0.01(00) M2 mol CO_2 = M1 / 2 = 0.0100 / 2 = 0.005(00) M3 volume CO_2 = M2 × 24000 = 120 (cm^3)	**3**

Question	Answer	Marks
3(a)	nitrogen (from air) and oxygen (from air) react react due to high temperatures (of engine)	**2**
3(b)	acid rain	**1**
3(c)(i)	(thermal) decomposition	**1**
3(c)(ii)	HCNO	**1**
3(c)(iii)	(damp red) litmus (litmus) turns blue	**2**
3(d)(i)	$6NO_2$ $8NH_3$ $7N_2$ either $6NO_2$ or $8NH_3$ all three balanced	**2**
3(d)(ii)	(nitrogen) loses oxygen	**1**
3(d)(iii)	reduction **and** oxidation occur	**1**
3(e)	M_r urea = 60 135 × 60 = 8100 and g to kg conversion = 8.1(00) kg	**2**
3(f)(i)	carbon monoxide	**1**
3(f)(ii)	carbon dioxide **and** nitrogen	**1**

Question	Answer	Marks
4(a)(i)	arrow going from Zn to Fe	**1**
4(a)(ii)	$Zn \rightarrow Zn^{2+} + 2e^{-}$ Zn as only reactant **and** Zn^{2+} as only product correct equation	**2**
4(b)(i)	any metal above zinc in reactivity series	**1**
4(b)(ii)	any metal below iron in reactivity series	**1**
4(c)(i)	hydrogen **and** oxygen	**1**
4(c)(ii)	water	**1**
4(d)(i)	electrolysis	**1**
4(d)(ii)	mobile ions	**1**
4(e)(i)	hydrogen chlorine sodium hydroxide	**3**
4(e)(ii)	sodium	**1**

Question	Answer	Marks
5(a)(i)	cracking	**1**
5(a)(ii)	$C_{10}H_{22} \rightarrow 4C_2H_4 + C_2H_6$ $C_{10}H_{22}$ as only reactant formulae of ethene **and** ethane as only products correct equation	**3**
5(b)(i)	hydrogen chloride	**1**
5(b)(ii)	ultraviolet light	**1**
5(c)(i)	(only) one product is formed	**1**
5(c)(ii)	M1 Bond energy in breaking bonds = [(4 × 410) + 610 + 240] = 2490 (kJ / mol) M2 Use of total E change to find bond energy of $C_2H_4Cl_2$ = M1 + 180 = 2490 + 180 = 2670 (kJ / mol) M3 Determination of total C–C*l* bond energy = M2 – [(4 × 410) + 350] = 2670 – 1990 = 680 (kJ / mol) M4 Determination of each C–C*l* bond energy = M3 / 2 = 680 / 2 = 340 (kJ / mol)	**4**

Question	Answer	Marks
6(a)(i)	homologous series	**1**
6(a)(ii)	Same functional group	**1**
6(a)(iii)	general (formula)	**1**
6(a)(iv)	7	**1**

Question	Answer	Marks
6(b)	fractional distillation	**2**
6(c)(i)	propanoic acid structure of propanoic acid	**2**
6(c)(ii)	methanol	**1**
6(d)(i)	structural isomers	**1**
6(d)(ii)	ethyl butanoate butyl ethanoate	**2**
6(e)(i)	any correct displayed ester link between any two blocks showing all atoms and all bonds correct orientation of three displayed inter-block ester links with correct orientation continuation bonds on polyester	**3**
6(e)(ii)	condensation	**1**
6(e)(iii)	terylene	**1**

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2022**

45 minutes

You must answer on the multiple choice answer sheet.

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

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

IB22 03_0620_22/RP

1 Which gas has the fastest rate of diffusion?

A H_2 **B** CH_4 **C** CO_2 **D** SO_2

2 In which state does 1 dm^3 of methane contain the most particles?

A gas at 100 °C

B gas at room temperature

C liquid

D solid

3 Which statement explains why isotopes of the same element have the same chemical properties?

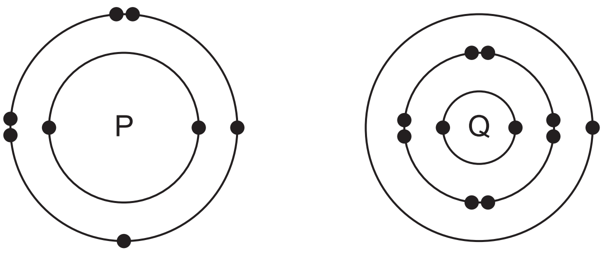
A They have the same electronic structure.

B They have the same relative mass.

C They have the same nucleon number.

D They have the same proton number.

4 The electronic structures of atoms P and Q are shown.



P and Q form an ionic compound.

What is the formula of the compound?

A PQ **B** P_2Q **C** P_2Q_3 **D** PQ_2

5 Fermentation of sugar produces a mixture of ethanol solution and solid yeast.

How is the solid yeast removed from the mixture?

A crystallisation

B distillation

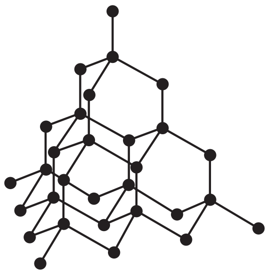
C filtration

D fractional distillation

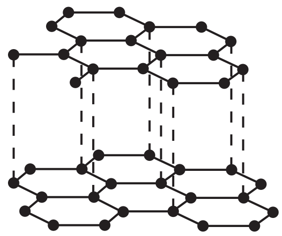
6 Which row explains why copper is a good conductor of electricity at room temperature?

	copper ions move freely	electrons move freely
A	no	no
B	no	yes
C	yes	no
D	yes	yes

7 Which pair of statements about diamond and graphite is correct?



diamond



graphite

A Diamond and graphite are both pure carbon. They are both macromolecules.

B Diamond and graphite can both be used as electrodes. Graphite is also used as a lubricant.

C Diamond has covalent bonds. Graphite has ionic bonds.

D Diamond is hard with a high melting point. Graphite is soft with a low melting point.

8 Sodium nitride contains the nitride ion, N^{3-}.

Sodium nitride is unstable and decomposes into its elements.

What is the equation for the decomposition of sodium nitride?

A $2NaN_3 \rightarrow 2Na + 3N_2$

B $2Na_3N \rightarrow 6Na + N_2$

C $2NaN_3 \rightarrow Na_2 + 3N_2$

D $2Na_3N \rightarrow 6Na + 2N$

9 Compound X contains carbon, hydrogen and oxygen only.

By mass, it contains 26.7% carbon and 2.2% hydrogen.

What is the empirical formula of X?

A CHO **B** C_2HO **C** CH_2O **D** CHO_2

10 Caesium fluoride is an ionic compound.

Which statements about caesium fluoride are correct?

1 It conducts electricity when solid.

2 It has a high melting point.

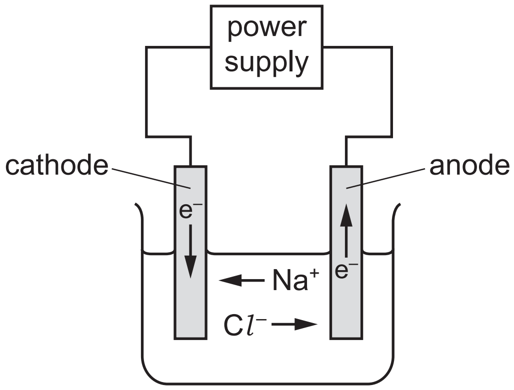
3 It is soluble in water.

4 It is highly volatile.

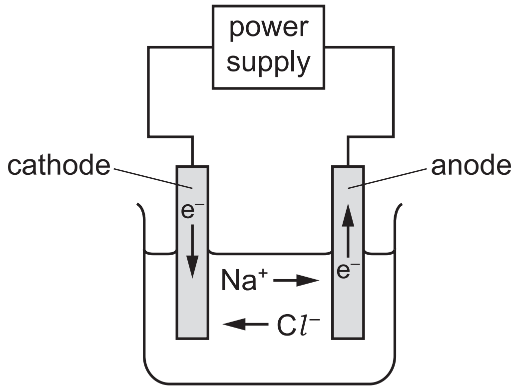
A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

11 Which diagram shows the direction of movement of ions and electrons during the electrolysis of molten sodium chloride?

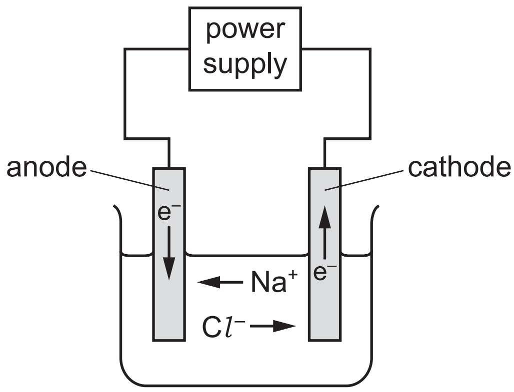
A



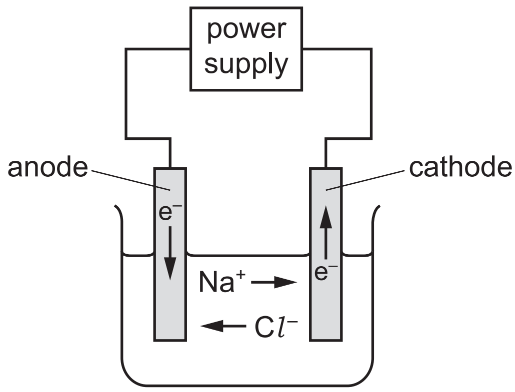
B



C



D



12 Calcium carbonate, $CaCO_3$, reacts with dilute hydrochloric acid to produce carbon dioxide.

The equation for the reaction is shown. The relative formula mass of calcium carbonate is 100.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

10 g of calcium carbonate is reacted with an excess of dilute hydrochloric acid.

Which mass of carbon dioxide is produced?

A 2.2 g **B** 2.8 g **C** 4.4 g **D** 44 g

13 Molten sodium chloride and concentrated aqueous sodium chloride are electrolysed using platinum electrodes.

What are the products at the negative electrode (cathode) in each electrolysis?

	molten sodium chloride	concentrated aqueous sodium chloride
A	hydrogen	hydrogen
B	hydrogen	sodium
C	sodium	hydrogen
D	sodium	sodium

14 An object is electroplated with silver using an aqueous silver salt as the electrolyte.

Which row is correct?

	the object to be electroplated is the	the other electrode is made from
A	anode	carbon
B	anode	silver
C	cathode	carbon
D	cathode	silver

15 Which row describes the changes that occur in an endothermic reaction?

	energy change	temperature
A	energy given out to the surroundings	decreases
B	energy given out to the surroundings	increases
C	energy taken in from the surroundings	decreases
D	energy taken in from the surroundings	increases

16 Which statement about fuels is correct?

A Heat energy is only produced by burning fuels.

B Hydrogen is used as a fuel although it is difficult to store.

C Methane is a good fuel because it produces only water when burned.

D Uranium is burned in air to produce energy.

17 Which statement about endothermic and exothermic reactions is correct?

A In an endothermic reaction, less energy is absorbed in bond breaking than is released in bond forming.

B In an endothermic reaction, the activation energy is always higher than in an exothermic reaction.

C In an exothermic reaction, more energy is absorbed in bond breaking than is released in bond forming.

D In an exothermic reaction, the reactants are higher on an energy level diagram than the products.

18 The reaction used to manufacture ammonia from nitrogen and hydrogen is reversible.

An equilibrium is established between ammonia, nitrogen and hydrogen.

Which statement describes the equilibrium?

A Both the forward reaction and the backward reaction have the same rate.

B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is greater than the rate of the backward reaction.

D The forward and backward reactions have both stopped.

19 How does increasing the concentration affect the reacting particles in a chemical reaction?

	increases the collision rate	increases the proportion of particles with the activation energy
A	✓	✗
B	✓	✓
C	✗	✗
D	✗	✓

20 Methyl orange is added to dilute hydrochloric acid and to aqueous sodium hydroxide.

What is the colour of the methyl orange in each solution?

	colour in dilute hydrochloric acid	colour in aqueous sodium hydroxide
A	orange	red
B	red	yellow
C	red	orange
D	yellow	red

21 Zinc oxide is an amphoteric oxide.

Which types of substances will react with zinc oxide?

A acids and bases

B acids only

C bases only

D neither acids nor bases

22 Information about some silver compounds is shown.

compound	formula	solubility in water
silver carbonate	Ag_2CO_3	insoluble
silver chloride	$AgCl$	insoluble
silver nitrate	$AgNO_3$	soluble
silver oxide	Ag_2O	insoluble

Which equation shows a reaction which **cannot** be used to make a silver salt?

A $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $Ag_2O(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l)$

C $Ag_2CO_3(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$

D $2Ag(s) + 2HCl(aq) \rightarrow 2AgCl(s) + H_2(g)$

23 Aqueous ethanoic acid is a weak acid.

Aqueous sodium hydroxide is a strong base.

Aqueous ethanoic acid is neutralised by aqueous sodium hydroxide.

Which statements are correct?

1 Aqueous ethanoic acid accepts protons from hydroxide ions.

2 The aqueous ethanoic acid used is fully dissociated into ions.

3 The aqueous sodium hydroxide used is fully dissociated into ions.

4 The reaction produces a salt and water.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

24 Three properties of element X are listed.

- It contains atoms with a full outer shell of electrons.
- It is monoatomic.
- It is unreactive.

In which part of the Periodic Table is the element placed?

A Group I

B Group VII

C Group VIII

D transition elements

25 Which word equation represents a reaction that occurs?

A sodium oxide + carbon → sodium + carbon dioxide

B sodium oxide + iron → sodium + iron(II) oxide

C iron(II) oxide + copper → iron + copper(II) oxide

D iron(III) oxide + carbon → iron + carbon dioxide

26 Which statement about the extraction of aluminium is correct?

A Aluminium is formed at the cathode during the electrolysis of aluminium oxide.

B Hematite is mainly aluminium oxide.

C Molten cryolite is used to raise the melting point of the aluminium oxide.

D Oxygen gains electrons at the anode during the electrolysis of aluminium oxide.

27 Metal M is mixed with copper to produce brass.

What is M?

A chromium

B nickel

C vanadium

D zinc

28 The table gives some properties of an element.

melting point in °C	3422
appearance of the element	grey
appearance of the chloride of the element	dark blue
density in g / cm^3	19.2
electrical conductivity when solid	good

Which other property does this element have?

A acts as a catalyst

B brittle

C forms an acidic oxide

D highly reactive with water

29 Ammonia is produced using the Haber process.

Which row shows the source of the raw materials and the reaction conditions?

	source of nitrogen	source of hydrogen	temperature / °C	pressure / atm
A	air	hydrocarbons	200	200
B	hydrocarbons	air	450	2
C	air	hydrocarbons	450	200
D	air	hydrocarbons	450	2

30 How many species are acting as bases in this reversible reaction?

$$HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$$

A 3 **B** 2 **C** 1 **D** 0

31 The equation for a reaction occurring in the Contact process is shown.

$$2SO_2 + O_2 \rightarrow 2SO_3$$

What is the catalyst used in this reaction?

A iron

B phosphoric(V) acid

C sulfuric acid

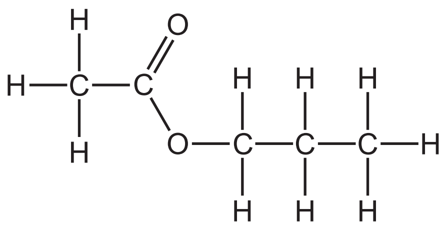
D vanadium(V) oxide

32 Which information about carbon dioxide and methane is correct?

		carbon dioxide	methane
A	formed when vegetation decomposes	✓	✗
B	greenhouse gas	✓	✓
C	present in unpolluted air	✗	✗
D	produced during respiration	✗	✓

key
✓ = correct
✗ = not correct

33 The structure of an ester is shown.



What are the names of the carboxylic acid and the alcohol that react together to form this ester?

	carboxylic acid	alcohol
A	ethanoic acid	ethanol
B	ethanoic acid	propan-1-ol
C	propanoic acid	ethanol
D	propanoic acid	propan-1-ol

34 Which statements about lime are correct?

1 Lime is made by heating calcium carbonate (limestone).

2 Lime is used to desulfurise flue gases.

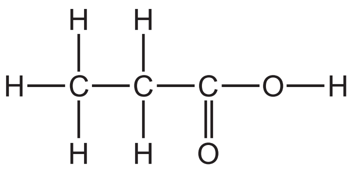
3 Lime is used to treat alkaline soil.

4 The chemical name for lime is calcium oxide.

A 1 and 3 **B** 1, 2 and 4 **C** 1 and 4 only **D** 2, 3 and 4

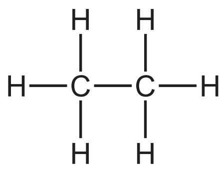
35 Which structure is correctly named?

A



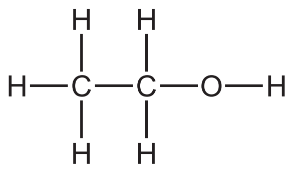
ethanoic acid

B



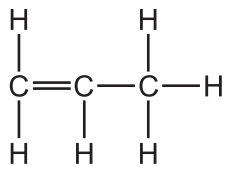
ethene

C



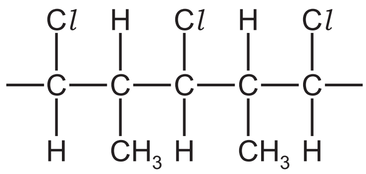
ethanol

D



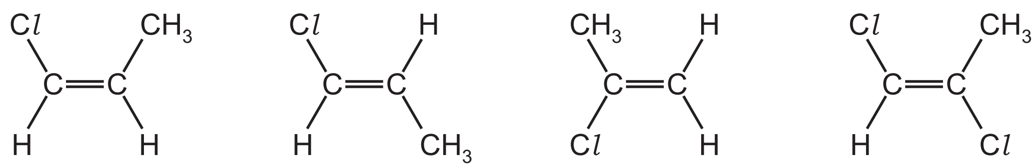
propane

36 The structure of part of a polymer is shown.



Which monomers can be used to make this polymer?

1 2 3 4



A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

37 Carboxylic acids are made by the oxidation of alcohols.

Which carboxylic acid is produced from CH_3CH_2OH?

A butanoic acid

B ethanoic acid

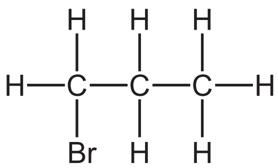
C methanoic acid

D propanoic acid

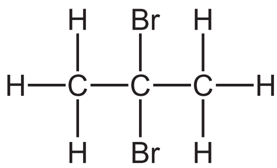
38 Propene, C_3H_6, reacts with bromine, Br_2, in an addition reaction.

Which structure represents the product of this reaction?

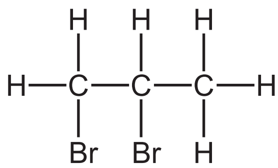
A



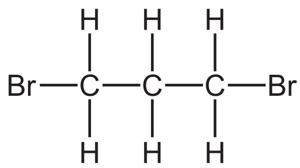
B



C



D



39 Which statements about ethanol are correct?

1 Ethanol is used as a solvent.

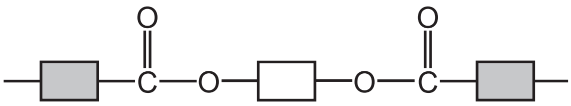
2 Ethanol can be made directly from ethane.

3 Ethanol is a covalent compound.

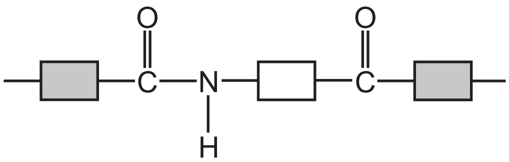
A 1 only **B** 1 and 2 **C** 1 and 3 **D** 2 and 3

40 Which diagram represents the structure of nylon?

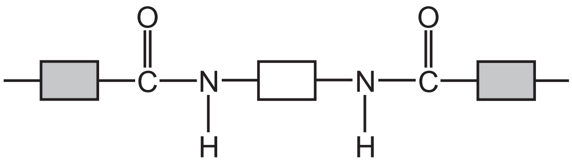
A



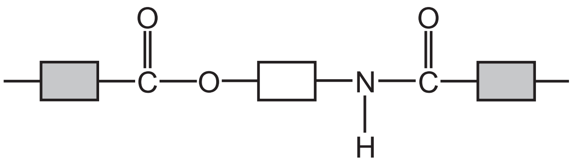
B



C



D



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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **3** printed pages.

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

Question	Answer	Marks
29	C	**1**
30	B	**1**
31	D	**1**
32	B	**1**
33	B	**1**
34	B	**1**
35	C	**1**
36	A	**1**
37	B	**1**
38	C	**1**
39	C	**1**
40	C	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 1 5 8 7 7 8 0 1 5 4 *

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

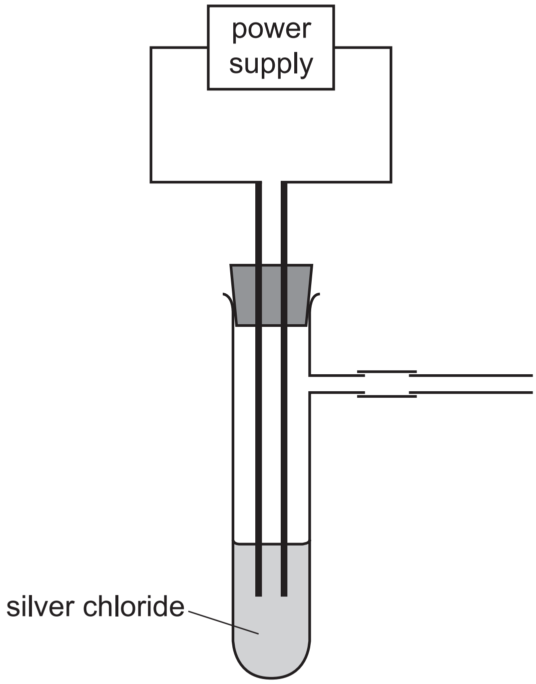
INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

IB21 03_0620_62/2RP

1 Silver chloride is an ionic compound and is insoluble in water. Molten silver chloride breaks down during electrolysis. The products are chlorine and silver.
Chlorine gas is soluble in water and toxic.

A student suggests using the apparatus shown to break down silver chloride.



(a) Draw an arrow on the diagram to show where heat must be applied so that the silver chloride can break down. [1]

(b) Complete the diagram to show how chlorine gas can be collected and the volume of the chlorine measured. Label any apparatus you have drawn. [2]

(c) Give **two** observations that are made as the silver chloride breaks down.

1 ....

2 ....
[2]

(d) The person doing the experiment followed all normal laboratory safety rules.

State **one** additional safety precaution that should be taken when doing this experiment. Give a reason for your answer.

safety precaution ....

reason ....
[2]

(e) Suggest **one** reason why zinc is **not** a suitable material to use as the electrodes.

....

.... [1]

(f) The chlorine gas was bubbled into an aqueous solution of a sodium salt. The colour of the solution changed from colourless to orange.

Identify the sodium salt and explain what has happened to cause the colour change.

sodium salt ....

explanation ....

....
[2]

[Total: 10]

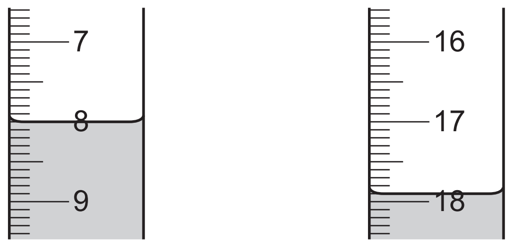
2 A student investigated the reaction between aqueous potassium hydroxide and two different aqueous solutions of hydrochloric acid labelled solution **A** and solution **B**.

Two experiments were done.

(a) *Experiment 1*

- A burette was filled with solution **A**. Some of solution **A** was run out of the burette so that the level of solution **A** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **A** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.



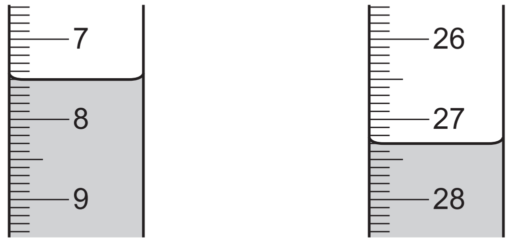
initial reading   final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **A** added / cm^3	

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was emptied and rinsed with distilled water.
- The burette was rinsed with solution **B**.
- The burette was filled with solution **B**. Some of solution **B** was run out of the burette so that the level of solution **B** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **B** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 2.



initial reading final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **B** added / cm^3	

[4]

(b) State the colour change observed in the conical flask at the end-point in Experiment 2.

from .... to .... [1]

(c) Before starting the titration in Experiment 2 the conical flask was rinsed with water.

(i) Explain why the conical flask was rinsed with water.

.... [1]

(ii) The conical flask was **not** then rinsed with aqueous potassium hydroxide.

State how rinsing the conical flask with aqueous potassium hydroxide would change the volume of solution **B** needed. Explain your answer.

....

.... [2]

(d) **(i)** Deduce which aqueous solution of hydrochloric acid, **A** or **B**, was more concentrated. Explain your answer.

....

.... [1]

(ii) Deduce how many times more concentrated this solution of hydrochloric acid was than the other solution of hydrochloric acid.

.... [1]

(e) Explain why Experiment 1 and Experiment 2 should be repeated.

....

.... [1]

(f) Deduce the volume of solution **B** required if Experiment 2 is carried out with 50 cm^3 of aqueous potassium hydroxide.

....

.... [2]

(g) Describe **one** change that could be made to the apparatus to improve the accuracy of the results.

....

.... [1]

(h) Describe what effect using a larger conical flask would have on the results obtained.

.... [1]

[Total: 15]

3 Two solids, solid **C** and solid **D**, were analysed.
Tests were done on each solid.

tests on solid C

Tests were carried out and the following observations were made.

tests	observations
test 1 A flame test was carried out on solid **C**.	a red flame was seen
Solid **C** was dissolved in distilled water to produce solution **C**. **test 2** About 5 cm^3 of aqueous sodium hydroxide was added to solution **C**.	no change
test 3 A piece of aluminium foil was added to the mixture formed in **test 2**.The mixture was warmed gently and any gas produced was tested.	effervescence was seen; damp red litmus paper turned blue

(a) Name the gas that turned the damp red litmus paper blue in **test 3**.

.... [1]

(b) Identify solid **C**.

....

.... [2]

tests on solid D

Solid **D** was aluminium sulfate.

Complete the expected observations.

Solid **D** was dissolved in water to form solution **D**. Solution **D** was divided into four approximately equal portions in four test-tubes.

(c) Aqueous sodium hydroxide was added dropwise and then in excess to the first portion of solution **D**.

observations ....

.... [2]

(d) Aqueous ammonia was added dropwise and then in excess to the second portion of solution **D**.

observations ....

.... [2]

(e) About 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **D**.

observations .... [1]

(f) About 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the fourth portion of solution **D**.

observations .... [1]

[Total: 9]

4 Old concrete contains calcium carbonate. Calcium carbonate reacts with dilute hydrochloric acid.

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

Plan an investigation to find which of two lumps of concrete contains the larger percentage of calcium carbonate. Your plan should include how you will use your results to determine which one of the two lumps has the larger percentage of calcium carbonate.

You have access to all common laboratory materials and a supply of dilute hydrochloric acid.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	decreases / goes down	**1**
	gas / carbon dioxide escapes / lost / released (from flask)	**1**
1(b)(i)	gas/carbon dioxide cannot escape (so the mass will not change when a bung is used)	**1**
1(b)(ii)	trap / prevent / stop acid spray	**1**
1(c)	calcium carbonate	**1**
1(d)	filter (to remove calcium carbonate)	**1**
	heat (to evaporate water)	**1**
	until crystals start to form / point of crystallisation / until saturated (then leave to cool) / until half evaporated	**1**

Question	Answer	Marks
2(a)	all initial temperatures correct (21.0, 21.0, 21.0, 21.5, 21.5, 21.5)	**1**
	all final temperatures correct (25.5, 27.5, 30.0, 32.5, 34.0, 39.5)	**2**
	all temperature changes in calculated correctly (4.5, 6.5, 9.0, 11.0, 12.5, 18.0)	**1**
	all temperature readings and calculated temperature changes are show to 1 dp	**1**
2(b)	*y*-axis scale is linear and points extend over halfway up scale	**1**
	all points plotted correctly	**2**
	best fit straight line	**1**
	line extended to (0,0)	**1**

Question	Answer	Marks
2(c)	correct working shown on graph	**1**
	correct reading from their working shown on graph	**1**
2(d)	9 °C / halved	**1**
	double the volume of water (to be heated)	**1**
2(e)	change: use a polystyrene cup / insulation / lid	**1**
	explanation: reduce / less heat lost	**1**
	change: use a burette (for the water)	**1**
	explanation: (more) accurate (than a measuring cylinder)	**1**

Question	Answer	Marks
3(a)	blue-green (flame)	**1**
3(b)	(light/pale) blue precipitate	**1**
	dissolves / forms a solution	**1**
	deep(er) blue	**1**
3(c)	cream precipitate	**1**
3(d)	any pH in range 8 to 14	**1**
3(e)	calcium / Ca^{2+}	**1**
	hydroxide / OH^{-}	**1**

Question	Answer	Marks
4	1 mark each for any 6 from: • known/specified volume of fizzy drink • warmed/heated • in a suitable container • gas collected in inverted measuring cylinder over water or in a (gas) syringe • until no more gas collected / all carbon dioxide given off / no more bubbles • volume of gas measured / recorded • volume of gas in 1 dm^3 = volume collected $\times$ 1000 / volume used	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6975746068

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

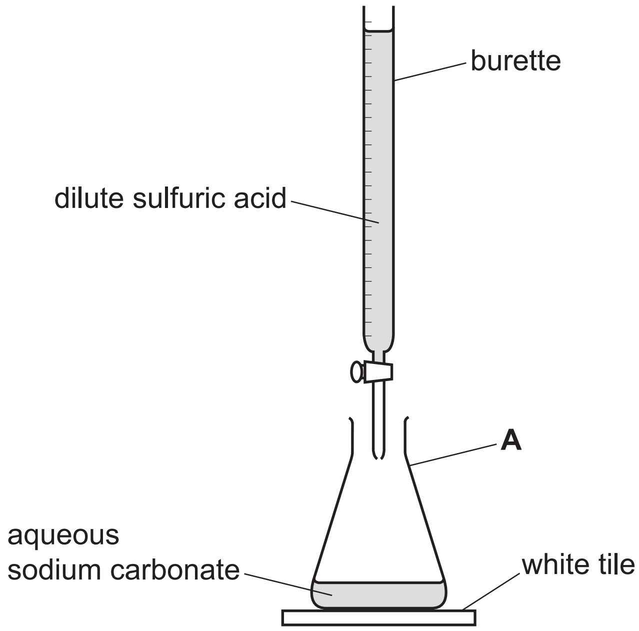
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

1 A student investigated the volume of dilute sulfuric acid that would react with 25.0 cm^3 of aqueous sodium carbonate.

- A burette was rinsed with water and then with dilute sulfuric acid.
- The burette was filled with dilute sulfuric acid. Some of the dilute sulfuric acid was run out of the burette so that the level of the dilute sulfuric acid was on the burette scale.
- 25.0 cm^3 of aqueous sodium carbonate was poured into the apparatus labelled **A** in the diagram.
- Five drops of methyl orange indicator were added to the aqueous sodium carbonate in **A**.
- The apparatus labelled **A** was placed on a white tile.
- The dilute sulfuric acid was added slowly to the 25.0 cm^3 of aqueous sodium carbonate until the colour of the methyl orange changed from yellow to orange.

The apparatus was arranged as shown in the diagram.



(a) Name the apparatus labelled **A**.

.... [1]

(b) State **one** safety precaution that should be taken when using dilute sulfuric acid.

.... [1]

(c) Give a reason why the white tile is used.

.... [1]

(d) Describe what should be done to the apparatus labelled **A** as the dilute sulfuric acid is added to the aqueous sodium carbonate.

.... [1]

(e) State why the burette was rinsed with water and then with dilute sulfuric acid at the start of the experiment.

water ....

....

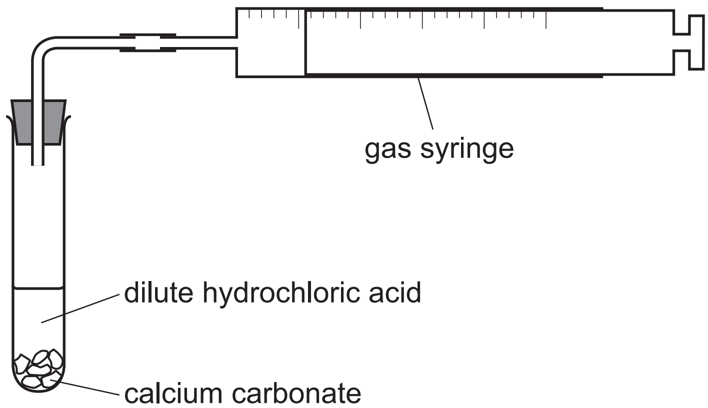
dilute sulfuric acid ....

.... [2]

[Total: 6]

2 A student investigated the rate of reaction between small lumps of calcium carbonate and dilute hydrochloric acid.

The experiment was done at two different temperatures using the apparatus shown in the diagram. All other conditions were kept the same.



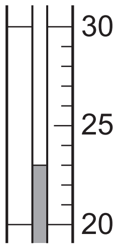
Experiment 1

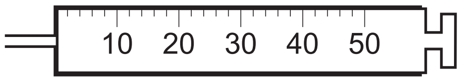
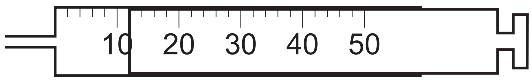
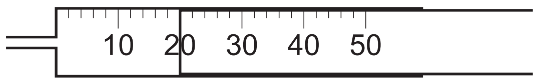
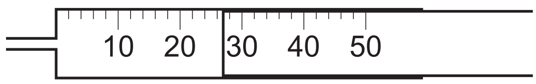
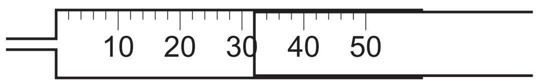
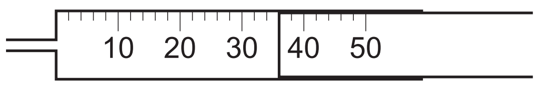
- Using a 50 cm^3 measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The temperature of the dilute hydrochloric acid was measured using a thermometer.
- 10 g of lumps of calcium carbonate were added to the boiling tube, the bung replaced and the stop-watch started.
- The volume of gas collected in the gas syringe was measured every 50 seconds for 250 seconds.

Experiment 2

- Using a 50 cm^3 measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The dilute hydrochloric acid in the boiling tube was warmed using a Bunsen burner.
- The temperature of the dilute hydrochloric acid was measured using a thermometer.
- 10 g of lumps of calcium carbonate were added to the boiling tube, the bung replaced and the stop-watch started.
- The volume of gas collected in the gas syringe was measured every 50 seconds for 250 seconds.

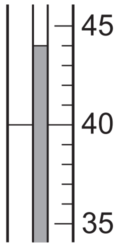
(a) Use the diagrams to complete the tables for Experiment 1.

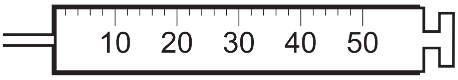
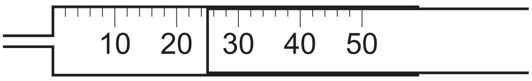
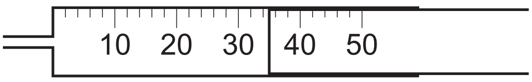
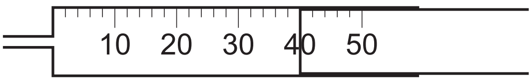
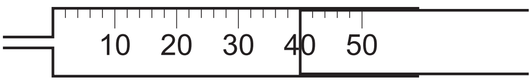
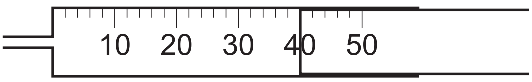
thermometer diagram	temperature of dilute hydrochloric acid / °C
	

time / s	gas syringe diagram	volume of gas collected / cm^3
0		
50		
100		
150		
200		
250		

[2]

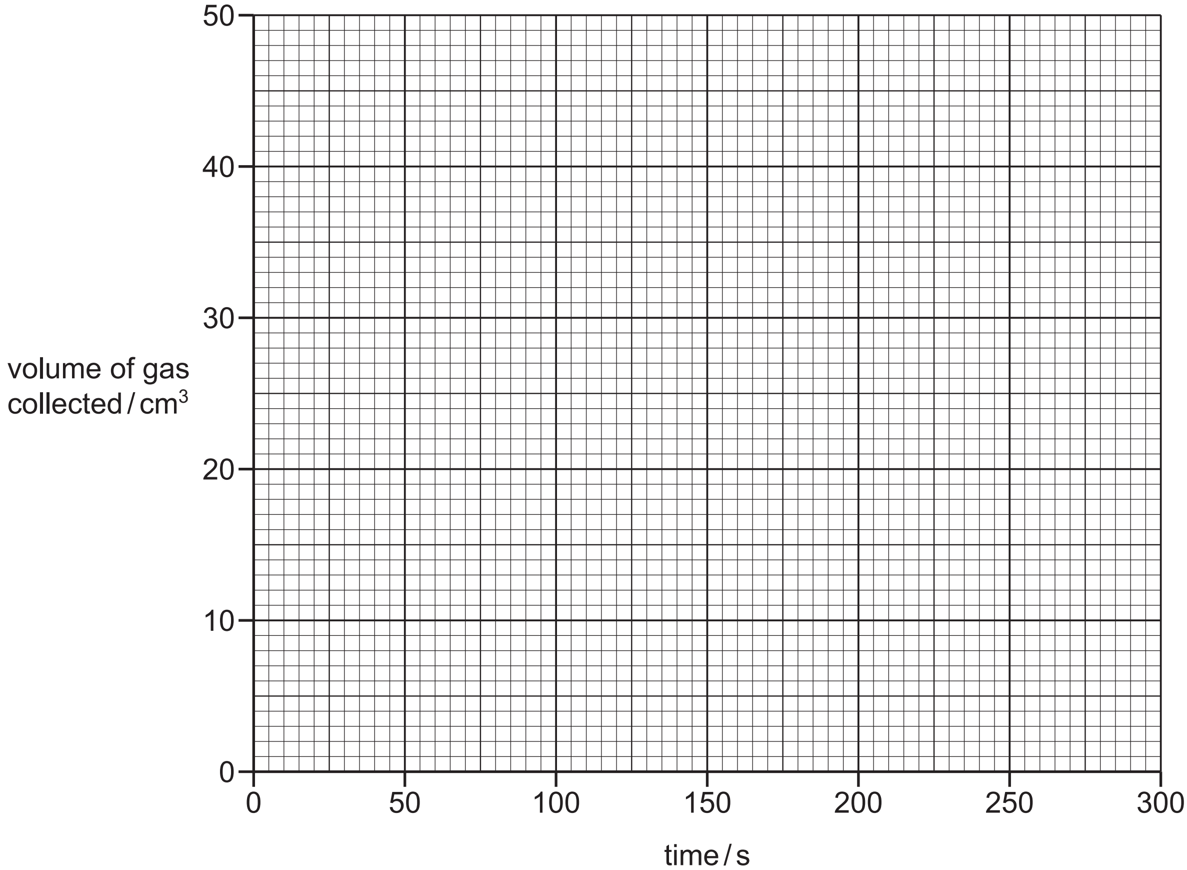
(b) Use the diagrams to complete the tables for Experiment 2.

thermometer diagram	temperature of dilute hydrochloric acid / °C
	

time / s	gas syringe diagram	volume of gas collected / cm^3
0		
50		
100		
150		
200		
250		

[2]

(c) Plot the results from Experiment 1 and Experiment 2 on the grid.
Draw a curve of best fit for each experiment. Label your curves.



[5]

(d) **From your graph**, deduce the volume of gas collected in Experiment 2 after 120 seconds.

Show clearly **on the grid** how you worked out your answer.

.... cm^3
[2]

(e) Explain how the results show that the reaction in Experiment 2 has stopped.

....

.... [1]

(f) Predict the volume of gas that would be collected in Experiment 1 after 800 seconds.
Explain your answer.

volume of gas collected after 800 seconds .... cm^3

explanation ....

....
[2]

(g) A student stated it would be an improvement to measure the volume of gas collected every 25 seconds.

Explain why this is an improvement.

....

....

.... [2]

(h) State **two** changes to the apparatus to improve the accuracy of the results obtained if the experiment is repeated using the same thermometer.

change 1 ....

....

change 2 ....

....
[2]

(i) Describe how the method used in Experiment 2 could be changed so that results can be obtained using dilute hydrochloric acid at 1 °C.

....

.... [1]

[Total: 19]

3 Solution **Y** and solution **Z** were analysed.
The following tests were done on the solutions.

tests on solution Y

tests	observations
Solution **Y** was divided into four portions in four test-tubes. **test 1** A strip of universal indicator paper was dipped into the first portion of solution **Y**.	the universal indicator paper turned blue
test 2 Aqueous copper(II) sulfate was added to the second portion of solution **Y**.	a blue precipitate formed
test 3 A flame test was done using the third portion of solution **Y**.	a red flame was seen
test 4 $2\,cm^3$ of dilute sulfuric acid was added to the fourth portion of solution **Y**.	no visible change; the test-tube became slightly warmer

(a) Suggest the pH of solution **Y**.

.... [1]

(b) Identify solution **Y**.

....

.... [2]

tests on solution Z

Solution **Z** was aqueous ammonium sulfite.

Complete all of the expected observations.

Solution **Z** was divided into three portions in two boiling tubes and a test-tube.

(c) 5 cm^3 of dilute hydrochloric acid was added to the first portion of solution **Z** in a boiling tube. The mixture was warmed and a piece of filter paper soaked in acidified aqueous potassium manganate(VII) held at the mouth of the boiling tube.

State the colour change of the acidified aqueous potassium manganate(VII).

from .... to .... [2]

(d) Name the gas being tested for in **(c)**.

.... [1]

(e) 5 cm^3 of aqueous sodium hydroxide was added to the second portion of solution **Z** in a boiling tube. The mixture was warmed and the gas given off was tested.

result of gas test ....

.... [1]

(f) Identify the gas given off in **(e)**.

.... [1]

(g) About 1 cm^3 of dilute hydrochloric acid followed by a few drops of aqueous barium nitrate were added to the third portion of solution **Z**.

observations .... [1]

[Total: 9]

4 Tartrazine is used as a yellow food colouring.

Plan an investigation to find out if a yellow sweet contains tartrazine. Explain how your results will tell you if the sweet contains tartrazine.

You have access to all normal laboratory materials, a yellow sweet and a sample of tartrazine.

You may draw a labelled diagram as part of your answer.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2021**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **7** printed pages.

[Turn over

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	<u>Guidance for chemical equations</u> Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	(conical) flask	**1**
1(b)	safety glasses/goggles/gloves/lab coat	**1**
1(c)	to see colour change clearly/easily/accurately/better	**1**
1(d)	swirl the flask	**1**
1(e)	water: to clean / to remove residue from previous experiment	**1**
	acid: to remove the water	**1**

Question	Answer	Marks
2(a)	mark syringe diagrams only. 0, 12, 20, 27, 32, 36	**2**
2(b)	thermometer diagrams Experiment 1: 23 **and** Experiment 2: 44	**1**
	syringe diagrams 0, 25, 35, 40,40,40	**1**
2(c)	all 12 points plotted correctly	**2**
	smooth curve for Experiment 1	**1**
	smooth curve for Experiment 2, must level off	**1**
	lines labelled either with Experiment 1/2, (a)/(b) or temperature	**1**
2(d)	correct indication/construction shown on graph	**1**
	correct reading for their indication/construction	**1**
2(e)	gas volume constant / stays at 40 cm^3	**1**

Question	Answer	Marks
2(f)	40	**1**
	same amount of reactants/acid as Experiment 2	**1**
2(g)	more data / more points	**1**
	can plot a better graph / see trend more clearly	**1**
2(h)	any two from • insulate the tube / use a waterbath • use a pipette/burette in place of the measuring cylinder • use a divided flask / description of this **max 2**	**2**
2(i)	description of how the acid would be cooled, such as place acid in fridge or freezer / stand tube in ice bath	**1**

Question	Answer	Marks
3(a)	11–14	**1**
3(b)	lithium / Li^+	**1**
	hydroxide / OH^-	**1**
3(c)	(from) purple	**1**
	(to) colourless	**1**
3(d)	sulfur dioxide / SO_2	**1**
3(e)	(red) litmus turns blue	**1**
3(f)	ammonia / NH_3	**1**

Question	Answer	Marks
3(g)	no change / no reaction	**1**

Question	Answer	Marks
4	any six from: • dissolve sweet in solvent/water • carry out chromatography • place spot of sweet solution on chromatography paper • place spot of tartrazine on same level/baseline • place/stand paper in solvent/water • let solvent rise to near top of paper • compare height of spot from sweet and tartrazine, if the same sweet contains tartrazine **OR** • compare R_f value of spot from sweet with R_f for tartrazine, if the same then sweet contains tartrazine **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8853844180

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

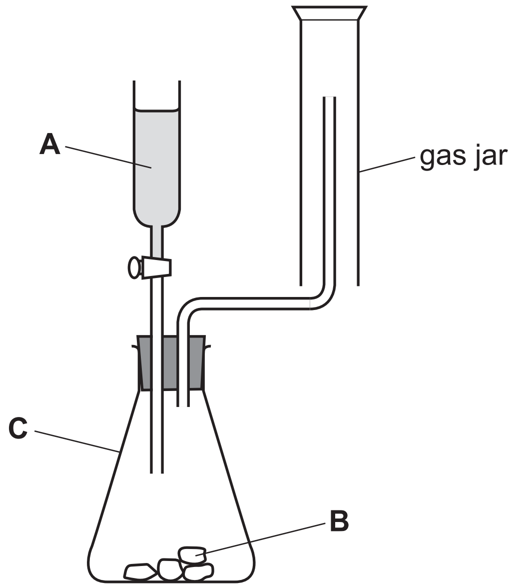
INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

1 Carbon dioxide is a colourless gas that is denser than air.
Carbon dioxide can be made by reacting marble chips with dilute hydrochloric acid.

A student tried to make and collect carbon dioxide gas using the apparatus shown.



(a) (i) Name the substances labelled **A** and **B**.

A ....

B ....
[1]

(ii) Name the item of apparatus labelled **C**.

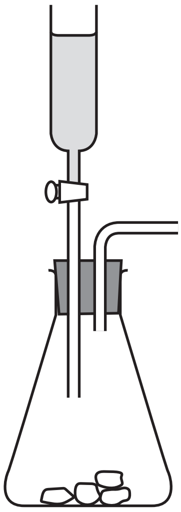
.... [1]

(b) Explain why very little carbon dioxide gas would be collected using the apparatus shown.

....

.... [2]

(c) Complete the diagram to show how carbon dioxide gas could be collected and the volume measured.



[2]

(d) At the end of the experiment there were unreacted marble chips and aqueous calcium chloride in the item of apparatus labelled **C**.

Describe how you would find the mass of unreacted marble chips in apparatus **C**.

....

....

....

.... [3]

[Total: 9]

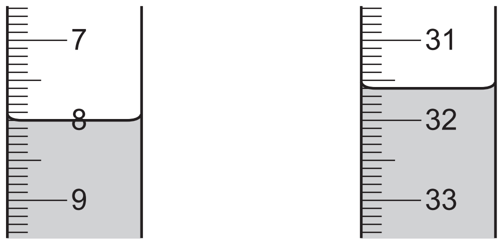
2 A student investigated the reaction between two different solutions of aqueous sodium carbonate, solution **K** and solution **L**, and two different solutions of dilute hydrochloric acid, acid **M** and acid **N**.

Three experiments were done.

(a) *Experiment 1*

- A burette was filled with solution **K**. Some of solution **K** was run out of the burette so that the level of solution **K** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **M** was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **K** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 1.



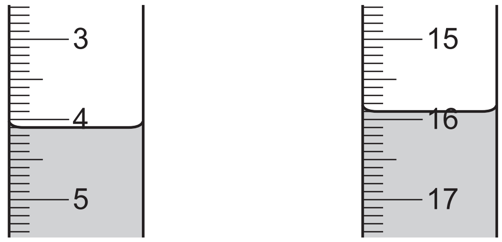
initial reading   final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **K** added / cm^3	

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was refilled with solution **K**. Some of solution **K** was run out of the burette so that the level of solution **K** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **N** was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **K** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 2.



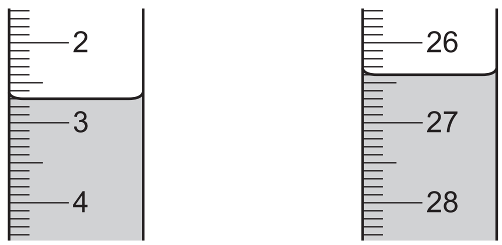
initial reading　　　　final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **K** added / cm^3	

Experiment 3

- The burette was emptied and rinsed with distilled water.
- The conical flask was emptied and rinsed with distilled water.
- The burette was filled with solution **L**. Some of solution **L** was run out of the burette so that the level of solution **L** was on the burette scale.
- Using a measuring cylinder 25 cm^3 of acid **N** was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- The conical flask was placed on a white tile.
- Solution **L** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

Use the burette diagrams to complete the table for Experiment 3.



initial reading　　　　final reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **L** added / cm^3	

[5]

(b) State the colour change observed at the end-point in the conical flask in Experiment 1.

from .... to .... [1]

(c) Describe one **other** observation made when solution **K** was added to acid **M** in Experiment 1.

.... [1]

(d) (i) Compare the volumes of solution **K** used in Experiment 1 and Experiment 2.

....

.... [2]

(ii) Suggest why different volumes of solution **K** were needed in Experiment 1 and Experiment 2.

.... [1]

(e) Deduce the volume of solution **L** required to reach the end-point if Experiment 3 is repeated using acid **M** in place of acid **N**.

volume of solution **L** = ... cm^3 [1]

(f) Explain why the conical flask was rinsed with water at the start of Experiment 2 and Experiment 3.

.... [1]

(g) At the start of Experiment 3 the burette was rinsed with water.

Describe an additional step that should have been done after rinsing the burette with water but before filling the burette with solution **L**. Explain your answer.

....

.... [2]

(h) Explain why the conical flask is placed on a white tile.

.... [1]

(i) Describe how the reliability of the results can be confirmed.

....

.... [1]

(j) State **one** source of error in Experiment 1. Suggest an improvement to reduce this error.

source of error ....

improvement ....

[2]

[Total: 18]

3 Solid **O** and liquid **P** were analysed. Solid **O** was ammonium bromide.
Tests were done on each substance.

tests on solid O

Complete the expected observations.

Solid **O** was dissolved in water to form solution **O**. Solution **O** was divided into four approximately equal portions in four test-tubes.

(a) To the first portion of solution **O**, approximately 2 cm^3 of aqueous ammonia was added.

observations .... [1]

(b) To the second portion of solution **O**, approximately 2 cm^3 of aqueous sodium hydroxide was added. The mixture formed was warmed. A gas was given off.

(i) The gas given off was tested with damp red litmus paper.

observations .... [1]

(ii) Identify the gas given off.

.... [1]

(c) To the third portion of solution **O**, approximately 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added.

observations .... [1]

(d) To the fourth portion of solution **O**, approximately 1 cm^3 of aqueous chlorine was added.

observations .... [1]

tests on liquid P

tests	observations
test 1 A few drops of liquid **P** were placed in a crucible. A lighted splint was applied to the surface of liquid **P** in the crucible.	burned with an orange flame and lots of smoke; soot was left around the top of the crucible
test 2 A few drops of liquid **P** were added to a test-tube containing 1 cm^3 of aqueous bromine.	colour changed from orange to colourless

(e) State what conclusions can be made about liquid **P**.

....

.... [2]

[Total: 7]

4 Cobalt is a metal. Cobalt is between copper and iron in the reactivity series. The mineral spherocobaltite contains the compound cobalt(II) carbonate and no other metal ions. Cobalt(II) carbonate is insoluble in water and reacts with dilute acids to form an aqueous solution of a salt.

Describe how you would obtain a sample of cobalt metal starting with a large lump of spherocobaltite. You have access to all normal laboratory apparatus and chemicals.

....

....

....

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2021**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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This document consists of **8** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
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GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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Question	Answer	Marks
1(a)(i)	**A** (dilute) hydrochloric acid **and** **B** marble chips	**1**
1(a)(ii)	(conical) flask	**1**
1(b)	**M1** (carbon dioxide) is denser than air	**1**
	M2 drops out of gas jar	**1**
1(c)	**M1** shows collection over water / in a gas syringe	**1**
	M2 in a measuring cylinder / graduations shown on collection vessel	**1**
1(d)	**M1** filter	**1**
	M2 wash	**1**
	M3 dry **and** weigh	**1**

Question	Answer	Marks
2(a)	**M1** Experiment 1 burette readings completed correctly (31.6 and 8.0)	**1**
	M2 Experiment 2 burette readings completed correctly (15.9 and 4.1)	**1**
	M3 Experiment 3 burette readings completed correctly (26.4 and 2.7)	**1**
	M4 All subtractions to give volume added correct (23.6, 11.8, 23.7)	**1**
	M5 All readings / volumes are given to 1 dp or better	**1**
2(b)	(from) red (to) orange	**1**
2(c)	effervescence / fizzing / bubbles	**1**

Question	Answer	Marks
2(d)(i)	**M1** greater volume used in experiment 1 / smaller volume used in experiment 2	**1**
	M2 twice as much in experiment 1 / half as much in experiment 2	**1**
2(d)(ii)	solution **M** is more concentrated than solution **N**	**1**
2(e)	47.4	**1**
2(f)	to clean / to remove residue from previous experiment	**1**
2(g)	**M1** rinse with solution **L**	**1**
	M2 to remove water / avoid diluting solution **L** / avoid changing concentration (of L)	**1**
2(h)	to see colour change clearly / easily / accurately / better	**1**
2(i)	repeat the experiments **and** compare the results	**1**
2(j)	**M1** source of error: measuring cylinder / error in volume of solution M	**1**
	M2 improvement: use a pipette	**1**

Question	Answer	Marks
3	**Tests on solid O**	
3(a)	no change / colourless / no reaction / no observation	**1**
3(b)(i)	(red litmus) becomes blue	**1**
3(b)(ii)	ammonia / NH_3	**1**
3(c)	cream precipitate	**1**
3(d)	(solution becomes) orange / yellow	**1**
3	**Tests on a liquid P**	
3(e)	any two from: flammable / fuel unsaturated / alkene / any named alkene organic / contains carbon / hydrocarbon	**2**

Question	Answer	Marks
4	**reduction method** Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and/or mortar, hammer • add more reactive metal / suitable gas • carbon / coke / zinc / aluminium / magnesium / CO / hydrogen specified • heat • In a suitable container (e.g. crucible, evaporating basin) • cobalt displaced / cobalt formed **electrolysis method** Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and / or mortar, hammer • add a (dilute) acid • suitable strong acid named (e.g. HCl, H_2SO_4, HNO_3) • electrolysis (of solution) • specified inert material for electrodes (e.g. carbon, platinum) • cobalt obtained at the negative electrode / cathode **displacement method** Any 6 from: • crush rock / break into smaller pieces / powder • using a suitable method, e.g. pestle and / or mortar, hammer • add a (dilute) acid • suitable strong acid named (e.g. HCl, H_2SO_4, HNO_3) • add metal more reactive than cobalt • name of metal added specified (e.g. iron, zinc, magnesium) • Cobalt displaced / cobalt formed	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4026350879

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

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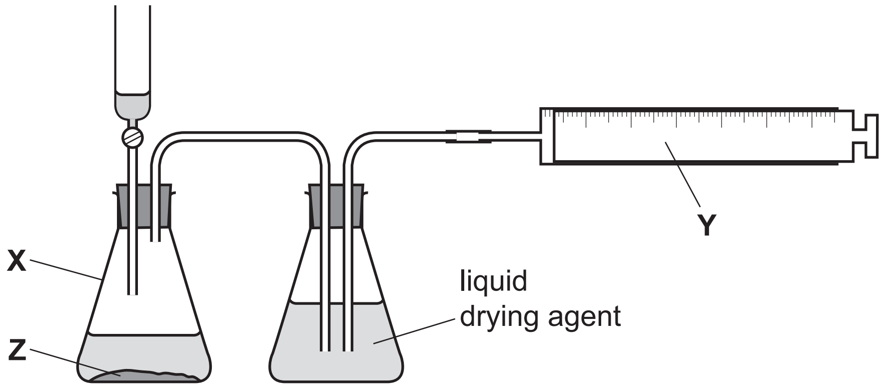
1 Hot concentrated hydrochloric acid reacts with solid manganese(IV) oxide to make chlorine gas. Chlorine gas can be dried by bubbling it through a liquid drying agent.

The diagram shows the apparatus used to make and collect a sample of dry chlorine gas. There is one error in the diagram.



(a) Name the items of apparatus labelled **X** and **Y**.

X ....

Y .... [2]

(b) Name the substance labelled **Z**.

.... [1]

(c) **On the diagram** draw **one** arrow to show where heat should be applied so that chlorine gas is made. [1]

(d) There is one error in the way the apparatus has been set up.

(i) **On the diagram** draw a circle around the error in the apparatus. [1]

(ii) Describe what would happen if the apparatus is used before the error is corrected.

....

.... [1]

[Total: 6]

2 A student investigated the temperature change when zinc reacted with two different aqueous solutions of copper(II) sulfate, solution **Q** and solution **R**.

Two experiments were done.

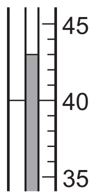
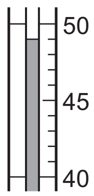
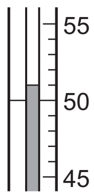
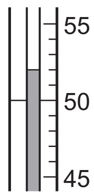
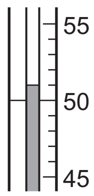
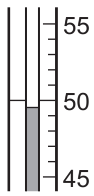
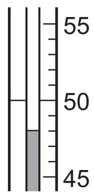
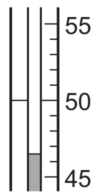
(a) *Experiment 1*

- A polystyrene cup was placed in a $250\,cm^3$ beaker for support.
- Using a measuring cylinder, $25\,cm^3$ of solution **Q** was poured into the polystyrene cup.
- Using a thermometer, the initial temperature of solution **Q** was measured.
- 3 g of zinc powder was added to the polystyrene cup. At the same time a stop-clock was started.
- Using the thermometer, the mixture in the polystyrene cup was continually stirred and the temperature measured every 30 seconds.

initial temperature in Experiment 1	23 °C

Use the thermometer diagrams and the initial temperature to complete the table.
Calculate the temperature changes using the equation:

temperature change = temperature – initial temperature

<table>
<tr><td>time / s</td><td>30</td><td>60</td><td>90</td><td>120</td><td>150</td><td>180</td><td>210</td><td>240</td></tr>
<tr><td>thermometer diagram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td></tr>
<tr><td>temperature / °C</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>temperature change / °C</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

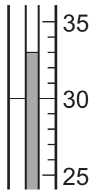
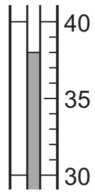
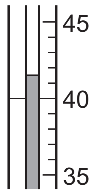
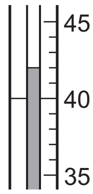
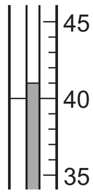
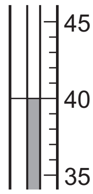
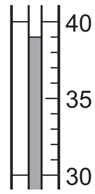
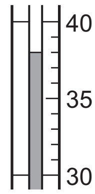
[3]

(b) *Experiment 2*

- The polystyrene cup was washed out with distilled water.
- Experiment 1 was repeated using solution **R** instead of solution **Q**.

initial temperature in Experiment 2	24 °C

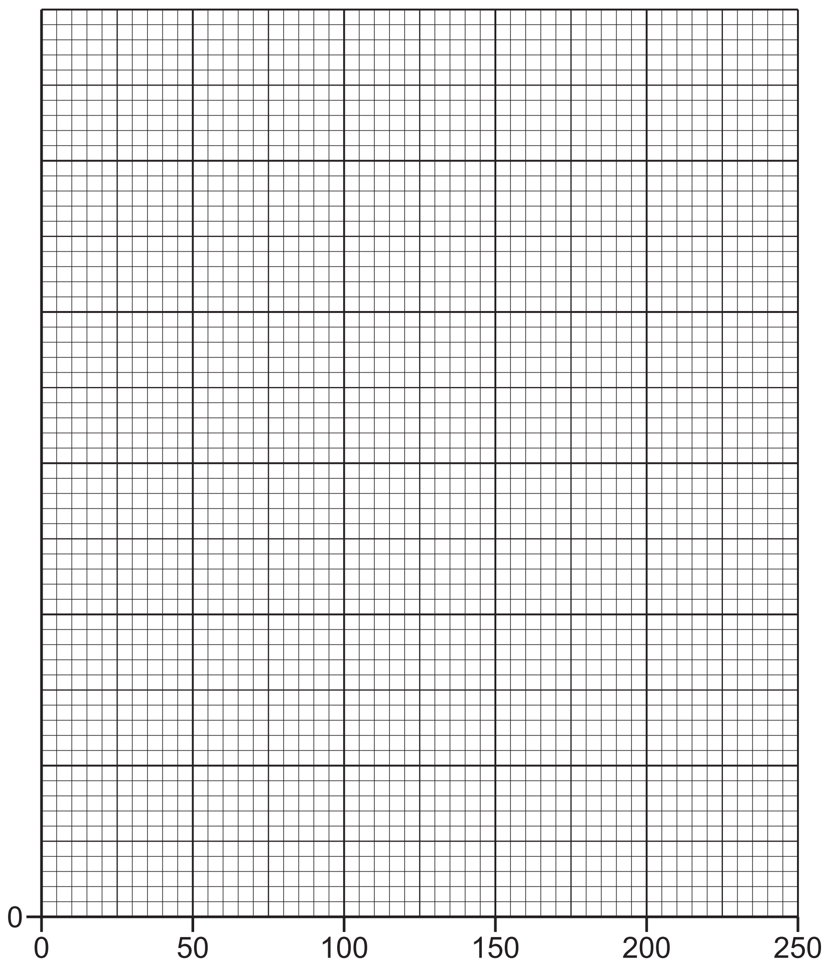
Use the thermometer diagrams and the initial temperature to complete the table.

time / s	30	60	90	120	150	180	210	240
thermometer diagram								
temperature / °C								
temperature change / °C								

[3]

(c) Complete a suitable scale on the *y*-axis and plot the results from Experiment 1 and Experiment 2 on the grid. Draw two curves of best fit. Both curves must start at (0,0). Label your curves.

temperature change / °C



time / s

[5]

(d) **From your graph**, deduce the temperature change at 110 seconds in Experiment 1.

Show clearly **on the grid** how you worked out your answer.

.... °C [2]

(e) Predict the temperature of the solution in Experiment 2 after 5 hours. Explain your answer.

....

.... [2]

(f) **(i)** Suggest why the experiments were done in a polystyrene cup rather than a glass beaker.

.... [1]

(ii) Describe how the results would be different if a glass beaker is used in place of the polystyrene cup.

.... [1]

(g) Suggest **one** change that could be made to the apparatus that would improve the accuracy of the results. Explain why this change would improve the accuracy of the results.

change ....

explanation ....

....
[2]

[Total: 19]

3 Solid **S** and solid **T** were analysed.
Tests were done on each substance.

tests on solid S

tests	observations
test 1 Solid **S** was placed in a boiling tube and $10\,cm^3$ of dilute hydrochloric acid was added.	effervescence
The solution formed in **test 1** was decanted from the remaining solid **S**. The solution is solution **U**. **test 2** Aqueous sodium hydroxide was added dropwise and then in excess to solution **U**.	white precipitate, insoluble in excess

The gas given off in **test 1** was carbon dioxide.

(a) Describe how the gas produced in **test 1** could be tested to show that it was carbon dioxide.
Give the expected result of the test.

test ....

result ....
[2]

(b) Identify solid **S**.

....

.... [2]

tests on solid T

Solid **T** was iron(III) chloride.

Solid **T** was dissolved in water to form solution **T**. Solution **T** was divided into four equal portions in four test-tubes.

(c) To the first portion of solution **T**, aqueous sodium hydroxide was added dropwise and then in excess.

observations ....

.... [2]

(d) To the second portion of solution **T**, 2 cm^3 of aqueous ammonia was added.

observations .... [1]

(e) To the third portion of solution **T**, 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added.

observations .... [1]

(f) To the fourth portion of solution **T**, 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added.

observations .... [1]

[Total: 9]

4 Catalysts are substances which increase the rate of a reaction but are unchanged at the end of the reaction.

Aqueous hydrogen peroxide decomposes slowly to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Copper(II) oxide is an insoluble solid.

Plan an investigation to find out if copper(II) oxide is a catalyst for the decomposition of hydrogen peroxide. You must include how your results will tell you if copper(II) oxide is a catalyst. You have access to copper(II) oxide, aqueous hydrogen peroxide and all normal laboratory apparatus.

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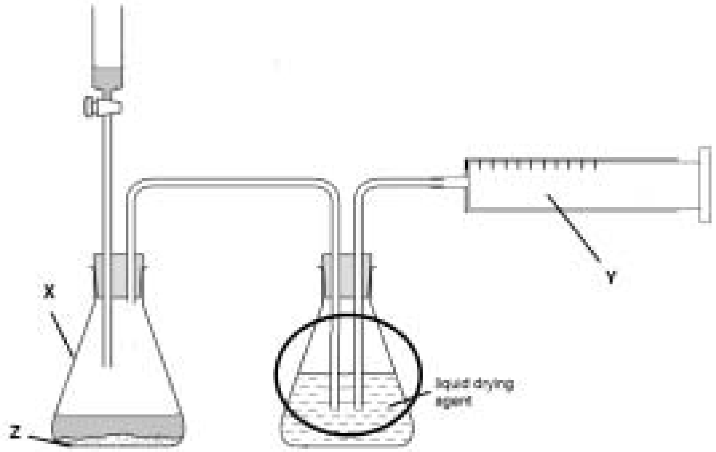
Question	Answer	Marks
1(a)	**X** (conical) flask	**1**
	Y (gas) syringe	**1**
1(b)	**Z** manganese(IV)oxide	**1**
1(c)	arrow under and pointing at left hand conical flask	**1**
1(d)(i)		**1**
1(d)(ii)	liquid / drying-agent pushed out of flask	**1**

Question	Answer	Marks
2(a)	**M1 and M2** all temperature recorded correctly (43.0, 49.0, 51.0, 52.0, 51.0, 49.5, 48.0, 46.5)**.** If seven correct score 1 mark	**2**
	M3 all temperature changes calculated correctly (20.0, 26.0, 28.0, 29.0, 28.0, 26.5, 25.0, 23.5)	**1**
2(b)	**M1** all temperature recorded correctly (33.0, 38.0, 41.5, 42.0, 41.0, 40.0, 39.0, 38.0)	**1**
	M2 all temperature changes calculated correctly (9.0, 14.0, 17.5, 18.0, 17.0, 16.0, 15.0,14.0)	**1**
	M3 all temperatures and changes in experiment 2 recorded to 1 dp	**1**
2(c)	**M1** suitable scale for y-axis	**1**
	M2 M3 plotting – all 16 correct scores 2, 14 or 15 correct scores 1	**2**
	M4 best fit curves for both experiments	**1**
	M5 correct labels	**1**
2(d)	**M1** correct working shown	**1**
	M2 Value read correctly from graph (correct line gives 28.5-29.0)	**1**
2(e)	**M1** room temperature / 24	**1**
	M2 reaction over	**1**
2(f)(i)	insulator	**1**
2(f)(ii)	temperature changes lower / temperatures lower	**1**
2(g)	change: use a pipette / burette	**1**
	explanation: more accurate than a measuring cylinder **OR** change: use a lid explanation: reduces heat loss	**1**

Question	Answer	Marks
Tests on solid S		
3(a)	test: (bubble the gas through) limewater	**1**
	result: turns milky	**1**
3(b)	calcium / Ca^{2+}	**1**
	carbonate / CO_3^{2-}	**1**
Tests on solid T		
3(c)	red-brown precipitate	**1**
	remains / insoluble in excess	**1**
3(d)	red-brown precipitate	**1**
3(e)	white precipitate	**1**
3(f)	no change	**1**

Question	Answer	Marks
4	Any 6 from: **MP1** weigh copper(II) oxide / stated mass copper oxide **MP2** add to known volume of hydrogen peroxide / stated volume of hydrogen peroxide **MP3** measure volume of gas made in set time **MP4** filter off copper(II) oxide **MP5** dry and weigh **MP6** repeat experiment with no copper oxide added **OR** compare gas volume to with no copper oxide added **MP7** bigger volume **AND** catalyst mass the same means it is a catalyst max 6	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6388004630

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 A list of substances is shown.

ammonia
bauxite
carbon dioxide
carbon monoxide
ethanol
hematite
oxygen
sodium chloride
sulfur dioxide

Answer the questions using the list of substances.

Each substance may be used once, more than once or not at all.

State which substance is:

(a) an element .... [1]

(b) an ore of aluminium .... [1]

(c) a gas that causes acid rain .... [1]

(d) used as a fuel .... [1]

(e) an ionic compound .... [1]

(f) produced in the Haber process .... [1]

(g) a product of respiration .... [1]

(h) a toxic product of the incomplete combustion of hydrocarbons

.... [1]

(i) a gas produced in the test for nitrate ions. .... [1]

[Total: 9]

2 This question is about electrolysis.

(a) State the meaning of the term *electrolyte*.

....

.... [2]

(b) The table gives information about the electrolysis of two electrolytes. Carbon (graphite) electrodes are used in each experiment.

(i) Complete the table to show the observations and products of electrolysis.

	positive electrode (anode)		negative electrode (cathode)	
electrolyte	observations	name of product	observations	name of product
aqueous copper(II) sulfate	colourless bubbles			
concentrated aqueous sodium bromide			colourless bubbles	hydrogen

[5]

(ii) Hydrogen is produced at the negative electrode (cathode) during the electrolysis of concentrated aqueous sodium bromide.

Write the ionic half-equation for this reaction.

.... [2]

(iii) State **two** reasons why carbon (graphite) is suitable to use as an electrode.

1 ....

2 ....
[2]

(iv) Name the particle responsible for the conduction of electricity in the metal wires used in a circuit.

.... [1]

[Total: 12]

3 Lead is a metallic element in Group IV. One of the ores of lead is galena, which is an impure form of lead(II) sulfide, PbS.

Lead also occurs in the ore cerussite, which contains lead(II) carbonate, $PbCO_3$.

(a) Calculate the relative formula mass, M_r, of $PbCO_3$.

M_r of $PbCO_3$ = ... [1]

(b) The M_r of PbS is 239.

Calculate the percentage of lead by mass in PbS.

percentage of lead by mass in PbS = ... [1]

(c) The percentage of lead by mass in $PbCO_3$ is 77.5%.

Use this information and your answer to **(b)** to suggest whether it would be better to extract lead from $PbCO_3$ or PbS.

Give a reason for your answer.

....

.... [1]

(d) When lead(II) carbonate is heated it decomposes into lead(II) oxide, PbO, and carbon dioxide.

Write a chemical equation for this reaction.

.... [1]

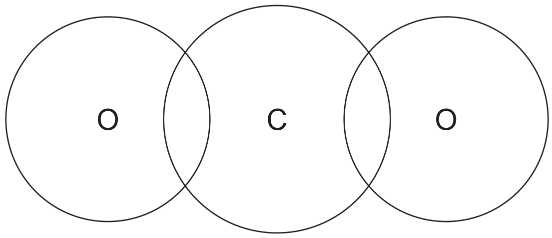
(e) Lead(II) carbonate reacts with dilute nitric acid. One of the products is aqueous lead(II) nitrate, $Pb(NO_3)_2$.

Write a chemical equation for this reaction.

.... [2]

(f) Lead(II) oxide and carbon dioxide are oxides of Group IV elements.

(i) Complete the diagram to show the electron arrangement in one molecule of CO_2.
Show only the outer electrons.



[2]

(ii) The melting points of lead(II) oxide and carbon dioxide are shown.

	melting point / °C
lead(II) oxide	886
carbon dioxide	–56

Use your knowledge of structure and bonding to explain why lead(II) oxide has a much higher melting point than carbon dioxide.

Your answer should refer to:

- the types of particles involved
- the relative strength of the forces of attraction between the particles.

....

....

....

.... [3]

(g) Part of the reactivity series is shown.

magnesium	most reactive
lead	↑
copper	least reactive

Aqueous lead(II) nitrate contains Pb^{2+} ions.

Two experiments are carried out.

In Experiment 1, magnesium is added to aqueous lead(II) nitrate.

In Experiment 2, copper is added to aqueous lead(II) nitrate.

Write an ionic equation for any reaction that occurs in each experiment. If no reaction occurs write 'no reaction'.

Experiment 1 ....

Experiment 2 ....
[2]

(h) When lead(II) nitrate is heated it decomposes to produce the same gaseous products as when copper(II) nitrate is heated.

(i) One of the gaseous products is oxygen.

Describe a test for oxygen.

test ....

observations ....
[2]

(ii) Name the other gaseous product.

.... [1]

[Total: 16]

4 Carbon is an important element.

(a) Carbon exists as the isotopes ${}^{12}_{6}C$ and ${}^{13}_{6}C$.

Complete the table.

isotope	number of protons in one atom	number of electrons in one atom	number of neutrons in one atom
${}^{12}_{6}C$			
${}^{13}_{6}C$			

[2]

(b) Name **two** forms of the element carbon which have giant covalent structures.

.... and .... [1]

(c) The Avogadro constant is the number of particles in 1 mole.

The numerical value of the Avogadro constant is 6.02×10^{23}.

(i) Calculate the number of molecules in 22.0 g of carbon dioxide, CO_2.

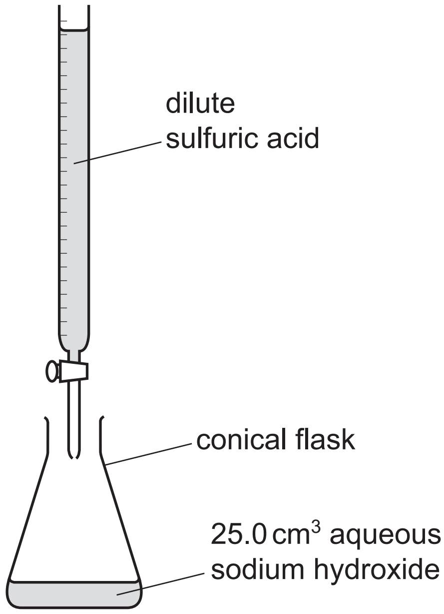
.... molecules [2]

(ii) Calculate the number of molecules in 6.00 dm^3 of carbon dioxide gas at room temperature and pressure.

.... molecules [1]

[Total: 6]

5 **(a)** Dilute sulfuric acid and aqueous sodium hydroxide can be used to prepare sodium sulfate crystals using a method that involves titration.



(i) Suggest why universal indicator is **not** suitable for this titration.

.... [1]

(ii) Name an indicator that can be used in this titration.

.... [1]

$20.0\,cm^3$ of dilute sulfuric acid neutralises $25.0\,cm^3$ of $1.00\,mol/dm^3$ aqueous sodium hydroxide. At the end of the titration the conical flask contains aqueous sodium sulfate with the dissolved indicator as an impurity.

(b) Describe how to prepare a **pure** sample of sodium sulfate crystals from the original solutions of dilute sulfuric acid and aqueous sodium hydroxide of the same concentrations.

You are not required to give details of how to carry out the titration.

....

....

....

....

....

....

....

....

.... [5]

(c) Sodium hydrogensulfate, $NaHSO_4$, dissolves in water to produce an aqueous solution, **X**, containing Na^+, H^+ and SO_4^{2-} ions.

State the observations when the following tests are done.

(i) A flame test is carried out on **X**.

.... [1]

(ii) Copper(II) oxide is warmed with an excess of **X**.

....

.... [2]

(iii) Acidified aqueous barium nitrate is added to **X**.

.... [1]

[Total: 11]

6 A student investigates the decomposition of hydrogen peroxide in the presence of a catalyst of manganese(IV) oxide.

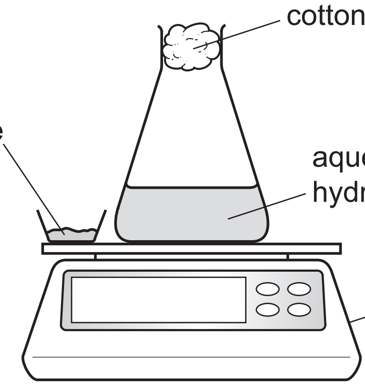
$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) State the meaning of the term *catalyst*.

....

.... [2]

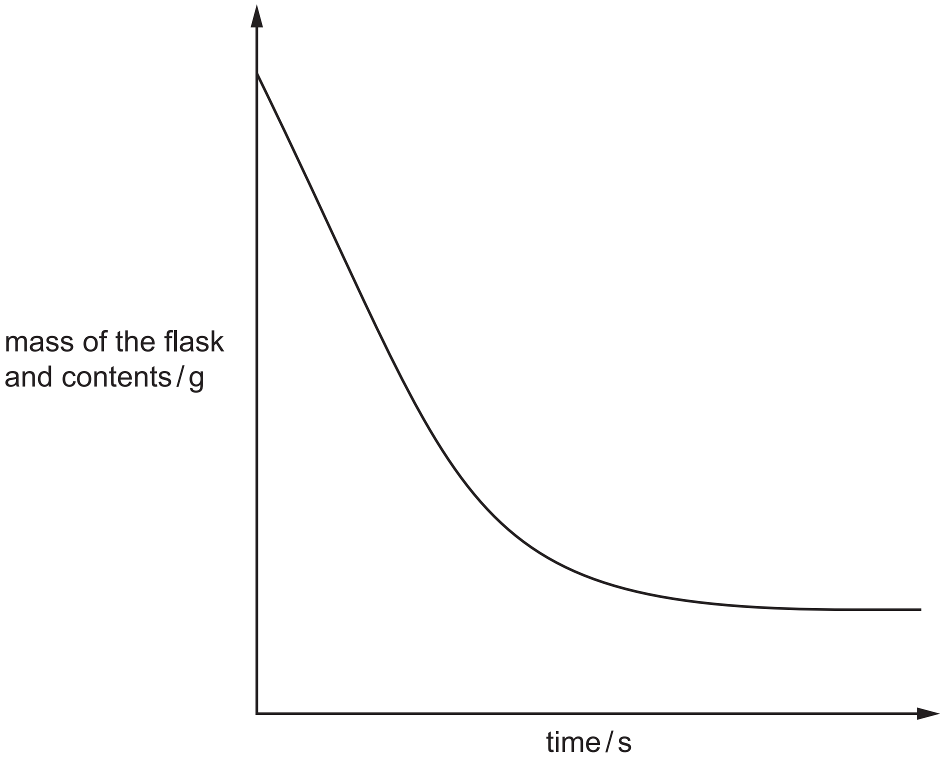
(b) The diagram shows the equipment the student uses.



The student uses this method:

- the catalyst is added to the aqueous hydrogen peroxide
- the stop-clock is started
- the mass of the flask and contents is recorded at regular time intervals.

A graph of the mass of the flask and contents against time is shown.



(i) Suggest why the mass of the flask and contents decreases as time increases.

.... [1]

(ii) Describe what happens to the rate of the reaction as time increases.

....

.... [2]

(c) The student repeats the experiment at a higher temperature. All other conditions stay the same. The rate of reaction increases.

(i) Explain, in terms of collisions between particles, why the rate of reaction increases at a higher temperature.

....

....

....

.... [3]

(ii) Draw a line on the graph in **(b)** for the experiment at a higher temperature. [2]

[Total: 10]

7 **(a)** Ethanol is a member of the homologous series of alcohols.

Give **two** characteristics of members of a homologous series.

1 ....

2 ....
[2]

(b) Ethanol can be manufactured from ethene.

Ethene can be made from long chain hydrocarbons such as decane, $C_{10}H_{22}$.

Ethene is then converted into ethanol.

(i) Name the process used to obtain ethene from long chain hydrocarbons such as decane, $C_{10}H_{22}$.

.... [1]

(ii) Complete the chemical equation to show the formation of ethene from decane, $C_{10}H_{22}$.

$C_{10}H_{22} \rightarrow C_4H_8$ + ... + ... [2]

(iii) Write the chemical equation for the conversion of ethene into ethanol.

.... [1]

(iv) Name the type of reaction occurring when ethene is converted into ethanol.

.... [1]

(v) Give **one** condition for the reaction in which ethene is converted into ethanol.

.... [1]

(c) Ethanol can also be produced by fermentation of carbohydrates such as glucose.

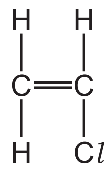
Give **two** advantages of manufacturing ethanol by fermentation compared to manufacturing ethanol from ethene.

1 ....

2 ....
[2]

(d) **(i)** Under certain conditions ethene can react with chlorine to produce chloroethene.

The structure of chloroethene is shown.



The equation for the chemical reaction is shown.

$$C_2H_4 + Cl_2 \rightarrow C_2H_3Cl + HCl$$

State the type of chemical reaction between ethene and chlorine that this equation shows.

.... [1]

(ii) Chloroethene monomers can be converted into a polymer called poly(chloroethene).

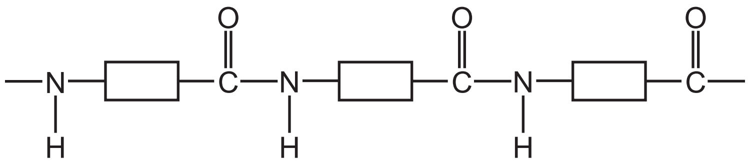
State the type of polymerisation that produces poly(chloroethene) from chloroethene.

.... [1]

(iii) Draw a section of the poly(chloroethene) molecule made from **two** monomer molecules.

[2]

(e) The structure of part of a polymer is shown.



This polymer is made from one type of monomer only.

Complete the diagram to show the structure of the monomer used to produce this polymer.
Show all of the atoms and all of the bonds in the functional groups.

[2]

[Total: 16]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge IGCSE™

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2021**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **11** printed pages.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>‘List rule’ guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	Guidance for chemical equations Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	oxygen	**1**
1(b)	bauxite	**1**
1(c)	sulfur dioxide	**1**
1(d)	ethanol	**1**
1(e)	sodium chloride	**1**
1(f)	ammonia	**1**
1(g)	carbon dioxide	**1**
1(h)	carbon monoxide	**1**
1(i)	ammonia	**1**

Question	Answer	Marks
2(a)	**M1** ionic compound **AND** either molten or aqueous(or both)(1) **M2** conducts electricity / undergoes electrolysis(1)	**2**
2(b)(i)	**M1** oxygen (1) **M2** pink / brown solid (1) **M3** copper (1) **M4** orange / brown / yellow liquid (1) **M5** bromine (1)	**5**

Question	Answer	Marks
2(b)(ii)	$2H^+ + 2e^{(-)} \rightarrow H_2$ (2)	**2**
2(b)(iii)	**M1** inert (1) **M2** good conductor of electricity (1)	**2**
2(b)(iv)	electron	**1**

Question	Answer	Marks
3(a)	267	**1**
3(b)	($207 / 239 \times 100 =$) 86.6**%**	**1**
3(c)	PbS because the percentage of lead is larger in PbS **or** answer to **(b) >** 77.5%	**1**
3(d)	$PbCO_3 \rightarrow PbO + CO_2$	**1**
3(e)	$PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2$	**2**
3(f)(i)	**M1** two double bonds (1) **M2** two pairs of non-bonding electrons on each oxygen and no non-bonding electrons on carbon (1)	**2**
3(f)(ii)	**M1** bonds between ions **or** ionic bonds in lead(II) oxide (1) **M2** attraction **between molecules** in carbon dioxide (1) **M3** weak**er** attraction (between particles) in carbon dioxide **ORA** (1)	**3**
3(g)	**M1** $Mg + Pb^{2+} \rightarrow Mg^{2+} + Pb$ (1) **M2** no reaction (1)	**2**

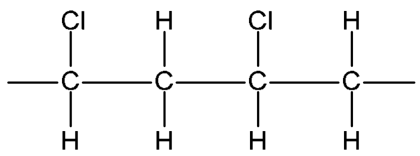
Question	Answer	Marks
3(h)(i)	**M1** glowing splint (1) **M2** relights (1)	**2**
3(h)(ii)	nitrogen dioxide / nitrogen(IV) oxide	**1**

Question	Answer	Marks
4(a)	1 mark for each row <table><tr><td>6</td><td>6</td><td>6</td></tr><tr><td>6</td><td>6</td><td>7</td></tr></table>	**2**
4(b)	diamond **and** graphite	**1**
4(c)(i)	**M1** (22 ÷ 44 =) 0.5 (moles) (1) **M2** 3.01×10^{23}(1)	**2**
4(c)(ii)	1.505×10^{23}	**1**

Question	Answer	Marks
5(a)(i)	too many colour changes	**1**
5(a)(ii)	Any acid-base indicator, e.g. methyl orange or phenolphthalein	**1**
5(b)	**M1** repeat without indicator using same volumes **OR** remove indicator by adding charcoal or carbon and filtering (1) **M2** evaporate / heat / warm/ boil/leave in hot place (1) **M3** until most of the water is gone / some water left / saturation(point) / crystallisation (point) / evaporate **some** of the water (1) **M4** cool / leave to crystallise(1) **M5** description of drying (1)	**5**
5(c)(i)	yellow flame	**1**
5(c)(ii)	**M1 solid** dissolves / disappears(1) **M2** blue solution(1)	**2**
5(c)(iii)	white precipitate	**1**

Question	Answer	Marks
6(a)	**M1** (a substance that) speeds up a reaction / increases the rate of a reaction (1) **M2** unchanged chemically at the end (1)	**2**
6(b)(i)	oxygen gas escapes	**1**
6(b)(ii)	**M1** rate decreases **OR** rate / reaction is fastest at the start (1) **M2** reaction stops **or** rate = zero (1)	**2**
6(c)(i)	**M1** (particles) have more kinetic energy / particles move fast**er**(1) **M2 more** collisions per unit time (1) **M3 more** particles have energy greater than or equal to activation energy **OR** **more** particles have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions have energy greater than or equal to activation energy **OR** A greater percentage or greater proportion or greater fraction of collisions are successful (1)	**3**
6(c)(ii)	**M1** steeper gradient from start (1) **M2** levels off **at the same mass** (1)	**2**

Question	Answer	Marks
7(a)	1 for each for any 2 of: • (same) general formula • similar chemical properties • (consecutive members) differ by CH_2 • same functional group • common (allow similar or same) methods of preparation • physical properties **and** vary in predictable manner **or** show trends **or** gradually change **OR** example of a physical property variation, e.g. melting points increase boiling points increase volatility decreases	**2**
7(b)(i)	cracking	**1**
7(b)(ii)	$\rightarrow$ C_2H_4 + C_4H_{10} (2)	**2**
7(b)(iii)	C_2H_4 + H_2O $\rightarrow$ C_2H_5OH	**1**
7(b)(iv)	hydration / addition	**1**
7(b)(v)	1 mark for **ANY 1** of: • 300 °C • 60 atmospheres • H_3PO_4	**1**

Question	Answer	Marks
7(c)	1 mark each for any 2 of: • **carbohydrates** are renewable • **fossil fuels** are non-renewable **OR** fossil fuels conserved • lower temperature **OR** lower energy • hydration is equilibrium meaning low**er** yield • lower pressure (used)	**2**
7(d)(i)	substitution	**1**
7(d)(ii)	addition	**1**
7(d)(iii)	 **M1** any one repeat unit with extension bonds (1) **M2** both units fully correct (1)	**2**
7(e)	1 mark for each functional group fully correct (2)	**2**