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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB24 11_0620_63/3RP

1 When crystals of hydrated calcium ethanedioate, $CaC_2O_4•H_2O$, are heated they decompose to form solid calcium carbonate, steam and carbon monoxide gas.

$$CaC_2O_4•H_2O(s) \rightarrow CaCO_3(s) + H_2O(g) + CO(g)$$

A student suggests using the apparatus shown in Fig. 1.1 to decompose hydrated calcium ethanedioate and obtain the products.

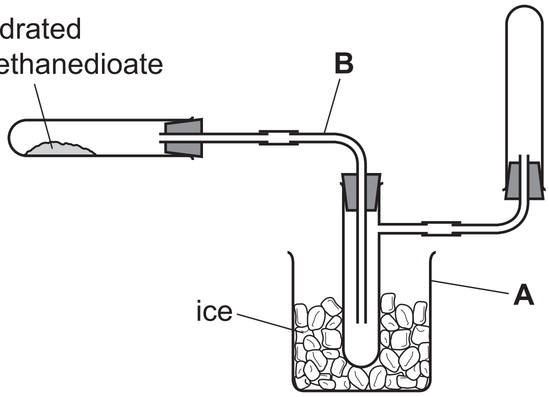

Fig. 1.1

Table 1.1 shows some information about carbon monoxide.

Table 1.1

	melting point / °C	boiling point / °C	density compared to air	solubility in water	safety warning
carbon monoxide	–205	–192	about the same	insoluble	toxic

(a) Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

A ....

B ....
[2]

(b) The apparatus shown in Fig. 1.1 will **not** work because there is an error in how the gas is collected. This error makes it dangerous to use the apparatus.

Identify the error and explain why this error makes it dangerous to use the apparatus.

error ....

....

explanation ....

....
[2]

(c) Complete Fig. 1.2 to show how the gas could be collected safely.

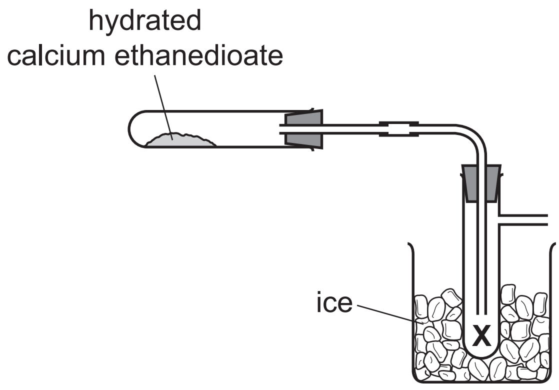

Fig. 1.2

[1]

(d) Add **one** arrow to Fig. 1.2 to show where the apparatus should be heated. [1]

(e) Identify the substance that collects at the point marked **X** on Fig. 1.2.

.... [1]

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

....

.... [1]

[Total: 8]

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2 A student investigates the temperature change when solid **P** dissolves in water.

The student does two experiments.

Experiment 1

- Use a 25 cm^3 measuring cylinder to pour 20 cm^3 of distilled water into a boiling tube.
- Use a thermometer to measure the temperature of the distilled water. This is the temperature at time = 0 seconds.
- Add a 5 g sample of solid **P** to the distilled water in the boiling tube. At the same time start a stop-watch.
- Continually stir the contents of the boiling tube using the thermometer.
- Measure the temperature of the mixture in the boiling tube every 20 seconds for 120 seconds.
- Rinse the boiling tube with distilled water.

Experiment 2

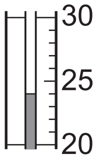
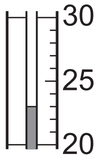
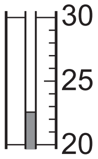
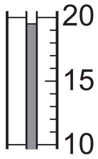
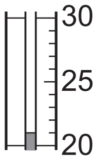
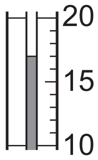
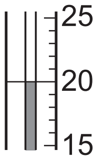
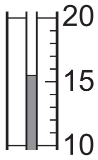
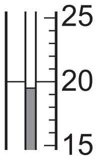
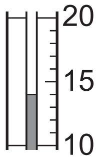
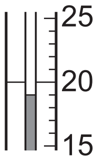
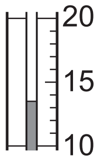
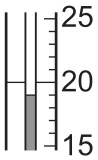
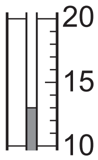
- Repeat Experiment 1 using 10 cm^3 of distilled water instead of the 20 cm^3 of distilled water.

(a) Complete Table 2.1 by using the thermometer diagrams and calculating the temperature decreases from the temperature at 0 seconds.

For example, at 60 seconds:

temperature decrease = temperature at 0 s – temperature at 60 s

Table 2.1

	Experiment 1			Experiment 2		
time / s	thermometer diagram	temperature / °C	temperature decrease / °C	thermometer diagram	temperature / °C	temperature decrease / °C
0		24.0	0.0		23.0	0.0
20						
40						
60						
80						
100						
120						

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiment 1 and Experiment 2 on Fig. 2.1.
Draw **two** lines of best fit. Both of your lines of best fit **must** go to (0,0). Label both lines.

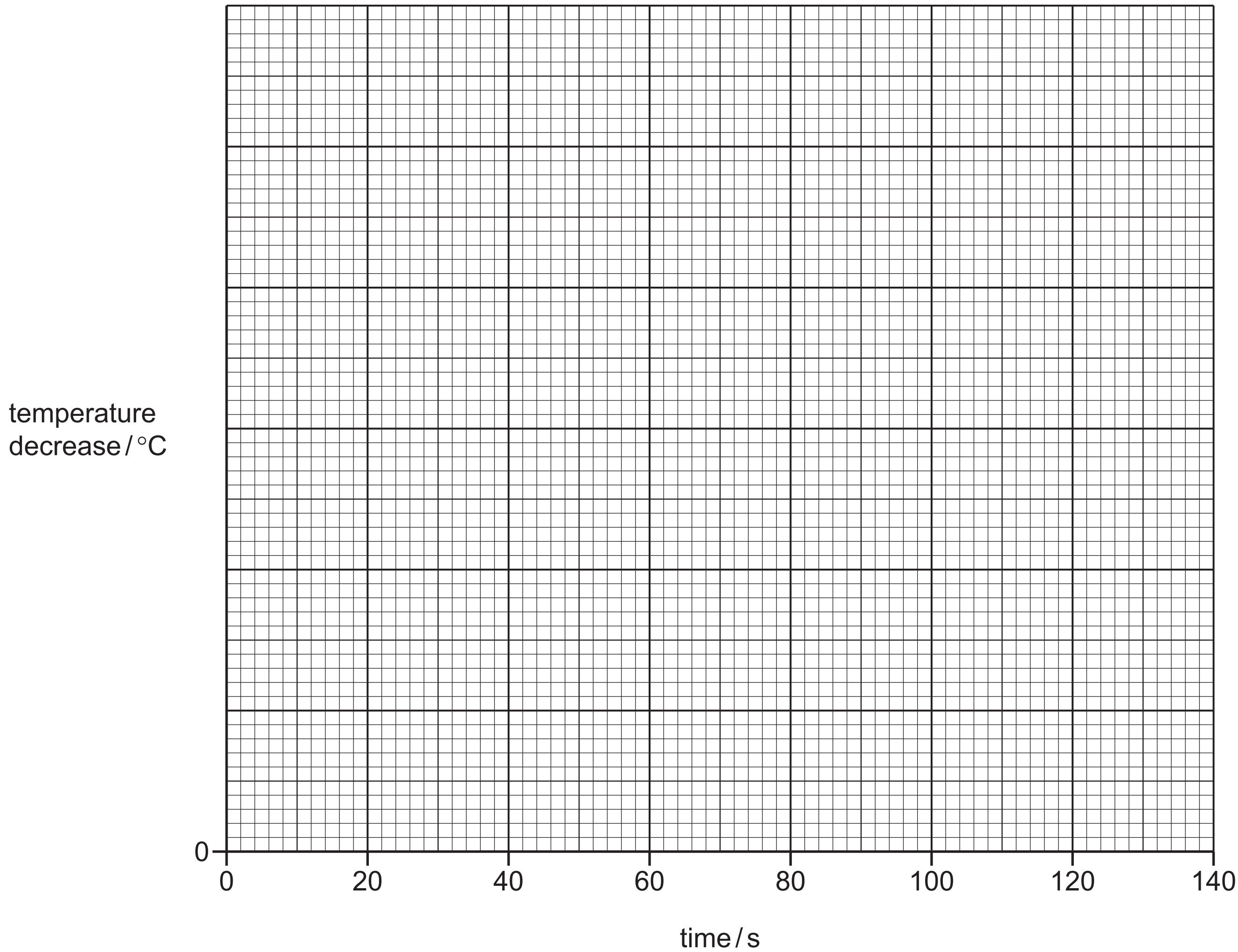


Fig. 2.1

[4]

(c) State whether the energy change in Experiment 1 is exothermic or endothermic.
Explain your answer.

....

.... [1]

(d) Compare the maximum temperature decrease in Experiment 1 with the maximum temperature decrease in Experiment 2.

....

....

.... [2]

(e) **From your graph in Fig. 2.1**, deduce the temperature decrease in Experiment 2 after 45 seconds.
Show clearly **on Fig. 2.1** how you worked out your answer.

temperature decrease = ... °C [2]

(f) The average rate of temperature decrease in each experiment can be calculated using the equation shown.

$$\text{average rate of temperature decrease} = \frac{\text{temperature decrease}}{\text{time}}$$

Calculate the average rate of temperature decrease in Experiment 1 for 120 seconds.
Give units for the average rate you have calculated.

average rate of temperature decrease = ...

units = ...
[2]

(g) State **two** possible sources of error in these experiments.
For each source of error, suggest an improvement which reduces the error.

source of error 1 ....

improvement 1 ....

....

source of error 2 ....

improvement 2 ....

....
[4]

[Total: 20]

Question 3 starts on the next page.

[Turn over

3 A student tests two substances: solid **R** and solid **S**.

Tests on solid R

Table 3.1 shows the tests and the student's observations for solid **R**.

Table 3.1

tests	observations
test 1 Gently heat about half of solid **R** in a boiling tube.	the white solid forms a colourless liquid steam comes out from the boiling tube and condensation forms at the top of the boiling tube
test 2 The remaining solid **R** is dissolved in distilled water to form solution **R**. Solution **R** is divided into four portions. To the first portion of solution **R**, add aqueous sodium hydroxide dropwise and then in excess.	white precipitate forms the white precipitate dissolves in excess aqueous sodium hydroxide
test 3 To the second portion of solution **R**, add aqueous ammonia dropwise and then in excess.	white precipitate forms the white precipitate remains in excess aqueous ammonia
test 4 To the third portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no change
test 5 To the fourth portion of solution **R**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	cream precipitate forms

(a) State the conclusion that can be made from the observations in **test 1**.

.... [1]

(b) Identify solid **R**.

....

.... [2]

Tests on solid S

Solid **S** is sodium sulfite.

Record the expected observations.

(c) The student carries out a flame test on solid **S**.

observations .... [1]

The student dissolves the remaining solid **S** in distilled water to form solution **S**.
The student divides solution **S** into two portions.

(d) To the first portion of solution **S**, the student adds about 2 cm^3 of aqueous sodium hydroxide.

observations .... [1]

(e) To the second portion of solution **S**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations .... [1]

[Total: 6]

4 A mixture contains three solid compounds:
- aluminium oxide
- calcium carbonate
- calcium chloride.

Table 4.1 gives some information about the three compounds in the mixture.

Table 4.1

name of compound	solubility in water	effect of adding aqueous sodium hydroxide
aluminium oxide	insoluble	reacts to form a soluble compound
calcium carbonate	insoluble	no effect
calcium chloride	soluble	reacts to form an insoluble compound

Plan an experiment to find the percentage by mass of calcium carbonate in the mixture. Your plan must include how you will calculate the percentage by mass of calcium carbonate in the mixture.

You are provided with a sample of the mixture, distilled water, aqueous sodium hydroxide and common laboratory apparatus.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2024**

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 2024 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 descriptions 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)	**M1 A** beaker **M2 B** delivery tube	**2**
1(b)	**M1** error: using a bung (in collecting tube) / the apparatus is sealed **M2** explanation: (pressure would increase and so the apparatus / tube would) explode/break	**2**
1(c)	diagram showing collection over water **OR** using a gas syringe	**1**
1(d)	an arrow pointing to the hydrated calcium ethanedioate	**1**
1(e)	water / H_2O	**1**
1(f)	carbon monoxide is toxic	**1**

Question	Answer	Marks
2(a)	**M1** all six temperatures for Experiment 1 correct (22.5, 21.0, 20.0, 19.5, 19.0, 19.0) **M2** all six temperature decreases for experiment 1 correct (1.5, 3.0, 4.0, 4.5, 5.0, 5.0) **M3** all six temperatures for Experiment 2 correct (19.5, 17.0, 15.5, 14.0, 13.5, 13.0) **M4** all six temperature decreases for Experiment 2 correct (3.5, 6.0, 7.5, 9.0, 9.5, 10.0) **M5** all temperatures and temperature changes are recorded to 1dp	**5**
2(b)	**M1** suitable scale on *y*-axis **M2** and **M3** all points plotted correctly **M4** best-fit curves **AND** at least one line labelled	**4**
2(c)	endothermic **AND** temperature decreases	**1**
2(d)	**M1** maximum temperature change / decrease is greater in Experiment 2 **M2** quantitative answer (e.g. 2 times greater in Experiment 2)	**2**
2(e)	**M1** correct construction at 45 s shown on Fig 2.1 **M2** correct reading	**2**
2(f)	**M1** correct evaluation of temperature change in Experiment 1 ÷ 120 (5 / 120 = 0.0417) **M2** °C / s	**2**

Question	Answer	Marks
2(g)	Any **2** pairs from: error: heat gain improvement: insulate / (use a) lid / (use a) polystyrene (cup) error: (volume of water due to using a) measuring cylinder improvement: (use a) burette error: water already in boiling tube for Experiment 2 improvement: dry / clean / new boiling tube	**4**

Question	Answer	Marks
3(a)	(**R** is) hydrated / has water of crystallisation	**1**
3(b)	**M1** aluminium / Al^{3+} **M2** bromide / Br^{-}	**2**
3(c)	yellow (flame)	**1**
3(d)	no change / no reaction / remains colourless	**1**
3(e)	becomes colourless / (pink / purple) is decolourised	**1**

Question	Answer	Marks
4	Any **six** from: **MP1** find mass of mixture **MP2** add water and stir **MP3** filter **MP4** add (excess) aqueous sodium hydroxide to residue and stir **MP5** filter and wash residue / calcium carbonate (with water) and dry **MP6** weigh residue / calcium carbonate **MP7** (mass calcium carbonate / initial mass) × 100 (%)	**6**

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CHEMISTRY **0620/62**

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1 hour

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1 A teacher uses the apparatus shown in Fig. 1.1 to pass an electric current through molten mercury(II) bromide at a temperature of 300 °C.

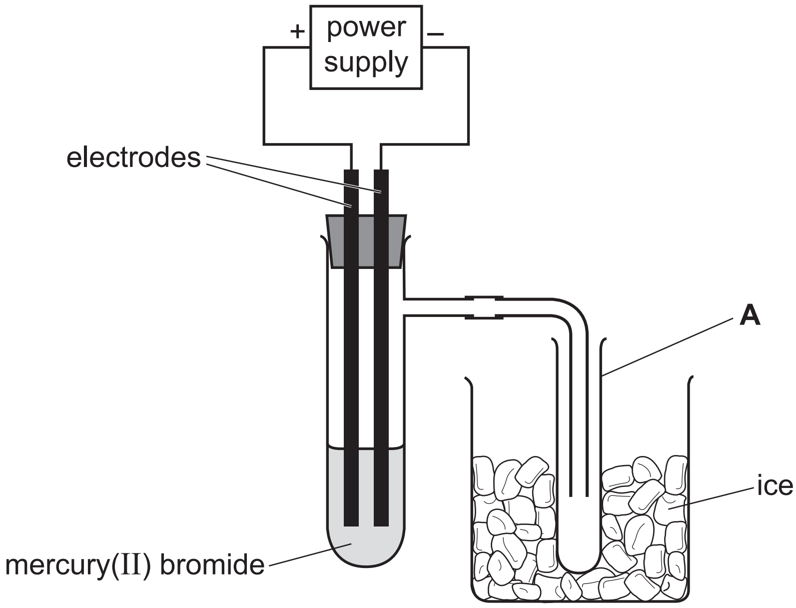

Fig. 1.1

During the process shown in Fig. 1.1, the molten mercury(II) bromide breaks down and forms bromine and mercury.

Table 1.1 shows some information about mercury(II) bromide, bromine and mercury.

Table 1.1

substance	melting point in °C	boiling point in °C	density when liquid in g/cm^3
mercury(II) bromide	236	322	6
bromine	–7	60	3
mercury	–39	357	14

(a) Draw an arrow on Fig. 1.1 to show where the apparatus should be heated. [1]

(b) Name the item of apparatus labelled **A** in Fig. 1.1.

.... [1]

(c) Name the process shown in Fig. 1.1 which breaks down mercury(II) bromide.

.... [1]

(d) The electrodes used in the process shown in Fig. 1.1 are made from platinum.

Give **two** reasons why platinum is a suitable material for the electrodes.

1 ....

2 ....
[2]

(e) On Fig. 1.1, draw an **X** to show where mercury will collect. [1]

(f) Explain why ice is used in the experiment.

....

.... [1]

[Total: 7]

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2 A student investigates the rate of the reaction between aqueous iron(III) nitrate and aqueous sodium thiosulfate.

The student does five experiments using the apparatus shown in Fig. 2.1.

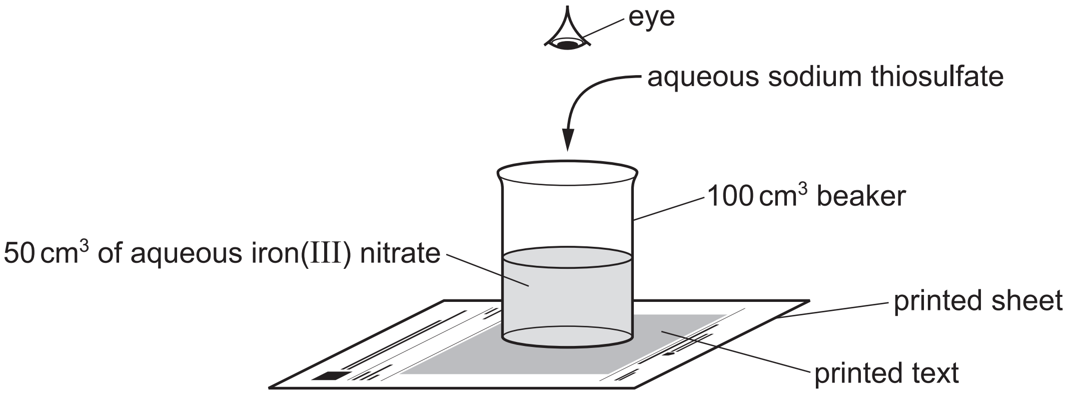


Fig. 2.1

Experiment 1

- Use a 50 cm^3 measuring cylinder to pour 50 cm^3 of aqueous iron(III) nitrate into a 100 cm^3 beaker.
- Stand the beaker on the text of the printed sheet as shown in Fig. 2.1.
- Use a 25 cm^3 measuring cylinder to pour 15.0 cm^3 of aqueous sodium thiosulfate into the beaker. At the same time start a stop-watch.
- Stir the contents of the beaker.
- Look down from above the beaker. When the text on the printed sheet becomes visible, stop the stop-watch and record the time in seconds to the nearest whole number.
- Rinse the beaker with distilled water.

Experiment 2

- Repeat Experiment 1, using 10.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 3

- Repeat Experiment 1, using 7.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 4

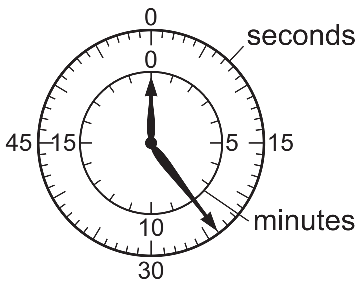
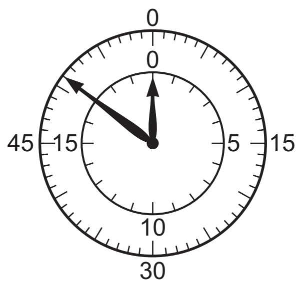
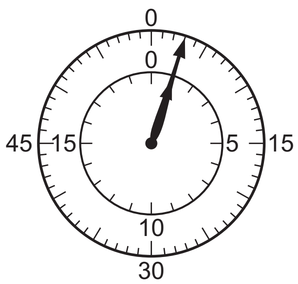
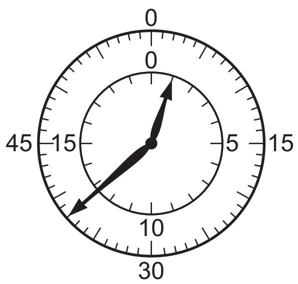
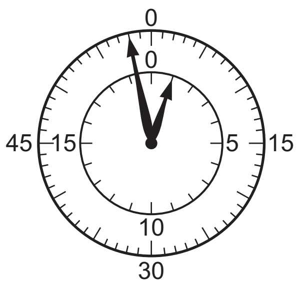
- Repeat Experiment 1, using 6.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

Experiment 5

- Repeat Experiment 1, using 5.0 cm^3 of aqueous sodium thiosulfate instead of 15.0 cm^3.

(a) Use the information in the description of the experiments and the stop-watch diagrams to complete Table 2.1.

Table 2.1

experiment	volume of aqueous sodium thiosulfate / cm^3	stop-watch diagram	time taken for the text to become visible / s
1			
2			
3			
4			
5			

[3]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on Fig. 2.2. Draw a smooth curve of best fit.

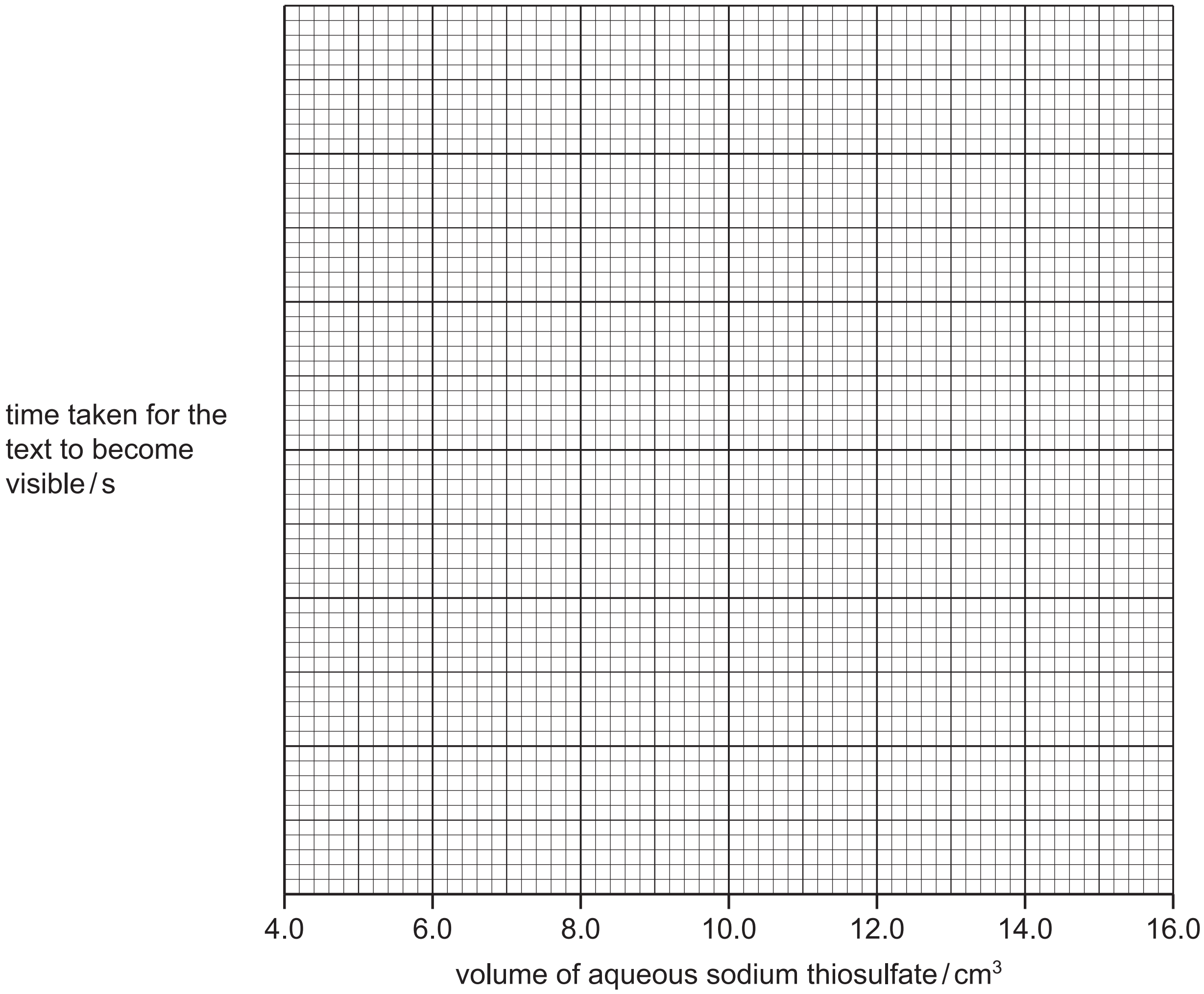


Fig. 2.2

[4]

(c) State why the contents of the beaker are stirred after adding the aqueous sodium thiosulfate to the aqueous iron(III) nitrate.

....

.... [1]

(d) Deduce which experiment has the highest rate of reaction.

.... [1]

(e) Use your graph in Fig. 2.2 to predict the time taken for the text to become visible if the volume of aqueous sodium thiosulfate is 12.5 cm^3.
Show your working on Fig. 2.2.

time = ... [3]

(f) **(i)** Explain why it would be an improvement to measure the volumes of aqueous iron(III) nitrate in a burette rather than in a measuring cylinder.

....

.... [1]

(ii) Explain why it is **not** possible to use a volumetric pipette to measure the volumes of the aqueous sodium thiosulfate used in the experiments.

....

.... [1]

(iii) Describe how the reliability of the results of this investigation can be checked.

....

.... [1]

(g) Describe how the results of the experiments would change if the experiments are repeated using a narrower and taller beaker.
Explain your answer.

change in results ....

explanation ....

....
[2]

(h) Describe additional measurements that must be taken to determine whether the reaction in this investigation is exothermic or endothermic.

....

.... [1]

[Total: 18]

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Question 3 starts on the next page.

3 A student tests two substances: solid **M** and solid **N**.

Tests on solid M

Table 3.1 shows the tests and the student's observations for solid **M**.

Table 3.1

tests	observations
test 1 Do a flame test on solid **M**.	lilac flame colour
test 2 Dissolve the rest of solid **M** in water to form solution **M**. Divide solution **M** into four portions. To the first portion of solution **M**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a cream precipitate forms
test 3 To the second portion of solution **M**, add aqueous sodium hydroxide dropwise and then in excess.	a green precipitate forms; the precipitate remains when excess aqueous sodium hydroxide is added
test 4 To the third portion of solution **M**, add 1 cm^3 of aqueous sodium hydroxide and a small square of aluminium foil. Warm the mixture and test any gas produced with damp red litmus paper.	litmus paper remains red
test 5 To the fourth portion of solution **M**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	a white precipitate forms

(a) Explain why a yellow (safety) Bunsen burner flame is **not** suitable for a flame test.

....

.... [1]

(b) Identify the **four** ions in solid **M**.

....

....

....

.... [4]

Tests on solid N

Solid **N** is ammonium carbonate.

Record the expected observations.

(c) The student transfers approximately half of solid **N** to a boiling tube and adds about 10 cm^3 of dilute sulfuric acid to the boiling tube. Any gas produced is tested.

observations ....

.... [2]

The student dissolves the remaining solid **N** in water to form solution **N**.
Solution **N** is divided into two portions.

(d) To the first portion of solution **N**, the student adds about 2 cm^3 of aqueous sodium hydroxide and gently warms the mixture. Any gas produced is tested.

observations ....

.... [1]

(e) To the second portion of solution **N**, the student adds excess aqueous ammonia.

observations ....

.... [1]

[Total: 9]

4 Limes and lemons are citrus fruits which contain aqueous citric acid in their juice. Citric acid reacts with alkalis such as aqueous sodium hydroxide.

Plan an investigation to find which of lime juice and lemon juice contains the most concentrated aqueous citric acid. Assume that citric acid is the only acid present in the juices.

Your plan must include:

- the method to use
- how the results are used to determine which juice contains the most concentrated aqueous citric acid.

You are provided with lime juice, lemon juice, aqueous sodium hydroxide and common laboratory apparatus and chemicals.

....

....

....

....

....

....

....

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....

....

....

....

....

....

.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Cambridge International Education

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2024**

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 2024 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 descriptions 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)	an arrow pointing to the bottom of the left-hand tube	**1**
1(b)	test-tube / boiling tube	**1**
1(c)	electrolysis	**1**
1(d)	any **two** from: • conducts electricity • high melting point / melts above 322 °C • does not react (with bromine / mercury(II) bromide / mercury / salt / compound) / inert	**2**
1(e)	**X** drawn in tube under the electrodes inside the left-hand tube	**1**
1(f)	condenses (the bromine / the gas / vapour)	**1**

Question	Answer	Marks
2(a)	**M1** all five volumes of aqueous sodium thiosulfate recorded correctly (15.0, 10.0, 7.0, 6.0, 5.0) **M2** all five times recorded correctly (24, 51, 63, 98, 118) **M3** all times recorded in seconds only	**3**
2(b)	**M1** *y*-axis scale is linear **AND** points extend over halfway up scale **M2** and **M3** all points plotted correctly **M4** best-fit line	**4**
2(c)	to mix the reactants / solutions **OR** so that concentration(s) are uniform throughout the mixture	**1**

Question	Answer	Marks
2(d)	Experiment 1	**1**
2(e)	**M1** working shown at 12.5 cm^3 on graph **M2** correct value from graph **M3** units given as s	**3**
2(f)(i)	burette is more accurate (than a measuring cylinder)	**1**
2(f)(ii)	volume is not the same in each run / volume is not 25 cm^3	**1**
2(f)(iii)	repeat **AND** compare / repeat **AND** look for/exclude anomalies / repeat **AND** compare curve shape	**1**
2(g)	**M1** times longer **M2** greater depth of liquid	**2**
2(h)	(measure) temperature before **AND** after (the reaction)	**1**

Question	Answer	Marks
3(a)	(the yellow flame) is not hot enough **OR** (the yellow flame) masks the colour caused by the metal ion	**1**
3(b)	**M1** iron(II) / Fe^{2+} **M2** potassium / K^+ **M3** bromide / Br^- **M4** sulfate / SO_4^{2-}	**4**

Question	Answer	Marks
3(c)	**M1** effervescence / fizzing / bubbles **M2** limewater turns milky	**2**
3(d)	(damp red) litmus (paper) turns blue	**1**
3(e)	no change	**1**

Question	Answer	Marks
4	any **six** from: **MP1** known / same / specified volume of juice **MP2** add a named acid-alkali indicator to the juice **MP3** suitable apparatus for titration (conical flask / beaker) **MP4** NaOH added from <u>burette</u> to juice **MP5** mix / swirl **MP6** indicator / juice changes colour **MP7** the juice that needs most NaOH is most concentrated **OR** **MP1** known / same / specified volume of NaOH **MP2** add a named acid-alkali indicator to the NaOH **MP3** suitable apparatus for titration (conical flask / beaker) **MP4** juice added from <u>burette</u> to NaOH **MP5** mix / swirl **MP6** indicator / alkali changes colour **MP7** the juice with the smallest volume is most concentrated	**6**

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 7 2 1 8 5 0 3 6 6 2 *

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

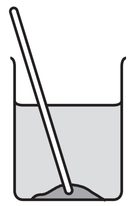
This document has **16** pages. Any blank pages are indicated.

1 A student has a mixture of copper(II) carbonate powder and crystals of sodium sulfate. Copper(II) carbonate is insoluble in water. Sodium sulfate is soluble in water.

The student tries to obtain pure copper(II) carbonate and crystals of pure sodium sulfate from the mixture. Fig. 1.1 shows four of the steps the student carries out.

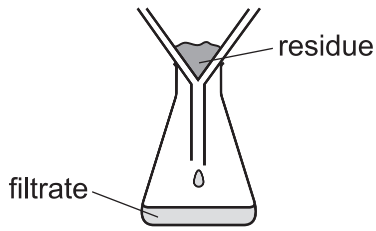
step 1

Add distilled water to the mixture and stir.



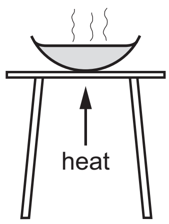
step 2

Filter the mixture.



step 3

Heat the filtrate from **step 2** until crystals start to form.



step 4

Leave the residue on the filter paper from **step 2** in a warm place to dry.

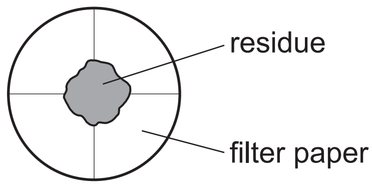


Fig. 1.1

(a) State what happens to the sodium sulfate in **step 1**.

.... [1]

(b) State what is removed from the filtrate in **step 3**.

.... [1]

(c) Describe what must be done after the filtrate has been heated in **step 3** to obtain a larger amount of sodium sulfate crystals.

....

.... [1]

(d) **(i)** State what must be done to the residue before it is allowed to dry in **step 4** to obtain pure copper(II) carbonate.

....

.... [1]

(ii) Identify the substance removed from the copper(II) carbonate in **(d)(i)**.

.... [1]

[Total: 5]

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2 A student investigates the reaction between aqueous magnesium sulfate and aqueous barium nitrate.
A precipitate of barium sulfate forms in the reaction.

The student does eight experiments.

Experiment 1

- Fill a burette with aqueous magnesium sulfate. Run some of the aqueous magnesium sulfate out of the burette so that the level of the aqueous magnesium sulfate is on the burette scale.
- Fill a second burette with aqueous barium nitrate. Run some of the aqueous barium nitrate out of the burette so that the level of the aqueous barium nitrate is on the burette scale.
- Add 4.0 cm^3 of aqueous magnesium sulfate from the first burette into a 10 cm^3 measuring cylinder.
- Add 1.0 cm^3 of aqueous barium nitrate from the second burette into the same measuring cylinder.
- Place a stopper in the top of the measuring cylinder and invert the measuring cylinder several times.
- Leave the measuring cylinder to stand for 15 minutes.
- Record the level of the precipitate on the measuring cylinder scale.
- Rinse the measuring cylinder with distilled water.

Experiment 2

- Repeat Experiment 1 using 1.5 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 3

- Repeat Experiment 1 using 2.5 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 4

- Repeat Experiment 1 using 3.0 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 5

- Repeat Experiment 1 using 3.5 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 6

- Repeat Experiment 1 using 4.5 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 7

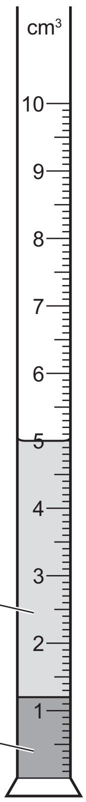
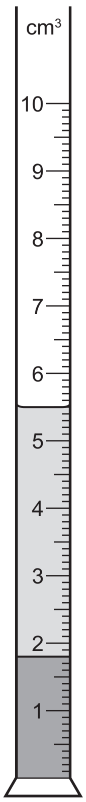
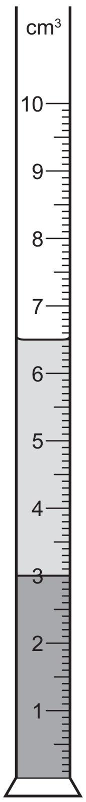
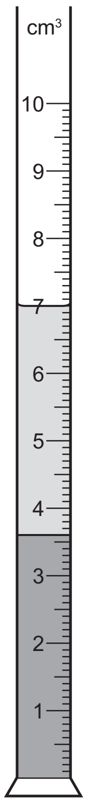
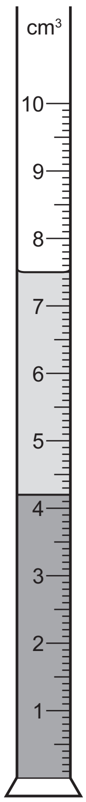
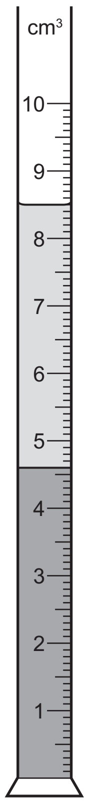
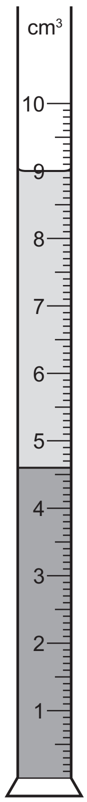
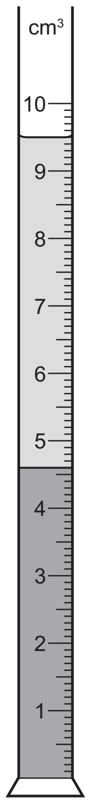
- Repeat Experiment 1 using 5.0 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

Experiment 8

- Repeat Experiment 1 using 5.5 cm^3 of aqueous barium nitrate instead of 1.0 cm^3.

(a) Use the information in the description of the experiments and the measuring cylinder diagrams to complete Table 2.1.

Table 2.1

experiment	1	2	3	4	5	6	7	8
volume of aqueous magnesium sulfate / cm^3	4.0							
volume of aqueous barium nitrate / cm^3	1.0							
measuring cylinder diagram solution precipitate								
level of precipitate on the measuring cylinder scale / cm^3	1.2							

[4]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 8 on Fig. 2.1. Draw **two** straight lines of best fit through your points. The first straight line should be for the first five experiments and must be extended to pass through (0,0). The second straight line should be for the last three experiments and must be horizontal. Extend the straight lines so that they cross each other.

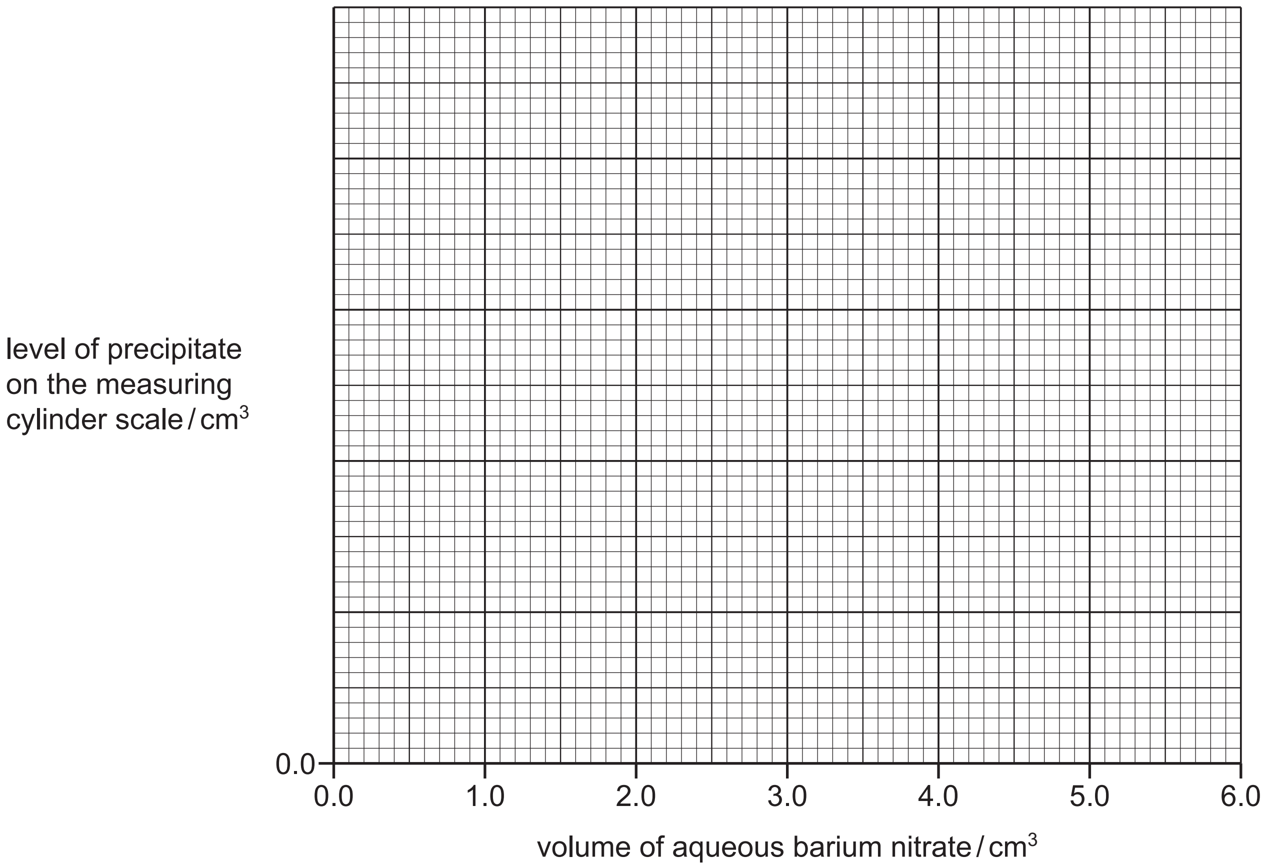


Fig. 2.1

[5]

(c) Use Fig. 2.1 to deduce the level of precipitate on the measuring cylinder scale when the experiment is repeated using 2.8 cm^3 of aqueous barium nitrate.
Show clearly on Fig. 2.1 how you worked out your answer.

level of precipitate = ... cm^3 [2]

(d) The student repeats the experiment using 6.5 cm^3 of aqueous barium nitrate.

Predict the level of precipitate on the measuring cylinder scale.

Explain your answer.

prediction ....

explanation ....

....

[2]

(e) Sketch on Fig. 2.1 the graph obtained if all of the experiments are repeated using aqueous barium nitrate of half the concentration used in Experiments 1 to 8. [2]

(f) Suggest why the measuring cylinder is inverted several times after the aqueous barium nitrate is added.

....

.... [1]

(g) Suggest why the measuring cylinder is left to stand before the level of the precipitate is recorded.

....

.... [1]

(h) The volumes of both aqueous solutions are measured using burettes.

(i) Give a reason why burettes are used rather than measuring cylinders.

....

.... [1]

(ii) Suggest why burettes are used rather than volumetric pipettes.

....

.... [1]

[Total: 19]

3 A student tests two solids: solid **T** and solid **U**.

Tests on solid T

Solid **T** is lithium sulfite.

Complete the expected observations.

(a) The student carries out a flame test on solid **T**.

observations .... [1]

The student dissolves the remaining solid **T** in water to form solution **T**.

The student divides solution **T** into two portions.

(b) The student adds the first portion of solution **T** to a test-tube containing acidified aqueous potassium manganate(VII).

State the colour change.

from .... to .... [2]

(c) **(i)** To the second portion of solution **T**, the student adds excess dilute nitric acid. The gas produced turns filter paper soaked in acidified aqueous potassium manganate(VII) white.

Identify the gas produced.

.... [1]

(ii) To the solution produced in **(c)(i)**, the student adds aqueous barium nitrate.

observations .... [1]

Tests on solid U

Solid **U** contains one cation and one anion.
Table 3.1 shows the tests and the student's observations for solid **U**.

The student dissolves solid **U** in distilled water to form solution **U**. The student then divides solution **U** into three portions.

Table 3.1

tests	observations
test 1 To the first portion of solution **U**, add a few drops of aqueous ammonia.	green precipitate
test 2 To the second portion of solution **U**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	yellow precipitate
test 3 To the third portion of solution **U**, add 1 cm^3 of aqueous chlorine.	the solution turns brown

(d) Identify **two** cations that the tests and observations in Table 3.1 show could be in solid **U**.

....

.... [2]

(e) Describe an additional test that the student could do to confirm which one of the two cations identified in **(d)** is in solid **U**.
Give the expected result for **one** of the cations.

test ....

cation ....

result ....
[2]

(f) Identify the anion in solid **U**.

.... [1]

[Total: 10]

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4 Beetroot is a coloured vegetable. The colour is caused by a mixture of water-soluble coloured compounds.

Plan an experiment to find how many water-soluble coloured compounds there are in a beetroot.

Include in your plan:
- how to extract the coloured compounds from a beetroot
- how to separate the mixture of coloured compounds
- how the results show how many coloured compounds there are in a beetroot.

You are provided with a beetroot, distilled water and common laboratory apparatus.

....

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.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

CAMBRIDGE
International Education

Cambridge IGCSE™

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2024**

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 2024 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.

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 descriptions 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)	dissolves	**1**
1(b)	water	**1**
1(c)	(leave it to) cool	**1**
1(d)(i)	wash (with water)	**1**
1(d)(ii)	sodium sulfate	**1**

Question	Answer	Marks
2(a)	**M1** all volumes **AND** precipitate levels are recorded to 1 dp **M2** all volumes of aqueous magnesium sulfate (4.0) and aqueous barium nitrate are correct ((1.0), 1.5, 2.5, 3.0, 3.5, 4.5, 5.0, 5.5) **M3** and **M4** all 7 precipitate levels correct (1.8, 3.0, 3.6, 4.2, 4.6, 4.6, 4.6)	**4**
2(b)	**M1** linear scale for *y*-axis **M2** and **M3** all 8 points plotted correctly **M4** ruler drawn straight line through first five points **AND** line extends to the origin **M5** ruler drawn straight line through last three points **AND** lines extend so that they meet / cross	**5**
2(c)	**M1** working on graph to show reading at 2.8 cm^3 of barium nitrate **M2** correct reading	**2**
2(d)	**M1** 4.6 (cm^3) **M2** all magnesium sulfate has reacted	**2**

Question	Answer	Marks
2(e)	**M1** graph line starts at (0,0) and is below results line **M2** sketch line continues to 6 cm^3 with positive gradient and does not level off and is approximately half precipitate level of original line	**2**
2(f)	to mix the reactants / solutions **OR** so that concentration(s) are uniform throughout the mixture	**1**
2(g)	so that the precipitate settles out / so that the precipitate falls to the bottom	**1**
2(h)(i)	(a burette is) more accurate (than a measuring cylinder)	**1**
2(h)(ii)	the volumes are not fixed volume / not the same in each run	**1**

Question	Answer	Marks
3(a)	red (flame colour)	**1**
3(b)	**M1** (from) purple **M2** (to) colourless	**2**
3(c)(i)	sulfur dioxide / SO_2	**1**
3(c)(ii)	no change	**1**
3(d)	**M1** iron(II) / Fe^{2+} **M2** chromium(III) / Cr^{3+}	**2**

Question	Answer	Marks
3(e)	**M1** add (excess / more) aqueous sodium hydroxide **M2** chromium(III) **AND** forms a solution / precipitate dissolves **OR** **M2** iron(II) **AND** forms a green precipitate / precipitate does not dissolve / (precipitate) becomes brown **OR** **M1** leave to stand / add more (aqueous ammonia) **M2** chromium(III) **AND** remains green / does not turn brown **OR** **M2** iron(II) **AND** turns brown	**2**
3(f)	iodide / I^-	**1**

Question	Answer	Marks
4	any **six** from: **MP1** crush / grind beetroot **MP2** with pestle / mortar **MP3** with water **MP4** place (a drop of) liquid / colour on (chromatography / filter) paper **MP5** chromatography **MP6** (bottom of) paper dipped in water **MP7** number of coloured substances = number of spots	**6**

* 0000800000001 *

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 3 5 7 1 2 9 9 7 7 6 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2024**

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 **20** pages. Any blank pages are indicated.

1 A list of substances is shown.

bauxite
carbon dioxide
cryolite
ethane
ethanol
ethene
graphite
helium
hematite
hydrogen
silicon(IV) oxide
sodium chloride

Answer the following questions using only the substances from the list.

Each substance may be used once, more than once or not at all.

State which substance:

(a) is manufactured by fermentation

.... [1]

(b) is monatomic

.... [1]

(c) is a reactant in photosynthesis

.... [1]

(d) is a solvent in the extraction of aluminium

.... [1]

(e) is an ore of iron

.... [1]

(f) is manufactured from methane

.... [1]

(g) is a compound with a giant covalent structure

.... [1]

(h) is used as a lubricant

.... [1]

(i) is tested for with limewater.

.... [1]

[Total: 9]

2 This question is about electrolysis.

(a) State the meaning of the term electrolysis.

....

.... [2]

(b) Table 2.1 gives some information about the electrolysis of two electrolytes using graphite electrodes.

Table 2.1

	anode (positive electrode)		cathode (negative electrode)	
electrolyte	observation	name of product	observation	name of product
concentrated aqueous potassium iodide			bubbles of colourless gas	
aqueous copper(II) sulfate	bubbles of colourless gas	oxygen	pink-brown solid	

(i) Complete Table 2.1. [4]

(ii) Oxygen is produced at the anode by the electrolysis of aqueous copper(II) sulfate.

Write the ionic half-equation for this reaction.

.... [2]

(c) Aqueous copper(II) sulfate is electrolysed using copper electrodes instead of graphite electrodes.

(i) Explain why the mass of the anode decreases during this electrolysis.

.... [1]

(ii) Name the product formed at the cathode.

.... [1]

(iii) State what change, if any, is observed in the appearance of the aqueous copper(II) sulfate.

.... [1]

[Total: 11]

3 This question is about compounds of tin.

(a) Tin(IV) oxide has the formula SnO_2.

The relative formula mass, M_r, of SnO_2 is 151.

Calculate the percentage by mass of tin in SnO_2.

percentage by mass of tin in SnO_2 = ...% [1]

(b) SnO_2 is an amphoteric oxide.

SnO_2 reacts with aqueous sodium hydroxide, NaOH, to form a sodium salt and water only. The sodium salt contains a negative ion with the formula SnO_3^{2-}.

(i) State the meaning of the term amphoteric.

....

.... [1]

(ii) Write the symbol equation for the reaction between SnO_2 and NaOH.

.... [2]

(c) Tin is a metal that forms both covalent and ionic compounds.

Suggest why this is unusual for a metal.

.... [1]

(d) (i) Tin(IV) chloride, $SnCl_4$, is covalently bonded.

A tin atom has four electrons in its outer shell.

Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of $SnCl_4$.
Show the outer shell electrons only.

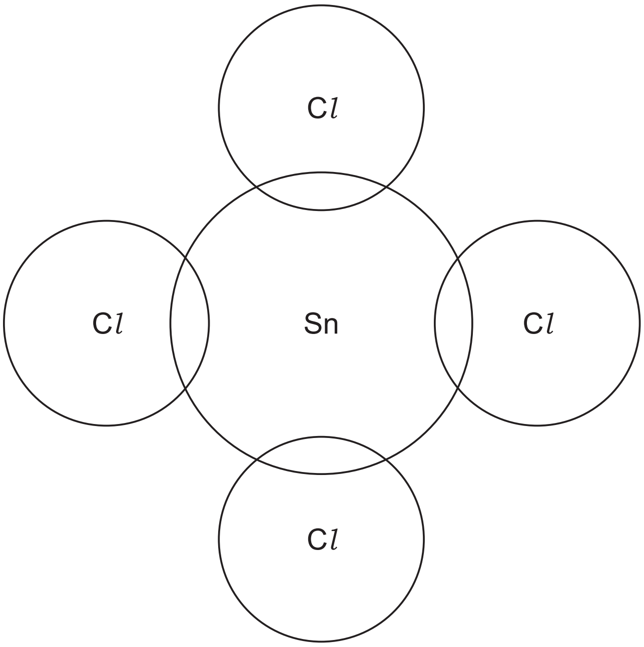

Fig. 3.1

[2]

(ii) Tin(II) oxide, SnO, is ionically bonded.

The melting points of $SnCl_4$ and SnO are shown in Table 3.1.

Table 3.1

	melting point / °C
$SnCl_4$	–33
SnO	1080

Explain, in terms of structure and bonding, why $SnCl_4$ has a much lower melting point than SnO.

....

....

....

....

.... [3]

(e) Part of the reactivity series is shown.

magnesium	most reactive
aluminium	↑
tin	
copper	least reactive

(i) When aluminium foil is added to aqueous tin(II) sulfate, a reaction does **not** occur even though aluminium is above tin in the reactivity series.

Explain why a reaction does **not** occur.

....

.... [1]

(ii) An aqueous solution of tin(II) sulfate contains Sn^{2+} ions.

Two experiments are carried out.

Experiment 1 Copper is added to aqueous tin(II) sulfate.

Experiment 2 Magnesium is added to aqueous tin(II) sulfate.

Write an ionic equation for any reaction that occurs in each experiment.
If no reaction occurs, write 'no reaction'.

Experiment 1 ....

Experiment 2 ....
[2]

(f) Hydrated tin(II) nitrate, $Sn(NO_3)_2{\cdot}20H_2O$, decomposes when it is heated.

(i) State what is meant by the term hydrated.

....

.... [1]

(ii) Complete the equation for the decomposition of $Sn(NO_3)_2{\cdot}20H_2O$.

$$2Sn(NO_3)_2{\cdot}20H_2O \rightarrow ......SnO + ...NO_2 + O_2 + ...H_2O$$

[2]

[Total: 16]

4 This question is about sulfuric acid, H_2SO_4.

(a) Dilute sulfuric acid and aqueous sodium hydroxide can be used to prepare sodium sulfate crystals using a method that involves titration.

The apparatus for titration is shown in Fig. 4.1.

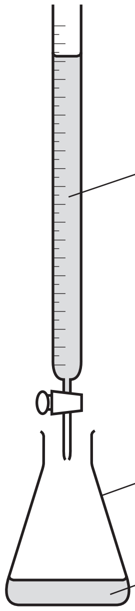

Fig. 4.1

Thymolphthalein is used as an indicator for this titration.

(i) State the colour change of thymolphthalein at the end-point of this titration.

from .... to .... [2]

(ii) Suggest why universal indicator is **not** used for this titration.

....

.... [1]

(b) $25.0\,cm^3$ of aqueous sodium hydroxide, NaOH, of concentration $0.100\,mol/dm^3$ is neutralised by $20.0\,cm^3$ of dilute sulfuric acid, H_2SO_4.

The equation for the reaction is shown.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of H_2SO_4 using the following steps.

- Calculate the number of moles of NaOH used.

.... 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]

(c) A student is provided with an aqueous solution of sodium sulfate.

Describe how to prepare a **pure** sample of sodium sulfate crystals from this solution.

....

....

....

....

.... [3]

(d) Potassium hydrogen sulfate, $KHSO_4$, can be prepared by a reaction between aqueous potassium hydroxide and dilute sulfuric acid. Water is the only other product.

Write a symbol equation for this reaction.

.... [1]

(e) Potassium hydrogen sulfate, $KHSO_4$, dissolves in water to form solution **X**.

Solution **X** contains K^+, H^+ and SO_4^{2-} ions.

(i) Name the **type** of solution that contains H^+ ions.

.... [1]

(ii) State the observations when the following tests are done.

- A flame test is carried out on **X**.

....

- Solid copper(II) carbonate is added to **X**.

....

....

....

- Aqueous barium nitrate acidified with dilute nitric acid is added to **X**.

....

[5]

(f) 0.325 g of Zn is added to dilute sulfuric acid which contains 0.0100 moles of H_2SO_4.

The equation for this reaction is shown.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

(i) Determine whether Zn or H_2SO_4 is the limiting reactant.
Explain your answer.

....

....

....

.... [2]

DO NOT WRITE IN THIS MARGIN

(ii) In another experiment, 48.0 cm^3 of hydrogen gas, H_2, is produced. The experiment is carried out at room temperature and pressure, r.t.p.

Calculate the number of molecules in 48.0 cm^3 of H_2 gas measured at r.t.p.

The value of the Avogadro constant is 6.02×10^{23}.

.... molecules [2]

[Total: 20]

5 This question is about rate of reaction and equilibrium.

A student investigates the rate of decomposition of aqueous hydrogen peroxide, H_2O_2, using manganese(IV) oxide as a catalyst.

The equation for the reaction is shown.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The student uses the apparatus shown in Fig. 5.1.

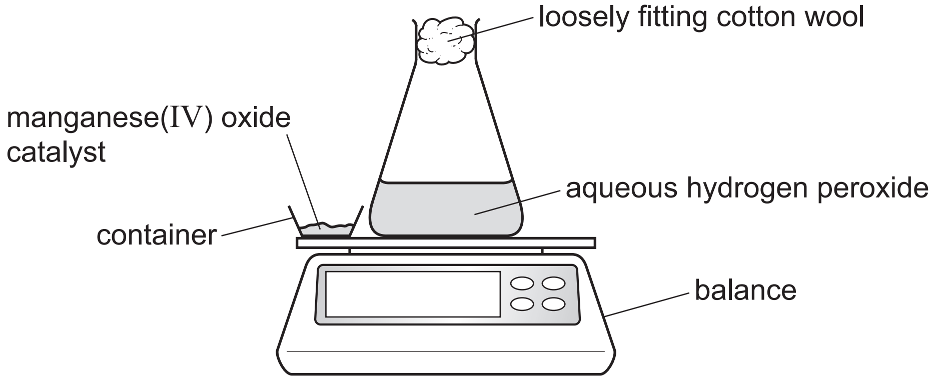

Fig. 5.1

The student:
- adds the catalyst to the aqueous hydrogen peroxide
- replaces the container on the balance
- starts a stop-watch
- records the mass at regular time intervals.

(a) Table 5.1 shows the mass recorded at regular time intervals.

Table 5.1

time / s	mass / g
0	50.64
30	49.80
60	49.38
90	49.17
120	49.07
150	49.02
180	48.99
210	48.97
240	48.97
270	48.97

(i) Suggest why the mass decreases as time increases.

.... [1]

DO NOT WRITE IN THIS MARGIN

(ii) After a certain time the reaction stops.

Explain why the reaction stops.

.... [1]

(iii) Suggest why it is **not** possible to use the results in Table 5.1 to determine the **exact** time when the reaction stops.

....

.... [1]

(b) Fig. 5.2 shows a graph of the mass against time.

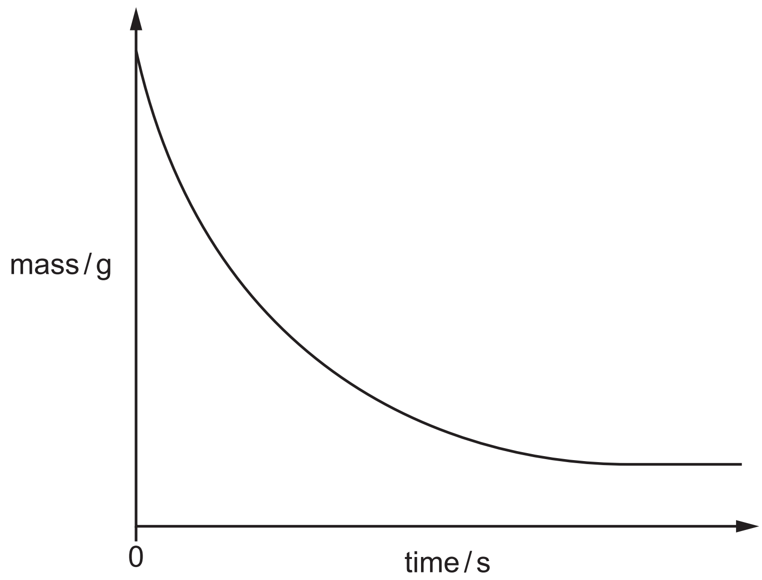

Fig. 5.2

The experiment is repeated at a higher temperature.
All other conditions remain the same.

(i) Explain, in terms of collision theory, why the rate of reaction is higher at a higher temperature.

....

....

....

....

.... [3]

(ii) On Fig. 5.2, sketch the line expected when the experiment is repeated at a higher temperature. [2]

(c) Manganese(IV) oxide is the catalyst in this reaction.

(i) Explain the meaning of (IV) in manganese(IV) oxide.

....

.... [2]

(ii) State how the mass of the **catalyst** has changed, if at all, at the end of the experiment.

.... [1]

(d) Nitrogen monoxide gas, NO, and oxygen gas, O_2, react to produce nitrogen dioxide gas, NO_2, at room temperature.

The reaction can reach equilibrium. The equation is shown.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = -113\,\text{kJ/mol}$$

NO(g) and O_2(g) are passed into a beaker as shown in Fig. 5.3.

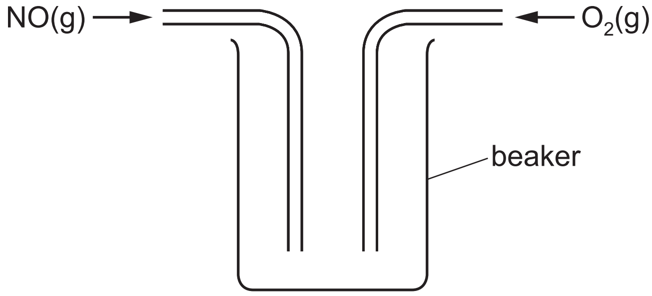

Fig. 5.3

(i) Explain why the method shown in Fig. 5.3 will **not** allow the reaction to reach equilibrium.

.... [1]

(ii) The apparatus is changed and equilibrium is reached.

The temperature of the equilibrium system is then increased and the position of equilibrium shifts to the left.

Explain why the position of equilibrium shifts to the left.

.... [1]

(iii) The pressure of the equilibrium system is then increased.

State the direction, if any, in which the position of equilibrium shifts.
Explain your answer.

direction ....

explanation ....
[2]

[Total: 15]

6 This question is about hydrocarbons.

(a) State the meaning of the term hydrocarbon.

.... [1]

(b) Propene, C_3H_6, can be made from long-chain alkanes such as dodecane.
Dodecane contains 12 carbon atoms.

(i) Deduce the molecular formula of dodecane.

.... [1]

(ii) Name the type of reaction that occurs when long-chain alkanes are converted into shorter chain alkenes.

.... [1]

(c) Propene is an unsaturated hydrocarbon.
Propene reacts with bromine.

(i) State the meaning of the term unsaturated.

.... [1]

(ii) Write the molecular formula of the product formed when propene reacts with bromine.

.... [1]

(d) A styrene molecule is represented as shown in Fig. 6.1.

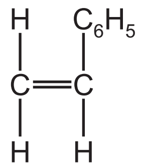

Fig. 6.1

(i) The molecular formula of styrene is C_8H_8.

Determine the empirical formula of styrene.

.... [1]

(ii) Styrene can be polymerised into poly(styrene).

State the type of polymerisation that occurs when styrene is converted into poly(styrene).

.... [1]

(iii) Draw the structure of **one** repeat unit of poly(styrene). Include all of the atoms and all of the bonds.
The C_6H_5 group should be represented as C_6H_5.

[2]

[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 –	113 Nh nihonium –	114 F*l* flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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 2024**

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 2024 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 descriptions 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)	ethanol / carbon dioxide	**1**
1(b)	helium	**1**
1(c)	carbon dioxide	**1**
1(d)	cryolite	**1**
1(e)	hematite	**1**
1(f)	hydrogen	**1**
1(g)	silicon(IV) oxide	**1**
1(h)	graphite	**1**
1(i)	carbon dioxide	**1**

Question	Answer	Marks
2(a)	**M1** breakdown by (the passage of) electricity **M2** of an ionic compound in molten or aqueous (state)	**2**
2(b)(i)	**M1** brown solution **OR** black solid **M2** iodine **M3** hydrogen **M4** copper	**4**

Question	Answer	Marks
2(b)(ii)	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ **M1** OH^- **AND** e^- **M2** correct equation	**2**
2(c)(i)	copper **OR** anode forms Cu^{2+} which goes into the solution	**1**
2(c)(ii)	copper	**1**
2(c)(iii)	no change	**1**

Question	Answer	Marks
3(a)	78.8 (%)	**1**
3(b)(i)	reacts with acids and with bases to produce a salt and water	**1**
3(b)(ii)	$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$ (2) **M1** Na_2SnO_3 **M2** correct equation	**2**
3(c)	metals form ionic compounds or ionic bonds only **OR** covalent compounds contain non-metals only	**1**
3(d)(i)	**M1** four single bonds using one dot and one cross **M2** three pairs of non-bonding electrons on each chlorine and no non-bonding electrons on tin	**2**

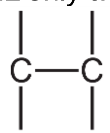
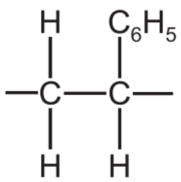
Question	Answer	Marks
3(d)(ii)	**M1** attraction between molecules **or** intermolecular forces in tin(IV) chloride **M2** tin(II) oxide has a giant ionic structure **M3** weak<u>er</u> attraction (between particles) in tin(IV) chloride **ORA**	**3**
3(e)(i)	unreactive coating of aluminium oxide	**1**
3(e)(ii)	**M1** no reaction **M2** $Mg + Sn^{2+} \rightarrow Mg^{2+} + Sn$	**2**
3(f)(i)	substance that is chemically combined with water **OR** containing water of crystallisation	**1**
3(f)(ii)	$2Sn(NO_3)_2{\bullet}20H_2O \rightarrow 2SnO + 4NO_2 + O_2 + 40H_2O$ (2) **M1** $2(SnO) + 4(NO_2)$ **M2** $40H_2O$	**2**

Question	Answer	Marks
4(a)(i)	blue (1) to colourless (1)	**2**
4(a)(ii)	too many colour changes	**1**

Question	Answer	Marks
4(b)	**M1** 0.0025 / 2.5 $\times$ 10^{-3} (mol) **M2** 0.00125 / 1.25 $\times$ 10^{-3} (mol) **M3** 0.0625 / 6.25 $\times$ 10^{-2} (mol / dm^3)	**3**
4(c)	**M1** heat the solution / warm the solution /boil the solution / leave solution in hot place **M2** to saturation (point)/ crystallisation point **AND** leave to cool **M3** suitable method of drying	**3**
4(d)	$KOH + H_2SO_4 \rightarrow KHSO_4 + H_2O$	**1**
4e(i)	acid / acidic	**1**
4(e)(ii)	*flame test is carried out on **X**:* **M1** lilac flame *solid copper(II) carbonate is added to **X**:* **M2** solid dissolves / solid disappears **M2** bubbles / fizzing / effervescence **M3** blue solution *aqueous barium nitrate acidified with dilute nitric acid is added to **X**:* **M5** white precipitate	**5**
4(f)(i)	**M1** moles of Zn = 0.005 / 5 $\times$ 10^{-3} (mol) **M2** Zn is limiting because moles of H_2SO_4 > moles of Zn **AND** 1:1 ratio required for reaction	**2**
4(f)(ii)	**M1** (48.0 ÷ 24 000 =) 0.00200 (mol) **M2** 1.20 $\times$ 10^{21} (molecules)	**2**

Question	Answer	Marks
5(a)(i)	oxygen gas escapes from the flask	**1**
5(a)(ii)	the hydrogen peroxide is used up **OR** <u>all</u> the hydrogen peroxide has reacted or decomposed	**1**
5(a)(iii)	time intervals are too large	**1**
5(b)(i)	**M1** kinetic energy of particles increases **M2** frequency of collisions between particles increases **M3** more / higher percentage **OR** higher proportion **OR** higher fraction of <u>particles</u> have energy greater than / equal to activation energy **OR** more of the collisions / higher percentage **OR** higher fraction or higher proportion of <u>collisions</u> have energy greater than or equal to activation energy	**3**
5(b)(ii)	**M1** graph starts at same mass and has steeper gradient **M2** levels off at the same mass but earlier	**2**
5(c)(i)	**M1** oxidation number of manganese **M2** $+4$	**2**
5(c)(ii)	no change	**1**
5(d)(i)	not a closed system	**1**
5(d)(ii)	forward reaction is exothermic	**1**

Question	Answer	Marks
5(d)(iii)	**M1** (to the) right **M2** there are fewer gas molecules on the right	**2**

Question	Answer	Marks
6(a)	compound containing carbon and hydrogen <u>only</u>	**1**
6(b)(i)	$C_{12}H_{26}$	**1**
6(b)(ii)	cracking	**1**
6(c)(i)	contains at least one carbon – carbon double bond	**1**
6(c)(ii)	$C_3H_6Br_2$	**1**
6(d)(i)	CH	**1**
6(d)(ii)	addition	**1**
6(d)(iii)	**M1** only two carbon atoms joined by a single bond and two additional bonds on each carbon  **M2** correct repeat unit including two extension bonds 	**2**

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9488202782

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2024**

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.

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1 The formulae of the molecules **A** to **I** are shown in Table 1.1.

Table 1.1

molecule	formula
A	C_2H_4
B	C_2H_5OH
C	CO
D	CO_2
E	Cl_2
F	NO_2
G	N_2
H	O_2
I	SO_2

Answer the following questions about the molecules, **A** to **I**.
Each letter may be used once, more than once or not at all.

State which of the molecules **A** to **I**:

(a) is an element with a triple bond .... [1]

(b) is a product of photosynthesis .... [1]

(c) is used as a fuel .... [1]

(d) turns limewater milky .... [1]

(e) undergoes a substitution reaction with alkanes .... [1]

(f) is a colourless liquid at r.t.p. .... [1]

(g) is unsaturated .... [1]

(h) is 21% of clean, dry air .... [1]

(i) is a reactant in the Haber process. .... [1]

[Total: 9]

2 Aluminium is manufactured by the electrolysis of aluminium oxide.

(a) State the name of the main ore of aluminium.

.... [1]

(b) Name the substance mixed with aluminium oxide to reduce the operating temperature of the process.

.... [1]

(c) Explain why the molten mixture in **(b)** conducts electricity.

.... [1]

(d) Table 2.1 contains some information about the processes which take place at the anode and the cathode.

Table 2.1

anode	cathode
$2O^{2-} \rightarrow O_2 + ...e^-$	....

(i) Complete Table 2.1:

- Write the number of electrons needed to balance the ionic half-equation for the reaction at the anode.
- Write the ionic half-equation for the reaction at the cathode.

[3]

(ii) State why the process at the anode is an oxidation.

.... [1]

(iii) Oxygen is formed at the anode.

Explain why the main gas given off at the anode is carbon dioxide and **not** oxygen.

....

.... [2]

(e) State why aluminium is used in food containers.

.... [1]

DO NOT WRITE IN THIS MARGIN

(f) Aluminium reacts with fluorine to form the ionic compound aluminium fluoride.

Complete the dot-and-cross diagram in Fig. 2.1 of the ions in aluminium fluoride.

Give the charges on the ions.

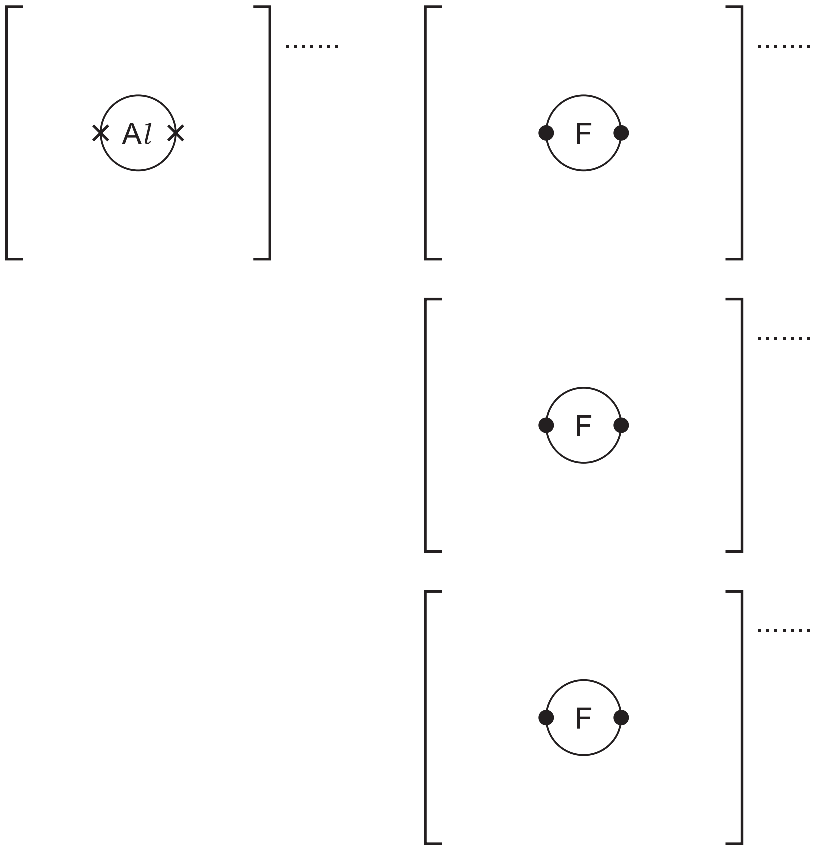

Fig. 2.1

[3]

[Total: 13]

3 Sulfur forms two chlorides, **P** and **Q**.
Chloride **P** has the formula S_2Cl_2. Chloride **Q** has the formula SCl_2.

(a) Both chlorides are covalently bonded and have low melting points.

Suggest, in terms of attraction between particles, why these chlorides have low melting points.

....

.... [2]

(b) Chloride **P**, S_2Cl_2, forms when sulfur reacts with chlorine.

Write the symbol equation for this reaction.

.... [1]

(c) Complete the dot-and-cross diagram in Fig. 3.1 of a molecule of chloride **Q**, SCl_2.

Show outer electrons only.

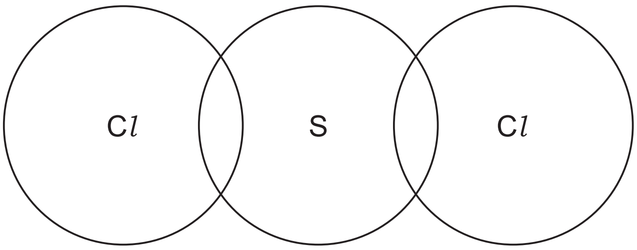

Fig. 3.1

[3]

(d) Chloride **P** is converted to chloride **Q** by reaction with chlorine in a closed system.
The reversible reaction reaches an equilibrium.

$$\underset{\textbf{P}}{S_2Cl_2(g)} + Cl_2(g) \rightleftharpoons \underset{\textbf{Q}}{2SCl_2(g)}$$

The forward reaction is exothermic.

Suggest **two** changes to the conditions which will result in a decrease in the concentration of chloride **Q** at equilibrium.

1 ....

2 ....
[2]

(e) The rate of the forward reaction in **(d)** is determined by collision theory.

The rate of reaction depends upon two factors:

- the frequency of collisions between particles
- the proportion of collisions which have energy greater than or equal to the activation energy.

(i) Define the term activation energy.

.... [1]

(ii) Give the symbol for activation energy.

.... [1]

(iii) Complete Table 3.1 to show the effect, if any, when the conditions are changed.

Use only the words **increases**, **decreases** or **no change**.

Table 3.1

change to conditions	effect on the frequency of collisions between particles	effect on the proportion of collisions which have energy greater than or equal to the activation energy
concentration of chlorine is increased		
temperature is increased		
a catalyst is added		

[5]

(f) The reaction of chloride **P** with chlorine is a redox reaction.

$$\underset{\mathbf{P}}{S_2Cl_2(g)} + Cl_2(g) \rightleftharpoons \underset{\mathbf{Q}}{2SCl_2(g)}$$

The oxidation number of Cl in chloride **P** and chloride **Q** is –1.

Use oxidation numbers to explain why:

- sulfur is oxidised in the forward reaction

  ....

  ....

- chlorine is oxidised in the reverse reaction.

  ....

  ....

[4]

[Total: 19]

Question 4 starts on the next page.

4 Silver bromide, AgBr, is made when aqueous silver ethanoate, CH_3COOAg, is added to aqueous sodium bromide, NaBr.

The equation for the reaction is shown in **equation 1**.

equation 1 $CH_3COOAg + NaBr \rightarrow CH_3COONa + AgBr$

The method includes the following steps.

step 1 Add 200.0 cm^3 of 0.0500 mol / dm^3 CH_3COOAg to a beaker.
This volume contains 0.0100 mol of Ag^+ ions.

step 2 Add 50.0 cm^3 of aqueous NaBr. This volume contains 0.0100 mol of Br^- ions.
A precipitate forms.

step 3 Filter the mixture.

step 4 Dry the solid residue until all the water is removed.

step 5 Record the mass of the dry residue.

(a) Complete the ionic equation for the reaction by adding the missing state symbols.

$Ag^+(.......) + Br^-(.......) \rightarrow AgBr(.......)$

[1]

(b) Name a different aqueous silver salt which could be used in **step 1**.

.... [1]

(c) Use the information in **step 2** to calculate the concentration of aqueous NaBr.

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

(d) State the colour of the precipitate which forms in **step 2**.

.... [1]

(e) Use the information in **step 1**, **step 2** and **equation 1** to determine the number of moles of AgBr formed. Use this value to calculate the mass of AgBr formed.

number of moles of AgBr = ...

mass of AgBr = ... g
[3]

(f) Name the salt dissolved in the filtrate in **step 3**.

.... [1]

(g) The recorded mass of the dry residue in **step 5** is greater than the mass calculated in **(e)** because a step is missing from the procedure.

(i) Suggest the missing step.

.... [1]

(ii) Name the substance responsible for the greater mass of the dry residue.

.... [1]

(h) Barium sulfate can be made by the same method but with different aqueous solutions.

(i) Suggest **two** aqueous solutions which can be added together to make barium sulfate.

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

(ii) Write the balanced symbol equation for this reaction.

.... [2]

[Total: 14]

5 Alkenes are manufactured by cracking larger alkane molecules.

(a) State the source of the large alkane molecules used in cracking.

.... [1]

(b) State **two** conditions needed for cracking large alkane molecules.

1 ....

2 ....
[2]

(c) When one molecule of dodecane, $C_{12}H_{26}$, is cracked, three molecules of but-1-ene and one other product are formed.

(i) Use molecular formulae to complete the symbol equation for this reaction.

$C_{12}H_{26} \rightarrow$ .... + ...
[2]

(ii) Suggest the type of chemical reaction which happens during cracking.

.... [1]

(d) Propene will undergo polymerisation.

(i) Suggest the name of the polymer formed from propene.

.... [1]

(ii) Draw part of this polymer molecule to show **three** repeat units.

[3]

(iii) State the type of polymerisation propene undergoes.

.... [1]

[Total: 11]

Question 6 starts on the next page.

6 Polyamides and polyesters are polymers.

Polyamides can occur naturally or can be manufactured.

(a) Part of the structure of a polyamide is shown in Fig. 6.1.

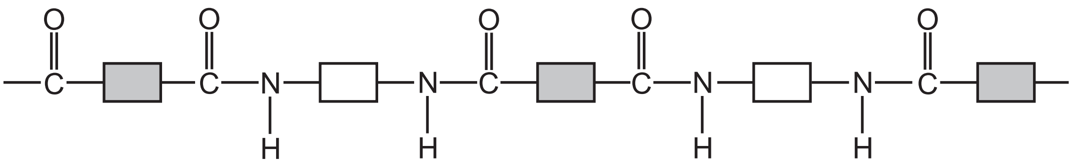

Fig. 6.1

(i) On Fig. 6.1, draw a circle around **one** amide linkage. [1]

(ii) Complete Fig. 6.2 to show the structures of the **two** monomers needed to make the polymer in Fig. 6.1.
Show all of the atoms and all of the bonds in the functional groups.

Fig. 6.2

[2]

(iii) Name the other product formed in this polymerisation.

.... [1]

(iv) State the term given to natural polyamides.

.... [1]

(v) Name the type of monomers which are used to make natural polyamides.

.... [1]

(vi) One of the monomers which forms part of a natural polyamide has **three** carbon atoms.

Complete Fig. 6.3 to show the displayed formula of this monomer.

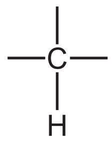

Fig. 6.3

[3]

(b) PET is a polyester.

(i) Name the **two** types of monomer molecules needed to make polyesters.

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

(ii) Draw part of the structure of PET which shows **two** repeat units.

Show all of the atoms and all of the bonds in the linkages.

[3]

[Total: 14]

* 0000800000016 *

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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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 –

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 **0620/42**

Paper 4 Theory (Extended) **October/November 2024**

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 2024 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 descriptions 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)	G	**1**
1(b)	H	**1**
1(c)	B	**1**
1(d)	D	**1**
1(e)	E	**1**
1(f)	B	**1**
1(g)	A	**1**
1(h)	H	**1**
1(i)	G	**1**

Question	Answer	Marks
2(a)	bauxite	**1**
2(b)	cryolite	**1**
2(c)	(it has) mobile ions	**1**
2(d)(i)	**M1** 4 $Al^{3+} + 3e^- \rightarrow Al$ **M2** Al^{3+} **AND** e^- **M3** correct equation	**3**
2(d)(ii)	electrons are lost (from oxide ions)	**1**

Question	Answer	Marks
2(d)(iii)	**M1** anode / electrode made of carbon or graphite **M2** anode / electrode reacts with oxygen / burns / combusts (in oxygen)	**2**
2(e)	aluminium is resistant to corrosion	**1**
2(f)	**M1** eight crosses in second shell of A*l* **M2** seven dots and one cross in second shell of each F **M3** '3+' charge on A*l* ion on correct answer line **AND** '–' charge on each F ion on correct answer line	**3**

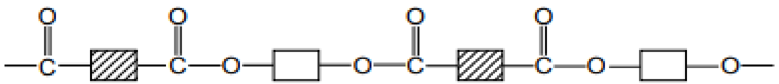
Question	Answer	Marks
3(a)	**M1** attraction between **molecules** **M2** attraction is weak	**2**
3(b)	$2S + Cl_2 \rightarrow S_2Cl_2$	**1**
3(c)	**M1** S with one dot-cross bonding pair with each C*l* **M2** four non-bonding dots for S **M3** six non-bonding crosses for each C*l*	**3**
3(d)	**M1** decrease concentration of S_2Cl_2 / P and / or Cl_2 **M2** increase temperature	**2**
3(e)(i)	the minimum energy that colliding particles must have to react	**1**
3(e)(ii)	E_a	**1**

Question	Answer	Marks
3(e)(iii)	**M1** increases **M2** no change **M3** increases **M4** increases **M5** increases	**5**
3(f)	**M1** oxidation number of S goes from +1 **M2** oxidation number of S goes to +2 **M3** oxidation number of C*l* (goes from **–**1) to 0 (in Cl_2) **M4** oxidation numbers of C*l* **AND** S increase	**4**

Question	Answer	Marks
4(a)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$	**1**
4(b)	(silver) nitrate	**1**
4(c)	0.01 × 1000 / 50 = 0.2(00) (mol / dm^3)	**1**
4(d)	cream	**1**
4(e)	**M1** mol of AgBr = 0.01(00) **M2** M_r of AgBr = 188 **M3** 188 x 0.01 = 1.88 (g)	**3**
4(f)	sodium ethanoate	**1**
4(g)(i)	rinsing of residue	**1**
4(g)(ii)	(crystals of) sodium ethanoate	**1**

Question	Answer	Marks
4(h)(i)	**M1** named soluble barium salt e.g. barium chloride / barium nitrate **M2** named soluble sulfate salt e.g. sodium sulfate / potassium sulfate / ammonium sulfate / sulfuric acid	**2**
4(h)(ii)	**M1** any equation with $BaSO_4$ as a product **M2** correct equation using soluble reactants	**2**

Question	Answer	Marks
5(a)	petroleum	**1**
5(b)	**M1** high temperature **M2** catalyst	**2**
5(c)(i)	$C_{12}H_{26} \rightarrow 3C_4H_8 + H_2$ **M1** C_4H_8 **M2** correct equation	**2**
5(c)(ii)	thermal decomposition	**1**
5(d)(i)	poly(propene)	**1**
5(d)(ii)	**M1** chain of six C atoms joined by single bonds in a chain **M2** three correctly placed CH_3 groups **M3** correct structure **AND** continuation bonds	**3**
5(d)(iii)	addition	**1**

Question	Answer	Marks
6(a)(i)	one amide linkage circled	**1**
6(a)(ii)	**M1** two fully displayed carboxylic acid groups on the shaded box **M2** two fully displayed amino groups on the unshaded box	**2**
6(a)(iii)	water	**1**
6(a)(iv)	protein(s)	**1**
6(a)(v)	amino acids	**1**
6(a)(vi)	displayed formula of 2-aminopropanoic acid (3) **M1** displayed NH_2 or displayed COOH group present **M2** displayed NH_2 and displayed COOH groups attached to same C atom **M3** correct displayed structure of 2-aminopropanoic acid	**3**
6(b)(i)	**M1** dicarboxylic acids **M2** diols	**2**
6(b)(ii)	 **M1** any one correct fully displayed ester link between any two blocks **M2** three fully displayed inter-block ester links with correct orientation **M3** fully correct diagram showing <u>two</u> complete repeat units of polyester including continuation bonds	**3**

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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 3 0 3 7 3 9 3 0 2 4 *

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2024**

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.

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1 A list of chemical and physical processes, **A** to **H**, is shown.

A combustion
B diffusion
C melting
D neutralisation
E photosynthesis
F reversible reaction
G roasting
H thermal decomposition

Answer the following questions about processes **A** to **H**.
Each letter may be used once, more than once or not at all.

State which of the processes **A** to **H**:

(a) happens when an acid reacts with an alkali

.... [1]

(b) reaches a position of equilibrium

.... [1]

(c) involves particles changing from fixed positions to being mobile, but still touching

.... [1]

(d) are physical changes

.... and .... [1]

(e) is caused by gas particles colliding with each other.

.... [1]

[Total: 5]

2 This question is about atomic structure and the Periodic Table.

(a) Define the term nucleon number.

.... [1]

(b) State the connection between the number of occupied electron shells in an atom and the period number of that element.

.... [1]

(c) Write the electronic configuration of the following atom and ion.

$^{28}_{14}Si$ ....

$^{37}_{17}Cl^{-}$ ....

[2]

(d) Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of neutrons	number of electrons
$^{23}_{11}Na$	11		
$^{19}_{9}F^{-}$	9	10	
	31	38	28

[5]

(e) A sample of thallium, Tl, contains two isotopes, ^{203}Tl and ^{205}Tl.

(i) Define the term isotopes.

....

.... [2]

(ii) The relative abundance of $^{203}Tl : ^{205}Tl$ is in the ratio 3 : 7.

Calculate the relative atomic mass of thallium in the sample to **one** decimal place.

relative atomic mass = ... [2]

(iii) Suggest why these two isotopes have identical chemical properties.

.... [1]

[Total: 14]

3 Copper(II) sulfate has the formula $CuSO_4$. Aqueous copper(II) sulfate is a blue solution.

A sample of aqueous copper(II) sulfate is made by adding excess copper(II) oxide, CuO, to hot dilute sulfuric acid, H_2SO_4.

(a) Complete the symbol equation for this reaction. Include state symbols.

$$CuO(..........) + H_2SO_4(..........) \rightarrow CuSO_4(..........) + ...(l)$$

[2]

(b) State **one** observation which shows that copper(II) oxide is added in excess.

.... [1]

(c) Describe how aqueous copper(II) sulfate can be separated from the reaction mixture.

.... [1]

(d) Crystals of hydrated copper(II) sulfate can be obtained from aqueous copper(II) sulfate by crystallisation.

(i) State what is meant by the term hydrated.

.... [1]

(ii) Write the formula of hydrated copper(II) sulfate.

.... [1]

(iii) Describe how this crystallisation is done.

....

....

.... [2]

DO NOT WRITE IN THIS MARGIN

(e) Aqueous copper(II) sulfate undergoes electrolysis using graphite electrodes.

(i) State why aqueous copper(II) sulfate conducts electricity.

.... [1]

(ii) Give **two** reasons why the electrodes are made of graphite.

1 ....

2 ....
[2]

(iii) Describe how the appearance of the electrolyte changes during the electrolysis of aqueous copper(II) sulfate.

.... [1]

(iv) Describe what is seen at the cathode during the electrolysis of aqueous copper(II) sulfate.

.... [1]

(v) Write the ionic half-equation for the reaction at the anode.

.... [3]

(vi) State **two** differences seen if the electrolysis is repeated using copper electrodes instead of graphite electrodes.

1 ....

2 ....
[2]

[Total: 18]

4 When magnesium nitrate is heated strongly, magnesium oxide is formed.

(a) The equation for this reaction is shown.

$$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$$

(i) State the change in oxidation number of nitrogen, N, in this reaction.

from .... to .... [2]

(ii) Identify the element which is oxidised in this reaction.

.... [1]

(iii) Calculate the volume of NO_2 gas, at r.t.p., formed when 7.40 g of $Mg(NO_3)_2$ is heated.

Use the following steps.

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

....

- Calculate the number of moles of $Mg(NO_3)_2$ used.

.... mol

- Determine the number of moles of NO_2 formed.

.... mol

- Calculate the volume of NO_2 gas, in cm^3, at r.t.p.

.... cm^3
[4]

DO NOT WRITE IN THIS MARGIN

(b) Magnesium oxide, MgO, is an ionic compound.

Complete the dot-and-cross diagram in Fig. 4.1 of the ions in magnesium oxide.

Give the charges on each of the ions.

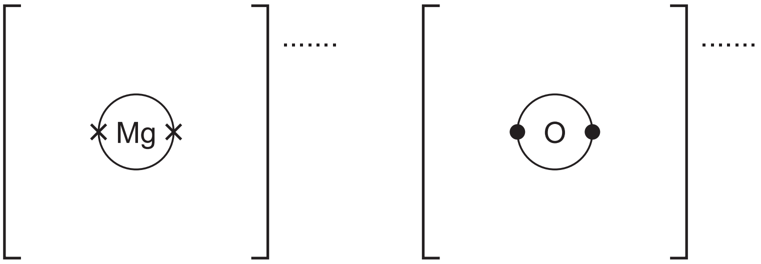

Fig. 4.1

[3]

(c) Oxygen is a covalent molecule.

Complete the dot-and-cross diagram in Fig. 4.2 of a molecule of oxygen.
The inner shells have been drawn.

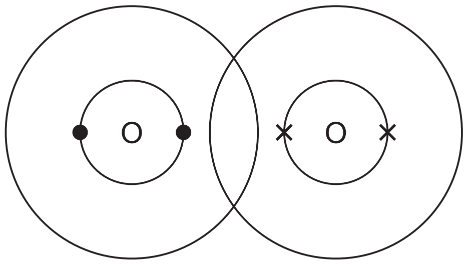

Fig. 4.2

[2]

[Total: 12]

5 Hydrogen is the first element of the Periodic Table.

(a) Hydrogen is used in fuel cells to produce electricity in vehicles.

(i) Name the substance which combines with hydrogen in a fuel cell.

.... [1]

(ii) Give **one** advantage and **one** disadvantage of using fuel cells instead of gasoline in vehicle engines.

advantage ....

disadvantage ....
[2]

(b) Hydrogen gas can be made from petroleum by a two-step procedure.

step 1 Petroleum is separated into different components.

step 2 Large molecules obtained in **step 1** are converted into smaller molecules including hydrogen gas.

(i) Name the process used in **step 1**.

.... [1]

(ii) Name the process used in **step 2**.

.... [1]

(c) Organic compounds contain hydrogen atoms.

Calculate the number of hydrogen atoms in 44.0 g of the ester methyl propanoate, $CH_3CH_2COOCH_3$.

One mole of $CH_3CH_2COOCH_3$ contains 6.02×10^{23} molecules.

Give your answer in standard form.

number of hydrogen atoms = ... [4]

(d) For each of the homologous series shown, name a member that contains **six** hydrogen atoms.

- alkanes ....
- alkenes ....
- alcohols ....
- carboxylic acids ....

[4]

(e) Unsaturated alkenes are converted into saturated alkanes by reaction with hydrogen gas.

(i) State why alkenes and alkanes are hydrocarbons.

.... [1]

(ii) State why alkenes are unsaturated.

.... [1]

(iii) Name the catalyst needed to convert alkenes into alkanes.

.... [1]

(iv) Explain why the conversion of alkenes into alkanes is an addition reaction.

.... [1]

[Total: 17]

6 Natural polyamides are polymers made from amino acid monomers.

(a) State the type of polymerisation reaction that occurs when natural polyamides form.

.... [1]

(b) State the term given to natural polyamides.

.... [1]

(c) An amino acid is represented as shown in Fig. 6.1.

Fig. 6.1

Complete Fig. 6.2 to show the general structure of an amino acid.

Show all of the atoms and all of the bonds in the functional groups.

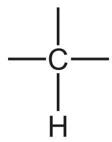

Fig. 6.2

[3]

(d) Three different amino acids are represented as shown in Fig. 6.3.

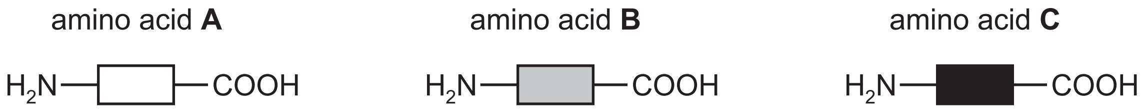

Fig. 6.3

Complete the diagram in Fig. 6.4 to show the part of the structure of the natural polyamide that forms when the three amino acids, **A**, **B** and **C**, combine.
Show all of the atoms and all of the bonds in the linkages.

Fig. 6.4

[3]

(e) A mixture of the three amino acids, **A**, **B** and **C**, can be separated and the amino acids identified using paper chromatography.

Complete the equation for R_f.

R_f =

[2]

(f) A sample of the mixture of the three amino acids, **A**, **B** and **C**, is placed onto the baseline and a chromatogram is allowed to develop as shown in Fig. 6.5.

The finished chromatogram is shown in Fig. 6.6.

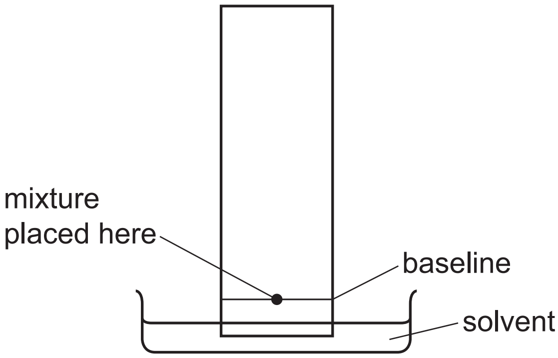

Fig. 6.5

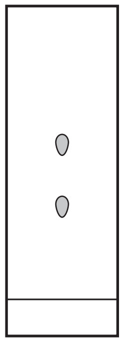

Fig. 6.6

The amino acids, **A**, **B** and **C**, are colourless. Water is used as the solvent.

(i) Explain why the baseline is drawn in pencil.

.... [1]

(ii) State the type of substance used to make the colourless amino acids visible on the chromatogram in Fig. 6.6.

.... [1]

(iii) Explain why in Fig. 6.6 only **two** spots are seen from the mixture of three amino acids.

....

.... [1]

(iv) Suggest how the experiment can be changed to separate all three amino acids.

.... [1]

[Total: 14]

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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			**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 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 –	113 Nh nihonium –	114 F*l* flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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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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)	D	**1**
1(b)	F	**1**
1(c)	C	**1**
1(d)	B **AND** C	**1**
1(e)	B	**1**

Question	Answer	Marks
2(a)	total number of protons and neutrons in the nucleus of an atom	**1**
2(b)	they are the same	**1**
2(c)	**M1** 2,8,4 **M2** 2,8,8	**2**
2(d)	**M1** 12n + 11e **M2** 10e **M3** Ga **M4** 69 above 31 and to the left of the symbol **M5** charge of 3+	**5**
2(e)(i)	**M1** atom(s) of the same element **M2** with different number of neutrons	**2**

Question	Answer	Marks
2(e)(ii)	**M1** (3 × 203) **AND** (7 × 205) (= 2044) **M2** 204.4	**2**
2(e)(iii)	same number of electrons / same electronic configuration	**1**

Question	Answer	Marks
3(a)	**M1** H_2O **M2** *state symbols:* (s) (aq) (aq)	**2**
3(b)	no more solid dissolves	**1**
3(c)	filtration	**1**
3(d)(i)	substance that is chemically combined with water	**1**
3(d)(ii)	$CuSO_4{\bullet}5H_2O$	**1**
3(d)(iii)	**M1** heat **M2** until saturation (point) **AND** allow to cool	**2**
3(e)(i)	mobile ions	**1**
3(e)(ii)	**M1** conducts electricity **M2** inert	**2**
3(e)(iii)	becomes lighter (blue)	**1**
3(e)(iv)	pink **AND** solid	**1**

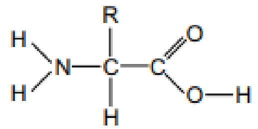
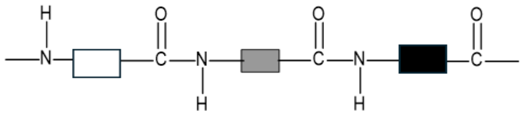
Question	Answer	Marks
3(e)(v)	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ **M1** O_2 as a product **M2** OH^- **AND** e^- **M3** correct equation	**3**
3(e)(vi)	one mark each for any two of: • colour remains constant • no bubbles at the anode • anode dissolves	**2**

Question	Answer	Marks
4(a)(i)	**M1** +5 **M2** +4	**2**
4(a)(ii)	oxygen	**1**
4(a)(iii)	**M1** M_r of $Mg(NO_3)_2$ = 148 **M2** mol of $Mg(NO_3)_2$ = 7.40 / 148 = 0.05(00) (mol) **M3** mol of NO_2 = 0.05(00) × 4 / 2 = 0.1(00) (mol) **M4** volume of NO_2 = 0.1(00) × 24 000 = 2400 (cm^3)	**4**

Question	Answer	Marks
4(b)	**M1** eight crosses in second shell of Mg **M2** six dots and two crosses in second shell of O **M3** ‘2+’ charge on Mg ion on correct answer line **AND** ‘2–’ charge on O ion on correct answer line	**3**
4(c)	**M1** two dot-cross pairs as a double bond **M2** four non-bonding electrons on each O	**2**

Question	Answer	Marks
5(a)(i)	oxygen	**1**
5(a)(ii)	*advantage:* any one of: • water is the only product • no carbon dioxide produced • more efficient *disadvantage:* any one of: • hydrogen needs to be stored at high pressure • hydrogen hard to store • heavy tanks needed to store hydrogen • fewer (hydrogen) filling stations • less efficient	**2**
5(b)(i)	fractional distillation	**1**
5(b)(ii)	cracking	**1**

Question	Answer	Marks
5(c)	**M1** M_r of $CH_3CH_2COOCH_3$ = 88 **M2** mol of $CH_3CH_2COOCH_3$ = 44 / 88 = 0.5 **M3** mol of H = 0.5 × 8 = 4.0 **M4** no of H atoms = 4.0 × 6.02 × 10^{23} = 2.408 × 10^{24}	**4**
5(d)	**M1** ethane **M2** propene **M3** ethanol **M4** propanoic acid	**4**
5(e)(i)	contain carbon and hydrogen atoms **only**	**1**
5(e)(ii)	they have a carbon-carbon double bond	**1**
5(e)(iii)	nickel	**1**
5(e)(iv)	only one product is formed	**1**

Question	Answer	Marks
6(a)	condensation	**1**
6(b)	proteins	**1**
6(c)	 (3) **M1** NH_2 group displayed **M2** COOH group displayed **M3** use of R	**3**
6(d)	 **M1** correct amide link between any two blocks showing all atoms and all bonds **M2** identical orientation of inter-block amide links including terminal groups with correct orientation **M3** continuation bonds on polymer	**3**
6(e)	**M1** <u>distance travelled by substance</u> **M2** distance travelled by solvent	**2**
6(f)(i)	pencil is insoluble (in solvent)	**1**
6(f)(ii)	locating agent	**1**
6(f)(iii)	same R_f value	**1**
6(f)(iv)	use a different solvent	**1**

Cambridge Assessment International Education

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2024**

45 minutes

You must answer on the multiple choice answer sheet.

3385665207

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 A sample of ethanol is left in an open beaker at room temperature.

After 24 hours, no ethanol remains in the beaker.

What has happened to the ethanol?

A It has boiled.

B It has condensed.

C It has evaporated.

D It has frozen.

2 A gas is in a sealed container with a fixed volume.

Which statements describe what happens to the molecules in the gas when the temperature is increased?

1 They move more slowly.

2 They collide with the walls of the container more frequently.

3 They collide with the walls of the container with less force.

4 They have greater kinetic energy.

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

3 What happens when sodium atoms combine with chlorine atoms to form sodium chloride?

A Sodium atoms each gain one electron, and chlorine atoms each lose one electron.

B Sodium atoms each lose one electron, and chlorine atoms each gain one electron.

C Sodium atoms and chlorine atoms share one electron with each other.

D Sodium atoms and chlorine atoms share two electrons with each other.

4 The table shows some properties of four substances.

substance	melting point	electrical conductivity when solid	electrical conductivity when molten
1	high	poor	poor
2	high	poor	good
3	low	poor	poor
4	high	good	good

Which substances are ionic?

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

5 Which statement about methane is correct?

A In methane, positive hydrogen ions are attracted to negative carbon ions.

B In methane, electrons are shared between carbon atoms and hydrogen atoms.

C Methane has a high boiling point.

D Methane is a good conductor of electricity.

6 A sample of iridium has a relative atomic mass of 192.29.

The sample contains two isotopes only.

64.50% of the sample is ^{193}Ir.

What is the other isotope in the sample?

A ^{189}Ir **B** ^{190}Ir **C** ^{191}Ir **D** ^{192}Ir

7 Ammonium iron(III) citrate contains in its formula:

- more than one ammonium ion
- one iron ion
- two $C_6H_4O_7^{4-}$ ions.

What is the formula of ammonium iron(III) citrate?

A $(NH_4)_4Fe(C_6H_4O_7)_2$

B $(NH_4)_5Fe(C_6H_4O_7)_2$

C $(NH_4)_6Fe(C_6H_4O_7)_2$

D $(NH_4)_7Fe(C_6H_4O_7)_2$

8 Silicon(IV) oxide reacts with chlorine and carbon to form liquid silicon(IV) chloride, $SiCl_4$, and carbon dioxide gas.

If the reaction is carried out at r.t.p., which symbol equation represents this reaction?

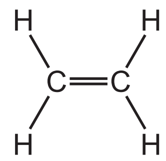
A $SiO_2(l) + 2Cl_2(g) + C(s) \rightarrow SiCl_4(l) + CO_2(g)$

B $SiO_2(l) + 2Cl_2(g) + C(g) \rightarrow SiCl_4(l) + CO_2(g)$

C $SiO_2(s) + 2Cl_2(g) + C(s) \rightarrow SiCl_4(g) + CO_2(g)$

D $SiO_2(s) + 2Cl_2(g) + C(s) \rightarrow SiCl_4(l) + CO_2(g)$

9 The structure of ethene is shown.



How many hydrogen atoms and how many carbon atoms are in one mole of ethene?

	hydrogen atoms	carbon atoms
A	2.4×10^{24}	1.2×10^{24}
B	2.4×10^{24}	6.0×10^{23}
C	6.0×10^{23}	1.2×10^{22}
D	6.0×10^{23}	6.0×10^{23}

10 A known volume and concentration of aqueous sodium hydroxide is titrated against dilute hydrochloric acid.

The volume of dilute hydrochloric acid needed to exactly neutralise the sodium hydroxide is measured.

Five calculation steps are shown.

1 Calculate the amount of hydrochloric acid in moles.

2 Calculate the relative formula mass of hydrochloric acid.

3 Calculate the concentration of hydrochloric acid in g/dm^3.

4 Calculate the amount of sodium hydroxide in moles.

5 Calculate the concentration of hydrochloric acid in mol/dm^3.

What is the order of these steps to calculate the concentration of the hydrochloric acid in g/dm^3?

A $1 \rightarrow 4 \rightarrow 3 \rightarrow 5 \rightarrow 2$

B $1 \rightarrow 2 \rightarrow 4 \rightarrow 5 \rightarrow 3$

C $4 \rightarrow 1 \rightarrow 5 \rightarrow 2 \rightarrow 3$

D $4 \rightarrow 2 \rightarrow 1 \rightarrow 3 \rightarrow 5$

11 Two different substances are electrolysed using inert electrodes in two separate experiments.

Hydrogen is produced in both experiments.

Which row identifies the two substances and the electrode at which hydrogen is produced?

	substance 1	substance 2	electrode
A	molten sodium chloride	aqueous sodium chloride	anode
B	molten sodium chloride	aqueous sodium chloride	cathode
C	dilute sulfuric acid	concentrated hydrochloric acid	anode
D	dilute sulfuric acid	concentrated hydrochloric acid	cathode

12 Aqueous copper(II) sulfate can be electrolysed using either carbon electrodes or copper electrodes.

Which statement describes what happens at the positive electrode?

A Copper is deposited if the electrode is made from carbon.

B Copper is deposited if the electrode is made from copper.

C Oxygen gas is produced if the electrode is made from carbon.

D Oxygen gas is produced if the electrode is made from copper.

13 Which statement about a hydrogen–oxygen fuel cell is **not** correct?

A Chemical energy is converted into electrical energy.

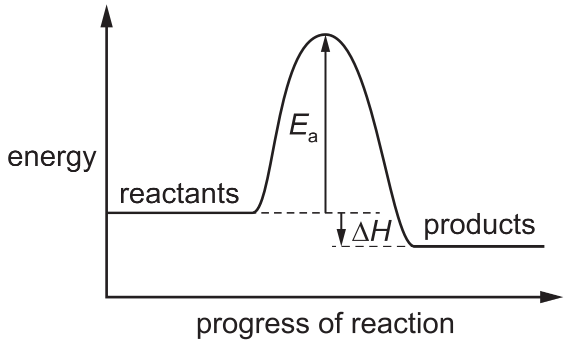
B Hydrogen is oxidised.

C The reaction that takes place is endothermic.

D Water is the only chemical product.

14 Which reaction pathway diagram is correctly labelled?

A



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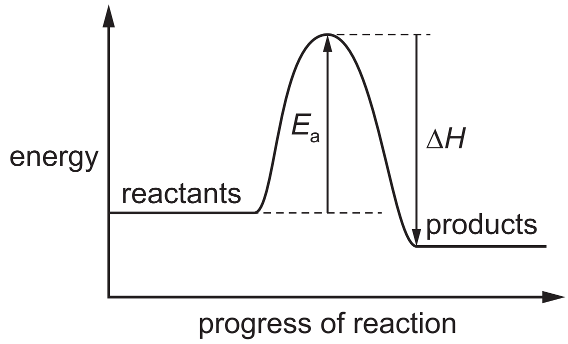

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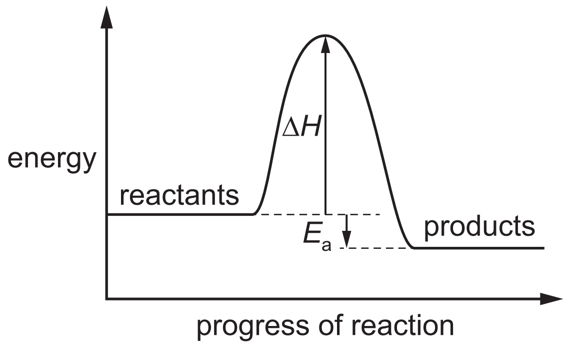
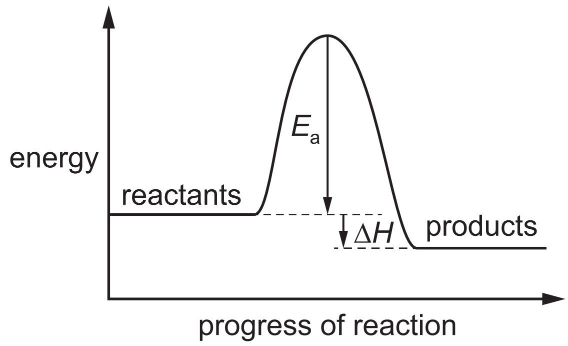


D



15 Which row describes a reaction where the overall energy change is exothermic?

	energy needed for breaking bonds / kJ	energy released by forming bonds / kJ	temperature of the surroundings
A	600	300	decreases
B	600	1200	decreases
C	900	300	increases
D	900	1200	increases

16 Which process involves a physical change only?

A heating calcium carbonate strongly

B burning wood

C melting an ice cube

D mixing an acid and a base

17 In the Haber process, an equilibrium is established.

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

The forward reaction is exothermic.

Which change to the reaction conditions will move the position of equilibrium to the left?

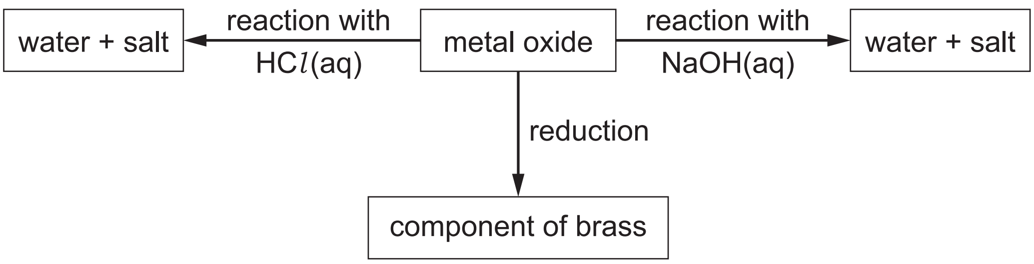
A decreasing the pressure by 100 atm

B decreasing the temperature by 100 °C

C adding more nitrogen gas to the mixture

D removing the iron catalyst

18 The flow chart shows some properties of a metal oxide.



What is the metal oxide?

A aluminium oxide

B copper(II) oxide

C iron(III) oxide

D zinc oxide

19 Which statement about reactants in redox reactions is correct?

A An oxidising agent donates electrons, and a reducing agent accepts electrons.

B When one element gains electrons, the oxidation number of a different element increases.

C When the oxidation number of one element increases, a different element gains oxygen.

D When the oxidation number of one element increases, a different element loses electrons.

20 Aluminium is extracted from aluminium oxide by electrolysis. The ionic half-equation for the reaction at one of the electrodes is shown.

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

Which row describes the change in oxidation number of the aluminium and the type of reaction at this electrode?

	change in oxidation number of aluminium	type of reaction
A	decrease	reduction
B	decrease	oxidation
C	increase	reduction
D	increase	oxidation

21 Which statement about dilute hydrochloric acid is correct?

A It is a strong acid as it fully dissociates.

B It is a strong acid as it partially dissociates.

C It is a weak acid as it fully dissociates.

D It is a weak acid as it partially dissociates.

22 Which row describes and gives the formula of hydrated copper(II) sulfate?

	description of hydrated copper(II) sulfate	formula of hydrated copper(II) sulfate
A	aqueous copper(II) sulfate	$CuSO_4{\bullet}5H_2O$
B	aqueous copper(II) sulfate	$CuSO_4(aq)$
C	copper(II) sulfate chemically combined with water molecules	$CuSO_4(aq)$
D	copper(II) sulfate chemically combined with water molecules	$CuSO_4{\bullet}5H_2O$

23 The equations for three reactions are shown.

1 $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

2 $2AgNO_3(aq) + CuI_2(aq) \rightarrow Cu(NO_3)_2(aq) + 2AgI(s)$

3 $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

Which reactions are suitable for making a salt by precipitation?

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

24 Acidified potassium dichromate(VI), $K_2Cr_2O_7$, is used to oxidise ethanol, C_2H_5OH.

The ionic equation for the reaction is shown.

$$3C_2H_5OH + 2Cr_2O_7^{2-} + 16H^+ \rightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O$$

Which properties of transition elements are shown by chromium in this reaction?

	acts as a catalyst	variable oxidation number
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

25 Which statements describe the Periodic Table?

1 The elements are arranged in order of their nucleon number.

2 The elements are arranged in order of their proton number.

3 It is used to predict the properties of elements.

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

26 Which row shows the correct order of reactivity of the four named metals?

	most reactive	→		least reactive
A	magnesium	copper	zinc	silver
B	magnesium	zinc	copper	silver
C	silver	copper	zinc	magnesium
D	silver	zinc	copper	magnesium

27 Four iron nails are added to four different metal sulfate solutions.

In which solution does a displacement reaction occur?

A copper(II) sulfate

B magnesium sulfate

C sodium sulfate

D zinc sulfate

28 A fertiliser contains ammonium nitrate and potassium phosphate.

Why is the fertiliser described as an NPK fertiliser?

A It provides nitrogen, which is an essential element for improved plant growth.

B It contains the element oxygen, which neutralises acidic soil.

C It contains the elements nitrogen and phosphorus.

D It provides the three main elements needed for improved plant growth.

29 What are the approximate percentages of oxygen and nitrogen in clean, dry air?

	percentage of oxygen	percentage of nitrogen
A	19	80
B	21	78
C	80	19
D	78	21

30 Which compounds have similar chemical properties?

A butanol and butanoic acid

B ethane and ethene

C methane and butane

D propene and propanol

31 Four statements about organic compounds P, Q, R and S are listed.

P is a saturated hydrocarbon.

The formula of Q is CH_3CH_3.

A molecule of R contains only one oxygen atom.

Compound S is a carboxylic acid.

Which statement about these compounds is correct?

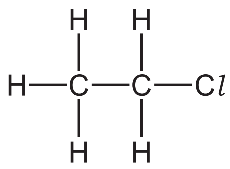
A P and Q are members of different homologous series.

B P and S are members of the same homologous series.

C Q and S are members of the same homologous series.

D Q, R and S are all members of different homologous series.

32 The structure of an organic compound is shown.



What is the name of the compound?

A chloroethane

B chloroethene

C chloroethanol

D chloroethanoic acid

33 Which statement about the manufacture of ethene from larger alkane molecules is correct?

A A low temperature is required.

B The process is called cracking.

C The process requires an excess of oxygen.

D Water is also a product.

34 Which processes are used to make ethanoic acid?

1 heating ethanol with acidified aqueous potassium manganate(VII)

2 bacterial oxidation of ethanol

3 distilling ethanol using a fractionating column

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

35 Which statement about propene, C_3H_6, is correct?

A Propene reacts with bromine in the dark in a substitution reaction.

B Propene reacts with steam in the presence of an alkaline catalyst, forming an alcohol.

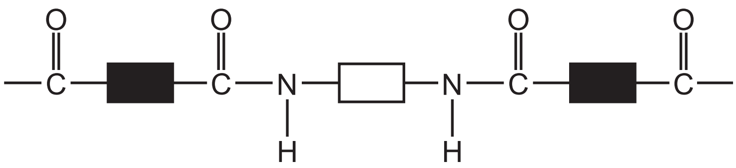
C Propene undergoes addition polymerisation, forming poly(ethene).

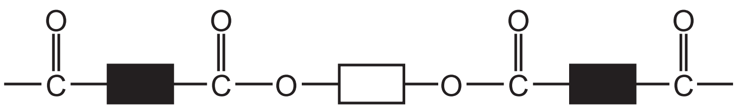
D Propene undergoes an addition reaction to form an alkane.

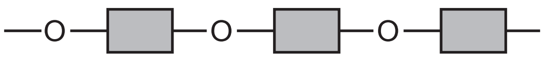
36 How many of each type of bond are present in ethanoic acid, CH_3COOH?

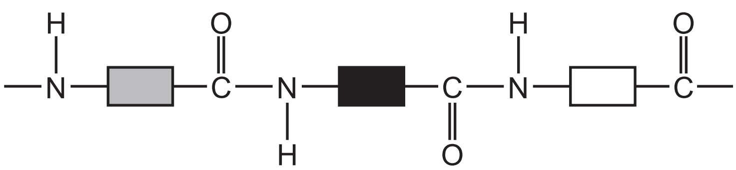
	type of bond		
	C–H	C–C	C=O
A	3	1	1
B	3	0	2
C	4	0	2
D	4	1	2

37 Which diagram represents the structure of a protein?

A 

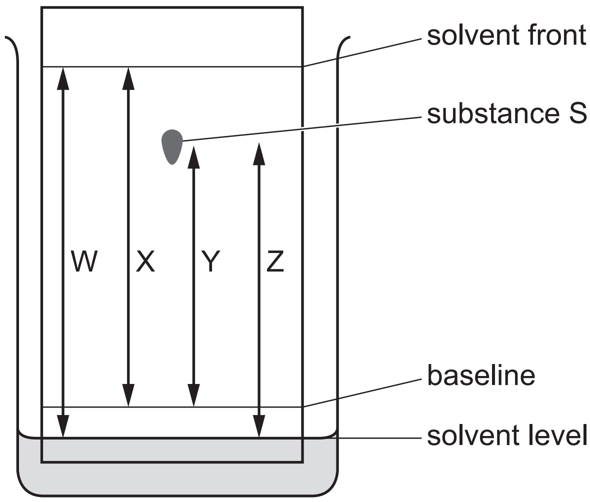
B 

C 

D 

38 The chromatogram of substance S is shown.

Some distances, W, X, Y and Z, are labelled on the diagram.



How is the R_f value of substance S calculated?

A $\frac{X}{Y}$ **B** $\frac{W}{Z}$ **C** $\frac{Y}{X}$ **D** $\frac{Y}{W}$

39 Some information about solid silver chloride and solid sodium chloride is shown.

- Silver chloride and sodium chloride do **not** dissolve in kerosene.
- Silver chloride is insoluble in water, but sodium chloride is soluble in water.
- The boiling point of silver chloride is 1547 °C and the boiling point of sodium chloride is 1413 °C.

Which processes are used to separate a mixture of solid silver chloride and solid sodium chloride?

A add kerosene, stir and then filter

B add water, stir and then filter

C add water, stir and then leave to crystallise

D add water, stir and then perform fractional distillation

40 Which statement describes how a flame test is done?

A The tip of a clean wire is dipped into the substance and the wire is placed in a blue Bunsen burner flame.

B The tip of a clean wire is dipped into the substance and the wire is placed in a yellow Bunsen burner flame.

C A wooden splint is lit and is placed above a test-tube containing the gas being tested.

D A wooden splint is lit, blown out and the glowing splint put into a test-tube of the gas being tested.

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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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Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2024**

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.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2024**

45 minutes

You must answer on the multiple choice answer sheet.

* 5 7 3 2 5 6 8 8 7 3 *

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

INSTRUCTIONS

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1 Oxygen melts at –219 °C and boils at –183 °C.

At which temperature is oxygen a liquid?

A –225 °C **B** –189 °C **C** –175 °C **D** 25 °C

2 The pressure of a sample of gas is decreased. The temperature is kept constant.

Which row describes the effects on the particles?

	movement of particles	collisions between particles
A	slower	occur less often
B	slower	occur with more force
C	no change in speed	occur less often
D	no change in speed	occur with more force

3 Rubidium has two isotopes, $^{85}_{37}Rb$ and $^{87}_{37}Rb$.

Which statement explains why both isotopes have the same chemical properties?

A They have the same number of protons.

B They have the same electronic configuration.

C They have different numbers of neutrons.

D They have different mass numbers.

4 Which pair of elements react to form a compound with a strong attraction between oppositely charged ions?

A carbon and bromine

B carbon and nitrogen

C sodium and oxygen

D sodium and potassium

5 Four substances, P, Q, R and S, are described.

- P is diatomic.
- Q is a good conductor of electricity when solid and when molten.
- R is a silver solid with a very high melting point.
- S reacts with oxygen to form a brown gas.

Which substances are metals?

A P and Q **B** P and S **C** Q and R **D** R and S

6 Which diagram shows the covalent bonding in a molecule of carbon dioxide?

A O–C–O **B** O=C–O **C** O=C=O **D** O≡C≡O

7 The bonding, structure and melting point of sodium chloride and sulfur dichloride are shown.

compound	bonding	structure	melting point / °C
sodium chloride	ionic	giant lattice	801
sulfur dichloride	covalent	simple molecular	–121

Why does sulfur dichloride have a lower melting point than sodium chloride?

A The covalent bonds in sulfur dichloride are weaker than the attractive forces between molecules in sodium chloride.

B The covalent bonds in sulfur dichloride are weaker than the ionic bonds in sodium chloride.

C The attractive forces between molecules in sulfur dichloride are weaker than the attractive forces between molecules in sodium chloride.

D The attractive forces between molecules in sulfur dichloride are weaker than the ionic bonds in sodium chloride.

8 Diamond and graphite have giant covalent structures of carbon atoms.

Which statement describes graphite?

A It has a strong, rigid three-dimensional structure.

B It has four strong covalent bonds between each carbon atom.

C It has layers, which can slide over each other.

D It has no delocalised electrons so does **not** conduct electricity.

9 Which row explains the malleability and electrical conductivity of a solid metal?

	malleability	electrical conductivity
A	Delocalised electrons can move freely through the structure.	Delocalised electrons can move freely through the structure.
B	Delocalised electrons can move freely through the structure.	Positive ions can move freely through the structure.
C	Rows of positive ions can slide over each other.	Delocalised electrons can move freely through the structure.
D	Rows of positive ions can slide over each other.	Positive ions can move freely through the structure.

10 The equation for the decomposition of ammonium carbonate, $(NH_4)_2CO_3$, is shown.

$$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + CO_2(g) + H_2O(l)$$

[M_r: $(NH_4)_2CO_3$, 96]

The **total** volume of gas produced is 360 cm^3 at r.t.p.

Which mass of ammonium carbonate, $(NH_4)_2CO_3$, is decomposed?

A 0.24 g **B** 0.48 g **C** 0.96 g **D** 1.44 g

11 What is the empirical formula of a compound that contains 3.66 g of hydrogen, 37.8 g of phosphorus and 58.5 g of oxygen?

A $H_6P_2O_6$ **B** H_4PO_4 **C** H_3PO_3 **D** HPO

12 Aqueous copper(II) sulfate is electrolysed using graphite electrodes.

Which row identifies the product and observations at each electrode during the electrolysis?

	anode		cathode	
	product	observation	product	observation
A	oxygen	bubbles of gas	copper	electrode turns pink
B	copper	electrode turns pink	oxygen	bubbles of gas
C	none	electrode dissolves	copper	electrode turns pink
D	oxygen	bubbles of gas and electrode dissolves	hydrogen	bubbles of gas

13 Molten sodium chloride is electrolysed using inert electrodes.

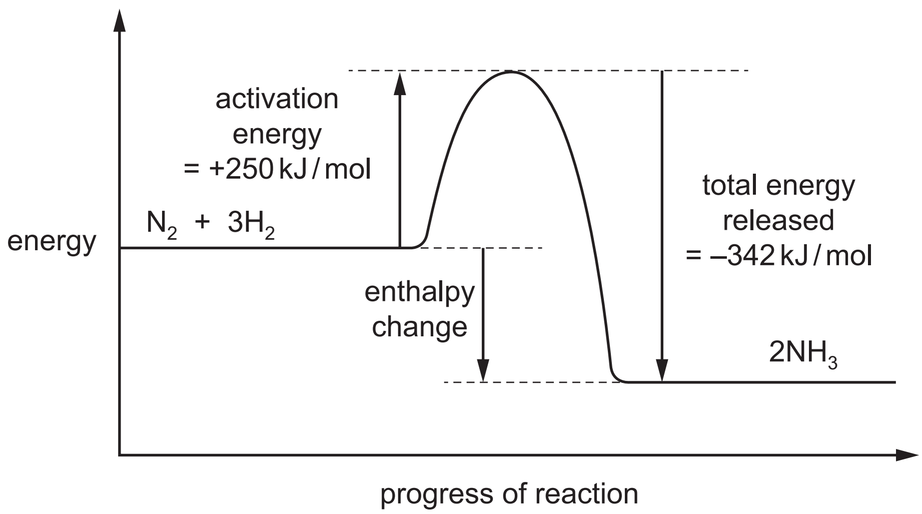
Which row shows the products formed at the cathode and anode?

	cathode	anode
A	chlorine	hydrogen
B	chlorine	sodium
C	hydrogen	chlorine
D	sodium	chlorine

14 The equation for the formation of ammonia is shown.

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

The reaction pathway diagram for the reaction is shown.



What is the enthalpy change for the reaction?

A –592 kJ / mol

B –92 kJ / mol

C +92 kJ / mol

D +592 kJ / mol

15 Sulfur dioxide is converted to sulfur trioxide in the Contact process.

The conditions used are 450 °C and 200 kPa with a vanadium(V) oxide catalyst.

Which row describes and explains the effect of changing conditions on the rate of reaction?

	change in conditions	effect on rate	explanation
A	no catalyst	lower	the activation energy is higher
B	higher pressure	higher	the particles have more kinetic energy
C	lower temperature	lower	the particles collide more frequently
D	lower pressure	higher	there are more particles per unit volume

16 Hydrogen gas reacts with iodine gas to form hydrogen iodide gas in an equilibrium reaction.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +26.5\,kJ/mol$$

Which changes increase the yield of HI at equilibrium?

1 adding a catalyst

2 adding more hydrogen gas

3 increasing the pressure

4 increasing the temperature

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

17 The equation for the reaction of carbon with carbon dioxide is shown.

$$C + CO_2 \rightarrow 2CO$$

Which row identifies the carbon atom that is reduced and its change in oxidation number?

	atom that is reduced	change in oxidation number
A	carbon in CO_2	$+2 \rightarrow +4$
B	carbon in CO_2	$+4 \rightarrow +2$
C	elemental carbon, C	$0 \rightarrow +2$
D	elemental carbon, C	$+2 \rightarrow 0$

18 Aqueous iron(II) sulfate is added to acidified potassium manganate(VII). The purple colour of the potassium manganate(VII) disappears.

Aqueous potassium iodide is added to acidified potassium dichromate(VI). A dark brown solution forms.

Which row identifies the role of the iron(II) sulfate and the potassium dichromate(VI) in these reactions?

	iron(II) sulfate	potassium dichromate(VI)
A	oxidising agent	oxidising agent
B	oxidising agent	reducing agent
C	reducing agent	reducing agent
D	reducing agent	oxidising agent

19 Which row shows the difference between a weak acid and a strong acid?

	weak acid	strong acid
A	fully dissociated	partially dissociated
B	concentrated	dilute
C	dilute	concentrated
D	partially dissociated	fully dissociated

20 Which substance turns methyl orange red?

A aqueous ammonia

B dilute hydrochloric acid

C aqueous sodium hydroxide

D distilled water

21 Which row describes zinc oxide and calcium oxide?

	zinc oxide	calcium oxide
A	basic	acidic
B	acidic	basic
C	amphoteric	acidic
D	amphoteric	basic

22 Which row shows the properties of a transition element?

	catalyst	colour of oxide	electrical conductivity
A	yes	red	good
B	yes	green	poor
C	no	yellow	good
D	no	white	poor

23 Fluorine is the element at the top of Group VII of the Periodic Table.

Which statement describes fluorine?

A It is inert.

B It is monatomic.

C It is non-metallic.

D It is a solid at room temperature.

24 When aluminium is placed in dilute hydrochloric acid, there is no reaction.

When zinc is placed in dilute hydrochloric acid, bubbles of gas are immediately given off.

Which statement correctly explains these observations?

A Aluminium is coated with a layer of aluminium oxide.

B Aluminium is more reactive than hydrogen.

C Aluminium is less reactive than zinc.

D Zinc is less reactive than hydrogen.

25 Which statements about the use of sacrificial protection to prevent iron from rusting are correct?

1 A more reactive metal than iron is used as a sacrificial protector because it undergoes reduction before iron.

2 Zinc is used as a sacrificial protector because it gains electrons more readily than iron.

3 Copper is **not** used as a sacrificial protector because it is less reactive than iron.

4 Magnesium is used as a sacrificial protector because it loses electrons more readily than iron.

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

26 Aluminium is extracted from its ore by electrolysis.

What is the role of cryolite in this process?

A to lower the operating temperature

B to lower the boiling point of bauxite

C to raise the melting point of bauxite

D to act as a catalyst

27 Which row identifies two greenhouse gases and three processes by which they contribute to global warming?

	two greenhouse gases	three processes
A	carbon dioxide and methane	absorption, creation and reflection of thermal energy
B	carbon dioxide and oxygen	absorption, creation and reflection of thermal energy
C	carbon dioxide and methane	absorption, emission and reflection of thermal energy
D	methane and oxygen	absorption, emission and reflection of thermal energy

28 Which mixture contains all of the elements in a typical NPK fertiliser?

A ammonium nitrate and calcium phosphate

B ammonium phosphate and potassium chloride

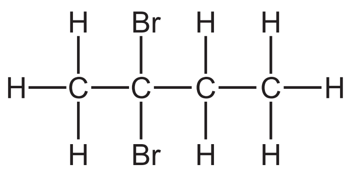
C potassium nitrate and ammonium chloride

D potassium carbonate and ammonium nitrate

29 Bromine reacts with but-2-ene.

What is the displayed formula of the product of this reaction?

A



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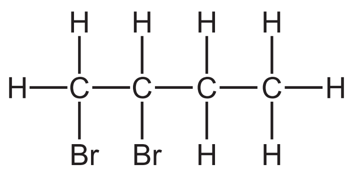

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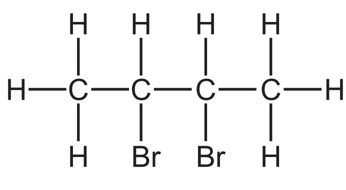

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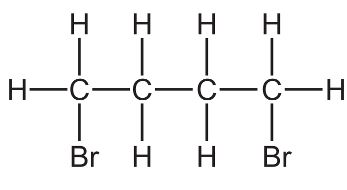


30 Which statement is correct?

A Bitumen is used as a fuel for ships.

B Coal, natural gas and oxygen are all fuels.

C Hydrogen is the main constituent of natural gas.

D Petroleum is separated into useful substances by fractional distillation.

31 Which statement explains why ethanoic acid is saturated?

A The molecule dissociates completely in water.

B There is a carbon–oxygen double bond in the molecule.

C The carbon–carbon bond in the molecule is a single bond.

D All the carbon–hydrogen bonds in the molecule are single bonds.

32 Which statement about compounds in the same homologous series is correct?

A They have the same chemical properties because they have the same number of carbon atoms.

B They have the same physical properties because they have the same number of carbon atoms.

C They have different chemical properties because they have different numbers of carbon atoms.

D They have different physical properties because they have different numbers of carbon atoms.

33 Which row shows the properties of methane?

	soluble in water	state at room temperature	gives a positive test with aqueous bromine
A	no	gas	no
B	no	gas	yes
C	yes	liquid	no
D	yes	liquid	yes

34 The table shows two methods used to make ethanol.

method	type of process	conditions			source of raw material
		temperature / °C	pressure / atm	catalyst	
fermentation	batch	35	1	yeast	sugar cane
adding steam to ethene	continuous	300	60	acid	petroleum

Which statement gives an advantage of preparing ethanol by fermentation rather than by adding steam to ethene?

A Fermentation takes several days to complete.

B Little energy is used in the fermentation process.

C The fermentation of glucose from sugar cane produces pure ethanol.

D Fermentation uses a non-renewable raw material.

35 Which equation represents an addition reaction?

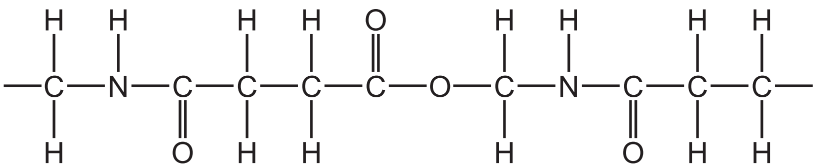
A $CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$

B $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

C $NH_4Br \rightarrow NH_3 + HBr$

D $C_{14}H_{30} \rightarrow C_2H_4 + C_8H_{18} + C_4H_8$

36 The structure of part of a polymer is shown.

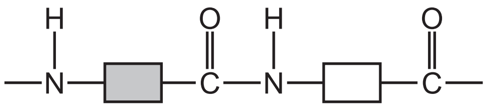


How many amide and ester linkages are included in the structure shown?

	amide linkages	ester linkages
A	1	0
B	1	1
C	2	1
D	2	2

37 Which structure represents part of a protein?

A



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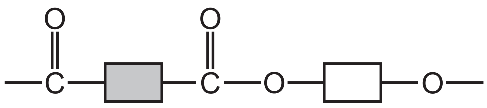

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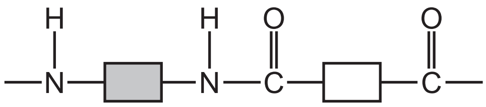

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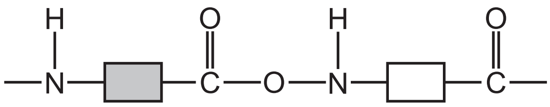

38 Which piece of apparatus can only measure a single fixed volume?

A a 250 cm^3 beaker

B a 50 cm^3 burette

C a 100 cm^3 measuring cylinder

D a 25 cm^3 volumetric pipette

39 Pure solid copper(II) nitrate can be obtained from a mixture of copper(II) nitrate and copper powder.

Three stages in the method are listed.

X add water and stir

Y crystallise

Z filter

After the three stages, the copper(II) nitrate is washed and dried.

What is the correct order of stages X, Y and Z to obtain pure solid copper(II) nitrate from the mixture?

A $X \rightarrow Y \rightarrow Z$ **B** $X \rightarrow Z \rightarrow Y$ **C** $Y \rightarrow X \rightarrow Z$ **D** $Z \rightarrow X \rightarrow Y$

40 Which row describes a test and the observation for aqueous sulfate ions?

	test	observation
A	add dilute nitric acid	a gas is produced which turns limewater cloudy
B	add dilute nitric acid and aqueous barium nitrate	white precipitate forms
C	add dilute nitric acid and aqueous potassium manganate(VII)	solution decolourises
D	add dilute nitric acid and aqueous silver nitrate	white precipitate forms

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

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7	D	**1**
8	C	**1**
9	C	**1**
10	B	**1**
11	C	**1**
12	A	**1**
13	D	**1**
14	B	**1**
15	A	**1**
16	D	**1**
17	B	**1**
18	D	**1**
19	D	**1**
20	B	**1**
21	D	**1**
22	A	**1**
23	C	**1**
24	A	**1**
25	D	**1**
26	A	**1**
27	C	**1**
28	B	**1**

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

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IB24 11_0620_21/6RP

1 Which row describes the arrangement and motion of the particles in a liquid?

	arrangement	motion
A	random and particles are touching	moving slowly
B	random with space between all particles	moving slowly
C	an ordered lattice with all particles touching	moving slowly
D	an ordered lattice with space between all particles	moving quickly

2 Which gas has the lowest rate of diffusion at room temperature and pressure?

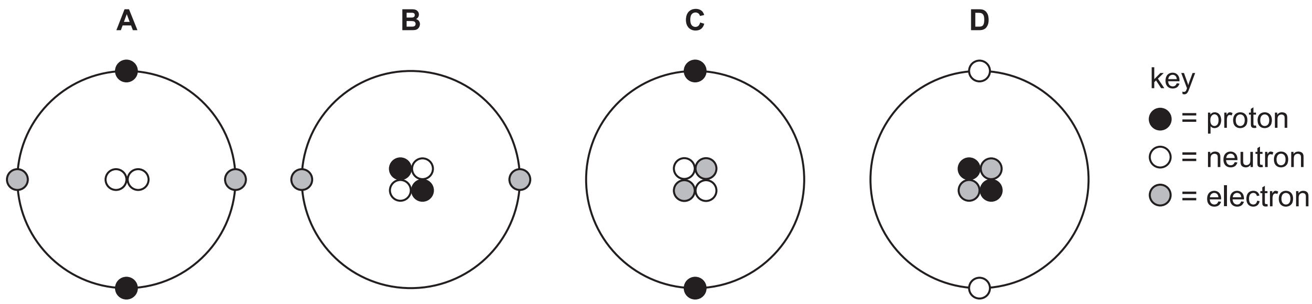
A the gas produced when ammonium chloride is heated with aqueous sodium hydroxide

B the gas which makes up approximately 78% of clean, dry air

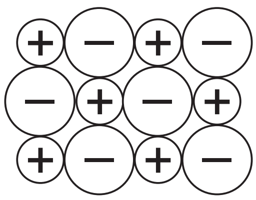
C the gas produced when sodium carbonate is added to dilute hydrochloric acid

D the gas produced when zinc is added to dilute sulfuric acid

3 Which diagram represents one helium atom?



4 The diagram shows part of an ionic lattice structure.



Which compound does the diagram represent?

A potassium bromide

B sodium oxide

C magnesium chloride

D carbon monoxide

5 Which statement about nitrogen molecules and ethene molecules is correct?

A A nitrogen molecule has 2 more shared electrons than an ethene molecule.

B An ethene molecule has 3 more shared electrons than a nitrogen molecule.

C A nitrogen molecule has 4 more shared electrons than an ethene molecule.

D An ethene molecule has 6 more shared electrons than a nitrogen molecule.

6 Sulfur is a simple molecule with the formula S_8.

Which row describes and explains the melting point of sulfur?

	melting point	explanation
A	high	the covalent bonds between sulfur atoms are strong
B	high	the covalent bonds between sulfur molecules are strong
C	low	the forces of attraction between sulfur atoms are weak
D	low	the forces of attraction between sulfur molecules are weak

7 Which row identifies a property and an explanation of the property for both diamond and silicon(IV) oxide?

	property	explanation of property
A	very hard	diamond has a giant covalent structure and silicon(IV) oxide has a giant ionic structure
B	high melting point	both have giant covalent structures with many strong bonds between the atoms
C	good lubricant	both have layers of atoms, which can slide over each other
D	poor conductor	both contain only non-metal elements and are simple molecules

8 Which statement about the structure of metals explains why metals are malleable?

A The electrons can move freely throughout the lattice.

B The layers of metal ions can slide over each other.

C The metal ions are positively charged.

D There is a strong force of attraction between the metal ions and the electrons.

9 What is the formula of iron(III) oxide?

A FeO **B** Fe_3O_4 **C** FeO_2 **D** Fe_2O_3

10 Calcium carbonate is heated. Calcium oxide and carbon dioxide gas are formed.

The equation for the reaction is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

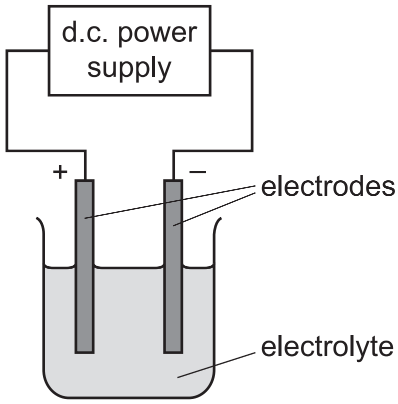
225 kg of calcium carbonate is heated until there is no further change in mass.

The yield of calcium oxide is 85 kg.

What is the percentage yield?

A 37.8% **B** 47.2% **C** 67.5% **D** 85.0%

11 The apparatus used for electrolysis is shown.



Which statement is correct?

A Copper forms at the anode in some electrolysis reactions.

B Hydrogen forms at the cathode in some electrolysis reactions.

C Oxygen forms at the cathode in some electrolysis reactions.

D Sodium forms at the anode in some electrolysis reactions.

12 Which statement about the electrolysis of aqueous copper(II) sulfate is correct?

A When copper electrodes are used, the solution turns from blue to colourless.

B When graphite electrodes are used, bubbles of gas are formed at the cathode.

C When copper electrodes are used, the anode gets smaller.

D When graphite electrodes are used, the colour of the solution does **not** change.

13 Which statement describes an advantage of using a hydrogen–oxygen fuel cell in a car compared to a gasoline engine?

A The hydrogen is difficult to store.

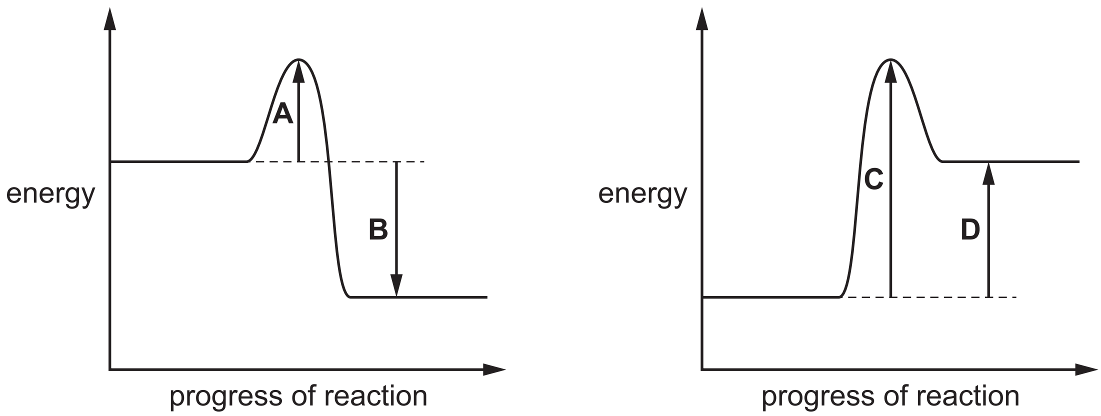
B The hydrogen is highly flammable.

C The hydrogen used is made from hydrocarbons.

D The only chemical product is water.

14 Two reaction pathway diagrams are shown.

Which arrow represents the activation energy for a reaction which releases thermal energy?



15 Which statements about the Haber process are correct?

1 A high temperature is used because the reaction is slow at room temperature.

2 A high pressure is used because there are more moles of gaseous reactants than moles of gaseous product.

3 A nickel catalyst is used to increase the rate of reaction.

4 An iron catalyst is used to increase the equilibrium yield of ammonia.

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

16 Which substance is a raw material used to manufacture sulfuric acid?

A vanadium(V) oxide

B sulfur

C sulfur dioxide

D sulfur trioxide

17 Which colours are seen when litmus and methyl orange are added to separate samples of aqueous sodium hydroxide?

	litmus	methyl orange
A	blue	orange
B	blue	yellow
C	purple	orange
D	purple	yellow

18 Information about the solubility in water of four oxides is shown.

Which oxide, when added to water, gives a solution with a pH less than pH 7?

	name of oxide	solubility in water
A	nitrogen dioxide	soluble
B	copper(II) oxide	insoluble
C	silicon(IV) oxide	insoluble
D	barium oxide	soluble

19 Copper(II) sulfate is made when copper(II) carbonate reacts with dilute sulfuric acid.

$$CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$$

Pure copper(II) sulfate crystals are obtained.

Which reagent is in excess and how are the crystals obtained?

	reagent in excess	how the crystals are obtained
A	copper(II) carbonate	filter and evaporate the solution to dryness
B	copper(II) carbonate	filter, evaporate the solution to crystallising point and then cool
C	dilute sulfuric acid	evaporate the solution to dryness
D	dilute sulfuric acid	evaporate the solution to crystallising point and then cool

20 Which statement about elements in Group I or Group VII of the Periodic Table is correct?

A Bromine reacts with potassium chloride to produce chlorine.

B Iodine is a monatomic non-metal.

C Lithium has a higher melting point than potassium.

D Sodium is more reactive with water than potassium.

21 Some information about an element from Group VII of the Periodic Table is shown.

melting point / °C	–7
boiling point / °C	59

What is the element?

A fluorine

B chlorine

C bromine

D iodine

22 Manganese(IV) oxide, MnO_2, is a black solid.

The equation for the reaction between manganese(IV) oxide and dilute hydrochloric acid is shown.

$$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$$

The reaction produces a pale pink solution.

Which properties of transition elements does this reaction show?

1 They can act as catalysts.

2 They form coloured compounds.

3 They have high melting points.

4 They have variable oxidation numbers.

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

23 Part of a steel ship is protected from rusting using a sacrificial metal.

What is a suitable sacrificial metal?

A copper

B zinc

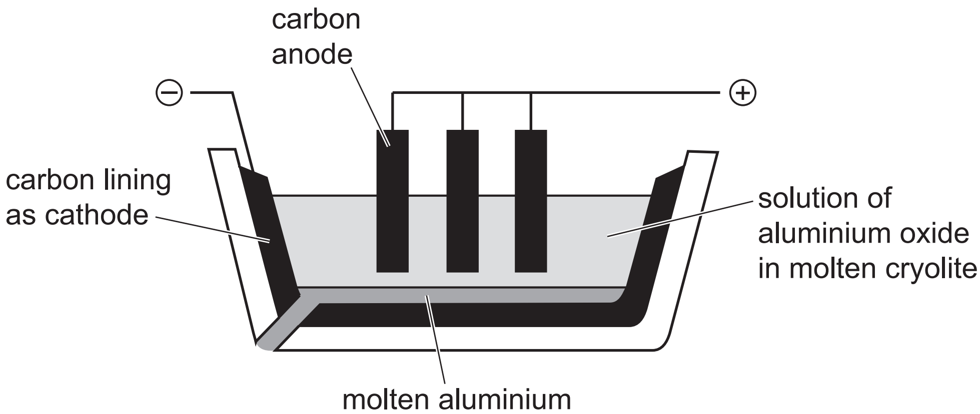
C silver

D potassium

24 Which row gives a use for the named metal and two properties which **both** explain this use?

	metal	use	property 1	property 2
A	aluminium	aircraft construction	high density	resistant to corrosion
B	copper	electrical wiring	good electrical conductivity	ductile
C	aluminium	food containers	resistant to corrosion	**not** malleable
D	copper	aircraft construction	malleable	low density

25 The apparatus used for the extraction of aluminium by electrolysis is shown.



Which equation represents the reaction at the anode?

A $O + 2e^- \rightarrow O^{2-}$

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

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

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

26 Which gas is both an element and present in clean, dry air?

A argon

B carbon dioxide

C chlorine

D water vapour

27 Oxides of nitrogen formed in a car's engine are removed using a catalytic converter.

What happens to the oxides of nitrogen in the catalytic converter?

A They are hydrated.

B They are neutralised.

C They are oxidised.

D They are reduced.

28 What is the equation for photosynthesis?

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

B $2CO_2 + 2H_2O \rightarrow 2C_2H_5OH + 3O_2$

C $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$

D $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

29 Four statements about members of the same homologous series are listed.

1 They have the same volatility.

2 They have the same molecular formula.

3 They have the same functional group.

4 They have the same general formula.

Which statements are correct?

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

30 Ethene reacts with steam to produce ethanol.

Which row describes each compound?

	ethene	ethanol
A	saturated	saturated
B	saturated	unsaturated
C	unsaturated	saturated
D	unsaturated	unsaturated

31 Which process is used to make an alkene from a long-chain alkane?

A combustion

B condensation

C cracking

D polymerisation

32 Which fraction obtained from petroleum has the lowest boiling point?

A diesel oil

B fuel oil

C kerosene

D naphtha

33 Alkanes undergo substitution reactions with chlorine in the presence of ultraviolet light.

Which equation shows a reaction of this type?

A $C_3H_6 + Cl_2 \rightarrow C_3H_6Cl_2$

B $C_3H_8 + Cl_2 \rightarrow C_3H_6Cl_2 + H_2$

C $C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$

D $C_3H_6 + Cl_2 \rightarrow C_3H_5Cl + HCl$

34 Information about two reactions of ethene is listed.

- Reaction 1 requires a nickel catalyst.
- Reaction 2 requires an acid catalyst.

Which substance reacts with ethene in each reaction?

	reaction 1	reaction 2
A	bromine	steam
B	bromine	hydrogen
C	hydrogen	bromine
D	hydrogen	steam

35 Which process converts CH_3CH_2OH to CH_3COOH?

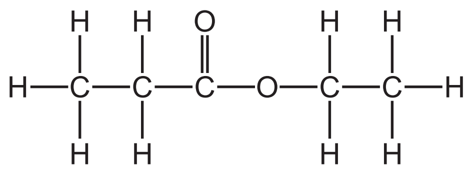
A bacterial oxidation

B fermentation

C catalytic addition of steam

D catalytic addition of hydrogen

36 The structure of an ester is shown.



Which row identifies the name of the ester and the two compounds from which it is made?

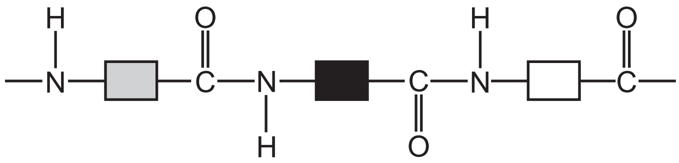
	name	compound 1	compound 2
A	ethyl propanoate	ethanol	propanoic acid
B	ethyl propanoate	propanol	ethanoic acid
C	propyl ethanoate	ethanol	propanoic acid
D	propyl ethanoate	propanol	ethanoic acid

37 Which statements about monomers or polymers are correct?

1. Monomers are **always** joined together by addition reactions.
2. A polymer can be formed from a single type of monomer.
3. A polymer can be formed by joining two different types of monomer.
4. Water is **always** produced when monomer molecules join together.

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

38 The diagram shows the structure of a naturally occurring polymer, Q.



What is Q?

A an amino acid

B nylon

C a protein

D PET

39 Which row shows how the boiling point and the melting point of water change when a soluble impurity is added to the water?

	boiling point	melting point
A	increases	increases
B	decreases	decreases
C	increases	decreases
D	decreases	increases

40 X is a white powder. The following tests are done on X.

- When a few drops of aqueous sodium hydroxide are added to a solution of X, no precipitate is seen.
- When X is heated with aqueous sodium hydroxide, no gas is formed.
- X gives a lilac colour when put into a flame.
- When acidified aqueous silver nitrate is added to a solution of X, a yellow precipitate is seen.

What is X?

A ammonium bromide

B ammonium iodide

C potassium bromide

D potassium iodide

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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 **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2024**

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 2024 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	C	**1**
3	B	**1**
4	A	**1**
5	D	**1**
6	D	**1**
7	B	**1**
8	B	**1**
9	D	**1**
10	C	**1**
11	B	**1**
12	C	**1**
13	D	**1**
14	A	**1**
15	A	**1**
16	B	**1**
17	B	**1**
18	A	**1**
19	B	**1**
20	C	**1**
21	C	**1**
22	D	**1**
23	B	**1**
24	B	**1**
25	B	**1**
26	A	**1**
27	D	**1**
28	A	**1**

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

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

1 A sample of rock salt contains sodium chloride, sand and mud.

Sodium chloride is soluble in water. Sand and mud are insoluble in water.

A student obtains dry crystals of pure sodium chloride from a lump of rock salt.

Fig. 1.1 shows some of the steps the student uses.

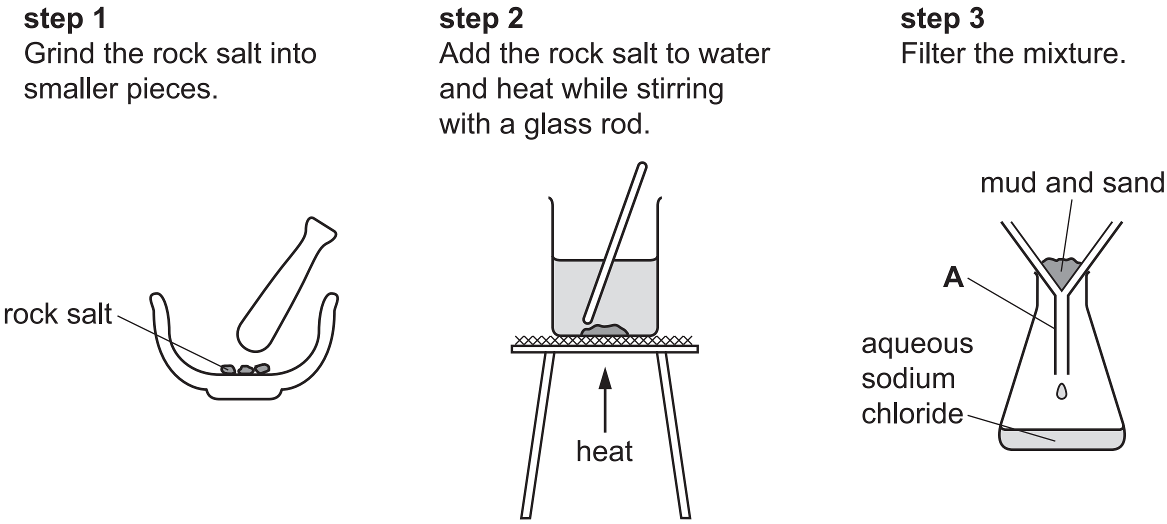


Fig. 1.1

(a) Explain why the rock salt is made into smaller pieces in **step 1**.

.... [1]

(b) Name an item of apparatus that can be used to heat the water in **step 2**.

.... [1]

(c) Name the apparatus labelled **A** in **step 3**.

.... [1]

(d) Describe what the student must do after **step 3** to obtain dry crystals of pure sodium chloride.

....

....

....

.... [3]

[Total: 6]

2 A student investigates the rate at which hydrogen gas is made when magnesium ribbon reacts with dilute ethanoic acid at two different temperatures.

Instructions

The student does two experiments using the apparatus shown in Fig. 2.1.

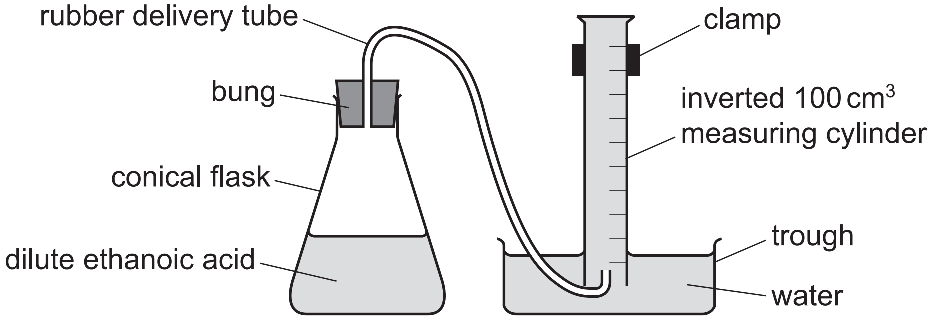


Fig. 2.1

Experiment 1

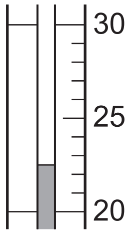
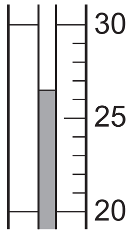
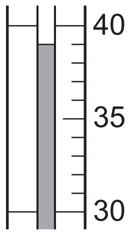
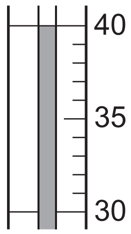
- Use a measuring cylinder to pour 50 cm^3 of dilute ethanoic acid into a conical flask.
- Use a thermometer to measure the initial temperature of the dilute ethanoic acid and record the initial temperature.
- Set the apparatus up as shown in Fig. 2.1, ensuring the inverted measuring cylinder is full of water.
- Remove the bung from the conical flask, ensuring the delivery tube remains in the measuring cylinder.
- Add a coil of magnesium ribbon to the conical flask, immediately put the bung back into the conical flask and start the timer. If the magnesium sticks to the side of the flask, gently shake the flask so that it is washed off the side.
- Measure the volume of gas collected in the inverted measuring cylinder every 15 seconds for 150 seconds. Record the volume of gas collected.
- Use the thermometer to measure the final temperature of the mixture in the conical flask and record the final temperature.
- Rinse out the conical flask with distilled water.

Experiment 2

- Repeat Experiment 1 but warm the acid by about 15 °C after it has been poured into the conical flask and before the initial temperature is measured and recorded.

(a) Use the thermometer diagrams to complete Table 2.1.

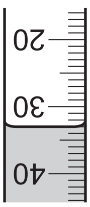
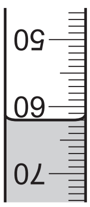
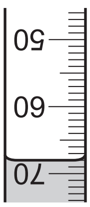
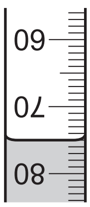
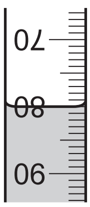
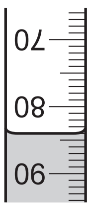
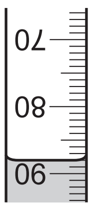
Table 2.1

	initial		final		
experiment	thermometer diagram	temperature / °C	thermometer diagram	temperature / °C	average temperature / °C
1					
2					

[3]

(b) Use the diagrams of the inverted measuring cylinders to complete Table 2.2.

Table 2.2

time / s	15	30	45	60	75	90	105	120	135	150
volume of gas collected in Experiment 1 / cm^3	12	22	31	37	43	48	52	56	59	62
diagram of inverted measuring cylinder in Experiment 2										
volume of gas collected in Experiment 2 / cm^3										

[2]

(c) Complete a suitable scale on the *y*-axis and plot the results for Experiments 1 and 2 on Fig. 2.2. Draw two lines of best fit. Both lines **must** start at (0,0). Label your lines.

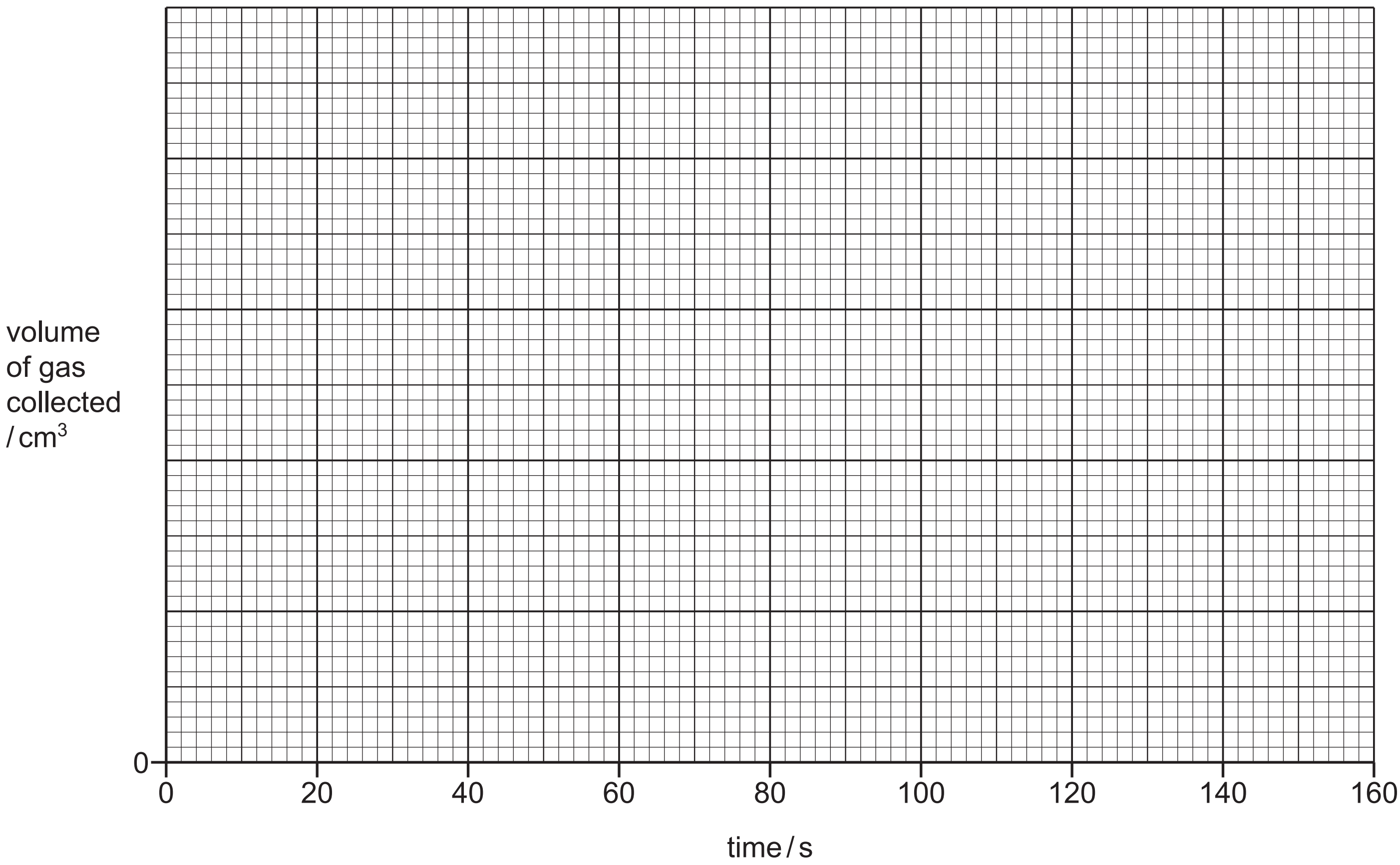


Fig. 2.2

[4]

(d) Deduce the volume of gas collected between 20 seconds and 40 seconds in Experiment 1. Show clearly on Fig. 2.2 how you worked out your answer.

volume of gas collected between 20 seconds and 40 seconds .... cm^3 [3]

(e) Use Fig. 2.2 to explain which experiment had the faster rate of reaction.

experiment with faster rate ....

explanation ....

.... [1]

(f) During Experiment 1, the temperature of the mixture in the conical flask changed.

(i) State how this change in temperature affects the rate of the reaction.

.... [1]

(ii) Describe how the apparatus could be altered to minimise the change in temperature.

....

.... [1]

(g) Some gas escapes in the short time between adding the magnesium ribbon to the conical flask and putting the bung back into the conical flask.

Explain how the apparatus could be altered so that no gas escapes and the results of the experiment are more accurate. You may draw a diagram to help explain your answer.

....

.... [2]

(h) Describe one **other** way in which the results of Experiments 1 and 2 could be made more accurate.

....

.... [1]

(i) Sketch on Fig. 2.2 the graph you would expect when Experiment 2 is repeated using ethanoic acid with a higher concentration.

Label your line **X**. [1]

[Total: 19]

3 A student tests two substances: solid **K** and solution **L**.

Tests on solid K

Solid **K** is copper(II) carbonate.

Complete the expected observations.

(a) The student adds about 5 cm^3 of dilute hydrochloric acid to solid **K**.

observations ....

.... [1]

The solution made in **(a)** is solution **M**. The student divides solution **M** into two portions.

(b) To the first portion of solution **M**, the student adds aqueous ammonia dropwise until it is in excess.

observations ....

....

.... [3]

(c) The student carries out a flame test on the second portion of solution **M**.

(i) State the colour the Bunsen burner flame becomes during the flame test.

.... [1]

(ii) Describe how the student should carry out the flame test.

....

....

.... [2]

Tests on solution L

Table 3.1 shows the tests and the student's observations for solution **L**.

Solution **L** was divided into two portions.

Table 3.1

tests	observations
test 1 To the first portion of solution **L**, add aqueous sodium hydroxide dropwise until in excess.	a white precipitate forms which is insoluble in excess
test 2 To the second portion of solution **L**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a cream precipitate forms

(d) Identify solution **L**.

....

.... [2]

[Total: 9]

4 Iron rusts slowly when exposed to water and air. There is an increase in mass when iron rusts as the insoluble solid hydrated iron(III) oxide forms.

Cast iron, mild steel and stainless steel are all alloys that contain iron.

Plan an experiment to find which of these three alloys rusts most quickly when exposed to water and air. Include in your answer how the results of the experiment will show which alloy rusts most quickly.

You are provided with powdered cast iron, powdered mild steel, powdered stainless steel and common laboratory apparatus.

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.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Cambridge International Education

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2024**

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 **7** printed pages.

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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 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.
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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)	(to) speed up (the dissolving)	**1**
1(b)	Bunsen (burner)	**1**
1(c)	funnel	**1**
1(d)	**M1** heat (solution)	**1**
	M2 to the point of crystallisation	**1**
	M3 dry crystals with filter/absorbent paper	**1**

Question	Answer	Marks
2(a)	**M1** all four temperature readings correct (22.5, 26.5, 39.0, 40.0)	**1**
	M2 both mean temperatures calculated correctly (24.5, 39.5)	**1**
	M3 all temperatures and mean temperatures recorded to nearest 0.5	**1**
2(b)	all 10 volumes for experiment 2 correct 21, 33, 45, 54, 62, 68, 75, 80, 84, 88	**2**
2(c)	**M1** sensible y-axis scale which is linear and points extend over halfway up scale	**1**
	M2 all points plotted correctly for experiment	**1**
	M3 best fit lines	**1**
	M4 lines labelled	**1**

Question	Answer	Marks
2(d)	**M1** working on graph to show readings at 20 seconds and 40 seconds	**1**
	M2 correct readings	**1**
	M3 correct calculation of difference between the two volumes	**1**
2(e)	Experiment 2 **and** line steeper / gas volume greater at end	**1**
2(f)(i)	increases	**1**
2(f)(ii)	stand flask in a water bath (at initial temperature of the acid)	**1**
2(g)	**M1** place one reagent in tube inside boiling tube/flask **M2** tip tube to start reaction	**1**
	OR **M1** use a divided flask **M2** tip flask to start reaction OR **M1** suspend the magnesium (above the acid) in the flask **M2** tip the flask	**1**
2(h)	repeat **and** find mean **OR** use a burette in place of measuring cylinder	**1**
2(i)	graph line starts at (0,0) and rises more steeply than Experiment 2 line and doesn’t level off	**1**

Question	Answer	Marks
3(a)	bubble / fizz / effervescence	**1**
3(b)	**M1** blue precipitate	**1**
	M2 which dissolves	**1**
	M3 and becomes darker blue	**1**
3(c)(i)	blue-green	**1**
3(c)(ii)	**M1** description of using a non-luminous / blue / roaring Bunsen flame	**1**
	M2 description of how the substance is got into the flame – on a wire / on a splint / spray a solution	**1**
3(d)	**M1** calcium / Ca^{2+}	**1**
	M2 bromide / Br^{-}	**1**

Question	Answer	Marks
4	any 6 from: • known/stated/same mass of iron/steel • placed in a suitable container with water • left for a suitable time • filter out the solid/iron/rust • dry the solid/iron/rust/residue • weight the solid/iron/rust/residue • largest mass has rusted most	**6**

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Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 2 3 1 0 0 7 6 8 1 6 *

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB24 06_0620_62/2RP

1 When a mixture of calcium hydroxide and ammonium chloride is heated, ammonia gas is made.

calcium hydroxide + ammonium chloride → calcium chloride + water + ammonia

Ammonia gas is soluble in water and toxic. Ammonia gas reacts with hot copper(II) oxide to make nitrogen.

ammonia + copper(II) oxide → copper + water + nitrogen

A student makes nitrogen using the apparatus shown in Fig. 1.1.

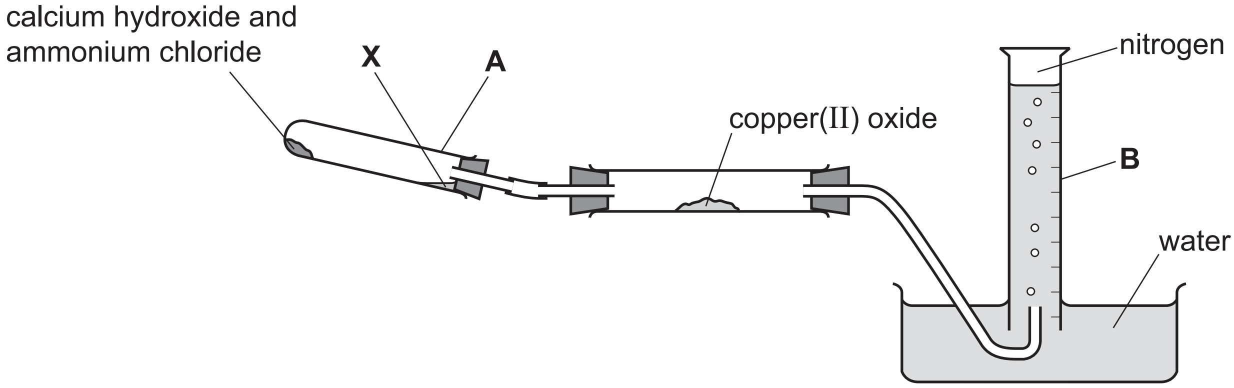

Fig. 1.1

(a) Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

A ....

B ....
[2]

(b) The apparatus needs to be heated in two places.

On Fig. 1.1, draw arrows in **two** places to show where the apparatus should be heated during the experiment. [2]

(c) During the reaction, a colourless liquid collects at the point marked **X** in Fig. 1.1.

Suggest the identity of the colourless liquid.

.... [1]

(d) Some of the ammonia gas passes over the copper(II) oxide without reacting.

Suggest why none of this ammonia gas is collected in the item of apparatus labelled **B** in Fig. 1.1.

....

.... [1]

(e) The student does not collect the first few bubbles of gas.

Suggest why the first few bubbles of gas are **not** collected.

....

.... [1]

(f) Explain why this experiment should be carried out in a fume cupboard.

....

.... [1]

[Total: 8]

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2 A student investigates the reaction between aqueous aluminium chloride and two aqueous solutions of sodium hydroxide, solution **F** and solution **G**. Solution **F** and solution **G** have different concentrations.

The student does three experiments.

Experiment 1

- Rinse a burette with distilled water and then with aqueous aluminium chloride.
- Rinse a conical flask with distilled water.
- Fill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour $25\,cm^3$ of solution **F** into the conical flask.
- Stand the conical flask on a black or dark-coloured sheet of paper.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the mixture in the conical flask just starts to become cloudy.
- Record the final burette reading.

Experiment 2

- Refill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Rinse the conical flask with distilled water.
- Rinse the measuring cylinder with distilled water and then with solution **G**.
- Use the measuring cylinder to pour $25\,cm^3$ of solution **G** into the conical flask.
- Stand the conical flask on a black or dark-coloured sheet of paper.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the mixture in the conical flask just starts to become cloudy.
- Record the final burette reading.

Experiment 3

- Refill the burette with aqueous aluminium chloride. Run some of the aqueous aluminium chloride out of the burette so that the level of the aqueous aluminium chloride is on the burette scale.
- Record the initial burette reading.
- Rinse the conical flask with distilled water.
- Use the measuring cylinder to pour $25\,cm^3$ of solution **G** into the conical flask.
- Add 5 drops of thymolphthalein indicator to the conical flask.
- Stand the conical flask on a **white tile**.
- Slowly add aqueous aluminium chloride from the burette to the conical flask, while swirling the flask, until the thymolphthalein indicator changes colour.
- Record the final burette reading.

(a) Use the burette diagrams in Fig. 2.1, Fig. 2.2 and Fig. 2.3 to record the readings for Experiments 1, 2 and 3 in Table 2.1 and complete Table 2.1.

Experiment 1

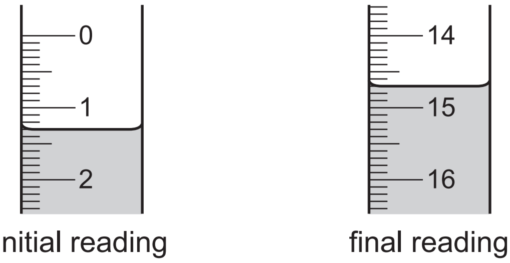

Fig. 2.1

Experiment 2

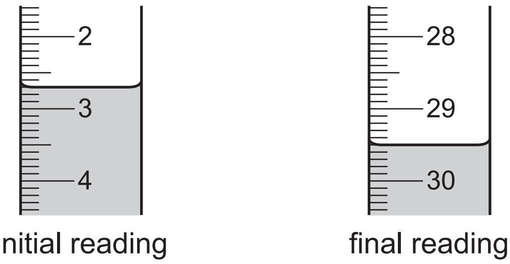

Fig. 2.2

Experiment 3

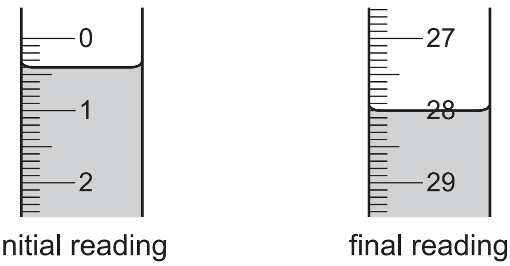

Fig. 2.3

Table 2.1

	Experiment 1	Experiment 2	Experiment 3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of aqueous aluminium chloride added / cm^3			

[4]

(b) In Experiment 3, the aqueous sodium hydroxide in the conical flask is alkaline. At the end-point, the mixture in the flask is no longer alkaline.

State the colour change seen at the end-point in Experiment 3.

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

(c) State why the conical flask is swirled as solution **F** is added in Experiment 1.

....

.... [1]

(d) Suggest why the conical flask is placed on black or dark-coloured paper in Experiments 1 and 2.

....

.... [1]

(e) **(i)** Explain why the measuring cylinder is rinsed between Experiment 1 and Experiment 2.

.... [1]

(ii) Explain why the measuring cylinder does **not** need rinsing between Experiment 2 and Experiment 3.

.... [1]

(f) Compare the concentration of solution **F** used in Experiment 1 with the concentration of solution **G** used in Experiment 2.

Explain your answer.

....

....

.... [3]

(g) Calculate the volume of aqueous aluminium chloride required when Experiment 1 is carried out with $10\,cm^3$ of aqueous sodium hydroxide instead of $25\,cm^3$.

.... [2]

(h) In all three experiments it is more accurate to measure the volume of the aqueous sodium hydroxide using a volumetric pipette instead of a measuring cylinder.

Explain why it is **not** possible to use a volumetric pipette to measure the volume of aqueous aluminium chloride in these experiments.

....

.... [1]

[Total: 15]

3 A student tests two substances: solid **H** and solution **I**.

Tests on solid H

Solid **H** is barium carbonate.

Complete the expected observations.

(a) **(i)** The student adds an excess of dilute nitric acid to the sample of solid **H** in a boiling tube and tests any gas produced.

observations ....

....

.... [2]

(ii) Identify the gas made in **(a)(i)**.

.... [1]

The solution produced in **(a)(i)** is solution **J**. The student divides solution **J** into four approximately equal portions.

(b) The student carries out a flame test on the first portion of solution **J**.

observations .... [1]

(c) To the second portion of solution **J**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations ....

.... [1]

(d) To the third portion of solution **J**, the student adds a few drops of dilute sulfuric acid.

observations ....

.... [1]

(e) To the fourth portion of solution **J**, the student adds about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations ....

.... [1]

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Tests on solution I

Table 3.1 shows the tests and the student's observations for solution **I**.

The student divides solution **I** into two portions.

Table 3.1

tests	observations
test 1 To the first portion of solution **I** in a boiling tube, add 2 cm^3 of aqueous sodium hydroxide and warm the mixture. Test any gas produced, using damp red litmus paper.	damp red litmus paper turns blue
test 2 To the second portion of solution **I** in a boiling tube, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	a white precipitate forms

(f) **(i)** Identify the gas produced in **test 1**.

.... [1]

(ii) State what is observed when the gas produced in **test 1** is tested using damp blue litmus paper.

.... [1]

(g) Identify solution **I**.

....

.... [2]

[Total: 11]

4 Bismuth is a metal that has a reactivity similar to that of copper. The ore bismite contains the compound bismuth(III) oxide, Bi_2O_3.

Bismuth(III) oxide is insoluble in water and reacts with dilute acids to form an aqueous solution of a salt. The ore bismite contains no other compounds that are insoluble in water and no other compounds that react with acids to form aqueous solutions.

Describe how you could obtain a sample of bismuth metal starting with a large lump of the ore bismite.

You have access to common laboratory apparatus and chemicals.

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.... [6]

Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
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bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
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cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
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gas	test and test result
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Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Cambridge IGCSE™

CHEMISTRY **0620/62**

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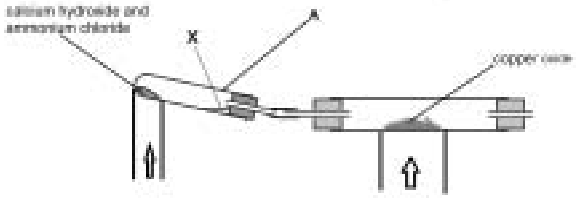
6	<u>Calculation specific guidance</u> Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states ‘show your working’. For questions in which the number of significant figures required is not stated, credit should be awarded 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)	**A** boiling tube / test-tube	**1**
	B measuring cylinder	**1**
1(b)	 one arrow in each region shown	**2**
1(c)	water / H_2O	**1**
1(d)	ammonia dissolves in the water	**1**
1(e)	it is air	**1**
1(f)	ammonia is toxic / poisonous	**1**

Question	Answer	Marks
2(a)	**M1** all three final readings recorded correctly (14.7, 29.5, 28.0)	**1**
	M2 all three initial readings recorded correctly (1.3, 2.7, 0.4)	**1**
	M3 all three titres correct (13.4, 26.8, 27.6)	**1**
	M4 all volumes recorded to 1 d.p. or better	**1**
2(b)	(from) blue (to) colourless	**1**
2(c)	to mix (reactants)	**1**

Question	Answer	Marks
2(d)	(white) precipitate / cloudiness easier to see	**1**
2(e)(i)	to clean / to remove solution **F**	**1**
2(e)(ii)	same solution (of NaOH) used / used for solution **G** in both	**1**
2(f)	**M1** solution G is more concentrated	**1**
	M2 as larger volume (of $AlCl_3$(aq)) required (in Experiment 2)	**1**
	M3 quantitative relationship such as: twice as concentrated OR needed twice as much aluminium chloride	**1**
2(g)	**M1** 5.36 / 5.4	**1**
	M2 cm^3	**1**
2(h)	volume used is not fixed / volume needed is not the same in each experiment.	**1**

Question	Answer	Marks
3(a)(i)	• limewater turns milky (when gas passed through it) and any **one** from • effervescence / fizzing / bubbles • solid disappears / dissolves	**2**
3(a)(ii)	carbon dioxide / CO_2	**1**
3(b)	(pale / light) green (flame)	**1**
3(c)	(solution becomes) pink / pale purple / lilac	**1**
3(d)	white precipitate	**1**

Question	Answer	Marks
3(e)	no change	**1**
3(f)(i)	ammonia / NH_3	**1**
3(f)(ii)	no change / stays blue	**1**
3(g)	ammonium chloride / NH_4Cl **M1** ammonium / NH_4^+ **M2** chloride / Cl^-	**2**

Question	Answer	Marks
4	any 6 from **MP1** crush the ore / lumps / powder the ore / lumps / make the ore / lumps into smaller pieces **MP2** using a suitable method e.g. pestle and / or mortar, hammer **MP3** adds water (stirs) and filters **then either:** **displacement in solid state method** **MP4** add more reactive element / suitable reducing agent (to residue / ore) **MP5** identified as carbon / coke / iron / zinc / aluminium / magnesium / hydrogen / CO / ammonia / (subsumes **MP4**) **MP6** heat (the ore or Bi_2O_3) (to form bismuth) **MP7** bismuth displaced / reduced or bismuth formed by displacement **OR** **electrolysis method** **MP4** adds suitable named (**A** correct formula) strong acid (to residue / ore) **R** adding acid to filtrate **MP5** electrolysis (of solution) **MP6** using inert electrodes / C or Pt electrodes **MP7** bismuth forms at cathode **OR** **displacement from aqueous solution** **MP4** adds suitable named strong acid (to residue / ore) **R** adding acid to filtrate **MP5** add more reactive metal **MP6** suitable more reactive metal identified (and added to **solution** of salt) (subsumes **MP5**) (e.g. Zn, Fe, Mg, Al but not K, Na, Ca) **MP7** bismuth displaced / reduced or bismuth formed by displacement	**6**

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6847793774

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB24 06_0620_61/2RP

1 A student carries out a titration to find the concentration of a sample of dilute hydrochloric acid.

The student:

- adds 25.0 cm^3 of aqueous potassium hydroxide to the apparatus labelled **A** in Fig. 1.1

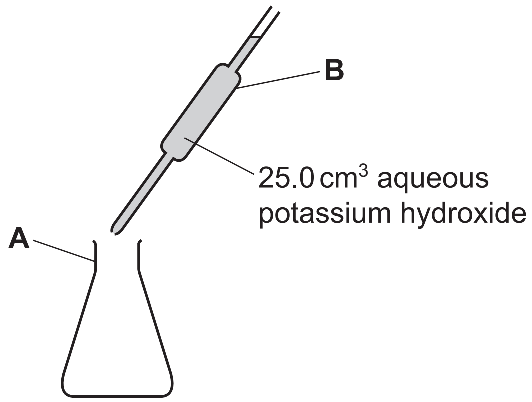

Fig. 1.1

- adds a few drops of a suitable indicator to the apparatus labelled **A**
- uses a burette to add dilute hydrochloric acid to the aqueous potassium hydroxide and indicator mixture in the apparatus labelled **A**.

(a) Name the items of apparatus labelled **A** and **B** in Fig. 1.1.

A ....

B .... [2]

(b) The student adds the indicator after the volume of the 25.0 cm^3 of aqueous potassium hydroxide has been measured.

(i) Explain why the student adds an indicator to the aqueous potassium hydroxide.

.... [1]

(ii) Name a suitable indicator.

.... [1]

(c) Describe how the student can determine the volume of dilute hydrochloric acid used in this titration.

....

.... [2]

(d) The student observes the colour changes that occur as they add dilute hydrochloric acid from the burette.

State one **other** thing the student should do as they add the dilute hydrochloric acid to the aqueous potassium hydroxide.

....

.... [1]

[Total: 7]

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2 A student investigates the temperature change when magnesium reacts with dilute sulfuric acid.

The student does five experiments.

Experiment 1

- Use a 25 cm^3 measuring cylinder to pour 20 cm^3 of dilute sulfuric acid into a boiling tube.
- Use a thermometer to measure the initial temperature of the acid in the boiling tube. Record the initial temperature.
- Add a coiled 5 cm length of magnesium ribbon to the acid in the boiling tube. At the same time start a timer.
- Continually stir the contents of the boiling tube using the thermometer.
- After 45 seconds, measure the temperature of the mixture in the boiling tube. Record this temperature.
- Rinse the boiling tube with distilled water.

Experiment 2

- Use the 25 cm^3 measuring cylinder to pour 20 cm^3 of dilute sulfuric acid into the boiling tube.
- Use a 10 cm^3 measuring cylinder to add 2.0 cm^3 of distilled water to the acid in the boiling tube.
- Place a bung in the boiling tube and invert the tube to mix the acid and water.
- Use the thermometer to measure the initial temperature of the contents of the boiling tube. Record the initial temperature.
- Add a coiled 5 cm length of magnesium ribbon to the contents of the boiling tube. At the same time start a timer.
- Continually stir the contents of the boiling tube using the thermometer.
- After 45 seconds, measure the temperature of the mixture. Record this temperature.
- Rinse the boiling tube with distilled water.

Experiment 3

- Repeat Experiment 2, adding 4.0 cm^3 of distilled water instead of 2.0 cm^3.

Experiment 4

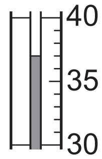
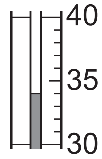
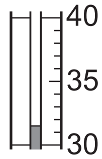
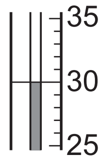
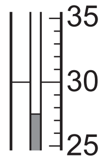
- Repeat Experiment 2, adding 6.0 cm^3 of distilled water instead of 2.0 cm^3.

Experiment 5

- Repeat Experiment 2, adding 10.0 cm^3 of distilled water instead of 2.0 cm^3.

(a) Use the information in the description of the experiments and the thermometer diagrams to complete Table 2.1.

Table 2.1

experiment	volume of dilute sulfuric acid / cm^3	volume of distilled water / cm^3	initial temperature / °C	thermometer diagram after 45 s / °C	temperature after 45 s / °C	temperature increase / °C
1			25.0			
2			25.5			
3			25.5			
4			26.0			
5			26.0			

[5]

(b) **(i)** State which Experiment, 1, 2, 3, 4 or 5, had the smallest temperature change.

.... [1]

(ii) Explain why the temperature change was smallest in the experiment you have given in **(b)(i)**.

....

.... [1]

(c) Complete a suitable scale on the *y*-axis and plot your results from Experiments 1 to 5 on Fig. 2.1. Draw a line of best fit.

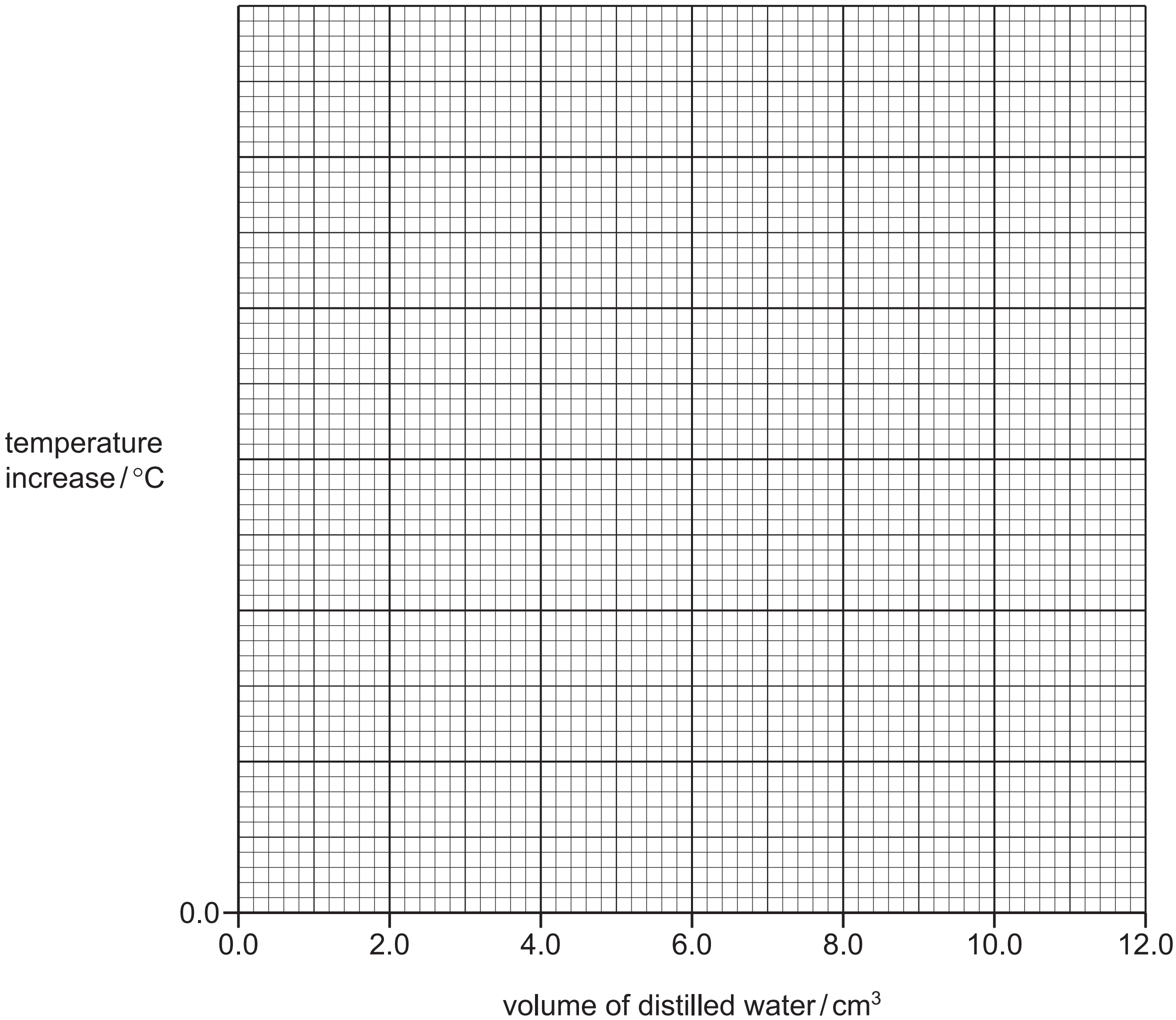


Fig. 2.1

[4]

(d) Use your graph in Fig. 2.1 to deduce the temperature increase when Experiment 2 is repeated with 7.5 cm^3 of distilled water instead of 2.0 cm^3.

Show clearly **on Fig. 2.1** how you worked out your answer.

.... °C
[2]

(e) The average rate of temperature increase in each experiment is calculated using the equation shown.

$$\text{average rate of temperature increase} = \frac{\text{temperature increase}}{45\ \text{seconds}}$$

Calculate the average rate of temperature increase in Experiment 1. Give units for the rate you have calculated.

average rate of temperature increase = ...

units = ...
[2]

(f) **(i)** Explain why the results of the experiment are more accurate if the boiling tube is wrapped in cotton wool.

....

....

.... [2]

(ii) Explain why a 25.0 cm^3 volumetric pipette **cannot** be used to accurately measure the volume of the distilled water added.

....

.... [1]

(iii) State one **other** way in which the **apparatus** can be changed to give more accurate results.

....

....

.... [1]

(g) Sketch **on Fig. 2.1** the graph you would expect if all of the experiments were repeated using a 2 cm length of magnesium ribbon instead of the 5 cm length.

Label your line **g**. [1]

[Total: 20]

3 A student tests two substances: solution **E** and solid **F**.

Tests on solution E

Solution **E** is aqueous chromium(III) bromide.

Solution **E** is divided into two portions.

Record the expected observations.

(a) To the first portion of solution **E**, the student adds aqueous sodium hydroxide dropwise and then in excess.

observations adding dropwise ....

....

observation in excess ....

....
[2]

(b) To the second portion of solution **E**, the student adds about 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate.

observations ....

.... [1]

Tests on solid F

Table 3.1 shows the tests and the student's observations for solid **F**.

Table 3.1

tests	observations
test 1 Heat about half of solid **F** in a boiling tube until there is no further change.	the white solid forms a colourless liquid, steam comes out from the boiling tube and condensation is seen at the top of the boiling tube, after a while the colourless liquid becomes a white solid
test 2 The remaining solid **F** is dissolved in water to form solution **F**. Solution **F** is divided into three portions. To the first portion of solution **F** in a boiling tube, add aqueous sodium hydroxide dropwise and then in excess. Warm the product and hold damp red litmus paper at the mouth of the boiling tube.	no change the damp red litmus paper remains red
test 3 To the second portion of solution **F**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	white precipitate
test 4 To the third portion of solution **F**, add a few drops of acidified aqueous potassium manganate(VII).	the solution becomes light purple

(c) The observations in **test 1** show that solid **F** is hydrated.

Describe a chemical test to show that the condensation at the top of the boiling tube contains water.

test ....

result ....
[2]

(d) From the tests and observations in Table 3.1 it is **not** possible to identify the cation in solid **F**.

Give another test that can be carried out to help identify the cation in solid **F**.

....

.... [1]

(e) Identify the anion in solid **F**.

.... [1]

[Total: 7]

4 A **mixture** contains three compounds:

- liquid ethanol
- solid sodium chloride
- solid zinc carbonate.

Table 4.1 gives some information about these three compounds.

Table 4.1

name of compound	solubility in water	solubility in ethanol
ethanol	soluble	
sodium chloride	soluble	insoluble
zinc carbonate	insoluble	insoluble

Describe how to obtain a pure sample of each of the three compounds, ethanol, sodium chloride and zinc carbonate, from the mixture.

You are provided with common laboratory apparatus.

....

....

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....

.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Cambridge IGCSE™

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2024**

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 2024 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 descriptions 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)	**M1** A (conical) flask	1
	M2 B volumetric pipette	1
1(b)(i)	so that it can change colour at the end point	1
1(b)(ii)	methyl orange / thymolphthalein	1
1(c)	**M1**: take initial and final (burette) readings	1
	M2 final reading minus initial reading	1
1(d)	swirl (A) / swirl (the flask) / mix (the contents of A)	1

Question	Answer	Marks
2(a)	**M1** all five volumes of dilute sulfuric acid are 20	1
	M2 all five volumes of water are correct (0, 2, 4, 6, 10)	1
	M3 all temperatures and temperature changes are recorded to nearest 0.5 °C	1
	M4 all five temperatures after 45 seconds are recorded correctly (37.0, 34.0, 31.5, 30.0, 27.5)	1
	M5 all temperature increases correct (12.0, 8.5, 6.0, 4.0, 1.5)	1
2(b)(i)	5	1
2(b)(ii)	larger / largest volume (being heated)	1
2(c)	**M1** suitable sensible scale on *y*-axis	1
	M2 and **M3** all five points plotted correctly	2
	M4 best fit line	1

Question	Answer	Marks
2(d)	**M1** correct working shown on graph	**1**
	M2 correct value from their working to a point on the line	**1**
2(e)	**M1** (12 ÷ 45 =) 0.27 or 0.267 or 0.3	**1**
	M2 °C / s	**1**
2(f)(i)	any two from: • insulator • so reduces / prevents heat loss / traps heat • temperature (more) accurate / does not cool down / prevents temperature decreasing	**2**
2(f)(ii)	volume used is not fixed / volume needed is not the same in each experiment / volume used is not 25 cm^3	**1**
2(f)(iii)	use a burette instead of a measuring cylinder	**1**
2(g)	sketch line is below results line for all volumes of water	**1**

Question	Answer	Marks
3(a)	**M1** green precipitate	**1**
	M2 precipitate dissolves (giving a green solution) / soluble (in excess) / precipitate disappears	**1**
3(b)	cream precipitate	**1**
3(c)	**M1** anhydrous copper(II) sulfate **M2** (changes from white to) blue	**1**
	OR **M1** anhydrous cobalt(II) chloride **M2** (changes from blue to) pink	**1**
3(d)	flame test	**1**

Question	Answer	Marks
3(e)	sulfate / SO_4^{2-}	**1**

Question	Answer	Marks
4	**max 6** **to obtain ethanol** **MP1** filter the initial mixture (ethanol obtained as filtrate)	**1**
	and then any five from: **to obtain zinc carbonate** **MP2** add water to the residue / mixture **MP3** stir / warm after adding water **MP4** filter after adding water **MP5** wash residue from filtration after the addition of water **MP6** dry the solid zinc carbonate **to obtain sodium chloride** **MP7** heat filtrate to remove water and obtain solid sodium chloride **If candidates do not have a valid method of obtaining ethanol then MP1 cannot be awarded and the maximum score is 5. If ethanol is obtained AFTER adding more ethanol to the mixture, then do not award MP1, maximum 5**	**5**

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 5 4 2 3 8 9 3 2 6 0 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2024**

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.

IB24 06_0620_43/3RP

1 Name the process used to:

(a) produce ammonia from nitrogen

.... [1]

(b) produce lead from molten lead(II) bromide

.... [1]

(c) separate an insoluble solid from a mixture of an insoluble solid and a solution

.... [1]

(d) produce ethanol from ethene

.... [1]

(e) identify the components of a mixture of soluble coloured substances

.... [1]

(f) separate a mixture of several liquids with different boiling points

.... [1]

(g) determine the volume of an acid required to neutralise a given volume of an alkali.

.... [1]

[Total: 7]

2 Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of electrons	number of neutrons
$^{63}_{29}Cu$	29		
$^{37}_{17}Cl^{-}$			20
	30	28	34

[5]

3 This question is about elements and compounds.

(a) Some properties of graphite, oxygen and carbon monoxide are shown in Table 3.1.

Table 3.1

	melting point / °C	boiling point / °C	conduction of electricity when solid
graphite	3652	4827	good
oxygen	–218	–183	poor
carbon monoxide	–199	–191	poor

(i) Explain why graphite conducts electricity when solid.

....

.... [1]

(ii) Complete the dot-and-cross diagram in Fig. 3.1 of a molecule of oxygen.

Show outer shell electrons only.

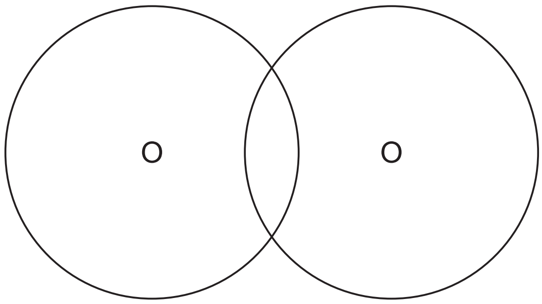

Fig. 3.1

[2]

(iii) Deduce the physical state of carbon monoxide at –195 °C. Use the data in Table 3.1 to explain your answer.

physical state ....

explanation ....

....

[2]

(iv) Explain in terms of structure and bonding why graphite has a much higher melting point than carbon monoxide.

....

....

....

.... [3]

(b) Potassium reacts with chlorine to form potassium chloride.

Write a symbol equation for this reaction.

.... [2]

(c) A dilute aqueous solution of potassium chloride undergoes electrolysis.

Oxygen is produced at the anode.

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

....

....

.... [2]

(ii) Write an ionic half-equation for the production of oxygen at the anode.

.... [2]

[Total: 14]

4 Dinitrogen tetroxide, N_2O_4, decomposes into nitrogen dioxide, NO_2.The reaction is reversible.

$$\underset{\text{colourless gas}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown gas}}{2NO_2(g)}$$

Fig. 4.1 shows a gas syringe containing a mixture of dinitrogen tetroxide and nitrogen dioxide. The gas syringe is sealed. The mixture reaches equilibrium and the colour of the mixture of gases is a pale brown.

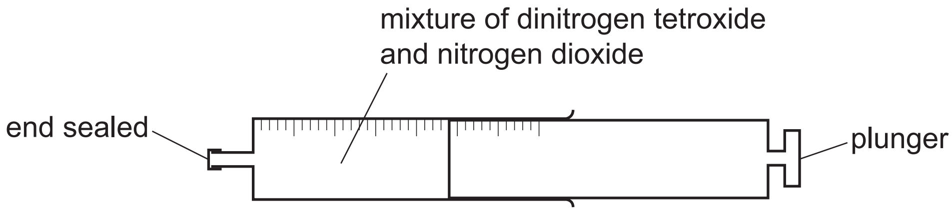

Fig. 4.1

(a) Describe a reversible reaction at equilibrium in terms of:

- the rate of the forward reaction and the rate of the reverse reaction

....

- the concentration of reactants and products.

....
[2]

(b) The pressure of the mixture is increased. All other conditions stay the same.

The mixture immediately turns darker brown before the position of equilibrium changes.

Explain in terms of particles why the mixture immediately turns darker brown.

.... [1]

(c) The temperature of the mixture is increased. All other conditions stay the same.

The mixture turns darker brown.

State what can be deduced about the forward reaction from this information.

.... [1]

(d) Sulfur is converted into sulfuric acid, H_2SO_4, by a series of reactions.

Sulfur dioxide, SO_2, and oxygen, O_2, react to form sulfur trioxide, SO_3. The reversible reaction reaches equilibrium.

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

(i) Complete Table 4.1 using only the words, **increases**, **decreases** or **no change**.

Table 4.1

	effect on the rate of the forward reaction	effect on the equilibrium yield of SO_3(g)
add a catalyst		
increase the pressure		

[4]

(ii) Deduce the oxidation number of sulfur in:

S ....

SO_3 ....

[2]

[Total: 10]

5 **(a)** Barium sulfate, $BaSO_4$, is an insoluble salt and is made by precipitation.

(i) Name **two** aqueous solutions that produce a precipitate of barium sulfate when they are mixed.

1 ....

2 ....
[2]

(ii) Describe how to produce a pure sample of barium sulfate from the mixture of aqueous solutions in **(a)(i)**.

....

.... [2]

(iii) Write an ionic equation for the precipitation reaction which produces barium sulfate. Include state symbols.

.... [3]

(b) Soluble salts are made from dilute acids.

Name the dilute acid and one other substance that react together to make copper(II) sulfate.

dilute acid ....

other substance ....
[2]

(c) Nitrates decompose when they are heated.

When hydrated copper(II) nitrate is heated, oxygen gas is produced.

(i) Describe a test for oxygen.

test ....

observations ....
[1]

(ii) Complete the equation for the decomposition of hydrated copper(II) nitrate.

$$2Cu(NO_3)_2{\bullet}3H_2O \rightarrow .....CuO + ...NO_2 + O_2 + ...H_2O$$ [2]

(d) Hydrated zinc sulfate gives off water when it is heated.

$$ZnSO_4{\bullet}\mathbf{x}H_2O(s) \rightarrow ZnSO_4(s) + \mathbf{x}H_2O(g)$$

A student does an experiment to determine the value of **x** in $ZnSO_4{\bullet}\mathbf{x}H_2O$.

step 1 The student weighs a sample of hydrated zinc sulfate.

step 2 The student heats the sample of hydrated zinc sulfate.

step 3 The student weighs the solid after heating.

step 4 The student repeats **step 2** and **step 3** until the mass of solid after heating is constant.

(i) State why the student does **step 4**.

.... [1]

(ii) In an experiment, 0.574 g of $ZnSO_4{\bullet}\mathbf{x}H_2O$ is heated until the mass is constant.

The mass of $ZnSO_4$ that remains is 0.322 g.

[M_r: $ZnSO_4$, 161; H_2O, 18]

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

- Calculate the number of moles of $ZnSO_4$ remaining.

.... mol

- Calculate the mass of H_2O given off.

.... g

- Calculate the number of moles of H_2O given off.

.... mol

- Determine the value of **x**.

x = ...
[4]

[Total: 17]

6 This question is about iron.

(a) Fig. 6.1 shows a blast furnace used to extract iron from its ore.

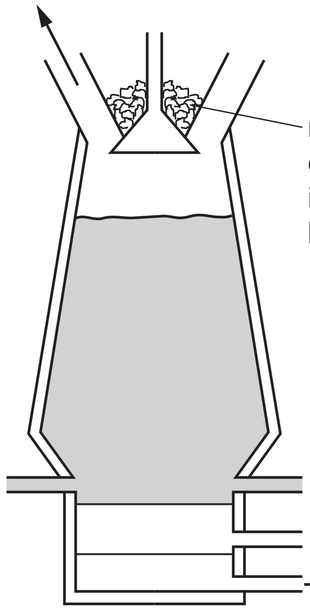

Fig. 6.1

(i) Name the main ore of iron used in the blast furnace.

.... [1]

(ii) Name the substance that enters the blast furnace at **A**.

.... [1]

(iii) Name the reducing agent in the extraction of iron in the blast furnace.

.... [1]

(iv) Explain why limestone is added to the blast furnace. Give details of the chemical reactions that are involved.

....

....

....

.... [3]

(b) The list shows the properties of some elements.

- act as catalysts
- have low densities
- have low melting points
- form acidic or basic oxides
- form coloured compounds
- form positive or negative ions

Iron is a transition metal. Sodium is a Group I metal.

State which property from the list:

(i) is true for sodium but **not** iron

.... [1]

(ii) is true for iron but **not** sodium

.... [1]

(iii) is true for both sodium and iron

.... [1]

(iv) is **not** true for sodium and **not** true for iron.

.... [1]

(c) Steel consists mainly of iron.

Iron rusts when it reacts with water and oxygen.

Fig. 6.2 shows magnesium blocks attached to the bottom of a steel boat. The magnesium does **not** completely cover the steel.

The magnesium blocks provide sacrificial protection for the steel.

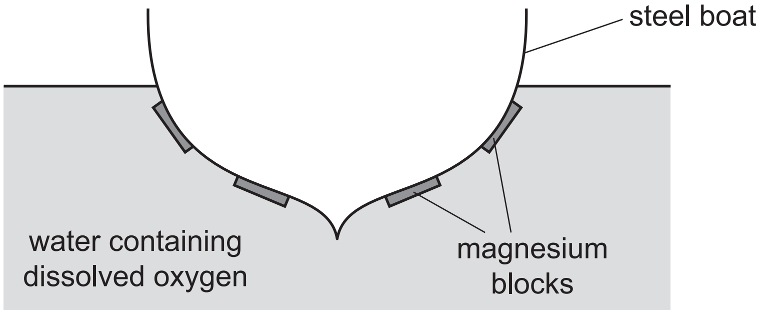

Fig. 6.2

(i) Explain, in terms of electrons, why magnesium is used for sacrificial protection.

....

.... [2]

(ii) Name a metal that cannot provide sacrificial protection for steel.

.... [1]

[Total: 13]

7 Many organic compounds contain carbon and hydrogen only.

(a) **(i)** An organic compound **A** has the following composition by mass.

C, 83.33%; H, 16.67%

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

empirical formula = ... [3]

(ii) Compound **B** has the empirical formula C_2H_5 and a relative molecular mass of 58.

Determine the molecular formula of compound **B**.

molecular formula = ... [2]

(b) Fig. 7.1 shows a section of a polymer formed from an alkene.

(i) Identify the functional group in alkenes that reacts when alkenes form polymers.

.... [1]

(ii) A section of a polymer is shown in Fig. 7.1.

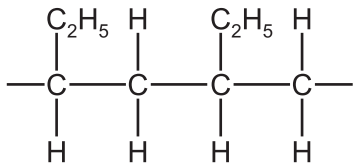

Fig. 7.1

- Draw the displayed formula of the monomer that forms this polymer.

- Name the monomer used to form this polymer.

....

[3]

(c) Alkenes are produced by cracking alkanes.

When $C_{12}H_{26}$ is cracked, the products are ethene and an alkane which form in a 2 : 1 mole ratio.

Write a symbol equation for this reaction.

$C_{12}H_{26}$ → .... + ... [2]

(d) **(i)** State the general formula for alcohols.

.... [1]

(ii) Draw the displayed formula of **one** alcohol with the molecular formula C_3H_8O. Name the alcohol you have drawn.

name of alcohol ....
[2]

[Total: 14]

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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) **May/June 2024**

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 2024 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 descriptions 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	'List rule' guidance 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)	Haber (process)	**1**
1(b)	electrolysis	**1**
1(c)	filtration	**1**
1(d)	catalytic addition	**1**
1(e)	chromatography	**1**
1(f)	fractional distillation	**1**
1(g)	titration	**1**

Question	Answer	Marks
2	M1 Cu: 29 and 34 M2 Cl^- : 17 and 18 M3 $^{64}{}_{30}$ to left of symbol M4 Zn M5 2^+	**5**

Question	Answer	Marks
3(a)(i)	mobile electrons	**1**
3(a)(ii)	M1 double bond of two dots and two crosses M2 4 non-bonding electrons on each oxygen atom	**2**
3(a)(iii)	M1 liquid M2 melting point is below –195 °C and boiling point is above –195 °C **or** –195 °C is higher than –199 °C / melting point and lower than –191 °C / boiling point **or** –195 °C is in between melting point / –199 °C and boiling point / –191 °C	**2**
3(a)(iv)	M1 graphite has a giant covalent structure M2 attraction between molecules in carbon monoxide M3 weaker attraction (between particles) in carbon monoxide ORA	**3**
3(b)	$2K + Cl_2 \rightarrow 2KCl$ M1 KCl as only product M2 correct equation	**2**
3(c)(i)	M1 breakdown by (the passage of) electricity M2 of an ionic compound in molten or aqueous (state)	**2**

Question	Answer	Marks
3(c)(ii)	$4OH^- \rightarrow 2H2O + O2 + 4e^-$ M1 any negatively charged OH species losing electrons M2 correct ionic half-equation	**2**

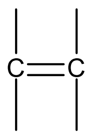
Question	Answer	Marks
4(a)	M1 (rates are) equal M2 (concentrations are) no longer changing	**2**
4(b)	more molecules of nitrogen dioxide per unit volume OR same number of nitrogen dioxide molecules in a smaller volume	**1**
4(c)	(the forward reaction is) endothermic	**1**
4(d)(i)	<table><tr><td>M1 increases</td><td>M3 no change</td></tr><tr><td>M2 increases</td><td>M4 increases</td></tr></table>	**4**
4(d)(ii)	M1 (the oxidation number of sulfur in S) = zero M2 (the oxidation number of sulfur in SO_3) = +6	**2**

Question	Answer	Marks
5(a)(i)	M1 named soluble barium salt e.g. barium chloride / barium nitrate M2 named soluble sulfate salt e.g. sodium sulfate / potassium sulfate / ammonium sulfate / sulfuric acid	**2**
5(a)(ii)	M1 filter M2 wash (residue) with water and dry (residue) between filter papers / in a warm place	**2**
5(a)(iii)	Ba^{2+} (aq) + $SO4^{2-}$ (aq) → $BaSO_4$(s) M1 $BaSO_4$ as only product M2 Ba^{2+} + $SO4^{2-}$ as only reactants M3 state symbols	**3**
5(b)	M1 sulfuric (acid) M2 copper(II) carbonate / copper(II) oxide / copper(II) hydroxide	**2**
5(c)(i)	glowing splint and relights	**1**
5(c)(ii)	M1 2CuO + $4NO_2$ M2 $6H_2O$	**2**
5(d)(i)	(To ensure that) all the water is given off	**1**

Question	Answer	Marks
5(d)(ii)	M1 mol $ZnSO_4$ (0.322 / 161 =) 0.002(00) M2 mass H_2O given off (0.574 – 0.322 =) 0.252 M3 mol H_2O given off (0.252 ÷ 18 =) 0.014(0) M4 value of x (0.014 ÷ 0.002 =) 7	**4**

Question	Answer	Marks
6(a)(i)	hematite	**1**
6(a)(ii)	air	**1**
6(a)(iii)	carbon monoxide	**1**
6(a)(iv)	M1 limestone thermally decomposes (into calcium oxide and carbon dioxide) M2 calcium oxide reacts with silicon(IV) oxide M3 producing slag	**3**
6(b)(i)	have low densities or have low melting point	**1**
6(b)(ii)	act as catalysts **or** form coloured compounds	**1**

Question	Answer	Marks
6(b)(iii)	form basic oxides **or** form positive ions	**1**
6(b)(iv)	form acidic oxides **or** form negative ions	**1**
6(c)(i)	M1 magnesium loses electrons more readily than / in preference to / instead of iron M2 magnesium is more reactive than iron ORA	**2**
6(c)(ii)	any metal below iron in the reactivity series e.g. copper / silver / gold	**1**

Question	Answer	Marks
7(a)(i)	M1 C 83.33 / 12: H 16.67 / 1 or 6.94:16.67 M2 C 6.94 / 6.94: H 16.67 / 6.94 or 1:2.4 or 5:12 M3 C_5H_{12}	**3**
7(a)(ii)	M1 M_r of C_2H_5 = 29 M2 58 / 29 = 2 and C_4H_{10}	**2**
7(b)(i)	C=C	**1**
7(b)(ii)	M1  any C=C with both carbons having a valency of 4 M2 displayed formula of but-1-ene M3 but-1-ene	**3**

Question	Answer	Marks
7(c)	M1 $2C_2H_4$ M2 C_8H_{18}	**2**
7(d)(i)	$C_nH_{2n} + {}_1OH$	**1**
7(d)(ii)	M1 displayed formula of propan-1-ol or propan-2-ol M2 propan-1-ol **or** propan-2-ol	**2**

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* 7 0 7 1 6 6 8 7 3 5 *

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2024**

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.

IB24 06_0620_42/4RP

1 A list of gases is shown.

ammonia
helium
hydrogen
carbon dioxide
carbon monoxide
chlorine
methane
nitrogen dioxide
propene
sulfur dioxide

Answer the following questions about these gases.

Each gas may be used once, more than once or not at all.

(a) State **one** gas which:

(i) is the main constituent of natural gas

.... [1]

(ii) is responsible for both photochemical smog **and** acid rain

.... [1]

(iii) is unsaturated

.... [1]

(iv) has monatomic particles

.... [1]

(v) reduces iron(III) oxide in a blast furnace.

.... [1]

(b) Nitrogen dioxide, NO_2, and carbon monoxide are removed from a car exhaust by a catalytic converter.

Write the symbol equation for this reaction.

.... [2]

[Total: 7]

2 A list of five metals is shown.

copper
iron
magnesium
potassium
silver

(a) All metals form positive ions.

(i) Describe how atoms form positive ions.

.... [1]

(ii) State which of the five metals in the list has the greatest tendency to form positive ions.

.... [1]

(iii) Suggest **one** of the five metals in the list which is **not** likely to show catalytic properties.

.... [1]

(iv) State which of the five metals in the list is a major component of stainless steel.

.... [1]

(b) A student adds a sample of a metal to an aqueous metal salt in a beaker to see if a displacement reaction takes place.

Complete Table 2.1 to show the colour of the solution in the beaker at the start and at the end of the experiment.

Table 2.1

metal	aqueous solution	colour at the start	colour at the end
magnesium	iron(II) sulfate	green	
silver	copper(II) sulfate		

[3]

(c) Most Group II metals form a gas when placed into cold water. An alkaline solution is also formed.

(i) Name the gas formed when strontium is added to cold water.

.... [1]

(ii) Name the alkaline solution formed when strontium is added to cold water.

.... [1]

(iii) One Group II metal reacts very slowly when placed in cold water. When heated, the metal reacts with steam to form a white solid.

Identify this metal and name the white solid formed.

metal ....

white solid ....
[2]

(d) Under certain conditions, iron will react with steam to form an oxide of iron with the formula Fe_3O_4.

Fe_3O_4 reacts with dilute hydrochloric acid to form a mixture of iron(II) and iron(III) salts and water.

Deduce the symbol equation for the reaction between Fe_3O_4 and dilute hydrochloric acid.

.... [3]

[Total: 14]

3 The symbol equation for the industrial production of ammonia is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -90\,\text{kJ/mol}$$

(a) Name this industrial process.

.... [1]

(b) State the meaning of ΔH.

.... [1]

(c) State the typical conditions and name the catalyst used in the industrial production of ammonia.

temperature and units ....

pressure and units ....

catalyst used ....

[3]

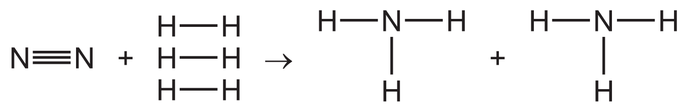
(d) State **two** methods of increasing the rate of this reaction.

1 ....

2 ....

[2]

(e) The symbol equation for the reaction can be represented as shown in Fig. 3.1.



ΔH = –90 kJ / mol

Fig. 3.1

Table 3.1 shows some bond energies.

Table 3.1

bond	N≡N	H–H
bond energy in kJ / mol	945	435

Use the bond energies in Table 3.1 and ΔH to calculate the bond energy of an N–H bond, in kJ / mol.

Use the following steps.

- Calculate the energy needed to break bonds in the reactants.

.... kJ

- Calculate the energy released when bonds form in the products.

.... kJ

- Calculate the energy of an N–H bond.

.... kJ / mol
[3]

(f) An incomplete symbol equation for the preparation of ammonia in the laboratory is shown.

$$CaO + 2NH_4Cl \rightarrow CaCl_2 + \text{.........................} + 2NH_3$$

(i) Complete the symbol equation. [1]

(ii) Name NH_4Cl.

.... [1]

(iii) Calculate the volume of ammonia, NH_3, measured at room temperature and pressure, which forms when 1.12 g of CaO is heated with excess NH_4Cl.
[M_r: CaO, 56]

.... cm^3 [3]

[Total: 15]

4 A carboxylic acid reacts with an alcohol to produce an ester and water.

Under certain conditions, this reaction can be reversed so an ester reacts with water to produce a carboxylic acid **X** and an alcohol **Y**.

The reaction reaches an equilibrium.

$$CH_3CH_2COOCH_3 + H_2O \rightleftharpoons \mathbf{X} + \mathbf{Y}$$

The forward reaction is endothermic.

(a) Deduce the empirical formula of the ester.

.... [1]

(b) Name the ester.

.... [1]

(c) Name carboxylic acid **X** and draw its displayed formula.

name ....

displayed formula

[2]

(d) Name alcohol **Y** and give its structural formula.

name ....

structural formula ....
[2]

(e) Complete Table 4.1 to show the effect, if any, for each change of condition.

Table 4.1

change of condition	effect on the concentration of carboxylic acid **X** at equilibrium
temperature is decreased	
concentration of $CH_3CH_2COOCH_3$ is decreased	
more alcohol **Y** is added	
a catalyst is added	

[4]

(f) At the beginning of the reaction between the ester and water, no carboxylic acid is present in the reaction mixture.

(i) Suggest how the pH of the reaction mixture changes from the start of the reaction until equilibrium is reached.
Assume alcohols and esters are neutral.

pH at start of reaction ....

pH at equilibrium ....
[2]

(ii) Identify the ion that causes the change in pH.

.... [1]

(iii) Name an indicator which can be used to follow the change in pH.

.... [1]

[Total: 14]

5 Sulfur is a Group VI element.

(a) A sample of sulfur contains two isotopes, ^{32}S and ^{34}S.

(i) Complete Table 5.1 to show the number of protons and neutrons in one atom of each isotope of sulfur.

Table 5.1

	^{32}S	^{34}S
protons		
neutrons		

[2]

(ii) State why these isotopes have identical chemical properties.

.... [1]

(iii) State the mass of 6.02×10^{23} atoms of ^{34}S. Include units in your answer.

.... [1]

(iv) State the name of the amount of substance which contains 6.02×10^{23} atoms.

.... [1]

(v) Table 5.2 shows the relative abundance of these isotopes of sulfur in the sample.

Table 5.2

atom	^{32}S	^{34}S
relative abundance	95%	5%

Calculate the relative atomic mass of sulfur in this sample to **one** decimal place.

relative atomic mass = ... [2]

(b) Sulfur reacts with magnesium to form magnesium sulfide, MgS, an ionic compound.

(i) Complete the dot-and-cross diagram in Fig. 5.1 of the ions in magnesium sulfide.

Give the charges on the ions.

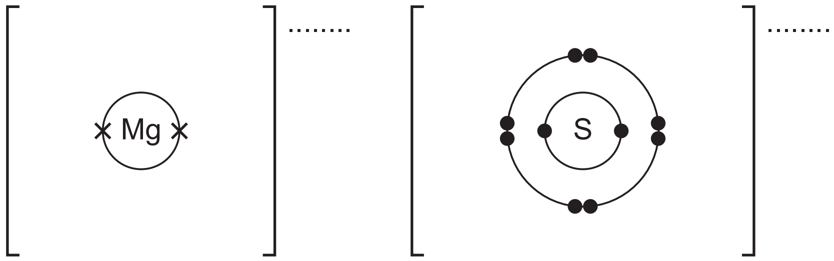


Fig. 5.1

[3]

(ii) State why MgS has a high melting point.

.... [1]

(iii) State why molten MgS conducts electricity.

.... [1]

(c) An acid containing sulfur reacts with sodium hydroxide, NaOH, to form a salt and water. The salt has the formula Na_2SO_3.

(i) Deduce the formula of this acid.

.... [1]

(ii) Deduce the formula of the anion in Na_2SO_3.

.... [1]

(d) Na_2SO_3 is oxidised by acidified aqueous potassium manganate(VII).

(i) State what VII refers to in the name potassium manganate(VII).

.... [1]

(ii) State the colour change when this reaction happens.

from .... to .... [2]

[Total: 17]

6 Glucose is involved in two processes.

(a) Glucose, $C_6H_{12}O_6$, is made in plants from carbon dioxide and water.

(i) Name this process.

.... [1]

(ii) Write the symbol equation for this process.

.... [1]

(iii) State **two** essential conditions needed for this process to happen.

1 ....

2 ....
[2]

(b) Glucose is converted to ethanol.

(i) Name this process.

.... [1]

(ii) Name the **other** product formed when glucose is converted to ethanol.

.... [1]

(c) Ethanol is made by reacting ethene with steam in an industrial process.

(i) State the conditions and type of catalyst used in this industrial production of ethanol.

temperature and units ....

pressure and units ....

type of catalyst used ....
[3]

(ii) Explain why this reaction is an addition reaction.

.... [1]

(iii) Complete the dot-and-cross diagram in Fig. 6.1 of a molecule of ethanol.

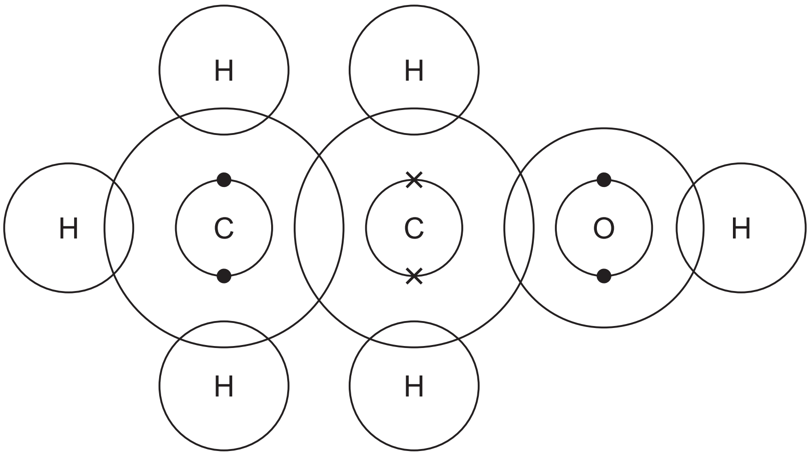


Fig. 6.1

[3]

[Total: 13]

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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		**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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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 International Education

Cambridge IGCSE™

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2024**

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 2024 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 **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 descriptions 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)(i)	methane	**1**
1(a)(ii)	nitrogen dioxide	**1**
1(a)(iii)	propene	**1**
1(a)(iv)	helium	**1**
1(a)(v)	carbon monoxide	**1**
1(b)	$2NO_2 + 4CO \rightarrow N_2 + 4CO_2$ **M1** N_2 + CO_2 as only products **M2** correct equation	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>electron loss (from outer shell)</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>potassium</td><td>1</td></tr>
<tr><td>2(a)(iii)</td><td>magnesium or potassium</td><td>1</td></tr>
<tr><td>2(a)(iv)</td><td>iron</td><td>1</td></tr>
<tr><td>2(b)</td><td><table><tr><td></td><td>M1 Colourless</td></tr><tr><td>M2 Blue</td><td>M3 Colour given in M2</td></tr></table></td><td>3</td></tr>
<tr><td>2(c)(i)</td><td>hydrogen</td><td>1</td></tr>
<tr><td>2(c)(ii)</td><td>strontium hydroxide</td><td>1</td></tr>
</table>

Question	Answer	Marks
2(c)(iii)	**M1** magnesium **or** Mg **M2** magnesium oxide	**2**
2(d)	$Fe_3O_4 + 8HCl \rightarrow 2FeCl_3 + FeCl_2 + 4H_2O$ M1 $FeCl_2$ **or** $FeCl_3$ as product of equation M2 $FeCl_2$ **and** $FeCl_3$ **and** H_2O as only products of equation M3 Correct equation	**3**

Question	Answer	Marks
3(a)	Haber	**1**
3(b)	enthalpy change (of reaction)	**1**
3(c)	450 **and** °C 200 **and** atm **or** 20 000 **and** kPa iron	**3**
3(d)	**M1** increase temperature **M2** increase pressure	**2**
3(e)	**M1** bond energy in breaking bonds = [945 + (3 × 435)] = **(+) 2250** (kJ / mol) **M2** = 2250 **+** 90 = **2340** **M3** = 2340 / 6 = **390**	**3**
3(f)(i)	H_2O	**1**
3(f)(ii)	Ammonium chloride	**1**

Question	Answer	Marks
3(f)(iii)	**M1** mol CaO = 1.12 / 56 = **0.02(00)** **M2** mol NH_3 = M1 × 2 = 0.02(00) × 2 = **0.04(00)** **M3** vol NH_3 = M2 × 24000 = 0.04 × 24000 = **960**	**3**

Question	Answer	Marks
4(a)	C_2H_4O	**1**
4(b)	methyl propanoate	**1**
4(c)	**M1 displayed** formula of propanoic acid **M2** propanoic acid	**2**
4(d)	**M1** structure of CH_3OH **M2** methanol	**2**
4(e)	**M1** decreases **M2** decreases **M3** decreases **M4** no effect	**4**
4(f)(i)	**M1** 7 **M2** $3 \geqslant pH < 7$	**2**
4(f)(ii)	$H^+(aq)$	**1**
4(f)(iii)	universal indicator	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)(i)</td><td><table><tr><th></th><th>^{32}S</th><th>^{34}S</th></tr><tr><td>protons</td><td>16</td><td>16</td></tr><tr><td>neutrons</td><td>16</td><td>18</td></tr></table></td><td>2</td></tr>
<tr><td>5(a)(ii)</td><td>same electronic configuration / structure</td><td>1</td></tr>
<tr><td>5(a)(iii)</td><td>34 and g</td><td>1</td></tr>
<tr><td>5(a)(iv)</td><td>1 mole</td><td>1</td></tr>
<tr><td>5(a)(v)</td><td>M1 $(32 \times 95) + (34 \times 5) = 3210$

M2 $3210 / 100 = 32.1$</td><td>2</td></tr>
<tr><td>5(b)(i)</td><td>M1 eight crosses in second shell of Mg
M2 6 dots and 2 cross in third shell of S
M3 ‘2+’ charge on Mg on correct answer line
and ‘2–’ charge on S on correct answer line</td><td>3</td></tr>
<tr><td>5(b)(ii)</td><td>ionic bonds are strong</td><td>1</td></tr>
<tr><td>5(b)(iii)</td><td>mobile ions</td><td>1</td></tr>
<tr><td>5(c)(i)</td><td>H_2SO_3</td><td>1</td></tr>
<tr><td>5(c)(ii)</td><td>SO_3^{2-}</td><td>1</td></tr>
<tr><td>5(d)(i)</td><td>the oxidation number of manganese / Mn is +7</td><td>1</td></tr>
<tr><td>5(d)(ii)</td><td>M1 purple
to
M2 colourless</td><td>2</td></tr>
</table>

Question	Answer	Marks
6(a)(i)	photosynthesis	**1**
6(a)(ii)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$	**1**
6(a)(iii)	**M1** energy from light **M2** presence of chlorophyll	**2**
6(b)(i)	fermentation	**1**
6(b)(ii)	carbon dioxide	**1**
6(c)(i)	**M1** 300 °C **M2** 60 atm or 6000 kPa **M3** acid	**3**
6(c)(ii)	only one product is formed	**1**
6(c)(iii)	**M1** C–C bond as dot and cross and C–O as 'cross and dot' **M2** all C–H bonds and O–H bond as dot and cross **M3** 4 non-bonding **dot** electrons on O atom **and** no other non-bonding electrons on C or H	**3**

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Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 1 1 8 2 4 5 5 7 1 8 *

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2024**

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 Name the process that is used to:

(a) convert sulfur dioxide into sulfur trioxide in the manufacture of sulfuric acid

.... [1]

(b) obtain water from aqueous sodium chloride

.... [1]

(c) extract aluminium from purified bauxite

.... [1]

(d) separate petroleum into useful substances

.... [1]

(e) produce ethanol from aqueous glucose

.... [1]

(f) manufacture alkenes and hydrogen from large alkane molecules

.... [1]

(g) separate a mixture of soluble coloured substances.

.... [1]

[Total: 7]

2 Complete Table 2.1.

Table 2.1

atom or ion	number of protons	number of electrons	number of neutrons
$^{37}_{17}Cl$		17	
$^{63}_{29}Cu^{+}$			34
	16	18	17

[5]

3 This question is about the elements sodium and fluorine and the compound sodium fluoride.

(a) Sodium reacts with fluorine to form sodium fluoride.

Write a symbol equation for this reaction.

.... [2]

(b) Some properties of sodium, fluorine and sodium fluoride are shown in Table 3.1.

Table 3.1

	melting point / °C	boiling point / °C	conduction of electricity when solid	conduction of electricity in aqueous solution
sodium	98	883	good	
fluorine	–220	–188	poor	
sodium fluoride	993	1695	poor	good

(i) Explain why sodium conducts electricity when it is a solid.

.... [1]

(ii) Complete the dot-and-cross diagram in Fig. 3.1 of a molecule of fluorine.

Show outer shell electrons only.

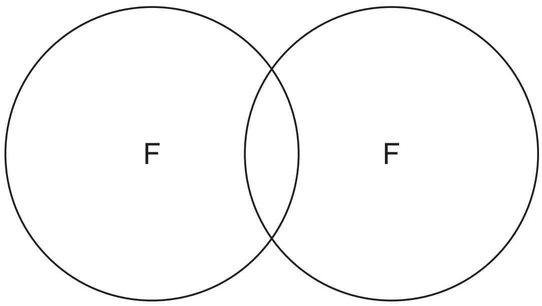

Fig. 3.1

[2]

(iii) Deduce the physical state of fluorine at –200 °C. Use the data in Table 3.1 to explain your answer.

physical state ....

explanation ....

....
[2]

(iv) Explain in terms of structure and bonding why sodium fluoride has a much higher melting point than fluorine.

....

....

....

....

.... [3]

(c) Dilute aqueous sodium fluoride undergoes electrolysis.

Hydrogen is produced at the cathode.

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

....

....

.... [2]

(ii) Write an ionic half-equation for the production of hydrogen at the cathode.

.... [2]

[Total: 14]

4 Hydrogen iodide thermally decomposes into iodine and hydrogen. The reaction is reversible.

2HI(g)	$\rightleftharpoons$	I_2(g)	+	H_2(g)
colourless gas		purple gas		colourless gas

Fig. 4.1 shows a gas syringe containing a mixture of hydrogen iodide, iodine and hydrogen gases. The gas syringe is sealed and the mixture is heated to 300 °C. The mixture of gases reaches equilibrium and is purple.

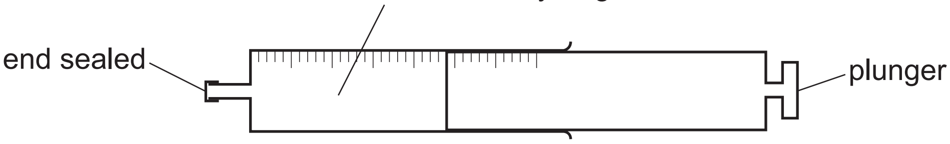

Fig. 4.1

(a) State what is meant by the term equilibrium.

....

....

.... [2]

(b) The pressure of the mixture is increased. All other conditions stay the same. The position of equilibrium does **not** change.

The colour of the gaseous mixture turns darker purple.

The temperature remains constant.

2HI(g)	$\rightleftharpoons$	I_2(g)	+	H_2(g)
colourless gas		purple gas		colourless gas

(i) Explain why the position of equilibrium does **not** change.

....

.... [1]

(ii) Suggest why the colour of the mixture of gases turns darker purple.

....

.... [1]

(c) The temperature of the mixture of gases is decreased. All other conditions stay the same.

The mixture of gases turns lighter purple.

State what can be deduced about the forward reaction from this information.

.... [1]

(d) Deduce the oxidation number of iodine, I, in:

HI ....

I_2. ....
[2]

(e) Methanol is manufactured by reacting carbon monoxide with hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The rate of formation of methanol increases when a catalyst is used.

(i) Choose from the list the element that is most likely to be used as the catalyst.

Draw a circle around your chosen answer.

calcium **carbon** **copper** **sodium** **sulfur** [1]

(ii) State the effect on the position of equilibrium when a catalyst is used.

.... [1]

(iii) State the effect that a catalyst has on the activation energy, E_a, of a reaction.

.... [1]

[Total: 10]

5 **(a)** Lead(II) bromide, $PbBr_2$, is an insoluble salt and is made by precipitation.

(i) Name **two** aqueous solutions that produce a precipitate of lead(II) bromide when they are mixed.

1 ....

2 ....
[2]

(ii) Describe how to produce a pure sample of lead(II) bromide from the mixture of aqueous solutions in **(a)(i)**.

....

.... [2]

(iii) Write an ionic equation for the precipitation reaction which produces lead(II) bromide. Include state symbols.

.... [3]

(b) When iron(II) sulfate crystals are heated strongly, sulfur dioxide gas is given off.

Describe a test for sulfur dioxide gas.

test ....

observations ....
[2]

(c) Complete the equation for the thermal decomposition of hydrated cobalt(II) nitrate.

$$2Co(NO_3)_2{\bullet}4H_2O \rightarrow ....CoO + ...NO_2 + O_2 + ...H_2O$$ [2]

(d) Hydrated cobalt(II) sulfate, $CoSO_4 \cdot \mathbf{x}H_2O$, produces water when it is heated.

$$CoSO_4 \cdot \mathbf{x}H_2O(s) \rightarrow CoSO_4(s) + \mathbf{x}H_2O(g)$$

A student does an experiment to determine the value of **x** in $CoSO_4 \cdot \mathbf{x}H_2O$.

step 1 The student weighs a sample of hydrated cobalt(II) sulfate.

step 2 The student heats the sample of hydrated cobalt(II) sulfate.

step 3 The student weighs the remaining solid after heating.

(i) Describe what else the student should do to ensure that **all** the water has been given off. No other substances are required.

....

....

.... [2]

(ii) In an experiment, 1.405 g of $CoSO_4 \cdot \mathbf{x}H_2O$ is heated until all the water is given off.

The mass of $CoSO_4$ that remains is 0.775 g.

[M_r: $CoSO_4$, 155; H_2O, 18]

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

- Calculate the number of moles of $CoSO_4$ that remains.

.... mol

- Calculate the mass of H_2O given off.

.... g

- Calculate the number of moles of H_2O given off.

.... mol

- Determine the value of **x**.

x = ...
[4]

[Total: 17]

6 This question is about metals.

(a) Fig. 6.1 shows a blast furnace used to extract iron from its ore.

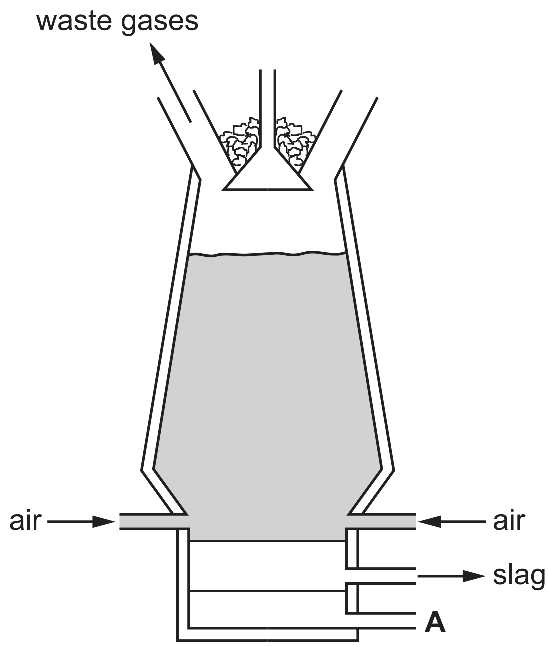

Fig. 6.1

(i) Coke and iron ore are added at the top of the blast furnace.

Name one **other** substance that is added at the top of the blast furnace.

.... [1]

(ii) Name the substance that leaves the blast furnace at **A**.

.... [1]

(iii) Slag is produced from an impurity in iron ore.

Name the impurity in iron ore that is converted into slag.

.... [1]

(iv) Name **two** substances that react together to produce the high temperature in the blast furnace.

.... and .... [1]

(v) Name **two** waste gases that leave the blast furnace.

1 ....

2 ....
[2]

(b) Zinc is produced from zinc oxide in a furnace.

The zinc is produced as a gas. It then forms molten zinc.

(i) Suggest why the zinc produced inside the furnace is a gas.

.... [1]

(ii) State the name of the physical change that occurs when gaseous zinc is converted into molten zinc.

.... [1]

(c) Zinc is used to coat iron to prevent rusting.

(i) Name the process used to coat iron with zinc as a method of rust prevention.

.... [1]

(ii) When the zinc coating is scratched, the iron underneath does not rust.

Explain why the iron underneath the zinc does **not** rust.

....

.... [2]

(d) Zinc oxide neutralises both acids and bases.

(i) State the general name given to oxides that neutralise both acids and bases.

.... [1]

(ii) When zinc oxide neutralises aqueous sodium hydroxide, sodium zincate is formed.

The formula of the zincate ion is ZnO_2^{2-}.

Deduce the formula of sodium zincate.

.... [1]

(iii) Name the zinc compound that forms when zinc oxide neutralises dilute sulfuric acid.

.... [1]

[Total: 14]

7 Many organic compounds contain carbon and hydrogen only.

(a) **(i)** Organic compound **A** has the following composition by mass.

C, 82.76%; H, 17.24%

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

empirical formula = ... [3]

(ii) Compound **B** has the empirical formula CH_2 and a relative molecular mass of 70.

Determine the molecular formula of compound **B**.

molecular formula = ... [1]

(b) Fig. 7.1 shows a section of polymer **Q**.

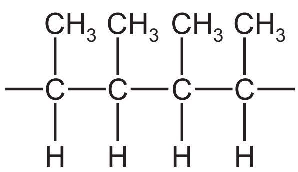

Fig. 7.1

- Draw the displayed formula of the monomer that forms polymer **Q**.

- Name the monomer used to form polymer **Q**.

.... [3]

(c) Propene, C_3H_6, can be produced by heating $C_{11}H_{24}$. The products of the reaction are propene, hydrogen and one other product in a 1 : 1 : 1 mole ratio.

Complete the symbol equation for this reaction.

$C_{11}H_{24} \rightarrow C_3H_6 + H_2 +$ .... [1]

(d) Carboxylic acids and esters contain carbon, hydrogen and oxygen only.

An ester **X** and a carboxylic acid **Y** both contain 3 carbon atoms.

X and **Y** have the same molecular formula.

(i) State the name given to compounds with the same molecular formula but different structural formulae.

.... [1]

(ii) Esters are made by the reaction between carboxylic acids and alcohols.

Ester **X** is methyl ethanoate.

Name the carboxylic acid and the alcohol used to make methyl ethanoate.

carboxylic acid ....

alcohol ....
[2]

(iii) Draw the displayed formula of carboxylic acid **Y**. Name the carboxylic acid.

name ....
[2]

[Total: 13]

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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 International Education

Cambridge IGCSE™

CHEMISTRY	**0620/41**
Paper 4 Theory (Extended)	**May/June 2024**
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 2024 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 descriptions 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.

If the candidate uses different terminology to the terminology on the Mark Scheme full credit must be given if the meaning is the same.

Any response that is worth more than 1 mark must be annotated by tick(s). The number of ticks should be the same as the number of marks awarded. This applies even if other annotations such as BOD or ECF are used. Ticks should be placed as near as possible to the place where the mark is awarded. Please see Practice scripts for examples.

Question	Answer	Marks
1(a)	Contact process	**1**
1(b)	distillation	**1**
1(c)	electrolysis	**1**
1(d)	fractional distillation	**1**
1(e)	fermentation	**1**
1(f)	cracking	**1**
1(g)	chromatography	**1**

Question	Answer	Marks
2	**M1** : Cl: 17 **AND** 20 (1) **M2** Cu^{+}: 29 **AND** 28 (1) **M3** 33(above) **and** 16(below) on left hand side of symbol (1) **M4** S (1) **M5** 2^{-} (1)	**5**

Question	Answer	Marks
3(a)	$2Na + F_2 \rightarrow 2NaF$(2) **M1** NaF(1) Has to be the only product **M2** equation completely correct(1)	**2**
3(b)(i)	**electrons** move **OR** **electrons** are mobile **OR** **electrons** flow	**1**
3(b)(ii)	**M1** one shared dot and cross(1) **M2** 6 non–bonding electrons (either) dots or crosses on each fluorine atom to complete both octets (1)	**2**
3(b)(iii)	**M1** liquid(1) **M2 BOTH** melting point is below –200 °C **AND** boiling point is above –200 °C(1) **OR** **BOTH** –200 °C is higher than –220 °C/ melting point **AND** lower than –188 °C/ boiling point(1) **OR** –200 °C is **between** melting point **or** –220 °C **and** boiling point or –188 °C(1)	**2**
3(b)(iv)	**M1 ionic bonds** in NaF(1) **M2** attraction between molecules **or** intermolecular forces in F_2(1) **M3** weak**er** attraction (between particles) in F_2 **ORA** (1)	**3**

Question	Answer	Marks
3(c)(i)	**M1 breakdown** by (the passage of) **electricity**(1) **M2** of an **ionic compound** in **molten or aqueous** (state) (1)	**2**
3(c)(ii)	$2H^+ + 2e^{(-)} \rightarrow H_2$ **M1** $H^+ + e^{(-)}$ on left hand side(1) **M2** equation fully correct(1)	**2**

Question	Answer	Marks
4(a)	**M1** The **rate** of forward reaction equals the rate of the reverse reaction(1) **M2 concentrations** of reactants and products are no longer changing(1)	**2**
4(b)(i)	same number of gas moles on both sides of the equilibrium **OR** same number of gas molecules on both sides of the equilibrium	**1**
4(b)(ii)	iodine **particles** or **molecules** (forced) closer together **OR** same number of iodine **particles** or **molecules** in a smaller volume	**1**
4(c)	endothermic	**1**
4(d)	**M1** –1 (1) **M2** zero (1)	**2**
4(e)(i)	copper	**1**

Question	Answer	Marks
4(e)(ii)	no effect	**1**
4(e)(iii)	(activation energy is) low**er**	**1**

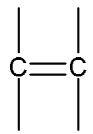
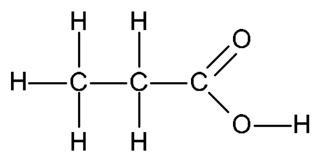
Question	Answer	Marks
5(a)(i)	**M1** lead(II) nitrate(1) **M2** sodium bromide / potassium bromide / ammonium bromide(1)	**2**
5(a)(ii)	**M1** filter precipitate **or** lead(II) bromide **or** solid **or** residue(1) **M2** wash the residue with distilled water **AND** dry e.g. between filter papers(1)	**2**
5(a)(iii)	$Pb^{2+}(aq) + 2Br^{-}(aq) \rightarrow PbBr_2(s)$ **M1** $PbBr_2$ as the **only** product (1) **M2** $Pb^{2+} + 2Br^{-}$ as the **only** reactants in a balanced equation(1) **M3** state symbols (aq) + (aq) → (s)(1)	**3**
5(b)	**M1** acidified aqueous potassium manganate(VII) (1) **M2** purple to colourless (1)	**2**
5(c)	**M1** 2CoO + $4NO_2$ (1) **M2** $8H_2O$ (1)	**2**

Question	Answer	Marks
5(d)(i)	**M1 heat** again **and weigh** again **OR** repeat steps 2 and 3(1) **M2** until mass is constant (1)	**2**
5(d)(ii)	**M1** 0.005 / 5 $\times 10^{-3}$ (1) **M2** 0.63 (1) **M3** (0.63 / 18 =) 0.035 (1) **M4** (0.035 ÷ 0.005 =) 7 (1)	**4**

Question	Answer	Marks
6(a)(i)	limestone **OR** calcium carbonate	**1**
6(a)(ii)	(molten) iron	**1**
6(a)(iii)	silicon(IV) oxide **OR** silicon dioxide	**1**
6(a)(iv)	coke or carbon **and** oxygen	**1**
6(a)(v)	**Any two from:** • nitrogen • carbon dioxide • argon	**2**

Question	Answer	Marks
6(b)(i)	the temperature in the furnace is above **or** higher than the boiling point of zinc **ORA** **OR** the boiling point of zinc is below **or** less than the temperature of the furnace **ORA**	**1**
6(b)(ii)	condensation / condensing	**1**
6(c)(i)	galvanising	**1**
6(c)(ii)	**M1** zinc is more reactive than iron (1) **M2** zinc is oxidised / zinc loses electrons / zinc forms positive ions / zinc forms zinc ions (1)	**2**
6(d)(i)	amphoteric	**1**
6(d)(ii)	Na_2ZnO_2	**1**
6(d)(iii)	zinc sulfate	**1**

Question	Answer	Marks
7(a)(i)	**M1** C 82.76 / 12: H 17.24/1 (1) **OR** evaluation i.e. 6.90:17.24 **M2** fractions showing division of both by smaller ie 6.9 / 6.9 and 17.24 / 6.9 **OR** evaluation ie 1:2.5 **OR** 4:10 **M3** C_2H_5 (1)	**3**

Question	Answer	Marks
7(a)(ii)	C_5H_{10}	**1**
7(b)	**M1**  any C=C with both carbons having a valency of 4(1) **M2** correct displayed formula of (cis or trans) but–2–ene(1) **M3** but–2–ene	**3**
7(c)	C_8H_{16}	**1**
7(d)(i)	structural isomers	**1**
7(d)(ii)	**M1** ethanoic acid(1) **M2** methanol(1)	**2**
7(d)(iii)	**M1** Displayed formula of propanoic acid showing **ALL** atoms and bonds  (1) **M2** propanoic acid(1)	**2**

Cambridge Assessment International Education

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2024**

45 minutes

You must answer on the multiple choice answer sheet.

3391087851

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 **20** pages. Any blank pages are indicated.

1 Sodium chloride is a liquid at 900 °C.

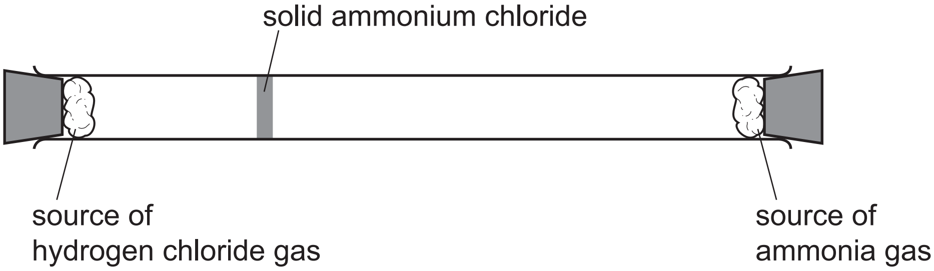
Which row describes the arrangement and the motion of the particles in sodium chloride at 900 °C?

	arrangement of particles	motion of particles
A	regular	vibrate about a fixed point
B	regular	move randomly
C	random	vibrate about a fixed point
D	random	move randomly

2 Hydrogen chloride gas, HCl, reacts with ammonia gas, NH_3, to form solid ammonium chloride.

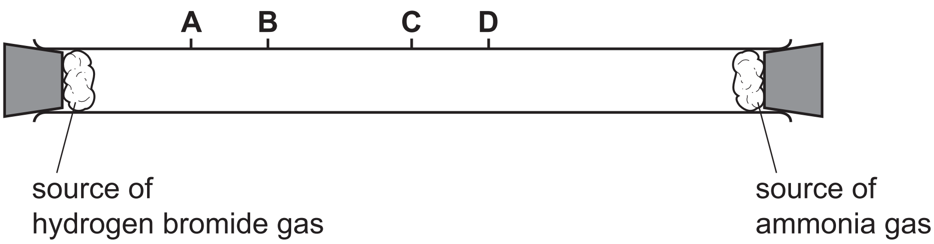
The apparatus is set up as shown.

After a few minutes, a white cloud of solid ammonium chloride forms where the two gases meet.



The experiment is repeated using hydrogen bromide gas, HBr, in place of hydrogen chloride.

How far along the tube does the white cloud of solid ammonium bromide form?



3 Substances P and Q both conduct electricity.

P is a mixture of two different types of atom.

Q is made of only one type of atom.

Which row describes P and Q?

	P	Q
A	alloy	element
B	alloy	compound
C	compound	alloy
D	compound	element

4 An atom of element R contains 15 protons, 16 neutrons and 15 electrons.

What is R?

A gallium

B phosphorus

C sulfur

D zinc

5 Which molecule contains a double covalent bond between two atoms of the same element?

A carbon dioxide

B ethanol

C ethene

D nitrogen

6 Silicon(IV) oxide is a covalently bonded compound.

Which statements are correct?

1 Silicon atoms form four single bonds in silicon(IV) oxide.

2 Oxygen atoms form two double bonds in silicon(IV) oxide.

3 Silicon(IV) oxide has a high melting point.

4 Silicon(IV) oxide contains one silicon atom and four oxygen atoms.

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

7 The equation for the reaction of iron(III) oxide with carbon monoxide is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

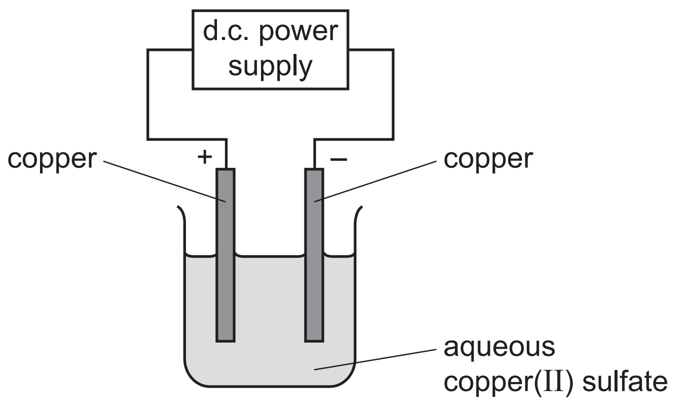
What is the percentage yield of iron when 16.8 g of carbon monoxide reacts completely with iron(III) oxide to form 8.96 g of iron?

A 26.7% **B** 40.0% **C** 53.3% **D** 80.0%

8 What is the volume of 14.5 g of gaseous butane, C_4H_{10}, at room temperature and pressure?

A 96.0 cm^3 **B** 6.0 cm^3 **C** 96.0 dm^3 **D** 6.0 dm^3

9 Aqueous copper(II) sulfate is electrolysed using copper electrodes.



Which statement describes what happens during the electrolysis?

A Copper atoms gain electrons at the cathode and copper(II) ions lose electrons at the anode.

B Electrons move in the external circuit from the positive electrode to the negative electrode.

C Copper(II) ions move through the electrolyte from the cathode to the anode.

D Copper is formed at the cathode and oxygen is formed at the anode.

10 Electrolysis is carried out on concentrated aqueous potassium bromide using inert electrodes.

Which products are formed at the anode and the cathode?

	anode	cathode
A	bromine	hydrogen
B	bromine	potassium
C	hydrogen	bromine
D	hydrogen	potassium

11 Hydrogen–oxygen fuel cells and gasoline are each used to power cars.

Which statement describes an advantage of using hydrogen–oxygen fuel cells in cars in comparison with gasoline engines?

A Hydrogen is a non-renewable resource.

B Hydrogen is produced during the fractional distillation of petroleum.

C Hydrogen–oxygen fuel cells do **not** release carbon dioxide.

D Hydrogen–oxygen fuel cells need electricity to work.

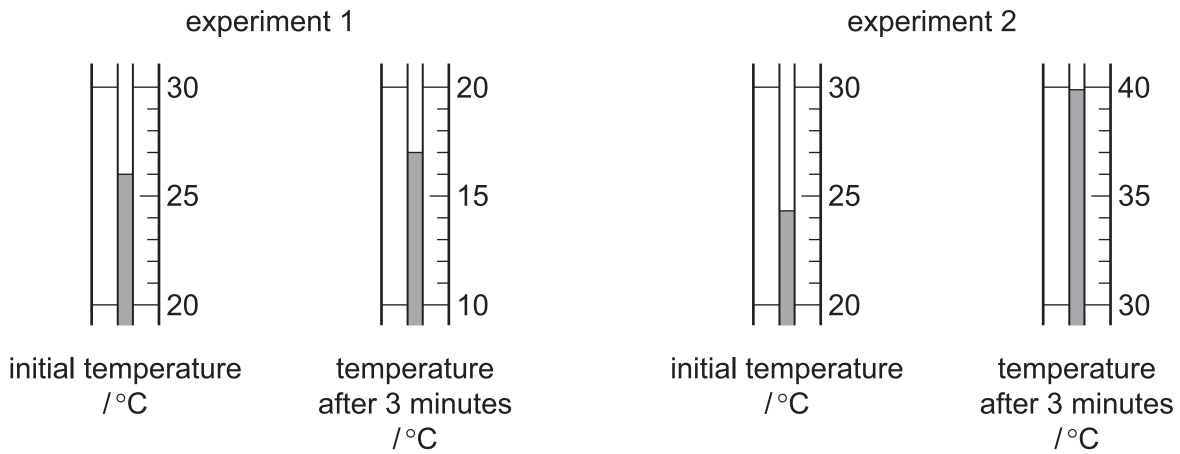
12 Plant cells use energy from sunlight for photosynthesis.

Which row describes and explains the energy change that occurs?

	type of energy change	explanation of energy change
A	endothermic	less energy is released making bonds than is absorbed to break bonds
B	endothermic	more energy is released making bonds than is absorbed to break bonds
C	exothermic	less energy is released making bonds than is absorbed to break bonds
D	exothermic	more energy is released making bonds than is absorbed to break bonds

13 Two different experiments are done to find the enthalpy change, ΔH, of each reaction.

The temperature of each reaction mixture is measured at the beginning of the reaction and after 3 minutes.

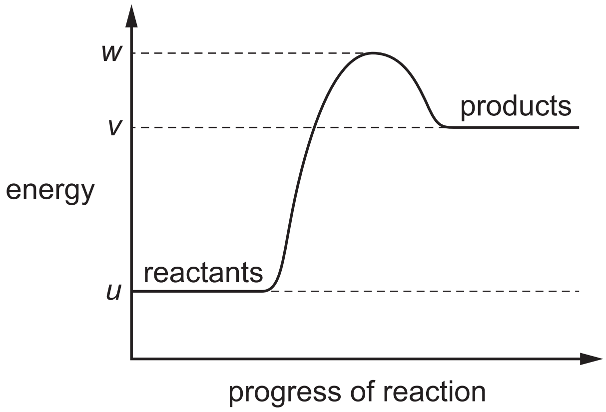


Which row gives the correct sign for the value of ΔH for each experiment and identifies if the reaction is endothermic or exothermic?

	experiment 1	experiment 2
A	negative and endothermic	positive and exothermic
B	negative and exothermic	positive and endothermic
C	positive and endothermic	negative and exothermic
D	positive and exothermic	negative and endothermic

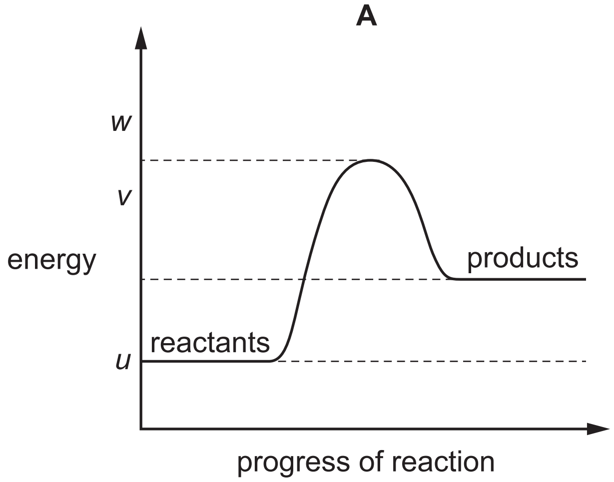
14 The reaction pathway diagram for an endothermic reaction is shown.

u, *v* and *w* are known energy values.

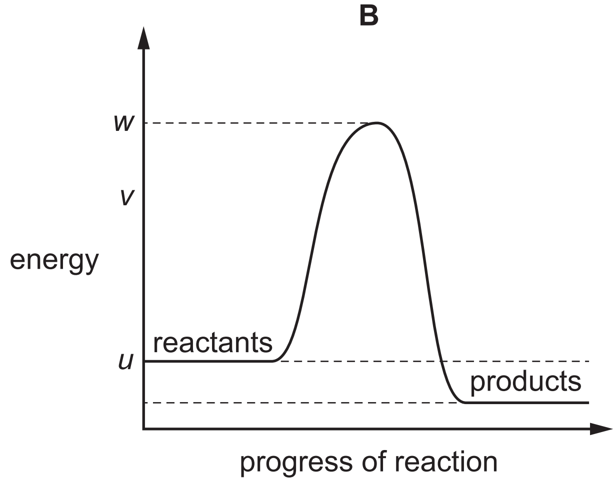


Which diagram shows the reaction pathway diagram when a catalyst is used in the reaction?

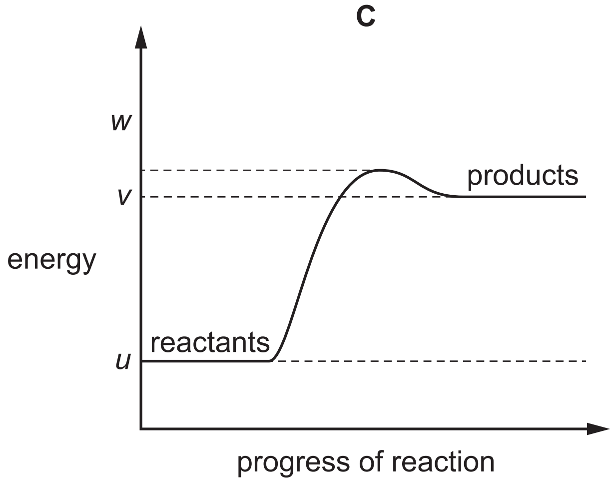
A



B



C



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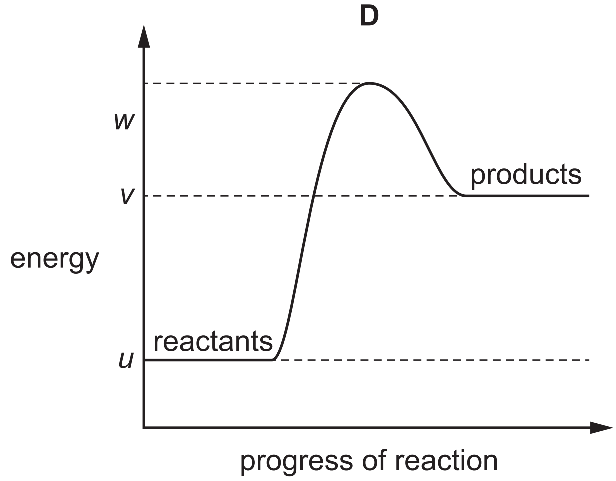


15 Which process is a physical change?

A burning a piece of magnesium

B reacting calcium carbonate with hydrochloric acid

C melting an ice cube

D the rusting of an iron nail

16 The Contact process is used to convert sulfur dioxide to sulfur trioxide. Vanadium(V) oxide is the catalyst in this process.

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

The forward reaction in this equilibrium is exothermic.

Which statements about this process are correct?

1 The catalyst increases the rate of both the forward and backward reactions.

2 A low pressure increases the yield of sulfur trioxide.

3 A low pressure is used to keep the costs low.

4 A high temperature increases the yield of sulfur trioxide.

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

17 The equation for the decomposition of hydrogen peroxide, H_2O_2, is shown.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

In an experiment, the total volume of oxygen produced is $100\,cm^3$.

The experiment is repeated using 1.00 g of a solid catalyst. All other conditions remain the same.

Which row describes the total volume of oxygen and the mass of the catalyst at the end of the second experiment?

	total volume of oxygen / cm^3	mass of catalyst / g
A	more than 100	less than 1.00
B	100	less than 1.00
C	100	1.00
D	more than 100	1.00

18 Nitrogen reacts with hydrogen to form ammonia in the presence of an iron catalyst. The reaction is reversible.

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

Which statement about this reaction is correct?

A The iron catalyst decreases the activation energy of only the forward reaction.

B When equilibrium is reached, the forward reaction has stopped.

C When the pressure changes, the concentration of ammonia at equilibrium remains constant.

D Nitrogen and hydrogen never completely convert to ammonia.

19 The equation for a redox reaction is shown.

$$H_2O_2 + 2KI + H_2SO_4 \rightarrow I_2 + K_2SO_4 + 2H_2O$$

Potassium iodide is ...... 1 ...... agent in this reaction because iodide ions ...... 2 ...... electrons.

Which words complete gaps 1 and 2?

	1	2
A	an oxidising	lose
B	an oxidising	gain
C	a reducing	lose
D	a reducing	gain

20 Element E is in Group II of the Periodic Table.

Which row describes element E and its oxide?

	element E	oxide of E
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

21 Lead(II) iodide is formed as a precipitate in the reaction shown.

$$Pb(NO_3)_2(aq) \quad + \quad 2NaI(aq) \quad \rightarrow \quad PbI_2(s) \quad + \quad 2NaNO_3(aq)$$

Which method is used to separate the lead(II) iodide from the mixture?

A crystallisation

B distillation

C evaporation

D filtration

22 Which statement explains why sulfur, S, has similar chemical properties to selenium, Se?

A They both have the same number of electrons in their outer electron shell.

B They are both solids at room temperature and pressure.

C They are both non-metals.

D They both form negative ions.

23 Atoms of sodium, rubidium and element Q each have one outer shell electron.

Some properties of these elements are shown.

element	melting point in °C	boiling point in °C	density in g/cm^3
sodium	98	883	0.97
rubidium	39	688	1.53
Q	28	672	1.87

What is Q?

A hydrogen

B lithium

C potassium

D caesium

24 Which statement about elements in Group VIII of the Periodic Table is correct?

A They all have a full outer shell of electrons.

B They all react with Group I elements to form ionic compounds.

C They are all diatomic molecules.

D They are all liquids at room temperature and pressure.

25 The electrical conductivity of magnesium is tested.

Magnesium is then added to dilute sulfuric acid. A gas, W, is produced.

Which row describes the electrical conductivity of magnesium and identifies W?

	electrical conductivity of magnesium	gas W
A	good	hydrogen
B	good	oxygen
C	poor	hydrogen
D	poor	oxygen

26 Aluminium metal is extracted from its purified ore by electrolysis.

Which statement about the electrolyte in this process is correct?

A The electrolyte is purified molten bauxite only.

B The electrolyte is purified bauxite dissolved in molten cryolite.

C The electrolyte is purified molten cryolite only.

D The electrolyte is purified cryolite dissolved in molten bauxite.

27 Part of the reactivity series is shown.

potassium
X
calcium
Y
aluminium

Which metals are represented by X and Y?

	X	Y
A	copper	magnesium
B	sodium	magnesium
C	sodium	silver
D	copper	silver

28 Some substances found in water extracted from a river are listed.

1 plastics
2 nitrates
3 oxygen

Which substances are harmful to aquatic life?

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

29 Car engines which use gasoline as a fuel produce oxides of nitrogen.

Oxides of nitrogen are removed from the exhaust gases.

Which statements about the formation or removal of oxides of nitrogen are correct?

1 Gasoline reacts with nitrogen in the air to produce oxides of nitrogen.
2 Gasoline contains nitrogen.
3 Nitrogen and oxygen react at high temperatures to produce oxides of nitrogen.
4 Nitrogen monoxide, NO, reacts with carbon monoxide, CO, in a catalytic converter.

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

30 Which structures represent a pair of structural isomers?

1 $CH_3CH_2CH_2CH_2CH_2CH_3$

2 $CH_3CH_2CH_2CH_2CH(CH_3)_2$

3 $CH_3CH(CH_3)CH_2CH_2CH_3$

4 $CH_3CH(CH_3)CH_2CH_2CH_2CH_3$

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

31 Alkanes are a homologous series of hydrocarbons.

The table shows the names and boiling points of the first four members of this series.

name	boiling point / °C
methane	–162
ethane	–89
propane	–42
butane	0

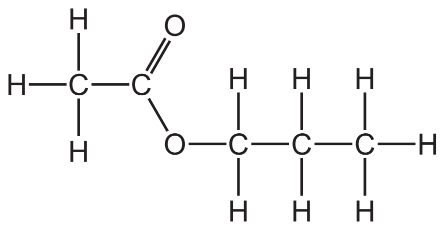
Pentane is the next member of the series.

Which row gives the molecular formula and the boiling point of pentane?

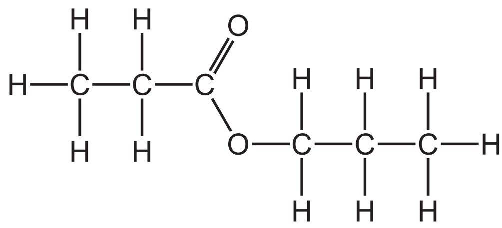
	molecular formula	boiling point / °C
A	C_5H_{10}	36
B	C_5H_{12}	–51
C	C_5H_{10}	–51
D	C_5H_{12}	36

32 Which displayed formula represents the ester formed by the reaction of propan-1-ol with ethanoic acid?

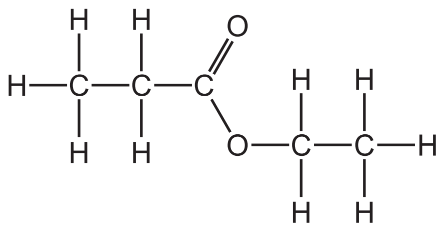
A



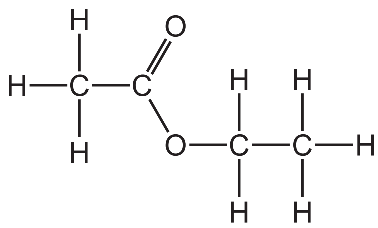
B



C



D



33 Ethanol can be manufactured by fermentation and by the catalytic addition of steam to ethene.

Which statement identifies an advantage of using **one** of these methods?

A Catalytic addition requires a high temperature and pressure.

B Ethanol produced by fermentation is extracted by distillation.

C Fermentation is a batch process.

D The raw material in fermentation is a renewable resource.

34 Which statement about carboxylic acids is correct?

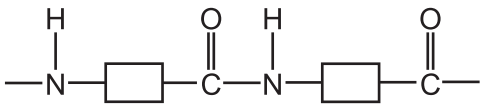
A They react with alkalis to form a salt and water.

B They react with metals to form a salt and water.

C They react with metal carbonates to form a salt, water and hydrogen.

D The general formula for carboxylic acids is $C_nH_{2n+1}OH$.

35 The structure of a polymer is shown.



Which statement about this polymer is correct?

A Alkenes are polymerised to make the polymer.

B It is a polyester.

C It is an addition polymer.

D Water is produced when the polymer is made.

36 Methane undergoes substitution reactions with chlorine and complete combustion with excess oxygen.

Which row about the two reactions is correct?

	condition for reaction with chlorine	equation for the complete combustion
A	an acid catalyst	methane + oxygen $\rightarrow$ carbon dioxide + hydrogen
B	an acid catalyst	methane + oxygen $\rightarrow$ carbon dioxide + water
C	ultraviolet light	methane + oxygen $\rightarrow$ carbon dioxide + hydrogen
D	ultraviolet light	methane + oxygen $\rightarrow$ carbon dioxide + water

37 What is used to identify the end-point of an acid–base titration?

A balance

B measuring cylinder

C indicator

D volumetric pipette

  [Turn over

38 Four pure substances, P, Q, R and S, are tested using chromatography. The same solvent is used each time.

The table shows the distance moved by each substance and by the solvent from the baseline.

substance	distance moved by substance / cm	distance moved by solvent / cm
P	4.5	10.0
Q	3.0	20.0
R	4.5	20.0
S	13.5	30.0

Which two substances are identical?

A P and R **B** P and S **C** Q and R **D** Q and S

39 A substance is tested with three different reagents.

Which row shows the results obtained with aqueous iron(II) nitrate?

	aqueous sodium hydroxide	acidified aqueous silver nitrate	acidified aqueous barium nitrate
A	green precipitate, insoluble in excess	no reaction	no reaction
B	green precipitate, insoluble in excess	white precipitate	white precipitate
C	white precipitate, insoluble in excess	cream precipitate	no reaction
D	white precipitate that dissolves in excess	no reaction	white precipitate

40 A student carries out a flame test on a sample.

The flame colour observed is light green.

Which ion is present in the sample?

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

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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 –	113 Nh nihonium –	114 F*l* flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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 (Extended) **May/June 2024**

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 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2024**

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.
- 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 Which gas has the slowest rate of diffusion?

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

2 Which statements about the position of the elements in the Periodic Table are correct?

1 Elements in the same group have similar chemical properties.

2 Elements in the same period have similar chemical properties.

3 Elements in the same group have the same number of electron shells.

4 Elements in the same group have the same number of outer shell electrons.

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

3 Which statements about isotopes are correct?

1 Isotopes are atoms of different elements with the same number of protons.

2 Isotopes of the same element have the same chemical properties.

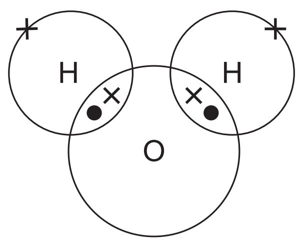
3 Isotopes are atoms with the same relative atomic mass.

4 Isotopes of the same element have the same electronic configuration.

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

4 Which diagram shows the arrangement of the outer shell electrons in a molecule of water?

A



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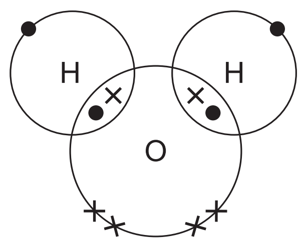

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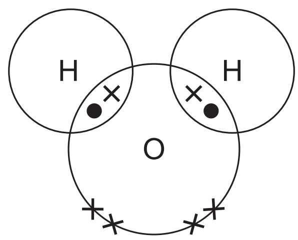
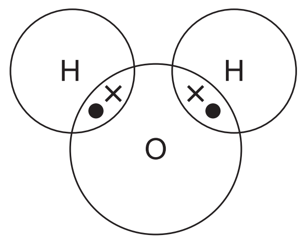
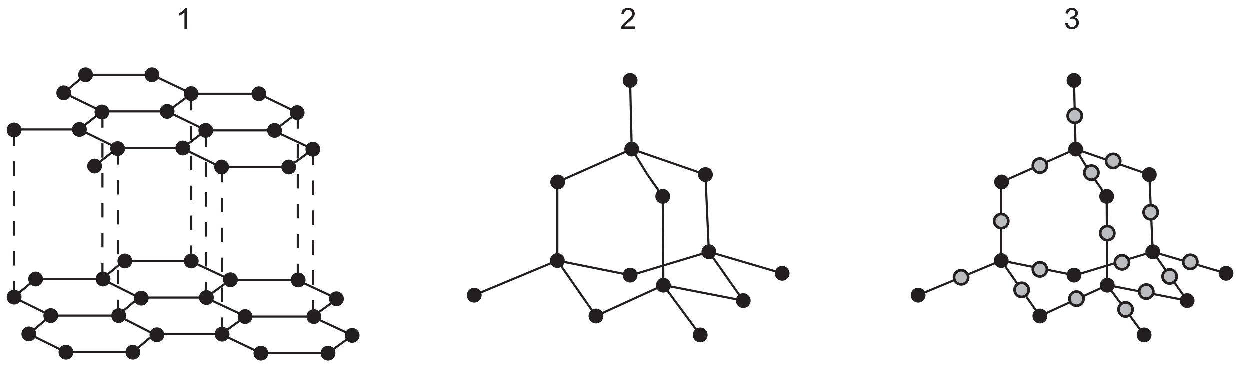


D



5 The structures of three substances are shown.



Which substances are hard and have a high melting point?

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

6 Information about four substances, W, X, Y and Z, is shown.

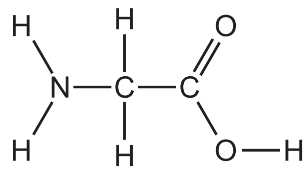
	melting point / °C	electrical conductivity
W	1710	does not conduct when solid
X	3500	conducts when solid
Y	120	does not conduct
Z	801	conducts when molten

W, X, Y and Z are graphite, poly(ethene), sodium chloride and silicon(IV) oxide but not in that order.

What are W, X, Y and Z?

	W	X	Y	Z
A	graphite	poly(ethene)	silicon(IV) oxide	sodium chloride
B	sodium chloride	graphite	poly(ethene)	silicon(IV) oxide
C	poly(ethene)	sodium chloride	graphite	silicon(IV) oxide
D	silicon(IV) oxide	graphite	poly(ethene)	sodium chloride

7 The structure of glycine is shown.



Which row is correct?

	formula of glycine	number of different elements in glycine
A	CH_5O_2N	10
B	$C_2H_5O_2N$	4
C	$C_2H_5O_2N$	10
D	$H_2NCHCOOH$	4

8 The incomplete equation for photosynthesis is shown.

$$wCO_2 + xH_2O \rightarrow P + yO_2$$

Compound P is a product of the reaction.

Which row describes the values of *w*, *x* and *y* and gives the empirical formula of compound P?

	values of *w*, *x* and *y*	empirical formula of compound P
A	*w*, *x* and *y* are all the same	CH_2O
B	*w*, *x* and *y* are all the same	$C_6H_{12}O_6$
C	*w* and *x* are the same and both are greater than *y*	CH_2O
D	*w* and *x* are the same and both are greater than *y*	$C_6H_{12}O_6$

9 The concentration and volume of an aqueous alkali are known.

Which additional information is required to calculate the number of moles of acid needed to neutralise the aqueous alkali?

A the concentration of the acid

B the equation for the acid–alkali reaction

C the formula of the acid

D the volume of the acid required for neutralisation

10 Which statement about electrolysis is correct?

A Electrons move through the electrolyte from the cathode to the anode.

B Electrons move in the external circuit towards the cathode.

C Negative ions move in the external circuit towards the anode.

D Positive ions move through the electrolyte towards the anode.

11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

What is the half-equation for the reaction at the cathode?

A $2H^+ + 2e^- \rightarrow H_2$

B $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

C $Cu \rightarrow Cu^{2+} + 2e^-$

D $Cu^{2+} + 2e^- \rightarrow Cu$

12 Three statements about activation energy, E_a, are listed.

1 Colliding particles must have at least E_a before they can react.

2 E_a for exothermic reactions is always greater than for endothermic reactions.

3 E_a is always endothermic.

Which statements are correct?

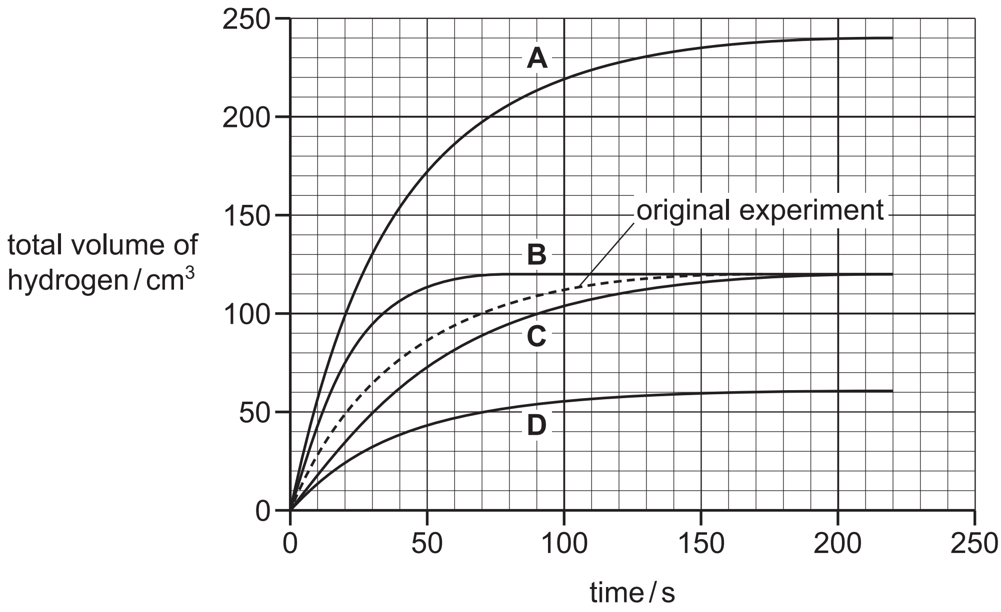
A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 A student adds excess magnesium ribbon to $10\,cm^3$ of $0.5\,mol/dm^3$ sulfuric acid.

The hydrogen gas produced is collected and its total volume is measured every 10 seconds.

The experiment is repeated with $5\,cm^3$ of $0.5\,mol/dm^3$ sulfuric acid added to $5\,cm^3$ of water using the same mass of magnesium ribbon.

Which line on the graph shows the results of the second experiment?



14 The equation represents the reversible reaction between ethene and steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H \text{ is negative}$$

Which row describes the conditions that produce the greatest yield of ethanol?

	pressure	temperature
A	low	low
B	low	high
C	high	low
D	high	high

15 Which row identifies the pressure and the catalyst used for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	pressure / atm	catalyst
A	2	iron
B	2	vanadium(V) oxide
C	200	iron
D	200	vanadium(V) oxide

16 Which equation represents a redox reaction?

A $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

B $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$

C $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

D $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$

17 The equation for the reaction between aluminium and copper(II) oxide is shown.

$$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$$

Which statements about this equation are correct?

1 The oxidation number of the aluminium reactant is +2.

2 The oxidation number of the aluminium in the product is +6.

3 The oxidation number of the copper in the reactant is +2.

4 The oxidation number of the copper product is 0.

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

18 What is the colour of thymolphthalein in dilute hydrochloric acid?

A blue

B red

C yellow

D colourless

19 Two acids, P and Q, with the same concentration and volume are reacted separately with the same mass of magnesium ribbon.

The reactions produce the same total volume of hydrogen gas but acid Q reacts much more slowly than acid P.

Which explanation for the difference between P and Q is correct?

A Acid P has a higher pH than acid Q.

B Acid P has a lower concentration of hydrogen ions.

C Acid Q is partially dissociated and acid P is fully dissociated.

D Acid Q is a proton acceptor.

20 Which process is **not** used in the preparation of an insoluble salt?

A filtration

B washing

C crystallisation

D drying

21 Lithium and potassium are metals in Group I of the Periodic Table.

Lithium has a melting point of 181 °C and a density of 0.53 g/cm^3.

Which row describes the melting point and density of potassium?

	melting point in °C	density in g/cm^3
A	less than 181	less than 0.53
B	less than 181	greater than 0.53
C	greater than 181	less than 0.53
D	greater than 181	greater than 0.53

22 Which statements about transition elements are correct?

1 They have a low density.

2 They form ions with variable oxidation numbers.

3 They have a high melting point.

4 They form only colourless compounds.

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

23 Which statements describe the elements in Group VIII of the Periodic Table?

1 Their atoms have full outer electron shells.

2 They are unreactive metals.

3 They are monatomic gases.

4 They are diatomic gases.

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

24 Four metals, Q, R, S and T, are each added to separate samples of water, steam and dilute hydrochloric acid.

The results are shown.

	observation with water	observation with steam	observation with dilute hydrochloric acid
Q	slow reaction	fast reaction	fast reaction
R	no reaction	no reaction	no reaction
S	no reaction	very slow reaction	slow reaction
T	fast reaction	explodes	explodes

Which statements are correct?

1 R is the least reactive metal.

2 T could be potassium.

3 S is more reactive than Q and R.

4 Metals generally react faster with steam than they react with water.

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

25 Metal X acts as a sacrificial metal to prevent iron from corroding.

Metal X does **not** act as a sacrificial metal to prevent aluminium from corroding.

What is X?

A copper

B magnesium

C silver

D zinc

26 Which equation represents the reduction of a compound found in hematite in the blast furnace?

A $2Al_2O_3 \rightarrow 4Al + 3O_2$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $2FeO + CO \rightarrow Fe_2O_3 + C$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

27 Which statements about the treatment of domestic water supplies are correct?

1 Filtration is used to remove insoluble substances from the water.

2 Sedimentation is used to remove soluble substances from the water.

3 Carbon is used to remove tastes and odours from the water.

4 Chlorine is used to lower the pH of the water.

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

28 Which statement about water is correct?

A It turns anhydrous copper(II) sulfate from pink to blue.

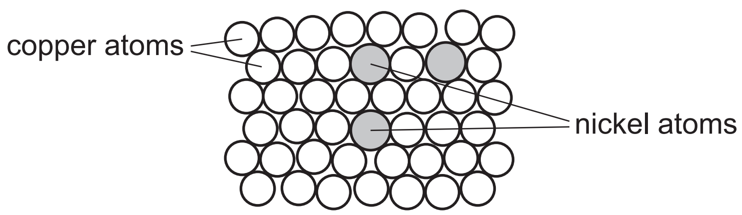
B It turns anhydrous copper(II) sulfate from white to blue.

C It turns cobalt(II) chloride paper from blue to white.

D It turns cobalt(II) chloride paper from pink to blue.

29 Cupronickel is used to make coins.

The arrangement of atoms in cupronickel is shown.



Which kind of substance is cupronickel?

A an alloy

B an isotope

C a compound

D a transition element

30 Which physical properties are typical of **all** metals?

1 good heat conductivity

2 low density

3 malleability

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

31 Which oxide is used to neutralise acidic gases in flue gas desulfurisation?

A calcium oxide

B carbon dioxide

C nitrogen oxide

D sulfur dioxide

32 Some information about three gases, P, Q and R, is listed.

- Gas P forms when magnesium reacts with dilute hydrochloric acid.
- Gas Q makes up 78% of the air.
- Gas R forms when gas P reacts with gas Q.

What is gas R?

A ammonia

B methane

C nitrogen dioxide

D water vapour

33 Which formula represents an alkene?

A CH_4 **B** C_2H_4 **C** C_2H_6 **D** C_2H_5OH

34 The structures of two compounds used to make an ester are shown.

What is the name of the ester?

A ethyl propanoate

B propyl ethanoate

C ethyl ethanoate

D propyl propanoate

35 Which statement about a homologous series is correct?

A All members have the same general formula.

B All members have the same molecular formula.

C All members have similar physical properties.

D Members show a trend in their chemical properties.

36 Which statements about aqueous ethanoic acid are correct?

1 It contains the functional group –COOH.

2 It reacts with carbonates to produce hydrogen.

3 It turns universal indicator paper blue.

4 It has a pH lower than pH 7.

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

37 Alkenes react with steam in an addition reaction.

Some alkenes produce only one alcohol product.
Some alkenes produce two different alcohols which are structural isomers.

Which row gives the number of alcohol isomers formed when ethene reacts with steam and when propene reacts with steam?

	number of alcohol isomers formed	
	ethene + steam	propene + steam
A	1	1
B	1	2
C	2	1
D	2	2

38 What is an advantage of manufacturing ethanol by fermentation rather than by the addition of steam to ethene?

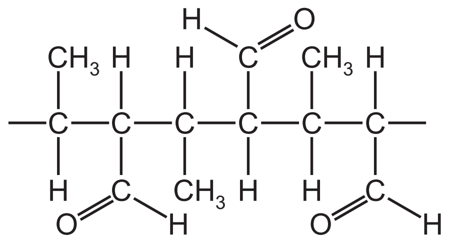
A No gases that cause global warming are produced.

B The ethanol that is produced is pure.

C Fermentation is a fast process.

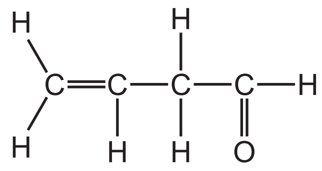
D Fermentation uses renewable raw materials.

39 The diagram shows the structure of a polymer.

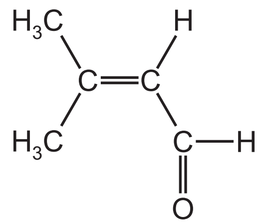


Which structure represents the monomer for this polymer?

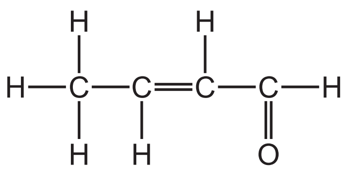
A



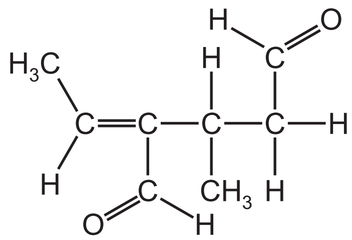
B



C



D



40 Which piece of apparatus is used to measure 24.5 cm^3 of gas produced during a reaction?

A beaker

B conical flask

C measuring cylinder

D volumetric pipette

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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) **May/June 2024**

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

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2024**

45 minutes

You must answer on the multiple choice answer sheet.

* 0 8 9 0 3 8 8 5 8 4 *

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 A gas is heated. The pressure is kept constant.

Which statement describes the behaviour of the particles in the gas?

A The particles move faster and become closer together.

B The particles move faster and become further apart.

C The particles move more slowly and become closer together.

D The particles move more slowly and become further apart.

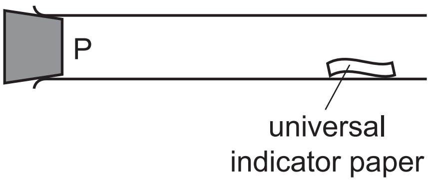
2 A mixture of ice and water is left to stand and the ice melts.

Which row describes what happens as the ice is melting?

	temperature of mixture	energy change
A	increases	average kinetic energy of particles decreases
B	increases	energy is used to overcome attractive forces
C	stays the same	average kinetic energy of particles decreases
D	stays the same	energy is used to overcome attractive forces

3 Hydrogen chloride gas [M_r: HCl, 36.5] is released at P in the apparatus shown.

The universal indicator paper turns red after 38 s.



The experiment is repeated using sulfur dioxide gas [M_r: SO_2, 64].

What is the result for sulfur dioxide gas?

	universal indicator paper turns	time for universal indicator paper to change colour / s
A	blue	26
B	blue	51
C	red	26
D	red	51

4 Four statements about atoms are listed.

1 The centre of an atom is positively charged.

2 Protons and electrons are located in the nucleus.

3 Protons and electrons have the same mass.

4 Most of the mass of an atom is in the nucleus.

Which statements are correct?

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

5 The electronic configurations of two elements are given.

element L: 2,8,8,1

element M: 2,8,4

Which row identifies the group number and the period number for element L and element M?

	element L		element M	
	group number	period number	group number	period number
A	I	4	IV	3
B	I	4	III	4
C	IV	1	III	4
D	IV	1	IV	3

6 Which statement explains why isotopes of the same element have the same chemical properties?

A They have different numbers of protons in their nucleus.

B They have different numbers of neutrons in their nucleus.

C They have the same electronic configuration.

D They have the same number of electrons as protons.

7 Which statements about potassium chloride are correct?

1 It conducts electricity when solid because its ions are free to move.
2 It has a high melting point because it has strong intermolecular forces.
3 Its structure is a giant lattice of alternating positive and negative ions.
4 It is soluble in water.

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

8 How many electrons are shared in **one** molecule of nitrogen and in **one** molecule of ethene?

	nitrogen	ethene
A	2	12
B	2	8
C	6	12
D	6	8

9 What is the total number of electrons in **one** molecule of ammonia, NH_3?

A 6 **B** 8 **C** 10 **D** 11

10 When heated, copper(II) oxide, CuO, reacts with ammonia, NH_3.

$$3CuO + 2NH_3 \rightarrow 3Cu + N_2 + 3H_2O$$

8.5 g of ammonia reacts with an excess of copper(II) oxide to produce 26.4 g of copper.

What is the percentage yield of copper in this reaction?

A 27.5% **B** 32.2% **C** 55.0% **D** 82.5%

11 What is the empirical formula of ethanoic acid?

A CHO **B** CH_2O **C** C_2H_2O **D** $C_2H_4O_2$

12 Magnesium chloride, $MgCl_2$, contains magnesium ions and chloride ions.

How many chloride ions are present in **two** moles of magnesium chloride?

A 6.02×10^{23}

B 1.204×10^{24}

C 2.408×10^{24}

D 3.612×10^{24}

13 A metal object is electroplated with copper.

One electrode is the metal object and the other electrode is copper. The electrolyte is aqueous copper(II) sulfate.

Which row shows the ionic half-equation for the reaction at the anode and the observation of the electrolyte?

	anode	electrolyte
A	$Cu^{2+} + 2e^- \rightarrow Cu$	blue colour fades
B	$Cu^{2+} + 2e^- \rightarrow Cu$	blue colour does not change
C	$Cu \rightarrow Cu^{2+} + 2e^-$	blue colour fades
D	$Cu \rightarrow Cu^{2+} + 2e^-$	blue colour does not change

14 Which statement about electrolysis is correct?

A Chemical energy is converted to electrical energy.

B Electrons flow through the electrolyte.

C Ionic compounds are broken down.

D Metals are formed at the positive electrode.

15 The reaction between hydrogen and oxygen releases 486 kJ / mol of energy.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

The bond energy of H–H is 436 kJ / mol and that of H–O is 464 kJ / mol.

What is the bond energy of O=O?

A 430 kJ / mol

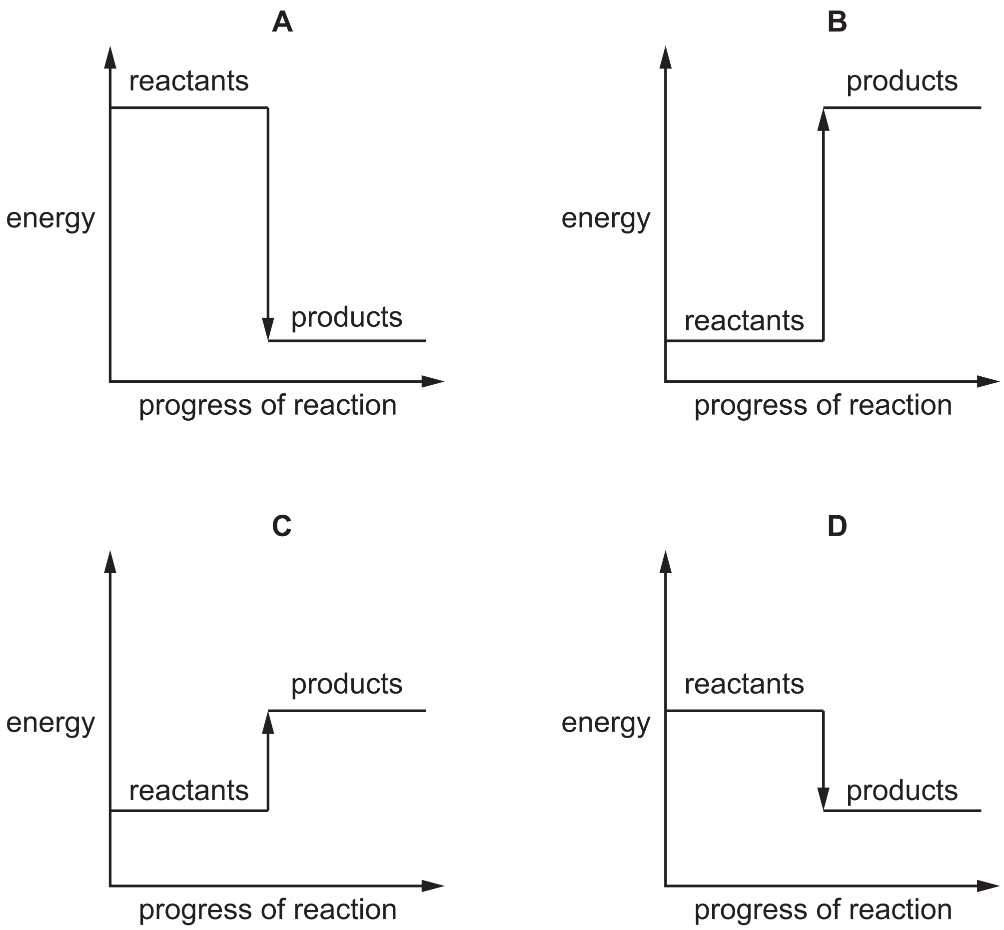
B 458 kJ / mol

C 498 kJ / mol

D 984 kJ / mol

16 Which reaction pathway diagram shows the reaction that will give out the most energy?

The scale on the *y*-axis is the same in each diagram.



17 When calcium carbonate is heated strongly, a gas is given off.

Which word describes this change?

A chemical

B exothermic

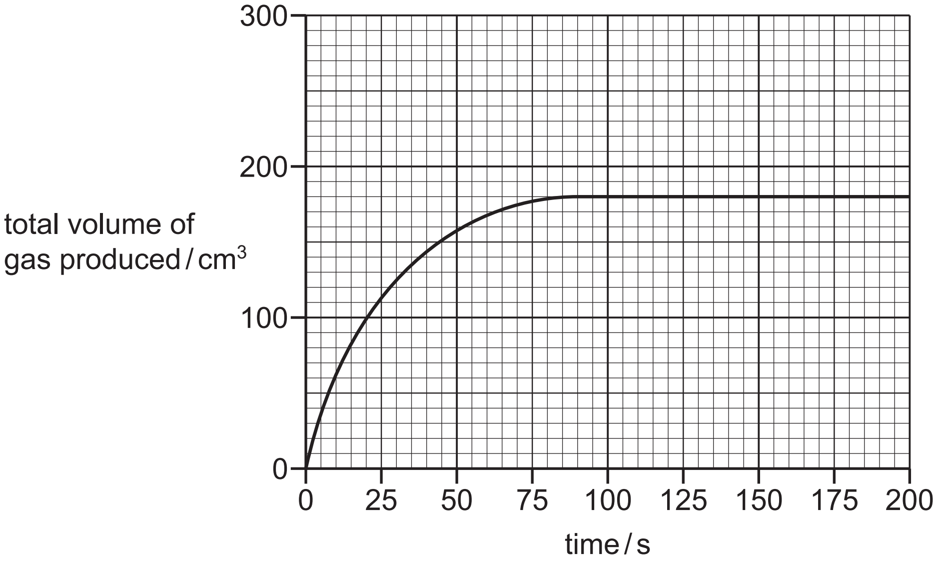
C physical

D reduction

18 Powdered magnesium carbonate is added to excess dilute hydrochloric acid.

The total volume of gas produced is measured over time.

A graph of the results is shown.



The experiment is repeated but the concentration of the hydrochloric acid is doubled.

All other conditions are kept the same.

Which statements about the second experiment are correct?

1 The final volume of gas is $360\,cm^3$.

2 The reaction finishes before 90 seconds.

3 The activation energy of the reaction is lower.

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

19 Which statements explain why increasing the temperature changes the rate of a chemical reaction?

1 It increases the activation energy.

2 It increases the frequency of collisions between the reacting particles.

3 It increases the kinetic energy of the reacting particles.

4 It increases the number of particles per unit volume.

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

20 Hydrogen is made by reacting carbon with steam. The equation for the reaction is shown.

$$C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g)$$

The forward reaction is endothermic.

Which row describes changes in the pressure and the temperature that will **both** shift the position of equilibrium to the right?

	pressure	temperature
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

21 Which row shows the conditions used for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	pressure / atm	temperature / °C	catalyst
A	250	200	vanadium(V) oxide
B	2	450	vanadium(V) oxide
C	250	200	iron
D	2	450	iron

22 The equation for the reaction of magnesium with carbon dioxide is shown.

$$2Mg + CO_2 \rightarrow 2MgO + C$$

Which statement about this reaction is correct?

A Magnesium is oxidised and carbon dioxide is reduced.

B Magnesium is reduced and carbon dioxide is oxidised.

C Magnesium and carbon dioxide are both oxidised.

D Magnesium and carbon dioxide are neither oxidised nor reduced.

23 Chlorine displaces bromine from aqueous potassium bromide.

The ionic equation for the reaction is shown.

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

Which statement about this reaction is correct?

A Bromide ions act as an oxidising agent.

B Bromide ions are oxidised as electrons are lost.

C Chlorine acts as a reducing agent.

D Chlorine is reduced as electrons are lost.

24 Which gas is produced when ammonium chloride is warmed with aqueous sodium hydroxide?

A ammonia

B chlorine

C hydrogen

D nitrogen

25 Which equation represents a solution of ethanoic acid in water?

A $HCOOH(aq) \rightleftharpoons HCOO^-(aq) + H^+(aq)$

B $HCOOH(aq) \rightarrow HCOO^-(aq) + H^+(aq)$

C $CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$

D $CH_3COOH(aq) \rightarrow CH_3COO^-(aq) + H^+(aq)$

26 Four statements about the reactions of oxides with dilute hydrochloric acid and with aqueous sodium hydroxide are listed.

1 Aluminium oxide reacts with both dilute hydrochloric acid and aqueous sodium hydroxide.

2 Calcium oxide reacts with both dilute hydrochloric acid and aqueous sodium hydroxide.

3 Copper(II) oxide reacts with dilute hydrochloric acid but **not** with aqueous sodium hydroxide.

4 Sulfur dioxide does **not** react with either dilute hydrochloric acid or aqueous sodium hydroxide.

Which statements are correct?

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

27 Which statement about elements in Period 3 of the Periodic Table is correct?

A Aluminium is a non-metal in Group III.

B Argon is in Group VIII and has eight electrons in its outer electron shell.

C Magnesium is in Group II and has three electrons in its outer electron shell.

D Sulfur is a metal in Group VI.

28 Which row describes the structure of Group VII elements and the trend in their reactivity down the group?

	structure	reactivity down Group VII
A	diatomic	increases
B	diatomic	decreases
C	monatomic	increases
D	monatomic	decreases

29 Some information about four elements, P, Q, R and S, is shown.

	melting point in °C	density in g / cm^3	colour of chloride
P	1247	7.43	pink
Q	1410	2.33	white
R	1910	6.11	purple
S	115	2.07	red

Which elements are transition elements?

A P and R **B** P and S **C** Q and R **D** R and S

30 Propanoic acid is a carboxylic acid. It has similar chemical properties to ethanoic acid.

Which statements are correct?

1 Aqueous propanoic acid is a weaker acid than dilute hydrochloric acid.

2 Propanoic acid partially ionises in aqueous solution.

3 Propanoic acid reacts with ethanol to form propyl ethanoate.

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

31 Iron rusts in the presence of oxygen and water.

Which statements about the rusting of iron are correct?

1 Anhydrous iron(II) oxide is produced when iron rusts.

2 Iron rusts more quickly when attached to a piece of zinc.

3 Coating the iron with plastic prevents the iron from rusting.

4 Iron loses electrons when it rusts.

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

32 An iron nail is added to aqueous copper(II) sulfate and a different iron nail is added to aqueous magnesium sulfate.

The results are shown.

experiment	result
iron nail in aqueous copper(II) sulfate	nail is coated with a brown solid
iron nail in aqueous magnesium sulfate	no reaction

Which statement is correct?

A Copper atoms are oxidised more easily than magnesium atoms.

B Copper atoms are reduced more easily than iron ions.

C Iron atoms are oxidised more easily than copper atoms.

D Iron atoms are reduced more easily than copper ions.

33 Which pollutant leads to the deoxygenation of water in ponds and lakes?

A fertilisers containing nitrates and phosphates

B toxic metal compounds

C combustion products of fossil fuels

D acid rain

34 Which statement identifies a sample of water as pure?

A It melts at room temperature.

B It turns anhydrous copper(II) sulfate blue.

C It turns hydrated cobalt(II) chloride from blue to pink.

D It boils at 100 °C.

35 Oxides of nitrogen are produced by car engines.

In a catalytic converter oxides of nitrogen are removed by reacting them with compound X.

Which row describes the type of reaction oxides of nitrogen undergo and identifies compound X?

	type of reaction	compound X
A	oxidation	carbon dioxide
B	oxidation	carbon monoxide
C	reduction	carbon dioxide
D	reduction	carbon monoxide

36 What is a disadvantage of producing ethanol using the catalytic addition of steam to ethene?

A the energy cost is low

B the process is continuous

C the process uses a non-renewable raw material

D the ethanol is pure

37 Which statement about the polymer PET is correct?

A It can be broken down into its monomers and re-polymerised.

B It is an addition polymer.

C It is a polyamide.

D It is made from amino acid monomers.

38 The formulae of five compounds are listed.

1 C_4H_{10}

2 C_2H_5OH

3 C_4H_9OH

4 C_4H_9COOH

5 $C_5H_{11}OH$

Which compounds are in the same homologous series?

A 1, 3 and 4

B 2, 3 and 5

C 3 and 4 only

D 3 and 5 only

39 Propane reacts with chlorine.

Which statements about this reaction are correct?

1 Ultraviolet light is used to provide the activation energy.

2 Propane undergoes an addition reaction.

3 One of the products is CH_3CH_2Cl.

4 One of the products is HCl.

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

40 Which statement about chromatography is correct?

A It is **not** possible for two different substances to have the same R_f value.

B It is only possible to use chromatography on substances which have a colour.

C It is possible to use chromatography on colourless substances using a locating agent.

D The R_f value of a substance = $\dfrac{\text{the distance travelled by the solvent}}{\text{the distance travelled by the substance}}$

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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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Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2024**

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 2024 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	C	**1**
3	B	**1**
4	A	**1**
5	D	**1**
6	D	**1**
7	B	**1**
8	B	**1**
9	D	**1**
10	C	**1**
11	B	**1**
12	C	**1**
13	D	**1**
14	A	**1**
15	A	**1**
16	B	**1**
17	B	**1**
18	A	**1**
19	B	**1**
20	C	**1**
21	C	**1**
22	D	**1**
23	B	**1**
24	B	**1**
25	B	**1**
26	A	**1**
27	D	**1**
28	A	**1**

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8713532268

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2024**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB24 03_0620_62/5RP

1 Calcium carbonate is an insoluble solid.
Calcium carbonate can be made by adding excess aqueous calcium chloride to aqueous sodium carbonate.

$$CaCl_2(aq) + Na_2CO_3(aq) \rightarrow CaCO_3(s) + 2NaCl(aq)$$

A student makes a sample of calcium carbonate.
The first two steps of the method are shown in Fig. 1.1.

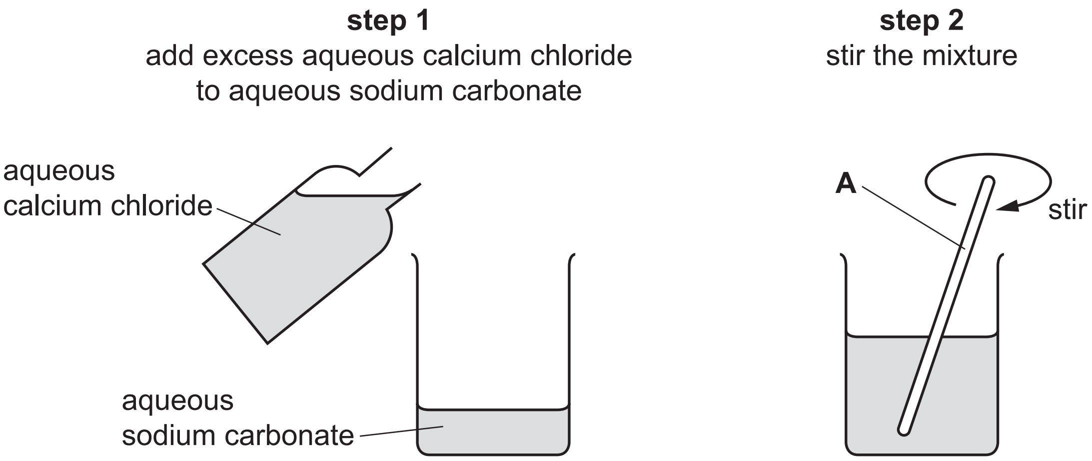

Fig. 1.1

(a) Name the item of apparatus labelled **A** in Fig. 1.1.

.... [1]

(b) Suggest why the mixture is stirred in **step 2**.

....

.... [1]

(c) After **step 2** the student filters the mixture to remove the solid calcium carbonate formed and collect the filtrate.

Draw a labelled diagram to show the apparatus used for this filtration.

[2]

(d) The solid calcium carbonate obtained by filtration is not pure.

(i) Identify **one** substance, **other** than water, which is mixed with the calcium carbonate and makes it impure.

.... [1]

(ii) Describe how the substance you have identified in **(d)(i)** can be removed from the calcium carbonate.

....

.... [1]

(e) Describe a test the student can do on the filtrate obtained in **(c)** to show that the calcium chloride used is in excess. Give the result the student obtains if the calcium chloride is in excess.

test ....

....

result ....

....

[2]

[Total: 8]

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2 A student investigates the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, labelled **A** and **B**.

The student does three experiments.

Experiment 1

- Rinse a burette with distilled water and then with dilute hydrochloric acid **A**.
- Rinse a conical flask with distilled water.
- Fill the burette with dilute hydrochloric acid **A**. Run some of the dilute hydrochloric acid out of the burette so that the level of the dilute hydrochloric acid is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour $25\,cm^3$ of aqueous sodium carbonate into the conical flask.
- Add five drops of methyl orange indicator to the conical flask.
- Stand the conical flask on a white tile.
- Slowly add dilute hydrochloric acid **A** from the burette to the conical flask, while swirling the flask, until the solution becomes orange.
- Record the final burette reading.

Experiment 2

- Refill the burette with dilute hydrochloric acid **A**. Run some of the dilute hydrochloric acid out of the burette so that the level of the dilute hydrochloric acid is on the burette scale.
- Record the initial burette reading.
- Empty the conical flask and rinse it with distilled water.
- Use the measuring cylinder to pour $25\,cm^3$ of aqueous sodium carbonate into the conical flask.
- Add five drops of thymolphthalein indicator to the conical flask.
- Stand the conical flask on a white tile.
- Slowly add dilute hydrochloric acid **A** from the burette to the conical flask, while swirling the flask, until the solution becomes colourless.
- Record the final burette reading.

Experiment 3

- Repeat Experiment 1, using dilute hydrochloric acid **B** instead of dilute hydrochloric acid **A**.

(a) Use the burette diagrams in Fig. 2.1, Fig. 2.2 and Fig. 2.3 to record the readings for Experiments 1, 2 and 3 in Table 2.1 and complete Table 2.1.

Experiment 1

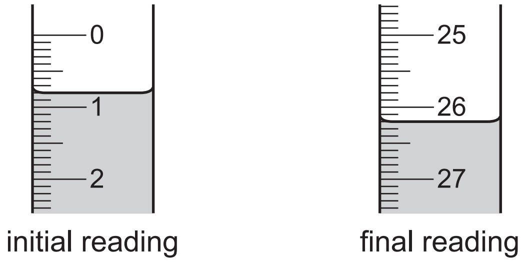

Fig. 2.1

Experiment 2

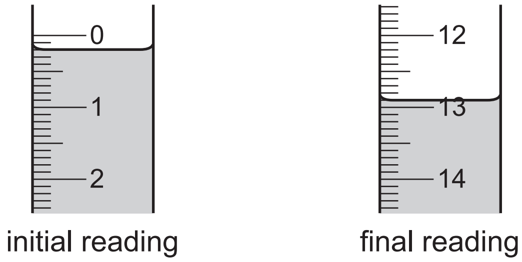

Fig. 2.2

Experiment 3

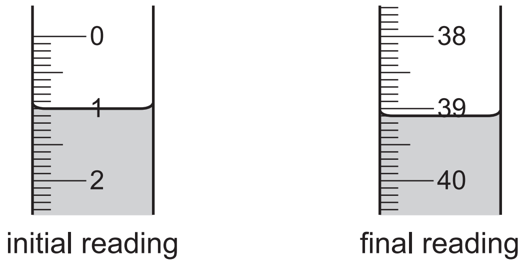

Fig. 2.3

Table 2.1

	Experiment 1	Experiment 2	Experiment 3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of dilute hydrochloric acid added / cm^3			

[4]

(b) **(i)** State which solution of dilute hydrochloric acid, **A** or **B**, is the more concentrated. Explain your answer.

more concentrated solution of dilute hydrochloric acid ....

explanation ....

.... [1]

(ii) Deduce how many times more concentrated this solution of dilute hydrochloric acid is than the other solution of dilute hydrochloric acid.

....

.... [1]

(c) **(i)** Compare the volume of dilute hydrochloric acid **A** used in Experiment 1 to the volume of dilute hydrochloric acid **A** used in Experiment 2.

....

....

.... [2]

(ii) Deduce the volume of dilute hydrochloric acid **B** required to reach the end-point if Experiment 3 is repeated using thymolphthalein indicator instead of methyl orange indicator. Use your answer to **(c)(i)** to help you.

volume of dilute hydrochloric acid **B** = ... [2]

(d) At the start of Experiment 3 the burette is rinsed with distilled water and then with dilute hydrochloric acid **B**.

(i) Identify the substance removed from the burette when it is rinsed with distilled water at the start of Experiment 3.

.... [1]

(ii) Describe how the result of the titration would change if the burette was **not** rinsed with dilute hydrochloric acid **B** after it had been rinsed with water.

....

.... [1]

(iii) Explain why the conical flask is **not** rinsed with aqueous sodium carbonate after it is rinsed with water.

....

.... [1]

(e) Explain why a white tile is used during the titration.

....

.... [1]

(f) Describe the effect on the result of warming the aqueous sodium carbonate used in Experiment 1 before carrying out the titration. Explain your answer.

effect ....

explanation ....
[2]

[Total: 16]

3 A student tests two substances: solid **C** and solid **D**.

Tests on solid C

Solid **C** is ammonium iodide.

The student dissolves solid **C** in water to form solution **C**. The student divides solution **C** into three approximately equal portions.

Complete the expected observations.

(a) To the first portion of solution **C**, the student adds about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations ....

.... [1]

(b) To the second portion of solution **C**, the student adds about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations ....

.... [1]

(c) **(i)** To the third portion of solution **C**, the student adds an excess of aqueous sodium hydroxide.

observations ....

.... [1]

(ii) The student warms the product from **(c)(i)** and tests any gas given off.

observations ....

.... [1]

Tests on solid D

Table 3.1 shows the tests and the student's observations for solid **D**.

Table 3.1

tests	observations
test 1 Do a flame test on solid **D**.	yellow coloured flame
test 2 Gently heat about half of the remaining solid **D**. Hold a strip of anhydrous cobalt(II) chloride paper at the mouth of the boiling tube.	steam is given off and condensation forms at the top of the boiling tube the anhydrous cobalt(II) chloride paper changes colour
test 3 Dissolve the remaining solid **D** in water to form solution **D**. Divide solution **D** into three portions. To the first portion of solution **D**, add aqueous ammonia dropwise until in excess.	green precipitate which is insoluble in excess
test 4 To the second portion of solution **D**, add a piece of aluminium foil and about 5 cm^3 of aqueous sodium hydroxide. Heat the mixture formed and hold damp red litmus paper at the mouth of the boiling tube.	green precipitate the red litmus paper remains red
test 5 To the third portion of solution **D**, add about 5 cm^3 of dilute nitric acid. Bubble any gas formed through limewater.	effervescence the limewater becomes milky

(d) State the final colour of the cobalt(II) chloride paper in **test 2**.

.... [1]

(e) State what ion the observations in **test 4** show is **not** present.

.... [1]

(f) Identify the gas produced in **test 5**.

.... [1]

(g) Identify the **three** ions in solid **D**.

....

....

.... [3]

[Total: 10]

4 When excess dilute sulfuric acid is added to solid zinc, hydrogen gas and aqueous zinc sulfate are made.

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

Plan an experiment to show that copper is a catalyst for this reaction. Your plan should include how the results of the experiment will show that copper is a catalyst for this reaction.

You are provided with zinc powder, dilute sulfuric acid, copper powder and common laboratory apparatus.

....

....

....

....

....

....

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....

....

.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2024**

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 2024 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 descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

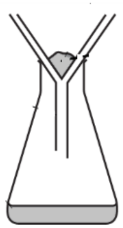
GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate 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
There are six pages above **Q1(a)** that all require 'seen' on them. These should be checked before you start marking a script and any answers linked to the appropriate question part.		
1(a)	glass rod / stirring rod	**1**
1(b)	to mix (the substances together)	**1**
1(c)		
	M1 funnel over a suitable container to collect the filtrate	**1**
	M2 filter paper shown inside the funnel	**1**
1(d)(i)	calcium chloride / $CaCl_2$ **OR** sodium chloride / $NaCl$	**1**
1(d)(ii)	pour water over the residue in the funnel	**1**
1(e)	**Test for carbonate ions** **M1** add dilute hydrochloric acid / nitric acid / sulfuric acid (1) **M2** does **not** effervesce / fizz / bubble (1) **OR** **Test for calcium ions** **M1** add aqueous sodium hydroxide / aqueous sodium carbonate (1) **M2** (white) precipitate / filter and there is a solid residue (1)	**2**

Question	Answer	Marks
2(a)	**M1** All three final readings recorded correctly (26.2, 12.9, 39.1)	**1**
	M2 All three initial readings recorded correctly (0.8, 0.2, 1.0)	**1**
	M3 all three titres correct (25.4, 12.7, 38.1)	**1**
	M4 all **nine** volumes recorded to 1 dp or better	**1**
2(b)(i)	A **AND** as volume (of A in Experiment 1 needed was) lower (than volume of B in Experiment 3)	**1**
2(b)(ii)	1.5	**1**
2(c)(i)	**M1** a greater volume is used in Experiment 1	**1**
	M2 by a factor of two / twice as much	**1**
2(c)(ii)	**M1** 19.05 / 19.1	**1**
	M2 cm^3	**1**
2(d)(i)	(dilute) hydrochloric acid / **A**	**1**
2(d)(ii)	larger volume (of acid) / more acid needed / larger titre	**1**
2(d)(iii)	increases volume of aqueous sodium carbonate	**1**
2(e)	so colour (change) is easy to see / colour (change) clear(er) / colour (change) more obvious	**1**
2(f)	**M1** none	**1**
	M2 amount / moles (of sodium carbonate) does not change / volume of sodium carbonate does not change / concentration (of sodium carbonate) does not change	**1**

Question	Answer	Marks
3(a)	no change	**1**
3(b)	yellow precipitate	**1**
3(c)(i)	no change	**1**
3(c)(ii)	(red) litmus (paper) turns blue	**1**
3(d)	pink	**1**
3(e)	nitrate / NO_3^-	**1**
3(f)	carbon dioxide / CO_2	**1**
3(g)	**M1** Na^+ / sodium (ion)	**1**
	M2 Fe^{2+}/ iron(II) (ion)	**1**
	M3 CO_3^{2-} / carbonate (ion)	**1**

Question	Answer	Marks
4	Any 6 from: **MP1** use a known / measured / stated / fixed volume of dilute sulfuric acid. **MP2** add a known / measured / stated / fixed mass of zinc **MP3** measure time to collect a set volume of gas / measure the volume of gas collected in a set time **OR** time until no more fizzing **OR** no more gas made **OR** time until no more solid **OR** time until no more mass loss **OR** time until no more gas collected **OR** measure mass loss / gas volume in set time **MP4** use of suitable reaction vessel – (conical) flask, test-tube, boiling tube **OR** gas syringe / inverted measuring cylinder to collect gas **MP5** repeat but add (a known mass / measure) of copper as well as zinc **MP6** filter out the copper from the solution, (wash and) dry the copper and weigh the copper **MP7** copper is a catalyst if mass does not change **AND** more gas collected in set time / time to collect set volume of gas is less / time to end is less **max 6**	**6**

	time to			**how much gas made reaction for fixed time**		**mass**
	make a known volume of gas	**make a known number of bubbles gas**	**end of reaction**	**vol of gas**	**bubbles of gas**	**mass loss**
MP1	know / specified / stated / measured VOLUME of sulfuric acid **Ignore** amount / mass / moles / excess					
MP2	known / specified / stated / measured MASS / WEIGHT of zinc **Ignore** amount / volume / moles / excess					
MP3	measure time to collect a set volume / amount of gas	measure time for a set number of bubbles	measure time until fizzing stops / no more gas made / time until all zinc dissolved / time until bubbles stop	measure the volume / amount of gas collected in a set time	count the number of bubbles in a set time	measure mass loss in a set time or time for set mass loss or time to mass stops changing
MP4	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube **Allow** gas syringe / inverted measuring cylinder over water	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube **Allow** delivery tube dipping into beaker of water if no suitable reaction vessel	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube or beaker if collecting gas then allow gas syringe / inverted measuring cylinder	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube **Allow** gas syringe / inverted measuring cylinder over water	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube **Allow** delivery tube dipping into beaker of water if no suitable reaction vessel	use of suitable reaction vessel – (conical) flask, test-tube, boiling tube or beaker
MP5	**repeat** with copper added					
MP6	weigh the copper or even just a visual inspection 'look at copper to see if changed'					

	time to			**how much gas made reaction for fixed time**		**mass**
	make a known volume of gas	**make a known number of bubbles gas**	**end of reaction**	**vol of gas**	**bubbles of gas**	**mass loss**
MP7	copper is a catalyst if unchanged **and** time is less			copper is a catalyst if unchanged **and** more gas collected in set time	copper is a catalyst if unchanged **and** more bubbles in set time	copper is a catalyst if unchanged **and** bigger mass loss in set time / shorter time for set mass loss / shorter time to end
	visual inspection in MP6 could be awarded for statement in MP7					

Cambridge Assessment International Education

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CANDIDATE NAME											
CENTRE NUMBER							CANDIDATE NUMBER				

* 4 8 6 4 3 6 1 4 9 4 *

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2024**

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 **12** pages.

IB24 03_0620_42/6RP

1 Iron ore contains iron(III) oxide, Fe_2O_3. A blast furnace is used to extract iron from Fe_2O_3.

Equations for some of the reactions in the blast furnace are shown.

equation 1 $C + O_2 \rightarrow CO_2$

equation 2 $CaCO_3 \rightarrow CaO + CO_2$

equation 3 $CaO + SiO_2 \rightarrow CaSiO_3$

(a) **Equation 1** shows the combustion of carbon in the blast furnace.

(i) Name the substance which provides the carbon for this reaction.

.... [1]

(ii) State the purpose of the combustion of carbon in the blast furnace.

.... [1]

(b) Iron(III) oxide, Fe_2O_3, in iron ore is converted to iron when it reacts with carbon monoxide, CO, in the blast furnace.

(i) Calculate the percentage by mass of iron in iron(III) oxide, Fe_2O_3.

percentage = ...% [2]

(ii) State the name of the iron ore which consists mainly of iron(III) oxide.

.... [1]

(iii) Describe how carbon monoxide is formed in the blast furnace.

.... [1]

(iv) Write the symbol equation to show the reaction that occurs when iron(III) oxide is converted to iron in the blast furnace.

.... [2]

(v) Name the chemical process which happens to iron when iron(III) oxide is converted to iron in the blast furnace.

.... [1]

(c) State the type of reaction shown by **equation 2**.

.... [1]

(d) **(i)** Explain why the reaction in **equation 3** can be described as an acid–base reaction.

....

....

.... [2]

(ii) State:

- the chemical name of SiO_2

....

- the common name given to $CaSiO_3$ when it is formed in the blast furnace.

....
[2]

(e) Aluminium **cannot** be extracted from its ore using a blast furnace.

(i) State why aluminium is **not** extracted from its ore using a blast furnace.

.... [1]

(ii) Name the process used to extract aluminium from its ore.

.... [1]

(f) Both iron(III) oxide and aluminium oxide contain metal ions with a 3+ charge.

(i) Write the electronic configuration of an Al^{3+} ion.

.... [1]

(ii) Deduce the number of protons and electrons in an Fe^{3+} ion.

protons	electrons

[2]

[Total: 19]

2 The elements in Group VII of the Periodic Table are known as the halogens. Halogens can form halide ions.

(a) Identify the halogen with the lowest density at r.t.p. (room temperature and pressure).

.... [1]

(b) State the appearance of bromine at r.t.p.

.... [1]

(c) Use the Periodic Table to:

- give the symbol of the halogen with the highest atomic number

....

- deduce the number of occupied electron shells in an atom of this element.

....
[2]

(d) Bromine molecules have covalent bonding.

(i) State what is meant by the term covalent bond.

....

.... [2]

(ii) Name **one** halide ion which bromine molecules can displace.

.... [1]

(iii) Explain why bromine can displace the halide ion in **(d)(ii)**.

.... [1]

(e) Name a halide compound which can be used to detect the presence of water.

.... [2]

(f) Calcium chloride is an ionic compound.

Complete the dot-and-cross diagram in Fig. 2.1 for the ions in calcium chloride.

Give the charges on each of the ions.

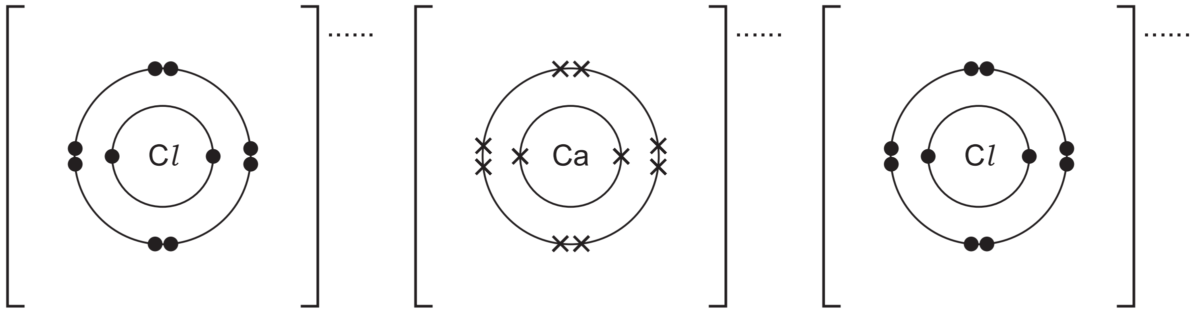

Fig. 2.1

[3]

(g) Aqueous lead(II) ions are added to aqueous chloride ions. A white precipitate of insoluble lead(II) chloride, $PbCl_2$, is formed.

(i) Name a lead(II) compound which can be used in this reaction.

.... [1]

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

....

.... [3]

(iii) Name one **other** insoluble chloride.

.... [1]

[Total: 18]

3 This question is about acids, bases and alkalis.

Table 3.1 shows the pH values of some substances.

Table 3.1

substance	pH
$NaOH(aq)$	14
$Ca(OH)_2(aq)$	10
$H_2O(l)$	7
$CH_3COOH(aq)$	4
$HNO_3(aq)$	1

(a) Define the term base.

.... [1]

(b) State what is meant by the term alkali.

.... [1]

(c) Thymolphthalein is an indicator.

State the colour of thymolphthalein in:

- $NaOH(aq)$ ....
- $CH_3COOH(aq)$. ....

[2]

(d) **(i)** Use the information in Table 3.1 to identify the substance with the highest concentration of $H^+(aq)$ ions.

Explain your answer.

substance ....

explanation ....

[2]

(ii) Name an indicator which can be used to identify the substance with the highest concentration of $H^+(aq)$ ions.

.... [1]

(e) Complete the equation to show the dissociation of ethanoic acid, CH_3COOH, in aqueous solution.

$CH_3COOH(aq)$ .... [3]

(f) Write the **ionic** equation which represents a neutralisation reaction between any acid and any alkali.

.... [1]

(g) Dilute nitric acid, $HNO_3(aq)$, reacts with aqueous calcium hydroxide, $Ca(OH)_2(aq)$, as shown.

$$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$$

20.0 cm^3 of 0.0150 mol/dm^3 $Ca(OH)_2(aq)$ reacts with 25.0 cm^3 of $HNO_3(aq)$.

Calculate the concentration of $HNO_3(aq)$ in g/dm^3.

Use the following steps.

- Calculate the number of moles of $Ca(OH)_2(aq)$ used.

.... mol

- Determine the number of moles of $HNO_3(aq)$ which react with the $Ca(OH)_2(aq)$.

.... mol

- Calculate the concentration of $HNO_3(aq)$ in mol/dm^3.

.... mol/dm^3

- Calculate the concentration of $HNO_3(aq)$ in g/dm^3.

.... g/dm^3
[5]

[Total: 16]

4 The equation for the reaction between methanoic acid and ethanol in the presence of a catalyst can be represented as shown.

$$HCOOH + CH_3CH_2OH \rightleftharpoons \mathbf{X} + H_2O \qquad \Delta H = -29.5\,kJ/mol$$

X represents the ester formed.

(a) **(i)** In the equation, methanoic acid is represented by the formula HCOOH.

Name this type of formula.

.... [1]

(ii) Write the empirical formula of methanoic acid.

.... [1]

(b) Name and draw the displayed formula of ester **X**.

name ....

displayed formula

[3]

(c) The reaction is reversible and reaches an equilibrium within a closed system.

(i) State what is meant by the term closed system.

.... [1]

(ii) State **two** characteristics of an equilibrium.

1 ....

....

2 ....

....
[2]

(iii) Complete Table 4.1 to show the effect, if any, on the concentration of **X** at equilibrium for each change of condition.

Table 4.1

change of condition	effect on the concentration of **X** at equilibrium
temperature is decreased	
concentration of HCOOH is decreased	
concentrations of both HCOOH and CH_3CH_2OH are decreased	
the catalyst is removed	

[4]

[Total: 12]

5 Butane and but-1-ene are colourless gases at room temperature and pressure.

(a) Suggest why but-1-ene diffuses quicker than butane.

.... [1]

(b) Identify the products formed when butane undergoes complete combustion.

.... [1]

(c) One molecule of butane reacts with one molecule of chlorine in the presence of ultraviolet light. During the reaction, one hydrogen atom in butane is replaced by one chlorine atom.

(i) Name the type of reaction which needs ultraviolet light.

.... [1]

(ii) State the purpose of ultraviolet light during this reaction.

.... [1]

(iii) Name the type of reaction which takes place when one atom of chlorine replaces one atom of hydrogen.

.... [1]

(iv) Determine how many different structural isomers can form during this reaction.

.... [1]

(d) When but-1-ene reacts with steam, **two** possible products form.

(i) Identify the type of catalyst which is used in this reaction.

.... [1]

(ii) Name and draw the displayed formulae of the **two** possible products.

product 1	product 2
name	name ....
displayed formula	displayed formula

[4]

(e) But-1-ene undergoes polymerisation.

(i) State the type of polymerisation but-1-ene undergoes.

.... [1]

(ii) Draw part of the polymer molecule to show **three** repeat units.

[3]

[Total: 15]

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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
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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2024**

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 2024 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 descriptions 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)	coke	**1**
1(a)(ii)	provide heat	**1**
1(b)(i)	**M1** 160 **M2** 112 **AND** 70.(0)(%)	**2**
1(b)(ii)	hematite	**1**
1(b)(iii)	by reduction of carbon dioxide	**1**
1(b)(iv)	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ **M1** species **M2** correct equation	**2**
1(b)(v)	reduction	**1**
1(c)	thermal decomposition	**1**
1(d)(i)	**M1** CaO is basic **M2** SiO_2 is acidic	**2**
1(d)(ii)	**M1** silicon(IV) oxide **M2** slag	**2**
1(e)(i)	aluminium is above carbon in the reactivity series **OR** aluminium is more reactive than carbon	**1**

Question	Answer	Marks
1(e)(ii)	electrolysis	**1**
1(f)(i)	2,8	**1**
1(f)(ii)	**M1** 26 (protons) **M2** 23 (electrons)	**2**

Question	Answer	Marks
2(a)	fluor**ine**	**1**
2(b)	red-brown **AND** liquid	**1**
2(c)	**M1** Ts **M2** 7	**2**
2(d)(i)	**M1** **pair** of electrons **M2** electron(s) shared between **two** atoms	**2**
2(d)(ii)	iod**ide /** astat**ide** / tenness**ide**	**1**
2(d)(iii)	brom**ine** is more reactive than iod**ine** / astat**ine** / tenness**ine**	**1**
2(e)	**M1** cobalt(II) chloride **M2** anhydrous	**2**
2(f)	**M1** 8 crosses in third shell of Ca **M2** 7 dots and 1 cross in third shell of both C*l* **M3** '2+' charge on Ca on correct answer line **AND** '–' charge on both C*l* ions on correct answer line	**3**

Question	Answer	Marks
2(g)(i)	lead(II) nitrate	**1**
2(g)(ii)	$Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$ **M1** $PbCl_2$ as **only** product **M2** Pb^{2+} + $2Cl^{-}$ as **only** reactants **M3** correct state symbols	**3**
2(g)(iii)	silver chloride	**1**

Question	Answer	Marks
3(a)	proton acceptor	**1**
3(b)	a soluble base	**1**
3(c)	**M1** blue **M2** colourless	**2**
3(d)(i)	**M1** HNO_3 **M2** lowest pH	**2**
3(d)(ii)	universal indicator	**1**
3(e)	$(CH_3COOH) \rightleftharpoons CH_3COO^{-} + H^{+}$ **M1** H^{+} **M2** CH_3COO^{-} **M3** $\rightleftharpoons$	**3**

Question	Answer	Marks
3(f)	$H^+ + OH^- \rightarrow H_2O$	**1**
3(g)	**M1** (0.0150 × 20.0/1000 =) 0.0003(00) / 3.00×10^{-4} (mol) **M2** (M1 × 2 = $3.00 \times 10^{-4} \times 2$ =) 0.0006(00) / 6.00×10^{-4} (mol) **M3** (M2 × 1000/25.0 = $6.00 \times 10^{-4} \times 1000$ / 25.0 =) 0.0240 (mol / dm^3) **M4** 63 (g / mol) **M5** (M3 × M4 = 0.0240 × 63 =) 1.51(2) (g / dm^3)	**5**

Question	Answer	Marks
4(a)(i)	structural	**1**
4(a)(ii)	CH_2O_2	**1**
4(b)	**M1** ethyl methanoate **M2** ester link **M3** correct displayed formula of ethyl methanoate	**3**
4(c)(i)	nothing can enter or leave	**1**
4(c)(ii)	**M1** the rate of forward reaction equals (the rate of the) reverse reaction **M2** concentrations of reactants and products are constant	**2**

Question	Answer	Marks
4(c)(iii)	**M1** increases **M2** decreases **M3** decreases **M4** no effect	**4**

Question	Answer	Marks
5(a)	(but-1-ene) has a lower relative molecular mass	**1**
5(b)	carbon dioxide **AND** water	**1**
5(c)(i)	photochemical	**1**
5(c)(ii)	to provide the activation energy	**1**
5(c)(iii)	substitution	**1**
5(c)(iv)	2	**1**
5(d)(i)	acid	**1**
5(d)(ii)	**M1** displayed formula of butan-1-ol **M2** displayed formula of butan-2-ol **M3** butan-1-ol **M4** butan-2-ol	**4**
5(e)(i)	addition (polymerisation)	**1**

Question	Answer	Marks
5(e)(ii)	**M1** chain of six C atoms joined by single bonds in a chain **M2** three correctly placed C_2H_5 groups **M3** correct structure **AND** continuation bonds	**3**

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2024**

45 minutes

You must answer on the multiple choice answer sheet.

2996709064

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.

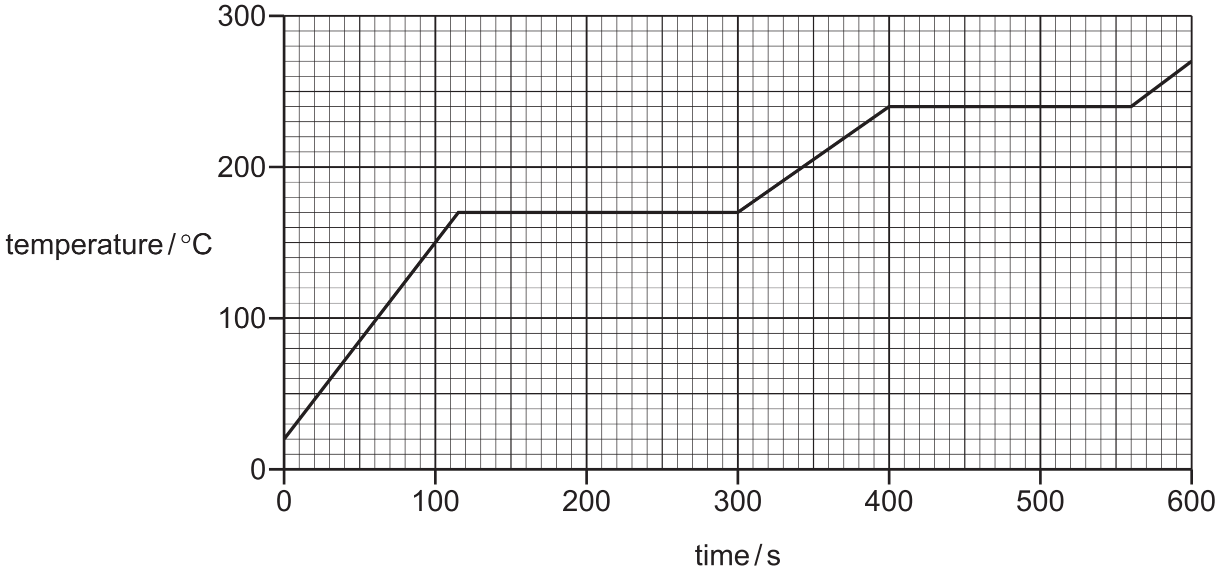
INFORMATION

- 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 Solid X is heated for 600 seconds.

The graph shows the heating curve that is obtained.



What is the melting point of X?

A 20 °C **B** 170 °C **C** 240 °C **D** 270 °C

2 Which statements about diffusion are correct?

1 Aqueous ions cannot diffuse in water.

2 Diffusion is caused by the random movement of particles.

3 Particles spread out in all directions in diffusion.

4 Diffusion can only take place in solids and liquids.

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

3 Which statement about an atom of fluorine, ${}^{19}_{9}F$, is correct?

A It contains a total of 28 protons, neutrons and electrons.

B It contains more protons than neutrons.

C Its isotopes contain different numbers of protons.

D Its nucleus contains 9 neutrons.

4 Two of the isotopes of calcium are represented as $^{40}_{20}Ca$ and $^{44}_{20}Ca$.

Which statement explains why these isotopes of calcium have identical chemical properties?

A Both isotopes have the same number of neutrons.

B Both isotopes have an electronic configuration of 2,8,8,2.

C Both isotopes have a mass number of 20.

D Both isotopes have four fully occupied electron shells.

5 Which statement describes a property of potassium iodide?

A It is insoluble in water.

B It is a volatile substance.

C It has a low melting point.

D It conducts electricity when molten.

6 Methanal, CH_2O, has a boiling point of –19 °C.

At –20 °C, the liquid methanal is a non-conductor of electricity.

In a sample of methanal, each atom of carbon, hydrogen and oxygen has noble gas electronic configuration. Each atom has achieved this electronic configuration in one of three ways:

- gaining electrons
- losing electrons
- sharing electrons.

Which statement describes the bonding between the carbon atom and the oxygen atom in methanal?

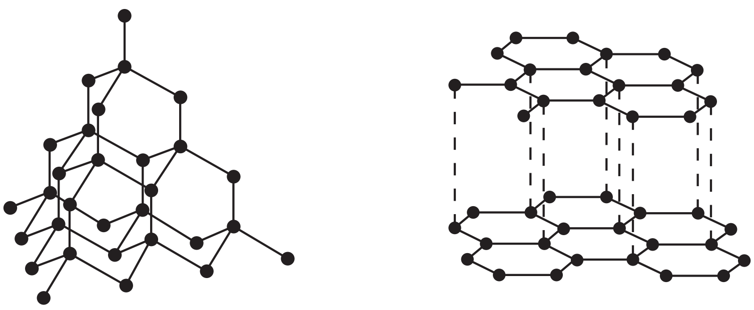
A The carbon atom and the oxygen atom share four electrons.

B The carbon atom and the oxygen atom share two electrons.

C Carbon is a negative ion and oxygen is a positive ion. These two ions attract each other.

D Carbon is a positive ion and oxygen is a negative ion. These two ions attract each other.

7 The structures of diamond and graphite are shown.



Which statement about diamond and graphite is correct?

A Diamond and graphite contain strong covalent bonds between carbon atoms.

B Diamond and graphite have delocalised electrons.

C Diamond and graphite have layered structures.

D Diamond and graphite have low melting points.

8 Which row contains a description of metallic bonding and a property that is explained by reference to metallic bonding?

	description of metallic bonding	property explained by reference to metallic bonding
A	a lattice of negative ions in a sea of delocalised electrons	a metal will react with an acid, producing hydrogen
B	a lattice of negative ions in a sea of delocalised electrons	a piece of a metal can be moulded into different shapes
C	a lattice of positive ions in a sea of delocalised electrons	a metal will react with an acid, producing hydrogen
D	a lattice of positive ions in a sea of delocalised electrons	a piece of a metal can be moulded into different shapes

9 What is the relative molecular mass, M_r, of sulfur dioxide?

A 24 **B** 32 **C** 48 **D** 64

10 Magnetite is an ore of iron which contains the ions Fe^{2+}, Fe^{3+} and O^{2-} only.

What is the formula of magnetite?

A Fe_2O **B** Fe_2O_3 **C** Fe_3O_2 **D** Fe_3O_4

11 Concentrated aqueous sodium chloride and dilute sulfuric acid are both electrolysed using inert electrodes.

Which row identifies the product at the cathode in each electrolysis?

	aqueous sodium chloride	dilute sulfuric acid
A	hydrogen	oxygen
B	hydrogen	hydrogen
C	chlorine	oxygen
D	chlorine	hydrogen

12 Electrolytes can be broken down by electrolysis.

Which rows are correct for each electrolyte?

	electrolyte	reaction at cathode	product at anode
1	dilute aqueous potassium chloride	$2H^+ + 2e^- \rightarrow H_2$	oxygen
2	concentrated hydrochloric acid	$2H^+ + 2e^- \rightarrow H_2$	chlorine
3	molten aluminium oxide	$2O^{2-} \rightarrow O_2 + 4e^-$	aluminium
4	concentrated aqueous sodium bromide	$Na^+ + e^- \rightarrow Na$	bromine

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

13 Which statement about hydrogen–oxygen fuel cells is correct?

A Hydrogen is extracted from clean, dry air.

B The only product is carbon dioxide.

C The reaction is endothermic.

D No toxic gases are produced.

14 Which statement defines the activation energy, E_a, for a reaction?

A It is the minimum energy that colliding particles must have to react.

B It is the minimum energy that endothermic reactions take in from their surroundings.

C It is the maximum energy that exothermic reactions transfer to their surroundings.

D It is the maximum energy released when the bonds in the products of a reaction form.

15 The equation for the complete combustion of ethyne, H–C≡C–H, is shown.

$$2\text{H–C}\equiv\text{C–H} \ + \ 5\text{O=O} \ \rightarrow \ 4\text{O=C=O} \ + \ 2\text{H–O–H}$$

The bond energies are listed.

bond	bond energy in kJ / mol
C≡C	837
C–H	415
O=O	498
C=O	805
O–H	464

What is the enthalpy change of the reaction when **1 mol** of ethyne is completely burned?

A –2472 kJ / mol

B –1236 kJ / mol

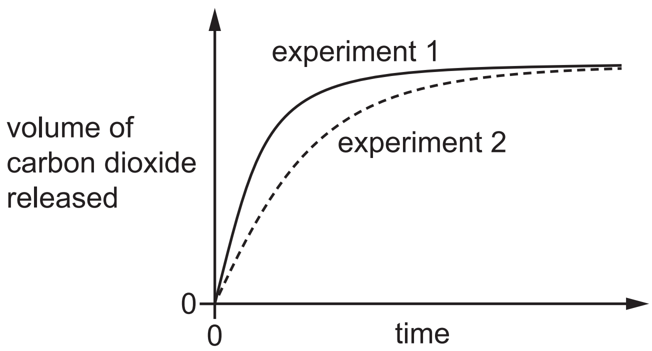
C +1236 kJ / mol

D +2472 kJ / mol

16 In experiment 1, small lumps of limestone are added to dilute ethanoic acid at 40 °C.

The volume of carbon dioxide released is measured at regular time intervals.

A graph of the results is shown.



Which changes give the results shown in experiment 2?

	limestone	temperature / °C
A	large lumps	40
B	powder	40
C	powder	60
D	small lumps	60

17 In the Haber process, nitrogen and hydrogen are reacted to make ammonia.

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

The forward reaction is exothermic.

Which conditions produce the maximum yield of ammonia?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

18 The Ostwald process is used to make nitric acid.

The conditions used in this process are:

1 a catalyst containing a transition element

2 a pressure of 10 atm

3 a temperature of 800 °C.

Which of these conditions are also used in the Contact process?

A 1 and 2

B 1 only

C 2 and 3

D 3 only

19 Hydrogen iodide is dissolved in water.

$$HI \rightarrow H^{+} + I^{-}$$

Which row describes the final colours seen when the solution is tested with damp red litmus paper and with acidified aqueous potassium manganate(VII)?

	damp red litmus paper	acidified aqueous potassium manganate(VII)
A	blue	brown
B	blue	colourless
C	red	brown
D	red	colourless

20 Which statements about aqueous ethanoic acid are correct?

1 It can be produced by oxidising ethanol with potassium iodide.

2 It reacts with magnesium to produce hydrogen gas.

3 It has an approximate pH value of 3.

4 It produces esters called methanoates.

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

21 Which element forms an acidic oxide?

A calcium

B lithium

C magnesium

D sulfur

22 Which statement describes the properties of hydrochloric acid?

A Carbon dioxide is produced when limestone reacts with hydrochloric acid.

B Hydrogen is produced when sodium hydroxide reacts with hydrochloric acid.

C Methyl orange turns yellow in strong hydrochloric acid.

D Red litmus paper turns blue when dipped into hydrochloric acid.

23 Elements P and Q have the same number of electron shells.

An atom of Q has more electrons in its outer electron shell than an atom of P.

Which statements are correct?

1 P and Q are in the same group of the Periodic Table.

2 P and Q are in the same period of the Periodic Table.

3 P has a greater tendency to form positive ions than Q.

4 The oxide of Q is more basic than the oxide of P.

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

24 Which substance reacts with dilute sulfuric acid to form a salt that can be removed from the resulting mixture by filtration?

A aqueous barium chloride

B aqueous sodium hydroxide

C copper

D copper(II) carbonate

25 Astatine is below iodine in Group VII in the Periodic Table.

Which row describes the properties of astatine?

	state at room temperature	reactivity
A	gas	displaces chlorine, bromine and iodine
B	gas	displaces iodine but does not displace chlorine or bromine
C	solid	displaces iodine but does not displace chlorine or bromine
D	solid	does not displace chlorine, bromine or iodine

26 Which property of copper explains why it is classified as a transition element?

A Copper can be bent into different shapes.

B Copper forms Cu^{2+} and Cu^{+} ions.

C Copper is a good conductor of electricity.

D Copper has a low density.

27 Brass is an alloy that is formed from copper and zinc.

Which statements are correct?

1 Brass, copper and zinc all conduct electricity.

2 Brass is a compound of copper and zinc.

3 Brass is harder than zinc.

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

28 The equation for the reaction of metal M with aqueous zinc sulfate is shown.

$$M(s) + ZnSO_4(aq) \rightarrow MSO_4(aq) + Zn(s)$$

Which statement explains why metal M reacts with aqueous zinc sulfate?

A Zinc is less reactive than M because M is able to accept electrons from zinc ions.

B Zinc is a more powerful reducing agent than M.

C Zinc is more reactive than M because it can lose electrons more easily than M.

D Zinc ions can remove electrons from M.

29 In the blast furnace, the impurity silicon(IV) oxide is removed by the formation of slag.

Which equation represents the formation of the substance which reacts with silicon(IV) oxide to form slag?

A $C + O_2 \rightarrow CO_2$

B $C + CO_2 \rightarrow 2CO$

C $CaCO_3 \rightarrow CaO + CO_2$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

30 Aluminium is extracted from bauxite by electrolysis.

Which statement is correct?

A Aluminium ions are oxidised to form aluminium.

B The cathode has to be replaced regularly because it reacts with the oxygen which is formed.

C Carbon dioxide is produced at the anode.

D Cryolite is added to remove impurities.

31 Iron rusts but aluminium does **not** easily corrode.

Which statement explains why aluminium does **not** easily corrode?

A It is an alloy.

B It is below iron in the reactivity series.

C It is a transition element.

D Its surface is protected by an oxide layer.

32 Which chemicals can be used as a fertiliser to provide the three elements needed for improved plant growth?

A $(NH_2)_2CO$ and KCl

B $(NH_4)_2HPO_4$ and K_2SO_4

C $(NH_4)_2HPO_4$ and $(NH_2)_2CO$

D $(NH_2)_2CO$ and K_2SO_4

33 What is the colour change when water is added to anhydrous cobalt(II) chloride?

A blue to white

B blue to pink

C white to blue

D white to pink

34 How do carbon dioxide and methane cause global warming?

A They emit the thermal energy they have absorbed back to the Earth.

B They absorb the radiation directly from the Sun.

C They increase thermal energy loss to space.

D They reduce reflection of thermal energy from the Earth's surface.

35 Four statements about photosynthesis are listed.

1 Chlorophyll is required for photosynthesis.

2 The equation for photosynthesis is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$.

3 Photosynthesis requires energy from light.

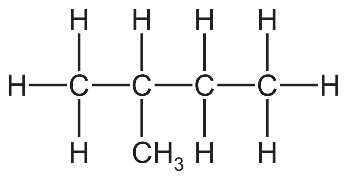
4 Photosynthesis releases carbon dioxide, which can lead to climate change.

Which statements are correct?

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

36 Which molecules are structural isomers?

1



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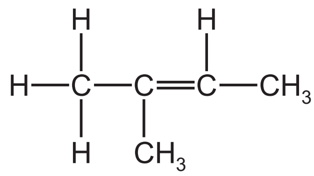

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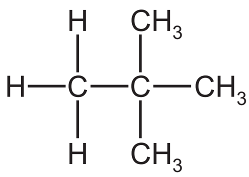

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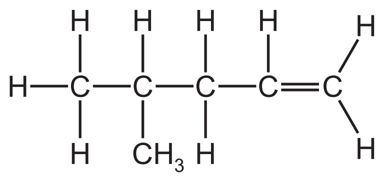


A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

37 Which statements about the reaction of ethene with steam are correct?

1 The product has a higher molecular mass than ethane.

2 The product reacts with aqueous bromine.

3 The number of electrons shared between carbon atoms decreases.

4 The reaction produces an alcohol and hydrogen.

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

38 Methane and chlorine react to form chloromethane.

Which row describes the necessary reaction condition and the type of reaction?

	reaction condition	type of reaction
A	ultraviolet light	substitution
B	nickel catalyst	substitution
C	nickel catalyst	addition
D	ultraviolet light	addition

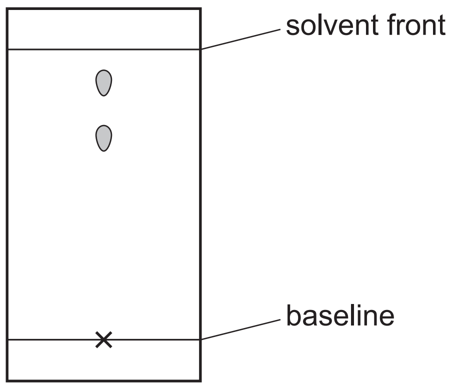
39 Parts of the structure of two different polymers, X and Y, are shown.

Which row about the monomers and the linkages between the monomers in polymers X and Y is correct?

	monomers in X and Y	linkages
A	different	the linkages in X are different from the linkages in Y
B	different	the linkages in X are the same as the linkages in Y
C	same	the linkages in X are different from the linkages in Y
D	same	the linkages in X are the same as the linkages in Y

40 Substance Q is tested using paper chromatography.

The resulting chromatogram is shown.



Which statement is correct?

A Q is a pure substance.

B The R_f value of the lower spot is 0.25.

C Q is a mixture of at least two different substances.

D Q is a compound of two elements.

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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		**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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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) **February/March 2024**

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 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7401624526

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2023**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB23 11_0620_63/5RP

[Turn over

1 Hydrated aluminium chloride is a white solid. When heated very strongly, hydrated aluminium chloride produces steam, hydrogen chloride gas and aluminium oxide. Hydrogen chloride gas is toxic and aluminium oxide is a white solid.

A teacher heats a sample of hydrated aluminium chloride using the apparatus shown in Fig. 1.1.

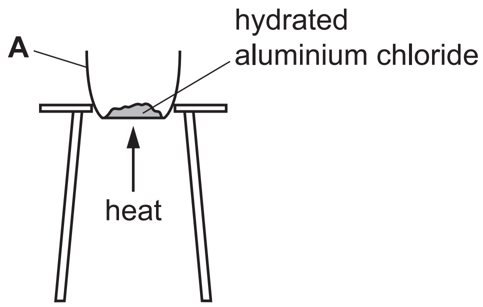

Fig. 1.1

(a) Name the item of apparatus labelled **A** in Fig. 1.1.

.... [1]

(b) Explain why this experiment should be carried out in a fume cupboard.

....

.... [1]

(c) The hydrated aluminium chloride has to be heated very strongly.

Describe how a Bunsen burner is adjusted to make the flame as hot as possible.

....

.... [1]

(d) During the experiment, the mass of apparatus **A** and its contents decreases.

(i) Explain why the mass decreases.

....

.... [1]

(ii) Describe what the teacher can do to be sure all the hydrated aluminium chloride reacts.

....

....

.... [2]

(e) In a second experiment, the teacher uses the apparatus shown in Fig. 1.2 to collect the water made.

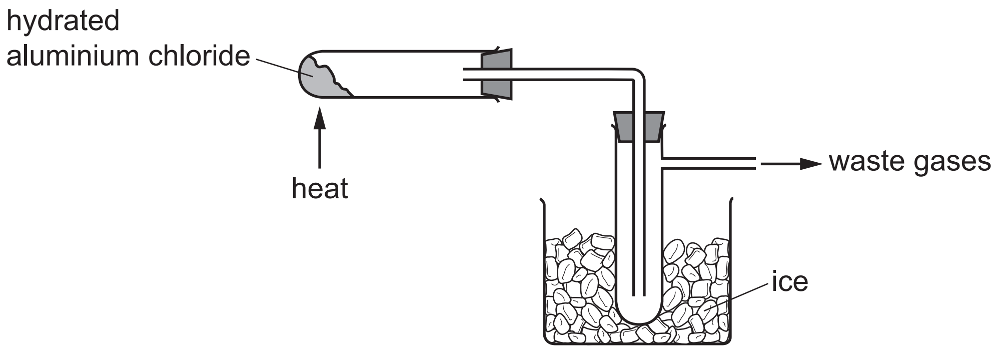

Fig. 1.2

(i) Explain the purpose of the ice.

....

.... [1]

(ii) The water collected is **not** pure.

Describe a test the teacher can do to show that the water collected is **not** pure.
State the result of the test if the water is **not** pure.

test ....

result ....
[2]

[Total: 9]

2 A student investigates the reaction between dilute hydrochloric acid and aqueous sodium hydroxide.

The student does two experiments.

Experiment 1

- Fill a burette with aqueous sodium hydroxide and run some of the aqueous sodium hydroxide out of the burette so that the level is on the burette scale.
- Record the initial burette reading.
- Use a measuring cylinder to pour 25 cm^3 of dilute hydrochloric acid into a conical flask.
- Stand the conical flask on a white tile.
- Add five drops of methyl orange indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour.
- Record the final burette reading.

Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Refill the burette with aqueous sodium hydroxide.
- Record the initial burette reading.
- Use the measuring cylinder to pour 25 cm^3 of dilute hydrochloric acid into the conical flask.
- Add 0.50 g of calcium carbonate powder to the conical flask and swirl the flask.
- Stand the conical flask on the white tile.
- Add five drops of methyl orange indicator to the conical flask.
- Slowly add aqueous sodium hydroxide from the burette to the conical flask, while swirling the flask, until the solution just changes colour.
- Record the final burette reading.

(a) Use the burette diagrams in Fig. 2.1 and Fig. 2.2 to record the readings for Experiment 1 and Experiment 2 in Table 2.1 and complete Table 2.1.

Experiment 1

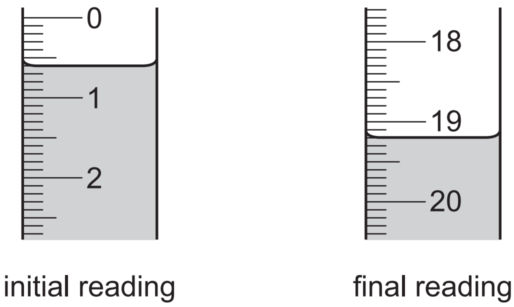

Fig. 2.1

Experiment 2

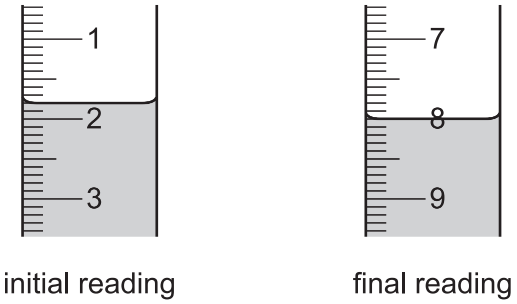

Fig. 2.2

Table 2.1

	Experiment 1	Experiment 2
final burette reading / cm^3		
initial burette reading / cm^3		
volume of aqueous sodium hydroxide added / cm^3		

[4]

(b) State the colour change observed in the conical flask at the end-point in both experiments.

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

(c) When 0.50 g of calcium carbonate is added to the conical flask in Experiment 2, a gas is produced.

Suggest the identity of the gas.

.... [1]

(d) In Experiment 2, the conical flask is rinsed with water but the burette is **not** rinsed with water.

(i) State why there is no need to rinse the burette with water.

.... [1]

(ii) Explain why the conical flask is rinsed with water.

....

.... [1]

(iii) The conical flask is **not** dried after being rinsed with water.

State how drying the conical flask affects the volume of aqueous sodium hydroxide needed to reach the end-point. Explain your answer.

....

....

.... [2]

(e) **(i)** Compare the volumes of aqueous sodium hydroxide needed to reach the end-point in Experiment 1 and Experiment 2.

....

.... [2]

(ii) Explain why different volumes of aqueous sodium hydroxide are needed in Experiment 1 and Experiment 2.

....

.... [1]

(iii) Calculate the volume of aqueous sodium hydroxide needed to reach the end-point if Experiment 2 is repeated using 0.25 g of calcium carbonate instead of 0.50 g.

volume of aqueous sodium hydroxide = ... [2]

(f) Describe how the reliability of the results obtained can be confirmed.

....

.... [1]

[Total: 16]

3 A student tests two substances: solid **I** and solution **J**.

Tests on solid I

Solid **I** is chromium(III) sulfate.

The student dissolves solid **I** in water to form solution **I**. The student divides solution **I** into three portions.

Complete the expected observations.

(a) To the first portion of solution **I**, the student adds aqueous sodium hydroxide dropwise until it is in excess.

observations adding dropwise ....

observations in excess ....
[2]

(b) To the second portion of solution **I**, the student adds about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations ....

.... [1]

(c) To the third portion of solution **I**, the student adds about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations ....

.... [1]

Tests on solution J

Table 3.1 shows the tests and the student's observations for solution **J**. The student divides solution **J** into five portions.

Table 3.1

tests	observations
test 1 Use a glass rod to transfer one drop of the first portion of solution **J** onto a piece of universal indicator paper.	the universal indicator paper turns red
test 2 To the second portion of solution **J**, add a piece of magnesium ribbon. Test any gas produced.	the piece of magnesium ribbon disappears and effervescence is seen the gas produces a pop when tested with a lighted splint
test 3 To the third portion of solution **J**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	white precipitate
test 4 To the fourth portion of solution **J**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no change
test 5 Do a flame test on the fifth portion of solution **J**.	lilac coloured flame

(d) Suggest the pH of solution **J**.

pH = ... [1]

(e) Identify the gas given off in **test 2**.

.... [1]

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

....

....

.... [3]

[Total: 9]

4 You are asked to investigate the effect of temperature on the rate of decomposition of aqueous hydrogen peroxide.

Aqueous hydrogen peroxide decomposes to make oxygen gas.

hydrogen peroxide → water + oxygen

The reaction is very slow unless a catalyst is added to the hydrogen peroxide.
Manganese(IV) oxide is a catalyst for this reaction.

Plan an investigation to find how the **temperature** of the aqueous hydrogen peroxide affects the rate of the catalysed reaction. Your answer should include an explanation of how your results will tell you how the rate of reaction has changed.

You are provided with aqueous hydrogen peroxide, manganese(IV) oxide and common laboratory apparatus.

....

....

....

....

....

....

....

....

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....

....

....

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....

....

....

....

....

.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2023**

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 2023 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.

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)	crucible	**1**
1(b)	hydrogen chloride is toxic	**1**
1(c)	air hole (fully) open	**1**
1(d)(i)	steam / water (of crystallisation) / hydrogen chloride / gases **and** leave / escape / released / given off / lost	**1**
1(d)(ii)	**M1** reheat **M2** until mass / weight remains constant	**2**
1(e)(i)	so that the steam / vapour condenses / becomes liquid / water	**1**
1(e)(ii)	**M1** (measure) boiling point / freezing point **M2** **not** 100 °C / **not** 0 °C	**2**

Question	Answer	Marks
2(a)	**M1** final and initial burette reading for Experiment 1 correct (19.2 and 0.6) **M2** final and initial burette reading for Experiment 2 correct (8.0 and 1.8) **M3** both titres correct (18.6 and 6.2) **M4** all volumes recorded to 1 dp or better	**4**
2(b)	(from) red (to) orange	**1**
2(c)	carbon dioxide / CO_2	**1**
2(d)(i)	used with same solution / same concentration (of sodium hydroxide) / solution not changed	**1**
2(d)(ii)	to remove residue / impurities (from Experiment 1)	**1**
2(d)(iii)	**M1** no change **M2** water does not change amount of acid / acid is measured with the measuring cylinder	**2**
2(e)(i)	**M1** more in Experiment 1 **M2** quantitative description of how much more	**2**
2(e)(iii)	the calcium carbonate reacts with / neutralises (some of) the acid (so there is less acid left)	**1**
2(e)(iii)	**M1** 12.4 **M2** cm^3	**2**
2(f)	repeat **and** compare (results)	**1**

Question	Answer	Marks
3(a)	**M1** dropwise: green precipitate **M2** in excess: dissolves	**2**
3(b)	no change / no precipitate	**1**
3(c)	white precipitate	**1**
3(d)	any pH in range 1 to 3	**1**
3(e)	hydrogen / H_2	**1**
3(f)	**M1** hydrogen / H^+ **M2** potassium / K^+ **M3** chloride / Cl^-	**3**

Question	Answer	Marks
4	any 6 from: **volume of gas in set time** **MP1** known / stated volume of hydrogen peroxide **MP2** add known / stated mass of catalyst **MP3** reaction done in a suitable container (test-tube / boiling tube / flask) **MP4** collect gas made in suitable graduated container **MP5** measure volume after set time **MP6** repeat at higher / different temperature(s) **MP7** higher volume (in set time) is faster rate **OR** **time to get set volume of gas** **MP1** known / stated volume of hydrogen peroxide **MP2** add known / stated mass of catalyst **MP3** reaction done in a suitable container (test-tube / boiling tube / flask) **MP4** collect gas made in suitable graduated container **MP5** measure time to get a set volume / measure time when no more gas collected / measure time for reaction to stop fizzing **MP6** repeat at higher / different temperature(s) **MP7** shorter time is faster rate **OR** **mass loss in a set time** **MP1** known / stated volume of hydrogen peroxide **MP2** add known / stated mass of catalyst **MP3** reaction done in a suitable container (test-tube / boiling tube / flask / beaker) **MP4** apparatus on balance **MP5** measure mass loss at set time **MP6** repeat at higher / different temperature(s) **MP7** higher mass loss (in set time) is faster rate	**6**

Question	Answer	Marks
4	**OR** **time to get set mass loss** **MP1** known / stated volume of hydrogen peroxide **MP2** add known / stated mass of catalyst **MP3** reaction done in a suitable container (test-tube / boiling tube / flask / beaker) **MP4** apparatus on balance **MP5** measure time for set mass loss / measure time when no more change in mass **MP6** repeat at higher / different temperature(s) **MP7** shorter time is faster rate **OR** **measure time to stop reacting** **MP1** known / stated volume of hydrogen peroxide **MP2** add known / stated mass of catalyst **MP3** reaction done in a suitable container (test-tube / boiling tube / flask / beaker) **MP4** observe bubbles / collect gas until no more made / weigh until constant **MP5** measure time for bubbles / fizzing **MP6** repeat at higher / different temperature(s) **MP7** shorter time is faster rate **max 6**	

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2538350813

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2023**

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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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

IB23 11_0620_62/5RP

[Turn over

1 Some seashells contain a mixture of the insoluble compounds calcium carbonate and silicon(IV) oxide only.

Calcium carbonate reacts with dilute hydrochloric acid to form the soluble salt calcium chloride. Silicon(IV) oxide does **not** react with or dissolve in dilute hydrochloric acid.

A student wants to find the percentage of silicon(IV) oxide in a seashell. The first four steps of the method the student uses are shown.

step 1 The student grinds the seashell to form a powder.

step 2 The student finds the mass of the powdered seashell.

step 3 The student adds the powdered seashell to an excess of dilute hydrochloric acid and heats while stirring with a glass rod as shown in Fig. 1.1.

step 4 The student filters the mixture as shown in Fig. 1.2.

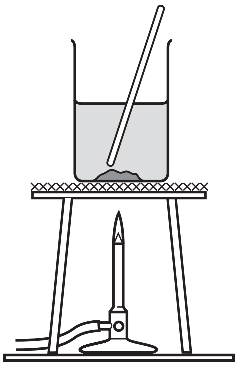

Fig. 1.1

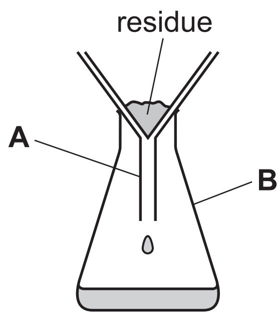

Fig. 1.2

(a) Name the apparatus used to grind the seashell to form a powder in **step 1**.

.... [1]

(b) Explain why it is important that the dilute hydrochloric acid is in excess in **step 3**.

....

.... [1]

(c) Name the items of apparatus labelled **A** and **B** in Fig. 1.2.

A ....

B ....
[2]

(d) The residue obtained in **step 4** is not pure.

(i) Identify **one** substance, other than water, that is in the residue and prevents it from being pure.

.... [1]

(ii) The student washes the residue.

Describe **two** additional steps the student must now take to find the percentage of silicon(IV) oxide in the seashell.

....

....

....

.... [2]

[Total: 7]

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2 A student investigates the temperature change when aqueous sodium hydroxide neutralises dilute hydrochloric acid. The equation for the reaction is shown.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The student does six experiments.

Experiment 1

- Fill a burette with dilute hydrochloric acid.
- Run some of the dilute hydrochloric acid out of the burette so that the level of the dilute hydrochloric acid is on the burette scale.
- Fill a second burette with aqueous sodium hydroxide.
- Run some of the aqueous sodium hydroxide out of the burette so that the level of the aqueous sodium hydroxide is on the burette scale.
- Run 1.0 cm^3 of dilute hydrochloric acid from the burette into a boiling tube.
- Run 9.0 cm^3 of aqueous sodium hydroxide from the second burette into the same boiling tube.
- Stir the mixture with a thermometer and measure the highest temperature reached.
- Measure the pH of the mixture in the boiling tube.
- Rinse out the boiling tube with distilled water.

Experiment 2

- Run 2.0 cm^3 of dilute hydrochloric acid from the burette into the boiling tube.
- Run 8.0 cm^3 of aqueous sodium hydroxide from the second burette into the same boiling tube.
- Stir the mixture with a thermometer and measure the highest temperature reached.
- Measure the pH of the mixture in the boiling tube.
- Rinse out the boiling tube with distilled water.

Experiment 3

- Repeat Experiment 2 using 3.0 cm^3 of dilute hydrochloric acid and 7.0 cm^3 of aqueous sodium hydroxide.

Experiment 4

- Repeat Experiment 2 using 6.0 cm^3 of dilute hydrochloric acid and 4.0 cm^3 of aqueous sodium hydroxide.

Experiment 5

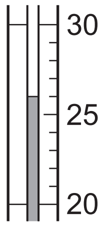
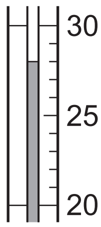
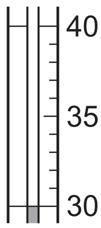
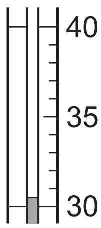
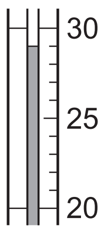
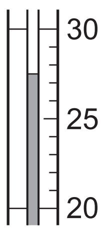
- Repeat Experiment 2 using 7.0 cm^3 of dilute hydrochloric acid and 3.0 cm^3 of aqueous sodium hydroxide.

Experiment 6

- Repeat Experiment 2 using 8.0 cm^3 of dilute hydrochloric acid and 2.0 cm^3 of aqueous sodium hydroxide.

(a) Use the description of the experiments and the thermometer diagrams to complete Table 2.1.

Table 2.1

experiment	volume of dilute hydrochloric acid / cm^3	volume of aqueous sodium hydroxide / cm^3	thermometer diagram when highest temperature reached	highest temperature reached / °C	pH
1	1.0				11
2	2.0				11
3	3.0				11
4	6.0				1
5	7.0				1
6	8.0				1

[4]

(b) Add a suitable scale to the *y*-axis in Fig. 2.1. **Your scale should extend by 2 °C above your highest temperature in Table 2.1.**
Plot your results from Experiments 1 to 6 on the grid.
Draw **two** straight lines through your points, one through the first three points and one through the last three points. Extend your straight lines so that they cross.

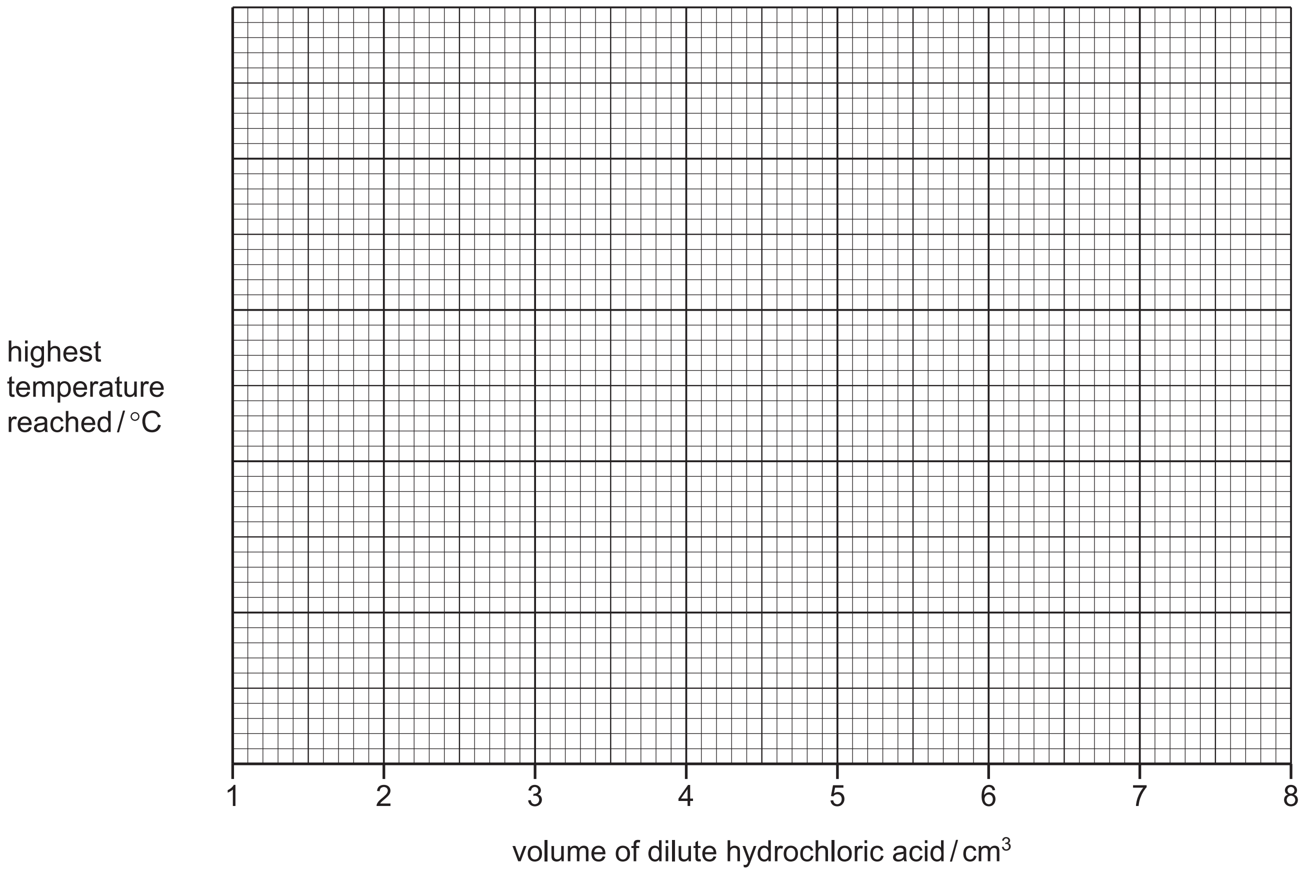


Fig. 2.1

[5]

(c) The point on the graph where the two straight lines cross is where all of the aqueous sodium hydroxide reacts with all of the dilute hydrochloric acid to form a neutral solution.

(i) **Use your graph** in Fig. 2.1 to deduce the volume of dilute hydrochloric acid and the volume of aqueous sodium hydroxide that react together to produce a neutral solution.
Show your working **on Fig. 2.1**.

volume of dilute hydrochloric acid = ... cm^3

volume of aqueous sodium hydroxide = ... cm^3
[3]

(ii) Predict the pH of the solution in the boiling tube when the volumes in **(c)(i)** are mixed together.

pH = ... [1]

(iii) Deduce which solution, dilute hydrochloric acid or aqueous sodium hydroxide, is the most concentrated.

Use your answer to **(c)(i)** to explain why.

most concentrated solution ....

explanation ....

.... [1]

(d) State how the pH and temperature recorded in each experiment would differ, if at all, if a polystyrene cup is used in place of the boiling tube.

Explain any differences.

pH ....

temperature ....

explanation ....

.... [3]

(e) The volumes of the solutions used in these experiments were measured using a burette.

Explain why a volumetric pipette could **not** be used instead of a burette in this experiment.

.... [1]

[Total: 18]

3 A student tests two substances: solid **K** and solid **L**.

Tests on solid K

The student dissolves solid **K** in water to form solution **K**. The student divides solution **K** into four portions.
Table 3.1 shows the tests and the student's observations for solution **K**.

Table 3.1

tests	observations
test 1 To the first portion of solution **K**, add a few drops of aqueous ammonia.	white precipitate
test 2 To the second portion of solution **K**, add a few drops of acidified aqueous potassium manganate(VII).	pale purple solution
test 3 To the third portion of solution **K**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	cream precipitate
test 4 To the fourth portion of solution **K**, add aqueous chlorine.	the solution becomes orange

(a) **(i)** Identify **two** cations that **test 1** shows could be in solid **K**.

....

.... [2]

(ii) Describe an additional test that could be carried out on solution **K** to confirm which of the two cations you have identified in **(a)(i)** is in solid **K**.

Explain how the test will show which of these two cations is in solid **K**.

test ....

explanation ....

....
[2]

(b) Identify the anion in solid **K**.

.... [1]

Tests on solid L

Solid **L** is barium nitrate.

Complete the expected observations.

(c) The student carries out a flame test on solid **L**.

observations .... [1]

The student dissolves the remaining solid **L** in water to form solution **L**.

The student divides solution **L** into three portions.

(d) To the first portion of solution **L**, the student adds a piece of aluminium foil and 5 cm^3 of aqueous sodium hydroxide and warms the mixture. The student tests for any gas produced.

observations ....

.... [1]

(e) To the second portion of solution **L**, the student adds 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate.

observations ....

.... [1]

(f) To the third portion of solution **L**, the student adds 1 cm^3 of dilute sulfuric acid.

observations ....

.... [1]

[Total: 9]

4 The solubility of solid sodium sulfate in water changes as the temperature of the water changes.

Plan an experiment to find out how the solubility of sodium sulfate in water changes with temperature.

You are provided with sodium sulfate, distilled water and common laboratory apparatus.

....

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.... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

Cambridge Assessment International Education

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2023**

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 2023 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	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.

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)	pestle and mortar	**1**
1(b)	so that all the calcium carbonate reacts / dissolves	**1**
1(c)	**A** (filter) funnel **B** (conical) flask	**2**
1(d)(i)	hydrochloric acid / calcium chloride	**1**
1(d)(ii)	**M1** dry **M2** determine the mass	**2**

Question	Answer	Marks
2(a)	**M1** all volumes of aqueous sodium hydroxide completed correctly (9.0, 8.0, 7.0, 4.0, 3.0, 2.0) **M2 and M3** all six temperatures completed correctly (26.0; 28.0; 30.0; 30.5; 29.0; 27.5) **M4** all temperatures completed to same number of dp **and** all volumes of aqueous sodium hydroxide shown to 1 dp	**4**
2(b)	**M1** appropriate vertical scale so that points and extrapolation to maximum extend over halfway up scale **M2** and **M3** all points plotted correctly **M4** two suitable straight lines **M5** <u>straight</u> lines extended so that they cross / meet	**5**
2(c)(i)	**M1** working shown on graph from where lines cross **M2** volume of dilute hydrochloric acid correct for their graph **M3** volume of aqueous sodium hydroxide correct based on their recorded volume of hydrochloric acid	**3**

Question	Answer	Marks
2(c)(ii)	7	**1**
2(c)(iii)	dilute hydrochloric acid **and** (as volume) less / low(er) / small(er) than sodium hydroxide (to be neutral / reach maximum temperature)	**1**
2(d)	**M1** pH: no change **M2** temperature: higher / greater / bigger **M3** explanation: polystyrene is a better insulator than glass	**3**
2(e)	(volumetric) pipettes not available in those sizes / (volumetric) pipettes do not measure variable volumes	**1**

Question	Answer	Marks
3(a)(i)	**M1** zinc / Zn^{2+} **M2** aluminium / Al^{3+}	**2**
3(a)(ii)	**M1** add excess / more ammonia **M2** for zinc ions: precipitate redissolves / colourless solution **OR** for aluminium ions: the precipitate remains / stays white / unchanged	**2**
3(b)	bromide / Br^-	**1**
3(c)	(light / pale / apple) green (flame colour)	**1**
3(d)	(red) litmus turns blue	**1**
3(e)	no change / (remains) colourless / no reaction	**1**
3(f)	white precipitate	**1**

Question	Answer	Marks
4	any 6 from: **add excess solute, find mass not dissolved** **MP1** known / stated <u>volume</u> of water **MP2** add known / stated mass of sodium sulfate (in excess) **MP3** water and solute combined in a suitable named container (test-tube / boiling tube / beaker / flask / polystyrene cup) **MP4** stir / mix / shake **MP5** filter **MP6** dry **and** weigh residue (ignore washing) **MP7** repeat at (an)other temperature(s) **OR** **add solute gradually, stop when no more dissolves** **MP1** known / stated <u>volume</u> of water **MP2** add stated measure of sodium sulfate **MP3** water and solute combined in a suitable named container (test-tube / boiling tube / beaker / flask / polystyrene cup) **MP4** stir / mix / shake **MP5** if all dissolved, add more sodium sulfate **MP6** count number of measures / mass added / mass left from initial supply **MP7** repeat at (an)other temperature(s) **OR** **add excess solute, find mass that dissolves** **MP1** known / stated <u>volume</u> of water **MP2** add **excess** of sodium sulfate **MP3** water and solute combined in a suitable named container (test-tube / boiling tube / beaker / flask / polystyrene cup) **MP4** stir / mix / shake **MP5** filter **MP6** heat solution to evaporate **all** water and weigh residue **MP7** repeat at (an)other temperature(s)	**6**

Question	Answer	Marks
4	**OR** **fixed mass solute add solvent until all dissolves** **MP1** add known volumes / fixed quantities of water gradually to **MP2** known / stated <u>mass</u> of sodium sulfate **MP3** water and solute combined in a suitable named container (test-tube / boiling tube / beaker / flask / polystyrene cup) **MP4** stir / mix / shake **MP5** if not all dissolved, add more water **MP6** measure total volume of water added **MP7** repeat at (an)other temperature(s) **max 6**	