Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

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CHEMISTRY **0620/61**

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.

1 A student uses chromatography to analyse samples of three different dyes. The apparatus the student uses is shown in Fig. 1.1.

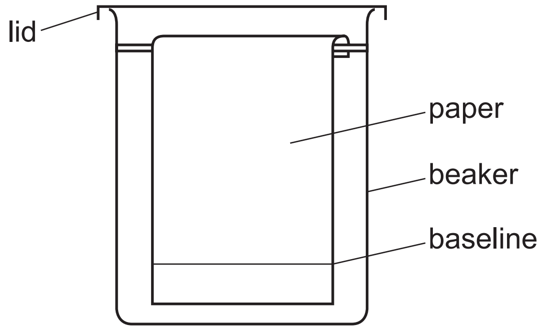


Fig. 1.1

(a) A spot of each dye is placed on the paper and some ethanol is poured into the beaker.

Draw on Fig. 1.1:

- **three** spots (●) to show where the three dyes are placed on the paper at the start of the experiment
- a line to show the level of ethanol in the beaker at the start of the experiment.

[2]

(b) During the experiment the ethanol moves up the paper.

State when the student should remove the chromatography paper from the ethanol in the beaker.

.... [1]

(c) Fig. 1.2 shows the result of the chromatography experiment.

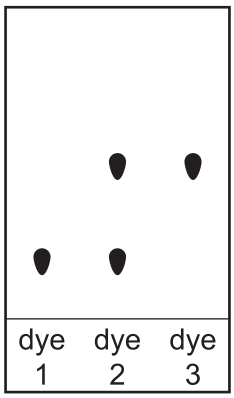


Fig. 1.2

State what conclusions can be made from this result.

....

....

.... [2]

[Total: 5]

2 Copper(II) carbonate reacts with dilute acids to make carbon dioxide gas.
Malachite is a mineral that contains copper(II) carbonate.
A student investigates the rate of reaction between powdered malachite and dilute ethanoic acid at different temperatures. The student does six experiments.

Experiment 1

- Use a measuring cylinder to pour 40 cm^3 of dilute ethanoic acid into a conical flask.
- Warm the dilute ethanoic acid by about 5 °C.
- Measure the temperature of the acid using a thermometer.
- Set the apparatus up as shown in Fig. 2.1.

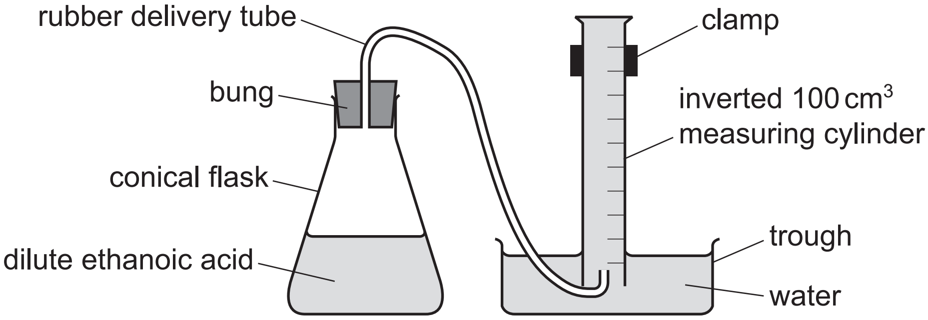


Fig. 2.1

- Remove the bung from the conical flask and add 1.0 g of powdered malachite to the conical flask, replace the bung and start a stop-clock.
- Record the time taken for 100 cm^3 of gas to be collected in the measuring cylinder.
- Empty the conical flask and rinse it with distilled water.

Experiment 2

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 10 °C.

Experiment 3

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 15 °C.

Experiment 4

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 25 °C.

Experiment 5

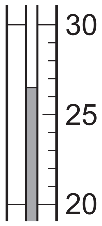
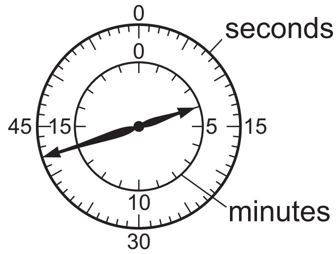
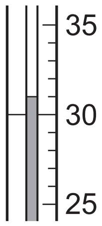
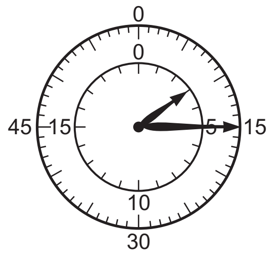
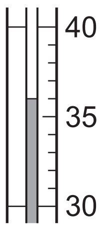
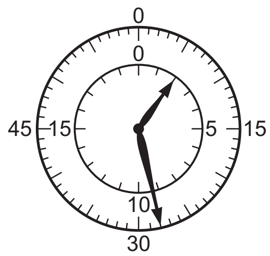
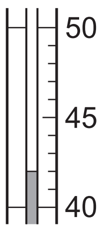
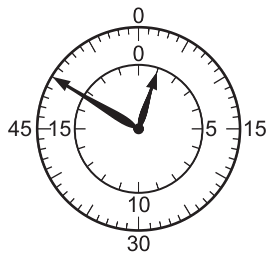
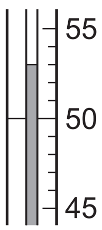
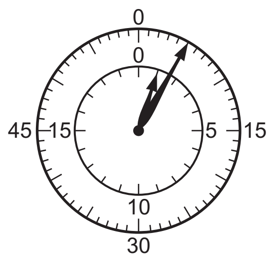
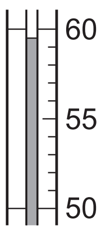
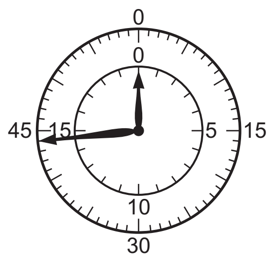
- Repeat Experiment 1 but warm the dilute ethanoic acid by about 35 °C.

Experiment 6

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 40 °C.

(a) Use the thermometer and stop-clock diagrams to complete Table 2.1.

Table 2.1

experiment	thermometer diagram	temperature of ethanoic acid / °C	stop-clock diagram	time taken to collect 100 cm^3 of gas / s
1				
2				
3				
4				
5				
6				

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 6 on Fig. 2.2.

Draw a line of best fit through your points.

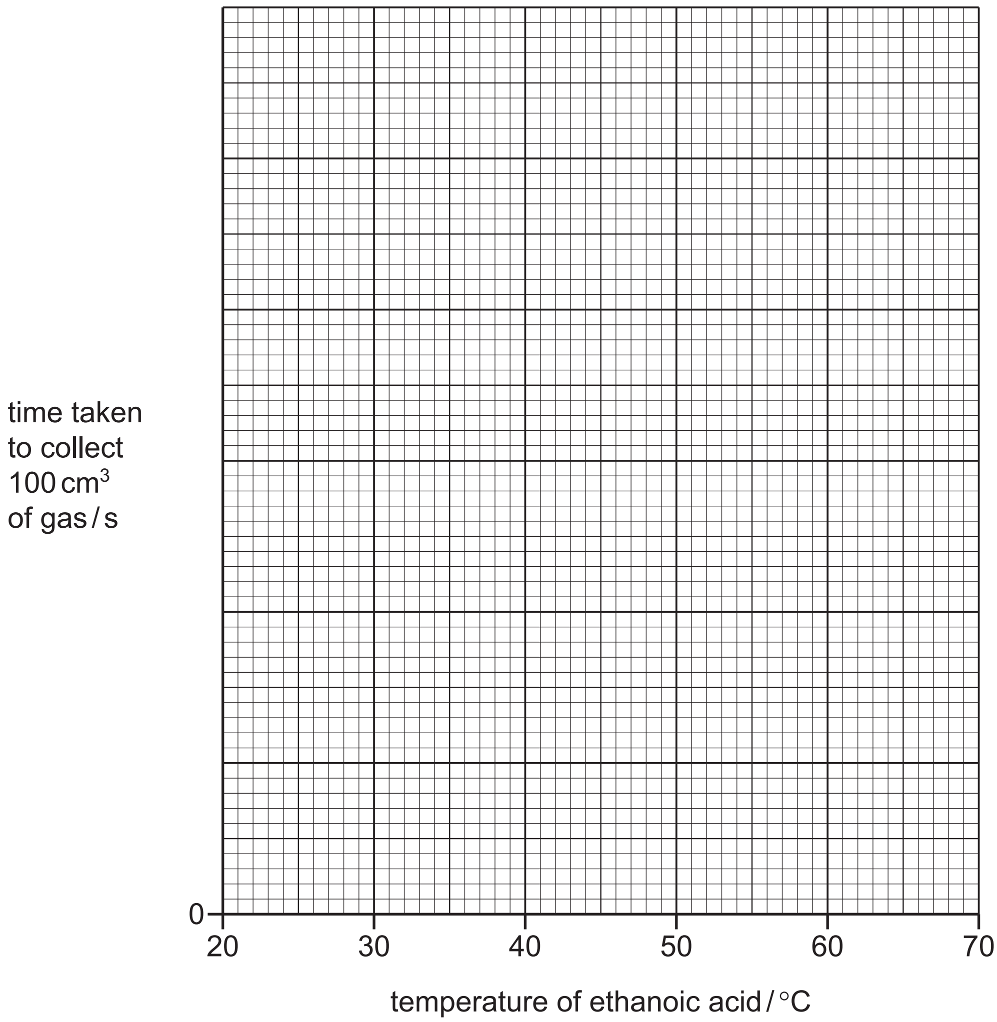


Fig. 2.2

[4]

(c) The average rate of reaction in an experiment can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the average rate of reaction in Experiment 6.
Give the units for the rate you have calculated.

average rate = ... units ....

[2]

(ii) Deduce in which experiment, 1, 2, 3, 4, 5 or 6, the rate of reaction is greatest.

.... [1]

(d) Extend the line on your graph in Fig. 2.2.
Deduce the time taken to collect 100 cm^3 of gas when the temperature of the ethanoic acid is 65 °C.

Show clearly on Fig. 2.2 how you worked out your answer.

.... s
[3]

(e) The 40 cm^3 of ethanoic acid used in each experiment is measured using a measuring cylinder. Measuring cylinders are available in the following sizes.

10 cm^3 **25 cm^3** **50 cm^3** **100 cm^3** **500 cm^3**

Draw a circle around the size of measuring cylinder which would be most suitable to measure 40 cm^3 of ethanoic acid. [1]

(f) Most of the gas collected in the measuring cylinder is air rather than carbon dioxide.

(i) Explain why air is collected in the measuring cylinder.

....

.... [1]

(ii) Explain why this does **not** affect the accuracy of the results.

....

.... [1]

(g) During each experiment the temperature of the acid decreases slowly.

Give a reason why the temperature of the acid decreases and suggest a change to the apparatus used that would minimise the decrease in temperature.

reason temperature decreases ....

....

change to apparatus ....

....
[2]

[Total: 20]

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

Tests on solid M

Solid **M** is hydrated chromium(III) nitrate.

Complete the expected observations.

(a) The student places half of solid **M** in a boiling tube and heats it strongly.

(i) The student holds a piece of anhydrous cobalt(II) chloride paper at the mouth of the boiling tube.

observations ....

.... [1]

(ii) The student inserts a glowing splint into the mouth of the boiling tube. The splint bursts into flames.

Identify the gas given off by heating solid **M** which causes this result.

.... [1]

(b) The student dissolves the remaining solid **M** in water to form solution **M**.

(i) The student adds aqueous sodium hydroxide dropwise and then in excess to solution **M**.

observations adding dropwise ....

observations in excess ....

[2]

(ii) The student adds a piece of aluminium foil to the product from **(b)(i)**. The mixture is then warmed. The student tests for any gas produced.

observations ....

....

.... [1]

Tests on solid N

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

Table 3.1

tests	observations
test 1 Do a flame test on solid **N**.	light green flame
test 2 Dissolve the remaining solid **N** in water to form solution **N**. Divide solution **N** into four portions. To the first portion of solution **N**, add dilute sulfuric acid.	white precipitate
test 3 To the second portion of solution **N**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	pale yellow precipitate
test 4 To the third portion of solution **N**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no visible change
test 5 To the fourth portion of solution **N**, add about 1 cm^3 of aqueous chlorine.	brown solution

(c) Describe how to carry out a flame test.

....

....

.... [2]

(d) Identify solid **N**.

....

.... [2]

[Total: 9]

4 *Greaseaway* and *Kitchenclean* are two solutions used as household cleaners that contain aqueous ammonia.

Plan an investigation to find which of the two household cleaners contains aqueous ammonia with the highest concentration. Assume that aqueous ammonia is the only alkali in the cleaners.

Include in your plan:

- the method you will use
- how your results will be used to determine which household cleaner contains aqueous ammonia with the highest concentration.

You are provided with common laboratory apparatus and chemicals.

[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 **0620/61**

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

Examples of how to apply the list rule

State **three** reasons…. [3]

A	1 Correct	✓	**2**
	2 Correct	✓	
	3 Wrong	×	

B	1 Correct, Correct	✓, ✓	**3**
(4 responses)	2 Correct	✓	
	3 Wrong	ignore	

C	1 Correct	✓	**2**
(4 responses)	2 Correct, Wrong	✓, ×	
	3 Correct	ignore	

D	1 Correct	✓	**2**
(4 responses)	2 Correct, CON (of 2.)	×, (discount 2)	
	3 Correct	✓	

E	1 Correct	✓	**3**
(4 responses)	2 Correct	✓	
	3 Correct, Wrong	✓	

F	1 Correct	✓	**2**
(4 responses)	2 Correct	✓	
	3 Correct CON (of 3.)	× (discount 3)	

G	1 Correct	✓	**3**
(5 responses)	2 Correct	✓	
	3 Correct Correct CON (of 4.)	✓ ignore ignore	

H	1 Correct	✓	**2**
(4 responses)	2 Correct	×	
	3 CON (of 2.) Correct	(discount 2) ✓	

I	1 Correct	✓	**2**
(4 responses)	2 Correct	×	
	3 Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1(a)	**M1** three spots shown horizontally along the baseline	**1**
	M2 solvent level above / touching the bottom of the paper but below the base line and **not** touching any of the spots	**1**
1(b)	when the ethanol is almost at the top of the paper	**1**
1(c)	**any two from:** **MP1** dye 1 **and** dye 3 are pure substances / contain only 1 colour / substance **MP2** dye 2 contains dye 1 and dye 3 **MP3** all of the dyes were soluble	**2**

Question	Answer	Marks
2(a)	**M1 and M2** all temperatures correct (26.5, 31.0, 36.0, 42.0, 53.0, 59.5)	**2**
	M3 all six temperatures recorded to 1 dp	**1**
	M4 all times correct (282, 195, 148, 110, 65, 44)	**1**
	M5 all six times in seconds only	**1**
2(b)	**M1** appropriate linear vertical scale so that points take up more half space	**1**
	M2 and **M3** all points plotted correctly	**2**
	M4 a suitable best-fit curve drawn	**1**
2(c)(i)	**M1** 2.27(272727...)	**1**
	M2 cm^3 / s	**1**
2(c)(ii)	6	**1**

Question	Answer	Marks
2(d)	**M1** suitable extrapolation to 65 °C (and beyond)	**1**
	M2 working shown on graph	**1**
	M3 correct reading from graph	**1**
2(e)	circle round 50 cm^3	**1**
2(f)(i)	displaced / pushed out of flask by carbon dioxide	**1**
2(f)(ii)	the volume of air displaced is the same as the volume of carbon dioxide	**1**
2(g)	**M1** reason: heat lost (to surroundings) / glass / flask is not a good insulator / glass / flask conducts / absorbs heat	**1**
	M2 change: insulate (the flask) **or** place in water bath (kept at the starting temperature of the acid)	**1**

Question	Answer	Marks
3(a)(i)	(changes from blue to) pink	**1**
3(a)(ii)	oxygen / O_2	**1**
3(b)(i)	**M1** dropwise: green precipitate	**1**
	M2 excess: dissolves	**1**
3(b)(ii)	damp (red) litmus (paper) turns blue	**1**

Question	Answer	Marks
3(c)	**M1** use of a wire / splint (to get substance into a flame)	**1**
	M2 putting sample <u>into</u> flame **and** identifying (Bunsen) flame as roaring / blue / non-luminous / hot	**1**
3(d)	**M1** barium / Ba^{2+}	**1**
	M2 iodide / I^{-}	**1**

Question	Answer	Marks
4	**any 6 from:** **MP1** known / stated volume of one cleaner **MP2** measured with appropriate named apparatus (pipette / measuring cylinder / burette) **MP3** named indicator used in this experiment **MP4** acid added to cleaner in flask **MP5** correct end-point colour for indicator used stated **MP6** recorded / measured start and end reading on burette **MP7** biggest volume (of acid) used has most concentrated ammonia	**6**

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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

0306701071

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

1 A list of gases is shown.

ammonia
carbon dioxide
carbon monoxide
ethene
fluorine
oxygen
sulfur dioxide
xenon

Answer the following questions using only the gases from the list.
Each gas may be used once, more than once or not at all.

Give the name of the gas that:

(a) causes acid rain

.... [1]

(b) forms an alkaline solution when dissolved in water

.... [1]

(c) is inert

.... [1]

(d) is a product of photosynthesis

.... [1]

(e) can form a polymer

.... [1]

(f) is produced in the test for nitrate ions.

.... [1]

[Total: 6]

2 Boron and aluminium are Group III elements.

(a) Boron has only two naturally occurring isotopes, ^{10}B and ^{11}B.

Complete Table 2.1 to show the numbers of protons, neutrons and electrons in an atom of ^{11}B.

Table 2.1

number of protons	number of neutrons	number of electrons

[2]

(b) The relative atomic mass of boron to one decimal place is 10.8.

(i) Determine the relative abundance of ^{10}B present in boron. Give your answer as a percentage.

.... % [1]

(ii) Use the relative atomic mass of boron to calculate the number of atoms in 0.540 g of boron. Give your answer in standard form.

number of atoms = ... [2]

(c) Aluminium is extracted from its purified ore as shown in Fig. 2.1.

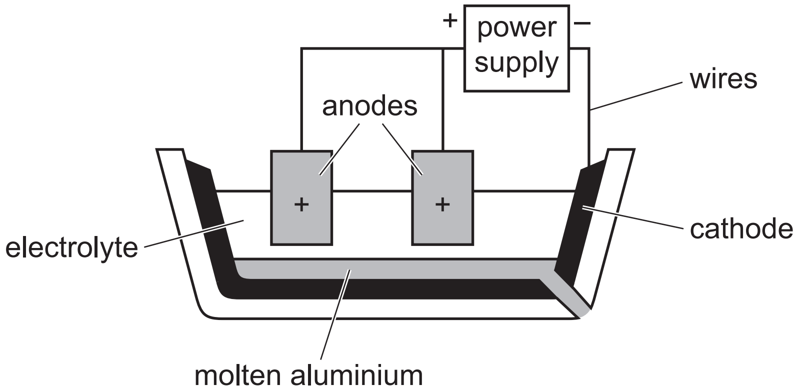

Fig. 2.1

(i) Name the ore of aluminium.

.... [1]

(ii) The electrolyte contains aluminium oxide and one other substance.

Name the other substance and explain why it is used.

name ....

explanation ....

....
[2]

(iii) Write the ionic half-equation for the reaction at the cathode.

.... [2]

(iv) Explain why the anodes need frequent replacement.

....

.... [2]

(d) State **two** physical properties of aluminium that make it suitable for use in overhead electrical cables.

1 ....

2 ....
[2]

(e) Explain the apparent unreactivity of aluminium.

....

.... [2]

(f) Aluminium reacts with fluorine to form aluminium fluoride, AlF_3, an ionic compound.

(i) Write the symbol equation for this reaction.

.... [2]

(ii) Complete Fig. 2.2 to show the electronic configuration of one aluminium ion and one fluoride ion.
Show the charges on the ions.

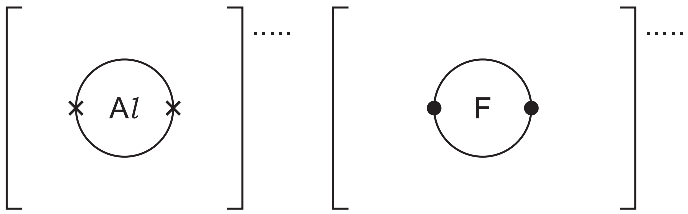

Fig. 2.2

[3]

[Total: 21]

3 Order of reactivity can be determined by displacement reactions.

(a) A student investigates the reactivities of four metals by carrying out a series of experiments.

Each of the metals lead, manganese, silver and zinc are added separately to aqueous metal nitrates of the other metals.

(i) Table 3.1 shows some of the results.

Table 3.1

aqueous solution	lead Pb	manganese Mn	silver Ag	zinc Zn
lead(II) nitrate		✓		
manganese(II) nitrate				
silver nitrate	✓	✓		✓
zinc nitrate	✗	✗		

key
✓ = displacement reaction occurs
✗ = displacement reaction does not occur

Complete Table 3.1 and place the four metals in their order of reactivity with the most reactive first.

1 .... most reactive

2 ....

3 ....

4 ....

[3]

(ii) Suggest why the metal nitrates and not the metal sulfates of these four metals are used as the aqueous solutions.

.... [1]

(iii) Write the symbol equation for the reaction between zinc and silver nitrate.

.... [2]

(b) The reactivity of Group VII elements can be investigated experimentally.

A student bubbles chlorine gas into a test-tube containing aqueous potassium bromide.

(i) Describe the colour change seen in the test-tube.

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

(ii) Complete the ionic equation for this reaction.

Include state symbols.

.... + ...Br^-(aq) $\rightarrow$ .... + ... [3]

(iii) The reactivity trend seen in Cl, Br and I applies to all the elements in Group VII.

Use the Periodic Table to identify the Group VII element which **cannot** displace any other Group VII elements.

.... [1]

[Total: 12]

4 Aqueous hydrogen peroxide, H_2O_2, slowly forms water and oxygen at room temperature and pressure, r.t.p. This reaction is catalysed by manganese(IV) oxide.

The equation is shown.

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

(a) State the test for oxygen gas.

test ....

observations .... [1]

(b) A student investigates the rate of formation of oxygen gas when manganese(IV) oxide is added to aqueous hydrogen peroxide.

The volume of oxygen gas formed is measured at regular time intervals at r.t.p. The results are plotted onto the graph in Fig. 4.1.

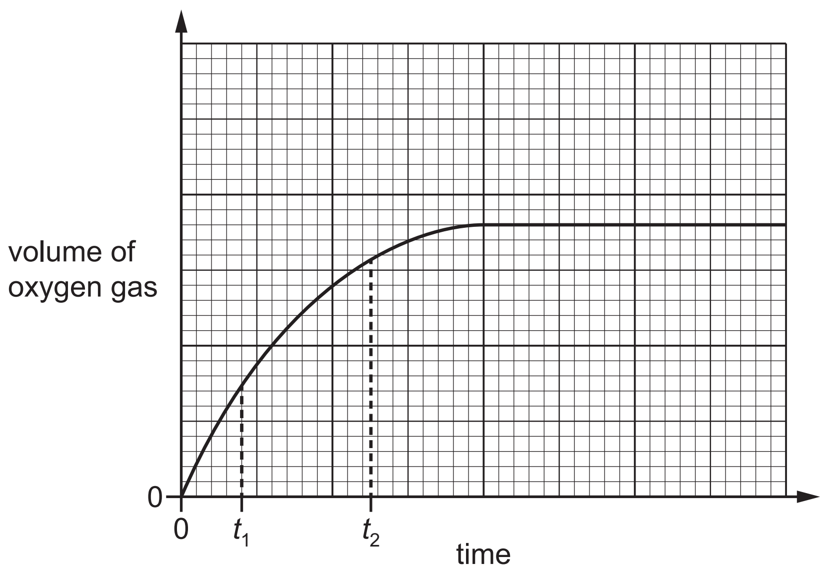

Fig. 4.1

(i) State how the graph in Fig. 4.1 shows the rate of reaction at time t_2, is lower than at time t_1.

.... [1]

(ii) Explain, using collision theory, why the rate of reaction at time t_2 is lower than at time t_1.

....

....

.... [2]

(iii) On Fig. 4.1, sketch the graph obtained when the experiment is repeated using aqueous hydrogen peroxide at a higher temperature. All other conditions remain the same. [2]

(c) Manganese(IV) oxide is added to 20 cm^3 of aqueous hydrogen peroxide. The total volume of oxygen gas produced is 72 cm^3 at r.t.p.

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

Calculate the concentration of the aqueous hydrogen peroxide in g / dm^3 using the following steps.

- Calculate the number of moles of oxygen gas produced.

.... mol

- Determine the number of moles of hydrogen peroxide which reacts.

.... mol

- Calculate the concentration of aqueous hydrogen peroxide in mol / dm^3.

.... mol / dm^3

- Calculate the concentration of aqueous hydrogen peroxide in g / dm^3.

.... g / dm^3
[5]

(d) Suggest the identity of one **other** metal oxide which also catalyses this reaction.

.... [1]

[Total: 12]

5 Methane reacts with steam to produce hydrogen gas.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +200\,kJ/mol$$

The reaction takes place at 1000 °C and 100 kPa pressure.

(a) The reaction is reversible and reaches an equilibrium in a closed system.

State **two** features of an equilibrium.

1 ....

2 ....
[2]

(b) State and explain, in terms of equilibrium, what happens to the concentration of hydrogen when:

(i) the pressure is increased

....

.... [2]

(ii) the temperature is increased

....

.... [2]

(iii) a catalyst is used.

....

.... [2]

(c) Methane is a greenhouse gas which contributes to global warming.

(i) Name a greenhouse gas found in clean, dry air.

.... [1]

(ii) Explain, in terms of thermal energy, how greenhouse gases cause global warming.

....

....

....

....

.... [3]

[Total: 12]

6 Ethanol is manufactured by **two** methods:

method 1 fermentation of aqueous glucose

method 2 catalytic addition of steam to an alkene.

(a) Method 1 takes place at room temperature and pressure.

State **two** other conditions needed in method 1.

1 ....

2 ....
[2]

(b) **(i)** State the typical temperature and pressure used in method 2.

temperature .... °C

pressure .... kPa

[2]

(ii) Name the alkene used in method 2.

.... [1]

(iii) State why the reaction in method 2 is referred to as an addition reaction.

.... [1]

(c) The catalyst in method 2 is phosphoric acid, H_3PO_4. Dilute phosphoric acid is a weak acid which contains phosphate ions, PO_4^{3-}.

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

.... [1]

(ii) State the meaning of weak in the term weak acid.

.... [1]

(iii) Determine the oxidation number of phosphorus in the PO_4^{3-} ion.

Show your working.

oxidation number = ... [2]

(d) Give **one** advantage of each method of production of ethanol.

method 1 ....

method 2 ....
[2]

(e) Ethanol can be converted to ethanoic acid by reacting it with an acidified oxidising agent.

(i) Name the acidified oxidising agent.

.... [1]

(ii) State, in terms of redox, what type of reagent ethanol is in this reaction.

.... [1]

(f) Ethanoic acid reacts with calcium to form a salt and one other product.

(i) Name the salt.

.... [1]

(ii) Write the formula of the salt.

.... [1]

(iii) Identify the other product.

.... [1]

[Total: 17]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	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 **0620/41**

Paper 4 Theory (Extended) **October/November 2023**

MARK SCHEME

Maximum Mark: 80

Published

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

[Turn over

Generic Marking Principles

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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.

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)	sulfur dioxide	**1**
1(b)	ammonia	**1**
1(c)	xenon	**1**
1(d)	oxygen	**1**
1(e)	ethene	**1**
1(f)	ammonia	**1**

Question	Answer	Marks
2(a)	**M1** 5p and 5e (1) **M2** 6n (1)	**2**
2(b)(i)	20%	**1**
2(b)(ii)	**M1** 0.540 / 10.8 = 0.05(0) mol (1) **M2** $0.05 \times 6.02 \times 10^{23} = 3.01 \times 10^{22}$ (1)	**2**
2(c)(i)	bauxite	**1**
2(c)(ii)	**M1** cryolite (1) **M2** lowers operating temperature **OR** improves conductivity (1)	**2**
2(c)(iii)	$Al^{3+} + 3e^- \rightarrow Al$ **M1** $Al^{3+} + 3e^-$ on the left-hand side (1) **M2** equation correct (1)	**2**

Question	Answer	Marks
2(c)(iv)	**M1** (anodes of) carbon react with oxygen (formed at the anode) (1) **M2** (form) carbon dioxide (1)	**2**
2(d)	**M1** (good) conductor (of electricity) (1) **M2** low density (1)	**2**
2(e)	**M1** aluminium oxide layer (1) **M2** (oxide layer) is unreactive (1)	**2**
2(f)(i)	$2Al + 3F_2 \rightarrow 2AlF_3$ **M1** Al and F_2 as reactants (1) **M2** equation correct (1)	**2**
2(f)(ii)	**M1** eight crosses in second shell of Al (1) **M2** 7 dots and 1 cross in second shell of F (1) **M3** 3+ charge on Al ion on correct answer line and – charge on F ion on correct answer line (1)	**3**

Question	Answer	Marks
3(a)(i)	**M1** Ag column all ✗ (1) **M2** ✗ in Pb **AND** 2 ✓ in Zn (1) **M3** Zn, Mn, Pb Ag (1)	**3**
3(a)(ii)	(all) nitrates are soluble **OR** lead sulfate is insoluble	**1**

Question	Answer	Marks
3(a)(iii)	$Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$ **M1** $Zn(NO_3)_2$ on the right hand side (1) **M2** correct equation (1)	**2**
3(b)(i)	**M1** colourless (1) **M2** orange (1)	**2**
3(b)(ii)	Cl_2**(g)** + $2Br^-$(aq) $\rightarrow$ Br_2**(aq)** + $2Cl^-$**(aq)** **M1** $Br_2 + Cl^-$ as products (1) **M2** correct equation (1) **M3** state symbols (1)	**3**
3(b)(iii)	tenessine / Ts	**1**

Question	Answer	Marks
4(a)	*test:* relights **AND** *observations:* a glowing splint	**1**
4(b)(i)	lower gradient (at t2)	**1**
4(b)(ii)	**M1** concentration (of H_2O_2 particles) decreases (1) **M2** frequency of collisions between particles decreases (1)	**2**

Question	Answer	Marks
4(b)(iii)	**M1** steeper curve which does not cross original curve and levels off before the original curve (1) **M2** finishes at same volume (1)	**2**
4(c)	**M1** mol O_2 = 72 / 24000 = 0.003(00) (1) **M2** mol H_2O_2 = M1 × 2 = 0.002 × 2 = 0.006(00) (1) **M3** conc H_2O_2 = M2 × 1000 / 20 = 0.006 × 1000 / 20 = 0.3(00) (1) **M4** M_r H_2O_2 = 34 (1) **M5** = M4 × M3 = 34 × 0.3 = 10.2 (g / dm^3) (1)	**5**
4(d)	any transition metal oxide	**1**

Question	Answer	Marks
5(a)	**M1** the rate of forward reaction equals (the rate of the) reverse reaction (1) **M2** the concentrations of reactants and products are no longer changing (1)	**2**
5(b)(i)	**M1** concentration decreases (1) **M2** position of equilibrium shifts to left **AND** fewer moles of gas on left hand side (1)	**2**
5(b)(ii)	**M1** concentration increases (1) **M2** position of equilibrium shifts to the right **AND** forward reaction is endothermic (1)	**2**
5(b)(iii)	**M1** no change (1) **M2** catalysts do not affect position of equilibrium (1)	**2**
5(c)(i)	carbon dioxide	**1**

Question	Answer	Marks
5(c)(ii)	**M1** greenhouse gases absorb thermal energy (from the Earth) (1) **M2 and M3** one mark each for any two of: • energy (from the sun) absorbed by Earth's surface • Earth emits or reflects thermal energy • (greenhouse gases) reduces or stops thermal energy loss (into space) • increasing in amount of greenhouse gas results in a higher atmospheric temperature	**3**

Question	Answer	Marks
6(a)	**M1** yeast (1) **M2** absence of air (1)	**2**
6(b)(i)	**M1** 300 (1) **M2** 6000 (1)	**2**
6(b)(ii)	ethene	**1**
6(b)(iii)	only one product	**1**
6(c)(i)	proton donor	**1**
6(c)(ii)	partial dissociation	**1**
6(c)(iii)	**M1** 4×-2 or -8 (1) **M2** $P + (4 \times -2) = -3 \therefore P = \mathbf{+5}$ (1)	**2**
6(d)	**M1** uses renewable resources (1) **M2** high rate of reaction (1)	**2**
6(e)(i)	potassium manganate(VII)	**1**

Question	Answer	Marks
6(e)(ii)	reducing agent	**1**
6(f)(i)	calcium ethanoate	**1**
6(f)(ii)	$(CH_3COO)_2Ca$	**1**
6(f)(iii)	hydrogen	**1**

Cambridge Assessment International Education

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CHEMISTRY	**0620/42**
Paper 4 Theory (Extended)	**October/November 2023**
MARK SCHEME	
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1(a)	B	**1**
1(b)	F	**1**
1(c)	D	**1**
1(d)	A **AND** E	**1**
1(e)	G	**1**
1(f)	C	**1**
1(g)	B	**1**
1(h)	F	**1**

Question	Answer	Marks
2(a)(i)	<table><tr><td></td><td>^{59}Co</td><td>$^{65}Cu^{2+}$</td></tr><tr><td>protons</td><td>27</td><td>29</td></tr><tr><td>neutrons</td><td>32</td><td>36</td></tr><tr><td>electrons</td><td>27</td><td>27</td></tr></table> one mark for each correct row	**3**
2(a)(ii)	**M1** $(63 \times 70) + (65 \times 30) = 6360$ (1) **M2** $6360 / 100 = 63.6$ (1)	**2**

Question	Answer	Marks
2(b)	**M1** (high) density (1) **M2** (high) melting point (1)	**2**
2(c)(i)	**M1** water molecules (1) **M2** (the water present) in hydrated crystals (1)	**2**
2(c)(ii)	**M1** pink (1) **M2** $CoCl_2 \cdot 6H_2O$ (1)	**2**
2(c)(iii)	**M1** white (1) **M2** blue (1)	**2**
2(c)(iv)	heating (the hydrated copper(II) sulfate)	**1**

Question	Answer	Marks
3(a)	(hot) air	**1**
3(b)(i)	hematite	**1**
3(b)(ii)	$Fe_2O_3 + \mathbf{3}CO \rightarrow \mathbf{3}CO_2 + \mathbf{2}Fe$	**1**
3(b)(iii)	**M1** from **+**3 (1) **M2** to 0 (1)	**2**
3(b)(iv)	decrease (in oxidation number)	**1**

Question	Answer	Marks
3(c)	**M1** $CaCO_3 \rightarrow CaO + CO_2$ (1) **M2** thermal decomposition (1) **M3** $SiO_2 + CaO \rightarrow CaSiO_3$ (1) **M4** acid-base reaction (1)	**4**
3(d)(i)	alloy	**1**
3(d)(ii)	nickel / chromium	**1**
3(e)	hydrated iron(III) oxide	**1**
3(f)(i)	galvanising	**1**
3(f)(ii)	painting / greasing / coating with plastic	**1**
3(f)(iii)	**M1** zinc more reactive (than iron) (1) **M2** zinc corrodes / oxidises / reacts in preference to / instead of iron (1)	**2**

Question	Answer	Marks
4(a)(i)	**M1** lead nitrate (1) **M2** soluble chloride e.g. sodium chloride (1)	**2**
4(a)(ii)	$Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$ **M1** $PbCl_2$ as **only** product (1) **M2** $Pb^{2+} + 2Cl^-$ as **only** reactants (1) **M3** state symbols (1)	**3**

Question	Answer	Marks
4(a)(iii)	**M1** filter (1) **M2** wash (the residue) using water (1) **M3** dry the residue between filter papers / in a warm place (1)	**3**
4(b)(i)	mobile ions	**1**
4(b)(ii)	$2Cl^- \rightarrow Cl_2 + 2e^-$ **M1** any negative Cl species **losing** electron(s) (1) **M2** correct ionic half equation (1)	**2**
4(b)(iii)	**M1** (damp) litmus (paper) (1) **M2** is bleached / goes white (1)	**2**
4biv	(shiny) grey **AND** solid	**1**

Question	Answer	Marks
5(a)	enthalpy change (of reaction)	**1**
5(b)(i)	**M1** rate of reaction increases (1) **M2** more (CCl_4) particles per unit volume (1) **M3** frequency of collisions between (CCl_4 and H_2O) particles increases (1)	**3**
5(b)(ii)	**M1** (position of) equilibrium moves to left hand side (1) **M2** more (gaseous) moles / molecules on right hand side (1)	**2**

Question	Answer	Marks
5(b)(iii)	**M1** *Labels mark* $CCl_4(g) + 2H_2O(g)$ on reactant line **AND** $CO_2(g) + 4HCl(g)$ on product line **M2** *Activation E mark* upward arrow labelled E_a from energy level of reactants to top of 'hump' **M3** *Energy change mark* one downward arrow labelled ΔH **AND** energy change starting from E level of reactants and finishing at E level of products	**3**
5(b)(iv)	**M1** minimum energy (1) **M2** that colliding particles must have to react (1)	**2**
5(b)(v)	(decreased by adding) catalyst	**1**
5(c)	*energy needed to break bonds in reactants* **M1** [(4 × 340) + (4 × 460) = **3200** (kJ / mol) (1) *energy released when bond in carbon dioxide form* **M2** 2 × 805 = **1610** (kJ / mol) (1) *calculate H–Cl bond energy* **M3** 3200 – (1610 + E(4H–Cl)) = – 130 E(4H–Cl) = 3330 – 1610 = **1720** (kJ / mol) (1) **M4** 1720 / 4 = **430** (kJ / mol) (1)	**4**

Question	Answer	Marks
6(a)	**M1** (same) general formula (1) **M2** (contain the same) functional group (1)	**2**
6(b)	-CH_2- unit	**1**
6(c)(i)	**M1** alkenes (1) **M2** alkanes (1) **M3** carboxylic acids (1)	**3**
6(c)(ii)	**M1** propanoic acid (1) **M2** displayed formula of propanoic acid (1)	**2**
6(d)(i)	**M1** *working to give the mass of atoms shown in Fig 6.1* $103 - 14 - (2 \times 12) - (2 \times 16) - (4 \times 1)$ (= 29) **M2** 'R' = C_2H_5	**2**
6(d)(ii)	proteins	**1**

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7065534560

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2023**

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 Table 1.1 gives the electronic configurations of some atoms and ions, **A** to **G**.

Table 1.1

	electronic configuration
A	2,5
B	2,8
C	2,8,2
D	2,8,4
E	2,8,5
F	2,8,6
G	2,8,18,7

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

State which of the atoms or ions, **A** to **G**, could be:

(a) a noble gas atom

.... [1]

(b) an atom of an element in Group VI

.... [1]

(c) an atom with an atomic number of 14

.... [1]

(d) atoms from the same group

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

(e) a halogen atom

.... [1]

(f) an atom of an element which is a good conductor of electricity

.... [1]

(g) a stable ion of a Group V element

.... [1]

(h) an atom that forms an ion with a 2– charge.

.... [1]

[Total: 8]

2 Cobalt and copper are transition elements.

(a) Copper has two naturally occurring isotopes, ^{63}Cu and ^{65}Cu. Cobalt has only one naturally occurring isotope, ^{59}Co.

(i) Complete Table 2.1 to show the number of protons, neutrons and electrons in the ^{59}Co atom and the $^{65}Cu^{2+}$ ion.

Table 2.1

	^{59}Co	$^{65}Cu^{2+}$
protons		
neutrons		
electrons		

[3]

(ii) Table 2.2 shows the relative abundance of the two naturally occurring isotopes of copper.

Table 2.2

isotope	^{63}Cu	^{65}Cu
relative abundance	70%	30%

Calculate the relative atomic mass of copper to **one** decimal place.

relative atomic mass = ... [2]

(b) One physical property of transition elements such as copper and cobalt is that they are hard. Other metals such as lithium are softer.

State **two** other physical properties of copper and cobalt which are significantly different from lithium.

1 ....

2 ....

[2]

(c) Both copper and cobalt can form coloured compounds. Some of these compounds contain water of crystallisation.

(i) Define the term water of crystallisation.

....

.... [2]

(ii) State the colour and formula of hydrated cobalt(II) chloride crystals.

colour ....

formula ....
[2]

(iii) State the colour change seen when a few drops of water are added to anhydrous copper(II) sulfate.

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

(iv) State how this colour change can be reversed.

.... [1]

[Total: 14]

3 Iron is manufactured in a blast furnace.

(a) Three of the starting materials added to the blast furnace are coke, iron ore and limestone.

Name the **other** starting material added to the blast furnace.

.... [1]

(b) The source of iron in the blast furnace is Fe_2O_3. Fe_2O_3 is found in iron ore.

(i) Name the main ore of iron which contains Fe_2O_3.

.... [1]

(ii) The iron in Fe_2O_3 is reduced by reaction with carbon monoxide. The unbalanced symbol equation is shown.

Complete the equation.

$$Fe_2O_3 + ...CO \rightarrow .....CO_2 + ...Fe$$ [1]

(iii) State the change in oxidation number of iron in the reaction in **(ii)**.

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

(iv) Explain how the change of oxidation number shows that iron has been reduced.

.... [1]

(c) The major impurity in iron ore is silicon(IV) oxide. Limestone is added to the blast furnace to remove this impurity.

Write two symbol equations to show how silicon(IV) oxide is removed. For each equation, state the type of chemical reaction that takes place.

equation 1 ....

type of chemical reaction ....

equation 2 ....

type of chemical reaction ....
[4]

(d) Iron is converted to steel by mixing it with carbon and other elements.

(i) State the term given to a substance which is a mixture of a metal and other elements.

.... [1]

(ii) Name **one** element, other than carbon, mixed with iron in the making of stainless steel.

.... [1]

(e) Preventing the rusting of steel is important.

State the chemical name of rust.

.... [1]

(f) Steel can be coated with zinc to prevent rusting. This provides both a barrier method and sacrificial protection.

(i) State the term used for coating steel with zinc.

.... [1]

(ii) Describe another barrier method for preventing rusting.

.... [1]

(iii) Explain how zinc provides sacrificial protection.

....

.... [2]

[Total: 17]

4 This question is about lead(II) chloride, $PbCl_2$.

(a) A student prepares a sample of insoluble lead(II) chloride, $PbCl_2$, by mixing aqueous solutions of **two** salts in a beaker.

(i) Identify **two** soluble salts suitable for making lead(II) chloride when mixed together.

....

.... [2]

(ii) Write the ionic equation for the formation of lead(II) chloride by mixing aqueous solutions.

Include state symbols.

.... [3]

(iii) List the steps the student should take in preparing a pure sample of lead(II) chloride from the mixture in the beaker.

....

....

.... [3]

(b) The student carries out an electrolysis experiment on molten lead(II) chloride using the apparatus shown in Fig. 4.1. Chlorine gas forms at the anode and escapes from the apparatus.

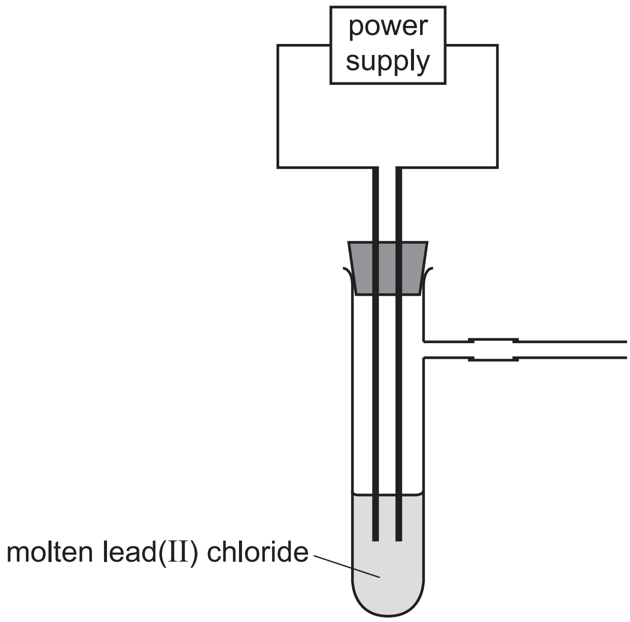


Fig. 4.1

(i) Explain why lead(II) chloride needs to be molten before it will conduct electricity.

....

.... [1]

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

.... [2]

(iii) State the test for chlorine gas.

test ....

observations ....
[2]

(iv) Describe what is observed at the cathode.

.... [1]

[Total: 14]

5 Chemical reactions can involve transfer of thermal energy.

(a) State the term used for the transfer of thermal energy during a reaction.

.... [1]

(b) Tetrachloromethane gas, $CCl_4(g)$, reacts with steam as shown.

$$CCl_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4HCl(g)$$

The reaction is reversible. The forward reaction is exothermic.

(i) State what happens, if anything, to the rate of the forward reaction if the concentration of CCl_4 is increased.
Explain your answer in terms of collision theory.

....

....

....

.... [3]

(ii) State what happens to the position of equilibrium, if anything, when the pressure is increased.
Explain your answer.

....

.... [2]

(iii) Fig. 5.1 shows an incomplete reaction pathway diagram for the forward reaction.

$$CCl_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4HCl(g)$$

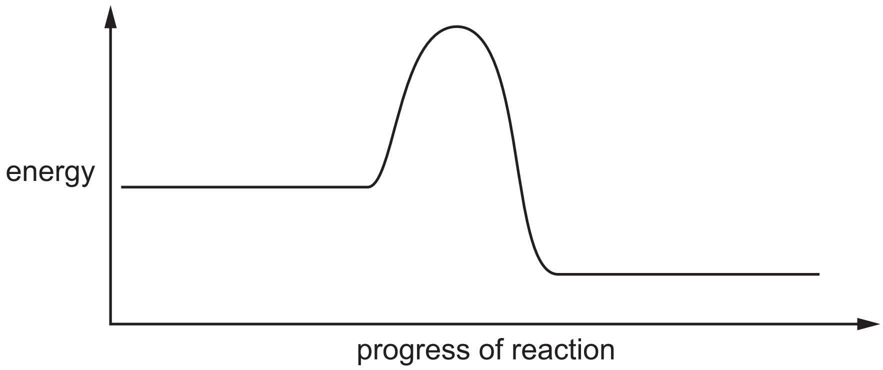


Fig. 5.1

On Fig. 5.1:

- insert the formulae of the reactants and products
- draw an arrow, labelled E_a, to show the activation energy
- draw an arrow, labelled ΔH, to show the transfer of energy in the reaction.

[3]

(iv) Define the term activation energy.

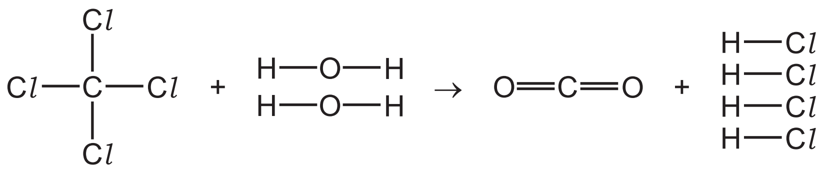
....

.... [2]

(v) State **one** way in which the activation energy of a reaction can be changed.

.... [1]

(c) The equation for the reaction between tetrachloromethane gas and steam can be represented as shown in Fig. 5.2.



ΔH = –130 kJ / mol

Fig. 5.2

Table 5.1 shows some bond energies.

Table 5.1

bond	C–C*l*	H–O	C=O
bond energy in kJ / mol	340	460	805

Use the bond energies in Table 5.1 and the ΔH value for the reaction to calculate the H–C*l* bond energy using the following steps.

- Calculate the energy needed to break the bonds in the reactants.

.... kJ

- Calculate the energy released when the bonds in carbon dioxide form.

.... kJ

- Calculate the H–C*l* bond energy.

.... kJ / mol
[4]

[Total: 16]

6 A homologous series is a family of organic compounds whose members have similar chemical properties.

(a) Give **two** characteristics that are the **same** for all members of a homologous series.

1 ....

2 ....
[2]

(b) In terms of structure, state how one member of a homologous series differs from the next member of that homologous series.

.... [1]

(c) **A**, **B** and **C** are organic compounds.

A has the molecular formula $C_{12}H_{24}$.

B has the name tetradecane.

C has three carbon atoms and is in the homologous series with the general formula $C_nH_{2n+1}COOH$.

(i) Name the homologous series each organic compound belongs to.

A ....

B ....

C ....
[3]

(ii) Name **C** and draw its displayed formula.

name ....

displayed formula

[2]

(d) Amino acids are a homologous series where each member has the general structure shown in Fig. 6.1.

The R side chain contains carbon and hydrogen atoms only.

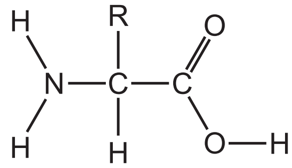


Fig. 6.1

(i) An amino acid has a relative molecular mass of 103.

Deduce the formula of the R side chain in this amino acid.

Show your working.

.... [2]

(ii) State the name given to the natural polyamides formed from amino acid monomers.

.... [1]

[Total: 11]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	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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5023388906

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

1 A list of substances is shown.

barium nitrate
carbon monoxide
hydrated cobalt(II) chloride
copper(II) oxide
anhydrous copper(II) sulfate
ethane
potassium iodide
propene
sodium bromide
sulfur dioxide
zinc oxide

Answer the following questions using only the substances from the list.
Each substance may be used once, more than once or not at all.

Give the name of the substance that:

(a) gives a lilac colour in a flame test

.... [1]

(b) forms a cream precipitate when its aqueous solution reacts with acidified aqueous silver nitrate

.... [1]

(c) is an acidic oxide

.... [1]

(d) is an unsaturated hydrocarbon

.... [1]

(e) is a product of incomplete combustion of fossil fuels

.... [1]

(f) is used to test for the presence of water.

.... [1]

[Total: 6]

2 Table 2.1 gives information about particles **A**, **B**, **C**, **D**, **E** and **F**.

Table 2.1

particle	number of electrons	number of neutrons	number of protons
A	5	6	5
B	10	11	10
C	10	14	13
D	18	17	16
E	18	17	17
F	15	16	15

(a) Give the letters of **all** the particles which are:

(i) atoms

.... [1]

(ii) ions with a charge of 2–

.... [1]

(iii) cations.

.... [1]

(b) State the atomic number of **A**.

.... [1]

(c) Determine the number of nucleons in **D**.

.... [1]

(d) State the electronic configuration of **D**.

.... [1]

(e) State the group number of **F**.

.... [1]

(f) State the period number of **B**.

.... [1]

[Total: 8]

3 This question is about nitrogen and some of its compounds.

(a) Nitrogen is converted into ammonia, NH_3, in the Haber process.

(i) Nitrogen is obtained from air.

State the percentage of nitrogen in clean, dry air.

.... [1]

(ii) State the source of hydrogen for the Haber process.

.... [1]

(iii) Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of ammonia.

Show the outer shell electrons only.

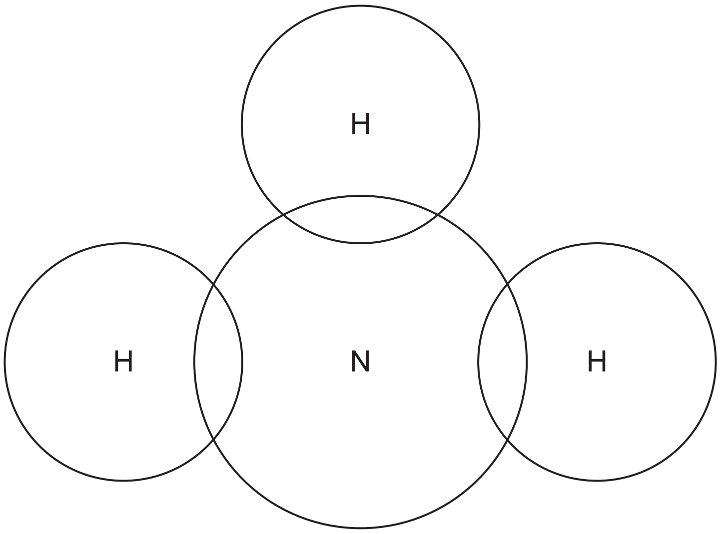

Fig. 3.1

[2]

(iv) Write a chemical equation for the reaction occurring in the Haber process and give the typical reaction conditions. Include units where appropriate.

chemical equation ....

reaction conditions:

temperature ....

pressure ....

catalyst ....

[5]

(b) Ammonia is converted into nitric acid.

The first stage of this conversion uses a catalyst and occurs at a temperature of 900 °C and a pressure of 5 atmospheres.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The forward reaction is exothermic.

(i) Suggest which of the following elements is most likely to be used as a catalyst.
Draw a circle around your answer.

calcium **lead** **platinum** **sodium** **sulfur** [1]

(ii) State the oxidation number of nitrogen in:

NH_3 ....

NO ....
[2]

(iii) Use your answer to **(ii)** to explain whether the nitrogen in ammonia undergoes oxidation or reduction.

....

.... [1]

(iv) Complete Table 3.1 using the words **increases**, **decreases** or **no change**.

Table 3.1

	effect on the equilibrium yield of NO(g)	effect on the rate of the forward reaction
decreasing the pressure		
decreasing the temperature		decreases
removing the catalyst		decreases

[4]

(v) Decreasing the temperature causes the rate of the forward reaction to decrease.

Explain, using collision theory, why the rate of the reaction is slower at the decreased temperature.

....

....

....

.... [3]

(c) In the second stage, nitric acid is produced.

Balance the symbol equation for this reaction.

$$.....NO + ...O_2 + ...H_2O \rightarrow .....HNO_3$$ [1]

[Total: 21]

4 This question is about sulfuric acid and salts that are made from sulfuric acid.

(a) Zinc reacts with dilute sulfuric acid. Aqueous zinc sulfate is one of the products.

Powdered zinc is added to dilute sulfuric acid. The mixture is stirred. More zinc is added, with stirring, until the zinc is in excess.

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

The mixture is then filtered.

(i) Name the limiting reactant.

.... [1]

(ii) State two **observations** that indicate the zinc is in excess.

1 ....

2 ....
[2]

(iii) Name the filtrate.

.... [1]

(iv) Name **two** compounds which both react with dilute sulfuric acid to produce aqueous zinc sulfate.

1 ....

2 ....
[2]

(b) Zinc sulfate crystals are produced by heating aqueous zinc sulfate until a saturated solution is formed. When the saturated solution cools down, crystals of zinc sulfate start to form.

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

....

.... [2]

(ii) Explain why crystals form when the saturated solution cools down.

.... [1]

(c) Nickel(II) sulfate crystals contain water of crystallisation.

When nickel(II) sulfate crystals, $NiSO_4{\bullet}\mathbf{x}H_2O$, are heated, they give off water.

$$NiSO_4{\bullet}\mathbf{x}H_2O(s) \rightarrow NiSO_4(s) + \mathbf{x}H_2O(g)$$

A student carries out an experiment to determine the value of **x** in $NiSO_4{\bullet}\mathbf{x}H_2O$.

step 1 Nickel(II) sulfate crystals are weighed.

step 2 Nickel(II) sulfate crystals are heated.

step 3 The remaining solid is allowed to cool and is then weighed.

step 4 The remaining solid is heated again, allowed to cool and is then weighed.

step 5 Step 4 is repeated until there is no change in mass.

(i) State the term used to describe crystals that contain water of crystallisation.

.... [1]

(ii) State why **step 4** is repeated until there is no change in mass.

.... [1]

(iii) In an experiment, 0.454 g of nickel(II) sulfate crystals, $NiSO_4{\bullet}\mathbf{x}H_2O$, is used. The mass of anhydrous nickel(II) sulfate, $NiSO_4$, remaining is 0.310 g.

[M_r: $NiSO_4$, 155; H_2O, 18]

Determine the value of **x** in $NiSO_4{\bullet}\mathbf{x}H_2O$.

Use the following steps.

- Calculate the number of moles of $NiSO_4$ remaining.

moles of $NiSO_4$ = ...

- Calculate the mass of H_2O given off.

mass of H_2O = ... g

- Calculate the number of moles of H_2O given off.

moles of H_2O = ...

- Calculate the value of **x**.

x = ...
[4]

[Total: 15]

5 This question is about iron.

(a) **(i)** Describe the bonding in a metallic element such as iron.

You may include a labelled diagram as part of your answer.

....

....

.... [3]

(ii) Explain why iron conducts electricity when it is solid.

.... [1]

(b) Iron is extracted from hematite in the blast furnace as shown in Fig. 5.1.

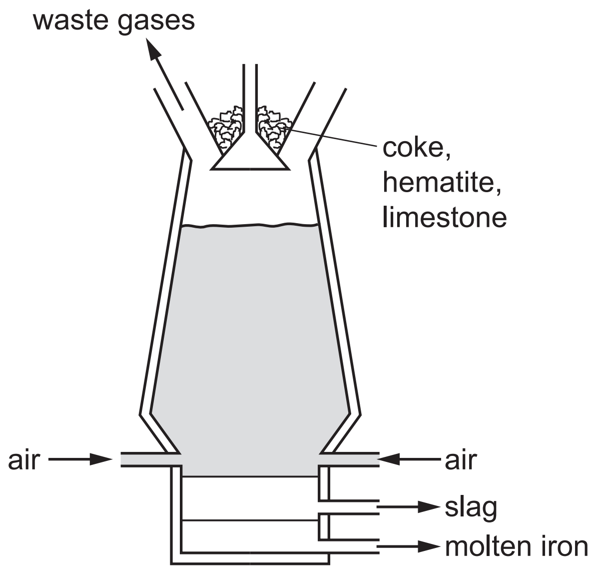

Fig. 5.1

(i) Give **two** reasons why coke is added to the blast furnace.

1 ....

2 ....
[2]

(ii) Explain how limestone removes the impurities in the hematite.

....

....

.... [2]

(iii) Hematite contains iron(III) oxide.

Write a symbol equation for the conversion of iron(III) oxide to iron in the blast furnace.

.... [2]

(iv) Suggest why the iron produced in the blast furnace is molten.

.... [1]

(c) Most iron is converted into steel. Steel is an alloy.

Steel is more useful than pure iron because it is harder and stronger.

Explain why the structure of alloys causes them to be harder and stronger than pure metals.

You may include a diagram as part of your answer.

....

.... [2]

(d) Iron forms rust.

Rusting is prevented by coating iron with zinc.

(i) Name the substances that react with iron to form rust.

.... [1]

(ii) Name the process in which zinc is used to coat iron to prevent rusting.

.... [1]

(iii) Explain how the coating of zinc prevents rusting if the zinc is **not** scratched.

.... [1]

(iv) When zinc is scratched the iron becomes exposed.

Explain how the zinc continues to prevent rusting.

....

....

.... [2]

[Total: 18]

6 **(a)** Esters are members of a homologous series of organic compounds.

Give **two** characteristics that are the **same** for all members of a homologous series.

1 ....

2 ....
[2]

(b) Ester **X** has the structure shown in Fig. 6.1.

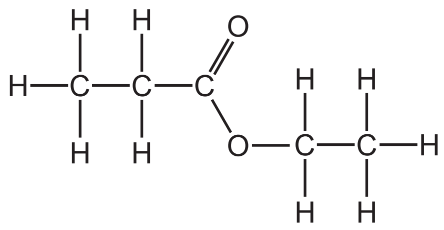

Fig. 6.1

Name ester **X**.

.... [1]

(c) **(i)** Ester **Y** has the structural formula $HCOOCH_2CH_2CH_3$.

Name the alcohol and the carboxylic acid used to make ester **Y**.

alcohol ....

carboxylic acid ....
[2]

(ii) State the molecular formula of ester **Y**.

.... [1]

(d) Ester **Z** has the molecular formula $C_4H_8O_2$.

State the empirical formula of ester **Z**.

.... [1]

(e) Polymers containing ester linkages are known as polyesters.

Polyamides are another type of polymer. Nylon is a polyamide.

The structure of nylon is shown in Fig. 6.2.

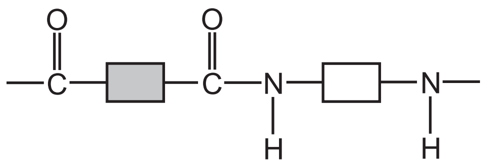

Fig. 6.2

(i) State the term used to describe the type of polymerisation used to produce polyesters and polyamides.

.... [1]

(ii) Complete Fig. 6.3 to show the structures of the monomers used to produce nylon. Show all of the atoms and all of the bonds.

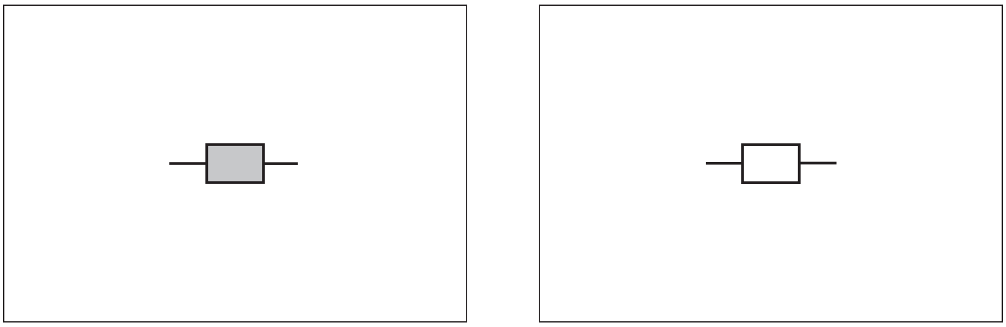

Fig. 6.3

[2]

(f) Naturally occurring polyamides are found in food.

(i) State the name given to naturally occurring polyamides.

.... [1]

(ii) Name the type of monomer which forms naturally occurring polyamides.

.... [1]

[Total: 12]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			**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 **0620/43**

Paper 4 Theory (Extended) **October/November 2023**

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **11** printed pages.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

6	<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)	potassium iodide	**1**
1(b)	sodium bromide	**1**
1(c)	sulfur dioxide	**1**
1(d)	propene	**1**
1(e)	carbon monoxide	**1**
1(f)	anhydrous copper(II) sulfate	**1**

Question	Answer	Marks
2(a)(i)	A, B, F	**1**
2(a)(ii)	D	**1**
2(a)(iii)	C	**1**
2(b)	5	**1**
2(c)	33	**1**
2(d)	2,8,8	**1**
2(e)	5	**1**
2(f)	2	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>78</td><td>1</td></tr>
<tr><td>3(a)(ii)</td><td>natural gas</td><td>1</td></tr>
<tr><td>3(a)(iii)</td><td>M1 three single bonding pairs containing one dot and one cross (1)

M2 two dots or two crosses on N (and no additional electrons on Hs) to complete the outer shell on N and all 3 Hs (1)</td><td>2</td></tr>
<tr><td>3(a)(iv)</td><td>M1 $N_2 + 3H_2 \rightarrow 2NH_3$ (1)

M2 $\rightleftharpoons$ (1)

M3 450 °C (1)

M4 200 atmospheres / 20 000 kPa (1)

M5 iron (1)</td><td>5</td></tr>
<tr><td>3(b)(i)</td><td>platinum</td><td>1</td></tr>
<tr><td>3(b)(ii)</td><td>M1 –3 (1)

M2 +2 (1)</td><td>2</td></tr>
<tr><td>3(b)(iii)</td><td>oxidation AND oxidation number increases</td><td>1</td></tr>
<tr><td>3(b)(iv)</td><td><table><tr><td>M1 increase (1)</td><td>M4 decrease (1)</td></tr><tr><td>M2 increase (1)</td><td></td></tr><tr><td>M3 no change (1)</td><td></td></tr></table></td><td>4</td></tr>
</table>

Question	Answer	Marks
3(b)(v)	**M1** kinetic energy of particles is lower (1) **M2** frequency of collisions between particles is lower (1) **M3** fewer / lower percentage **/** lower proportion **/** lower fraction of particles have energy greater than / equal to activation energy **OR** fewer / lower percentage / lower fraction of collisions have energy greater than / equal to activation energy (1)	**3**
3(c)	**4**NO + **3**O_2 + **2**H_2O $\rightarrow$ **4**HNO_3	**1**

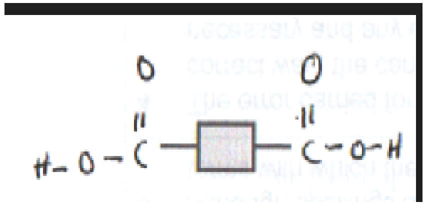
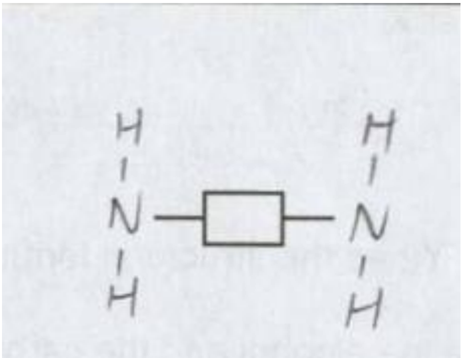
Question	Answer	Marks
4(a)(i)	dilute sulfuric acid	**1**
4(a)(ii)	**M1** solid remains / solid undissolved (1) **M2** bubbling / effervescence / fizzing stops (1)	**2**
4(a)(iii)	aqueous zinc sulfate	**1**
4(a)(iv)	any two • zinc oxide • zinc carbonate • zinc hydroxide	**2**
4(b)(i)	**M1** (a solution containing the) maximum amount of solute dissolved / no more solute can dissolve (1) **M2** at a given temperature (1)	**2**
4(b)(ii)	solubility decreases as temperature decreases	**1**
4(c)(i)	hydrated	**1**
4(c)(ii)	to ensure <u>all</u> the water of crystallisation is removed	**1**

Question	Answer	Marks
4(c)(iii)	**M1** 2×10^{-3} / 0.002 (1) **M2** 0.144 (g) (1) **M3** (0.144 ÷ 18 =) 8×10^{-3} / 0.008 (1) **M4** (0.008 ÷ 0.002 =) 4 (1)	**4**

Question	Answer	Marks
5(a)(i)	**M1** positive ions / cations (1) **M2** sea of electrons / mobile electrons / delocalised electrons (1) **M3** attraction between positive ions and electrons (1)	**3**
5(a)(ii)	electrons move / electrons mobile / electrons flow	**1**
5(b)(i)	any two • (coke) releases heat • (coke) reduces iron(III) oxide • (coke) reacts with carbon dioxide to form carbon monoxide	**2**
5(b)(ii)	**M1** limestone decomposes to calcium oxide (1) **M2** calcium oxide reacts with / neutralises silicon(IV) oxide to produce slag / calcium silicate (1)	**2**

Question	Answer	Marks
5(b)(iii)	$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ **OR** $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ **OR** $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ **M1** all formulae (1) **M2** equation correct (1)	**2**
5(b)(iv)	temperature in the furnace is above the melting point of iron	**1**
5(c)	**M1** atoms have different sizes (1) **M2** layers cannot slide over or past each other (1)	**2**
5(d)(i)	oxygen **AND** water	**1**
5(d)(ii)	galvanising	**1**
5(d)(iii)	acts as a barrier which prevents oxygen and water reaching the iron	**1**
5(d)(iv)	**M1** zinc is more reactive than iron (1) **M2** zinc is oxidised / zinc loses electrons / zinc forms positive ions / forms zinc ions (1)	**2**

Question	Answer	Marks
6(a)	any two • general formula • functional group • chemical properties	**2**
6(b)	ethyl propanoate	**1**
6(c)(i)	**M1** propan-1-ol (1) **M2** methanoic acid (1)	**2**
6(c)(ii)	$C_4H_8O_2$	**1**
6(d)	C_2H_4O	**1**
6(e)(i)	condensation	**1**

Question	Answer	Marks
6(e)(ii)	 **M1** 2 –COOH groups fully displayed (1) **M2**  2 $–NH_2$ groups fully displayed (1)	**2**
6(f)(i)	proteins	**1**
6(f)(ii)	amino acids	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2023**

45 minutes

You must answer on the multiple choice answer sheet.

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

1682985912

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.

IB23 11_0620_21/5RP

1 A gas is placed in a sealed container. The gas has a pressure of one atmosphere and a temperature of 50 °C.

It is heated to 100 °C.

Which row describes the cause of the pressure of the gas and the effect of increasing the temperature of the gas?

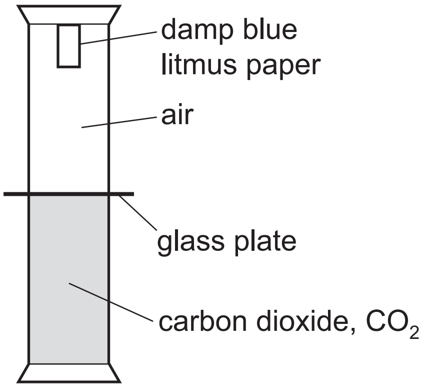
	cause of gas pressure	the effect of increased temperature of the gas
A	collisions between gas particles	collisions become less frequent
B	collisions between gas particles	the average speed of the gas particles increases
C	collisions between gas particles and the container	collisions become less frequent
D	collisions between gas particles and the container	the average speed of the gas particles increases

2 Four experiments, each containing a different acidic gas, are set up as shown.

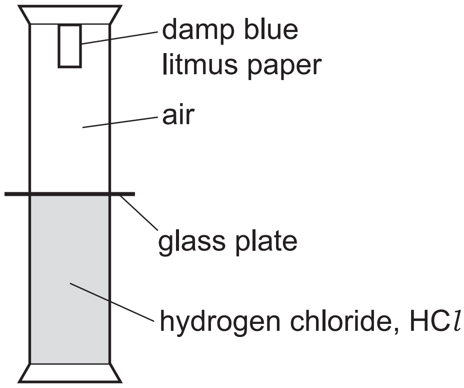
The dividing glass plates are removed at the same time.

In which set of apparatus does the litmus turn red first?

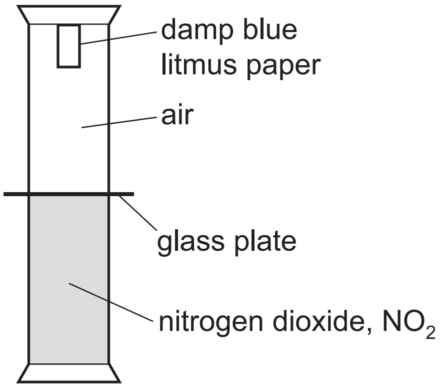
A



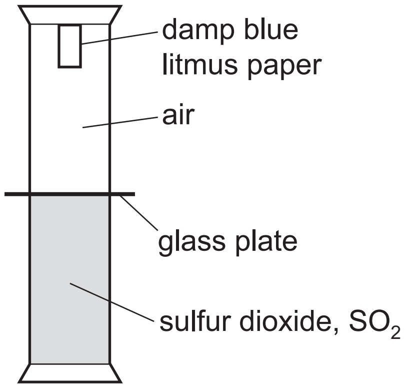
B



C



D



3 The Group I element potassium forms an ionic bond with the Group VII element fluorine.

Which two ions are produced?

A K^+ and F^+ **B** K^+ and F^- **C** K^- and F^- **D** K^- and F^+

4 X and Y are atoms.

- X and Y have the same number of electron shells.
- X and Y have the same number of outer electrons.
- X and Y have different mass numbers.

Which statements about X and Y are correct?

1 X and Y are isotopes.

2 X and Y have the same total number of electrons.

3 X and Y have the same chemical properties.

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

5 Lithium chloride is an ionic compound and silicon(IV) oxide is a covalent compound.

Which statement about **both** compounds is correct?

A They are not soluble in water.

B They conduct electricity when melted.

C They do not conduct electricity in solid form.

D They have low melting points.

6 Which equations are balanced?

1 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

2 $ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + 2H_2O$

3 $Mg(NO_3)_2 + NaOH \rightarrow Mg(OH)_2 + 2NaNO_3$

4 $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

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

7 Which row shows the formulae of sodium carbonate, zinc nitrate and ammonium sulfate?

	sodium carbonate	zinc nitrate	ammonium sulfate
A	Na_2CO_3	$ZnNO_3$	$(NH_4)_2SO_4$
B	Na_2CO_3	$Zn(NO_3)_2$	$(NH_4)_2SO_4$
C	$NaCO_3$	$ZnNO_3$	$(NH_3)_2SO_4$
D	$NaCO_3$	$Zn(NO_3)_2$	$(NH_3)_2SO_4$

8 Which statements about hydrogen and oxygen are correct?

	hydrogen and oxygen can react to produce electrical energy	hydrogen and oxygen can be made by the electrolysis of dilute aqueous sodium chloride
A	✗	✗
B	✗	✓
C	✓	✗
D	✓	✓

9 Graphite has a giant covalent structure.

Which statements about graphite are correct?

1 Carbon atoms form four covalent bonds with neighbouring atoms.

2 There are delocalised electrons between layers of carbon atoms.

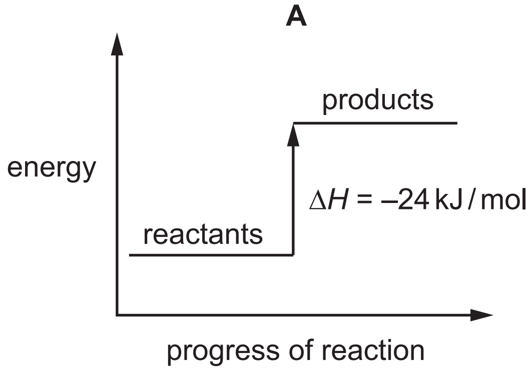
3 Graphite is a useful lubricant.

4 Graphite is a good conductor of electricity.

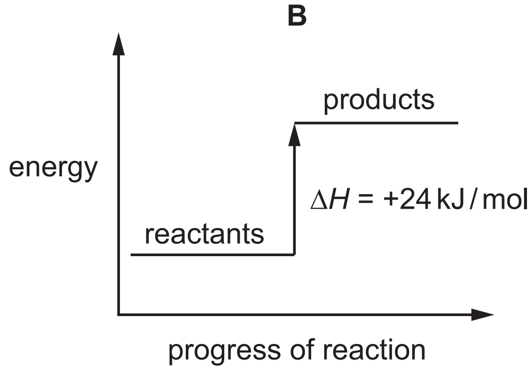
A 1 and 2 **B** 1, 3 and 4 **C** 2, 3 and 4 **D** 3 and 4 only

10 Which reaction pathway diagram represents an endothermic reaction?

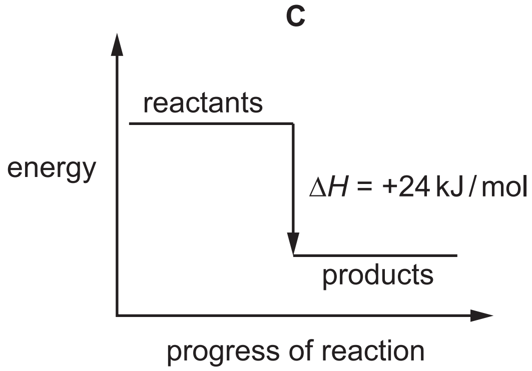
A



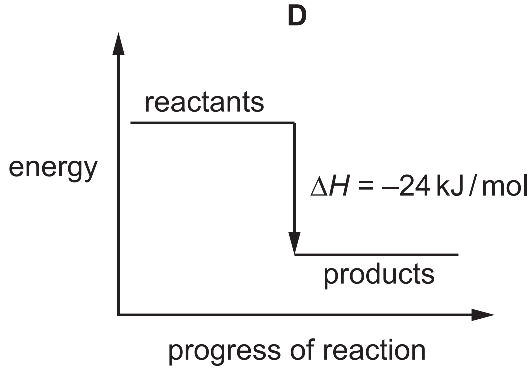
B



C



D



11 Hydrogen burns in oxygen.

The equation for the reaction is shown.

$$2H_2 + O_2 \rightarrow 2H_2O$$

The table shows the bond energies involved.

bond	bond energy in kJ / mol
H–H	436
O=O	498
O–H	464

What is the energy given out during the reaction?

A –3226 kJ / mol

B –884 kJ / mol

C –486 kJ / mol

D –442 kJ / mol

12 Which process involves a chemical change?

A adding sodium to water

B boiling water

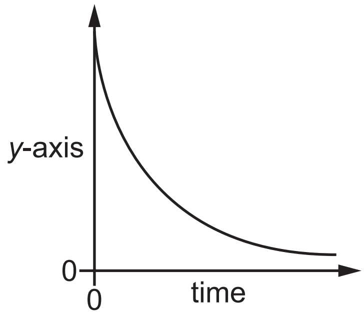
C dissolving sodium chloride in water

D producing water from aqueous sodium chloride

13 An experiment is carried out to find the rate of reaction between hydrochloric acid and zinc.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The results of the experiment are shown.



What is the label on the *y*-axis?

A amount of $ZnCl_2$ produced

B concentration of HCl

C mass of Zn reacted

D volume of H_2 produced

14 Hydrogen peroxide, H_2O_2, decomposes to form water and oxygen.

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

Manganese(IV) oxide catalyses the decomposition reaction.

The reaction is investigated in four experiments.

experiment	volume and concentration of hydrogen peroxide	conditions
1	$12.5\,cm^3$ of $1.0\,mol/dm^3$	$25\,°C$ with manganese(IV) oxide powder added
2	$12.5\,cm^3$ of $2.0\,mol/dm^3$	$40\,°C$ with manganese(IV) oxide powder added
3	$25\,cm^3$ of $1.0\,mol/dm^3$	$40\,°C$ without manganese(IV) oxide powder
4	$25\,cm^3$ of $1.0\,mol/dm^3$	$40\,°C$ with manganese(IV) oxide powder added

All reactions go to completion and all measurements of gas volumes are at room temperature and pressure.

Which statement is correct?

A Experiment 1 produces less gas than experiment 4, but at the same rate.

B Experiment 2 produces more gas than experiment 1, but at the same rate.

C Experiment 2 and experiment 4 each produce the same volume of gas, but at different rates.

D Experiment 3 and experiment 4 each produce the same volume of gas and at the same rate.

15 Sulfuric acid is produced by the Contact process.

Which row shows the typical conditions used in the process?

	catalyst	pressure / kPa	temperature / °C
A	iron	200	300
B	iron	20 000	450
C	vanadium(V) oxide	200	450
D	vanadium(V) oxide	20 000	300

16 Which equation shows the reduction of copper?

A $CuO + C \rightarrow Cu + CO$

B $2CuS + 3O_2 \rightarrow 2CuO + 2SO_2$

C $Cu(g) \rightarrow Cu(l)$

D $Cu(l) \rightarrow Cu(s)$

17 Which statement about acids is correct?

A A weak acid partially dissociates in aqueous solution.

B An acid accepts protons when added to water.

C Ethanoic acid acts as a strong acid when added to water.

D Hydrochloric acid is a strong acid that ionises in water to form H^- ions.

18 Copper(II) sulfate is formed by reacting excess solid copper(II) carbonate with dilute sulfuric acid.

Which processes are part of the preparation of solid copper(II) sulfate?

1 crystallisation

2 distillation

3 filtration

4 titration

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

19 Which type of reaction is represented by the equation shown?

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

A addition

B redox

C neutralisation

D precipitation

20 Which compound is likely to be coloured?

A $KMnO_4$ **B** KNO_3 **C** K_2CO_3 **D** K_2SO_4

21 Which statements about the metal zinc are correct?

1 It is extracted from the ore bauxite.

2 It is used to galvanise steel.

3 It is used to make the alloy brass.

4 It reacts with dilute hydrochloric acid to produce hydrogen gas.

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

22 The electronic configurations of four elements, P, Q, R and S, are shown.

element	electronic configuration
P	2
Q	2,2
R	2,6
S	2,8

Which elements are unreactive monatomic gases?

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

23 Which row compares the strength of alloys with pure metals and explains the difference in strength?

	strength of an alloy compared to a pure metal	explanation
A	weaker	larger atoms slide more easily over smaller atoms
B	weaker	larger atoms make it harder for layers to slide over one another
C	stronger	larger atoms slide more easily over smaller atoms
D	stronger	larger atoms make it harder for layers to slide over one another

24 Zinc oxide reacts with carbon to produce zinc.

Which equation represents this reaction?

A $2ZnO + C \rightarrow 2Zn + CO$

B $2ZnO + 2C \rightarrow 2Zn + 2CO_2$

C $ZnO + C \rightarrow Zn + CO$

D $ZnO + 2C \rightarrow Zn + 2CO_2$

25 When a piece of aluminium foil is added to dilute hydrochloric acid, no effervescence is seen.

Which statement explains why no effervescence is seen?

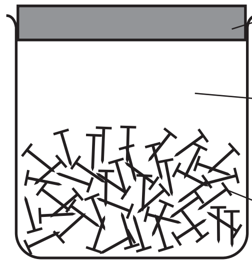
A Aluminium does not make a gas when it reacts with an acid.

B Aluminium has a surface layer of aluminium oxide.

C Aluminium is less reactive than hydrogen.

D Aluminium only reacts with concentrated acid.

26 Iron nails are stored in an airtight container.



The nails begin to rust after a few days.

How can the rusting of the nails be prevented?

A Leave the lid off.

B Replace the air with argon.

C Put the container in a warm place.

D Seal the container in a bag.

27 Four substances present in the blast furnace during iron extraction are listed.

1 calcium carbonate

2 carbon dioxide

3 carbon monoxide

4 iron(III) oxide

Which substances are both a reactant and a product during the reactions occurring in the blast furnace?

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

28 Aluminium is extracted from purified bauxite by electrolysis.

Which row shows the ionic half-equations for the reaction at each electrode?

	anode	cathode
A	$Al \rightarrow Al^{3+} + 3e^-$	$2O^{2-} + 4e^- \rightarrow O_2$
B	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$
C	$2O^{2-} + 4e^- \rightarrow O_2$	$Al \rightarrow Al^{3+} + 3e^-$
D	$2O^{2-} \rightarrow O_2 + 4e^-$	$Al^{3+} + 3e^- \rightarrow Al$

29 Which test is used to show that a sample of water is pure?

A Evaporate the water to see if any solids remain.

B Heat the water to check its boiling point.

C Test with anhydrous cobalt(II) chloride.

D Use universal indicator paper to check its pH.

30 Catalytic converters in car exhausts change polluting gases into non-polluting gases.

Which statements about oxides of nitrogen and car engines are correct?

1 The nitrogen in oxides of nitrogen comes from compounds in gasoline.

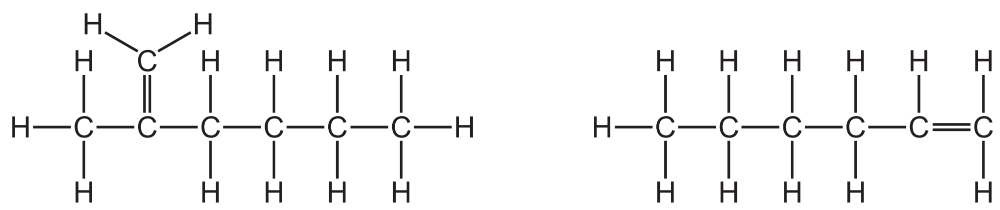
2 The oxygen in oxides of nitrogen comes from the air in the car engine.

3 Catalytic converters convert oxides of nitrogen into nitrogen.

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

31 The structures of two molecules, X and Y, are shown.

X Y

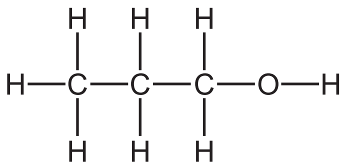


Which row describes X and Y?

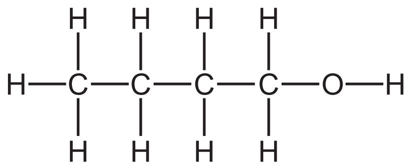
	structural isomers	belong to same homologous series
A	no	no
B	no	yes
C	yes	no
D	yes	yes

32 What is the structure of butanoic acid?

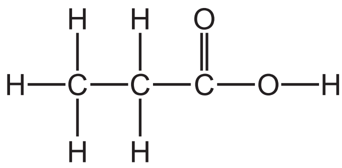
A



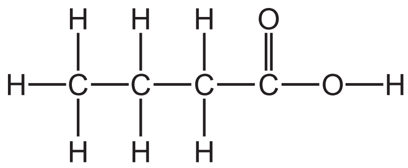
B



C



D



33 When a mixture of methane and chlorine is exposed to ultraviolet light, a reaction takes place.

Which statements about this reaction are correct?

1 It is an addition reaction.

2 The ultraviolet light provides the activation energy.

3 An equation for the reaction is $CH_4 + Cl_2 \rightarrow CH_2Cl_2 + H_2$.

4 CH_3Cl is made in the reaction.

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

34 Esters are formed when a carboxylic acid reacts with an alcohol.

What is the catalyst for this reaction?

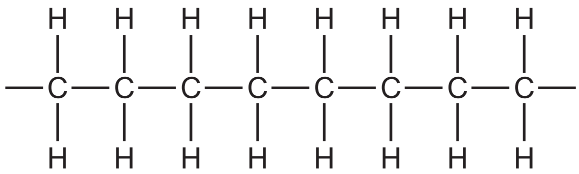
A aqueous potassium manganate(VII)

B iron

C sulfuric acid

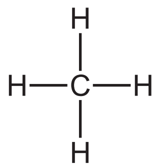
D vanadium(V) oxide

35 The diagram shows part of a polymer.

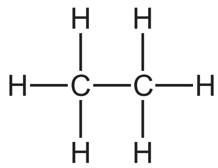


Which diagram shows the monomer from which this polymer is made?

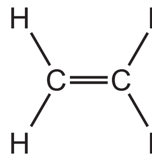
A



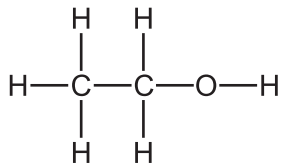
B



C



D



36 Nylon and PET are polymers.

Which statements about these polymers are correct?

1 They are both condensation polymers.

2 $HOCH_2CH_2CH_2OH$ could be a monomer for both polymers.

3 The complete combustion of both polymers gives two products only.

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

37 Ethane is used as a fuel.

Which equation shows the complete combustion of ethane?

A $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

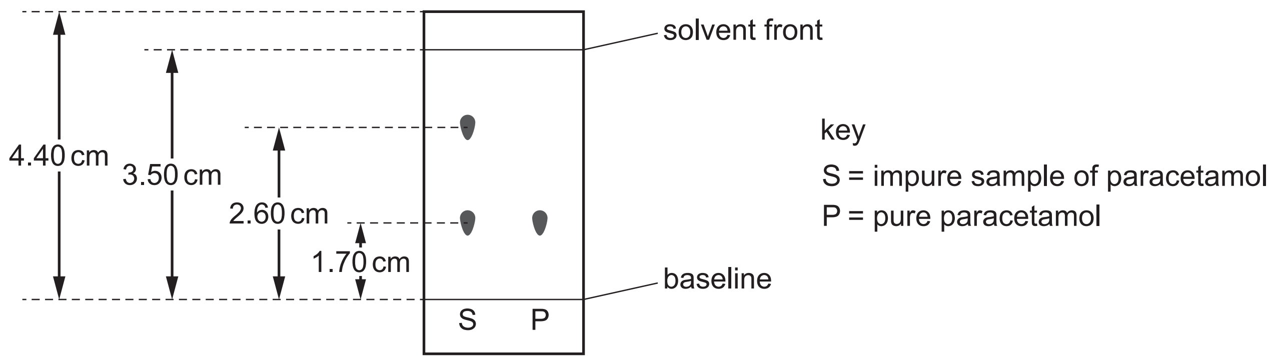
B $2C_2H_6 + 5O_2 \rightarrow 4CO + 6H_2O$

C $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

D $C_2H_4 + 2O_2 \rightarrow 2CO + 2H_2O$

38 The painkiller paracetamol is synthesised from 4-aminophenol.

Chromatography is done on an impure sample of paracetamol. The results are shown. The diagram is not drawn to scale.



The sample of paracetamol is contaminated with 4-aminophenol only.

What is the R_f value of 4-aminophenol?

A 0.49 **B** 0.65 **C** 0.74 **D** 1.35

39 The equation for the reaction of aqueous calcium nitrate and aqueous sodium hydroxide is shown.

$$Ca(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Ca(OH)_2(s) + 2NaNO_3(aq)$$

Which process is used to remove calcium hydroxide from the mixture?

A chromatography

B crystallisation

C distillation

D filtration

40 The results of two tests on aqueous compound X are given.

test	result
warm with aluminium foil and aqueous sodium hydroxide	ammonia is produced
aqueous sodium hydroxide	brown precipitate

What is X?

A iron(III) nitrate

B iron(II) nitrate

C iron(III) sulfate

D iron(II) sulfate

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 Assessment International Education

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **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.

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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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

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

Cambridge Assessment International Education

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2023**

45 minutes

* 3 5 0 9 1 2 5 5 5 9 *

You must answer on the multiple choice answer sheet.

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

INSTRUCTIONS

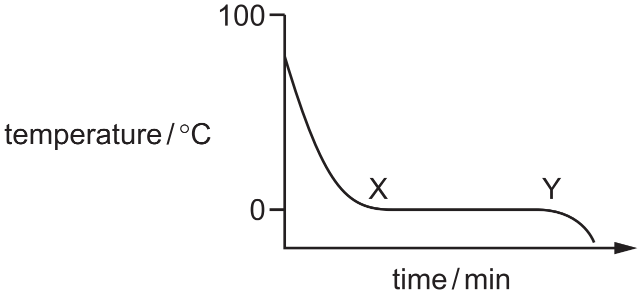
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the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

INFORMATION

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

This document has **16** pages.

1 Part of a cooling curve for water is shown.



What is occurring between points X and Y?

A Steam is condensing into water.

B The temperature of the water is decreasing.

C Ice is melting.

D Particles are losing heat to the surroundings.

2 Which statements about clean, dry air are correct?

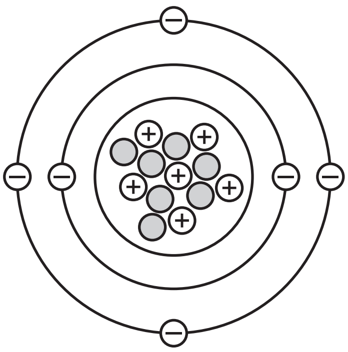
1 It is a mixture of elements only.

2 It is a mixture of elements and compounds.

3 It contains only non-metals.

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

3 A representation of an atom is shown.



What is the nucleon number of this atom?

A 6 **B** 7 **C** 12 **D** 13

4 The percentage abundances of three isotopes in a sample of neon are shown.

isotope	percentage abundance / %
$^{20}_{10}Ne$	90.48
$^{21}_{10}Ne$	0.27
$^{22}_{10}Ne$	9.25

What is the relative atomic mass, A_r, of this sample of neon?

A 10.19 **B** 20.19 **C** 21.00 **D** 30.19

5 Potassium reacts with iodine to form potassium iodide.

Which statement about potassium iodide is correct?

A Each potassium atom shares a pair of electrons with an iodine atom.

B In potassium iodide, the particles of potassium have more protons than electrons.

C Potassium iodide has a high melting point because it is a covalent compound.

D Potassium iodide has a low melting point because it is an ionic compound.

6 Which substance has the lowest melting point?

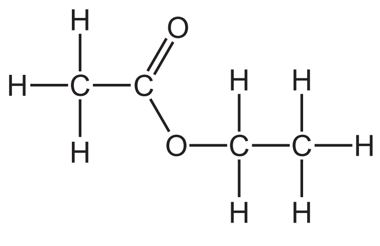
A graphite

B methanol

C silicon(IV) oxide

D sodium chloride

7 The diagram shows the structure of a molecule of ethyl ethanoate.



What is the molecular formula of a molecule of ethyl ethanoate?

A CHO **B** $C_4H_8O_2$ **C** $C_4(H_2)_2(O_2)$ **D** C_2H_4O

8 A hydrocarbon contains 85.7% of carbon by mass.

What is the empirical formula of the hydrocarbon?

A CH_2 **B** CH_4 **C** C_2H_5 **D** C_3H_6

9 The formula of a compound containing element X is $Na_2X_2O_3$.

The relative formula mass of the compound is 158.

What is the relative atomic mass of X?

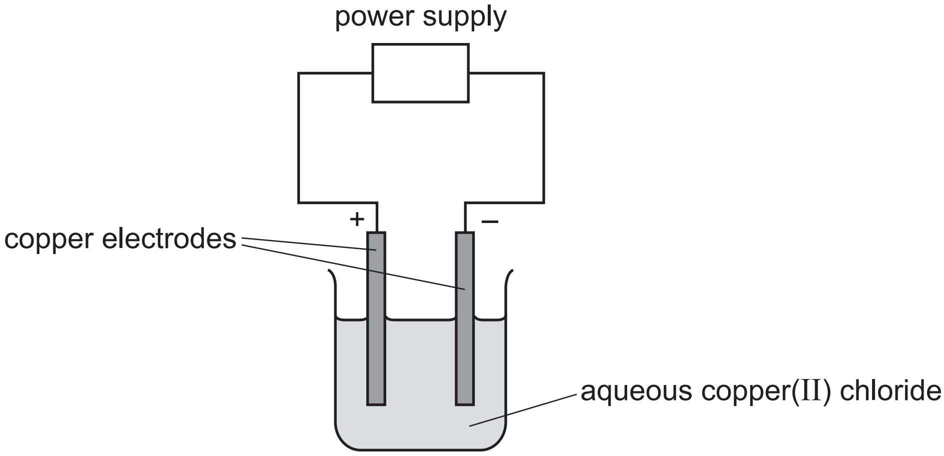
A 32 **B** 59.5 **C** 64 **D** 119

10 Dilute aqueous potassium chloride is electrolysed using platinum electrodes.

Which row identifies the product at each electrode?

	anode	cathode
A	chlorine	hydrogen
B	chlorine	potassium
C	oxygen	hydrogen
D	oxygen	potassium

11 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes, as shown.



What happens to the mass of each electrode during this process?

	positive electrode	negative electrode
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

12 The initial and final temperatures of four different reactions are measured.

Which reaction is the **least** exothermic?

	initial temperature / °C	final temperature / °C
A	19	25
B	21	18
C	22	17
D	22	26

13 Which equation represents an endothermic reaction?

A $Cl_2(g) \rightarrow 2Cl(g)$

B $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

C $H(g) + H(g) \rightarrow H_2(g)$

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

14 Methane burns in oxygen to form carbon dioxide and water.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

The bond energies are shown.

bond	bond energy in kJ / mol
C–H	410
C–O	360
C=O	805
O–H	460
O–O	146
O=O	496

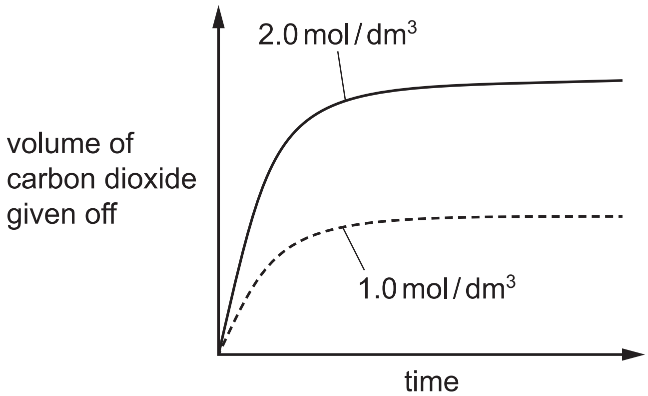
What is the energy change for this reaction?

A –818 kJ / mol **B** –102 kJ / mol **C** +102 kJ / mol **D** +818 kJ / mol

15 Hydrochloric acid is added to excess calcium carbonate in two separate experiments.

Two different concentrations of hydrochloric acid are used but the temperature is the same in both experiments.

The graph of the results shows the volume of carbon dioxide gas given off over time.



Which row is correct?

	particles in 2.0 mol / dm^3 compared to 1.0 mol / dm^3	
	collision rate	collision energy
A	higher	no change
B	higher	higher
C	lower	no change
D	lower	higher

16 The decomposition of dinitrogen tetroxide, N_2O_4, into nitrogen dioxide, NO_2, is a reversible reaction.

The equation for the reaction is shown.

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

The forward reaction is endothermic.

Which row shows the effect on the position of equilibrium and the rate of the reverse reaction when the temperature is increased?

	position of equilibrium	rate of the reverse reaction
A	shifts to the left	decreases
B	shifts to the left	increases
C	shifts to the right	decreases
D	shifts to the right	increases

[Turn over

17 In a blast furnace, iron(III) oxide is converted to iron and carbon monoxide is converted to carbon dioxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

What happens to each of these reactants?

A Both iron(III) oxide and carbon monoxide are oxidised.

B Both iron(III) oxide and carbon monoxide are reduced.

C Iron(III) oxide is oxidised and carbon monoxide is reduced.

D Iron(III) oxide is reduced and carbon monoxide is oxidised.

18 Which row describes what happens to Fe^{2+} ions when they are oxidised?

	electron movement	oxidation number of iron
A	they gain electrons	decreases
B	they gain electrons	increases
C	they lose electrons	decreases
D	they lose electrons	increases

19 In which reaction does an acid react with a base?

A Dilute sulfuric acid is added to a piece of magnesium ribbon producing hydrogen.

B Dilute sulfuric acid is added to aqueous barium chloride producing a white precipitate of barium sulfate.

C Aqueous sodium hydroxide is added to aqueous copper(II) sulfate producing a blue precipitate of copper(II) hydroxide.

D Aqueous sodium hydroxide is added to solid ammonium sulfate producing gaseous ammonia.

20 Which element forms an oxide that reacts with an aqueous solution of a base?

A argon

B sulfur

C magnesium

D copper

21 Which method is used to produce insoluble salts?

A addition of excess insoluble base to an acid

B addition of excess metal to an acid

C precipitation using two aqueous solutions

D titration using an acid and an alkali

22 The noble gases are in Group VIII of the Periodic Table.

Some properties of the first four noble gases are shown.

noble gas	boiling point in °C	density in g/dm^3
helium	–267	0.179
neon	–246	0.900
argon	–186	1.782
krypton	–152	3.708

Which row identifies the trends in boiling point and in density as Group VIII is descended?

	boiling point	density
A	decreasing	increasing
B	increasing	increasing
C	decreasing	decreasing
D	increasing	decreasing

23 Some properties of element R are shown.

melting point in °C	98
boiling point in °C	883
reaction with cold water	gives off H_2 gas
reaction when heated with oxygen	burns to give a white solid

In which part of the Periodic Table is R found?

A Group I

B Group VII

C Group VIII

D transition elements

24 Which pair of compounds shows that transition elements have variable oxidation states?

A Cr_2O_3 and $CrBr_3$

B $CuSO_4$ and $CuCl_2$

C Fe_2O_3 and $FeCl_2$

D NiO and $NiCl_2$

25 The list gives the order of some metals and hydrogen in the reactivity series.

Metal X is also included.

most reactive	K
	Mg
	Zn
	H
	X
least reactive	Cu

Which row shows the properties of metal X?

	reacts with dilute acids	oxide reduced by carbon
A	no	no
B	no	yes
C	yes	no
D	yes	yes

26 When zinc is added to an aqueous solution containing magnesium ions, there is no reaction.

Which species has the greatest tendency to lose electrons?

A Mg **B** Mg^{2+} **C** Zn **D** Zn^{2+}

27 Which gas in the air is needed for iron to rust?

A argon

B carbon dioxide

C nitrogen

D oxygen

28 Which coating prevents iron from rusting even when the coating is damaged?

A grease

B paint

C plastic

D zinc

29 Why is limestone added to the blast furnace?

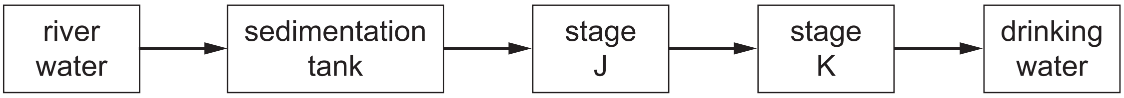
A It neutralises the molten slag produced.

B It reacts with impurities to form slag.

C It releases carbon dioxide which reduces the iron(III) oxide.

D It removes acidic gases such as carbon dioxide.

30 The flow chart shows stages in the treatment of river water to produce drinking water.



What occurs at stages J and K?

	J	K
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

31 Carbon dioxide acts as a greenhouse gas by interacting with a particular type of energy that radiates from the Earth's surface into the atmosphere.

Which type of energy is involved and what happens when this energy interacts with carbon dioxide molecules?

	type of energy involved	what happens
A	thermal	carbon dioxide molecules increase the Earth's energy loss to space
B	thermal	carbon dioxide molecules absorb the energy
C	light	carbon dioxide molecules increase the Earth's energy loss to space
D	light	carbon dioxide molecules absorb the energy

32 Oxides of nitrogen, such as NO and NO_2, are formed in the petrol engines of cars.

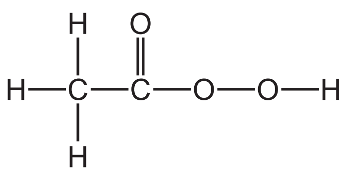
They are removed from the exhaust gases by reactions in the car's catalytic converter.

Which row describes how oxides of nitrogen are formed in a petrol engine and a reaction that happens in the catalytic converter?

	how oxides of nitrogen are formed	a reaction that happens in the catalytic converter
A	by the reaction between nitrogen and oxygen from the air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
B	by the reaction between nitrogen and oxygen from the air	$2NO + 2H_2 \rightarrow N_2 + 2H_2O$
C	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
D	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2NO + 2H_2 \rightarrow N_2 + 2H_2O$

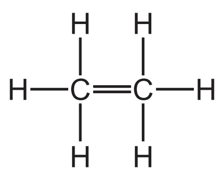
33 Which diagram shows the displayed formula for the named organic compound?

A



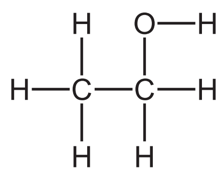
ethanoic acid

B



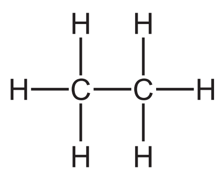
ethene

C



ethanol

D



methane

34 What is the total number of covalent bonds in a molecule of butane, C_4H_{10}?

A 3 **B** 10 **C** 13 **D** 14

35 Propane reacts with chlorine in a substitution reaction.

Which reaction condition is required for the reaction to occur?

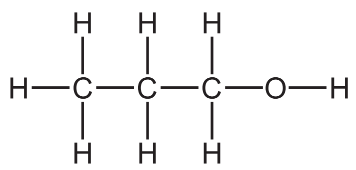
A acid catalyst

B iron catalyst

C temperature of 400 °C

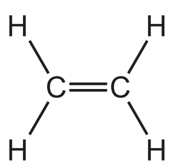
D ultraviolet light

36 The structure of an organic compound is shown.

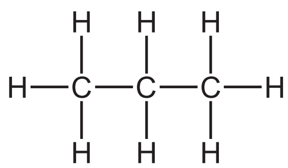


Which structure represents a molecule that reacts with steam to produce this product?

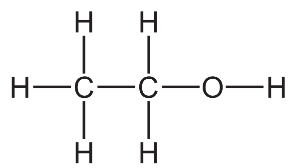
A



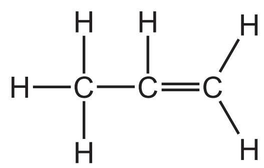
B



C



D



37 Which term describes nylon?

A addition polymer

B natural polymer

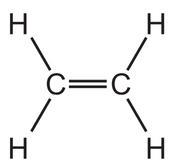
C polyamide

D polyester

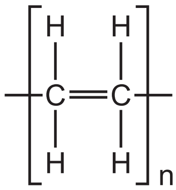
38 Ethene can be polymerised.

Which diagram represents the structure of the product formed?

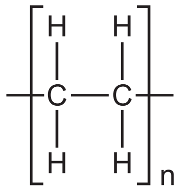
A



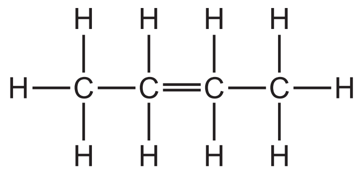
B



C



D



39 An acid–base titration is described.

- 25.0 cm^3 of dilute aqueous alkali is put into a conical flask.
- Indicator is added to the flask.
- Dilute acid is added to the aqueous alkali until the indicator changes colour.
- The volume of acid used is then recorded.

Which use of apparatus is correct?

A The 25.0 cm^3 of aqueous alkali is measured using a volumetric pipette.

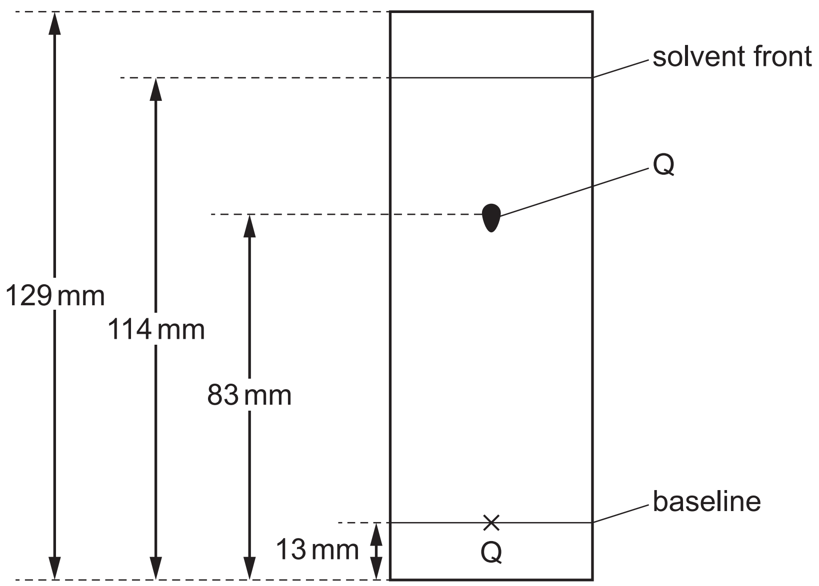
B The 25.0 cm^3 of aqueous alkali is measured using the lines on the conical flask.

C The volume of acid is measured using a measuring cylinder.

D The volume of acid is measured using a volumetric pipette.

40 Substance Q is investigated using chromatography.

The chromatogram is shown. The diagram is not drawn to scale.



What is the R_f value of Q?

A 0.60 **B** 0.64 **C** 0.69 **D** 0.72

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.).

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **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.

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.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2023**

45 minutes

You must answer on the multiple choice answer sheet.

9447354818

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.

IB23 11_0620_23/7RP

1 A sample of a gas occupies 340 cm^3 at room temperature and pressure.

The temperature and pressure are both increased, but the volume occupied by the gas remains 340 cm^3.

Which row describes what happens to the particle speed and the average distance between the particles in the gas when the temperature and pressure are both increased?

	particle speed	average distance between particles
A	unchanged	unchanged
B	unchanged	increased
C	increased	unchanged
D	increased	increased

2 Which statements about the rate of diffusion of the gases ammonia, carbon monoxide, nitrogen and oxygen are correct?

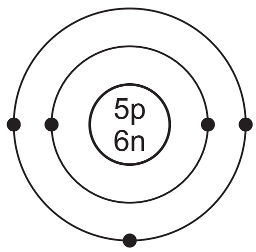
1 Nitrogen and carbon monoxide will diffuse at the same rate.

2 Oxygen will diffuse slowest because it is an element, whereas the others are compounds.

3 Ammonia will diffuse fastest.

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

3 The structure of an atom of element X is shown.



key
● = electron
n = neutron
p = proton

What is element X?

A boron

B carbon

C sodium

D sulfur

4 Which statement explains why isotopes of an element have the same chemical reactions?

A They have different numbers of neutrons.

B They have ions with different numbers of electrons.

C They have the same number of outer shell electrons.

D They have the same number of protons.

5 Magnesium reacts with oxygen to form magnesium oxide.

What happens to magnesium atoms and oxygen atoms during this reaction?

A Magnesium and oxygen share two electrons.

B Magnesium gains two electrons and oxygen loses two electrons.

C Magnesium loses one electron and oxygen gains one electron.

D Magnesium loses two electrons and oxygen gains two electrons.

6 Which row about the properties of both diamond and silicon(IV) oxide is correct?

	conductor of electricity	type of molecule
A	yes	giant covalent
B	yes	simple covalent
C	no	giant covalent
D	no	simple covalent

7 The equation represents the reaction between solid magnesium oxide and dilute hydrochloric acid to form magnesium chloride and water.

$$MgO + 2HCl \rightarrow MgCl_2 + H_2O$$

Which row shows the state symbols for hydrochloric acid, magnesium chloride and water?

	HCl	$MgCl_2$	H_2O
A	(aq)	(aq)	(l)
B	(aq)	(l)	(l)
C	(l)	(aq)	(aq)
D	(l)	(l)	(aq)

8 Which substance is a mixture?

A air

B graphite

C oxygen

D water

9 The number of moles of atoms X, Y and Z, in a compound, are shown.

atom	moles
X	0.6
Y	1.2
Z	0.3

What is the formula of the compound?

A XY_2Z_4 **B** XY_4Z_2 **C** X_2YZ_4 **D** X_2Y_4Z

10 1.0 mol of silver nitrate, $AgNO_3$, contains 1.2×10^{24} ions.

How many ions are there in 0.25 mol of iron(III) oxide, Fe_2O_3?

A 1.5×10^{23} **B** 3.0×10^{23} **C** 7.5×10^{23} **D** 3.0×10^{24}

11 Concentrated aqueous magnesium bromide is electrolysed using carbon electrodes.

Which equations represent the reactions occurring at each electrode?

	positive electrode	negative electrode
A	$2Br^-(aq) \rightarrow Br_2(aq) + 2e^-$	$2H^+(aq) + 2e^- \rightarrow H_2(g)$
B	$2H^+(aq) + 2e^- \rightarrow H_2(g)$	$2O^{2-}(aq) \rightarrow O_2(aq) + 4e^-$
C	$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	$2Br^-(aq) \rightarrow Br_2(aq) + 2e^-$
D	$2O^{2-}(aq) \rightarrow O_2(aq) + 4e^-$	$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$

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

Which statement is correct?

A Bubbles of hydrogen gas are formed at the anode.

B Bubbles of oxygen gas are formed at the cathode.

C Copper is deposited at the anode.

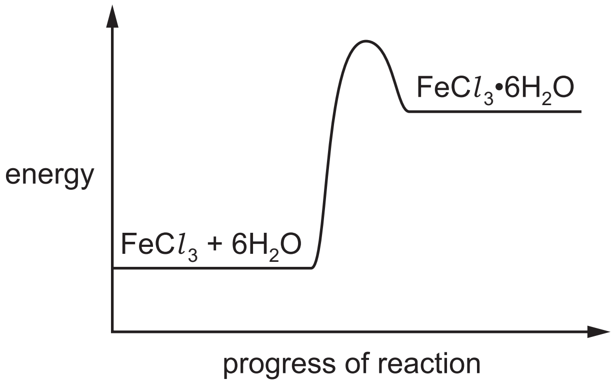
D The blue colour of the solution fades.

13 When water is added to anhydrous iron(III) chloride, $FeCl_3$, hydrated iron(III) chloride, $FeCl_3{\cdot}6H_2O$, is formed and energy is given out.

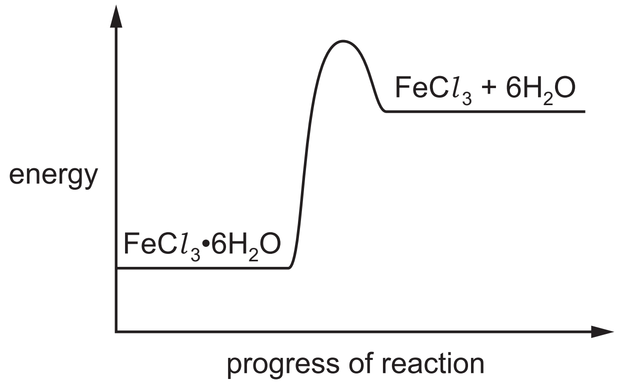
$$FeCl_3 + 6H_2O \rightleftharpoons FeCl_3{\cdot}6H_2O$$

Which reaction pathway diagram represents the formation of anhydrous iron(III) chloride in the **reverse** reaction?

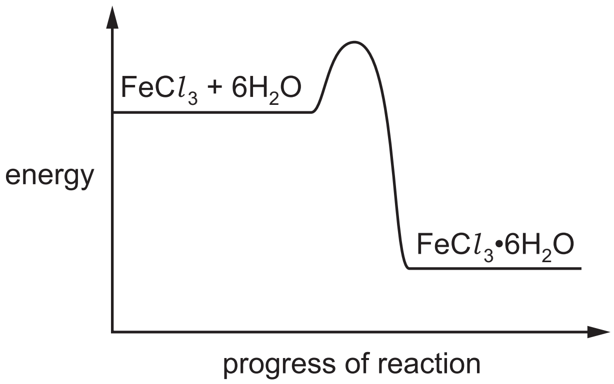
A



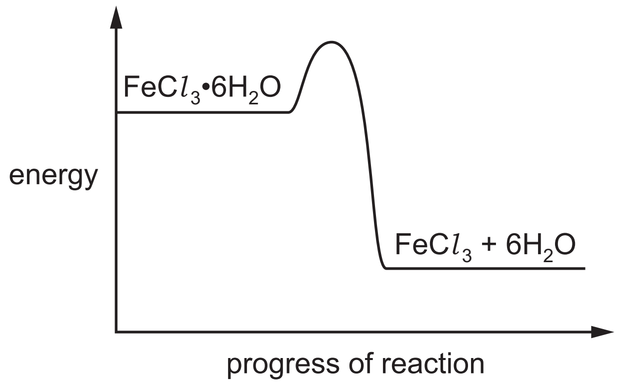
B



C



D



14 Ethene reacts with hydrogen. The equation is shown.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

The bond energies are shown.

bond	bond energy in kJ / mol
C–C	+350
C=C	+610
C–H	+410
H–H	+436

What is the energy change for the reaction?

A –560 kJ / mol **B** –124 kJ / mol **C** +486 kJ / mol **D** +5496 kJ / mol

15 Statements about four different acids are listed.

- A 0.0100 mol / dm^3 solution of hydrochloric acid has a pH of 2.
- A 0.0100 mol / dm^3 solution of ethanoic acid has a pH of 3.4.
- Hydrobromic acid, HBr, is a strong acid.
- Ethanoic acid is a slightly stronger acid than trimethylethanoic acid.

What are the pH values of 0.0100 mol / dm^3 HBr and 0.0100 mol / dm^3 trimethylethanoic acid?

	pH of 0.0100 mol / dm^3 HBr	pH of 0.0100 mol / dm^3 trimethylethanoic acid
A	2	3.3
B	2	3.5
C	3.4	3.3
D	3.4	3.5

16 Anhydrous cobalt(II) chloride is blue and turns pink when water is added.

How is this reaction reversed?

A adding dilute acid

B filtering

C heating

D cooling

17 The reaction between hydrogen and nitrogen is reversible.

The forward reaction is exothermic.

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

Which change to the conditions would increase the yield of ammonia?

A add a catalyst

B increase the pressure

C increase the temperature

D reduce the concentration of nitrogen

18 Ethanol can be turned into ethanoic acid by passing it over hot copper(II) oxide.

$$CH_3CH_2OH + 2CuO \rightarrow CH_3COOH + H_2O + 2Cu$$

What is this type of reaction?

A precipitation

B redox

C thermal decomposition

D neutralisation

19 When heated strongly, silicon(IV) oxide reacts with carbon.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

Which term describes what happens to silicon(IV) oxide?

A thermal decomposition

B neutralisation

C oxidation

D reduction

20 Which statement about aqueous weak acids is correct?

A Weak acids are always dilute aqueous solutions.

B Weak acids dissociate fully in aqueous solution.

C When a weak acid is added to blue litmus paper, it stays blue.

D When a weak acid is added to solid magnesium, effervescence is seen.

21 Which oxides are basic?

1 calcium oxide

2 sodium oxide

3 iron(II) oxide

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

22 Zinc oxide is an amphoteric oxide.

Zinc oxide is added to excess dilute hydrochloric acid.

Zinc oxide is added to excess aqueous sodium hydroxide.

Which row describes the observations made in these reactions?

	excess dilute hydrochloric acid	excess aqueous sodium hydroxide
A	colourless solution forms	colourless solution forms
B	colourless solution forms	no visible change
C	fizzing	colourless solution forms
D	fizzing	no visible change

23 Which row shows properties of an element that is in the same group of the Periodic Table as lithium?

	electrical conductivity	density in g/cm^3
A	high	0.97
B	high	8.93
C	low	0.07
D	low	3.12

24 The elements in Group VII include chlorine, bromine and iodine.

Which statements are correct?

1 Iodine is more dense than chlorine.

2 Iodine displaces chlorine from a solution containing chloride ions.

3 Bromine is a diatomic non-metal.

4 Chlorine gas is darker in colour than bromine vapour.

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

25 Cobalt is a transition element.

What is a property of cobalt?

A It can form coloured compounds.

B It is a poor electrical conductor.

C It has a low density.

D It has a low melting point.

26 Which metal has variable oxidation numbers?

A aluminium

B calcium

C copper

D sodium

27 Which statement about alloys is correct?

A Alloys are pure metal elements.

B At least two or more metals react together to make alloys.

C Alloys can be harder and stronger than a pure metal.

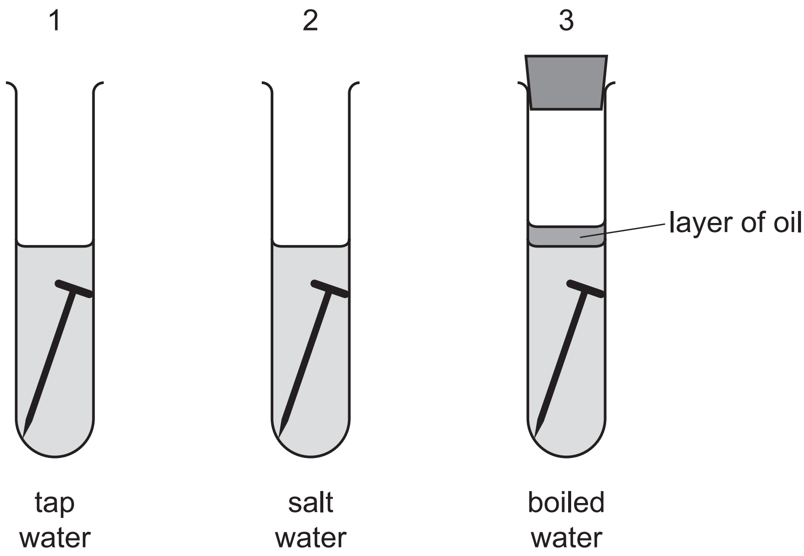
D Steel is **not** an alloy because it can contain the non-metal carbon.

28 A metal M is between sodium and magnesium in the reactivity series.

Which reactions occur with M and its oxide?

	M reacts with steam	M can be extracted by heating its oxide with carbon
A	no	no
B	no	yes
C	yes	no
D	yes	yes

29 The diagrams show experiments to investigate rusting of iron nails.



In which test-tubes do the nails rust?

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

30 Which equation represents a reaction that takes place when iron is extracted from its ore in the blast furnace?

A $CaO + SiO_2 \rightarrow CaSiO_3$

B $CaO + CO_2 \rightarrow CaCO_3$

C $2CO \rightarrow C + CO_2$

D $2Fe + 3CO_2 \rightarrow Fe_2CO_3 + 3CO$

31 Some uses of water are listed.

1 for drinking

2 in chemical reactions

3 in swimming pools

4 in washing

For which uses is it necessary to chlorinate the water?

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

32 Oxides of nitrogen are formed in car engines and are a source of air pollution.

To decrease this pollution, catalytic converters are fitted to car exhausts.

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

A combustion

B cracking

C oxidation

D reduction

33 Which pair of compounds are structural isomers of each other?

A $CH_3CH_2CH_3$ and $CH_3CH_2CH_2CH_3$

B $CH_2{=}CHCH_3$ and $CH_3CH{=}CH_2$

C $CH_2(OH)CH_2CH_3$ and $CH_3CH_2CH_2OH$

D $CH_3CH_2CH_2COOH$ and $CH_3COOCH_2CH_3$

34 Methane reacts with chlorine in sunlight.

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

Which statements about this reaction are correct?

1 It is a substitution reaction.

2 It is an addition reaction.

3 It is a photochemical reaction.

4 It is catalysed by nickel.

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

35 Propene reacts with bromine to give one product only.

What is the formula of the product?

A $CH_3CH_2CHBr_2$

B $CH_2BrCH_2CH_2Br$

C $CH_3CHBrCH_2Br$

D $CH_3CH_2CH_2Br$

36 Ethanol can be manufactured by fermentation or by the catalytic addition of steam to ethene.

Which statements describe an advantage of manufacturing ethanol by fermentation?

1 The yield of ethanol is low.

2 The method uses a batch process.

3 The process takes place at a lower temperature.

4 The ethanol is made from a renewable source.

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

37 A compound with the formula $CH_3COOC_2H_5$ is formed from ethanol in two separate reactions.

reaction 1 Ethanol reacts to form ethanoic acid.

reaction 2 Ethanoic acid and ethanol react together to form $CH_3COOC_2H_5$.

Which row describes reaction 1 and reaction 2?

	reaction 1	reaction 2
A	oxidation	ester formation
B	oxidation	addition
C	reduction	ester formation
D	reduction	addition

38 The flow diagram shows how poly(ethene) may be made from petroleum.

petroleum $\xrightarrow{1}$ fuel oil $\xrightarrow{2}$ ethene $\xrightarrow{3}$ poly(ethene)

What are stages 1, 2 and 3?

	1	2	3
A	cracking	polymerisation	fractional distillation
B	cracking	fractional distillation	polymerisation
C	fractional distillation	cracking	polymerisation
D	fractional distillation	polymerisation	cracking

39 R_f values are used to identify unknown substances using paper chromatography.

Which statements about R_f values are correct?

1 R_f values are always less than 1.0.

2 R_f value = distance travelled by solvent ÷ distance travelled by unknown substance.

3 The higher the R_f value, the further the unknown substance travels.

4 R_f values are **not** affected by the solubility of the unknown substance.

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

40 The results of some tests on an aqueous solution of substance X are listed.

1 A cream precipitate is produced when adding aqueous silver nitrate.

2 Adding aqueous sodium hydroxide produces a green precipitate which dissolves in excess alkali.

3 Adding aqueous ammonia produces a green precipitate which is insoluble in excess ammonia.

What is substance X?

A chromium(III) bromide

B chromium(III) chloride

C iron(II) bromide

D iron(II) chloride

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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 Assessment International Education

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **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.

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.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6941276161

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 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.

1 This question is about separating mixtures.

(a) The apparatus in Fig. 1.1 can be used to separate a mixture of liquids with different boiling points.

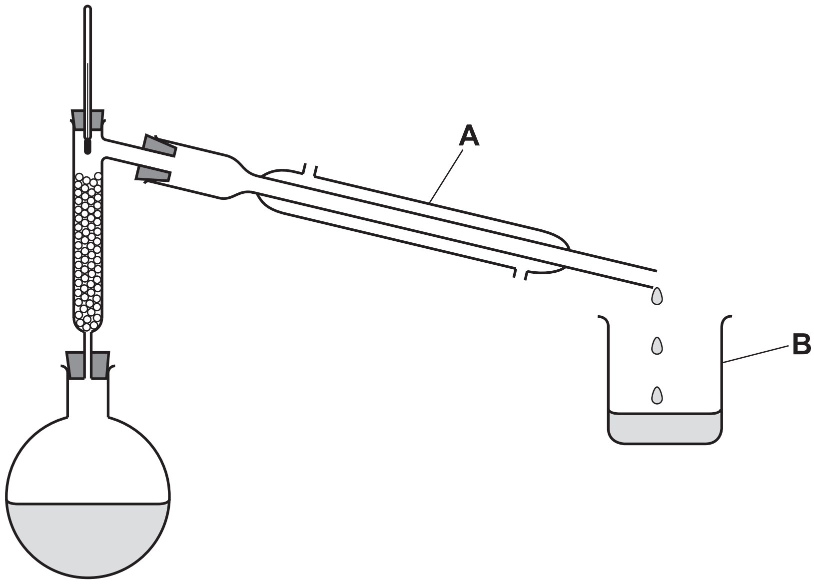

Fig. 1.1

(i) Name the separation technique that uses the apparatus shown in Fig. 1.1.

.... [1]

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

A ....

B ....

[2]

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

(b) Fig. 1.2 shows the apparatus that can be used to separate insoluble calcium carbonate from aqueous sodium chloride.

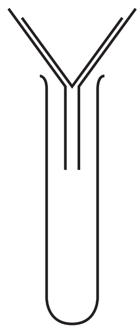

Fig. 1.2

(i) State the term used for the solid removed from a liquid using the apparatus shown in Fig. 1.2.

.... [1]

(ii) The calcium carbonate obtained using the apparatus in Fig. 1.2 is contaminated with aqueous sodium chloride.

Describe how the aqueous sodium chloride can be removed.

....

.... [1]

(iii) Name the method of separation that can be used to obtain solid sodium chloride from an aqueous solution of sodium chloride.

.... [1]

[Total: 7]

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2 A student investigates the temperature change when solid citric acid reacts with solid sodium carbonate.

The student does six experiments.

(a) Experiment 1

- Place 5.0 g of solid sodium carbonate in a 100 cm^3 beaker.
- Use a thermometer to stir the solid sodium carbonate for 30 seconds. Measure the temperature of the solid sodium carbonate.

Experiment 2

- Add 1.0 g of solid citric acid to the solid sodium carbonate in the beaker from Experiment 1.
- Use the thermometer to stir the mixture for 30 seconds. Measure the temperature of the mixture.
- Rinse the beaker and thermometer with water.

Experiment 3

- Place 5.0 g of solid sodium carbonate in the 100 cm^3 beaker.
- Add 2.0 g of solid citric acid to the solid sodium carbonate in the beaker.
- Use the thermometer to stir the mixture for 30 seconds. Measure the temperature of the mixture.
- Rinse the beaker and thermometer with water.

Experiment 4

- Repeat Experiment 3, using 4.0 g of solid citric acid instead of 2.0 g.

Experiment 5

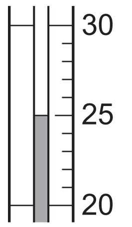
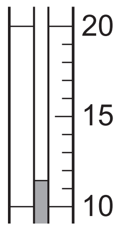
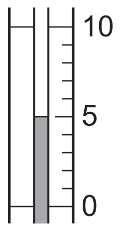
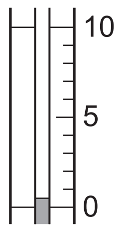
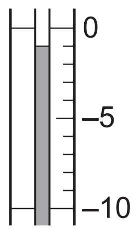
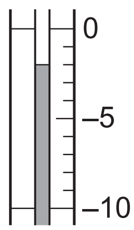
- Repeat Experiment 4, using 5.0 g of solid citric acid instead of 4.0 g.

Experiment 6

- Repeat Experiment 5, using 6.0 g of solid citric acid instead of 5.0 g.

Use the information in the description of the experiments and the thermometer diagrams to complete Table 2.1.

Table 2.1

experiment	mass of solid sodium carbonate / g	mass of solid citric acid / g	thermometer diagram after 30 seconds	temperature after 30 seconds / °C
1	5.0	0.0		
2	5.0	1.0		
3				
4				
5				
6				

[4]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 6 on Fig. 2.1.

Draw a line of best fit through your points.

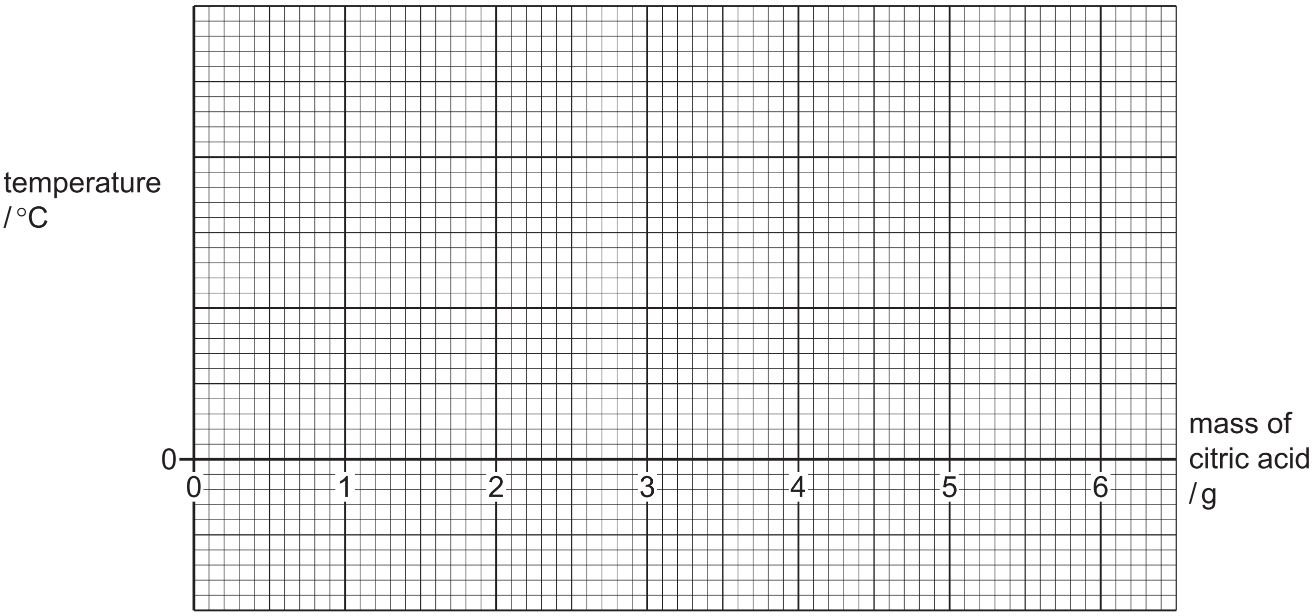


Fig. 2.1

[4]

(c) State whether the reaction between solid sodium carbonate and solid citric acid is exothermic or endothermic.
Explain your answer.

....

.... [1]

(d) Deduce which experiment had the greatest temperature change compared to the temperature in Experiment 1.

.... [1]

(e) **From your graph**, deduce the temperature, after stirring for 30 seconds, that is obtained when 3.5 g of solid citric acid is added to 5.0 g of solid sodium carbonate.

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

temperature = ... °C [2]

(f) Suggest why the solid sodium carbonate and solid citric acid are stirred before the temperature is measured.

....

.... [2]

(g) Explain why using a polystyrene cup in place of the glass beaker would increase the accuracy of the results.

....

.... [2]

[Total: 16]

Question 3 starts on the next page.

3 A student tests two solids: solid **G** and solid **H**.

Tests on solid G

Table 3.1 shows the student's observations for solid **G**.
Solid **G** contains three ions.

Table 3.1

tests	observations
test 1 Do a flame test on solid **G**.	lilac coloured flame
test 2 Heat half of solid **G** in a boiling tube. Hold anhydrous cobalt(II) chloride paper above the boiling tube.	solid **G** became a solution, condensation formed at the top of the boiling tube; cobalt(II) chloride paper turned pink
test 3 Dissolve the remaining solid **G** in water to form solution **G**. Divide solution **G** into three portions. To the first portion of solution **G**, add aqueous sodium hydroxide dropwise and then in excess.	white precipitate which dissolves in excess
test 4 To the second portion of solution **G**, add a few drops of acidified aqueous potassium manganate(VII).	pale purple solution
test 5 To the third portion of solution **G**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	white precipitate

(a) State what conclusion can be made about solid **G** from the observations in **test 2**.

.... [1]

(b) State what conclusion can be made about solid **G** from the observations in **test 4**.

.... [1]

(c) The observations in **test 3** show that one of two possible cations could be in solid **G**.

Identify these **two** possible cations.

....

.... [2]

(d) Identify **two** ions, other than those you gave in **(c)**, which must be in solid **G**.

....

.... [2]

Tests on solid H

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

(e) About 10 cm^3 of dilute hydrochloric acid is added to solid **H**.
Any gas given off is tested.

observations ....

....

.... [2]

The solution formed in **(e)** is solution **I**.
Solution **I** is divided into two portions.

(f) To the first portion of solution **I**, add aqueous sodium hydroxide dropwise and then in excess.

observations when added dropwise ....

observations in excess ....

[2]

(g) To the second portion of solution **I**, add 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations ....

.... [1]

[Total: 11]

4 Oxalic acid is a white solid which is soluble in both water and ethanol to form colourless solutions.

Plan an experiment to determine if oxalic acid is more soluble in water or in ethanol, at room temperature.
Your answer should include how your results tell you if oxalic acid is more soluble in water or in ethanol, at room temperature.

You are provided with oxalic acid, water, ethanol and common laboratory apparatus.

....

....

....

....

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....

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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

Cambridge IGCSE™

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

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)(i)	fractional distillation	**1**
1(a)(ii)	**A** condenser	**1**
	B beaker	**1**
1(a)(iii)	An arrow pointing to the round bottom flask anywhere below the top of the liquid	**1**
1(b)(i)	residue	**1**
1(b)(ii)	pour (distilled) water through / over it	**1**
1(b)(iii)	crystallisation (of sodium chloride) / evaporation (of water)	**1**

Question	Answer	Marks
2(a)	**M1** all masses of sodium carbonate and citric acid correct (5.0, 5.0, 5.0, 5.0, 5.0 and 1.0, 2.0, 4.0, 5.0, 6.0)	**1**
	M2 and M3 all temperatures correct (25.0; 11.5; 5.0; 0.5; –1.0; –2.0)	**2**
	M4 all values shown to 1 dp	**1**
2(b)	**M1** *y*-axis scale in linear and points extend over halfway up scale above zero	**1**
	M2 and M3 all points plotted correctly	**2**
	M4 curved line of best-fit	**1**
2(c)	endothermic **and** because the **temperature** decreased	**1**
2(d)	experiment 6	**1**

Question	Answer	Marks
2(e)	**M1** working shown on graph at 3.5 g	**1**
	M2 correct value from their graph	**1**
2(f)	any 2 from: • so that the sodium carbonate mix together • so they react • so the temperature is the same throughout the mixture	**2**
2(g)	**M1** insulation	**1**
	M2 reduces heat being gained from the surroundings / keeps temperature lower / stops temperature going up **OR** **M1** prevents heat loss / prevents heat gain / prevents energy exchange with surroundings **M2** stops temperature going up / reduces increase in temperature (after reaction has ended)	**1**

Question	Answer	Marks
3(a)	hydrated / contains water	**1**
3(b)	**not** a sulfite	**1**
3(c)	**M1** aluminium / Al^{3+}	**1**
	M2 zinc / Zn^{2+}	**1**
3(d)	**M1** potassium / K^{+}	**1**
	M2 sulfate / SO_4^{2-}	**1**
3(e)	**M1** effervescence / bubbles / fizzing	**1**
	M2 lime water turns milky	**1**

Question	Answer	Marks
3(f)	**M1** blue precipitate	**1**
	M2 does not dissolve in excess	**1**
3(g)	white precipitate	**1**

Question	Answer	Marks
4	any 6 from: **add excess solute, find mass not dissolved** **MP1** method is repeated for both ethanol and water **MP2** volume of ethanol / water known / stated / measured **MP3** solid added to solvent in a suitable container **MP4** add known / stated / measured mass of oxalic acid / solid to the solvent **MP5** shake / mix / stir **MP6** filter and find mass of solid left **MP7** smallest mass of solid is solvent in which it is the most soluble **OR** **add solute gradually, stop when no more dissolves** **MP1** method is repeated for both ethanol and water **MP2** volume of ethanol / water known / stated / measured **MP3** solid added to solvent in a suitable container **MP4** add stated / known mass / measure of ethanedioic acid **MP5** shake / mix / stir **MP6** if all dissolved, add more **MP7** largest mass / most measures added is solvent in which it is the most soluble **OR** **add excess solute, find mass that dissolves** **MP1** method is repeated for both ethanol and water **MP2** volume of ethanol / water known / stated / measured **MP3** solid added to solvent in a suitable container **MP4** add known / stated / measured mass of ethanedioic acid / solid to the solvent **MP5** shake / mix / stir **MP6** filter and heat solution to evaporate all solvent and weigh solid left **MP7** smallest mass of solid is solvent in which it is the most soluble **max 6**	**6**

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CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

6847411147

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 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.

1 Hot powdered lead(II) oxide is reduced by methane, a flammable gas. The products are lead, steam and carbon dioxide gas.
Fig. 1.1 shows the apparatus used to reduce lead(II) oxide using excess methane.

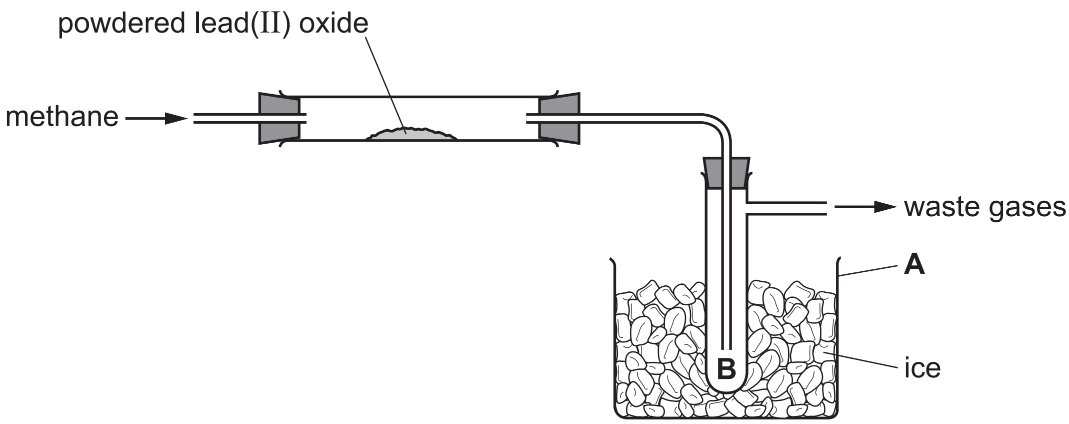


Fig. 1.1

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

.... [1]

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

(c) Explain why powdered lead(II) oxide is used and **not** a large lump of lead(II) oxide.

....

.... [1]

(d) Explain what happens at the point labelled **B**, on Fig. 1.1.

....

....

.... [2]

(e) The waste gases contain methane.

State why the waste gases should **not** be released into the laboratory.

....

.... [1]

[Total: 6]

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

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

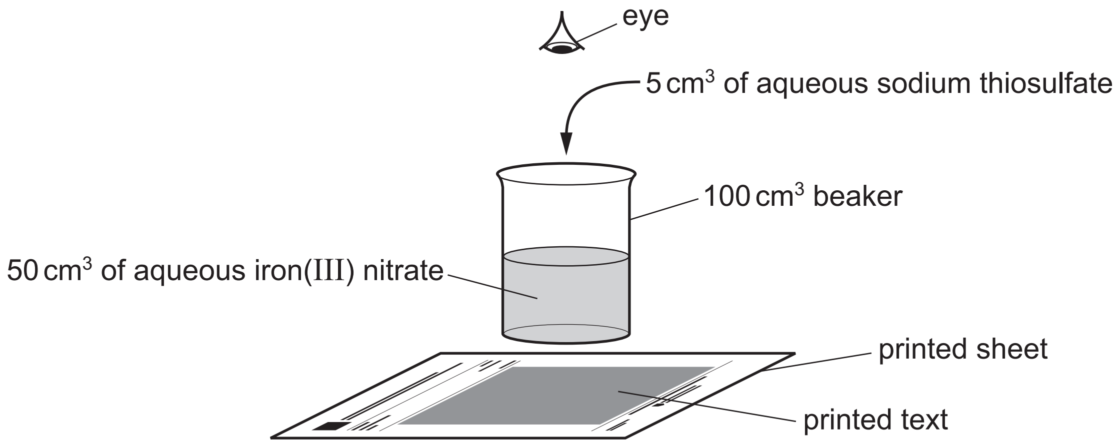


Fig. 2.1

(a) 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 a printed sheet as shown in Fig. 2.1.
- Use a 10 cm^3 measuring cylinder to pour 5 cm^3 of aqueous sodium thiosulfate into the beaker and at the same time start a stop-clock.
- Use a thermometer to stir the contents of the beaker.
- Look down from above the beaker and when the text on the printed sheet becomes visible, stop the stop-clock.
- Use the thermometer to measure the temperature of the solution when the text becomes visible.
- Rinse the beaker and thermometer with water.

Experiment 2

- Use the 50 cm^3 measuring cylinder to pour 50 cm^3 of aqueous iron(III) nitrate into the 100 cm^3 beaker.
- Heat the beaker on a gauze over a Bunsen burner until the temperature of the iron(III) nitrate has increased by about 5 °C.
- Stand the beaker on the printed sheet as shown in Fig. 2.1.
- Use the 10 cm^3 measuring cylinder to pour 5 cm^3 of aqueous sodium thiosulfate into the beaker and at the same time start a stop-clock.
- Use the thermometer to stir the contents of the beaker.
- Look down from above the beaker and when the text on the printed sheet becomes visible, stop the stop-clock.
- Use the thermometer to measure the temperature of the solution when the text becomes visible.
- Rinse the beaker and thermometer with water.

Experiment 3

- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 10 °C.

Experiment 4

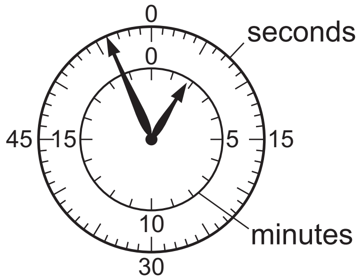
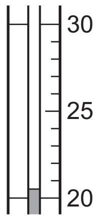
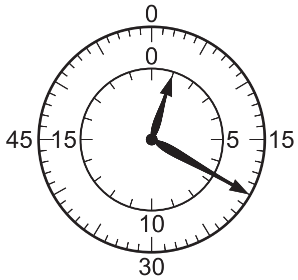
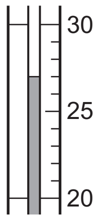
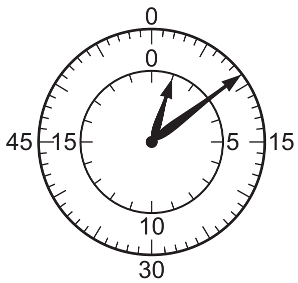
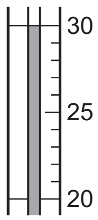
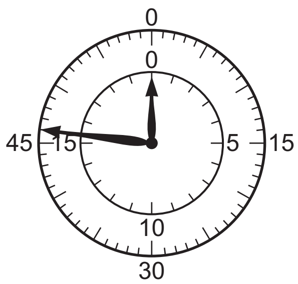
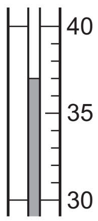
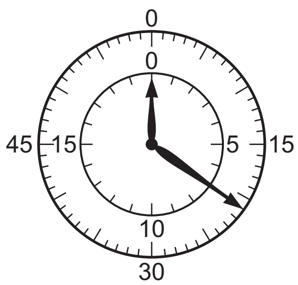
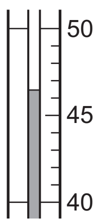
- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 15 °C.

Experiment 5

- Repeat Experiment 2, this time heating the aqueous iron(III) nitrate until the temperature has increased by about 25 °C.

Use the thermometer diagrams and stop-clock diagrams to complete Table 2.1.

Table 2.1

experiment	stop-clock diagram	time taken for the text to become visible / s	thermometer diagram	temperature of the solution when the text becomes visible / °C
1				
2				
3				
4				
5				

[4]

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

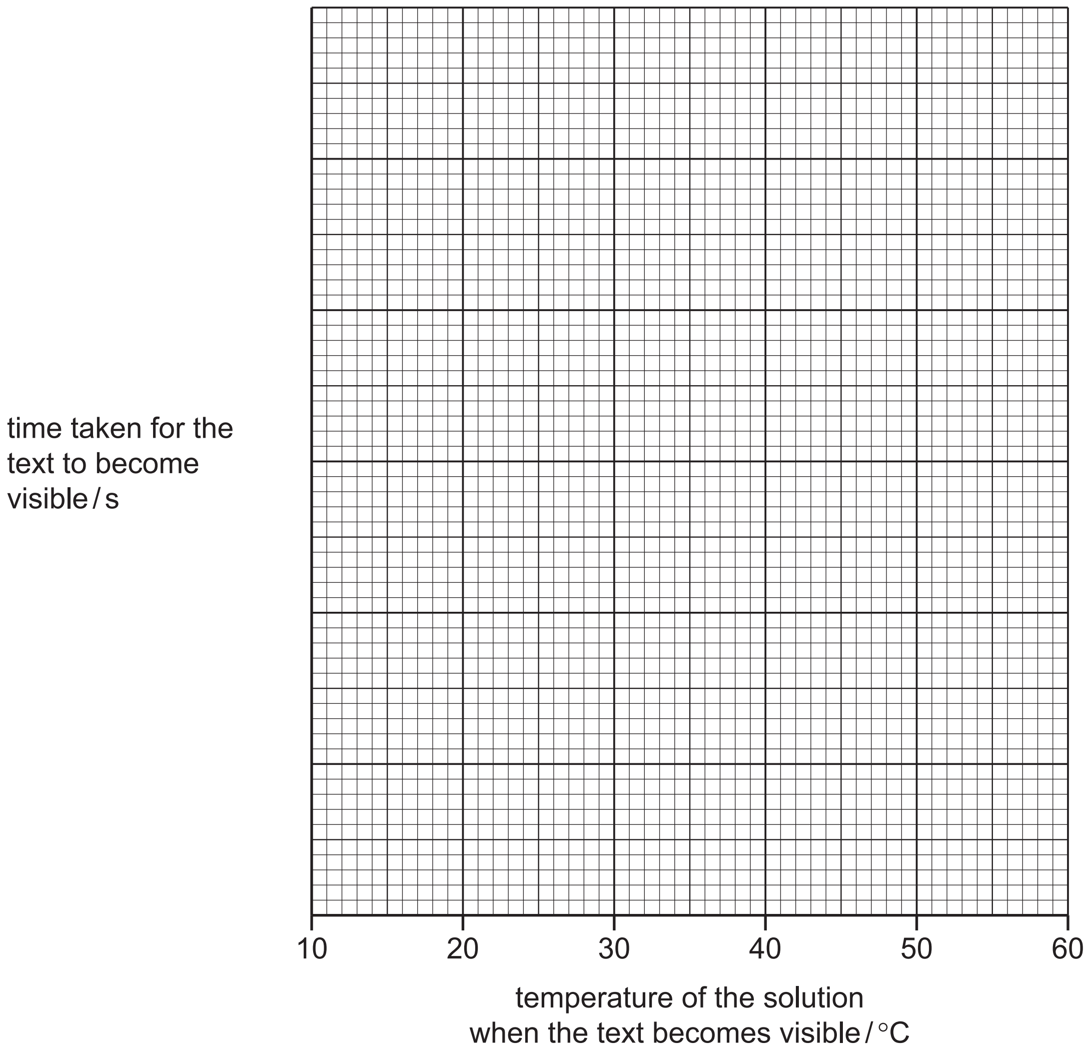


Fig. 2.2

[4]

(c) Deduce the experiment in which the rate of reaction is fastest.

.... [1]

(d) Use your graph to predict the temperature of the solution when the text becomes visible after 55 seconds.
Show your working on Fig. 2.2.

temperature = ... °C [2]

(e) Explain why wrapping the beaker in cotton wool after it has been heated will improve the accuracy of the results obtained.

....

.... [2]

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

....

.... [1]

(ii) Suggest why it would **not** be an improvement to add the aqueous sodium thiosulfate using a pipette.

....

.... [1]

(g) Suggest why the aqueous sodium thiosulfate must be added after the aqueous iron(III) nitrate has been heated and **not** before it is heated.

....

.... [1]

(h) Describe how the results of the experiment would change when the experiment is repeated using a 250 cm^3 beaker in place of the 100 cm^3 beaker.
Explain your answer.

change in results ....

explanation ....

....
[2]

[Total: 18]

3 A student tests two substances: solution **F** and solid **G**.

Tests on solution F

Table 3.1 shows the tests and the student's observations for solution **F**. The student divides solution **F** into three portions.

Table 3.1

tests	observations
test 1 Do a flame test on the first portion of solution **F**.	light green colour
test 2 To the second portion of solution **F**, add a 1 cm depth of aqueous sodium hydroxide and a piece of aluminium foil. Warm the mixture gently and test any gas produced.	effervescence was seen; the gas turned damp red litmus paper blue
test 3 To the third portion of solution **F**, add a 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	no change

(a) Describe how to do the flame test used in **test 1**.

....

....

.... [2]

(b) Identify the gas given off in **test 2**.

.... [1]

(c) Identify solution **F**.

....

.... [2]

(d) State what would be observed if the student adds dilute sulfuric acid to another portion of solution **F**.

observations ....

.... [1]

Tests on solid G

Solid **G** is iron(II) carbonate.

(e) About 10 cm^3 of dilute sulfuric acid is added to solid **G**.
Any gas given off is tested.

observations ....

....

.... [2]

(f) To the product from **(e)**, aqueous sodium hydroxide is added dropwise until in excess.

observations adding dropwise ....

observations in excess ....
[2]

[Total: 10]

4 A metal polish is a mixture of four substances.
The properties of these substances are shown in Table 4.1.

Table 4.1

name of substance	solubility in water	reaction with dilute nitric acid
propanol	soluble	dissolves
ethanoic acid	soluble	dissolves
iron(III) oxide	insoluble	reacts when warmed to form a soluble salt
silicon(IV) oxide	insoluble	no reaction

Plan an experiment to find the percentage by mass of silicon(IV) oxide in the mixture. Your plan should include how you will calculate the percentage of silicon(IV) oxide in the mixture.

You are provided with a sample of the metal polish, dilute nitric acid 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

Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

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

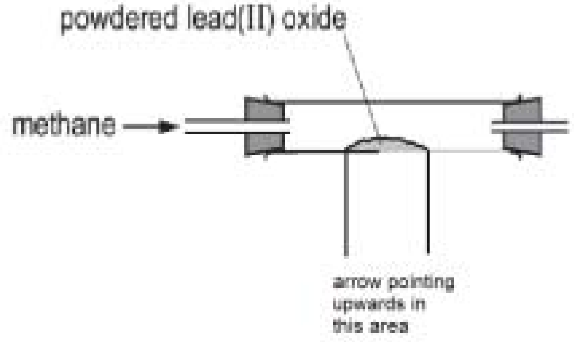
GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	beaker	**1**
1(b)	arrow pointing upwards towards lead oxide  	**1**
1(c)	(the powder has) larger surface area / reacts faster / rate increases	**1**
1(d)	**M1** (ice) cools (steam / vapour / gas)	**1**
	M2 (steam / vapour / gas) condenses / water (collects / forms)	**1**
1(e)	(methane is) flammable	**1**

Question	Answer	Marks
2(a)	**M1** all five times correct (116, 80, 69, 46, 21)	**1**
	M2 all times shown in seconds only	**1**
	M3 all temperatures correct (20.5, 27.0, 30.0, 37.0, 46.5)	**1**
	M4 all temperatures shown to 1 dp	**1**

Question	Answer	Marks
2(b)	**M1** *y*-axis scale in linear and points extend over halfway up scale	**1**
	M2 and M3 all points plotted correctly	**2**
	M4 best fit line	**1**
2(c)	experiment 5	**1**
2(d)	**M1** working shown on graph at 55 s	**1**
	M2 correct value for temperature from their graph	**1**
2(e)	**M1** insulation / reduces heat loss	**1**
	M2 temperature remains (more) constant / changes less / does not change / is maintained	**1**
2(f)(i)	(burette) (more) accurate (than a measuring cylinder)	**1**
2(f)(ii)	reaction starts while still adding the sodium thiosulfate / slow (to add)	**1**
2(g)	otherwise it will react while it is being heated / temperature increases while it is reacting / reaction starts at a lower temperature	**1**
2(h)	**M1** times shorter / decrease	**1**
	M2 less depth to look through	**1**

Question	Answer	Marks
3(a)	**M1** use of a wire / splint to get substance into a flame	**1**
	M2 putting sample INTO flame **and** identifying (Bunsen) flame as roaring / blue / non-luminous / hot	**1**
3(b)	ammonia / NH_3	**1**

Question	Answer	Marks
3(c)	**M1** barium / Ba^{2+}	**1**
	M2 nitrate / NO_3^-	**1**
3(d)	white precipitate	**1**
3(e)	**M1** fizzing / bubbles / effervescence	**1**
	M2 limewater becomes milky	**1**
3(f)	**M1** green precipitate	**1**
	M2 remains in excess / does not dissolve / green precipitate	**1**

Question	Answer	Marks
4	any 6 from: **MP1** stated / known **mass** of polish / weigh polish **MP2** add nitric acid **MP3** nitric acid and polish / solid combined in a **suitable container** **MP4** warm / heat (polish and acid / water) **MP5** filter (wash) **and** dry residue / solid **MP6** find the mass of the silicon(IV) oxide **MP7** percentage = (mass of SiO_2 / mass of polish) × 100 **max 6**	**6**

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5610007068

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 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.

1 Ethanol can be made by fermentation of sugars found in plants. A by-product of fermentation is carbon dioxide gas.

A student made some ethanol using the following method.

step 1 Cut up some sugar cane and crush it.
step 2 Add hot water to the sugar cane and stir to dissolve the sugar in the sugar cane.
step 3 Remove the solids from the mixture to obtain sugar solution.
step 4 Let the sugar solution cool and then add yeast.
step 5 Place the mixture obtained in the apparatus shown in Fig. 1.1.
step 6 Leave the apparatus until fermentation is complete.

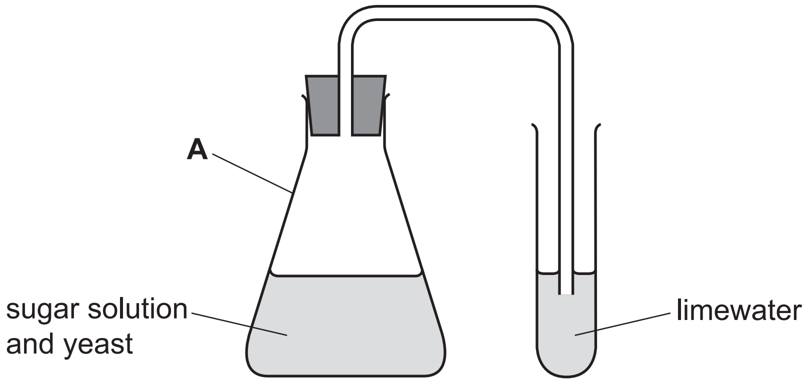

Fig. 1.1

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

.... [1]

(b) Explain why hot water rather than cold water is used in **step 2**.

.... [1]

(c) Name the method used to remove the solids from the mixture in **step 3** and draw a diagram to show how this is done.

name of process ....

diagram

[2]

(d) State why the sugar solution is allowed to cool before the yeast is added in **step 4**.

....

.... [1]

(e) Describe how the appearance of the limewater changes as fermentation takes place.

.... [1]

(f) Describe how the student could tell that fermentation is complete.

....

.... [1]

(g) Name the process used to separate ethanol from the mixture obtained by fermentation.

.... [1]

[Total: 8]

2 A student investigates the reaction between aqueous ammonia and two different aqueous solutions of copper(II) sulfate labelled **A** and **B**. Solutions **A** and **B** have different concentrations.

The student does two experiments.

Experiment 1

- Fill a burette with solution **A**.
- Run some of solution **A** out of the burette so that the level of solution **A** is on the burette scale and record the initial burette reading.
- Use a measuring cylinder to pour 25 cm^3 of aqueous ammonia into a conical flask.
- Stand the conical flask on a white tile.
- Slowly add solution **A** 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

- Empty the conical flask and rinse it with distilled water.
- Empty the burette and rinse it with distilled water.
- Rinse the burette with solution **B**.
- Repeat Experiment 1 using solution **B** instead of solution **A**.

(a) Use the burette diagrams in Fig. 2.1 and Fig. 2.2 to complete Table 2.1.

Experiment 1

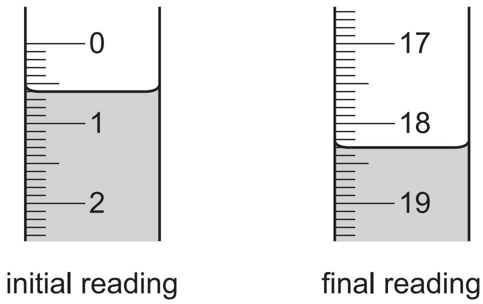

Fig. 2.1

Experiment 2

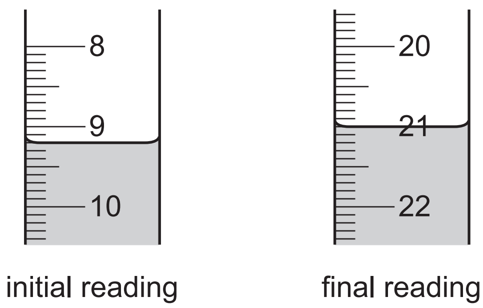

Fig. 2.2

Table 2.1

	Experiment 1 using solution **A**	Experiment 2 using solution **B**
final burette reading / cm^3		
initial burette reading / cm^3		
volume of aqueous copper(II) sulfate added / cm^3		

[4]

(b) Explain why a white tile is used during the titration.

....

.... [1]

(c) In Experiment 2, the burette and the conical flask are both rinsed with water. The burette is then rinsed with solution **B**.

(i) State why both the burette and the conical flask are rinsed with water.

.... [1]

(ii) Explain why the burette is then rinsed with solution **B**.

....

.... [1]

(iii) Describe how the result of Experiment 2 would be different if the conical flask is rinsed with aqueous ammonia after rinsing with water.
Explain your answer.

....

.... [2]

(d) **(i)** Deduce which solution of copper(II) sulfate, **A** or **B**, is more concentrated.
Explain your answer.

....

.... [1]

(ii) Deduce how many times more concentrated this solution of copper(II) sulfate is than the other solution of copper(II) sulfate.

.... [1]

(e) Describe how the reliability of the results obtained can be checked.

....

.... [1]

(f) Deduce the volume of solution **A** required when Experiment 1 is carried out with 10 cm^3 of aqueous ammonia.

.... [2]

(g) In Experiments 1 and 2, the volume of aqueous ammonia is measured using a measuring cylinder.

Give an advantage and a disadvantage of using a volumetric pipette instead of a measuring cylinder to measure the volume of aqueous ammonia.

advantage ....

disadvantage ....
[2]

[Total: 16]

Question 3 starts on the next page.

3 A student tests two solids: solid **E** and solid **F**.

Tests on solid E

Table 3.1 shows the tests and the student's observations.

Table 3.1

tests	observations
test 1 Gently heat half of solid **E** in a boiling tube.	a solution forms, steam is given off and condensation forms at the top of the tube
test 2 Dissolve the remaining solid **E** in water to form solution **E**. Divide solution **E** into three portions. To the first portion of solution **E**, add aqueous sodium hydroxide dropwise and then in excess.	a brown precipitate forms which remains when excess is added
test 3 Warm the product of **test 2** and test any gas produced.	the gas turns red litmus paper blue
test 4 To the second portion of solution **E**, add 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	no change
test 5 To the third portion of solution **E**, add 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.	white precipitate

(a) State what conclusion can be made about solid **E** from the observations in **test 1**.

.... [1]

(b) Identify the gas produced in **test 3**.

.... [1]

(c) State what conclusion can be made about solid **E** from the observations in **test 4**.

.... [1]

(d) Identify the **three** ions in solid **E**.

....

.... [3]

Tests on solid F

Solid **F** is zinc sulfite.

Complete the expected observations.

The student dissolves solid **F** in water to form solution **F**.

The student divides solution **F** into three portions.

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

observations adding dropwise ....

observations in excess ....
[2]

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

observations ....

.... [1]

(g) To the third portion of solution **F**, the student adds 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations ....

.... [1]

[Total: 10]

4 Solid cobalt(II) oxide is a base which is insoluble in water. It reacts very slowly with cold dilute sulfuric acid to form a solution of cobalt(II) sulfate.

Describe how to make pure, dry crystals of hydrated cobalt(II) sulfate.

You are provided with cobalt(II) oxide, dilute sulfuric acid and common laboratory apparatus.

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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
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

Cambridge IGCSE™

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

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

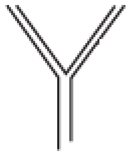
GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	(conical) flask	**1**
1(b)	(the sugars) dissolve fast(er)	**1**
1(c)	**M1** filtration	**1**
	M2 minimum is a diagram to show a filter funnel lined with filter paper: 	**1**
1(d)	fermentation occurs between 25 °C and 35 °C / enzymes denatured (at high temperatures)	**1**
1(e)	turns (from colourless to) milky	**1**
1(f)	(there are) no more bubbles (in limewater)	**1**
1(g)	(fractional) distillation	**1**

Question	Answer	Marks
2(a)	**M1** final and initial burette reading for experiment 1 correct (18.3 and 0.6)	**1**
	M2 final and initial burette reading for experiment 2 correct (21.0 and 9.2)	**1**
	M3 both titres correct 17.7 and 11.8)	**1**
	M4 all volumes recorded consistently to 1 dp or better	**1**
2(b)	to make solid easier to see / so colour (change) easier to see	**1**
2(c)(i)	to clean / remove solution A	**1**
2(c)(ii)	to remove water	**1**
2(c)(iii)	**M1** more solution B needed	**1**
	M2 as more (than 25 cm^3 of) aqueous ammonia in flask	**1**
2(d)(i)	solution B **and** as a smaller volume was needed / smaller titre	**1**
2(d)(ii)	1.5, ecf from results	**1**
2(e)	repeat experiment **and** compare	**1**
2(f)	**M1** 7.1 or calculated value of titre in experiment 1 ÷ 2.5	**1**
	M2 cm^3	**1**
2(g)	advantage: (more) accurate	**1**
	disadvantage: slower / takes longer	**1**

Question	Answer	Marks
3(a)	hydrated / contains water	**1**
3(b)	ammonia / NH_3	**1**
3(c)	solid **C** does not contain chloride, bromide or iodide ions	**1**
3(d)	**M1** ammonium / NH_4^+	**1**
	M2 iron(III) / Fe^{3+}	**1**
	M3 sulfate / SO_4^{2-}	**1**
3(e)	**M1** white precipitate	**1**
	M2 dissolves / forms a colourless solution	**1**
3(f)	(pink/purple / lilac solution) becomes colourless / decolourised	**1**
3(g)	no change / remains colourless	**1**

Question	Answer	Marks
4	**any 6 from** **MP1** adds cobalt(II) oxide to (dilute) sulfuric acid in a suitable container	**6**
	MP2 cobalt(II) oxide is in excess	
	MP3 the mixture is stirred / mixed	
	MP4 the acid / mixture is heated/warmed	
	MP5 filter (to remove (excess) cobalt(II) oxide)	
	MP6 heat filtrate / solution / leave to evaporate (reject heat to dryness)	
	MP7 filter out crystals / **description** of drying crystals	

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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

9534637521

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2023**

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.

1 Some symbol equations and word equations, **A** to **J**, are shown.

A $H^+ + OH^- \rightarrow H_2O$

B $Cr^{3+} + 3OH^- \rightarrow Cr(OH)_3$

C methane + chlorine → chloromethane + hydrogen chloride

D propene + bromine → 1,2-dibromopropane

E $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$

F chlorine + aqueous potassium bromide → bromine + aqueous potassium chloride

G methane + oxygen → carbon monoxide + water

H $C_2H_5COOH + CH_3OH \rightarrow C_2H_5COOCH_3 + H_2O$

I hydrogen + oxygen → water

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

Use the equations to answer the questions that follow.
Each equation may be used once, more than once, or not at all.

Give the letter, **A** to **J**, for the equation which represents:

(a) photosynthesis .... [1]

(b) an addition reaction .... [1]

(c) a precipitation reaction .... [1]

(d) incomplete combustion .... [1]

(e) a displacement reaction .... [1]

(f) a substitution reaction. .... [1]

[Total: 6]

Question 2 starts on the next page.

2 **(a)** The symbols of the elements in Period 3 of the Periodic Table are shown.

Na Mg A*l* Si P S C*l* Ar

Use the symbols of the elements in Period 3 to answer the questions that follow.
Each symbol may be used once, more than once, or not at all.

Give the symbol of the element that:

(i) is present in purified bauxite .... [1]

(ii) contains atoms with a full outer shell of electrons .... [1]

(iii) is used to kill microbes in water treatment .... [1]

(iv) forms an amphoteric oxide .... [1]

(v) forms an oxide which causes acid rain .... [1]

(vi) has an oxidation number of –1 when it forms a compound with hydrogen.

.... [1]

(b) The relative atomic masses of elements can be calculated from the relative masses of isotopes and their percentage abundances.

(i) Identify the isotope to which all relative masses are compared.

.... [1]

(ii) Table 2.1 shows the relative masses and the percentage abundances of the two isotopes in a sample of magnesium.

Table 2.1

relative mass of isotope	percentage abundance of isotope
24	85
26	15

Calculate the relative atomic mass of magnesium to **one** decimal place.

relative atomic mass = ... [2]

(c) An ion contains 10 electrons, 13 protons and 14 neutrons.

(i) State the nucleon number of the ion.

.... [1]

(ii) Identify the element that forms this ion.

.... [1]

[Total: 11]

3 Magnesium forms ionic compounds.

(a) Magnesium reacts with fluorine to form the ionic compound magnesium fluoride.
The electronic configurations of an atom of magnesium and an atom of fluorine are shown in Fig. 3.1.

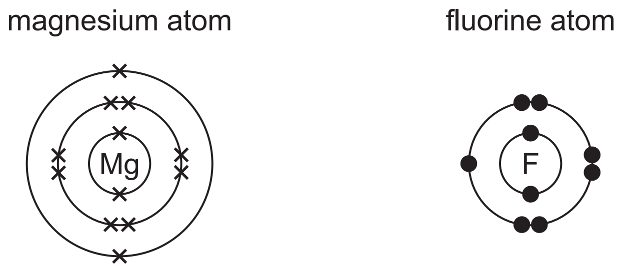

Fig. 3.1

(i) Ions are formed by the transfer of electrons from magnesium atoms to fluorine atoms.

Complete the dot-and-cross diagrams in Fig. 3.2 to show the electronic configurations of **one** magnesium ion and **one** fluoride ion. Show the charges on the ions.

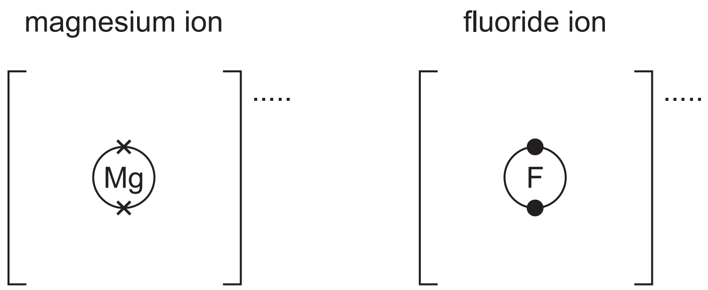

Fig. 3.2

[3]

(ii) Deduce the formula of magnesium fluoride.

.... [1]

(iii) When solid magnesium fluoride is dissolved in water it forms a solution that conducts electricity.

State one other change that can be made to solid magnesium fluoride to allow it to conduct electricity.

.... [1]

(b) Silicon tetrachloride, $SiCl_4$, and silicon(IV) oxide, SiO_2, are covalent compounds.

Complete the dot-and-cross diagram in Fig. 3.3 to show the electronic configuration in a molecule of silicon tetrachloride. Show outer shell electrons only.

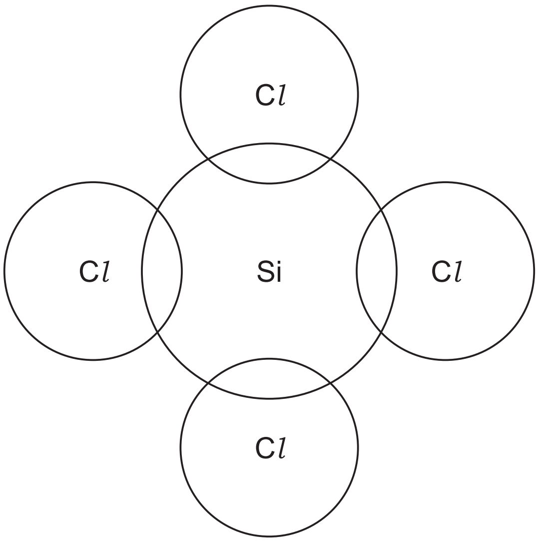

Fig. 3.3

[2]

(c) The melting points of silicon tetrachloride and silicon(IV) oxide are shown in Table 3.1.

Table 3.1

	melting point / °C
silicon tetrachloride	–69
silicon(IV) oxide	1710

(i) Silicon tetrachloride has a low melting point because it has weak forces of attraction between particles.

Name the type of particles that are held together by these weak forces of attraction.

.... [1]

(ii) Explain, in terms of structure and bonding, why silicon(IV) oxide has a high melting point.

....

....

....

.... [2]

[Total: 10]

4 Hydrogen is produced by the reaction between zinc and dilute sulfuric acid, H_2SO_4.

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

(a) A student carries out an experiment using excess zinc and dilute sulfuric acid.

The student measures the volume of hydrogen produced at regular time intervals using the apparatus shown in Fig. 4.1.

Lumps of zinc are used.

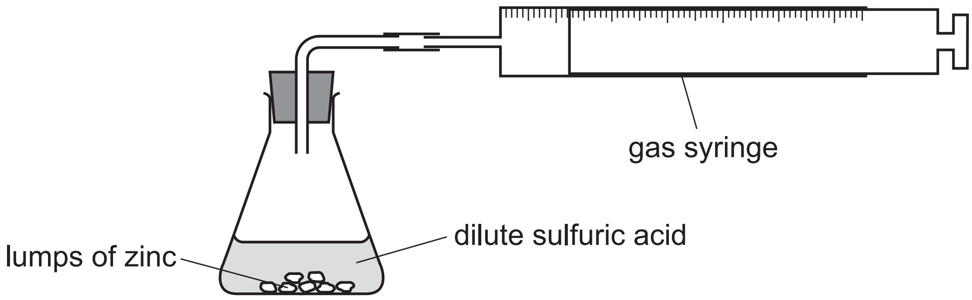

Fig. 4.1

The rate of reaction decreases as the reaction progresses. The rate eventually becomes zero.

(i) Explain why the rate of reaction decreases as the reaction progresses.

....

.... [1]

(ii) Explain why the rate of reaction eventually becomes zero.

....

.... [1]

(b) The experiment is repeated using powdered zinc instead of lumps of zinc.
All other conditions remain the same.

Explain, in terms of collision theory, why the rate of reaction increases if powdered zinc is used.

....

....

.... [2]

(c) The equation for the reaction is shown.

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

$25.0\,cm^3$ of $2.00\,mol/dm^3$ $H_2SO_4(aq)$ is added to excess zinc.

Calculate the volume of H_2 formed at room temperature and pressure (r.t.p.). The volume of one mole of any gas is $24\,dm^3$ at r.t.p.
Use the following steps.

- Calculate the number of moles of H_2SO_4 used.

.... mol

- Deduce the number of moles of H_2 produced.

.... mol

- Calculate the volume of H_2 formed at r.t.p.

.... dm^3
[3]

(d) Hydrogen can also be produced by the reaction of zinc with dilute hydrochloric acid.

(i) Write a symbol equation for this reaction.

.... [2]

(ii) State the test for hydrogen gas.

test ....

positive result ....
[1]

[Total: 10]

5 This question is about electricity and chemical reactions.

(a) Aqueous copper(II) sulfate is an electrolyte.
The electrolysis of aqueous copper(II) sulfate using inert electrodes forms:
- copper at the cathode
- oxygen at the anode.

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

....

.... [2]

(ii) State the term given to the Roman numeral, (II), in the name copper(II) sulfate.

.... [1]

(iii) State what happens to the colour of the aqueous copper(II) sulfate as this electrolysis progresses.

.... [1]

(iv) Write an ionic half-equation for the formation of copper at the cathode.

.... [2]

(v) Give the formula of the ion that forms oxygen at the anode.

.... [1]

(b) The electrolysis of aqueous copper(II) sulfate is repeated using **copper** electrodes.

State what happens to the anode.

.... [1]

(c) Spoons can be electroplated with silver.

(i) Name the substances used as:

the anode (positive electrode) ....

the cathode (negative electrode) ....

the electrolyte. ....
[3]

(ii) State **two** reasons why spoons are electroplated.

1 ....

2 ....
[2]

(d) Hydrogen–oxygen fuel cells can be used to produce electricity to power cars.
Petrol produces carbon dioxide and carbon monoxide when it powers cars.

(i) State **one** adverse effect of carbon dioxide and carbon monoxide.

carbon dioxide ....

carbon monoxide ....
[2]

(ii) State **one** disadvantage, other than cost, of using hydrogen–oxygen fuel cells to power cars compared to using petrol.

.... [1]

[Total: 16]

6 This question is about nitrogen and compounds of nitrogen.

(a) Ammonia is manufactured by the reaction between nitrogen and hydrogen in the Haber process.
The equation is shown.

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

(i) State the source of nitrogen for the Haber process.

.... [1]

(ii) State the source of hydrogen for the Haber process.

.... [1]

(iii) State the typical conditions used in the Haber process.

temperature .... °C

pressure .... atm

[2]

(iv) Name the catalyst used in the Haber process.

.... [1]

(v) State what is meant by the term catalyst.

....

.... [2]

(b) Ammonia is converted into nitric acid.

(i) The first stage is the conversion of ammonia into nitrogen monoxide, NO.
The equation is shown.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The reaction is carried out at a temperature of 900 °C and a pressure of 7 atm.
The forward reaction is exothermic.

Using explanations that do **not** involve cost:

- explain why a temperature less than 900 °C is **not** used

....

- explain why a pressure greater than 7 atm is **not** used.

....
[2]

(ii) In the second stage, nitrogen monoxide reacts with water and oxygen to produce nitric acid.

Balance the symbol equation for the reaction.

$$.....NO + ...O_2 + ...H_2O \rightarrow .....HNO_3$$ [1]

(c) A student makes aqueous copper(II) nitrate by adding an excess of solid copper(II) carbonate to dilute nitric acid.

(i) Write the symbol equation for this reaction.

.... [2]

(ii) State **two** observations that indicate the copper(II) carbonate is in excess.

1 ....

2 ....
[2]

(iii) Name **one** compound, other than copper(II) carbonate, that can be added to dilute nitric acid to produce aqueous copper(II) nitrate.

.... [1]

[Total: 15]

7 This question is about organic compounds.

(a) Propane and chlorine react at room temperature. An equation for the reaction is shown.

$$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$$

(i) State the condition required for this reaction.

.... [1]

(ii) Draw the displayed formulae of **two** structural isomers with the formula C_3H_7Cl.

[2]

(b) Alkenes are a homologous series of hydrocarbons.

(i) State **two** characteristics that all members of the same homologous series have in common.

1 ....

2 ....
[2]

(ii) Addition polymers are made from alkenes.

Complete Fig. 7.1 to show one repeat unit of the addition polymer formed from but-2-ene.

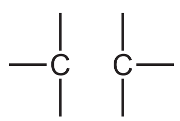

Fig. 7.1

[2]

(c) A repeat unit of a condensation polymer is shown in Fig. 7.2.
The polymer is made from two monomers.

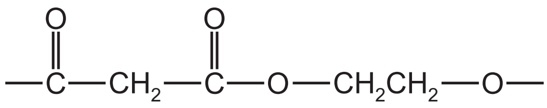

Fig. 7.2

(i) Draw the structures of the monomers used to produce the polymer in Fig. 7.2.

[2]

(ii) Name the **type** of condensation polymer in Fig. 7.2.

.... [1]

(iii) Name the **two** homologous series to which the monomers in **(i)** belong.

1 ....

2 ....
[2]

[Total: 12]

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.).

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2023**

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.

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Cambridge International is publishing the mark schemes for the May/June 2023 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

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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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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)	J	**1**
1(b)	D	**1**
1(c)	B	**1**
1(d)	G	**1**
1(e)	F	**1**
1(f)	C	**1**

Question	Answer	Marks
2(a)(i)	A*l*	**1**
2(a)(ii)	Ar	**1**
2(a)(iii)	C*l*	**1**
2(a)(iv)	A*l*	**1**
2(a)(v)	S	**1**
2(a)(vi)	C*l*	**1**
2(b)(i)	^{12}C	**1**
2(b)(ii)	**M1** 24 × 85(%) + 26 × 15(%) **M2** 2430 / 100 = 24.3	**2**
2(c)(i)	27	**1**
2(c)(ii)	Aluminium / A*l*	**1**

Question	Answer	Marks
3(a)(i)	**M1** eight crosses in second shell of Mg **M2** 7 dots and 1 cross in second shell of F **M3** '2+' charge on Mg ion on correct answer line **and** '–' charge on F ion on correct answer line	**3**
3(a)(ii)	MgF_2	**1**
3(a)(iii)	melting	**1**
3(b)	**M1** 4 dot and cross single bonds **M2** 3 pairs of non-bonding e on each Cl and no non-bonding e on Si	**2**
3(c)(i)	molecule(s)	**1**
3(c)(ii)	**M1** covalent bonds **M2** strong bonds **and** giant (covalent) structure	**2**

Question	Answer	Marks
4(a)(i)	concentration (of sulfuric acid particles) decreases **OR** frequency of collisions between particles decreases	**1**
4(a)(ii)	all the (**sulfuric**) **acid** has reacted	**1**

Question	Answer	Marks
4(b)	**M1** greater surface area (of zinc) **M2** frequency of collisions between (zinc and acid) particles increases	**2**
4(c)	**M1** mol H_2SO_4 = 2.00 x 25.0/1000 = 0.05(00) **M2** mol H_2 = M1 = 0.05(00) **M3** vol H_2 = M2 × 24 = 1.2(0)	**3**
4(d)(i)	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ **M1** $ZnCl_2$ **M2** equation correct	**2**
4(d)(ii)	lighted splint **and** (squeaky) pop	**1**

Question	Answer	Marks
5(a)(i)	**M1** ionic compound **M2** molten and / or aqueous	**2**
5(a)(ii)	oxidation number (of copper)	**1**
5(a)(iii)	fades / (becomes) colourless	**1**
5(a)(iv)	$Cu^{2+} + 2e \rightarrow Cu$ **M1** Cu^{2+} and (any number of) e on left hand side **M2** equation correct	**2**
5(a)(v)	OH^-	**1**
5(b)	anode dissolves	**1**

Question	Answer	Marks
5(c)(i)	**M1** silver **M2** spoon **M3** (aqueous or solution) of silver nitrate	**3**
5(c)(ii)	**M1** prevent corrosion **M2** improve appearance	**2**
5(d)(i)	**M1** carbon dioxide: (increased) global warming **M2** carbon monoxide: toxic	**2**
5(d)(ii)	needs high pressure to store hydrogen	**1**

Question	Answer	Marks
6(a)(i)	air	**1**
6(a)(ii)	methane	**1**
6(a)(iii)	**M1** 450 (°C) **M2** 200 (atm)	**2**
6(a)(iv)	iron	**1**
6(a)(v)	**M1** (a substance which) increases the rate of a reaction **M2** remains unchanged at the end of the reaction	**2**

Question	Answer	Marks
6(b)(i)	**temperature change:** **M1** low(er) rate (of reaction) **pressure change:** **M2** (position of) equilibrium shifts to the left hand side/ towards reactants	**2**
6(b)(ii)	**4**NO + **3**O_2 + **2**H_2O →.**4**HNO_3	**1**
6(c)(i)	$CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$ **M1** $Cu(NO_3)_2$ **M2** correct equation	**2**
6(c)(ii)	**M1** undissolved solid **M2** effervescence stops on addition of more copper(II) carbonate	**2**
6(d)(iii)	copper(II) oxide **or** copper(II) hydroxide	**1**

Question	Answer	Marks
7(a)(i)	ultraviolet (light)	**1**
7(a)(ii)	**M1** displayed formula of 1–chloropropane **M2** displayed formula of 2–chloropropane	**2**
7(b)(i)	any 2 from: (same) general formula (same / similar) chemical properties or reactions (contain the same) functional group	**2**

Question	Answer	Marks
7(b)(ii)	**M1** single bond between the two C atoms (and nothing on continuation bonds) **M2** 1 CH_3 group and 1 H on first carbon and 1 CH_3 group and 1 H on second carbon and whole structure correct	**2**
7(c)(i)	**M1** structural formula of propan-1,3-dioic acid **M2** structural formula of ethan-1,2-diol	**2**
7(c)(ii)	polyester	**1**
7(c)(iii)	**M1** carboxylic acids **M2** alcohols	**2**

Cambridge Assessment International Education

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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

7052172409

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2023**

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.

1 A list of oxides, **A** to **H**, is shown.

A calcium oxide

B aluminium oxide

C silicon(IV) oxide

D sulfur dioxide

E carbon dioxide

F iron(III) oxide

G silver oxide

H carbon monoxide

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

State which of the oxides, **A** to **H**:

(a) is responsible for acid rain

.... [1]

(b) has a giant covalent structure

.... [1]

(c) is a reducing agent in the blast furnace

.... [1]

(d) is the main constituent of bauxite

.... [1]

(e) is the main impurity in iron ore

.... [1]

(f) can be reduced by heating with copper.

.... [1]

[Total: 6]

2 Fluorine, chlorine and bromine are in Group VII of the Periodic Table.

(a) State the name given to Group VII elements.

.... [1]

(b) Explain why Group VII elements have similar chemical properties.

.... [1]

(c) Complete Table 2.1 to show the colour and state at r.t.p. of some Group VII elements.

Table 2.1

element	colour	state at r.t.p.
fluorine	pale yellow	
chlorine		
bromine		liquid

[3]

(d) Bromine has two naturally occurring isotopes, ^{79}Br and ^{81}Br.

(i) State the term given to the numbers 79 and 81 in these isotopes of bromine.

.... [1]

(ii) Complete Table 2.2 to show the number of protons, neutrons and electrons in the atom and ion of bromine shown.

Table 2.2

	^{79}Br	$^{81}Br^-$
protons		
neutrons		
electrons		

[3]

(iii) Table 2.3 shows the relative abundances of the two naturally occurring isotopes of bromine.

Table 2.3

isotope	^{79}Br	^{81}Br
relative abundance	55%	45%

Calculate the relative atomic mass of bromine to **one** decimal place.

relative atomic mass = ... [2]

(e) Chlorine displaces bromine from aqueous potassium bromide but does **not** displace fluorine from aqueous sodium fluoride.

(i) Write the symbol equation for the reaction between chlorine and aqueous potassium bromide.

.... [2]

(ii) State why chlorine does **not** displace fluorine from aqueous sodium fluoride.

.... [1]

(f) Aqueous silver nitrate is a colourless solution containing $Ag^{+}(aq)$ ions.

(i) Describe what is seen when aqueous silver nitrate is added to aqueous sodium chloride.

.... [1]

(ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium chloride.

Include state symbols.

.... [3]

[Total: 18]

3 Over 200 million tonnes of sulfuric acid are manufactured every year.

(a) State the name of the process used to manufacture sulfuric acid.

.... [1]

(b) Part of the manufacture of sulfuric acid involves converting sulfur dioxide to sulfur trioxide.

(i) Describe **two** methods by which sulfur dioxide is obtained.

1 ....

2 ....
[2]

The conversion of sulfur dioxide to sulfur trioxide is a reversible reaction which can reach equilibrium.

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

(ii) State **two** features of an equilibrium.

1 ....

2 ....
[2]

(iii) State the typical conditions and name the catalyst used in the conversion of sulfur dioxide to sulfur trioxide.

temperature .... °C

pressure .... kPa

catalyst ....

[3]

(iv) Complete Table 3.1 to show the effect, if any, when the following changes are applied to the conversion of sulfur dioxide to sulfur trioxide.

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

The forward reaction is exothermic.

Only use the words **increases**, **decreases** or **no change**.

Table 3.1

change	effect on the rate of the forward reaction	effect on the concentration of SO_3(g) at equilibrium
temperature decreases	decreases	
pressure increases		
no catalyst	decreases	

[4]

(v) Explain in terms of collision theory why reducing the temperature decreases the rate of the forward reaction.

....

....

....

....

.... [3]

(c) Sulfuric acid contains SO_4^{2-} ions.

The oxidation number of O atoms in SO_4^{2-} ions is –2.

Determine the oxidation number of S atoms in SO_4^{2-} ions. Show your working.

oxidation number = ... [2]

[Total: 17]

4 Solid sodium hydroxide is a base which dissolves to form an aqueous solution, NaOH(aq).

(a) State what is meant by the term base.

.... [1]

(b) State the term given to a base which dissolves to form an aqueous solution.

.... [1]

(c) State the colour of thymolphthalein in NaOH(aq).

.... [1]

(d) Complete the word equation for the reaction of NaOH(aq) with ammonium chloride.

sodium hydroxide + ammonium chloride → .... + ... + ...

[3]

(e) Some metal oxides react with NaOH(aq).

(i) State the term given to metal oxides which react with bases such as NaOH(aq).

.... [1]

(ii) Name a metal oxide which reacts with NaOH(aq).

.... [1]

(f) Ethanoic acid, CH_3COOH, is a weak acid.

(i) Complete the dot-and-cross diagram in Fig. 4.1 of a molecule of ethanoic acid.

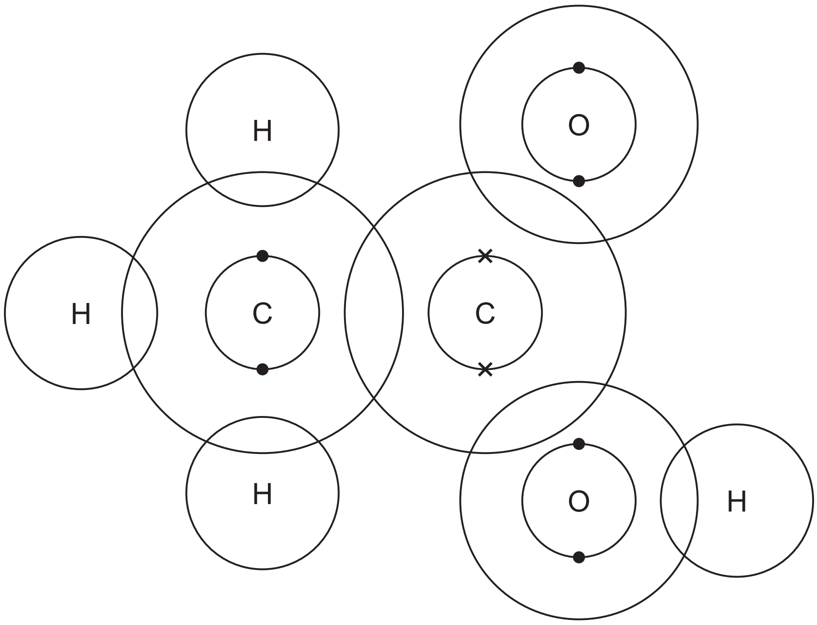

Fig. 4.1

[3]

(ii) Suggest the pH of dilute ethanoic acid.

.... [1]

(iii) Complete the symbol equation to show the dissociation of ethanoic acid.

CH_3COOH .... [3]

(iv) Write the ionic equation for the reaction when an acid neutralises a soluble base.

.... [1]

(g) In a titration, 25.0 cm^3 of 0.0800 mol / dm^3 aqueous potassium hydroxide, KOH(aq), is neutralised by 20.0 cm^3 of dilute sulfuric acid, H_2SO_4(aq).

$$2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of H_2SO_4, in g / dm^3 using the following steps.

- Calculate the number of moles of KOH used.

.... mol

- Determine the number of moles of H_2SO_4 which react with the KOH.

.... mol

- Calculate the concentration of H_2SO_4 in mol / dm^3.

.... mol / dm^3

- Calculate the concentration of H_2SO_4 in g / dm^3.

.... g / dm^3
[5]

[Total: 21]

5 Propane and propene both react with chlorine.

(a) When a molecule of propane, C_3H_8, reacts with chlorine in the presence of ultraviolet light, one atom of hydrogen is replaced by one atom of chlorine.

(i) State the term given to reactions in which one atom in an alkane is replaced by another atom.

.... [1]

(ii) State the purpose of ultraviolet light in this reaction.

.... [1]

(iii) State the term given to any reaction which requires ultraviolet light.

.... [1]

(iv) Write the symbol equation for the reaction between propane and chlorine.

.... [2]

(b) A molecule of propene, C_3H_6, is unsaturated and will react with chlorine at room temperature.

(i) State why propene is an unsaturated molecule.

.... [1]

(ii) Give the structural formula of the product of this reaction.

.... [1]

(c) Propene undergoes addition reactions with steam.
There are two possible products, **A** and **B**.

Draw the displayed formula and name each product.

displayed formula of product **A**

name of product **A** ....

displayed formula of product **B**

name of product **B** ....

[4]

[Total: 11]

6 Carboxylic acids can be converted to esters.

(a) Name the ester formed when butanoic acid, $CH_3CH_2CH_2COOH$, reacts with ethanol, CH_3CH_2OH.

.... [1]

(b) Identify the other product formed in this reaction.

.... [1]

(c) Deduce the empirical formula of the ester formed.

.... [1]

(d) PET is a polyester. Part of the structure of PET is shown in Fig. 6.1.

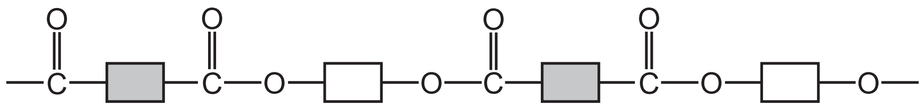

Fig. 6.1

(i) Circle **one** repeat unit of this polymer. [1]

(ii) Draw the structures of the monomers which make up PET. Draw the functional groups using displayed formulae.

[2]

(iii) State the type of polymerisation used in making PET.

.... [1]

[Total: 7]

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
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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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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2023**

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5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 <u>Calculation specific guidance</u>

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

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

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

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

7 <u>Guidance for chemical equations</u>

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

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

Check the page above **Q1(a)** and assuming no relevant work is there, place 'SEEN' on the page
For equations, allow multiples (including fractions); ignore state symbols except **Q2(f)(ii)**

Question	Answer	Marks
1(a)	D	**1**
1(b)	C	**1**
1(c)	H	**1**
1(d)	B	**1**
1(e)	C	**1**
1(f)	G	**1**

Question	Answer	Marks
2(a)	halogen(s)	**1**
2(b)	same number of outer shell electrons	**1**
2(c)	<table><tr><td></td><td>gas</td></tr><tr><td>M1 pale yellow-green</td><td>gas</td></tr><tr><td>M2 red-brown</td><td></td></tr></table> M3 both gases	**3**
2(d)(i)	nucleon number / mass number	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(d)(ii)</td><td>

	^{79}Br	$^{81}Br^-$
protons	35	35
neutrons	44	46
electrons	35	36

Each row ✓</td><td>3</td></tr>
<tr><td>2(d)(iii)</td><td>M1 79 × 55(%) + 81 × 45(%)
M2 7990 / 100 = 79.9</td><td>2</td></tr>
<tr><td>2(e)(i)</td><td>$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$
M1 KCl as product
M2 correct equation</td><td>2</td></tr>
<tr><td>2(e)(ii)</td><td>chlorine less reactive than fluorine</td><td>1</td></tr>
<tr><td>2(f)(i)</td><td>white precipitate</td><td>1</td></tr>
<tr><td>2(f)(ii)</td><td>$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
M1 AgCl as only product
M2 Ag^+ + Cl^- as only reactants (in 1 : 1 ratio)
M3 state symbols</td><td>3</td></tr>
</table>

Question	Answer	Marks
3(a)	contact (process)	**1**
3(b(i)	M1 burning sulfur (in air) M2 Roasting sulfide ores (in air)	**2**
3(b)(ii)	M1 the rate of forward reaction equals (the rate of the) reverse reaction M2 concentrations of reactants and products are constant	**2**
3(b)(iii)	450 (^{o}C) 200 (kPa) vanadium(V) oxide	**3**
3(b)(iv)	<table><tr><td></td><td>increases</td></tr><tr><td>increases</td><td>increase</td></tr><tr><td></td><td>no change</td></tr></table>	**4**
3(b)(v)	M1 kinetic energy of particles decreases M2 frequency of collisions between particles decreases M3 lower percentage / proportion / fraction of collisions / particles have energy greater than / qual to activation energy **OR** fewer **of the** collisions / particles have energy greater than / equal to activation energy	**3**
3(c)	M1 4×-2 or -8 M2 $S + (4 \times -2) = -2 \therefore S = +6$	**2**

Question	Answer	Marks
4(a)	proton acceptor	**1**
4(b)	alkali	**1**
4(c)	blue	**1**
4(d)	M1 sodium chloride M2 water M3 ammonia	**3**
4(e)(i)	amphoteric (oxides)	**1**
4(e)(ii)	aluminium oxide **or** zinc oxide	**1**
4(f)(i)	M1 all single bonding dot and cross pairs correct M2 double C = O bond dot and cross pairs are correct M3 complete diagram is correct	**3**
4(f)(ii)	$3 \leq pH < 7$	**1**
4(f)(iii)i	$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ M1 H^+ M2 CH_3COO^- M3 use of $\rightleftharpoons$	**3**
4(f)(iv)	$H^+ + OH^- \rightarrow H_2O$	**1**

Question	Answer	Marks
4(g)	M1 mol KOH = $0.0800 \times 25 / 1000$ $= 0.002(00)$ / $2(00) \times 10^{-3}$ M2 mol H_2SO_4 = M1 / 2 = 0.002 / 2 $= 0.001(00)$ / $1(00 \times 10^{-3}$ M3 = M2 $\times$ 1000 / 20 = 0.001 $\times$ 1000 / 20 $= 0.05(00)$ / $5.(00) \times 10^{-2}$ M4 = 98 M5 = 98 $\times$ M3 = 98 $\times$ 0.05(00) = 4.9(0) (g / dm^3)	**5**

Question	Answer	Marks
5(a)(i)	substitution	**1**
5(a)(ii)	provide activation energy	**1**
5(a)(iii)	photochemical	**1**
5(a)(iv)	$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$ M1 HCl M2 equation correct	**2**
5(b)(i)	it has a carbon-carbon bond which is not a single bond	**1**
5(b)(ii)	$CH_3CHClCH_2Cl$	**1**

Question	Answer	Marks
5(c)	M1 displayed formula of propan-1-ol M2 displayed formula of propan-2-ol M3 propan-1-ol (as either name) M4 propan-2-ol (under displayed formula of propan-2-ol)	**4**

Question	Answer	Marks
6(a)	ethyl butanoate	**1**
6(b)	water	**1**
6(c)	C_3H_6O	**1**
6(d)(i)	1 repeat unit circled	**1**
6(d)(ii)	M1 displayed diol on correct box (unshaded) M2 displayed dioic acid on correct box (shaded)	**2**
6(d)(iii)	condensation	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

3062140036

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2023**

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.

IB23 06_0620_41/3RP

1 Some symbol equations and word equations, **A** to **J**, are shown.

A $Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$

B $H^+ + OH^- \rightarrow H_2O$

C ethane + chlorine → chloroethane + hydrogen chloride

D $C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$

E ethene + steam → ethanol

F chlorine + aqueous potassium iodide → iodine + aqueous potassium chloride

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

H ethanoic acid + ethanol → ethyl ethanoate + water

I calcium carbonate → calcium oxide + carbon dioxide

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

Use the equations to answer the questions that follow.
Each equation may be used once, more than once, or not at all.

Give the letter, **A** to **J**, for the equation that represents:

(a) a neutralisation reaction .... [1]

(b) a precipitation reaction .... [1]

(c) the formation of an ester .... [1]

(d) photosynthesis .... [1]

(e) fermentation .... [1]

(f) cracking. .... [1]

[Total: 6]

2 **(a)** The symbols of the elements in Period 2 of the Periodic Table are shown.

Li **Be** **B** **C** **N** **O** **F** **Ne**

Use the symbols of the elements in Period 2 to answer the questions that follow.
Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(i) makes up approximately 78% of clean, dry air .... [1]

(ii) contains atoms with only three electrons in the outer shell .... [1]

(iii) contains atoms with only nine protons .... [1]

(iv) exists as graphite .... [1]

(v) is an alkali metal .... [1]

(vi) **only** has an oxidation number of zero. .... [1]

(b) Boron, B, has two isotopes.

(i) State the meaning of the term isotopes.

....

.... [2]

(ii) Table 2.1 shows the relative masses and the percentage abundances of the two isotopes of boron.

Table 2.1

relative mass of isotope	percentage abundance of isotope
10	20
11	80

Calculate the relative atomic mass of boron to **one** decimal place.

relative atomic mass = ... [2]

[Total: 10]

3 This question is about ionic and covalent compounds.

(a) (i) Sodium reacts with oxygen to form the ionic compound sodium oxide.
The electronic configurations of an atom of sodium and an atom of oxygen are shown in Fig. 3.1.

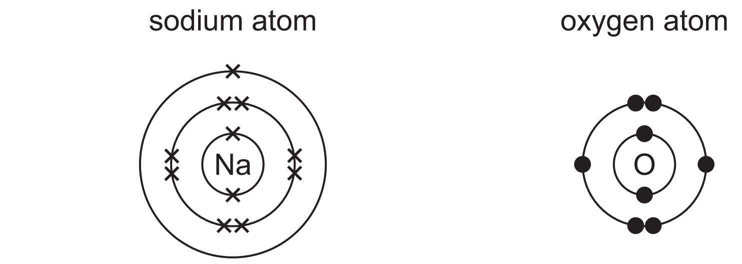

Fig. 3.1

Ions are formed by the transfer of electrons from sodium atoms to oxygen atoms.

Complete the dot-and-cross diagrams in Fig. 3.2 to show the electronic configuration of **one** sodium ion and **one** oxide ion. Show the charges on the ions.

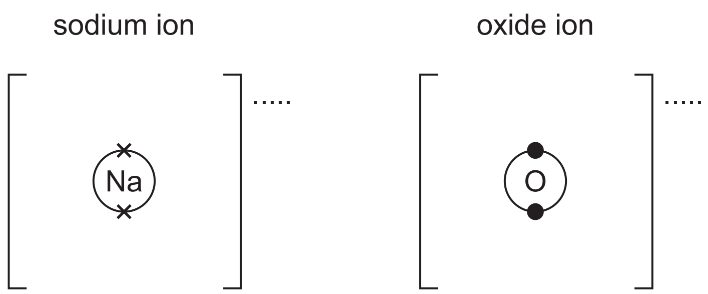

Fig. 3.2

[3]

(ii) Write the formula of sodium oxide.

.... [1]

(b) Carbon dioxide, CO_2, is a covalent compound.

Complete the dot-and-cross diagram in Fig. 3.3 to show the electronic configuration in a molecule of carbon dioxide. Show outer shell electrons only.

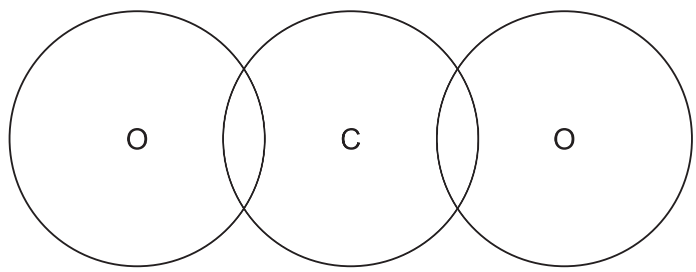

Fig. 3.3

[2]

(c) The melting points of sodium oxide and carbon dioxide are shown in Table 3.1.

Table 3.1

	melting point / °C
sodium oxide	1275
carbon dioxide	–78

(i) Explain, in terms of bonding, why sodium oxide has a high melting point.

....

....

....

.... [2]

(ii) Carbon dioxide has a low melting point.

State the general term for the weak forces that cause carbon dioxide to have a low melting point.

.... [1]

[Total: 9]

4 Oxygen is produced by the decomposition of aqueous hydrogen peroxide. Manganese(IV) oxide, MnO_2, is a catalyst for this reaction.

(a) State the meaning of the term catalyst.

....

.... [2]

(b) A student adds powdered manganese(IV) oxide to aqueous hydrogen peroxide in a conical flask as shown in Fig. 4.1. The mass of the conical flask and its contents is measured at regular time intervals. The mass decreases as time increases.

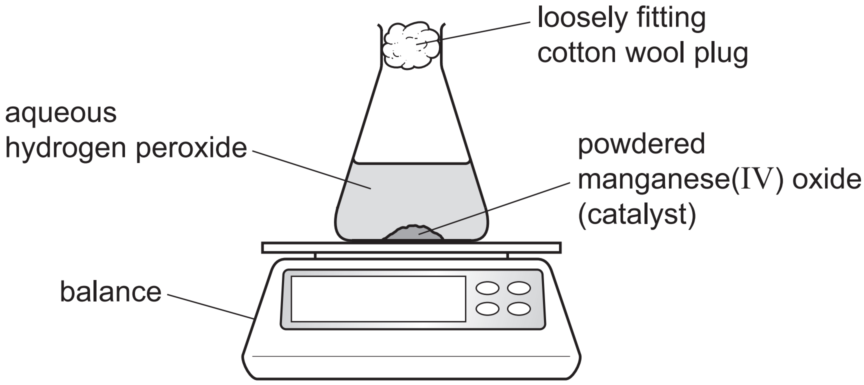

Fig. 4.1

(i) State why the mass of the conical flask and its contents decreases as time increases.

.... [1]

(ii) The rate of reaction is highest at the start of the reaction. The rate decreases and eventually becomes zero.

Explain why the rate of reaction is highest at the start of the reaction.

....

.... [1]

(iii) Explain why the rate of reaction eventually becomes zero.

....

.... [1]

(c) The experiment is repeated at an increased temperature.
All other conditions stay the same.

Explain in terms of collision theory why the rate of reaction is higher at an increased temperature.

....

....

....

.... [3]

(d) The equation for the decomposition of aqueous hydrogen peroxide, $H_2O_2(aq)$, is shown.

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

$50.0\,cm^3$ of a $0.200\,mol/dm^3$ solution of $H_2O_2(aq)$ is used.

Calculate the mass of O_2 that forms.
Use the following steps.

- Calculate the number of moles of H_2O_2 used.

.... mol

- Determine the number of moles of O_2 produced.

.... mol

- Calculate the mass of O_2 produced.

.... g
[3]

(e) State the effect on the mass of oxygen produced if the mass of powdered manganese(IV) oxide catalyst is increased.

.... [1]

(f) Oxygen can also be produced by the decomposition of mercury(II) oxide, HgO.
The only products of this decomposition are mercury and oxygen.

Write a symbol equation for this decomposition.

.... [2]

[Total: 14]

5 This question is about electricity and chemical reactions.

(a) The electrolysis of concentrated aqueous potassium bromide using graphite electrodes forms:

- hydrogen at the cathode
- bromine at the anode.

The electrolyte becomes aqueous potassium hydroxide.

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

....

.... [2]

(ii) State why graphite is suitable for use as an electrode.

.... [1]

(iii) Write an ionic half-equation for the formation of hydrogen at the cathode.

.... [2]

(iv) Name the type of particle responsible for the transfer of charge in the conducting wires.

.... [1]

(v) Name the type of particle responsible for the transfer of charge in aqueous potassium bromide.

.... [1]

(vi) State the names of the products formed when electricity is passed through **dilute** aqueous potassium bromide using graphite electrodes.

at the anode ....

at the cathode ....
[2]

(b) Bauxite is an ore containing aluminium.
Aluminium is extracted by electrolysis of purified bauxite in molten cryolite using carbon electrodes.

(i) Name the aluminium compound in purified bauxite.

.... [1]

(ii) State **two** reasons why cryolite is used in this electrolysis.

1 ....

2 ....
[2]

(iii) The anode is made from carbon.

Explain why the carbon anode has to be replaced regularly.

....

.... [1]

(c) Hydrogen–oxygen fuel cells can be used to produce electricity in vehicles.

(i) Write the symbol equation for the overall reaction in a hydrogen–oxygen fuel cell.

.... [2]

(ii) State **one** advantage of using hydrogen–oxygen fuel cells instead of petrol in vehicle engines.

.... [1]

[Total: 16]

6 This question is about sulfur and compounds of sulfur.

Sulfur is converted into sulfuric acid, H_2SO_4, by the Contact process.

The process involves four stages.

stage 1 Molten sulfur is converted into sulfur dioxide.

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

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

stage 4 Oleum reacts to form concentrated sulfuric acid.

(a) **(i)** In **stage 1**, iron pyrites, FeS_2, can be used instead of molten sulfur.
The iron pyrites is heated strongly in air.

Balance the equation for the reaction occurring when iron pyrites reacts with oxygen in the air.

$$.....FeS_2 + ...O_2 \rightarrow .....Fe_2O_3 + ...SO_2$$ [1]

(ii) Name Fe_2O_3. Include the oxidation number of iron.

.... [1]

(b) The equation for **stage 2** is shown.

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

The forward reaction is exothermic.
The reaction is carried out at a temperature of 450 °C and a pressure of 2 atm.

Using explanations that do **not** involve cost:

(i) explain why a temperature greater than 450 °C is **not** used

....

.... [1]

(ii) explain why a pressure lower than 2 atm is **not** used.

....

.... [1]

(c) When sulfuric acid reacts with ammonia the salt produced is ammonium sulfate.

Write the symbol equation for this reaction.

.... [2]

(d) Lead(II) sulfate is an insoluble salt.

Lead(II) sulfate can be made from aqueous ammonium sulfate using a precipitation reaction.

(i) Name a solution that can be added to aqueous ammonium sulfate to produce a precipitate of lead(II) sulfate.

.... [1]

(ii) Write an ionic equation for this precipitation reaction. Include state symbols.

.... [3]

(iii) The precipitate of lead(II) sulfate forms in an aqueous solution.

Describe how pure lead(II) sulfate can be obtained from the mixture.

....

....

.... [3]

[Total: 13]

7 This question is about organic compounds.

(a) Butane reacts with chlorine in a photochemical reaction.

$$C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$$

(i) State the meaning of the term photochemical.

.... [1]

(ii) An organic compound with the formula C_4H_9Cl is formed when one molecule of butane reacts with one molecule of chlorine.

Draw the displayed formulae of **two** possible structural isomers with the formula C_4H_9Cl formed in this reaction.

[2]

(b) The structure of compound **A** is shown in Fig. 7.1.

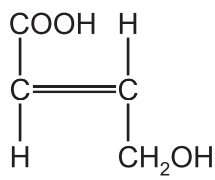

Fig. 7.1

(i) Deduce the molecular formula of compound **A**.

.... [1]

(ii) There are three functional groups in compound **A**.

Name the homologous series of compounds that contain the following functional groups:

–C=C– ....

–OH ....

–COOH. ....
[3]

(iii) State what is observed when compound **A** is added to:

aqueous bromine ....

aqueous sodium carbonate. ....
[2]

(iv) Compound **A** can be used as a single monomer to produce two different polymers.

Draw **one** repeat unit of the addition polymer formed from compound **A**.

[2]

(v) Compound **A** can be converted into a dicarboxylic acid.

Name the type of condensation polymer formed from a dicarboxylic acid and a diol.

.... [1]

[Total: 12]

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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 **0620/41**

Paper 4 Theory (Extended) **May/June 2023**

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **12** printed pages.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
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).
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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)	B	**1**
1(b)	A	**1**
1(c)	H	**1**
1(d)	J	**1**
1(e)	G	**1**
1(f)	D	**1**

Question	Answer	Marks
2(a)(i)	N	**1**
2(a)(ii)	B	**1**
2(a)(iii)	F	**1**
2(a)(iv)	C	**1**
2(a)(v)	Li	**1**
2(a)(vi)	Ne	**1**
2(b)(i)	**M1** different **atoms** of the same element with the **same** number of **protons**(1) **M2 different** numbers of **neutrons**(1)	**2**

Question	Answer	Marks
2(b)(ii)	**M1** 10 × 20 + 11 ×80 (= 1080)(1) **M2** (1080 ÷ 100 =) 10.8(1)	**2**

Question	Answer	Marks
3(a)(i)	**M1** Na with 2,8 **all crosses**(1) **M2** O with 2,8 outer shell **with 6 dots and 2 crosses**(1) **M3** + **AND** 2–(1)	**3**
3(a)(ii)	Na_2O	**1**
3(b)	**M1** both bonds with 2 dots and 2 crosses(1) **M2** 2 lone pairs (all dots or all crosses) on both oxygen atoms completing all 3 octets(1)	**2**
3(c)(i)	**M1** positive ions and negative ions (1) **M2** strong attraction / strong bonds (1)	**2**
3(c)(ii)	intermolecular forces	**1**

Question	Answer	Marks
4(a)	**M1** increases the rate of reaction / speeds up a reaction(1) **M2** unchanged at the end of the reaction(1)	**2**
4(b)(i)	oxygen escapes from the flask or apparatus	**1**
4(b)(ii)	**concentration** of hydrogen peroxide is highest at the start / **particles** of hydrogen peroxide are closest together at the start **OR** **collision** frequency is highest at the start	**1**
4(b)(iii)	the **hydrogen peroxide** is used up / **ALL** the **hydrogen peroxide** has reacted or decomposed	**1**
4(c)	**M1** kinetic energy of particles increases(1) **M2** frequency of collisions between particles increases(1) **M3 more or** higher percentage **or** higher proportion **or** higher fraction of **particles** have energy greater than / equal to activation energy **OR** **more of the** collisions **or** higher percentage **or** higher fraction of **collisions** have energy greater than or equal to activation energy(1)	**3**
4(d)	**M1** (50.0 × 0.200 ÷ 1000 =) 0.01(1) **M2** 0.005(1) **M3** 0.16(0)(1)	**3**
4(e)	no effect	**1**

Question	Answer	Marks
4(f)	$2HgO \rightarrow 2Hg + O_2$ **M1** all formulae correct(1) **M2** equation correct(1)	**2**
5(a)(i)	**M1 breakdown** by (the passage of) **electricity**(1) **M2** of an **ionic compound** in **molten or aqueous** (state) (1)	**2**

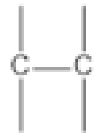
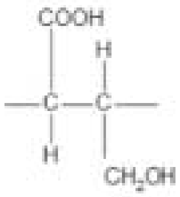
Question	Answer	Marks
5(a)(ii)	graphite is inert **AND** graphite conducts electricity	**1**
5(a)(iii)	$2H^+ + 2e^- \rightarrow H_2$ **M1** H^+ **+** e as only species on LHS(1) **M2** equation correct(1)	**2**
5(a)(iv)	electrons	**1**
5(a)(v)	ions	**1**
5(a)(vi)	**M1** oxygen(1) **M2** hydrogen(1)	**2**
5(b)(i)	aluminium oxide	**1**
5(b)(ii)	any **two** from: • solvent • lowers the operating temperature • increases conductivity	**2**
5(b)(iii)	carbon reacts with oxygen and forms carbon dioxide	**1**

Question	Answer	Marks
5(c)(i)	$2H_2 + O_2 \rightarrow 2H_2O$ **M1** all formulae(1) **M2** equation correct(1)	**2**
5(c)(ii)	no carbon dioxide evolved **OR** more efficient	**1**

Question	Answer	Marks
6(a)(i)	$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$	**1**
6(a)(ii)	iron(III) oxide	**1**
6(b)(i)	yield of SO_3 is less	**1**
6(b)(ii)	yield of SO_3 is less **OR** rate is less	**1**
6(c)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ **M1** $(NH_4)_2SO_4$ on the right (1) **M2** equation correct(1)	**2**
6(d)(i)	lead(II) nitrate	**1**

Question	Answer	Marks
6(d)(ii)	$Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$ **M1** $PbSO_4$ on the right(1) **M2 only** Pb^{2+} and SO_4^{2-} on the left(1) **M3**(aq) + (aq) → (s)(1)	**3**
6(d)(iii)	**M1** filter(1) **M2** wash (the residue or lead sulfate) with distilled or deionised **water**(1) **M3 description** of drying(1)	**3**

Question	Answer	Marks
7(a)(i)	needs or uses ultra violet light	**1**
7(a)(ii)	**M1** displayed formula of 1-chlorobutane(1) **M2** displayed formula of 2-chlorobutane(1)	**2**
7(b)(i)	$C_4H_6O_3$	**1**
7(b)(ii)	**M1** alkene(1) **M2** alcohol(1) **M3** carboxylic acid(1)	**3**
7(b)(iii)	**M1** turns colourless(1) **M2** bubbles / fizzing / effervescence(1)	**2**

Question	Answer	Marks
7(b)(iv)	**M1** only two carbon atoms joined by a single bond and two additional bonds on each(1)  **M2**  (1)	**2**
7(b)(v)	polyester	**1**

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2023**

45 minutes

You must answer on the multiple choice answer sheet.

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

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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 Nitrogen is heated in a balloon, which expands slightly.

Which statements about the molecules of nitrogen are correct?

1 They move further apart.

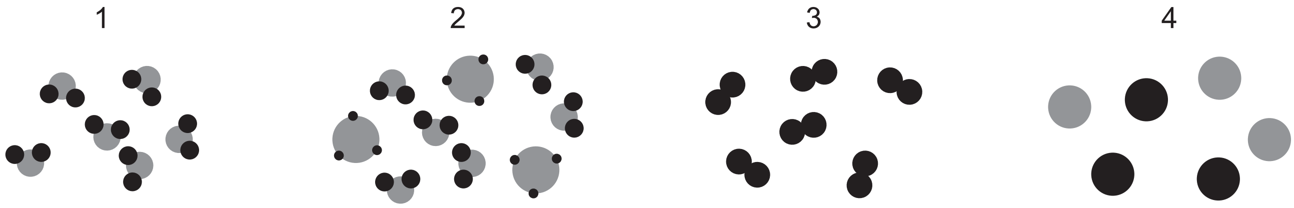
2 They move more quickly.

3 They remain the same distance apart.

4 Their speed remains unchanged.

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

2 The diagrams represent some elements, compounds and mixtures.



Which row describes the numbered substances?

	1	2	3	4
A	element	mixture of compounds	compound	mixture of elements
B	compound	mixture of compounds	element	mixture of elements
C	element	mixture of elements	compound	mixture of compounds
D	compound	mixture of elements	element	mixture of compounds

3 Two atoms, X and Y, have the same mass number but different atomic numbers.

Which statement about X and Y is correct?

A They have the same number of protons.

B They have the same number of electrons.

C They are in the same group of the Periodic Table.

D They have different numbers of neutrons.

4 A sample of pure iron contains three isotopes only.

percentage abundance of isotope / %	isotope
2	^{n}Fe
6	^{54}Fe
92	^{56}Fe

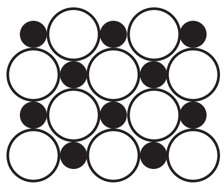
The iron in the sample has a relative atomic mass of 55.9.

What is the value of *n*?

A 53 **B** 55 **C** 57 **D** 58

5 Magnesium oxide is a white solid at room temperature and pressure.

Part of the structure of solid magnesium oxide is shown.



key

● = Mg^{2+} magnesium ion

○ = O^{2-} oxide ion

Three statements are listed.

1 Magnesium ions are smaller than oxide ions because they contain fewer electrons.

2 Magnesium oxide has good electrical conductivity when molten because the ions are mobile.

3 Magnesium oxide has a high melting point because of the strong electrostatic attraction between the ions and delocalised electrons in the giant lattice.

Which statements are correct?

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

6 In which molecule are all the outer-shell electrons involved in covalent bonding?

A Cl_2 **B** CH_4 **C** HCl **D** NH_3

7 Which row describes the properties of silicon(IV) oxide?

	giant covalent structure	melting point
A	no	high
B	no	low
C	yes	high
D	yes	low

8 Which row describes the structure of a solid metal and explains the property?

	structure of solid metal	property of solid metal
A	lattice of negative ions in a sea of electrons	conducts electricity because the electrons are free to move
B	lattice of negative ions in a sea of electrons	is malleable because the layers of ions can slide over each other
C	lattice of positive ions in a sea of electrons	conducts electricity because the ions are free to move
D	lattice of positive ions in a sea of electrons	is malleable because the layers of ions can slide over each other

9 What is the formula of potassium oxide?

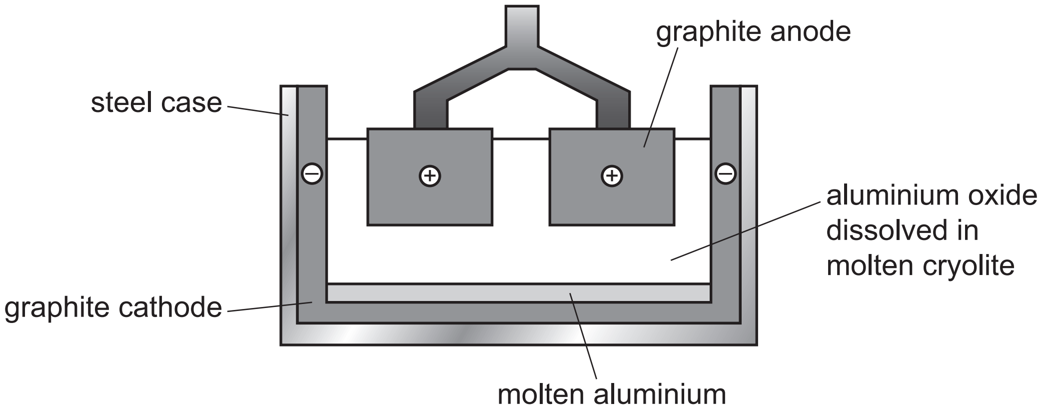
A P_2O **B** PO_2 **C** KO **D** K_2O

10 A dilute aqueous solution of sodium bromide is electrolysed using inert electrodes.

Which row identifies the product at the cathode and at the anode?

	cathode	anode
A	bromine	hydrogen
B	hydrogen	bromine
C	hydrogen	oxygen
D	oxygen	hydrogen

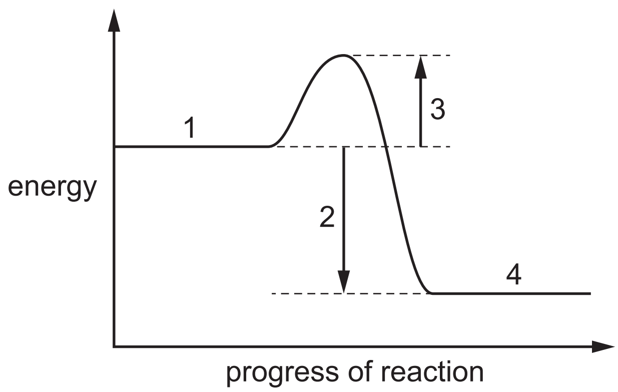
11 Aluminium is extracted by electrolysis, as shown.



Which row shows the ionic half-equations at the cathode and the anode?

	cathode	anode
A	$Al^{3+} \rightarrow Al + 3e^-$	$2O^{2-} \rightarrow O_2 + 4e^-$
B	$Al^{3+} \rightarrow Al + 3e^-$	$2O^{2-} + 4e^- \rightarrow O_2$
C	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} \rightarrow O_2 + 4e^-$
D	$Al^{3+} + 3e^- \rightarrow Al$	$2O^{2-} + 4e^- \rightarrow O_2$

12 The reaction pathway diagram for an exothermic reaction is shown.



Which row identifies labels 1, 2, 3 and 4?

	1	2	3	4
A	reactants	ΔH	E_a	products
B	products	ΔH	E_a	reactants
C	reactants	E_a	ΔH	products
D	products	E_a	ΔH	reactants

13 The equation for the complete combustion of ethene is shown.

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$

Some bond energies are listed.

bond	bond energy in kJ / mol
C–H	412
C–C	348
C=C	612
C–O	360
C=O	743
O–O	146
O=O	496
O–H	463

What is the overall energy change when one mole of ethene is completely burned?

A –456 **B** –1076 **C** –1340 **D** –2126

14 Magnesium reacts with hydrochloric acid to form magnesium chloride and hydrogen.

Why does magnesium powder react faster than magnesium ribbon?

A The magnesium atoms in the powder have a lower activation energy.

B The powder has a smaller surface area.

C The magnesium atoms in the powder have more frequent collisions with acid particles.

D The magnesium atoms in the powder have greater kinetic energy.

15 Which row shows the conditions used in the Contact process?

	catalyst	pressure / atm	temperature / °C
A	iron	2	100
B	iron	200	450
C	vanadium(V) oxide	2	450
D	vanadium(V) oxide	200	100

16 A student heats hydrated copper(II) sulfate. The blue crystals change to a white powder.

How can the student reverse this reaction?

A Add anhydrous copper(II) sulfate to the white powder.

B Add water to the white powder.

C Cool the white powder.

D Reheat the white powder.

17 Which reaction of hydrochloric acid is a redox reaction?

A $MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$

B $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

C $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

D $Mg + 2HCl \rightarrow MgCl_2 + H_2$

18 Which oxide is amphoteric?

A Al_2O_3 **B** CaO **C** Na_2O **D** SO_2

19 Four statements about strong acids are listed.

1 They react with carbonates to form carbon dioxide.

2 They completely dissociate in aqueous solution.

3 They react with ammonium salts to form ammonia.

4 They are proton acceptors.

Which statements are correct?

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

20 Which reaction mixture will produce a precipitate?

A aqueous Na_2CO_3 and aqueous $CuSO_4$

B dilute H_2SO_4 and aqueous NaOH

C dilute HNO_3 and solid MgO

D solid CuO and dilute H_2SO_4

21 Which set of elements shows the change from metallic to non-metallic character across a period of the Periodic Table?

A beryllium → magnesium → calcium

B fluorine → bromine → iodine

C oxygen → boron → lithium

D sodium → silicon → chlorine

22 A sample of ethanoic acid and a sample of hydrochloric acid have the same concentration.

How do the hydrogen ion concentration and pH of ethanoic acid compare to those of hydrochloric acid?

	ethanoic acid compared to hydrochloric acid	
	hydrogen ion concentration	pH
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

23 What is a typical property of transition elements?

A can act as catalysts

B poor electrical conductivity

C low melting point

D low density

24 Which statement about copper or aluminium is correct?

A Aluminium is more dense than copper.

B Aluminium is less reactive than copper.

C Copper has high ductility.

D Copper has poor electrical conductivity.

25 Water from a reservoir flows to the water works where purification process 1 takes place followed by process 2.

What are processes 1 and 2?

	process 1	process 2
A	chlorination	filtration
B	filtration	chlorination
C	fractional distillation	filtration
D	filtration	fractional distillation

26 Calcium reacts with cold water to produce hydrogen.

Lead reacts slowly when heated in air to form an oxide but has almost no reaction with steam.

Silver does not react with either air or water.

Zinc reacts when heated with steam to produce hydrogen.

What is the order of reactivity starting with the least reactive?

	least reactive	⟶		most reactive
A	calcium	lead	zinc	silver
B	calcium	zinc	lead	silver
C	silver	lead	zinc	calcium
D	silver	zinc	lead	calcium

27 Blocks of magnesium are attached to the bottom of a steel boat to prevent rusting.

Which equation describes a change that prevents the steel from rusting?

A $Fe \rightarrow Fe^{3+} + 3e^{-}$

B $Fe_2O_3 + 3Mg \rightarrow 2Fe + 3MgO$

C $3Mg^{2+} + 2Fe \rightarrow 2Fe^{3+} + 3Mg$

D $Mg \rightarrow Mg^{2+} + 2e^{-}$

28 Which statements about the extraction of iron in a blast furnace are correct?

1 The temperature inside the blast furnace is increased by burning carbon.

2 Iron(III) oxide is reduced to iron by carbon monoxide.

3 The thermal decomposition of calcium carbonate forms slag.

4 Slag reacts with acidic impurities.

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

29 Which statements about water are correct?

1 Tap water has fewer impurities than distilled water.

2 Tap water will turn anhydrous cobalt(II) chloride pink.

3 The domestic water supply is treated with carbon to kill microbes.

4 Phosphates from fertilisers can cause deoxygenation of water.

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

30 Oxides of nitrogen form in car engines and are removed by catalytic converters.

Which equation represents a reaction that occurs in a catalytic converter?

A $CO + NO_2 \rightarrow NO + CO_2$

B $2CO + 2NO \rightarrow N_2 + 2CO_2$

C $CO_2 + NO \rightarrow NO_2 + CO$

D $CO_2 + 2NO_2 \rightarrow N_2 + 3O_2 + C$

31 An alkene is represented by the formula $CH_3CH{=}CH_2$.

Which name is given to this type of formula?

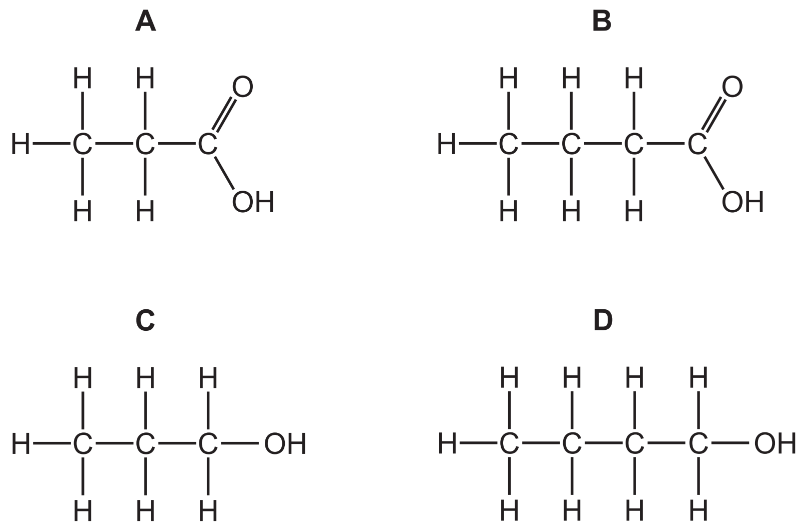
A displayed

B empirical

C general

D structural

32 What is the structure of propanoic acid?



33 Butane reacts with chlorine in the presence of ultraviolet radiation.

What is the equation for this reaction?

A $C_4H_{10} + Cl_2 \rightarrow C_4H_8Cl_2 + H_2$

B $C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$

C $C_4H_{10} + Cl_2 \rightarrow 2C_2H_5Cl + H_2$

D $C_4H_{10} + Cl_2 \rightarrow C_2H_4 + C_2H_5Cl + HCl$

34 A hydrocarbon P is cracked to make compound Q and hydrogen.

Compound R is formed by the addition polymerisation of compound Q.

To which homologous series do P, Q and R belong?

	alkene	alkane
A	P only	Q and R
B	Q only	P and R
C	P and Q	R only
D	P and R	Q only

35 Which substances are structural isomers?

A but-2-ene and propene

B ethyl ethanoate and butanoic acid

C methyl methanoate and ethanol

D propan-1-ol and butan-1-ol

36 Ethanol is produced by:

1 the catalytic addition of steam to ethene

2 fermentation.

Which statement is correct?

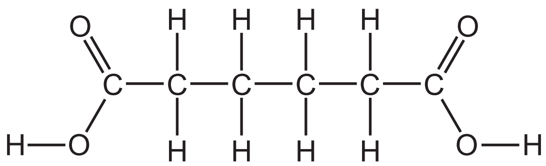
A Both processes use similar amounts of energy.

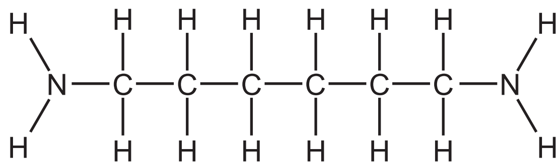
B Both processes use a catalyst.

C Process 1 uses a temperature of 25–35 °C.

D Process 2 uses a pressure of 60 atm.

37 The two monomers shown can be used to form a condensation polymer.





Which small molecule is released during this reaction?

A H_2O **B** NH_3 **C** CO_2 **D** $CONH_2$

38 Dilute hydrochloric acid is titrated into a conical flask containing sodium hydroxide solution and a few drops of methyl orange indicator.

Which piece of apparatus is used to add the hydrochloric acid?

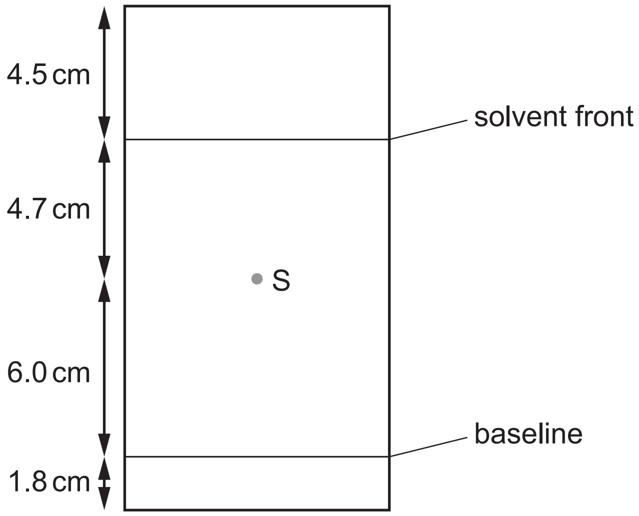
A beaker

B burette

C measuring cylinder

D pipette

39 The chromatogram obtained from a chromatography experiment on substance S is shown.



What is the R_f value of S?

A 0.39 **B** 0.46 **C** 0.56 **D** 0.62

40 Element X burns in air to form an acidic gas that decolourises potassium manganate(VII).

What is X?

A carbon

B nitrogen

C magnesium

D sulfur

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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.).

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 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.

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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

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

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

Cambridge Assessment International Education

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2023**

45 minutes

You must answer on the multiple choice answer sheet.

1398337971

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

INSTRUCTIONS

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

INFORMATION

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

This document has **16** pages.

1 Four physical changes of ethanol are listed.

1 condensation

2 evaporation

3 freezing

4 boiling

In which changes do the particles move further apart?

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

2 An atom of element X contains:

- 5 protons
- 6 neutrons
- 5 electrons.

Which statements about element X are correct?

1 X has an atomic number of 6.

2 X has a nucleon number of 11.

3 X is in Group II of the Periodic Table.

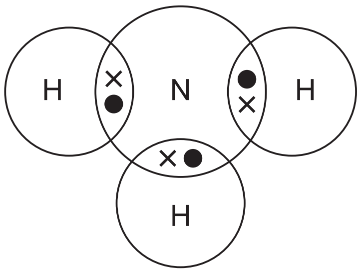
4 X is in the second period of the Periodic Table.

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

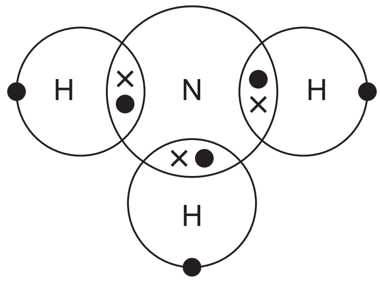
3 Ammonia, NH_3, is a covalent molecule.

Which diagram shows the outer-shell electron arrangement in a molecule of ammonia?

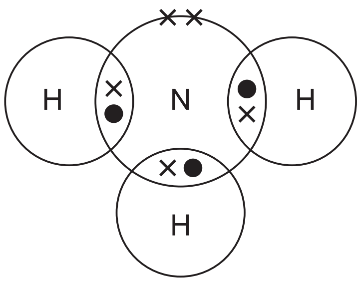
A



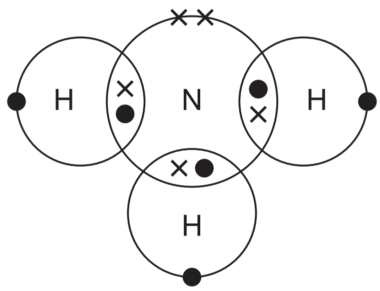
B



C



D



4 Which structure does silicon(IV) oxide most closely resemble?

A carbon dioxide

B diamond

C graphite

D sodium chloride

5 Substance P conducts electricity when solid.

Which particles move in solid P so that it can conduct electricity?

1 anions

2 cations

3 electrons

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

6 Which equation represents a chemical change?

A $BaCl_2(s) \rightarrow BaCl_2(l)$

B $Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$

C $KCl(s) + H_2O(l) \rightarrow K^+(aq) + Cl^-(aq)$

D $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(aq)$

7 Which sample contains the largest number of molecules?

A 16 g of methane, $CH_4(g)$

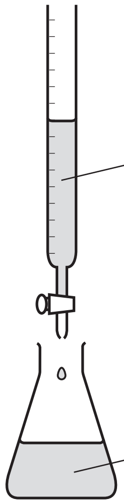
B 16 g of oxygen, $O_2(g)$

C 16 g of phosphorus, $P_4(s)$

D 16 dm^3 of methane at r.t.p., $CH_4(g)$

8 The concentration of a sample of dilute aqueous sodium hydroxide is found by titration.

The apparatus used is shown.



Which information is needed to calculate the concentration of the dilute aqueous sodium hydroxide in mol/dm^3?

	concentration of HC*l*	volume of HC*l* used	molar mass of HC*l*	volume of NaOH used	molar mass of NaOH
A	✓	✓	✓	✓	✓
B	✓	✓	✗	✓	✗
C	✗	✓	✓	✓	✗
D	✓	✗	✗	✗	✓

key

✓ = needed

✗ = not needed

9 In experiment 1, aqueous copper(II) sulfate is electrolysed using graphite electrodes.

In experiment 2, aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement identifies a half-equation for a reaction at one of the electrodes?

A In experiment 1, the half-equation for the anode reaction is $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$.

B In experiment 1, the half-equation for the cathode reaction is $2H^+ + 2e^- \rightarrow H_2$.

C In experiment 2, the half-equation for the anode reaction is $Cu^{2+} + 2e^- \rightarrow Cu$.

D In experiment 2, the half-equation for the cathode reaction is $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$.

10 Which substance is **not** produced during the electrolysis of concentrated aqueous sodium chloride?

A chlorine

B hydrogen

C sodium

D sodium hydroxide

11 Methane burns in excess oxygen.

The equation is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

Bond energies are shown.

bond	bond energy in kJ / mol
C=O	805
C–H	410
O=O	496
O–H	460

What is the energy change for the reaction?

A $(4 \times 410 + 2 \times 496) - (2 \times 805 + 4 \times 460)$

B $(2 \times 805 + 4 \times 460) - (4 \times 410 + 2 \times 496)$

C $(410 + 2 \times 496) - (805 + 2 \times 460)$

D $(410 + 496) - (805 + 460)$

12 Which change increases the rate of reaction by decreasing the activation energy, E_a?

A addition of a catalyst

B decrease in size of solid reactants

C increase in concentration of solutions

D increase in temperature

13 In the Contact process, sulfur dioxide is reacted with oxygen to form sulfur trioxide.

Which conditions are used in this reaction?

	temperature / °C	pressure / kPa	catalyst
A	300	200	iron
B	300	20 000	vanadium(V) oxide
C	450	200	vanadium(V) oxide
D	450	20 000	iron

14 Which reaction is reversible?

A an iron nail rusting when left in moist air

B limestone reacting with an acid to form carbon dioxide gas

C magnesium burning in air to produce a white ash

D white anhydrous copper(II) sulfate turning blue when water is added

15 The equation for the reaction of sulfur dioxide with acidified potassium dichromate(VI) is shown.

$$3SO_2 + Cr_2O_7^{2-} + 2H^+ \rightarrow 3SO_4^{2-} + 2Cr^{3+} + H_2O$$

What is oxidised and what is the oxidising agent?

	oxidised	oxidising agent
A	SO_2	$Cr_2O_7^{2-}$
B	SO_2	H^+
C	$Cr_2O_7^{2-}$	H^+
D	$Cr_2O_7^{2-}$	$Cr_2O_7^{2-}$

16 What is the definition of a strong acid?

A a proton acceptor that is completely dissociated in aqueous solution

B a proton acceptor that is partially dissociated in aqueous solution

C a proton donor that is completely dissociated in aqueous solution

D a proton donor that is partially dissociated in aqueous solution

17 Which statement about amphoteric oxides is correct?

A They are made by combining an acidic oxide with a basic oxide.

B They react with water to give a solution of pH 7.

C They react with both acids and bases.

D They do not react with acids or bases.

18 Copper(II) carbonate is formed when aqueous sodium carbonate is added to aqueous copper(II) nitrate.

The ionic equation for the reaction is shown.

$$CO_3^{2-}(aq) + Cu^{2+}(aq) \rightarrow CuCO_3(s)$$

How is pure copper(II) carbonate obtained from the reaction mixture?

A evaporate → filter → dry

B evaporate → wash → crystallise

C filter → evaporate → crystallise

D filter → wash → dry

19 Q and R are elements in the same period of the Periodic Table.

Q has 7 electrons in its outer shell and R has 2 electrons in its outer shell.

Which statement about Q and R is correct?

A Q is a metal and R is a non-metal.

B Q and R have different numbers of electron shells.

C R is found to the right of Q in the Periodic Table.

D The proton number of R is less than the proton number of Q.

20 Lead(II) sulfate is an insoluble salt.

Which reaction produces a mixture from which lead(II) sulfate is obtained by filtration?

A adding solid lead(II) carbonate to dilute sulfuric acid

B adding solid lead(II) hydroxide to dilute sulfuric acid

C adding metallic lead to dilute sulfuric acid

D adding aqueous lead(II) nitrate to dilute sulfuric acid

21 Which statement about alkali metals is correct?

A Lithium is more dense than sodium.

B Sodium is more reactive than potassium.

C Sodium has a higher melting point than potassium.

D They are in Group II of the Periodic Table.

22 Which row describes the properties of a transition element?

	melting point	density	forms coloured compounds
A	high	low	no
B	high	high	yes
C	low	low	no
D	low	low	yes

23 Which row identifies the properties of zinc?

	thermal conductivity	reacts with dilute acid
A	good	yes
B	good	no
C	poor	yes
D	poor	no

24 Uses of metals depend on their properties.

Which property is necessary for the use given?

	use of the metal	property of the metal
A	car bodies	ductile
B	cutlery	conducts heat
C	food containers	resists corrosion
D	overhead electrical cables	high density

25 Which compounds **both** contribute to acid rain?

- **A** carbon monoxide and carbon dioxide
- **B** carbon monoxide and oxides of nitrogen
- **C** oxides of nitrogen and sulfur dioxide
- **D** sulfur dioxide and carbon dioxide

26 P, Q, R and S are metals.

P reacts with dilute hydrochloric acid, forming hydrogen.

Q reacts violently with water.

R reacts with water to give hydrogen.

S is formed by heating its oxide with carbon.

Which row identifies the metals?

	P	Q	R	S
A	copper	sodium	potassium	iron
B	zinc	magnesium	calcium	iron
C	zinc	sodium	calcium	magnesium
D	iron	potassium	sodium	zinc

27 Which compound is formed when iron rusts?

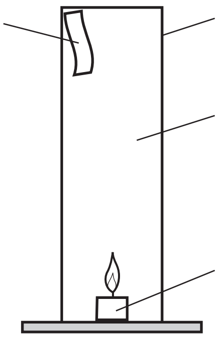
- **A** anhydrous iron(II) oxide
- **B** anhydrous iron(III) oxide
- **C** hydrated iron(III) hydroxide
- **D** hydrated iron(III) oxide

28 Why is cryolite used in the extraction of aluminium by electrolysis?

- **A** It dissolves the aluminium oxide.
- **B** It protects the anodes from corrosion.
- **C** It changes bauxite to aluminium oxide.
- **D** It decreases the melting point of the aluminium.

29 A wax candle is made from a mixture of hydrocarbons.

The candle is lit and placed in a gas jar along with a strip of cobalt(II) chloride test paper as shown.



After a short time, the oxygen in the jar is used up and the candle flame goes out.

Which substance does the cobalt(II) chloride paper identify?

A carbon dioxide

B carbon monoxide

C sulfur dioxide

D water

30 The hydrocarbon C_4H_8 has two structural isomers, but-1-ene and but-2-ene.

Which statement is correct?

A But-2-ene has the structural formula $CH_3CH{=}CHCH_3$ and the same general formula as butane.

B But-2-ene has the structural formula $CH_3CH{=}CHCH_3$ and the same empirical formula as ethene.

C But-1-ene has the structural formula $CH_3CH_2CH{=}CH_2$ and the same general formula as butane.

D But-1-ene has the structural formula $CH_3CHCH_2{=}CH$ and the same empirical formula as ethene.

31 Which compound rapidly decolourises aqueous bromine?

A propane

B propanoic acid

C propanol

D propene

32 What are the products of the addition reactions of ethene with bromine and hydrogen?

	bromine	hydrogen
A	CH_2BrCH_2Br	CH_3CH_3
B	CH_2BrCH_2Br	CH_2CH_2
C	CH_3CH_2Br	CH_3CH_3
D	CH_3CH_2Br	CH_2CH_2

33 Ethanol is manufactured by fermentation and the catalytic addition of steam to ethene.

Which row describes an advantage of both methods?

	from sugar by fermentation	from ethene and steam
A	ethanol needs to be purified	the process is continuous
B	it is a batch process	ethene comes from petroleum
C	the process is slow	the process is rapid
D	renewable resources are used	the ethanol produced is pure

34 Methanoic acid and propan-1-ol react to form an ester.

What is the structural formula of the ester?

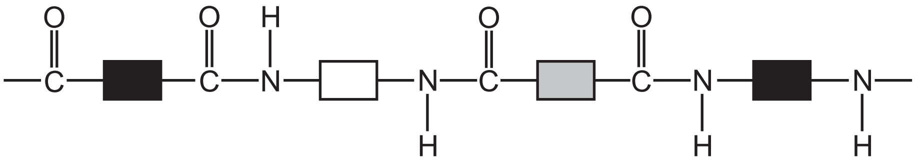
A $HCOOCH_2CH_2CH_3$

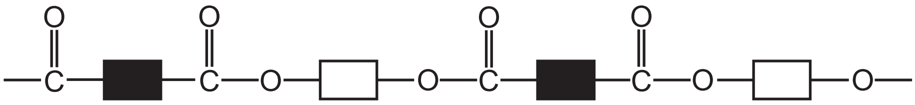
B $CH_3CH_2COOCH_3$

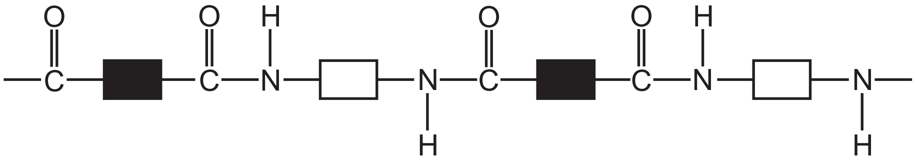
C $CH_3COOCH_2CH_3$

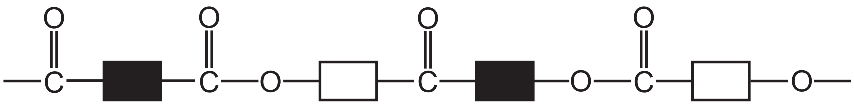
D $CH_3CH_2CH_2COOH$

35 What is the correct structure of PET?

A 

B 

C 

D 

36 Alkanes undergo substitution reactions in the presence of UV light.

Which equation represents a substitution reaction of ethane?

A $C_2H_6 + Cl_2 \rightarrow C_2H_4 + 2HCl$

B $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

C $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

D $C_2H_6 + HCl \rightarrow C_2H_5Cl + H_2$

37 Methane reacts with chlorine in substitution reactions.

How many different products, containing a single carbon atom, can be made during the reactions?

A 2 **B** 3 **C** 4 **D** 5

38 Rock salt is a mixture of salt and sand.

The method used to separate the sand from the salt is listed.

step 1 Crush the rock salt, add to warm water and stir.

step 2 Pour the mixture through a filter paper held in a funnel.

step 3 Evaporate the water to crystallise the salt.

Which statement about the method is correct?

A The filtrate in step 2 is pure water.

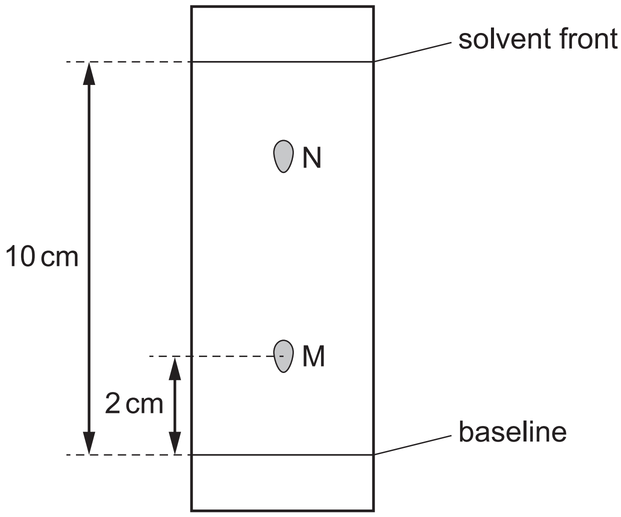
B The residue in step 2 is pure crystals of salt.

C The solute is salt.

D The solvent is a mixture of salt and water.

39 Two compounds, M and N, are dissolved in water and separated by chromatography.

The results are shown.



What is the R_f value of M and which compound is most soluble in water?

	R_f value of M	most soluble compound
A	0.2	M
B	0.2	N
C	5.0	M
D	5.0	N

40 When acid is added to salt X, a gas is produced which turns limewater milky.

When sodium hydroxide is added to salt X, a gas is produced which turns litmus paper blue.

What is X?

A $CaCO_3$ **B** $(NH_4)_2CO_3$ **C** NH_4NO_3 **D** $ZnCO_3$

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 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.).

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 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.

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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

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

Cambridge Assessment International Education

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2023**

45 minutes

You must answer on the multiple choice answer sheet.

6633968517

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

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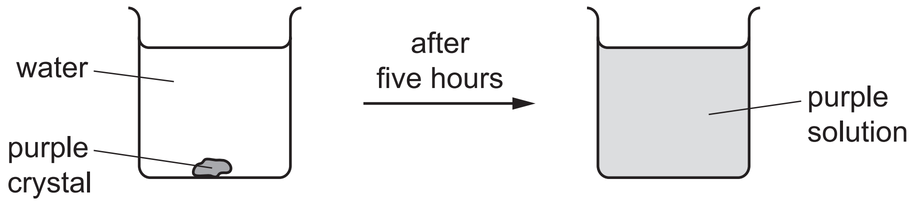
1 The diagram shows the result of dropping a purple crystal into water.



Which processes take place in this experiment?

	chemical reaction	diffusing	dissolving
A	✓	✓	✗
B	✓	✗	✗
C	✗	✗	✓
D	✗	✓	✓

2 Which row about elements, mixtures and compounds is correct?

	metallic element	non-metallic element	mixture	compound
A	copper	methane	brass	sulfur
B	brass	sulfur	copper	methane
C	copper	sulfur	brass	methane
D	brass	methane	copper	sulfur

3 The atomic structures of four particles, W, X, Y and Z, are shown.

	electrons	neutrons	protons
W	2	2	2
X	2	2	3
Y	2	3	2
Z	3	2	3

Which particles are isotopes of the same element?

A W and X **B** W and Y **C** X and Y **D** X and Z

4 Which statement explains why isotopes of the same element have the same chemical properties?

A They have the same number of outer shell electrons.

B They have the same number of neutrons.

C They have different numbers of protons.

D They have different mass numbers.

5 Nitrogen forms a nitride ion with the formula N^{3-}.

Which particle does **not** have the same electronic configuration as the nitride ion?

A Al^{3+} **B** Cl^{-} **C** Na^{+} **D** O^{2-}

6 Which row describes the formation of single covalent bonds in methane?

A	atoms share a pair of electrons	both atoms gain a noble gas electronic structure
B	atoms share a pair of electrons	both atoms have the same number of electrons in their outer shell
C	electrons are transferred from one atom to another	both atoms gain a noble gas electronic structure
D	electrons are transferred from one atom to another	both atoms have the same number of electrons in their outer shell

7 Which formula is an empirical formula?

A C_2H_4O

B $C_4H_8O_2$

C C_3H_7COOH

D $CH_3CH_2CH_2COOH$

8 Heating iron sulfide, FeS_2, in air produces sulfur dioxide.

$$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$

What is the maximum mass of sulfur dioxide produced from 120 kg of iron sulfide?

A 64 kg **B** 128 kg **C** 240 kg **D** 512 kg

9 Which substance produces hydrogen and bromine when electrolysed?

A concentrated aqueous copper(II) bromide

B concentrated aqueous sodium bromide

C dilute aqueous potassium bromide

D molten lead(II) bromide

10 Which statements about hydrogen fuel cells are correct?

1 Water is formed as the only waste product.

2 Both water and carbon dioxide are formed as waste products.

3 The overall reaction is $2H_2 + O_2 \rightarrow 2H_2O$.

4 The overall reaction is endothermic.

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

11 Ethene gas, C_2H_4, is completely burned in excess oxygen to form carbon dioxide and water.

The equation for this exothermic reaction is shown.

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

The table shows the bond energies involved in the reaction.

bond	bond energy in kJ / mol
C=C	614
C–H	413
O=O	495
C=O	799
O–H	467

What is the total energy change in this reaction?

A –954 kJ / mol

B –1010 kJ / mol

C –1313 kJ / mol

D –1369 kJ / mol

12 Which row describes the effect on the activation energy and the frequency of particle collisions when the temperature of a chemical reaction is increased?

	activation energy	frequency of collisions
A	increases	increases
B	no change	increases
C	increases	no change
D	no change	no change

13 Solid copper(II) sulfate exists in two different forms, anhydrous and hydrated.

One of these forms is blue and the other is white.

The change between these two forms is reversible.

$$\text{blue form} \rightleftharpoons \text{white form}$$

What is the blue form and how is the change from the blue form to the white form brought about?

	blue form	change to white form
A	anhydrous	add water
B	anhydrous	heat
C	hydrated	add water
D	hydrated	heat

14 Sodium ions, Na^+, and oxygen ions, O^{2-}, combine with chromium ions to form a salt.

The salt sodium dichromate has the formula $Na_2Cr_2O_7$.

What is the oxidation state of chromium in this salt?

A +2 **B** +3 **C** +6 **D** +12

15 The concentration of hydrogen ions in $100\,cm^3$ of $0.1\,mol/dm^3$ hydrochloric acid is higher than the concentration of hydrogen ions in $100\,cm^3$ of $0.1\,mol/dm^3$ ethanoic acid.

Which statement explains the difference in hydrogen ion concentration?

A Ethanoic acid is an organic acid.

B Ethanoic acid has a lower pH than hydrochloric acid.

C Ethanoic acid is partially dissociated.

D Ethanoic acid is a strong acid.

16 Which oxide is classified as an amphoteric oxide?

A aluminium oxide

B calcium oxide

C copper(II) oxide

D nitrogen oxide

17 Which method produces the salt copper(II) carbonate?

A Add copper(II) oxide to water, then add excess aqueous sodium carbonate. Filter off the precipitate.

B Add copper(II) oxide to dilute sulfuric acid, then add excess aqueous sodium carbonate. Filter off the precipitate.

C Add copper to dilute hydrochloric acid, then add aqueous sodium carbonate. Filter off the precipitate.

D Add copper(II) oxide to excess aqueous sodium carbonate. Filter off the precipitate.

18 Which statements about the trends across a period of the Periodic Table are correct?

1 Aluminium is more metallic than sodium.

2 Beryllium is more metallic than carbon.

3 Boron is more metallic than lithium.

4 Magnesium is more metallic than silicon.

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

19 Some information about elements in Group II of the Periodic Table is shown.

element	time taken to make 10 cm^3 of hydrogen gas when 1 g of metal is added to cold water	density in g/cm^3	melting point / °C
beryllium	no reaction	1.85	1280
magnesium	>300 seconds	1.74	650
calcium	60 seconds	1.54	850
strontium	30 seconds	2.62	768
barium	10 seconds	3.51	714

Which row shows the correct trends in reactivity, density and melting point of the elements going down Group II of the Periodic Table?

	reactivity	density	melting point
A	decreases down group	increases down group	decreases down group
B	decreases down group	decreases down group	no clear trend
C	increases down group	no clear trend	increases down group
D	increases down group	no clear trend	no clear trend

20 A new element oxfordium, Ox, was discovered with the following properties.

solubility	electrical conduction	formula of element	bonding in a molecule of Ox_2
insoluble in water	does not conduct	Ox_2	$Ox{\equiv}Ox$

In which group of the Periodic Table should the new element be placed?

A Group III

B Group V

C Group VII

D Group VIII

21 Which row describes a similarity and a difference between chlorine and bromine?

	similarity	difference
A	both are gases at room temperature and pressure	chlorine and bromine have different colours
B	both exist as diatomic molecules	chlorine is more dense than bromine
C	both have atoms with seven outer-shell electrons	only bromine will react with aqueous sodium chloride
D	both react with aqueous potassium iodide	chlorine is more reactive than bromine

22 Which statement describes transition elements?

A They have high densities and high melting points.

B They have high densities and low melting points.

C They have low densities and high melting points.

D They have low densities and low melting points.

23 Which gas is made when powdered zinc is added to dilute hydrochloric acid?

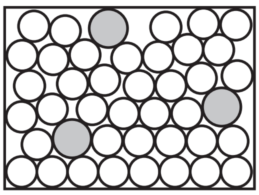
A carbon dioxide

B chlorine

C hydrogen

D oxygen

24 The diagram represents the structure of a solid.



Which solids does the diagram represent?

	brass	graphite	sodium chloride
A	✓	✓	✗
B	✓	✗	✗
C	✗	✓	✓
D	✗	✗	✓

25 Steel is an alloy of iron.

Which statement explains why steel is stronger than iron?

A Steel contains carbon which is a very hard substance.

B The carbon atoms in steel bond together very strongly.

C The carbon atoms in steel make the iron atoms bond together very strongly.

D The carbon atoms prevent layers of iron atoms from sliding over each other.

26 Three students, X, Y and Z, are told that solid P reacts with dilute acids and also conducts electricity.

The table shows the students' suggestions about the identity of P.

X	Y	Z
copper	iron	graphite

Which students are correct?

A X, Y and Z **B** X only **C** Y only **D** Z only

27 Which statement explains why aluminium appears to be unreactive?

A It is coated in an oxide layer.

B It has a low density.

C It is low in the reactivity series.

D It is solid at room temperature.

28 During the electrolysis of aluminium oxide, the mass of the carbon anode changes.

Which row describes the change and gives a reason for this change?

	mass change of the anode	reason
A	decreases	carbon reacts to form carbon dioxide
B	decreases	carbon dissolves in molten cryolite
C	increases	electrodes become coated with cryolite
D	increases	electrodes become coated with aluminium

29 Several processes are used to treat domestic water.

Which row identifies a reason for the given process?

	process	reason
A	chlorination	removes impurities
B	filtration	removes insoluble solids
C	sedimentation	removes soluble solids
D	use of carbon	kills bacteria

30 What is the equation for photosynthesis?

A $CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

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

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

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

31 Which statement describes how the C–H bonds in methane gas in the atmosphere contribute to global warming?

A They absorb thermal energy from the Sun and emit some of this energy into space.

B They absorb thermal energy from the Sun and emit all of this energy towards the Earth.

C They absorb thermal energy from the Earth and emit all of this energy towards the Earth.

D They absorb thermal energy from the Earth and emit some of this energy towards the Earth.

32 The structural formulae of two hydrocarbons are shown.

$CH_3CH_2CH_2CH_3$ $\qquad$ $CH_3CH(CH_3)CH_3$

Which statement about the hydrocarbons is correct?

A They are both alkenes.

B They decolourise aqueous bromine.

C They are structural isomers.

D They undergo addition reactions.

33 The structural formula of compound Q is given.

$$CH_3CH_2CH_2COOCH_2CH_2CH_3$$

What is compound Q?

A butyl butanoate

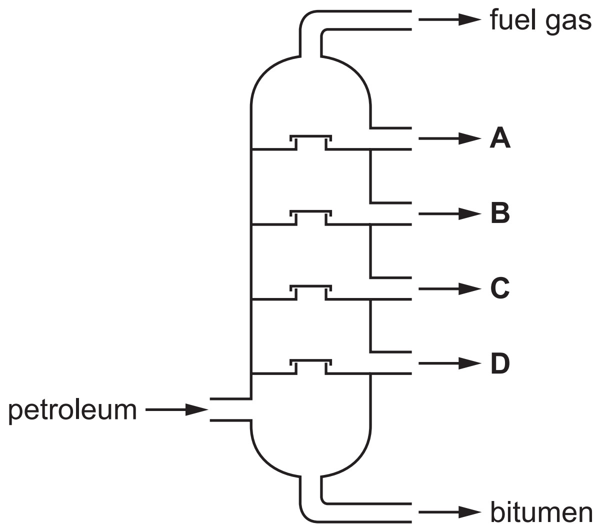
B butyl propanoate

C propyl butanoate

D propyl propanoate

34 The fractional distillation of petroleum is shown.

Which fraction contains hydrocarbons with the longest chain length?



35 Which equation represents the cracking of an alkane?

A $3C_2H_4 \rightarrow C_6H_{12}$

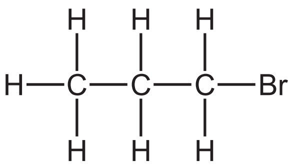
B $C_6H_{12} + H_2 \rightarrow C_6H_{14}$

C $C_6H_{14} \rightarrow 6C + 7H_2$

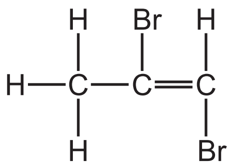
D $C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$

36 What is the structure of the product of the reaction of propene with bromine?

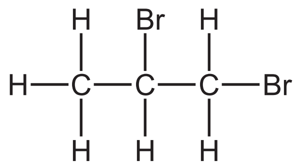
A



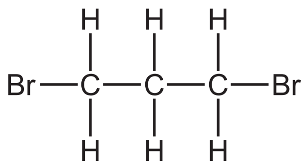
B



C



D



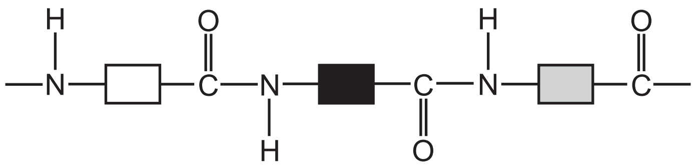
37 In reaction R, 2000 molecules of $CH_2{=}CH_2$ react to form a single molecule X only.

$$2000\ CH_2{=}CH_2 \rightarrow X$$

Which terms describe reaction R, $CH_2{=}CH_2$ and X?

	reaction R	$CH_2{=}CH_2$	X
A	addition	monomer	polymer
B	addition	polymer	monomer
C	substitution	monomer	polymer
D	substitution	polymer	monomer

38 Part of the structure of a polymer is shown.



Which statements about the polymer are correct?

1 The polymer is nylon.

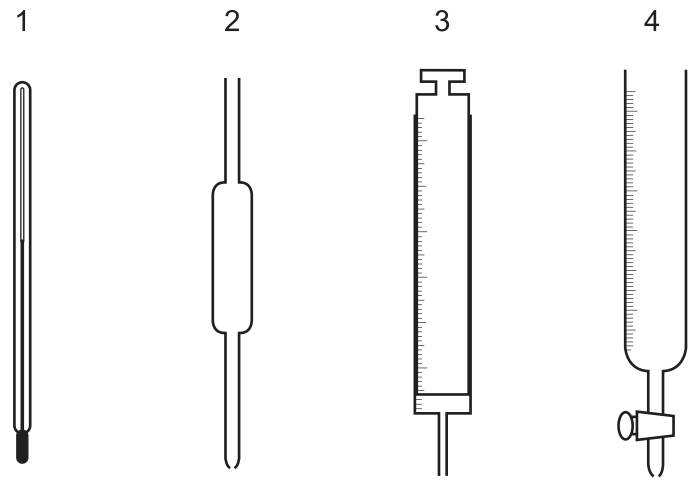
2 The polymer is formed by condensation polymerisation.

3 There are ester linkages between the monomers.

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

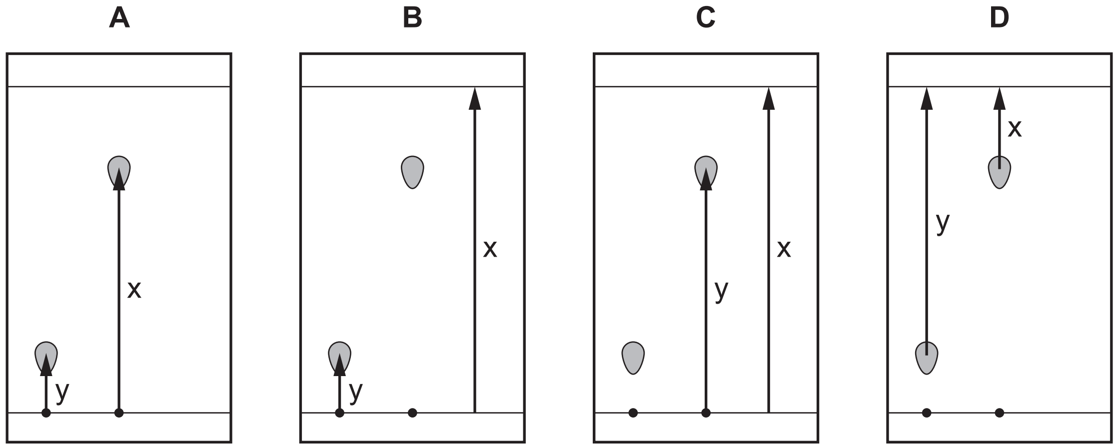
39 The concentration of acids and alkalis can be determined by titration.

Which pieces of equipment are needed to perform a titration?



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

40 Which chromatogram shows how the R_f value of a substance is calculated?



$R_f = \frac{y}{x}$ $R_f = \frac{y}{x}$ $R_f = \frac{x}{y}$ $R_f = \frac{x}{y}$

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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 Assessment International Education

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 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.

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 2023 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	C	**1**
3	B	**1**
4	A	**1**
5	B	**1**
6	A	**1**
7	A	**1**
8	B	**1**
9	B	**1**
10	A	**1**
11	C	**1**
12	B	**1**
13	D	**1**
14	C	**1**
15	C	**1**
16	A	**1**
17	B	**1**
18	C	**1**
19	D	**1**
20	B	**1**
21	D	**1**
22	A	**1**
23	C	**1**
24	B	**1**
25	D	**1**
26	C	**1**
27	A	**1**
28	A	**1**

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

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1780936797

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 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 03_0620_62/3RP

1 Long-chain alkanes can be broken down into shorter chain alkanes and gaseous alkenes. Vapour from a long-chain alkane is passed over a very hot catalyst and the gases formed are collected over water. The apparatus used is shown in Fig. 1.1.

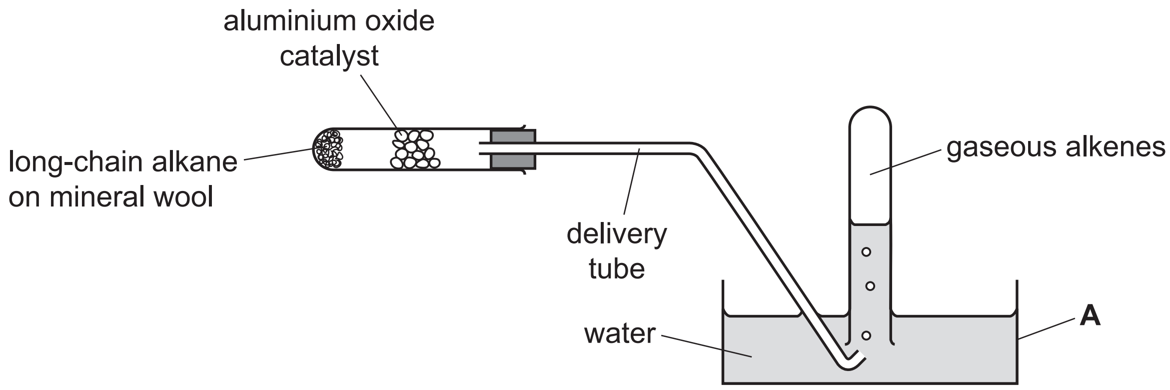

Fig. 1.1

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

.... [1]

(b) The catalyst is small pieces of aluminium oxide.

Explain why several small pieces of aluminium oxide speed up the reaction more than one large piece of aluminium oxide.

....

.... [1]

(c) **(i)** Name the item of apparatus that can be used to heat the long-chain alkane and catalyst.

.... [1]

(ii) Add **two** arrows to Fig. 1.1 to show where the apparatus should be heated. [1]

(d) The gas collected is tested using aqueous bromine. Alkenes turn aqueous bromine from orange to colourless.
When the first few bubbles of gas collected are tested, the aqueous bromine does **not** change colour.

Explain why the aqueous bromine does **not** change colour.

....

.... [1]

(e) As soon as the experiment is over and the heating is stopped, the delivery tube must be removed from the water.

Explain what happens if the delivery tube is **not** removed from the water as soon as the heating is stopped.

....

.... [2]

[Total: 7]

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2 A student investigates the solubility of ammonium chloride in water at different temperatures.

The student does five experiments using the following instructions.

Experiment 1

- Fill a burette with distilled water.
- Run some of the water out of the burette so that the level of the water is on the burette scale.
- Use the burette to add 8.0 cm^3 of distilled water to a 5.25 g sample of ammonium chloride in a boiling tube.
- Clamp the boiling tube at an angle, as shown in Fig. 2.1.

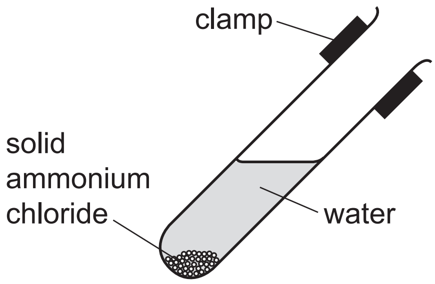


Fig. 2.1

- Gently heat the bottom of the boiling tube while stirring the contents with a thermometer.
- Stop heating as soon as all the solid has dissolved.
- Continuously stir the solution with the thermometer while it cools.
- Measure the temperature of the solution as soon as the solution becomes cloudy and a solid starts to form.

Experiment 2

- Use the burette to add 0.5 cm^3 of distilled water to the mixture in the boiling tube from the previous experiment.
- Clamp the boiling tube as shown in Fig. 2.1.
- Gently heat the bottom of the boiling tube while stirring the contents with a thermometer.
- Stop heating as soon as all the solid has dissolved.
- Continuously stir the solution with the thermometer while it cools.
- Measure the temperature of the solution as soon as the solution becomes cloudy and a solid starts to form.

Experiment 3

- Repeat Experiment 2.

Experiment 4

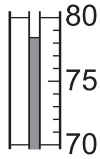
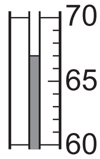
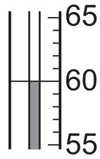
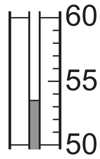
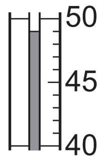
- Repeat Experiment 2.

Experiment 5

- Repeat Experiment 2.

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

Table 2.1

experiment	mass of ammonium chloride / g	total volume of water / cm^3	thermometer diagram when a solid starts to form	temperature when a solid starts to form / °C
1		8.0		
2				
3				
4				
5				

[4]

(b) Complete a suitable scale on the *y*-axis of Fig. 2.2 and plot your results from Experiments 1 to 5 on Fig. 2.2.

Draw a line of best fit through your points.

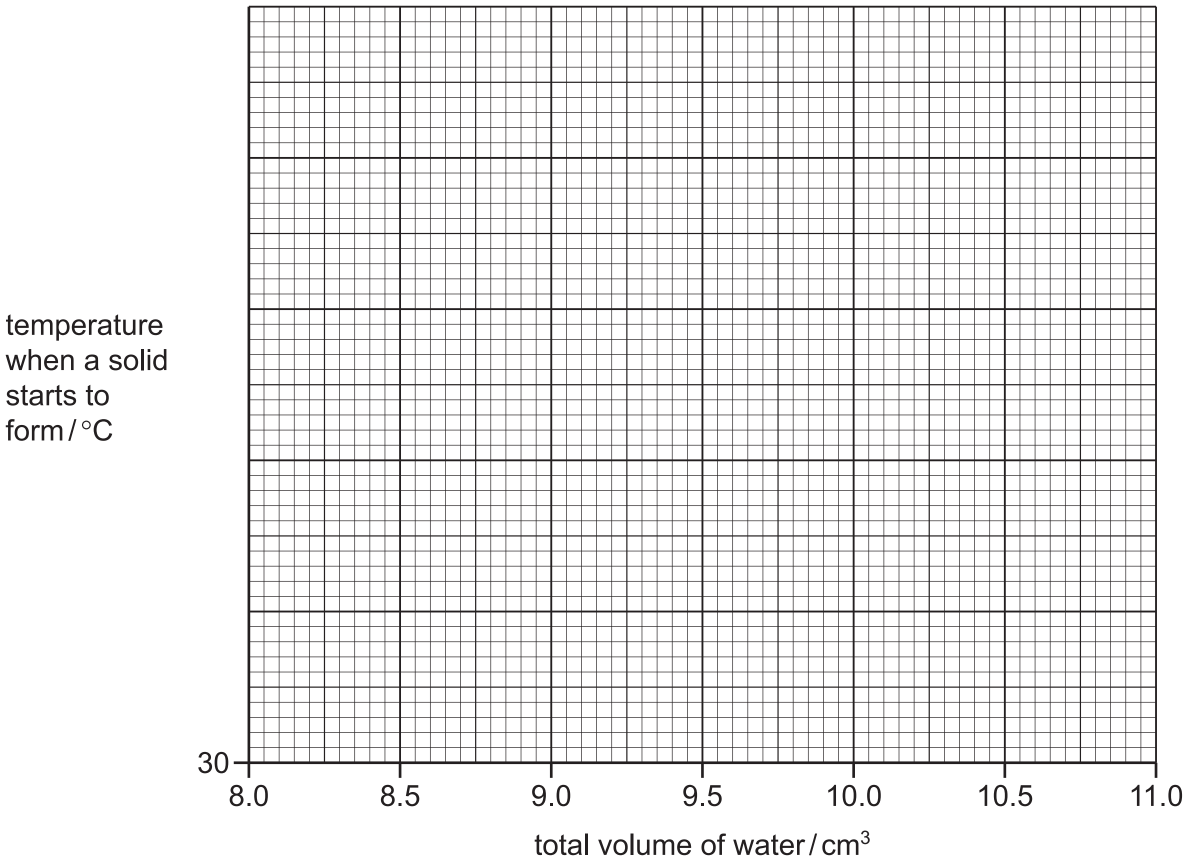


Fig. 2.2

[4]

(c) Extrapolate the line on your graph and deduce the temperature when a solid starts to form when a total volume of 10.5 cm^3 of water is used.

Show clearly **on Fig. 2.2** how you worked out your answer.

temperature when a solid starts to form = ... °C [3]

(d) Solubility, in g / 100 cm^3 of water, is calculated using the equation shown.

$$\text{solubility} = \frac{\text{mass of solid dissolved} \times 100}{\text{volume of water used}}$$

Use this equation to calculate the solubility of ammonium chloride in Experiment 1.

solubility = ... g / 100 cm^3 of water [1]

(e) Describe how the solubility of ammonium chloride changes as the temperature changes.

....

.... [1]

(f) In this experiment the volume of water was measured using a burette.

(i) State the advantage of using a burette rather than a measuring cylinder to measure the volume of water.

....

.... [1]

(ii) State the advantage of using a burette rather than a volumetric pipette to measure the volume of water.

....

.... [1]

(g) A total volume of 2.0 cm^3 of water was added to the original 8.0 cm^3 of water.

Explain the disadvantages of adding the 2.0 cm^3 of water in 1.0 cm^3 portions rather than 0.5 cm^3 portions.

....

.... [2]

(h) Suggest why it would **not** be possible to use 6.0 cm^3 of water instead of 8.0 cm^3 of water in Experiment 1.

....

.... [1]

[Total: 18]

3 A student tests two solutions: solution **C** and solution **D**.

Tests on solution C

Solution **C** is aqueous calcium nitrate.

Complete the expected observations.

The student divides solution **C** into three portions.

(a) The student carries out a flame test on the first portion of solution **C**.

observations .... [1]

(b) To the second portion of solution **C**, the student adds aqueous sodium hydroxide dropwise until it is in excess.

observations adding dropwise ....

observations in excess .... [2]

(c) To the product from **(b)**, the student adds a piece of aluminium foil and warms the mixture gently. Any gas produced is tested.

observations ....

.... [1]

(d) To the third portion of solution **C**, the student adds about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.

observations ....

.... [1]

tests on solution D

Table 3.1 shows the tests and the student's observations for solution **D**. The student divides solution **D** into four portions.

Table 3.1

tests	observations
test 1 Use a glass rod to transfer one drop of the first portion of solution **D** onto a piece of universal indicator paper.	the universal indicator paper turns red
test 2 To the second portion of solution **D**, add solid sodium carbonate. Test any gas produced.	the solid sodium carbonate disappears and there is effervescence the gas turns limewater milky
test 3 To the third portion of solution **D**, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.	no change
test 4 To the fourth portion of solution **D**, add about 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.	white precipitate

(e) Deduce the pH of solution **D**.

pH = ... [1]

(f) Identify the gas made when sodium carbonate is added to solution **D**.

.... [1]

(g) Identify the **two** ions in solution **D**.

....

.... [2]

[Total: 9]

4 Cadmium, cobalt and vanadium are all metals. They react with dilute hydrochloric acid to form hydrogen gas. These reactions are exothermic.

Plan an investigation to find the order of reactivity of the three metals.

Your plan must make it clear how your investigation will be a fair test and how you will use your results to place the metals in order of reactivity.

You are provided with powdered samples of each metal, dilute hydrochloric acid 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 IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 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.

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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.
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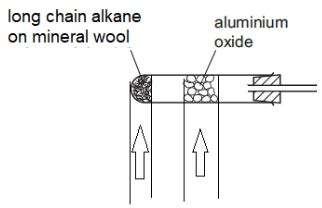
Question	Answer	Marks
1(a)	water-bath / trough	**1**
1(b)	larger surface area	**1**
1(c)(i)	Bunsen (burner)	**1**
1(c)(ii)	one arrow pointing upwards in each of the areas shown 	**1**
1(d)	it is air	**1**
1(e)	**M1** suck back / water goes into tube	**1**
	M2 test-tube / boiling tube breaks / cracks	**1**

Question	Answer	Marks
2(a)	**M1** mass ammonium chloride 5.25 g in all 5 experiments	**1**
	M2 total volume of water completed correctly (8.0, 8.5, 9.0, 9.5, 10.0)	**1**
	M3 all five temperatures completed correctly (78.5, 67.0, 60.0, 53.5, 49.0)	**1**
	M4 all volumes and temperatures are recorded to one decimal place	**1**

Question	Answer	Marks
2(b)	**M1** y-axis scale is linear with each large square = 10 °C	**1**
	M2 and **M3** all points plotted correctly	**2**
	M4 best fit line, this should be <u>a curve</u>	**1**
2(c)	**M1** suitable extrapolation of line shown	**1**
	M2 correct working shown on graph to show where value read	**1**
	M3 correct reading from working shown on graph	**1**
2(d)	66 / 65.6 / 65.63 / 65.625	**1**
2(e)	solubility increases as temperature increases **or** solubility decreases as temperature decreases	**1**
2(f)(i)	more accurate	**1**
2(f)(ii)	burettes can measure variable volumes **or** volumetric pipettes not available in required volumes / measure fixed volumes	**1**
2(g)	**M1** fewer points / less data / fewer results	**1**
	M2 poor(er) graph	**1**
2(h)	ammonium chloride will not (all) dissolve	**1**

Question	Answer	Marks
3(a)	orange-red (flame)	**1**
3(b)	**M1** white precipitate	**1**
	M2 (precipitate) remains / does not dissolve / insoluble / white precipitate	**1**
3(c)	(damp red) litmus (paper) turns blue	**1**
3(d)	no change / no reaction / no precipitate	**1**
3(e)	any pH in range 1 to 3	**1**
3(f)	carbon dioxide / CO_2	**1**
3(g)	hydrogen (ion) / H^+	**1**
	sulfate (ion) / SO_4^{2-}	**1**

Question	Answer	Marks
4	**MP1** react metal(s) with hydrochloric acid in a suitable container (beaker / flask / test-tube) **fair test – <u>max 3</u>** **MP2** same / specified / stated / known volume of acid **MP3** some / known / stated concentration of acid **MP4** same / known / stated / measured (start) temperature **of acid** **MP5** same / stated / specified mass or moles of metal **measurement** **MP6** time until all solid gone **OR** **MP6** time until set volume of gas collected **OR** **MP6** measure volume of gas after a set time **OR** **MP6** measure temperature after reaction over / after a fixed time / highest temperature **conclusion** **MP7** shortest time is most reactive **OR** **MP7** largest volume of gas in set time is most reactive **OR** **MP7** largest temperature / highest temperature change is most reactive If more than one method given, marks are awarded for the highest scoring method **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5375001254

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2023**

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.

IB23 03_0620_42/3RP

1 This question is about gases found in clean, dry air and gases found in polluted air.

(a) Name **one** gas found in clean, dry air which contributes to global warming.

.... [1]

(b) State the percentage of nitrogen in clean, dry air.

.... [1]

(c) Name the substance used to remove sulfur dioxide in flue gas desulfurisation.

.... [1]

(d) Nitrogen dioxide, NO_2, is formed in car engines.

Name the equipment in a car exhaust used to remove the NO_2 formed in car engines.

.... [1]

(e) All gases diffuse.

(i) Choose from the list of formulae the gas which diffuses most quickly.

Draw a circle around your answer.

CO **CO_2** **CH_4** **NO_2** **SO_2**

[1]

(ii) Explain your answer to **(i)**.

.... [1]

(f) State **one** adverse effect of carbon monoxide on human health.

.... [1]

(g) Carbon dioxide, CO_2, is a reactant in photosynthesis.

Name the **two** products of photosynthesis.

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

(h) Complete the dot-and-cross diagram in Fig. 1.1 for a molecule of CO_2.

Show outer shell electrons only.

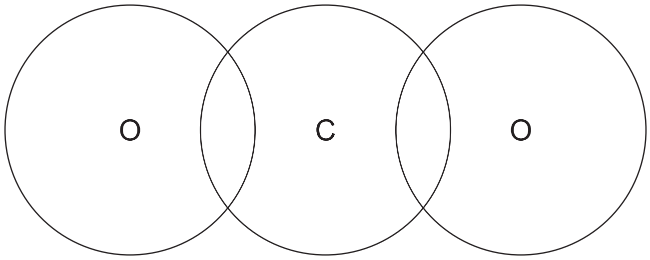


Fig. 1.1

[2]

[Total: 11]

2 Lithium, sodium and potassium are Group I elements.

(a) Name the type of bonding in these elements.

.... [1]

(b) Sodium reacts with cold water to form hydrogen gas and a solution of a strong alkali.

(i) State the test for hydrogen gas.

test ....

positive result ....
[1]

(ii) Suggest the pH of a solution of a strong alkali.

pH = ... [1]

(iii) Name a substance which can be used to confirm the pH of a solution of a strong alkali.

.... [1]

(iv) Write the symbol equation for the reaction between sodium and cold water.

Include state symbols.

.... [3]

(c) Lithium has two naturally occurring types of atoms, ^{6}Li and ^{7}Li.

(i) State the name given to atoms of the same element with different nucleon numbers.

.... [1]

(ii) Complete Table 2.1 to show the number of protons, neutrons and electrons in the atom and ion of lithium shown.

Table 2.1

	^{6}Li	$^{7}Li^{+}$
protons		
neutrons		
electrons		

[3]

(iii) Table 2.2 shows the relative abundance of the two naturally occurring atoms of lithium.

Table 2.2

atom	^{6}Li	^{7}Li
relative abundance	10%	90%

Calculate the relative atomic mass of lithium to **one** decimal place.

relative atomic mass = ... [2]

(d) Potassium oxide, K_2O, is an ionic compound.

Complete Fig. 2.1 to show the electronic configurations of the ions in potassium oxide.
Show the charges on the ions.

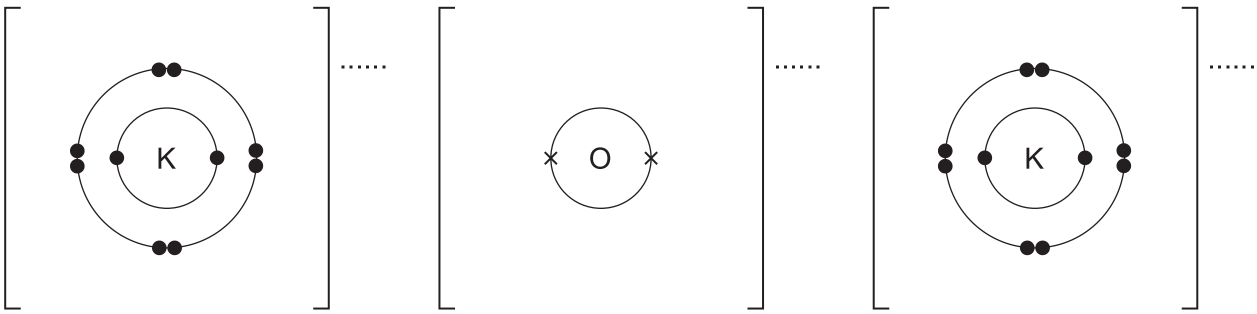


Fig. 2.1

[3]

[Total: 16]

3 The Haber process is used to manufacture ammonia.

(a) State the main source of each gas used in the Haber process.

nitrogen ....

hydrogen ....
[2]

(b) The equation for the Haber process is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ/mol$$

The reaction is reversible. The forward reaction is exothermic.

(i) State what is meant by the symbol ΔH.

.... [1]

(ii) ΔH for the forward reaction is $-92\,kJ/mol$.

State why this value shows that the forward reaction is exothermic.

.... [1]

(iii) State the typical conditions and name the catalyst used in the Haber process.

temperature .... °C

pressure .... kPa

catalyst ....
[3]

(iv) Complete Table 3.1 to show the effect, if any, when the typical conditions in the Haber process are changed. Use only the words **increases**, **decreases** or **no change**.

Table 3.1

change to typical conditions	effect on the rate of the forward reaction	effect on the concentration of $NH_3(g)$ at equilibrium
temperature increases	increases	
pressure decreases		
no catalyst	decreases	

[4]

(v) Explain in terms of collision theory why increasing the temperature increases the rate of the reaction.

....

....

....

....

.... [3]

(c) Ammonia reacts with an acid to form ammonium sulfate, $(NH_4)_2SO_4$.

(i) State the formula of the acid used.

.... [1]

(ii) State **one** use of ammonium sulfate.

.... [1]

(iii) Calculate the percentage composition by mass of nitrogen in $(NH_4)_2SO_4$.

percentage of nitrogen = ... % [2]

[Total: 18]

4 Copper is element 29 in the Periodic Table.

(a) Brass contains copper.

(i) Name the other metal in brass.

.... [1]

(ii) State the term given to a mixture of a metal with another element.

.... [1]

(b) Copper can be stretched into wires. Copper wires conduct electricity.

(i) Name the property of metals which means that they can be stretched into wires.

.... [1]

(ii) Name the particles responsible for the conduction of electricity in solid copper.

.... [1]

(c) Copper is a transition element.

Some physical and chemical properties of transition elements are shown.

physical properties:
- high density
- high strength

chemical properties:
- form coloured compounds
- have ions with variable oxidation numbers

(i) State one **other** physical property of transition elements.

.... [1]

(ii) State one **other** chemical property of transition elements.

.... [1]

(d) Hydrated copper(II) sulfate is a coloured compound. It exists as hydrated crystals which contain water molecules.

(i) State the term given to water molecules present in hydrated crystals.

.... [1]

(ii) State the colour of hydrated copper(II) sulfate crystals.

.... [1]

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

.... [2]

(e) Copper(II) oxide is formed when copper(II) nitrate, $Cu(NO_3)_2$, is heated.

$$2Cu(NO_3)_2(s) \rightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$$

(i) State the class of oxide to which copper(II) oxide belongs.

.... [1]

(ii) State the meaning of the Roman numeral (II) in the name copper(II) oxide.

.... [1]

(iii) 0.0200 moles of $Cu(NO_3)_2$ is heated.

Calculate the mass of 0.0200 moles of $Cu(NO_3)_2$.

mass = ... g [2]

(iv) Calculate the **total** volume of gas, in dm^3 at r.t.p., produced when 0.0200 moles of $Cu(NO_3)_2$ is heated.

volume = ... dm^3 [2]

(v) Powdered aluminium reduces copper(II) oxide.

Write the symbol equation for this reaction.

.... [2]

[Total: 18]

5 Propane, propene, propan-1-ol and propanoic acid are members of different homologous series. Molecules of these substances contain three carbon atoms.

(a) Explain why members of a homologous series have similar chemical properties.

.... [1]

(b) Name the homologous series to which propanoic acid belongs.

.... [1]

(c) State the general formula of the homologous series to which propanoic acid belongs.

.... [1]

(d) Propan-1-ol has an unbranched isomer.

- Name this isomer.

....

- Draw the displayed formula of this isomer.

[2]

(e) Propane and propene can be manufactured by heating decane, $C_{10}H_{22}$, in the presence of a catalyst. One other product is formed.

(i) Complete the equation for this reaction.

$C_{10}H_{22} \rightarrow$ .... + ... + ... [2]

(ii) Name this manufacturing process.

.... [1]

(f) Propene forms a polymer named poly(propene).

(i) Draw the displayed formula of a section of poly(propene) showing **three** repeat units.

[2]

(ii) State the type of polymerisation that occurs when propene forms poly(propene).

.... [1]

(g) Propanoic acid reacts with aqueous sodium carbonate to form a salt.

(i) Suggest the name of the salt formed.

.... [1]

(ii) Suggest the formula of the anion in this salt.

.... [1]

(h) Propanoic acid forms an ester when it reacts with ethanol in the presence of a catalyst.

(i) Suggest a suitable catalyst.

.... [1]

(ii) Name the ester formed.

.... [1]

(iii) Draw the displayed formula of this ester.

[2]

[Total: 17]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number atomic symbol name relative atomic mass

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2023**

MARK SCHEME

Maximum Mark: 80

Published

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

[Turn over

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Question	Answer	Marks
1(a)	carbon dioxide	**1**
1(b)	78 (%)	**1**
1(c)	calcium oxide	**1**
1(d)	catalytic converter	**1**
1(e)(i)	CH_4	**1**
1(e)(ii)	lowest relative molecular mass	**1**
1(f)	toxic	**1**
1(g)	**M1** glucose **M2** oxygen	**2**
1(h)	**M1** two dot-**and**-cross double bonds **M2** two pairs of non-bonding electrons on O **and** zero non-bonding electrons on C	**2**

Question	Answer	Marks
2(a)	metallic	**1**
2(b)(i)	lighted splint **and** (squeaky) pop	**1**
2(b)(ii)	14	**1**
2(b)(iii)	universal indicator	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)(iv)</td><td>$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

M1 NaOH as product in equation (1)

M2 fully correct equation (1)

M3 state symbols (1)</td><td>3</td></tr>
<tr><td>2(c)(i)</td><td>isotope(s)</td><td>1</td></tr>
<tr><td>2(c)(ii)</td><td><table><tr><th></th><th>^{6}Li</th><th>$^{7}Li^{+}$</th></tr><tr><td>protons</td><td>3</td><td>3</td></tr><tr><td>neutrons</td><td>3</td><td>4</td></tr><tr><td>electrons</td><td>3</td><td>2</td></tr></table>each row ✓</td><td>3</td></tr>
<tr><td>2(c)(iii)</td><td>M1 $(6 \times 10) + (7 \times 90)$ (= 690) (1)

M2 690 / 100 = 6.9 (1)</td><td>2</td></tr>
<tr><td>2(d)</td><td>M1 eight dots in third shell of both K (1)

M2 six crosses and two dots in second shell of O (1)

M3 ‘+’ charge on each K on correct answer line and ‘2–‘ charge on O ion on correct answer line (1)</td><td>3</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>nitrogen: air (1)

hydrogen: methane (1)</td><td>2</td></tr>
<tr><td>3(b)(i)</td><td>enthalpy change</td><td>1</td></tr>
<tr><td>3(b)(ii)</td><td>(the value of) ΔH is negative</td><td>1</td></tr>
<tr><td>3(b)(iii)</td><td>M1 450 (1)

M2 20 000 (1)

M3 iron (1)</td><td>3</td></tr>
<tr><td>3(b)(iv)</td><td>one mark for each of<table><tr><td></td><td>decreases</td></tr><tr><td>decreases</td><td>decreases</td></tr><tr><td></td><td>no change</td></tr></table></td><td>4</td></tr>
<tr><td>3(b)(v)</td><td>M1 kinetic energy of particles increases (1)

M2 frequency of collisions between particles increases (1)

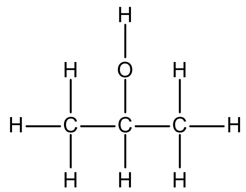
M3 higher percentage / proportion / fraction of collisions / particles have energy greater than / equal to activation energy (1)

or
more of the collisions / particles have energy greater than / equal to activation energy</td><td>3</td></tr>
<tr><td>3(c)(i)</td><td>H_2SO_4</td><td>1</td></tr>
<tr><td>3(c)(ii)</td><td>fertiliser</td><td>1</td></tr>
</table>

Question	Answer	Marks
3(c)(iii)	**M1** M_r of $(NH_4)_2SO_4$ = 132 (1) **M2** 2 × 14 = 28 and %N = 100 × 28 / 132 = 21.2% (1)	**2**

Question	Answer	Marks
4(a)(i)	zinc	**1**
4(a)(ii)	alloy	**1**
4(b)(i)	ductility	**1**
4(b)(ii)	electrons	**1**
4(c)(i)	high melting point	**1**
4(c)(ii)	(act as) catalysts	**1**
4(d)(i)	water(s) of crystallisation	**1**
4(d)(ii)	blue	**1**
4(d)(iii)	$CuSO_4{\cdot}5H_2O$ **M1** $CuSO_4$ (1) **M2** $\cdot 5H_2O$ (1)	**2**
4(e)(i)	basic	**1**
4(e)(ii)	the oxidation number of **copper** is **+**2	**1**
4(e)(iii)	**M1** M_r of $Cu(NO_3)_2$ = 188 (1) **M2** = 0.0200 × M1 = 0.0200 × 188 = 3.76 g (1)	**2**

Question	Answer	Marks
4(e)(iv)	**M1** moles of gas formed = $0.0200 \times 5 / 2 = 0.05(00)$ (1) **M2** volume = M1 $\times$ 24.0 = 0.05(00) $\times$ 24.0 = 1.2(0) (1)	**2**
4(e)(v)	$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$ **M1** correct products (1) **M2** rest of equation correct (1)	**2**

Question	Answer	Marks
5(a)	same functional group	**1**
5(b)	carboxylic acids	**1**
5(c)	$C_nH_{2n+1}COOH$	**1**
5(d)	**M1** propan-2-ol (1) **M2** displayed formula of propan-2-ol (1) 	**2**
5(e)(i)	$C_{10}H_{22} \rightarrow C_3H_8 + C_3H_6 + C_4H_8$ **M1** $C_3H_8 + C_3H_6$ (1) **M2** rest of equation correct (1)	**2**

Question	Answer	Marks
5(e)(ii)	cracking	**1**
5(f)(i)	**M1** six C atoms joined by single bonds in a chain and with continuation bonds (1) **M2** 3 × CH_3 at two C intervals **and** whole structure correctly displayed (1)	**2**
5(f)(ii)	addition	**1**
5(g)(i)	sodium propanoate	**1**
5(g)(ii)	$CH_3CH_2COO^-$	**1**
5(h)(i)	acid **or** any named inorganic acid, e.g. phosphoric acid	**1**
5(h)(ii)	ethyl propanoate	**1**
5(h)(iii)	**M1** displayed formula of any ester linkage (1) **M2** correct structure of ethyl propanoate (1)	**2**

Cambridge Assessment International Education

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2023**

45 minutes

You must answer on the multiple choice answer sheet.

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.

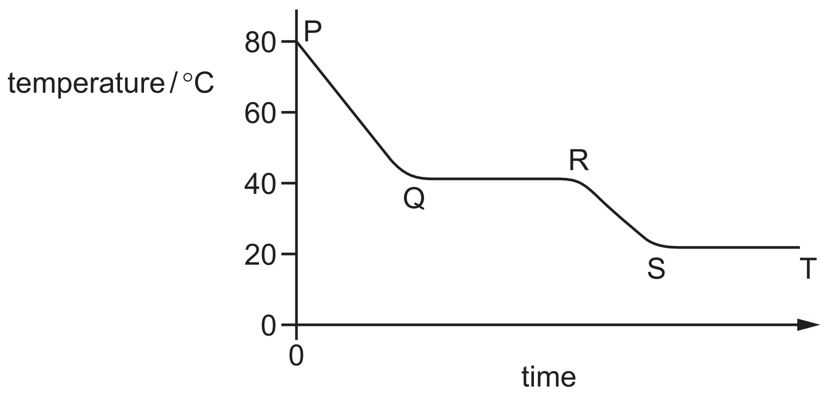
INFORMATION
- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

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

1 Substance M is a solid at 30 °C.

The substance is heated to 80 °C and its temperature measured as it cools down to room temperature.

The cooling curve is shown.



Between which times is substance M freezing?

A P to Q **B** Q to R **C** R to S **D** S to T

2 Which gas has the fastest rate of diffusion?

A Ar **B** C_2H_6 **C** HCl **D** H_2S

3 There are two stable isotopes of bromine.

The mass number of isotope 1 is 79.

The mass number of isotope 2 is 81.

Which statement is correct?

A The isotopes have the same number of neutrons.

B The isotopes have different chemical properties.

C The isotopes have different numbers of protons.

D The isotopes have the same number of outer electrons.

4 Which statement about ions and ionic bonds is correct?

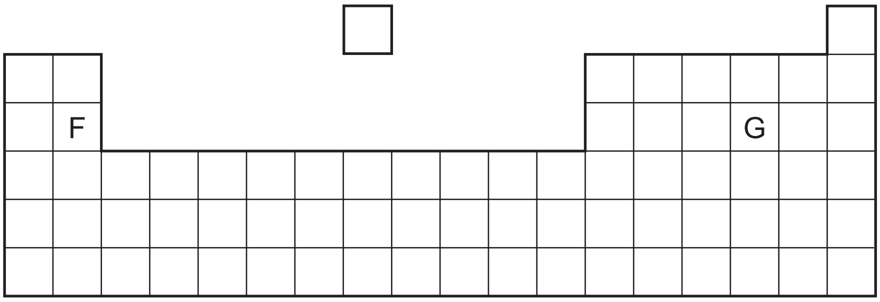
A Bromine atoms form negatively charged bromide ions.

B Ionic bonds form between elements in Group VII of the Periodic Table.

C Positive ions are formed when atoms lose protons.

D Potassium iodide contains negatively charged potassium ions.

5 Part of the Periodic Table is shown.



Which type of chemical bonding is present in the oxide of F and in the oxide of G?

	oxide of F	oxide of G
A	covalent	covalent
B	covalent	ionic
C	ionic	covalent
D	ionic	ionic

6 Elements X and Y react to form a compound.

Element X loses two electrons and element Y gains one electron.

What is the charge on the ions of elements X and Y and what is the formula of the compound?

	charge on X	charge on Y	formula of compound
A	2+	–	X_2Y
B	2+	–	XY_2
C	2–	+	X_2Y
D	2–	+	XY_2

7 Which statement about graphite explains why it is used as an electrode?

A It contains ions.

B It has a giant covalent structure.

C It is a metal.

D It has mobile electrons.

8 Methane, CH_4, burns in air to form carbon dioxide and water.

What is the balanced equation for this reaction?

A $CH_4(g) + O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

B $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

C $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + H_2O(g)$

D $CH_4(g) + 3O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

9 The equation for the thermal decomposition of sodium hydrogencarbonate is shown.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

The M_r of sodium hydrogencarbonate, $NaHCO_3$, is 84.

The M_r of sodium carbonate, Na_2CO_3, is 106.

In an experiment, 2.1 g of sodium hydrogencarbonate is heated but not all of it decomposes. All of the carbon dioxide is collected and measured at room temperature and pressure. The total volume of carbon dioxide produced is 0.21 dm^3.

The volume of 1 mole of a gas at room temperature and pressure is 24 dm^3.

Which statement is correct?

A The mass of sodium carbonate produced is 0.93 g.

B The mass of sodium carbonate produced is 1.33 g.

C The percentage yield of carbon dioxide is 10%.

D The percentage yield of carbon dioxide is 35%.

10 An electrolysis experiment is done using carbon electrodes.

Hydrogen and oxygen are formed at the electrodes.

What is the electrolyte?

A aqueous copper(II) sulfate

B concentrated hydrochloric acid

C dilute aqueous sodium chloride

D molten potassium oxide

11 Concentrated aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which ionic half-equation describes the reaction taking place 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 When powdered sodium carbonate and aqueous ethanoic acid are mixed, the temperature of the mixture falls.

Which statement about this reaction is correct?

A The reaction is endothermic and ΔH is negative.

B The reaction is endothermic and ΔH is positive.

C The reaction is exothermic and ΔH is negative.

D The reaction is exothermic and ΔH is positive.

13 Magnesium powder reacts with an excess of dilute hydrochloric acid to produce hydrogen gas.

Which statements about this reaction are correct?

1 The smaller the particles of magnesium powder, the more slowly the hydrogen is produced.

2 The higher the temperature, the faster the magnesium powder disappears.

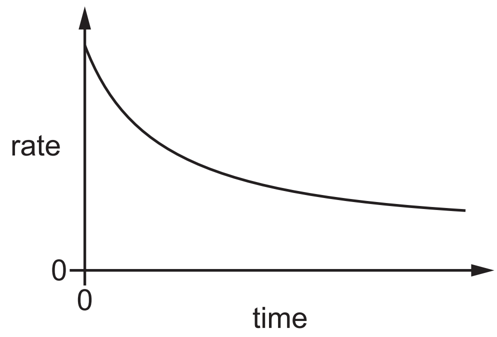
3 The lower the concentration of dilute hydrochloric acid, the faster the rate of reaction.

4 The faster the magnesium powder disappears, the faster the rate of reaction.

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

14 The reaction between two aqueous compounds, X and Y, is slow and exothermic.

The graph shows how the rate of this reaction changes with time.



A student suggests that the rate of reaction decreases with time because:

1 the activation energy decreases

2 the speed of the molecules of X and Y decreases

3 the concentration of both X and Y decreases with time.

Which suggestions are correct?

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

15 Hydrogen reacts with iodine to form hydrogen iodide.

$$H_2(g) + I_2(g) \rightarrow 2HI(g)$$

Which statements explain why the reaction is faster when the pressure is increased, at constant temperature?

1 At higher pressure, the molecules are moving faster.

2 At higher pressure, more of the molecules have the required activation energy.

3 At higher pressure, the molecules are closer together.

4 At higher pressure, the molecules collide more frequently.

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

16 Ammonium sulfate is used as a fertiliser.

It is made from ammonia and sulfuric acid.

The ......1...... is made by the ......2...... process in which ......3...... is used as a catalyst.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	ammonia	Contact	iron
B	ammonia	Haber	vanadium(V) oxide
C	sulfuric acid	Contact	vanadium(V) oxide
D	sulfuric acid	Haber	iron

17 The reversible reaction shown takes place in a closed system at constant temperature.

$$P(g) + Q(g) + R(g) \rightleftharpoons S(g) + T(g)$$

When the reaction has reached equilibrium, more T is added.

After the addition of T, which other substances increase in concentration?

A P, Q, R and S

B P and Q only

C P, Q and R only

D S only

18 In which equation is the underlined substance acting as a reducing agent?

A $3\underline{CO} + Fe_2O_3 \rightarrow 2Fe + 3CO_2$

B $\underline{CO_2} + C \rightarrow 2CO$

C $\underline{CuO} + H_2 \rightarrow Cu + H_2O$

D $\underline{CaO} + H_2O \rightarrow Ca(OH)_2$

19 An aqueous solution reacts with a solid. The products are an alkaline gas, a salt and water.

What are the aqueous solution and the solid?

	aqueous solution	solid
A	sodium hydroxide	magnesium carbonate
B	hydrochloric acid	magnesium carbonate
C	hydrochloric acid	ammonium chloride
D	sodium hydroxide	ammonium chloride

20 Butanoic acid partially dissociates in aqueous solution.

Which row about butanoic acid is correct?

	pH	effect on thymolphthalein
A	3	turns blue
B	5	turns colourless
C	8	turns blue
D	10	turns colourless

21 Copper(II) sulfate is prepared by adding excess copper(II) carbonate to sulfuric acid.

Why is an **excess** of copper(II) carbonate added?

A to ensure all the copper(II) carbonate has reacted

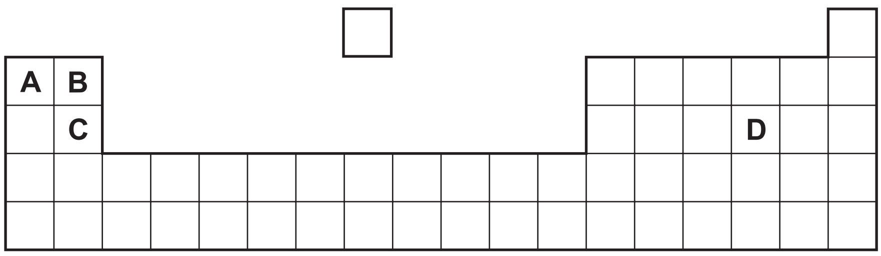
B to ensure all the sulfuric acid has reacted

C to increase the rate of reaction

D to increase the amount of copper(II) sulfate produced

22 Part of the Periodic Table is shown.

Which element has two electrons in its outer shell and three electron shells?



23 Elements in Group I and Group II show the same trends in their reactions with water and in their density.

Which row shows how the properties of barium compare with calcium?

	reaction with water	density
A	faster	higher
B	faster	lower
C	slower	higher
D	slower	lower

24 Which pair of compounds shows a transition element in two different oxidation states?

A Cr_2O_3 and $Cr_2(SO_4)_3$

B Cu_2O and $CuCO_3$

C ZnS and $ZnSO_4$

D NiO and $Ni(NO_3)_2$

25 Which description of brass is correct?

A a compound of copper and zinc

B a compound of copper and tin

C a mixture of copper and zinc

D a mixture of copper and tin

26 What is the symbol of the metal used in the manufacture of aircraft because of its low density?

A A*l* **B** Cu **C** Fe **D** Zn

27 Which substances react to form hydrogen gas?

1 calcium and water

2 silver and dilute hydrochloric acid

3 magnesium and steam

4 zinc and dilute hydrochloric acid

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

28 Coke (carbon) and limestone are two raw materials used in the extraction of iron from hematite.

Which type of reaction occurs when each substance is heated during the process?

	coke	limestone
A	redox	redox
B	redox	thermal decomposition
C	thermal decomposition	redox
D	thermal decomposition	thermal decomposition

29 Some combustion reactions produce pollutant gases.

Which reactions produce a pollutant gas that is **not** present in clean air?

1 $2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$

2 $2H_2 + O_2 \rightarrow 2H_2O$

3 $C + O_2 \rightarrow CO_2$

4 $N_2 + O_2 \rightarrow 2NO$

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

30 One mole of alkane Y produces $72\,dm^3$ of carbon dioxide when burned in excess oxygen, measured at room temperature and pressure.

What is Y?

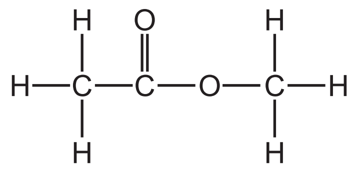
A butane

B ethane

C methane

D propane

31 The structure of organic compound X is shown.



What is X?

A ethyl ethanoate

B ethyl methanoate

C methyl ethanoate

D methyl methanoate

32 What is the structural formula of the compound formed in the addition reaction of propene with bromine?

A $CH_3CHBrCH_2Br$

B $CH_2BrCH_2CH_2Br$

C $CHBr_2CH_2CH_3$

D $CH_3CBr_2CH_3$

33 Ethanol is produced industrially by fermentation and also by a catalysed addition reaction involving steam.

Which row describes one advantage of each process?

	fermentation	catalysed addition reaction involving steam
A	the reactant used is renewable	it is a continuous process
B	the reactant used is renewable	it requires little energy
C	it is a very rapid reaction	it is a continuous process
D	it is a very rapid reaction	it requires little energy

34 Carboxylic acids react with alcohols when warmed with an acid catalyst.

Which type of substance is formed in this reaction?

A an alkene

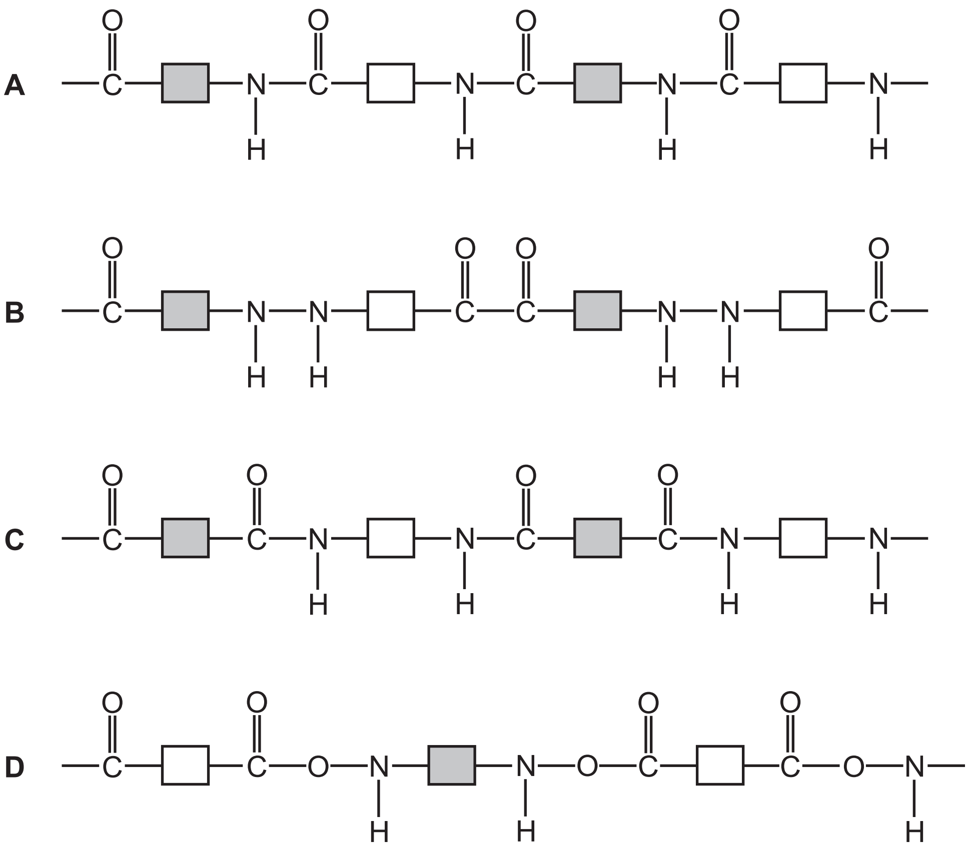
B an ester

C a salt

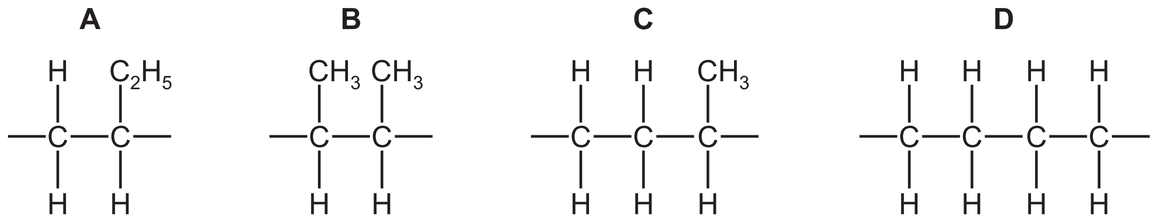
D a polymer

35 Nylon is formed by condensation polymerisation.

Which structure represents nylon?



36 Which structure represents the repeat unit of the addition polymer formed from but-1-ene?

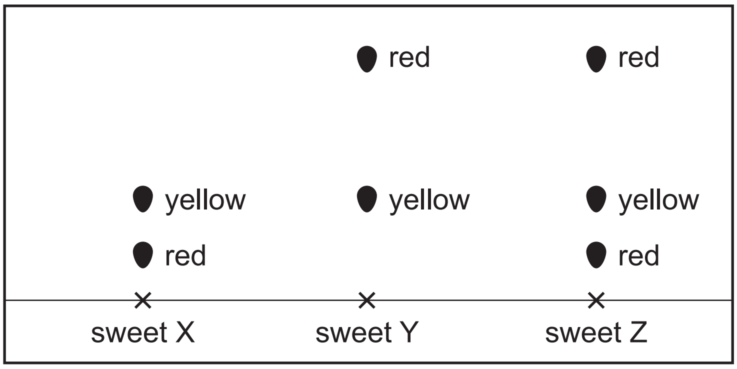


37 2.00 g of powdered calcium carbonate is added to 50.0 cm^3 of hydrochloric acid.

Which apparatus is used to measure these quantities of calcium carbonate and hydrochloric acid?

	calcium carbonate	hydrochloric acid
A	balance	burette
B	balance	thermometer
C	pipette	burette
D	pipette	thermometer

38 The diagram shows a chromatogram obtained from the colours of three different sweets, X, Y and Z.



How many different **red** dyes are present in the sweets?

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

39 A mixture contains sand and an aqueous solution of sodium chloride.

Which processes are used to obtain a sample of solid sand **and** a sample of solid sodium chloride from the mixture?

A crystallisation followed by filtration

B evaporation followed by filtration

C filtration followed by crystallisation

D simple distillation followed by crystallisation

40 A student tests an unknown compound M.

The compound:

- produces a lilac flame using a flame test
- produces a gas which turns limewater cloudy when dilute hydrochloric acid is added.

What is M?

A sodium sulfate

B sodium carbonate

C potassium sulfate

D potassium carbonate

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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) **February/March 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.

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 2023 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

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

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

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1582552913

CHEMISTRY **0620/63**

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

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

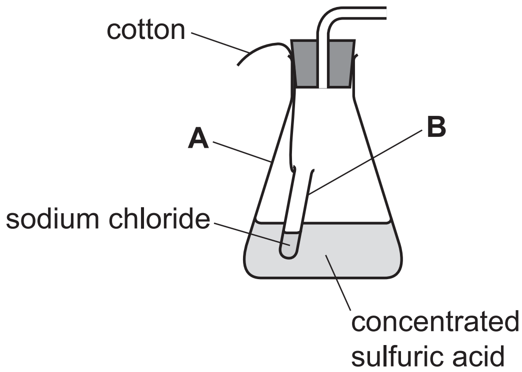
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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

IB22 11_0620_63/RP

1 Hydrogen chloride is a colourless gas that is soluble in water and denser than air.
Hydrogen chloride can be made by reacting sodium chloride with concentrated sulfuric acid.

The diagram shows some of the apparatus a teacher used to make hydrogen chloride gas and to measure the volume of gas made.



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

A ....

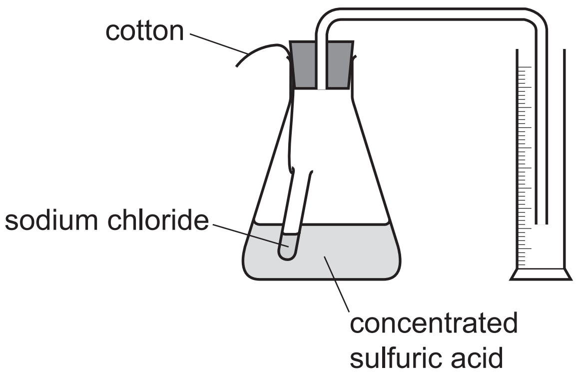
B ....
[2]

(b) Describe how the reaction is started after the apparatus has been set up.

....

.... [1]

(c) A student suggests the gas can be collected and its volume measured using a measuring cylinder as shown in the diagram.

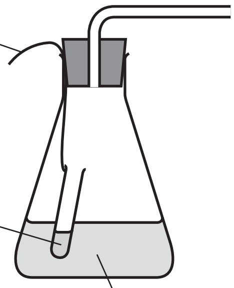


Explain why the volume of gas collected cannot be measured using this method.

....

.... [1]

(d) Complete the diagram to show how the hydrogen chloride gas could be collected and the volume of the gas measured.



[1]

(e) Hydrogen chloride is a toxic gas and concentrated sulfuric acid is corrosive.

(i) Give **one** safety precaution that should be taken when working with hydrogen chloride gas.

.... [1]

(ii) Give **one** safety precaution that should be taken when working with concentrated sulfuric acid.

.... [1]

[Total: 7]

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2 A student investigated the rate of the reaction between sodium metabisulfite and potassium iodate at different temperatures.

Five experiments were done at different temperatures.

(a) *Experiment 1*

- 70 cm^3 of aqueous potassium iodate was measured using a 100 cm^3 measuring cylinder and poured into a 250 cm^3 beaker.
- 5 cm^3 of aqueous starch was measured using a 10 cm^3 measuring cylinder and poured into the beaker containing the aqueous potassium iodate.
- 5 cm^3 of aqueous sodium metabisulfite was measured using a clean 10 cm^3 measuring cylinder and poured into the beaker. At the same time a stop-clock was started.
- The mixture was stirred until a sudden colour change was seen.
- The stop-clock was stopped and the temperature of the mixture in the beaker was measured using a thermometer.
- The beaker was rinsed with distilled water.

Experiment 2

- 70 cm^3 of aqueous potassium iodate was measured using a 100 cm^3 measuring cylinder and poured into a 250 cm^3 beaker.
- 5 cm^3 of aqueous starch was measured using a 10 cm^3 measuring cylinder and poured into the beaker containing the aqueous potassium iodate.
- The aqueous potassium iodate and starch mixture was warmed over a Bunsen burner until the temperature of the solution was about 35 °C. The beaker was then removed from above the Bunsen burner.
- 5 cm^3 of aqueous sodium metabisulfite was measured using a clean 10 cm^3 measuring cylinder and poured into the beaker. At the same time a stop-clock was started.
- The mixture was stirred until a sudden colour change was seen.
- The stop-clock was stopped and the temperature of the mixture in the beaker was measured using a thermometer.
- The beaker was rinsed with distilled water.

Experiment 3

- Experiment 2 was repeated but the aqueous potassium iodate and starch mixture was warmed until the temperature of the solution was about 40 °C.

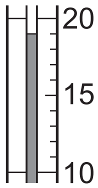
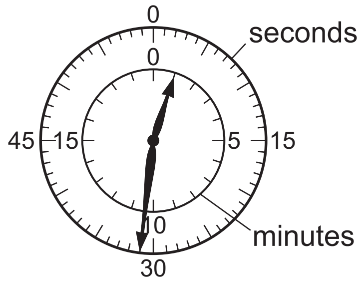
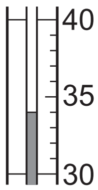
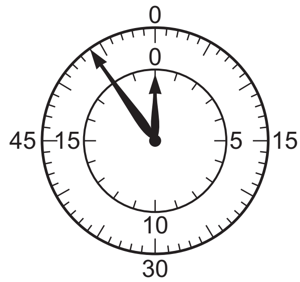
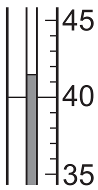
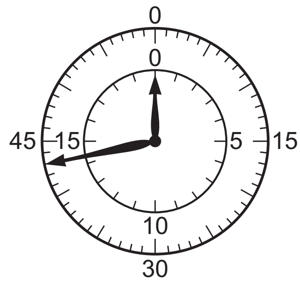
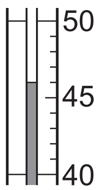
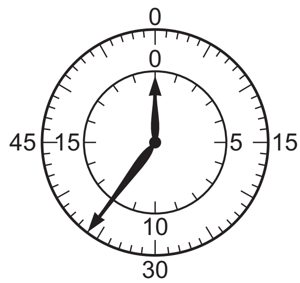
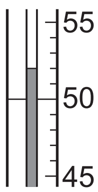
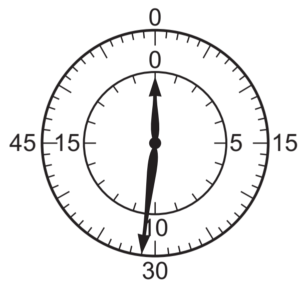
Experiment 4

- Experiment 2 was repeated but the aqueous potassium iodate and starch mixture was warmed until the temperature of the solution was about 45 °C.

Experiment 5

- Experiment 2 was repeated but the aqueous potassium iodate and starch mixture was warmed until the temperature of the solution was about 50 °C.

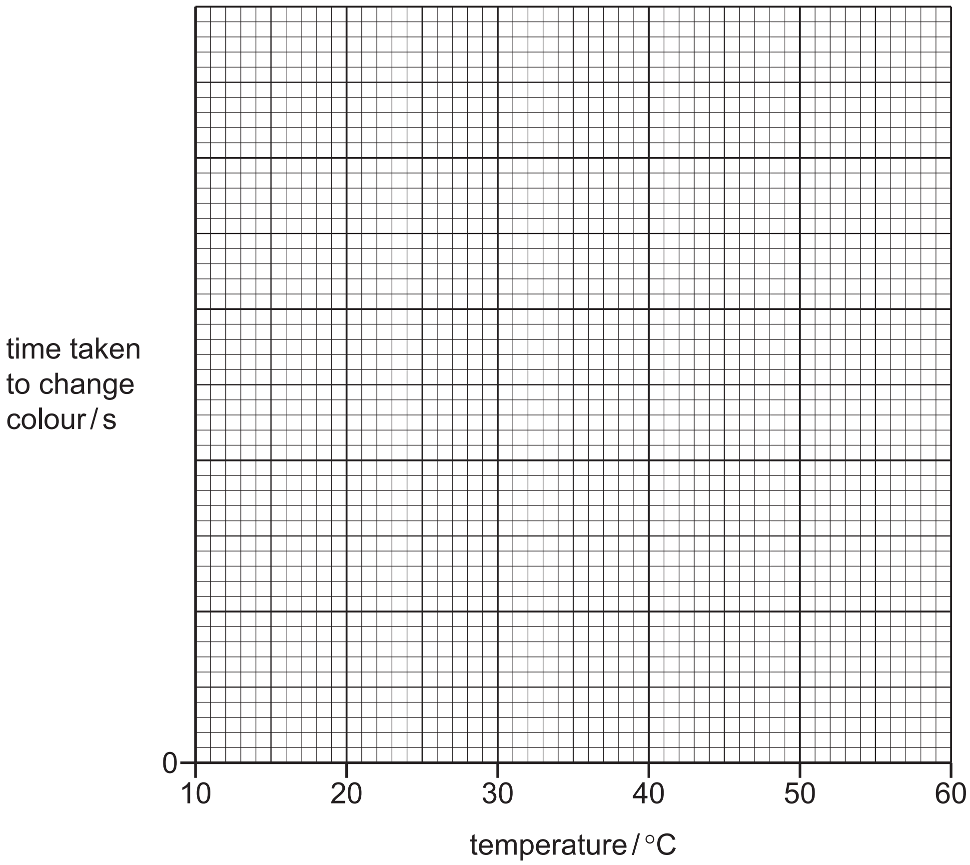
Use the thermometer diagrams and stop-clock diagrams to complete the table.

experiment	thermometer diagram	temperature / °C	stop-clock diagram	time / s
1				
2				
3				
4				
5				

[4]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on the grid.

Draw a curve of best fit through your points.



[4]

(c) Deduce which experiment had the fastest rate of reaction.

.... [1]

(d) **From your graph**, deduce the time taken for the mixture to change colour at a temperature of 60.0 °C.

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

time taken to change colour = ... [3]

(e) Experiments are often repeated and the results compared to check that they are reliable.

Suggest why this is difficult to do for these experiments.

....

.... [1]

(f) Suggest why the aqueous potassium iodate is warmed **before** the aqueous sodium metabisulfite is added rather than after it has been added.

....

.... [1]

(g) A polystyrene cup can be used instead of the beaker in this experiment.

(i) Explain the advantage of transferring the warmed potassium iodate to a polystyrene cup rather than leaving it in the beaker.

....

....

.... [2]

(ii) Suggest why it is **not** a good idea to put the aqueous potassium iodate in a polystyrene cup before it is warmed.

....

.... [1]

(h) Sketch **on the grid** the graph obtained when the experiments are repeated using aqueous potassium iodate of a higher concentration. [1]

[Total: 18]

3 Solid **N** and solution **O** were analysed. Solid **N** was zinc carbonate.

tests on solid N

(a) Dilute hydrochloric acid was added to a boiling tube containing solid **N**. Any gas produced was tested.

observations ....

....

.... [2]

The mixture formed in the boiling tube in **(a)** was filtered. The filtrate collected was solution **P**. Solution **P** was divided into two approximately equal portions in two test-tubes.

(b) To the first portion of solution **P**, aqueous sodium hydroxide was added gradually until it was in excess.

observations ....

.... [2]

(c) To the second portion of solution **P**, aqueous ammonia was added gradually until it was in excess.

observations ....

.... [2]

tests on solution O

tests	observations
test 1 A flame test was carried out on solution **O**.	lilac flame
The remaining solution **O** was divided into three portions in three test-tubes. **test 2** Universal indicator paper was dipped into the first portion of solution **O**.	the universal indicator turned purple
test 3 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the second portion of solution **O**.	no change
test 4 Aqueous copper(II) sulfate was added dropwise and then in excess to the third portion of solution **O**.	blue precipitate which remained in excess

(d) Deduce the pH of solution **O**.

pH = ... [1]

(e) Identify solution **O**.

....

.... [2]

[Total: 9]

4 Many fizzy drinks contain phosphoric acid. Phosphoric acid reacts with sodium hydrogencarbonate to make carbon dioxide gas.

Value Coke and **Kola Koola** are two fizzy drinks which contain phosphoric acid as the only acid.

Plan an investigation to find which of these two fizzy drinks contains the highest concentration of phosphoric acid.

Include in your answer how your results will tell you which drink contains the highest concentration of phosphoric acid.

You are provided with samples of both fizzy drinks, solid sodium hydrogencarbonate and common laboratory apparatus.

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.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY	**0620/63**
Paper 6 Alternative to Practical	**October/November 2022**
MARK SCHEME	
Maximum Mark: 40	

Published

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

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

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

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

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘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	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values. For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme. Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.
7	Guidance for chemical equations Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme. State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	**A** (conical) flask	**1**
	B test-tube	**1**
1(b)	tilt the container / flask **OR** lift bung (so tube falls over) (and then replace the bung)	**1**
1(c)	the gas / hydrogen chloride is colourless or cannot be seen (to read the volume)	**1**
1(d)	diagram showing gas syringe in horizontal position connected to delivery tube	**1**
1(e)(i)	use a fume cupboard	**1**
1(e)(ii)	wear gloves	**1**

Question	Answer	Marks
2(a)	**M1** all 5 temperatures correct (19.0, 34.0, 41.5, 46.0, 52.0)	**1**
	M2 all temperatures recorded to 1 decimal place	**1**
	M3 all 5 times correct (91, 54, 43, 36, 31)	**1**
	M4 all times recorded in seconds only	**1**
2(b)	**M1** y-axis scale in linear and points extend over halfway up the scale (each major grid line is 20 seconds)	**1**
	M2 and M3 all points plotted correctly	**2**
	M4 best fit curve	**1**
2(c)	(Experiment) 5	**1**

Question	Answer	Marks
2(d)	**M1** extrapolation of graph line shown	**1**
	M2 value from graph given	**1**
	M3 s	**1**
2(e)	difficult to get the temperature (exactly) the same	**1**
2(f)	otherwise the temperature is still increasing / changing **while it reacts**	**1**
2(g)(i)	**M1** insulator / reduces **heat** loss	**1**
	M2 temperature (more) constant / accurate	**1**
2(g)(ii)	the polystyrene would melt	**1**
2(h)	sketch line is below drawn line and does not meet plotted line at any point.	**1**

Question	Answer	Marks
3(a)	**M1** effervescence / bubbles / fizzing	**1**
	M2 limewater turns milky	**1**
3(b)	**M1** white precipitate	**1**
	M2 dissolves	**1**
3(c)	**M1** white precipitate	**1**
	M2 dissolves	**1**
3(d)	any pH in range 11 to 14	**1**

Question	Answer	Marks
3(e)	potassium / K^+	**1**
	hydroxide / OH^-	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4</td><td>any 6 from:

gas volume at end method

• known / same volume of drink
• add excess $NaHCO_3$
• suitable apparatus for reaction (e.g., flask / boiling tube) and to collect gas (syringe / over water)
• wait for reaction to finish (no fizzing / syringe stops moving)
• measure / record volume of gas
• repeat with other fizzy drink
• the drink with the largest volume of gas has the highest concentration of phosphoric acid

OR

gas volume at fixed time / time to make a fixed gas volume method

• known / same volume of drink
• add excess or any fixed mass $NaHCO_3$
• suitable apparatus for reaction (e.g., flask / test-tube) and to collect gas (syringe / over water)
• collect a fixed volume or waits a fixed time
• measure / record volume of gas or time or refers to time/volume of gas in conclusion
• repeat with other fizzy drink
• the drink with the shortest time / largest volume of gas has the highest concentration of phosphoric acid

Full credit possible for other valid methods (e.g., titration)
max 6</td><td>6</td></tr>
</table>