Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8417627571

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

1 This question is about states of matter.

(a) Complete the table, using ticks (✓) and crosses (✗), to describe the properties of gases, liquids and solids.

state of matter	particles are touching	particles have random movement	particles are regularly arranged
gas			
liquid			
solid			

[3]

(b) Substances can change state.

(i) Boiling and evaporation are two ways in which a liquid changes into a gas.

Describe **two** differences between boiling and evaporation.

1 ....

2 ....
[2]

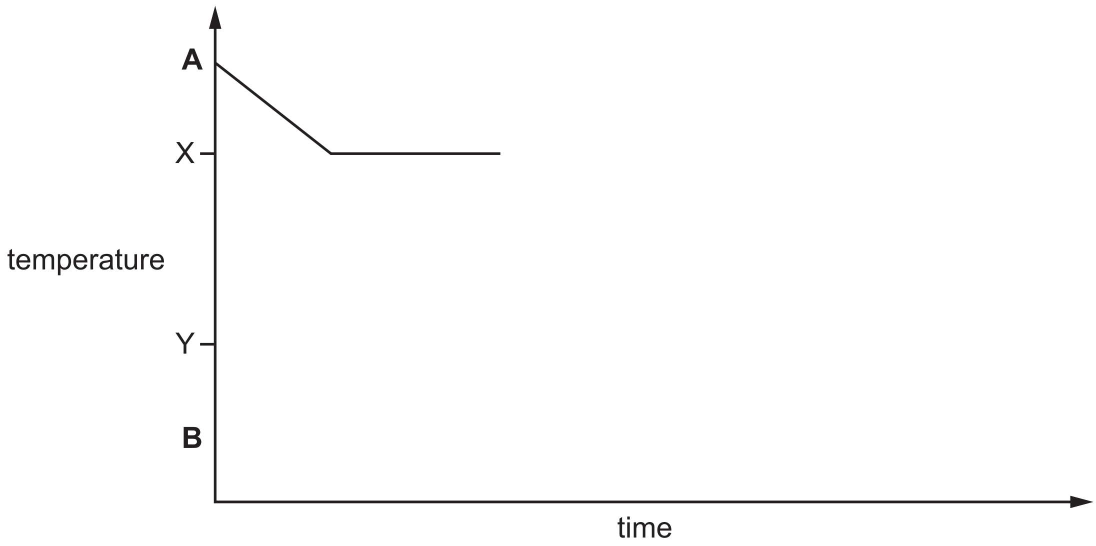
(ii) Name the change of state when:

- a gas becomes a liquid ....
- a solid becomes a gas. ....

[2]

(c) A substance boils at temperature X and melts at temperature Y.

Complete the graph to show the change in temperature over time as the substance cools from temperature **A** to temperature **B**.



[2]

(d) A solution is a mixture of a solute and a solvent.

(i) Name the process when a solid substance mixes with a solvent to form a solution.

.... [1]

(ii) Name the type of reaction when two solutions react to form an insoluble substance.

.... [1]

[Total: 11]

2 Acids are important laboratory chemicals.

(a) Some acids completely dissociate in water to form ions.

(i) State the term applied to acids that completely dissociate in water.

.... [1]

(ii) Complete the equation to show the complete dissociation of sulfuric acid in water.

$H_2SO_4 \rightarrow$ .... [2]

(iii) State the colour of methyl orange in sulfuric acid.

.... [1]

(b) The equation for the reaction between powdered zinc carbonate and dilute nitric acid is shown.

$ZnCO_3$....... + $2HNO_3$....... $\rightarrow$ $Zn(NO_3)_2$....... + H_2O....... + CO_2.......

(i) Complete the equation by adding state symbols. [2]

(ii) A student found that 2.5 g of zinc carbonate required 20 cm^3 of dilute nitric acid to react completely.

Calculate the concentration of dilute nitric acid using the following steps:

- calculate the mass of 1 mole of $ZnCO_3$

.... g

- calculate the number of moles of $ZnCO_3$ reacting

.... moles

- determine the number of moles of HNO_3 reacting

.... moles

- calculate the concentration of HNO_3.

.... mol / dm^3
[4]

[Total: 10]

3 Atoms contain protons, neutrons and electrons.

(a) Complete the table to show the relative mass and the relative charge of a proton, a neutron and an electron.

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

[3]

(b) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

atom or ion	number of protons	number of neutrons	number of electrons
$^{32}_{16}S$			
$^{39}_{19}K^{+}$			
	35	44	36

[5]

[Total: 8]

4 Chlorine reacts with carbon monoxide to produce phosgene gas, $COCl_2(g)$. A catalyst is used.

$$Cl_2(g) + CO(g) \rightleftharpoons COCl_2(g)$$

The reaction is exothermic.

(a) Explain why the reaction is exothermic in terms of the energy changes of bond breaking and bond making.

....

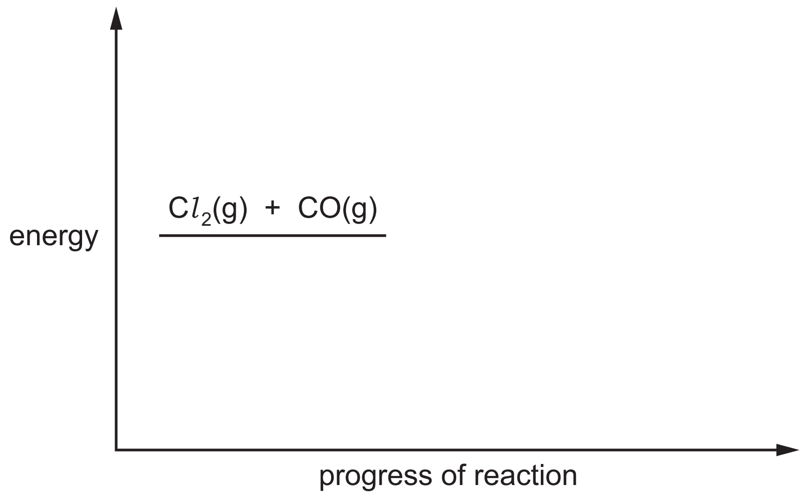
....

.... [3]

(b) **(i)** Complete the energy level diagram for this reaction.

On your diagram show:

- the product of the reaction
- an arrow representing the energy change, labelled ΔH
- an arrow representing the activation energy, labelled A.



[3]

(ii) State why a catalyst is used.

.... [1]

(c) Describe and explain the effect, if any, on the position of equilibrium when:

(i) the pressure is increased

....

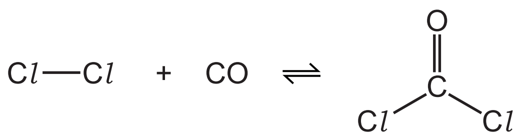
.... [2]

(ii) the temperature is increased.

....

.... [2]

(d) The reaction between chlorine and carbon monoxide can be represented as shown.



When one mole of chlorine reacts with one mole of carbon monoxide, 230 kJ of energy is released.

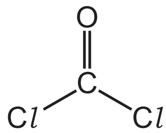
Some bond energies are shown in the table.

bond	bond energy in kJ / mol
C*l*–C*l*	240
C=O	745
C–C*l*	400

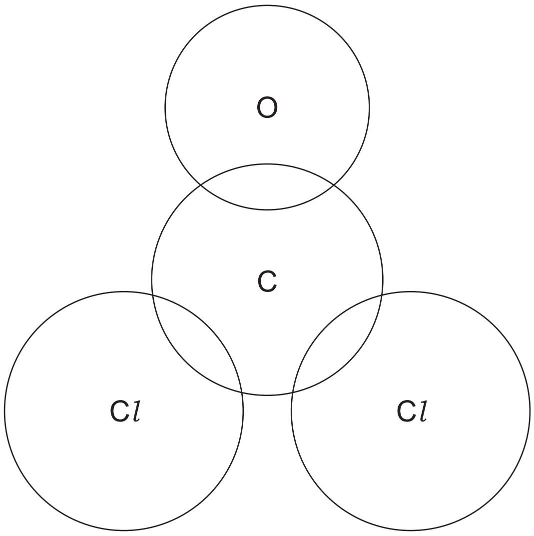
Use the information to calculate the energy of the bond between the C and the O in carbon monoxide, CO.

bond energy in carbon monoxide, CO = ... kJ / mol [3]

(e) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of $COCl_2$.



Show outer electrons only.



[3]

[Total: 17]

5 Iron is a transition element. Potassium is a Group I element.

(a) Iron and potassium have the same type of bonding.

Name and describe the type of bonding in these two elements.

name ....

description ....

....

....

....
[4]

(b) Transition elements and Group I elements have some similar physical properties.

They can both:

- be hammered into a shape
- conduct electricity
- be stretched into wires.

(i) Name the term used to describe the ability of elements to be hammered into a shape.

.... [1]

(ii) Describe what happens to the particles in iron when it is hammered into a shape.

....

.... [1]

(iii) Suggest why copper, rather than other transition elements, is used for wires which conduct electricity.

.... [1]

(c) Transition elements are harder and stronger than Group I elements.

Describe how **two** other **physical** properties of transition elements are different from those of Group I elements.

1 ....

2 ....
[2]

(d) Chemical properties of some Group I elements are shown in the table.

element	reaction with cold water	reaction with oxygen	flame test colour
lithium	• steadily effervesces • forms a colourless solution	very slowly forms an oxide layer	red
sodium	• strongly effervesces • forms a colourless solution	slowly forms an oxide layer	
potassium	• very strongly effervesces • forms a colourless solution	quickly forms an oxide layer	
rubidium			ruby red

(i) Add to the table:

- the flame test colours for sodium and potassium
- the predicted reactions of rubidium with water and with oxygen.

[4]

(ii) Name the gas produced when Group I elements react with water.

.... [1]

(iii) Name the solution formed when potassium reacts with water.

.... [1]

(iv) Predict the pH of the colourless solution formed when potassium reacts with water.

.... [1]

(v) Write the chemical equation for the reaction of sodium with oxygen.

.... [2]

(e) Iron is a typical transition element. It is the catalyst used in the Haber process.

(i) Write the equation for the reaction that occurs in the Haber process.

.... [2]

(ii) State the temperature and pressure used in the Haber process. Include units.

temperature ....

pressure ....

[2]

[Total: 22]

6 Ethanol, C_2H_5OH, belongs to the homologous series called alcohols.

(a) Write the general formula of alcohols.

.... [1]

(b) Explain why ethanol **cannot** be described as a hydrocarbon.

.... [1]

(c) Ethanol can be manufactured from different substances by reaction with steam or by fermentation.

(i) Give the formula of the substance which reacts with steam to form ethanol.

.... [1]

(ii) Name a substance which will undergo fermentation to form ethanol.

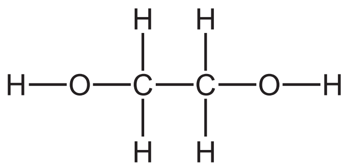
.... [1]

(d) Ethanol is a fuel.

Write the chemical equation for the complete combustion of ethanol.

.... [2]

(e) Ethane-1,2-diol has two alcohol functional groups.



One molecule of ethane-1,2-diol will react with two molecules of ethanoic acid to form molecule **X**.

X has two ester functional groups and a molecular formula of $C_6H_{10}O_4$.

(i) State the empirical formula of **X**.

.... [1]

(ii) Draw the structure of **X**.

Show all of the atoms and all of the bonds.

[2]

(iii) Name the **other** substance formed in this reaction.

.... [1]

(f) Each alcohol functional group in ethane-1,2-diol reacts with acidified potassium manganate(VII) to form a different organic compound, **Y**.

(i) Name the functional groups formed in **Y**.

.... [1]

(ii) Draw the structure of **Y**.

Show all of the atoms and all of the bonds.

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

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 **0620/42**

Paper 4 Theory (Extended) **October/November 2021**

MARK SCHEME

Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>1 mark for each correct row
<table><tr><th>State</th><th>touching</th><th>random movement</th><th>regularly arranged</th></tr><tr><td>Gas</td><td></td><td>✔</td><td></td></tr><tr><td>Liquid</td><td>✔</td><td>✔</td><td></td></tr><tr><td>Solid</td><td>✔</td><td></td><td>✔</td></tr></table></td><td>**3**</td></tr>
<tr><td>1(b)(i)</td><td>boiling happens at a specific temperature (1)
boiling has bubbles (1)</td><td>**2**</td></tr>
<tr><td>1(b)(ii)</td><td>condensation (1)
sublimation (1)</td><td>**2**</td></tr>
<tr><td>1(c)</td><td>one horizontal line level with Y (1)
two separate decreases before and after horizontal line (1)</td><td>**2**</td></tr>
<tr><td>1(d)(i)</td><td>dissolving</td><td>**1**</td></tr>
<tr><td>1(d)(ii)</td><td>precipitation</td><td>**1**</td></tr>
</table>

Question	Answer	Marks
2(a)(i)	strong	**1**
2(a)(ii)	$2H^+$ + SO_4^{2-} H^+ (1) correct equation (1)	**2**
2(a)(iii)	pink / red	**1**
2(b)(i)	$ZnCO_3$**(s)** + $2HNO_3$**(aq)** $\rightarrow$ $Zn(NO_3)_2$**(aq)** + H_2O**(l)** + CO_2**(g)** reactant states (1) product states (1)	**2**
2(b)(ii)	M1 125 M2 2.5 / 125 = 0.02(00) M3 0.02(00) $\times$ 2 = 0.04(00) M4 0.04(00) $\times$ 1000 / 20 = 2(.00)	**4**

Question	Answer	Marks
3(a)	1 mark for each correct row Name | Relative mass | Relative charge Proton | 1 | +1 Neutron | 1 | 0 Electron | 1 / 1840 | –1	3
3(b)	Particle | Number of protons | Number of neutrons | Number of electrons $^{32}_{16}S$ | 16 | 16 | 16 $^{39}_{19}K^{+}$ | 19 | 20 | 18 $^{79}_{35}Br^{-}$ | 35 | 44 | 36 M1 = row 1 (1) M2 = row 2 (1) M3 =Br (1) M4 = $^{79}_{35}$ (on left of any symbol) (1) M5 = charge (on any symbol) (1)	5

Inner tables:

Name	Relative mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	1 / 1840	–1

Particle	Number of protons	Number of neutrons	Number of electrons
$^{32}_{16}S$	16	16	16
$^{39}_{19}K^{+}$	19	20	18
$^{79}_{35}Br^{-}$	35	44	36

Question	Answer	Marks
4(a)	M1 E of making bonds > breaking bonds M2 bond making releases energy M3 bond breaking requires energy	**3**
4(b)(i)	M1 exothermic mark horizontal line below energy level to R.H.S. of reactants line and labelled $COCl_2$(g) (1) M2 activation E mark activation energy 'hump' with upward arrow labelled A / activation energy (1) 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 (1)	**3**
4(b)(ii)	increases rate of reaction	**1**
4(c)(i)	equilibrium shifts to right hand side (1) fewer moles (of gas) on right hand side (1)	**2**
4(c)(ii)	equilibrium shifts to left hand side (1) (forward) reaction is exothermic (1)	**2**

Question	Answer	Marks
4(d)	M1 bond energy in making bonds = [(2 × 400) + 745] = 1545 (kJ mol–1) M2 use of total E change –230 = [240 + E(C≡O)] – 1545 OR [240 + E(C≡O)] = –230 + 1545 = (+1315) M3 E(C≡O) = [–230 + 1545] – 240 = 1075 (kJ mol–1)	**3**
4(e)	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**

Question	Answer	Marks
5(a)	metallic (1) (lattice of) positive ions (1) sea of / delocalised / mobile electrons (1) attraction between positive ions and electrons (1)	**4**
5(b)(i)	malleability / malleable	**1**
5(b)(ii)	(particles) slide (over each other)	**1**
5(b)(iii)	unreactive	**1**
5(c)	high(er) density high(er) melting points	**2**
5(d)(i)	Na – yellow (1) K – lilac (1) colourless solution (1) clear idea of increased reactivity in **both** reactions (1)	**4**

Question	Answer	Marks
5(d)(ii)	hydrogen	1
5(d)(iii)	potassium hydroxide	1
5(d)(iv)	any number in the range $7 < pH \leqslant 14$	1
5(d)(v)	$4Na + O_2 \rightarrow 2Na_2O$ Na_2O (1) correct equation (1)	2
5(e)(i)	$N_2 + 3H_2 \rightarrow 2NH_3$ species (1) correct equation (1)	2
5(e)(ii)	450 °C (1) 200 atm (1)	2

Question	Answer	Marks
6(a)	$C_nH_{2n+1}OH$ (1)	1
6(b)	not all atoms are C or H	1
6(c)(i)	C_2H_4	1
6(c)(ii)	glucose	1
6(d)	$C_2H_5OH + 3O_2 \rightarrow 3H_2O + 2CO_2$ species (1) correct equation (1)	2
6(e)(i)	$C_3H_5O_2$	1
6(e)(ii)	any one ester link (1) rest of molecule (1)	2
6(e)(iii)	water	1
6(f)(i)	carboxylic acid	1

Question	Answer	Marks
6(f)(ii)	structure of ethanedioic acid	**1**

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4684088012

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2021**

1 hour 15 minutes

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INFORMATION

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This document has **12** pages.

1 Some elements are shown in the order they appear in the reactivity series. The most reactive element is at the top.

sodium
calcium
magnesium
aluminium
zinc
iron
hydrogen
copper

(a) Answer the questions using the list of elements. Each element may be used once, more than once or not at all.

Identify:

(i) a non-metal

.... [1]

(ii) a metal which is stored under oil

.... [1]

(iii) the main component of steel

.... [1]

(iv) a metal with three electrons in the outer shell of its atoms

.... [1]

(v) a metal found in brass

.... [1]

(vi) a metal that forms chlorides of the type XCl_2 and XCl_3.

.... [1]

(b) Name the main ores of:

(i) zinc .... [1]

(ii) aluminium. .... [1]

(c) In an experiment, a sample of aluminium appeared less reactive than expected.

Explain why.

....

.... [1]

(d) Name **two** metals from the list which are extracted by reduction of their ores using carbon.

1 ....

2 ....
[2]

(e) When zinc granules are added to aqueous copper(II) sulfate, a reaction occurs. During the reaction, a red-pink solid is formed and the solution becomes colourless.

(i) Name the red-pink solid.

.... [1]

(ii) Name the colourless solution.

.... [1]

(iii) Explain, in terms of particles, why the rate of this reaction increases when the temperature is increased.

....

....

....

....

....

.... [3]

(iv) Suggest two **other** ways of increasing the rate of this reaction.

1 ....

2 ....
[2]

[Total: 18]

2 This question is about copper and its compounds.

(a) Copper has two different naturally occurring atoms, ^{63}Cu and ^{65}Cu.

(i) State the term used for atoms of the same element with different nucleon numbers.

.... [1]

(ii) The atomic number of copper is 29.

Complete the table to show the number of protons, neutrons and electrons in the particles of copper shown.

	^{63}Cu	$^{65}Cu^{2+}$
protons		
neutrons		
electrons		

[3]

(iii) Relative atomic mass is the average mass of naturally occurring atoms of an element.

The percentage of the naturally occurring atoms in a sample of copper is shown.

^{63}Cu	^{65}Cu
70%	30%

Deduce the relative atomic mass of copper in this sample.

Give your answer to **one** decimal place.

relative atomic mass = ... [2]

(b) Anhydrous copper(II) sulfate is used to test for the presence of water. When this test is positive, hydrated copper(II) sulfate is formed.

(i) State the colour change seen during this test.

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

(ii) Complete the chemical equation to show the reaction that takes place.

$$CuSO_4 + \text{........................} \rightleftharpoons CuSO_4{\bullet}5H_2O$$ [1]

(iii) State how hydrated copper(II) sulfate can be turned back into anhydrous copper(II) sulfate.

.... [1]

(iv) Describe a test for pure water.

....

.... [2]

(c) Aqueous copper(II) sulfate contains $Cu^{2+}(aq)$ ions.

(i) Describe what is seen when aqueous copper(II) sulfate is added to aqueous sodium hydroxide, NaOH(aq).

.... [1]

(ii) Write the ionic equation for the reaction between aqueous copper(II) sulfate and aqueous sodium hydroxide.

Include state symbols.

.... [3]

(d) When solid copper(II) nitrate is heated copper(II) oxide, nitrogen dioxide and oxygen are formed.

$$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$$

Calculate the volume of nitrogen dioxide formed at room temperature and pressure when 4.7 g of $Cu(NO_3)_2$ is heated.

Use the following steps:

- calculate the mass of one mole of $Cu(NO_3)_2$

.... g

- calculate the number of moles of $Cu(NO_3)_2$ used

.... moles

- determine the number of moles of nitrogen dioxide formed

.... moles

- calculate the volume of nitrogen dioxide formed at room temperature and pressure.

.... dm^3
[4]

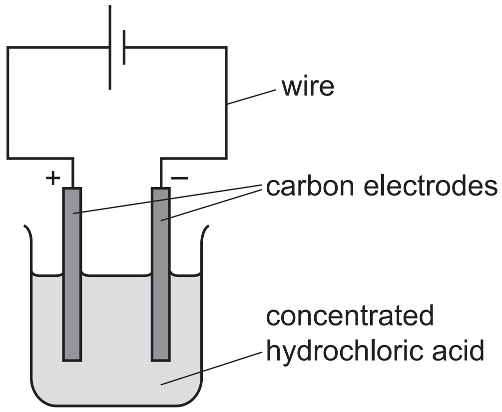
(e) Write the chemical equation to show the action of heat on sodium nitrate, $NaNO_3$.

.... [2]

[Total: 22]

3 This question is about electrolysis.

Concentrated hydrochloric acid is electrolysed using the apparatus shown.



(a) Chloride ions are discharged at the anode.

(i) Complete the ionic half-equation for this reaction.

..........$Cl^{-}(aq) \rightarrow$ ....(g) + ...e^{-} [2]

(ii) State whether oxidation or reduction takes place. Explain your answer.

....

.... [1]

(b) Describe what is seen at the cathode.

.... [1]

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

.... [2]

(d) The pH of the electrolyte is measured throughout the experiment.

(i) Suggest the pH of the electrolyte at the beginning of the experiment.

.... [1]

(ii) State how the pH changes, if at all, during the experiment.

Explain your answer.

....

.... [2]

(e) The electrolysis is repeated using molten lead(II) bromide.

Describe what is seen at the:

- cathode ....
- anode. ....

[2]

(f) State **two** properties of graphite (carbon) which make it suitable for use as an electrode.

1 ....

2 ....

[2]

[Total: 13]

4 Chalcopyrite, $FeCuS_2$, is used in the manufacture of sulfuric acid in the Contact process.

(a) In the first stage of the process, chalcopyrite reacts with oxygen in the air to produce sulfur dioxide, SO_2, iron(III) oxide and copper(II) oxide.

Complete the chemical equation for the reaction of $FeCuS_2$ with oxygen.

$$4FeCuS_2 + 13O_2 \rightarrow \text{................} + \text{................} + \text{................}$$ [2]

(b) Sulfur dioxide is then converted to sulfur trioxide.

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

The reaction is exothermic. It is also an equilibrium.

(i) State **two** features of an equilibrium.

1 ....

2 ....
[2]

(ii) State the temperature and pressure used in this reaction.
Include units.

- temperature ....
- pressure ....

[2]

(iii) Name the catalyst used.

.... [1]

(iv) Explain why a catalyst is used.

.... [1]

(v) Describe and explain, in terms of equilibrium, what happens when the temperature is increased.

....

.... [2]

(c) Concentrated sulfuric acid is a dehydrating agent.

When glucose is dehydrated, carbon and one other product are formed.

Complete the equation to show the dehydration of glucose, $C_6H_{12}O_6$.

$$C_6H_{12}O_6 \rightarrow \text{..........}C + \text{....................}$$ [2]

[Total: 12]

5 Alkenes and carboxylic acids are both families of similar compounds with similar chemical properties. Alkenes and carboxylic acids have different reactions.

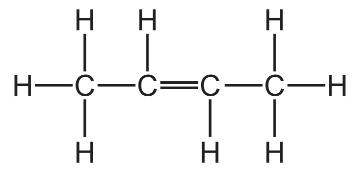
(a) State the term used for a 'family' of similar compounds.

.... [1]

(b) State the general formula of alkenes.

.... [1]

(c) The structure of but-2-ene is shown.



(i) But-2-ene reacts with aqueous bromine in an addition reaction.

Describe the colour change seen when but-2-ene is added to aqueous bromine.

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

(ii) State what is meant by the term *addition reaction*.

.... [1]

(iii) Write the chemical equation for the reaction between but-2-ene and bromine.

.... [2]

(iv) But-2-ene forms a polymer.

Suggest the name of the polymer formed from but-2-ene.

.... [1]

(v) Name and draw a structural isomer of but-2-ene.

Show all of the atoms and all of the bonds.

name ....

structure

[2]

(d) Butanoic acid, $CH_3CH_2CH_2COOH$, is a carboxylic acid.

(i) Deduce the empirical formula of butanoic acid.

.... [1]

(ii) Complete the chemical equation for the reaction of butanoic acid and sodium carbonate, Na_2CO_3.

$2CH_3CH_2CH_2COOH + Na_2CO_3 \rightarrow$ .... + ... + ... [2]

(iii) Butanoic acid reacts with methanol to form an organic compound and water.

- Name the organic compound formed.

.... [1]

- Draw the structure of the organic compound formed.

Show all of the atoms and all of the bonds.

[2]

[Total: 15]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2021**

MARK SCHEME

Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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)(i)	hydrogen	**1**
1(a)(ii)	sodium	**1**
1(a)(iii)	iron	**1**
1(a)(iv)	aluminium	**1**
1(a)(v)	zinc or copper	**1**
1(a)(vi)	iron	**1**
1(b)(i)	zinc blende	**1**
1(b)(ii)	bauxite	**1**
1(c)	protective oxide layer	**1**
1(d)	Any 2 from 3 • zinc • iron • copper	**2**
1(e)(i)	copper	**1**
1(e)(ii)	zinc sulfate	**1**
1(e)(iii)	**M1** particles have more energy **M2** More collisions (between particles) occur per second / per unit time **M3** A greater percentage / proportion / fraction of collisions (of particles) are successful / have energy above activation energy / have energy equal to activation energy	**3**

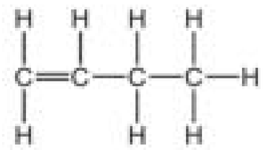
Question	Answer	Marks
1(e)(iv)	Any 2 from 3: • use a catalyst • use smaller granules • increase concentration	**2**

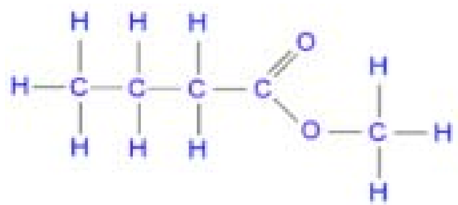
Question	Answer	Marks
2(a)(i)	isotopes	**1**
2(a)(ii)	1 mark for each correct row <table><tr><td></td><td>^{63}Cu</td><td>$^{65}Cu^{2+}$</td></tr><tr><td>p</td><td>29</td><td>29</td></tr><tr><td>n</td><td>34</td><td>36</td></tr><tr><td>e</td><td>29</td><td>27</td></tr></table>	**3**
2(a)(iii)	**M1** = (70 × 63) + (30 × 65) or [(4410) + (1950)] or 6360 (1) **M2** = M1 / 100 = 63.6 (1) OR **M1**= (0.7(0) × 63) + (0.3(0) × 65) or [(44.1(0)) + (19.5(0))] (1) **M2** = 63.6 (1)	**2**

Question	Answer	Marks
2(b)(i)	**M1** white (1) **M2** to (light) blue (1)	**2**
2(b)(ii)	$5H_2O$	**1**
2(b)(iii)	heating	**1**
2(b)(iv)	**M1** boiling point (1) **M2** is 100 °C OR **M1** freezing point (1) **M2** is 0 °C (1)	**2**
2(c)(i)	blue precipitate	**1**
2(c)(ii)	Alternative suggestion: **M1** $Cu(OH)_2$ (as only product) (1) **M2** Cu^{2+} and $2OH^-$ (as reactants) (1) **M3** state symbols (1)	**3**
2(d)	**M1** 188 **M2** 4.7 / 188 = 0.025(0) **M3** 0.025(0) × 2 = 0.05(0) **M4** 0.05(0) × 24.0 = 1.2	**4**
2(e)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ $NaNO_2$ (1) rest of equation (1)	**2**

Question	Answer	Marks
3(a)(i)	$2Cl^- \rightarrow Cl_2 + 2e^-$ Cl_2 (1) rest of equation (1)	**2**
3(a)(ii)	Oxidation AND lose electrons	**1**
3(b)	effervescence (of colourless gas)	**1**
3(c)	$2H^+ + 2e^- \rightarrow H_2$ H^+ + e as only species on LHS (1) rest of equation fully correct (1)	**2**
3(d)(i)	1	**1**
3(d)(ii)	**M1** increase (1) **M2** H+ ions being removed (1)	**2**
3(e)	**M1** cathode: silver / grey solid (1) **M2** anode: bubbles of orange / brown gas (1)	**2**
3(f)	**M1** inert (1) **M2** conducts electricity (1)	**2**

Question	Answer	Marks
4(a)	($4FeCuS$ $13O_2$) $\rightarrow$ $2Fe_2O_3$ + $4CuO$ + $8SO_2$ Fe_2O_3 and CuO as a product (1) Equation fully correct (1)	**2**
4(b)(i)	**M1** rate of forward reaction = rate of reverse reaction (1) **M2** concentration of reactants and products are constant (1)	**2**
4(b)(ii)	**M1** 450 °C (1) **M2** 1-2 atm (1)	**2**
4(b)(iii)	vanadium(V) oxide	**1**
4(b)(iv)	increase rate of reaction	**1**
4(b)(v)	**M1** equilibrium shifts to left hand side (1) **M2** forward reaction is exothermic (1)	**2**
4(c)	$C_6H_{12}O_6$ $\rightarrow$ $6C + 6H_2O$ H_2O (1) balance (1)	**2**

Question	Answer	Marks
5(a)	homologous series	**1**
5(b)	C_nH_{2n}	**1**
5(c)(i)	orange to colourless	**1**
5(c)(ii)	(only) one product is formed	**1**
5(c)(iii)	$C_4H_8 + Br_2 \rightarrow C_4H_8Br_2$ $C_4H_8Br_2$ (1) equation fully correct (1)	**2**
5(c)(iv)	(poly) but-2-ene	**1**
5(c)(v)	but-1-ene (1) structure of but-1-ene  (1)	**2**
5(d)(i)	C_2H_4O	**1**
5(d)(ii)	$2C_3H_7COOH + Na_2CO_3 \rightarrow 2C_3H_7COONa + H_2O + CO_2$ C_3H_7COONa (1) equation fully correct (1)	**2**

Question	Answer	Marks
5(d)(iii)	methyl butanoate (1)  ester link (1) rest of structure (1)	**3**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2021**

45 minutes

You must answer on the multiple choice answer sheet.

* 1 6 2 6 9 7 4 8 2 7 *

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 Brownian motion and the diffusion of gases provide evidence for the particulate nature of matter.

Which row identifies an example of Brownian motion and how molecular mass determines the rate of diffusion of gas molecules?

	Brownian motion	diffusion
A	pollen grains in water are seen to move randomly	heavier gas molecules diffuse more quickly
B	pollen grains in water are seen to move randomly	lighter gas molecules diffuse more quickly
C	salt dissolves faster in hot water than in cold water	heavier gas molecules diffuse more quickly
D	salt dissolves faster in hot water than in cold water	lighter gas molecules diffuse more quickly

2 A student put exactly 25.00 cm^3 of dilute hydrochloric acid into a conical flask.

The student added 2.5 g of solid sodium carbonate and measured the change in temperature of the mixture.

Which apparatus does the student need to use?

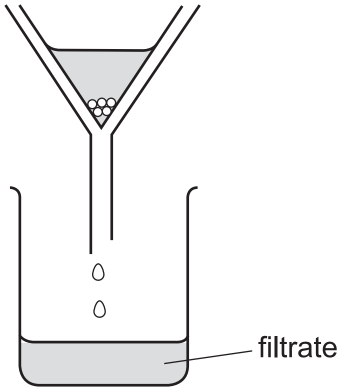
A balance, measuring cylinder, thermometer

B balance, pipette, stopwatch

C balance, pipette, thermometer

D burette, pipette, thermometer

3 A student separates sugar from pieces of broken glass by dissolving the sugar in water and filtering off the broken glass.



What is the filtrate?

A broken glass only

B broken glass and sugar solution

C pure water

D sugar solution

4 The nucleus of a particular atom consists of nineteen particles.

Nine of them are positively charged and ten of them are uncharged.

Which statement about this nucleus is correct?

A The nucleus has a nucleon number of nine.

B The nucleus has a nucleon number of ten.

C The nucleus has a proton number of nine.

D The nucleus has a proton number of ten.

5 Which description of brass is correct?

A alloy

B compound

C element

D non-metal

6 A Group I element combines with a Group VII element and forms an ionic bond.

Which row shows how the electronic structures change?

	Group I element		Group VII element	
	before bonding	after bonding	before bonding	after bonding
A	2,8,1	2,8,2	2,7	2,6
B	2,8	2,7	2,8	2,8,1
C	2,8,1	2,8	2,7	2,8
D	2,8	2,8,1	2,8	2,7

7 Which statement describes the attractive forces between molecules?

A They are strong covalent bonds which hold molecules together.

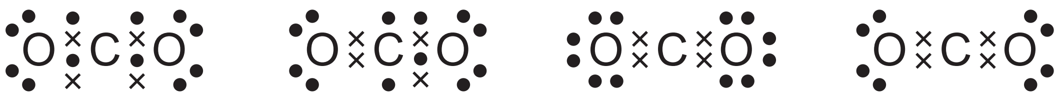
B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

8 Which diagram shows the outer electron arrangement in a molecule of carbon dioxide?

A **B** **C** **D**



9 Aluminium oxide is an ionic compound containing Al^{3+} ions and O^{2-} ions.

Aluminium hydroxide is an ionic compound containing Al^{3+} ions and OH^- ions.

In which row are the formulae for aluminium oxide and aluminium hydroxide correct?

	aluminium oxide	aluminium hydroxide
A	Al_2O_3	$Al(OH)_3$
B	Al_3O_2	$AlOH_3$
C	Al_2O_3	$AlOH_3$
D	Al_3O_2	$Al(OH)_3$

10 Effervescence is observed at the negative electrode (cathode) during the electrolysis of concentrated aqueous sodium chloride.

Which element is produced at the negative electrode (cathode)?

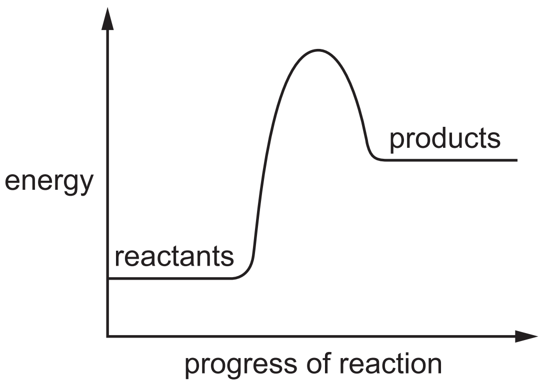
A chlorine

B hydrogen

C oxygen

D sodium

11 The energy level diagram for a chemical reaction is shown.



Which statement about this reaction is correct?

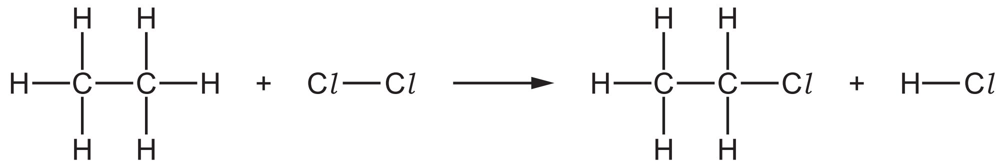
A The reaction is endothermic and energy is given out to the surroundings.

B The reaction is endothermic and energy is taken in from the surroundings.

C The reaction is exothermic and energy is given out to the surroundings.

D The reaction is exothermic and energy is taken in from the surroundings.

12 Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

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

What is the energy change for the reaction?

A –1420 kJ / mol

B –120 kJ / mol

C +120 kJ / mol

D +1420 kJ / mol

13 What is the concentration of the solution when 31.8 g of sodium carbonate, Na_2CO_3, is dissolved in water to make a solution of 250 cm^3?

A 0.075 mol / dm^3

B 0.30 mol / dm^3

C 1.2 mol / dm^3

D 1.5 mol / dm^3

14 A fuel cell is used to generate electricity.

Which chemicals are used in a fuel cell?

A hydrogen and methane

B hydrogen and oxygen

C nitrogen and methane

D nitrogen and oxygen

15 Sulfuric acid is manufactured using the Contact process. One of the reactions is shown.

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

The forward reaction is exothermic.

statement 1 The equation has more molecules on the left-hand side than on the right-hand side.

statement 2 Using a higher pressure shifts the equilibrium to the left.

statement 3 Higher temperatures increase the rate of reaction.

statement 4 Increasing the temperature shifts the equilibrium to the right.

Which alternative is correct?

A Statement 1 is correct and explains statement 2.

B Statement 1 and statement 3 are correct.

C Statement 2 and statement 4 are correct.

D Statement 3 is correct and explains statement 4.

16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.

$$2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$$

Which statements about this reaction are correct?

1 Fe^{2+} ions are reduced to Fe^{3+} ions.

2 Chlorine acts as a reducing agent.

3 Fe^{2+} ions each lose an electron.

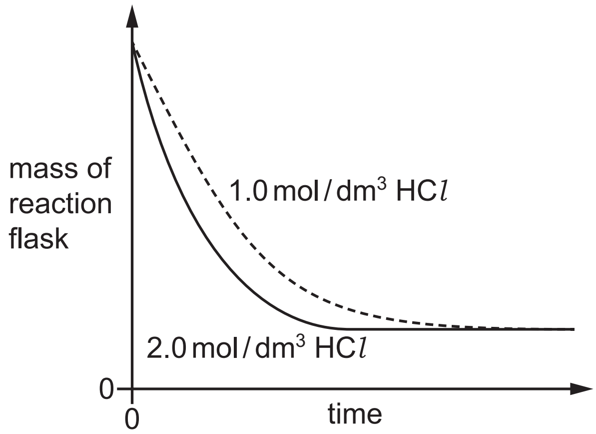
4 Cl_2 molecules are reduced to Cl^- ions.

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

17 Excess dilute hydrochloric acid is added to equal masses of powdered calcium carbonate in two separate experiments.

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

The results show the change in mass of the reaction flask measured over time.



Why is the rate of reaction for the 1.0 mol / dm^3 hydrochloric acid slower?

	collision energy	collision rate
A	lower	higher
B	lower	lower
C	same as for 2.0 mol / dm^3	higher
D	same as for 2.0 mol / dm^3	lower

18 Basic oxides are neutralised by acidic oxides.

Which element forms an oxide that neutralises calcium oxide?

A hydrogen

B magnesium

C sodium

D sulfur

19 Four solid oxides are added to dilute hydrochloric acid and aqueous sodium hydroxide.

Which row describes an amphoteric oxide?

	hydrochloric acid	sodium hydroxide
A	✓	✓
B	✗	✓
C	✓	✗
D	✗	✗

key

✓ = reacts

✗ = does not react

20 Which row describes an acid and an oxidising agent?

	acid	oxidising agent
A	proton acceptor	electron acceptor
B	proton acceptor	electron donor
C	proton donor	electron acceptor
D	proton donor	electron donor

21 A period of the Periodic Table is shown.

group	I	II	III	IV	V	VI	VII	VIII
element	R	S	T	V	W	X	Y	Z

The letters are not their chemical symbols.

Which statement is correct?

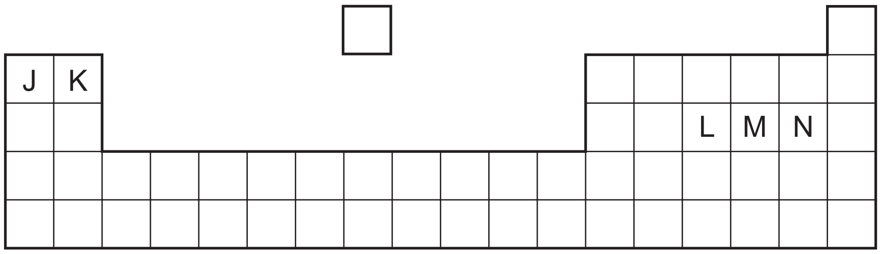
A Element R does not conduct electricity.

B Elements R and Y react together to form an ionic compound.

C Element Z exists as a diatomic molecule.

D Element Z reacts with element T.

22 Part of the Periodic Table is shown.



Which pairs of the elements J, K, L, M and N react together to form a product with a 1 : 1 ratio?

A J and L K and M

B J and M K and N

C J and N K and L

D J and N K and M

23 Which property is shown by transition metals but **not** shown by Group I metals?

A good electrical conductivity

B good thermal conductivity

C loss of electrons to form positive ions

D variable oxidation states

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

Which statement explains why noble gases are unreactive?

A They all have eight electrons in their outer shells.

B They all have full outer shells.

C They are all gases.

D They are all monoatomic.

25 Which statement is correct for **all** metals?

A They conduct electricity when molten.

B They gain electrons when they form ions.

C They have a low density.

D They have a low melting point.

26 Chromium is a more reactive metal than iron but less reactive than zinc.

Which statements are correct?

1 Chromium does not react with dilute hydrochloric acid.

2 Chromium oxide is reduced when it is heated with carbon.

3 Chromium reacts with zinc oxide to form zinc.

4 Chromium reacts with steam to form hydrogen gas.

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

27 Aluminium objects do not need protection from corrosion.

Iron objects must be protected from corrosion.

Which statement explains why aluminium resists corrosion?

A Aluminium does not form ions easily.

B Aluminium does not react with water or air.

C Aluminium has a protective oxide layer.

D Aluminium is below iron in the reactivity series.

28 Which statement describes how oxides of nitrogen are formed in a car engine?

A Nitrogen from the air reacts with oxygen from petrol.

B Nitrogen from the air reacts with oxygen from the air.

C Nitrogen from petrol reacts with oxygen from petrol.

D Nitrogen from petrol reacts with oxygen from the air.

29 Ships are made of steel, an alloy of iron.

Blocks of magnesium are attached to the underside of ships to prevent rusting.

Which statement explains how the magnesium prevents rusting?

A Magnesium oxidises instead of iron.

B Magnesium stops air and water getting to the iron.

C The magnesium forms an alloy with iron which does not corrode.

D The magnesium reacts with rust as soon as it is formed.

30 Which process is used to produce hydrogen for the Haber process?

A electrolysis of water

B reacting aluminium with sodium hydroxide

C reacting iron with sulfuric acid

D reacting methane with steam

31 One of the steps in manufacturing sulfuric acid in the Contact process is shown.

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

Which catalyst is used to increase the rate of this reaction?

A aluminium oxide

B iron

C phosphoric acid

D vanadium(V) oxide

32 Lime (calcium oxide) is used to treat waste water from a factory.

Which substance is removed by the lime?

A ammonia

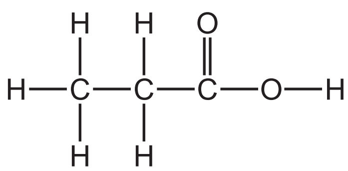
B sodium chloride

C sodium hydroxide

D sulfuric acid

33 What is the structure of propanol?

A



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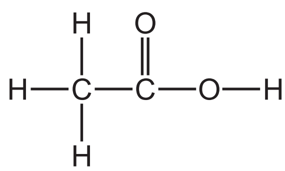
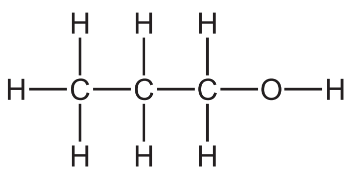
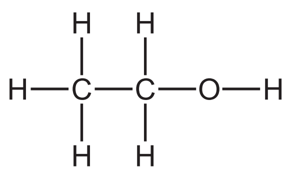


C



D



34 Fuel X produces carbon dioxide and water when it is burned in air. So does fuel Y.

What could X and Y be?

	X	Y
A	C	H_2
B	C	C_8H_{18}
C	CH_4	H_2
D	CH_4	C_8H_{18}

35 What is the main constituent of natural gas?

A hydrogen

B carbon monoxide

C methane

D nitrogen

36 Which statement describes the members of a homologous series?

A compounds with the same physical properties

B compounds containing the same functional group

C compounds containing the same number and type of bonds

D compounds obtained from the same raw material

37 The structures of two compounds are shown.

Which statements about these compounds are correct?

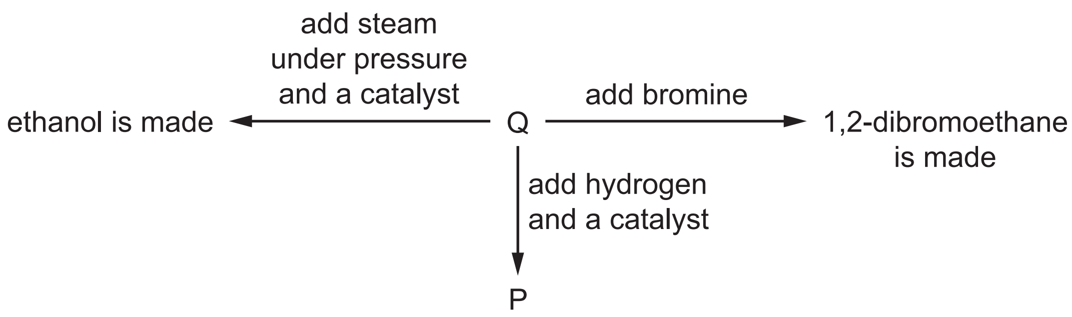
1 They have the same molecular formula.

2 They have similar chemical properties.

3 They are structural isomers.

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

38 Some reactions of substance Q are shown.



What is P?

A ethane

B ethanoic acid

C ethene

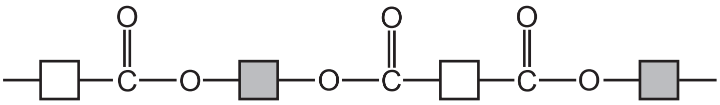
D poly(ethene)

39 Proteins and starch are natural polymers.

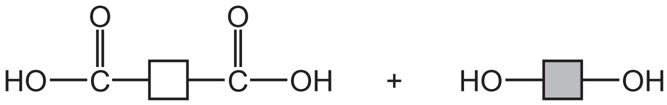
Which row identifies the method of polymerisation of proteins and starch?

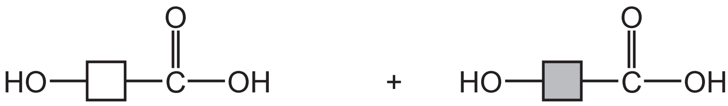
	proteins	starch
A	addition	addition
B	condensation	condensation
C	addition	condensation
D	condensation	addition

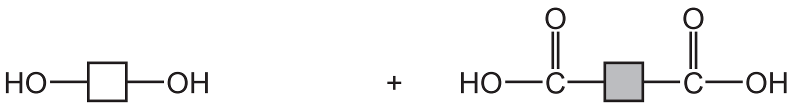
40 The diagram shows the partial structure of *Terylene*.

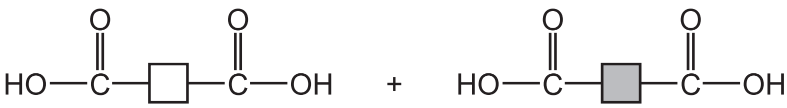


From which pair of compounds is it made?

A 

B 

C 

D 

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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

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

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2021**

45 minutes

You must answer on the multiple choice answer sheet.

* 8 1 8 1 2 2 1 3 7 2 *

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

INSTRUCTIONS

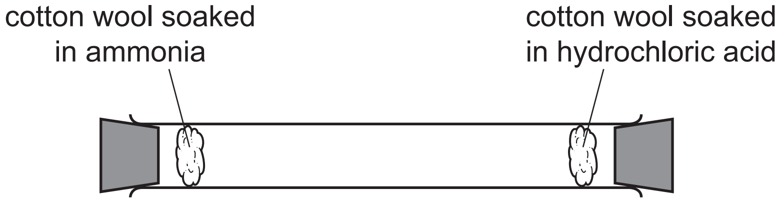
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the 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

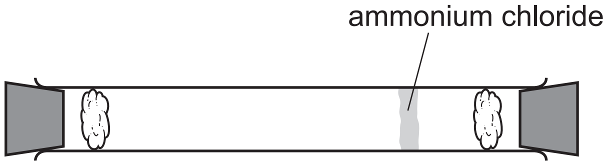
- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

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

1 An experiment is set up as shown.



After several minutes, a white ring of ammonium chloride appears as shown.



Which statement explains the observation after several minutes?

A Ammonia gas diffuses faster than hydrogen chloride gas because its molecules have a lower molecular mass.

B Ammonia gas diffuses faster than hydrogen chloride gas because its molecules have a higher molecular mass.

C Ammonia gas diffuses slower than hydrogen chloride gas because its molecules have a lower molecular mass.

D Ammonia gas diffuses slower than hydrogen chloride gas because its molecules have a higher molecular mass.

2 A student put exactly 25.00 cm^3 of dilute hydrochloric acid into a conical flask.

The student added 2.5 g of solid sodium carbonate and measured the change in temperature of the mixture.

Which apparatus does the student need to use?

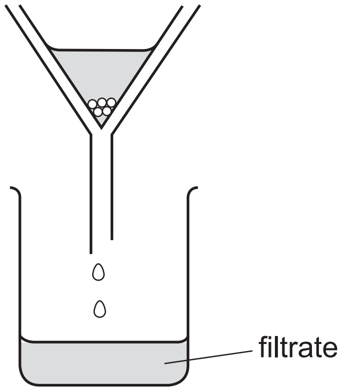
A balance, measuring cylinder, thermometer

B balance, pipette, stopwatch

C balance, pipette, thermometer

D burette, pipette, thermometer

3 A student separates sugar from pieces of broken glass by dissolving the sugar in water and filtering off the broken glass.



What is the filtrate?

A broken glass only

B broken glass and sugar solution

C pure water

D sugar solution

4 How many protons, neutrons and electrons are there in one atom of the isotope $^{27}_{13}\mathrm{A}l$?

	protons	neutrons	electrons
A	13	13	13
B	13	14	13
C	14	13	13
D	14	14	13

5 Which description of brass is correct?

A alloy

B compound

C element

D non-metal

6 Some properties of diamond are shown.

1 It is very hard.

2 Every atom forms four bonds.

3 It does not conduct electricity.

Which properties are also shown by silicon(IV) oxide?

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

7 Which statement describes the attractive forces between molecules?

A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

8 Which substance is described as a macromolecule?

A ammonia

B graphite

C iron

D sodium chloride

9 The equation for the reaction of sodium with water is shown.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

What is the volume of hydrogen gas, measured at r.t.p., produced when 18.4 g of sodium reacts with excess water?

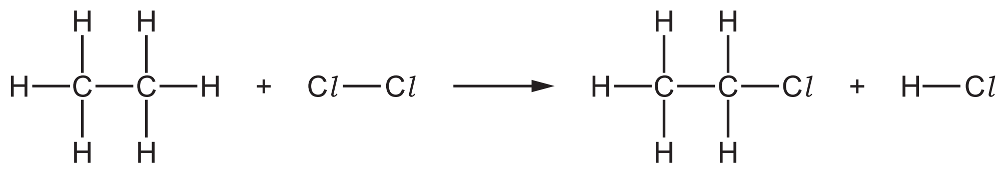
A $9.6\,dm^3$ **B** $15.0\,dm^3$ **C** $19.2\,dm^3$ **D** $30.0\,dm^3$

10 Iron can be electroplated with zinc to make it resistant to corrosion.

Which row about electroplating iron with zinc is correct?

	positive electrode (anode)	negative electrode (cathode)	electrolyte
A	iron	zinc	iron nitrate
B	iron	zinc	zinc nitrate
C	zinc	iron	iron nitrate
D	zinc	iron	zinc nitrate

11 Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

bond	bond energy in kJ / mol
C–Cl	+340
C–C	+350
C–H	+410
Cl–Cl	+240
H–Cl	+430

What is the energy change for the reaction?

A –1420 kJ / mol

B –120 kJ / mol

C +120 kJ / mol

D +1420 kJ / mol

12 Chlorine gas is bubbled into aqueous potassium iodide.

What is the ionic equation for the reaction that takes place?

A $Cl + I^- \rightarrow Cl^- + I$

B $Cl_2 + 2I^- \rightarrow Cl_2^- + I_2$

C $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$

D $Cl_2 + 2I^- \rightarrow 2Cl^- + 2I$

13 Concentrated aqueous sodium chloride is electrolysed.

Which equation represents the reaction at the cathode?

A $Na^+ + e^- \rightarrow Na$

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

C $2H^+ + 2e^- \rightarrow H_2$

D $2Cl^- \rightarrow Cl_2 + 2e^-$

14 Which statements about hydrogen are correct?

1 When hydrogen is burned, heat energy is released.

2 When hydrogen is used in a fuel cell, electrical energy is generated.

3 When hydrogen is used as a fuel, water is the only product.

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

15 Solid X is heated strongly.

The colour of the solid changes from blue to white.

What is solid X?

A anhydrous cobalt(II) chloride

B calcium carbonate

C hydrated copper(II) sulfate

D lead(II) bromide

16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.

$$2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$$

Which statements about this reaction are correct?

1 Fe^{2+} ions are reduced to Fe^{3+} ions.

2 Chlorine acts as a reducing agent.

3 Fe^{2+} ions each lose an electron.

4 Cl_2 molecules are reduced to Cl^- ions.

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

17 Which statements about acids and bases are correct?

1 An acid reacts with a metal to give off hydrogen.

2 A base reacts with an ammonium salt to give off ammonia.

3 An acid reacts with a carbonate to give off carbon dioxide.

4 Alkaline solutions are orange in methyl orange.

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

18 Oxide 1 is a solid that reacts with dilute hydrochloric acid.

Oxide 2 is a gas that reacts with sodium hydroxide solution.

What are the formulae of the oxides?

	oxide 1	oxide 2
A	CaO	MgO
B	MgO	NO_2
C	NO_2	SO_2
D	SO_2	CaO

19 Which reaction is a photochemical reaction?

A addition of bromine to propene

B esterification of ethanol and ethanoic acid

C oxidation of ethanol

D substitution of methane with chlorine

20 The equation shown represents a reaction at equilibrium.

m and n represent the balancing numbers for the reactant and product respectively.

$$mP(g) \rightleftharpoons nQ(g)$$

A high temperature increases the concentration of Q.

A high pressure increases the concentration of Q.

Which statement about the reaction is correct?

A The forward reaction is exothermic and m is greater than n.

B The forward reaction is exothermic and m is less than n.

C The forward reaction is endothermic and m is greater than n.

D The forward reaction is endothermic and m is less than n.

21 A period of the Periodic Table is shown.

group	I	II	III	IV	V	VI	VII	VIII
element	R	S	T	V	W	X	Y	Z

The letters are not their chemical symbols.

Which statement is correct?

A Element R does not conduct electricity.

B Elements R and Y react together to form an ionic compound.

C Element Z exists as a diatomic molecule.

D Element Z reacts with element T.

22 All metal nitrates are soluble in water.

All metal chlorides are soluble except silver and lead.

All metal carbonates are insoluble except sodium and potassium.

Which aqueous solutions produce a precipitate when mixed together?

1 silver nitrate + sodium carbonate

2 silver nitrate + sodium chloride

3 barium nitrate + potassium chloride

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

23 Which row describes properties of transition elements?

	property 1	property 2	property 3
A	coloured compounds	high density	variable oxidation states
B	high density	high melting point	one oxidation state
C	high melting point	coloured compounds	one oxidation state
D	low melting point	high density	variable oxidation states

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

Which statement explains why noble gases are unreactive?

A They all have eight electrons in their outer shells.

B They all have full outer shells.

C They are all gases.

D They are all monoatomic.

25 Which statement is correct for **all** metals?

A They conduct electricity when molten.

B They gain electrons when they form ions.

C They have a low density.

D They have a low melting point.

26 Carbon dioxide is produced during the extraction of aluminium from bauxite.

Which statement describes how this carbon dioxide is made?

A Carbon monoxide reduces aluminium oxide forming carbon dioxide and aluminium.

B Carbon is burned in the blast furnace to release heat energy.

C Oxygen made in the process reacts with the carbon electrode.

D The ore of aluminium undergoes thermal decomposition.

27 Aluminium objects do not need protection from corrosion.

Iron objects must be protected from corrosion.

Which statement explains why aluminium resists corrosion?

A Aluminium does not form ions easily.

B Aluminium does not react with water or air.

C Aluminium has a protective oxide layer.

D Aluminium is below iron in the reactivity series.

28 Which statements explain why zinc is used to protect iron from rusting?

1 Zinc is more reactive than iron.

2 Zinc is less reactive than iron.

3 Zinc can form alloys with iron.

4 Zinc acts as a sacrificial metal.

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

29 Which conditions are used in the Haber process?

	temperature / °C	pressure / atmospheres
A	100	10
B	450	10
C	450	200
D	1000	500

30 Which process does **not** produce a greenhouse gas?

A acid rain on limestone buildings

B combustion of wood

C digestion in cows

D zinc reacting with sulfuric acid

31 Which reaction involving sulfur dioxide is correct?

A It is produced during the extraction of zinc from zinc blende.

B It reacts with concentrated sulfuric acid to form oleum.

C It reacts with sulfur to form sulfur trioxide.

D It turns an acidified solution of potassium manganate(VII) purple.

32 Lime (calcium oxide) is used to treat waste water from a factory.

Which substance is removed by the lime?

A ammonia

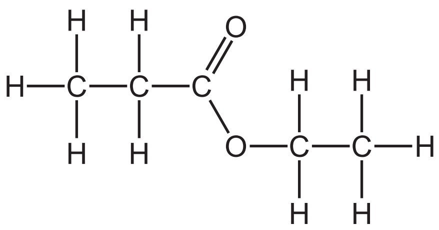
B sodium chloride

C sodium hydroxide

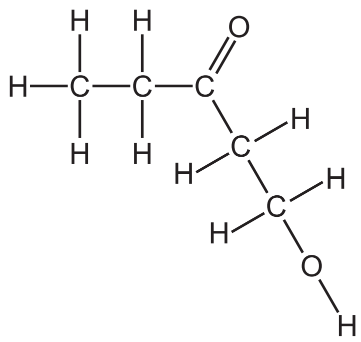
D sulfuric acid

33 What is the structure of the ester formed from ethanoic acid and propanol?

A



B



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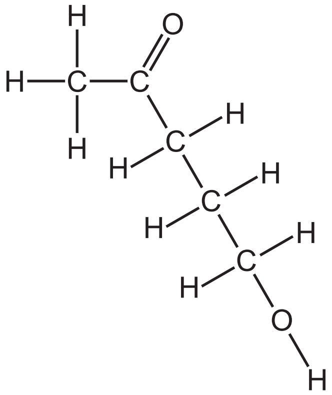
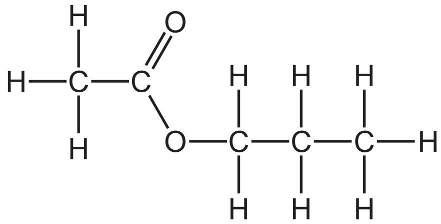


D

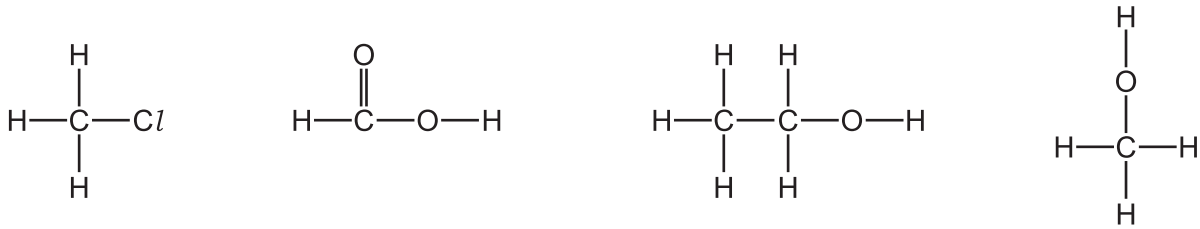


34 Fuel X produces carbon dioxide and water when it is burned in air. So does fuel Y.

What could X and Y be?

	X	Y
A	C	H_2
B	C	C_8H_{18}
C	CH_4	H_2
D	CH_4	C_8H_{18}

35 The structures of four organic molecules are shown.



How many different homologous series are represented by these molecules?

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

36 Which statement about ethene is correct?

A It has the chemical formula C_2H_6.

B It burns in excess oxygen producing carbon dioxide and water.

C It reacts with Br_2 to produce an orange solution.

D It reacts with oxygen to form ethanol.

37 Ethanol is manufactured by fermentation of sugars or by catalytic hydration of ethene.

Which row states an advantage of each method?

	fermentation	hydration
A	produces purer ethanol	is a batch process
B	produces purer ethanol	is a continuous process
C	uses a renewable resource	is a batch process
D	uses a renewable resource	is a continuous process

38 Which statements about unsaturated hydrocarbons are correct?

1 They contain both single and double bonds.

2 They turn aqueous bromine from colourless to brown.

3 They can be manufactured by cracking.

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

39 Which polymers have the same linkage between monomer units?

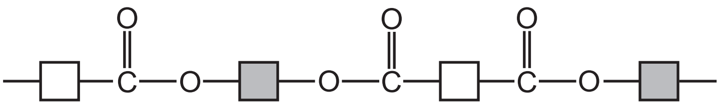
A carbohydrate and polyamide

B carbohydrate and polyester

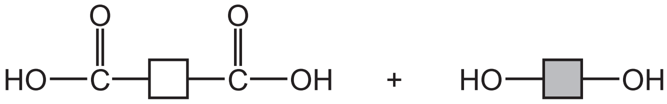
C protein and polyamide

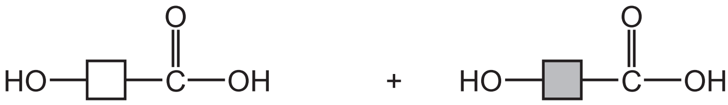
D protein and polyester

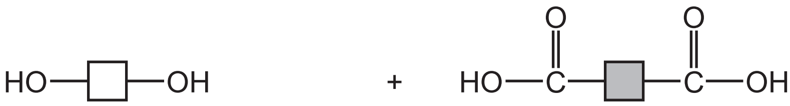
40 The diagram shows the partial structure of *Terylene*.

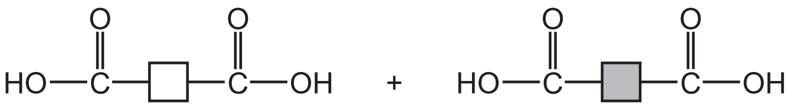


From which pair of compounds is it made?

A 

B 

C 

D 

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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

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

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2021**

45 minutes

You must answer on the multiple choice answer sheet.

3450275905

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.

IB21 11_0620_21/2RP

1 Decane has a freezing point of –30 °C and a boiling point of 174 °C.

A small sample of decane is placed in an open beaker in an oven at a temperature of 120 °C and at atmospheric pressure for 24 hours.

What happens to the sample of decane?

A It boils.

B It evaporates.

C It melts.

D It sublimes.

2 A student put exactly 25.00 cm^3 of dilute hydrochloric acid into a conical flask.

The student added 2.5 g of solid sodium carbonate and measured the change in temperature of the mixture.

Which apparatus does the student need to use?

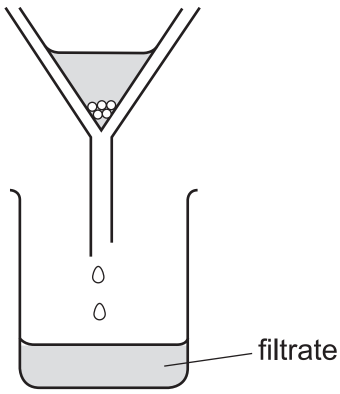
A balance, measuring cylinder, thermometer

B balance, pipette, stopwatch

C balance, pipette, thermometer

D burette, pipette, thermometer

3 A student separates sugar from pieces of broken glass by dissolving the sugar in water and filtering off the broken glass.



What is the filtrate?

A broken glass only

B broken glass and sugar solution

C pure water

D sugar solution

4 Which statement explains why metals conduct electricity when solid?

A They have atoms which are free to move.

B They have electrons which are free to move.

C They have molecules which are free to move.

D They have positive ions which are free to move.

5 Which description of brass is correct?

A alloy

B compound

C element

D non-metal

6 The equation for the reaction of iron(III) oxide with carbon monoxide is shown.

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

What is the maximum mass of iron that can be made from 480 g of iron(III) oxide?

A 56 g **B** 112 g **C** 168 g **D** 336 g

7 Which statement describes the attractive forces between molecules?

A They are strong covalent bonds which hold molecules together.

B They are strong ionic bonds which hold molecules together.

C They are weak forces formed between covalently-bonded molecules.

D They are weak forces which hold ions together in a lattice.

8 Which statement about carbon is correct?

A Diamond and graphite both have simple molecular structures.

B Diamond and graphite are both used to make cutting tools.

C Each carbon atom in diamond is bonded to three other carbon atoms.

D Graphite conducts electricity and has a giant covalent structure.

9 The formula of an aluminium ion is Al^{3+}.

What is the formula of aluminium sulfate?

A Al_2SO_4 **B** $Al(SO_4)_2$ **C** $Al_2(SO_4)_3$ **D** $Al_3(SO_4)_2$

10 Which statements about the products of electrolysis, using inert electrodes, are correct?

1 When molten lead(II) bromide is electrolysed, bromine is formed at the cathode.

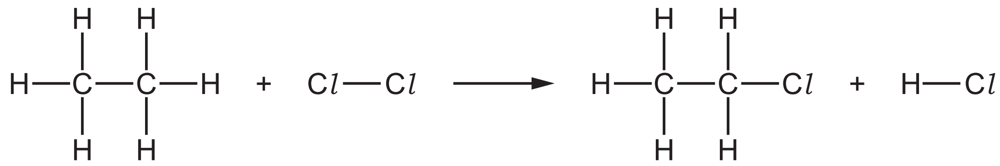
2 When dilute sulfuric acid is electrolysed, oxygen is formed at the anode.

3 When concentrated aqueous sodium chloride is electrolysed, sodium is formed at the cathode.

4 When concentrated hydrochloric acid is electrolysed, chlorine is formed at the anode.

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

11 Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

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

What is the energy change for the reaction?

A –1420 kJ / mol

B –120 kJ / mol

C +120 kJ / mol

D +1420 kJ / mol

12 Hydrogen is used as a fuel in rockets and is also used in hydrogen fuel cells.

Which statements are correct?

1 Both uses produce water vapour.

2 Burning hydrogen produces polluting gases.

3 A fuel cell produces electricity.

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

13 Which statements about the effect of increasing the temperature on the rate of a reaction are correct?

1 It increases the rate of a reaction.

2 It increases the activation energy.

3 It increases the frequency of collisions.

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

14 Ammonia is made by reacting nitrogen with hydrogen.

The equation for the reaction is shown.

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

The forward reaction is exothermic.

Which changes in temperature and pressure decrease the yield of ammonia?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

15 X is a pink solid.

Y is a blue solid.

When X is heated, water is produced and the solid turns blue.

When water is added to Y, the solid turns pink.

What are X and Y?

	X	Y
A	anhydrous cobalt(II) chloride	hydrated cobalt(II) chloride
B	hydrated cobalt(II) chloride	anhydrous cobalt(II) chloride
C	anhydrous copper(II) sulfate	hydrated copper(II) sulfate
D	hydrated copper(II) sulfate	anhydrous copper(II) sulfate

16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.

$$2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$$

Which statements about this reaction are correct?

1 Fe^{2+} ions are reduced to Fe^{3+} ions.

2 Chlorine acts as a reducing agent.

3 Fe^{2+} ions each lose an electron.

4 Cl_2 molecules are reduced to Cl^- ions.

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

17 Which row describes the properties of an acid?

	property 1	property 2
A	proton acceptor	pH less than 7
B	proton acceptor	pH more than 7
C	proton donor	pH less than 7
D	proton donor	pH more than 7

18 Which element forms an amphoteric oxide?

A aluminium

B carbon

C magnesium

D silicon

19 Copper(II) chloride crystals are made by adding solid copper(II) carbonate to dilute hydrochloric acid until no more dissolves.

Which process is used to obtain pure copper(II) chloride crystals from the mixture?

A distillation of the mixture

B evaporation of the mixture

C filtration followed by drying of the residue

D filtration followed by evaporation of the filtrate

20 Moving from right to left across the Periodic Table the elements show increasing metallic character.

Why does metallic character increase from right to left across a period?

A The atoms have more electrons in their outer shells.

B The atoms more readily gain electrons to form negative ions.

C The atoms more readily lose electrons to form positive ions.

D The charge on the nucleus of each atom gets larger.

21 A period of the Periodic Table is shown.

group	I	II	III	IV	V	VI	VII	VIII
element	R	S	T	V	W	X	Y	Z

The letters are not their chemical symbols.

Which statement is correct?

A Element R does not conduct electricity.

B Elements R and Y react together to form an ionic compound.

C Element Z exists as a diatomic molecule.

D Element Z reacts with element T.

22 Group VII elements show trends in their physical properties going down the group.

element	X	Y	Z
chlorine	–101	–34	0.003
bromine	–7	59	3.1
iodine	114	184	4.9

Which row shows the missing headings for the properties in the table?

	X	Y	Z
A	density in g/cm^3	boiling point in °C	melting point in °C
B	melting point in °C	boiling point in °C	density in g/cm^3
C	boiling point in °C	density in g/cm^3	melting point in °C
D	boiling point in °C	melting point in °C	density in g/cm^3

23 Some properties of two metals, G and H, are shown.

metal G	metal H
the formula of the chloride is GCl	high melting point
reacts with cold water	has more than one oxidation state

Which row about metals G and H is correct?

	metal G	metal H
A	in Group I of the Periodic Table	in Group II of the Periodic Table
B	in Group I of the Periodic Table	transition metal
C	in Group II of the Periodic Table	in Group I of the Periodic Table
D	in Group II of the Periodic Table	transition metal

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

Which statement explains why noble gases are unreactive?

A They all have eight electrons in their outer shells.

B They all have full outer shells.

C They are all gases.

D They are all monoatomic.

25 Which statement is correct for **all** metals?

A They conduct electricity when molten.

B They gain electrons when they form ions.

C They have a low density.

D They have a low melting point.

26 Which statement about the extraction of metals is correct?

A Aluminium is extracted from the ore bauxite by electrolysis.

B Aluminium is extracted from the ore hematite by electrolysis.

C Iron is extracted from the ore bauxite by electrolysis.

D Iron is extracted from the ore hematite by electrolysis.

27 Aluminium objects do not need protection from corrosion.

Iron objects must be protected from corrosion.

Which statement explains why aluminium resists corrosion?

A Aluminium does not form ions easily.

B Aluminium does not react with water or air.

C Aluminium has a protective oxide layer.

D Aluminium is below iron in the reactivity series.

28 Which statements about the thermal decomposition of copper(II) nitrate are correct?

1 A brown gas is given off.

2 A gas which relights a glowing splint is given off.

3 The solid residue is an acidic oxide.

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

29 Covering iron with zinc prevents the iron from rusting even when the zinc is scratched.

Covering iron with tin prevents the iron from rusting, but when the tin is scratched the iron underneath starts to rust.

Which statement is correct?

A Both tin and zinc prevent iron from rusting by sacrificial protection.

B Both tin and zinc prevent iron from rusting by stopping water and carbon dioxide reaching the iron.

C Tin is more reactive than iron and prevents iron from rusting until it is scratched.

D Zinc loses electrons more easily than iron and prevents iron from rusting by corroding first.

30 Which statements about the Haber process are correct?

1 One of the raw materials is extracted from liquid air by fractional distillation.

2 One of the raw materials is produced by the reaction of steam and methane.

3 The catalyst for the Haber process is vanadium(V) oxide.

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

31 Which raw material is used in the Contact process?

A air

B ammonia

C carbon

D nitrogen

32 Lime (calcium oxide) is used to treat waste water from a factory.

Which substance is removed by the lime?

A ammonia

B sodium chloride

C sodium hydroxide

D sulfuric acid

33 An alkane molecule of molecular formula C_8H_{18} undergoes cracking. The equation for the reaction is shown.

$$C_8H_{18} \rightarrow Q + 2R$$

Substance R has two carbon atoms per molecule and decolourises aqueous bromine.

What is substance Q?

A butane

B butene

C ethane

D ethene

34 Fuel X produces carbon dioxide and water when it is burned in air. So does fuel Y.

What could X and Y be?

	X	Y
A	C	H_2
B	C	C_8H_{18}
C	CH_4	H_2
D	CH_4	C_8H_{18}

35 Which molecule contains only single covalent bonds?

A propane

B propanoic acid

C propene

D propyl propanoate

36 Alkanes react with chlorine to form chloroalkanes.

Which statement about the reactions of alkanes with chlorine is correct?

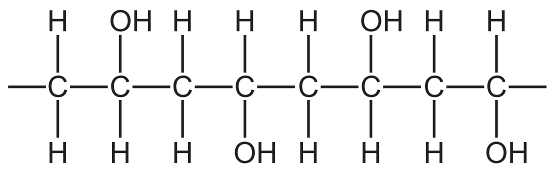
A Alkanes react with chlorine by addition.

B The gaseous product turns red litmus blue.

C The chlorine atom in chloroethane is covalently bonded.

D The general formula of the chloroalkanes is $C_nH_{2n}Cl$.

37 Part of the structure of a very large molecule is shown.



Which term describes the small unit used to make this molecule?

A hydrocarbon

B monomer

C polymer

D saturated

38 Propene reacts with steam to form propanol.

$$C_3H_6(g) + H_2O(g) \rightarrow C_3H_7OH(g)$$

Which type of reaction takes place?

A addition

B condensation

C oxidation

D substitution

39 Which statement about aqueous ethanoic acid is correct?

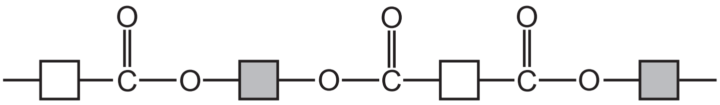
A It reacts with magnesium to produce a salt and hydrogen.

B It reacts with sodium hydroxide to produce a salt and hydrogen.

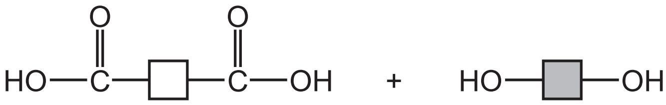
C It reacts with ammonium salts to produce ammonia.

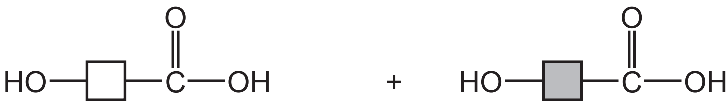
D It turns red litmus blue.

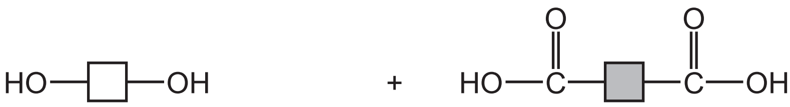
40 The diagram shows the partial structure of *Terylene*.

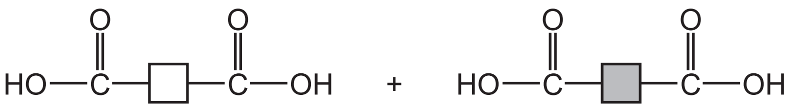


From which pair of compounds is it made?

A 

B 

C 

D 

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atomic number atomic symbol name relative atomic mass

Group

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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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87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

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

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

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Published

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

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

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

[Turn over

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

2770353343

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

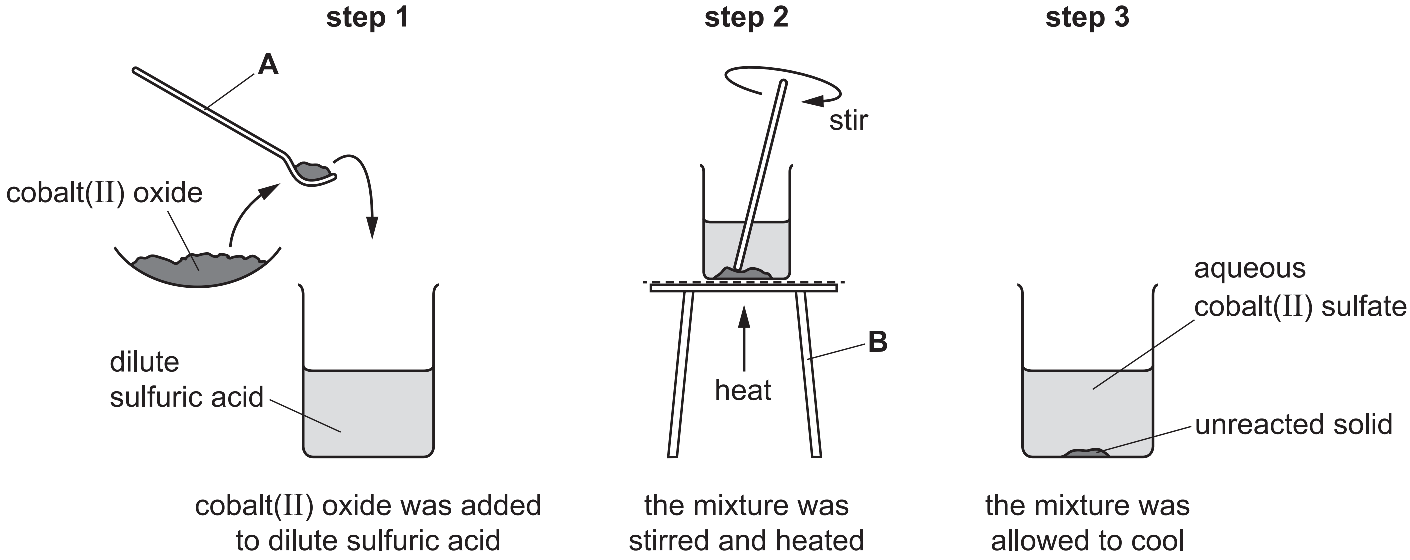
INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable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

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

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

1 Cobalt(II) sulfate is a soluble salt. It can be made by reacting insoluble cobalt(II) oxide with dilute sulfuric acid.

A student made a sample of hydrated cobalt(II) sulfate using the following steps.



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

A ....

B ....
[2]

(b) **(i)** Suggest why the mixture was heated in **step 2**.

....

.... [1]

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

.... [1]

(c) Name the reactant which was in excess.
Explain your answer.

....

.... [1]

(d) Additional steps are required to obtain pure cobalt(II) sulfate.

(i) The unreacted solid is removed from the aqueous cobalt(II) sulfate.

Name the process used to remove the unreacted solid.

.... [1]

(ii) Describe how crystals of hydrated cobalt(II) sulfate could be made from the solution obtained in **(i)**.

....

....

....

.... [2]

[Total: 8]

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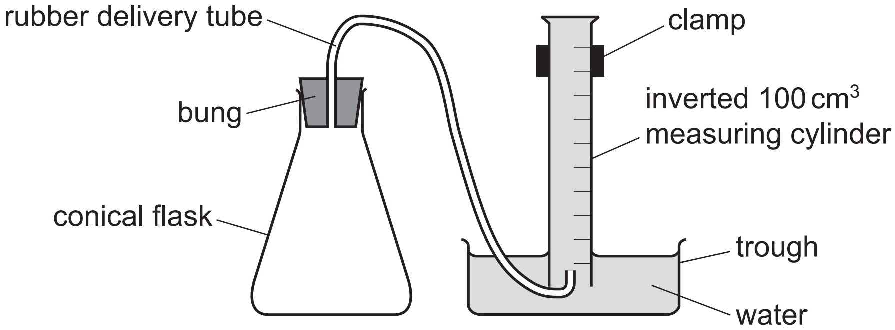
2 A student investigated the rate at which hydrogen gas was made when magnesium reacted with dilute sulfuric acid.

Five experiments were carried out using the apparatus shown.



Experiment 1
- Using a measuring cylinder, 25 cm^3 of dilute sulfuric acid was poured into a conical flask.
- Using a different measuring cylinder, 30 cm^3 of distilled water was poured into the conical flask.
- The apparatus was set up as shown in the diagram.
- The bung was removed from the conical flask.
- A coiled length of magnesium ribbon was added to the conical flask, the bung was replaced immediately and a timer started.
- The volume of gas collected in the inverted measuring cylinder after 30 seconds was measured.

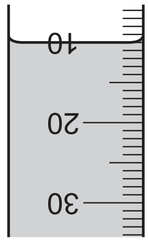
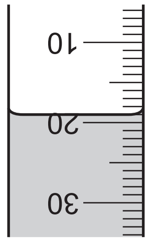
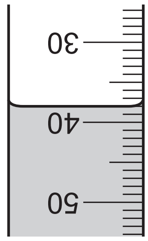
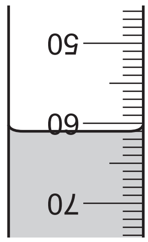
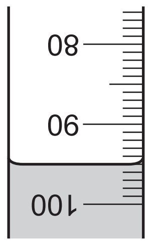
Experiment 2
- Experiment 1 was repeated using 20 cm^3 of distilled water instead of 30 cm^3.

Experiment 3
- Experiment 1 was repeated using 10 cm^3 of distilled water instead of 30 cm^3.

Experiment 4
- Experiment 1 was repeated using 5 cm^3 of distilled water instead of 30 cm^3.

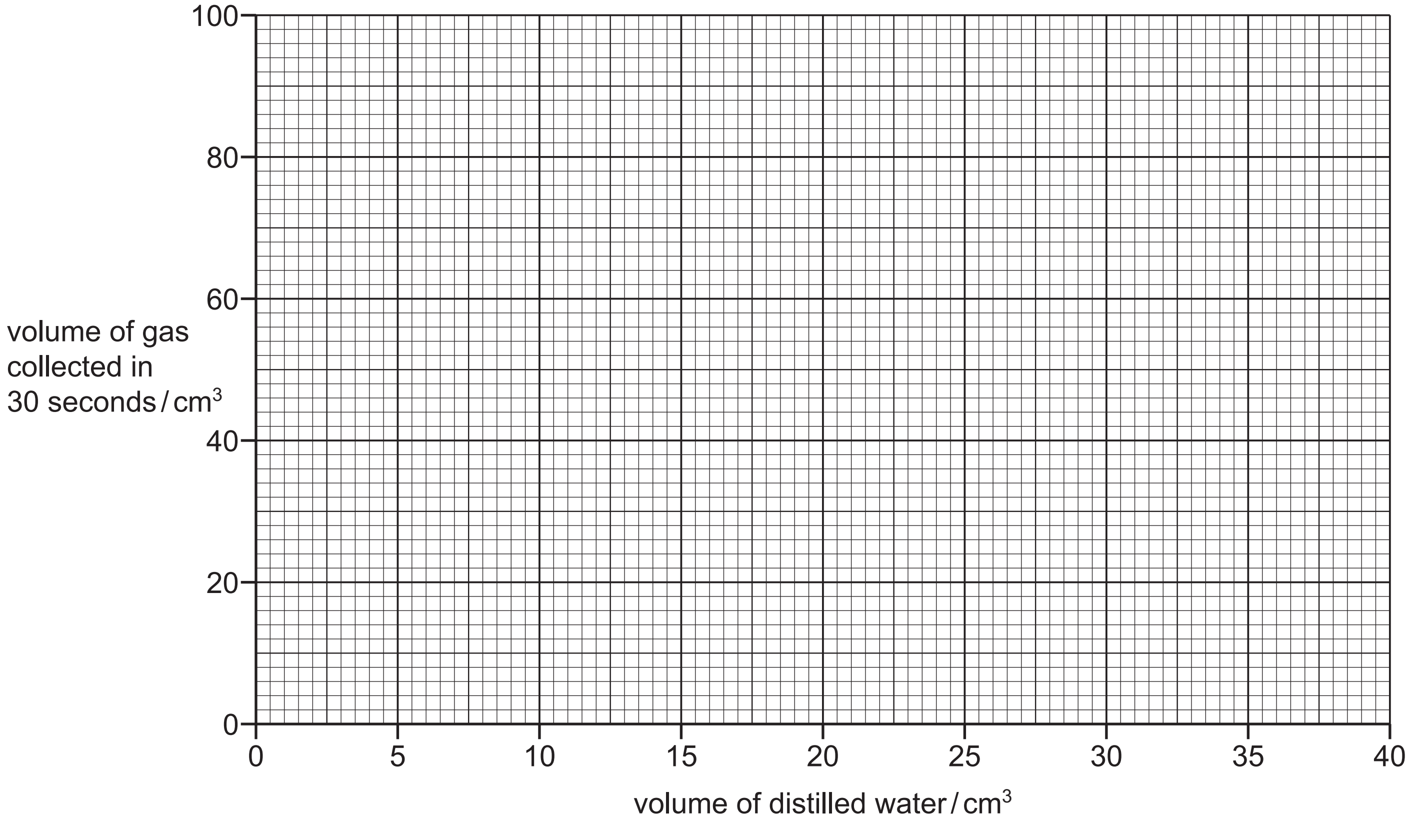
Experiment 5
- Experiment 1 was repeated without adding any distilled water to the dilute sulfuric acid.

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

experiment	volume of dilute sulfuric acid / cm^3	volume of distilled water / cm^3	inverted measuring cylinder diagram	volume of gas collected in 30 seconds / cm^3
1				
2				
3				
4				
5				

[4]

(b) Plot the results from Experiments 1 to 5 on the grid. Draw a smooth curve of best fit.



[3]

(c) Extrapolate (extend) the line on your graph and deduce the volume of gas that would be collected in 30 seconds if 35 cm^3 of distilled water was added to the dilute sulfuric acid.

.... cm^3
[2]

(d) The rate of reaction can be calculated using the equation shown.

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

(i) Use this equation to calculate the rate of reaction in Experiment 3. Give the units for the rate you have calculated.

rate = ...

units = ...
[2]

(ii) State which Experiment, 1, 2, 3, 4 or 5, had the highest rate of reaction.

.... [1]

(e) The volume of the dilute sulfuric acid was measured using a measuring cylinder. A 25 cm^3 pipette could have been used instead of a measuring cylinder.

(i) State **one** advantage of using a 25 cm^3 pipette instead of a measuring cylinder.

.... [1]

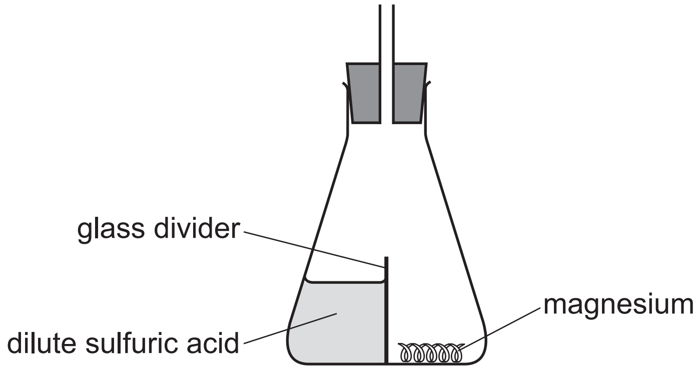
(ii) State **one** disadvantage of using a 25 cm^3 pipette instead of a measuring cylinder.

.... [1]

(f) Name another item of apparatus, which can be used instead of an inverted measuring cylinder, to collect and measure the volume of gas made in the reaction.

.... [1]

(g) The diagram shows a modified conical flask that could be used in this investigation.



Explain the advantage of using this type of conical flask instead of the type used in the investigation.

....

....

.... [2]

[Total: 17]

3 Solid **I** and solid **J** were analysed. Solid **I** was chromium(III) chloride.

tests on solid I

Complete the expected observations.

Solid **I** was placed in a boiling tube and about 10 cm^3 of distilled water was added to the boiling tube. The mixture was shaken to dissolve solid **I** and form solution **I**. Solution **I** was divided into four portions in four test-tubes.

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

observations ....

....

.... [2]

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

observations ....

....

.... [2]

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

observations .... [1]

(d) About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the fourth portion of solution **I**.

observations .... [1]

tests on solid J

tests	observations
test 1 A flame test was carried out on solid **J**.	lilac flame
The remaining solid **J** was placed in a boiling tube and about 10 cm^3 of distilled water was added to the boiling tube. The mixture was shaken to dissolve solid **J** and form solution **J**. **test 2** About 5 cm^3 of dilute nitric acid was added to solution **J**. Any gas produced was tested.	effervescence the gas turned limewater milky
test 3 A few drops of aqueous silver nitrate were added to the mixture formed in **test 2**.	no visible change

(e) Identify the gas formed in **test 2**.

.... [1]

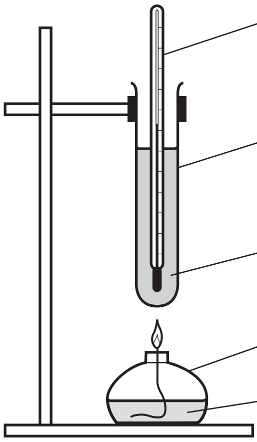
(f) Identify solid **J**.

....

.... [2]

[Total: 9]

4 The energy given out when different liquid alcohols are burned can be compared using the apparatus shown.



Describe how the apparatus shown can be used to compare the amount of energy given out by three different liquid alcohols, ethanol, propanol and butanol. Your answer should include how the results can be used to determine which fuel gives out the most energy.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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

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

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

Examples of how to apply the list rule
State **three** reasons…. [3]

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

B	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)	**A** spatula	**1**
	B tripod	**1**
1(b)(i)	to increase the rate of reaction	**1**
1(b)(ii)	Bunsen (burner)	**1**
1(c)	cobalt(II) oxide **and** solid left at end	**1**
1(d)(i)	filtration	**1**
1d(ii)	heat (to evaporate water)	**1**
	until half evaporated / point of crystallisation / until saturated (then leave to cool)	**1**

Question	Answer	Marks
2(a)	all experiments have volume of sulfuric acid of 25 cm^3	**1**
	all volumes of water correct (30, 20, 10, 5, 0) and all volumes given to the same precision	**1**
	all volume of gas collected correct (10, 19, 38, 61, 95), four volumes correct scores 1	**2**
2(b)	plotting – all 5 correct scores 2, 4 correct scores 1	**2**
	suitable best fit curve	**1**
2(c)	appropriate extrapolation of line to 35	**1**
	correct reading from extrapolation	**1**
2(d)(i)	correct calculation of volume for experiment 3; 38 / 30 = 1.27)	**1**
	cm^3 / s	**1**

Question	Answer	Marks
2(d)(ii)	5	**1**
2(e)(i)	more accurate	**1**
2(e)(ii)	slower / takes more time	**1**
2(f)	(gas) syringe	**1**
2(g)	any 2 from: • The reaction can be started by tipping the flask • do not have to replace / remove the bung • so no <u>gas</u> escapes (while the bung is being removed / replaced)	**2**

Question	Answer	Marks
	Tests on solid I	
3(a)	green precipitate	**1**
	dissolves in excess (forming a green solution)	**1**
3(b)	grey-green precipitate	**1**
	remains / does not dissolve	**1**
3(c)	white ppt	**1**
3(d)	no change	**1**
	Tests on solid J	
3(e)	carbon dioxide / CO_2	**1**

Question	Answer	Marks
3(f)	potassium / K^+	**1**
	carbonate / CO_3^{2-}	**1**

Question	Answer	Marks
4	any 6 from: • specified / set volume / mass of water • measure start temperature of water • heat water using sprit burner <u>for all three fuels</u> **and** • start timing when heating started • heat to set temperature / set temperature rise • record time • shortest time gives out most energy **OR** • measure mass of fuel (plus spirit burner) at start • heat to set temperature / set temperature rise • measure mass of fuel (plus sprit burner) at end (and subtract from first mass to fine mass of fuel used) • smallest mass used gives out most energy **OR** • put specified mass / volume of fuel in spirit burner • burn until burner goes out • measure final temperature of water and calculate temperature rise • highest temperature (rise) gives out most energy **OR** • heat water for a specified time • measure final temp of water • calculate temperature rise • highest temperature (rise) is fuel that gives out most energy	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2018500414

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

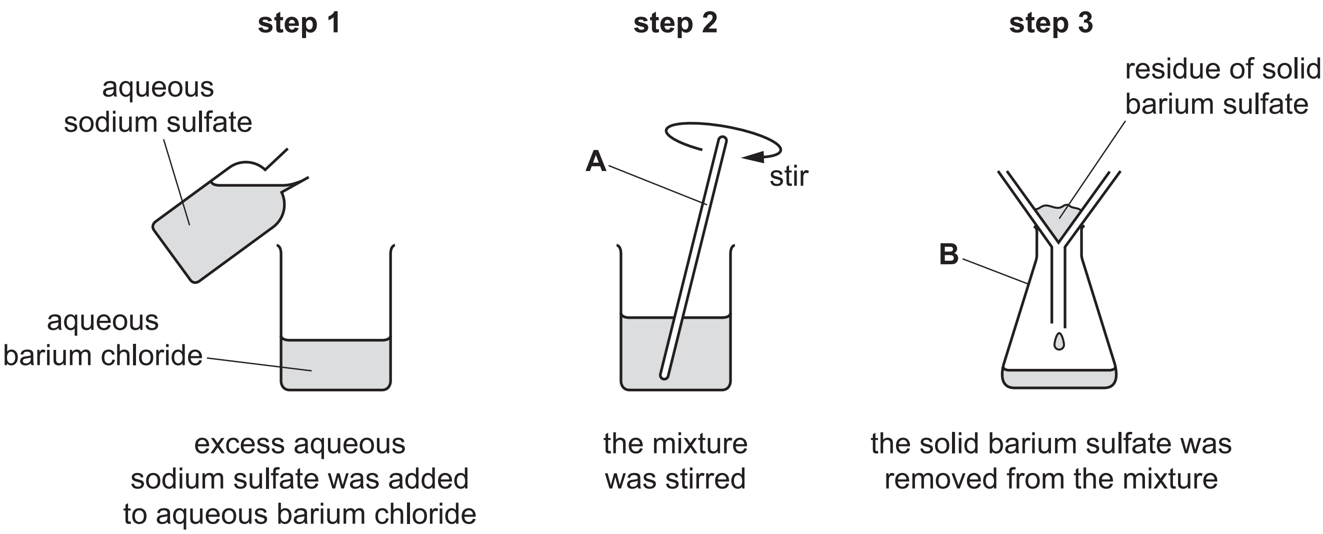
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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

1 Barium sulfate is an insoluble salt. Barium sulfate can be made by reacting excess aqueous sodium sulfate with aqueous barium chloride.

sodium sulfate + barium chloride → sodium chloride + barium sulfate

A student made a sample of barium sulfate using the following steps.



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

A ....

B ....
[2]

(b) Name the process shown in **step 3**.

.... [1]

(c) The general name for the solid in **step 3** is residue.

State the general name for the solution obtained from the process in **step 3**.

.... [1]

(d) Two more steps, **step 4** and **step 5**, are needed to obtain a pure sample of barium sulfate. In each of these steps something is removed from the residue.

State what is done in each of **step 4** and **step 5** and identify the substance removed from the barium sulfate.

step 4 ....

....

substance removed ....

step 5 ....

....

substance removed ....

[4]

[Total: 8]

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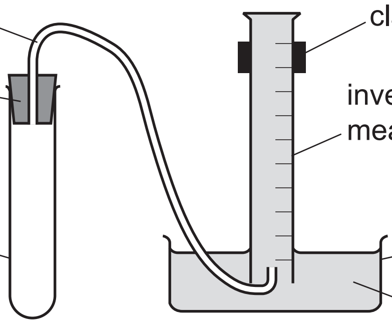
2 A student investigated the volume of gas made when sodium carbonate reacts with dilute hydrochloric acid.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 16 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The apparatus was set up as shown in the diagram.
- The bung was removed from the boiling tube.
- 2.5 g of sodium carbonate was added to the boiling tube and the bung was immediately replaced.
- When no more gas was being collected, the volume of gas in the measuring cylinder was measured.

Experiment 2

- Experiment 1 was repeated using 14 cm^3 of dilute hydrochloric acid instead of 16 cm^3.

Experiment 3

- Experiment 2 was repeated using 12 cm^3 of dilute hydrochloric acid instead of 14 cm^3.

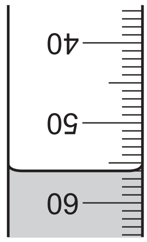
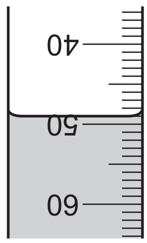
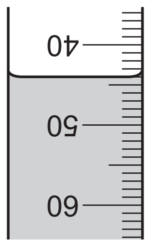
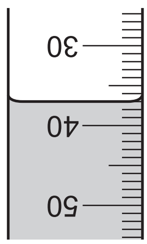
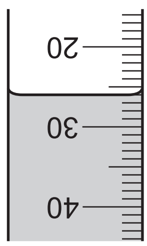
Experiment 4

- Experiment 3 was repeated using 10 cm^3 of dilute hydrochloric acid instead of 12 cm^3.

Experiment 5

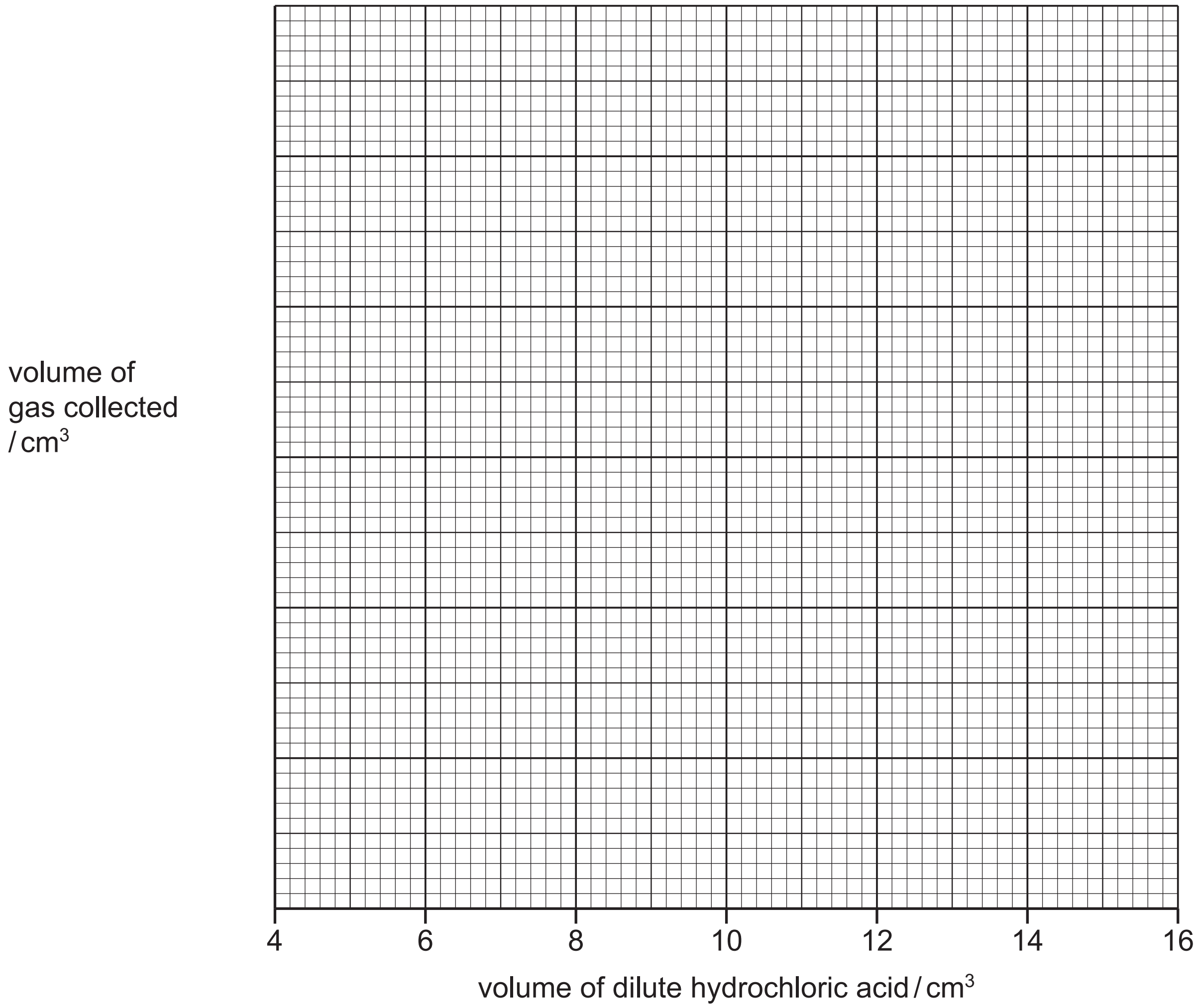
- Experiment 4 was repeated using 6 cm^3 of dilute hydrochloric acid instead of 10 cm^3.

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

experiment	volume of dilute hydrochloric acid / cm^3	inverted measuring cylinder diagram	volume of gas collected / cm^3
1			
2			
3			
4			
5			

[3]

(b) Write a suitable scale on the *y*-axis and plot the results from Experiments 1 to 5 on the grid. Draw a straight line of best fit.



[4]

(c) **(i)** **From your graph**, deduce the volume of gas that would be collected if 7 cm^3 of dilute hydrochloric acid was used.

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

.... cm^3 [2]

(ii) The volume of gas made per cm^3 of dilute hydrochloric acid can be calculated using the equation shown.

$$\text{volume of gas per cm}^3\text{ of acid} = \frac{\text{volume of gas collected in cm}^3}{\text{volume of acid in cm}^3}$$

Use this equation and your answer to **(c)(i)** to calculate the volume of gas made per cm^3 of dilute hydrochloric acid.

.... [1]

(d) The bung was removed and then replaced immediately after the sodium carbonate was added to the boiling tube.

(i) Explain why the bung must be replaced immediately after the sodium carbonate is added to the boiling tube.

....

.... [1]

(ii) Explain how the apparatus could be altered so that the bung does **not** have to be removed. You may draw a diagram to explain your answer.

....

.... [2]

(e) State **one** advantage of using a burette rather than a measuring cylinder to measure the volume of the dilute hydrochloric acid.

.... [1]

(f) In Experiments 1 to 5, the sodium carbonate was in excess.

Sketch **on the grid** the graph you would expect if all of the experiments were repeated using dilute hydrochloric acid of half the concentration.

Label your line **F**. [2]

[Total: 16]

3 Solution **G** and solid **H** were analysed.

tests on solution G

tests	observations
Solution **G** was divided into three equal portions in three test-tubes. **test 1** Sodium hydroxide was added dropwise and then in excess to the first portion of solution **G**.	white precipitate which did not dissolve in excess
test 2 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the second portion of solution **G**.	yellow precipitate
test 3 About 10 cm^3 of aqueous hydrogen peroxide was added to the third portion of solution **G**. The gas produced was tested.	the mixture became brown and bubbled; the gas relit a glowing splint

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

.... [1]

(b) Use the results of **test 1** and **test 2** to identify solution **G**.

....

....

.... [2]

tests on solid H

Solid **H** was hydrated copper(II) sulfate.

Complete the expected observations.

(c) About half of solid **H** was placed in a boiling tube and heated using a Bunsen burner.

observations ....

.... [2]

(d) A flame test was carried out on solid **H**.

observations .... [1]

The remaining solid **H** was placed in a boiling tube. About 10 cm^3 of distilled water was added to the boiling tube. The tube was shaken to dissolve solid **H** and form solution **H**.

Solution **H** was divided into two approximately equal portions in two test-tubes.

(e) Aqueous ammonia was added dropwise and then in excess to the first portion of solution **H**.

observations ....

....

.... [3]

(f) Approximately 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of solution **H**.

observations .... [1]

[Total: 10]

4 The mineral epsomite contains hydrated magnesium sulfate. When epsomite is heated strongly, it loses water and eventually becomes anhydrous magnesium sulfate.

Plan an investigation to find the percentage by mass of water in a sample of epsomite. Your plan should include how you would calculate the percentage by mass of water in epsomite.
You have access to common laboratory apparatus.

....

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.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2021**

MARK SCHEME

Maximum Mark: 40

Published

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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)	**A** glass / stirring rod	**1**
	B (conical) flask	**1**
1(b)	filtration	**1**
1(c)	filtrate	**1**
1(d)	step 4: wash / rinse (with water)	**1**
	to remove sodium sulfate / sodium chloride	**1**
	step 5: dry	**1**
	water	**1**

Question	Answer	Marks
2(a)	all volumes of dilute hydrochloric acid correct (16, 14, 12, 10, 6)	**1**
	all volumes recorded correctly, 4 correct scores 1 (56, 49, 44, 37, 26)	**2**
2(b)	suitable scale for *y*-axis	**1**
	plotting – all 5 correct scores 2, 4 correct scores 1	**2**
	line drawn is a straight line of best fit	**1**
2(c)(i)	correct reading from graph (usually 29 cm^3)	**1**
	working shown on graph	**1**
2(c)(ii)	answer to **(c)(i)** ÷ 7	**1**
2(d)(i)	gas escapes before bung is replaced /so that gas does not escape	**1**

Question	Answer	Marks
2(d)(ii)	either • place one reagent in tube inside boiling tube / flask • tip / shake tube to start reaction **OR** • use a divided flask • tip flask to start reaction	**2**
2(e)	more accurate	**1**
2(f)	line drawn is below plotted line	**1**
	volumes are half of the values of plotted line	**1**

Question	Answer	Marks
	Tests on solid G	
3(a)	oxygen / O_2	**1**
3(b)	calcium / Ca^{2+}	**1**
	iodide / I^-	**1**
	Tests on solid H	
3(c)	any 2 from: • white fumes given off • condensation at mouth of tube • solid (changes from blue and) becomes white	**2**
3(d)	blue-green	**1**

Question	Answer	Marks
3(e)	(light) blue precipitate	**1**
	dissolves / forms a solution / soluble (in excess)	**1**
	which is a darker / deep blue	**1**
3(f)	white precipitate	**1**

Question	Answer	Marks
4	any 6 from: • weighed sample / stated mass (e.g. 5 g) / known mass of epsomite • in a crucible • heated (strongly using a Bunsen burner / spirit burner) • reweigh • heat again, reweigh, continue until mass stops changing • calculate mass of water lost by original mass – final mass • calculate percentage water by 100 × mass water / original mass	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3435140504

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

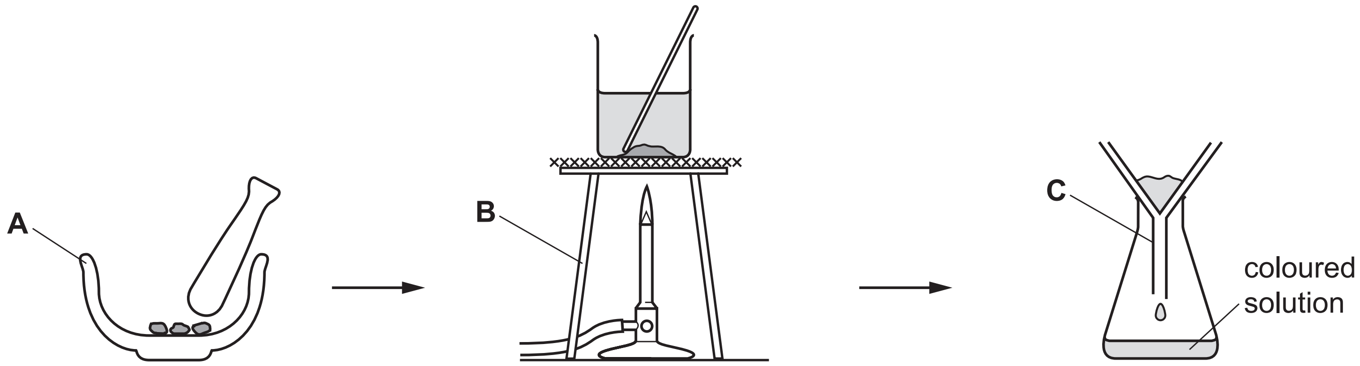
INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable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

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

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

1 Many indicators are coloured substances obtained from plants.

A student extracted the coloured substances from some berries using the method shown.



the berries were crushed → the crushed berries were heated in water to form a coloured solution → the solid was removed from the coloured solution

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

A ....

B ....

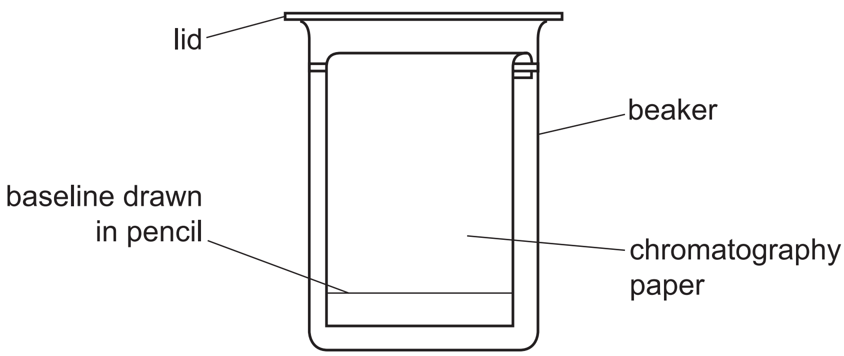
C ....

[3]

(b) The student analysed the coloured solution using chromatography.

(i) Complete the diagram to show:

- where the spot of coloured solution should be placed on the paper
- the level of the solvent in the beaker.



[2]

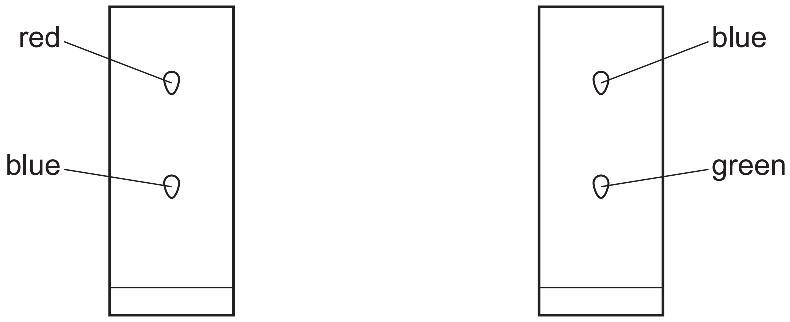
(ii) Explain why pencil is used to draw the baseline on the chromatography paper.

....

.... [1]

(c) The student made two chromatograms. After chromatography, one chromatogram was dipped in dilute hydrochloric acid and one was dipped in aqueous sodium hydroxide.

The results are shown.



chromatogram dipped in dilute hydrochloric acid

chromatogram dipped in aqueous sodium hydroxide

(i) Determine the number of coloured substances in the solution obtained from the berries.

.... [1]

(ii) The table gives the colours of some indicators in acid and alkali.

name of indicator	colour in acid	colour in alkali
anthocyanin	red	blue
bromothymol blue	yellow	blue
congo red	blue	red
methyl purple	purple	green

Use the data in the table and the results to give a possible identity for **one** indicator in the berries.

.... [1]

[Total: 8]

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2 A student investigated the temperature decrease when sodium hydrogencarbonate reacts with dilute hydrochloric acid.

The student did six experiments.

Experiment 1

- Using a measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a conical flask.
- The initial temperature of the acid was measured using a thermometer.
- 1 g of sodium hydrogencarbonate was added to the conical flask. At the same time a stop-clock was started.
- The acid and sodium hydrogencarbonate mixture in the conical flask was stirred continuously using the thermometer.
- The temperature of the mixture after 1 minute was measured.
- The conical flask was rinsed with distilled water.

Experiment 2

- Experiment 1 was repeated using 2 g of sodium hydrogencarbonate instead of 1 g.

Experiment 3

- Experiment 1 was repeated using 3 g of sodium hydrogencarbonate instead of 1 g.

Experiment 4

- Experiment 1 was repeated using 5 g of sodium hydrogencarbonate instead of 1 g.

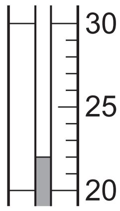
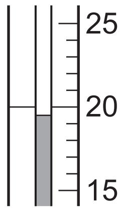
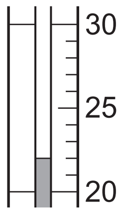
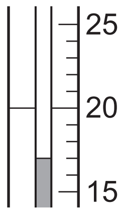
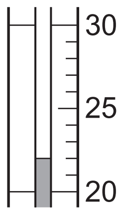
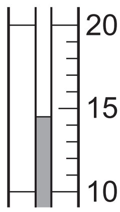
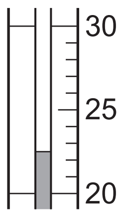
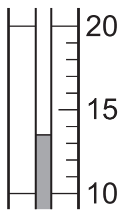
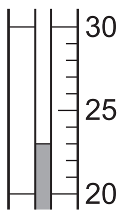
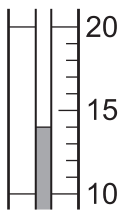
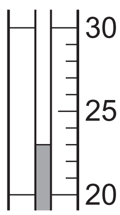
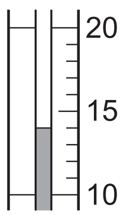
Experiment 5

- Experiment 1 was repeated using 6 g of sodium hydrogencarbonate instead of 1 g.

Experiment 6

- Experiment 1 was repeated using 7 g of sodium hydrogencarbonate instead of 1 g.

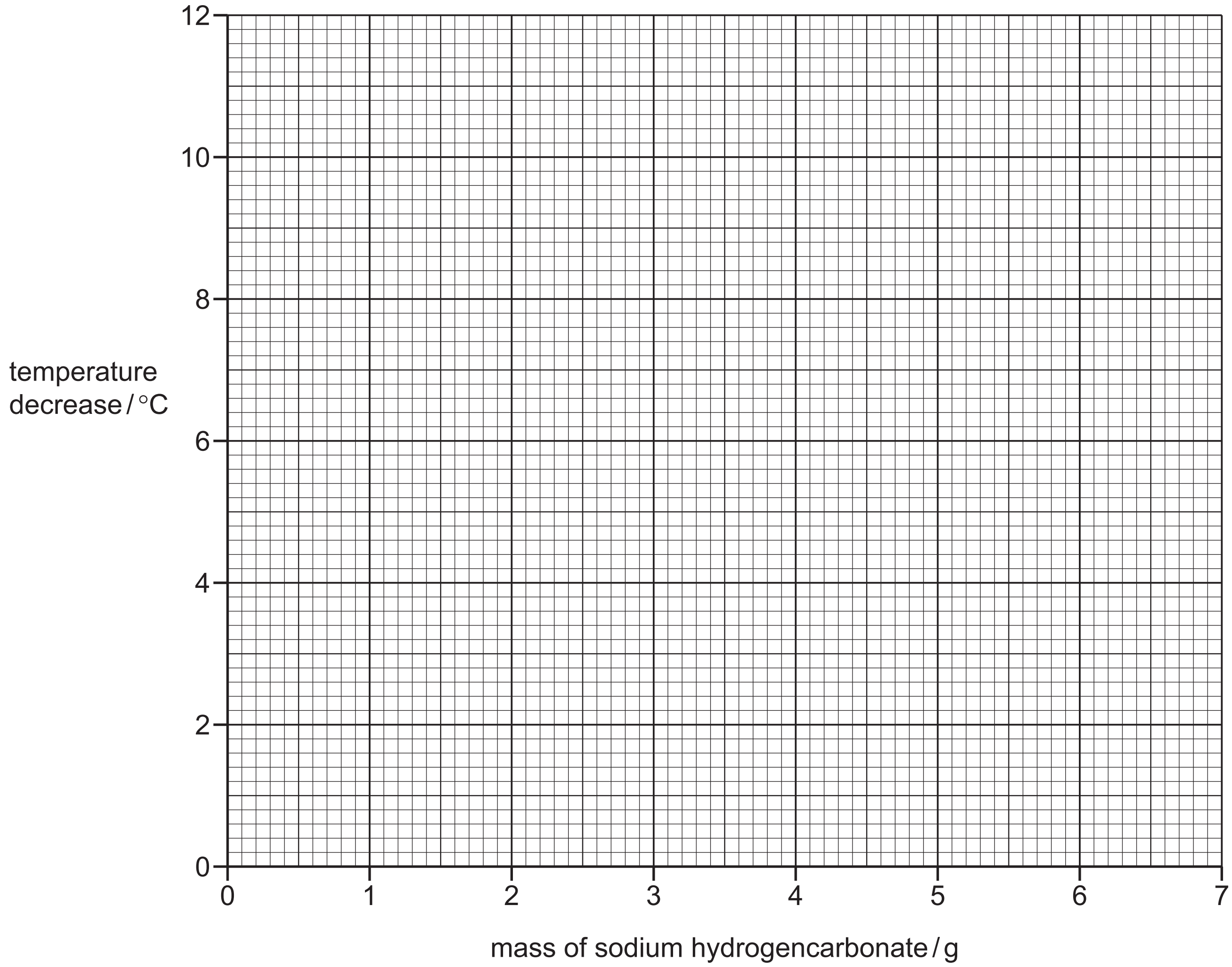
(a) Use the thermometer diagrams to complete the table and calculate the temperature decreases.

experiment	mass of sodium hydrogencarbonate / g	thermometer diagram	initial temperature of acid / °C	thermometer diagram	temperature after 1 minute / °C	temperature decrease / °C
1	1					
2	2					
3	3					
4	5					
5	6					
6	7					

[4]

(b) Plot the results from Experiments 1 to 6 on the grid.

Draw **two** best-fit straight lines through your points. The first straight line should be for the first three points and must pass through (0,0). The second straight line should be for the last three points and must be horizontal. Extend your straight lines so that they meet each other.



[4]

(c) **(i)** **From your graph**, determine the temperature decrease and mass of sodium hydrogencarbonate where your two straight lines meet. Include appropriate units in your answer.

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

temperature decrease = ...

mass of sodium hydrogencarbonate = ...

[3]

(ii) Explain why the temperature decrease becomes constant for high masses of sodium hydrogencarbonate.

....

.... [1]

(d) The investigation was repeated with dilute hydrochloric acid of half the concentration, but the same volume.

Sketch **on the grid** the graph you would expect to obtain.

Label your line **D**. [2]

(e) Suggest **two** changes that could be made to the apparatus that would improve the accuracy of the results. For each change explain why it would improve the accuracy of the results.

change 1 ....

explanation 1 ....

....

change 2 ....

explanation 2 ....

....
[4]

[Total: 18]

3 Solid **E** and solution **F** were analysed.
Tests were done on each substance.

tests on solid E

tests	observations
test 1 About half of solid **E** was placed in a test-tube and heated gently.	steam was given off; condensation appeared near the mouth of the test-tube
The remaining solid **E** was dissolved in distilled water to produce solution **E**. The solution was divided into four equal portions in three test-tubes and a boiling tube. **test 2** About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the first portion of solution **E**.	no visible change
test 3 About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the second portion of solution **E**.	white precipitate
test 4 Excess aqueous ammonia was added to the third portion of solution **E**.	white precipitate
test 5 Aqueous sodium hydroxide was added dropwise and then in excess to the fourth portion of solution **E** in the boiling tube.	white precipitate which dissolved in excess to form a colourless solution
test 6 The product from **test 5** was warmed gently and any gas given off was tested with damp red litmus paper.	the red litmus paper turned blue

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

....

.... [1]

(b) State the conclusion that can be made from the observation in **test 2**.

....

.... [1]

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

....

.... [3]

tests on solution F

Solution **F** was aqueous sodium hydroxide.

Complete the expected observations.

(d) A flame test was carried out on solution **F**.

observations .... [1]

(e) The remaining solution **F** was divided into two approximately equal portions in two test-tubes.

(i) To the first portion of solution **F** a few drops of universal indicator solution were added.

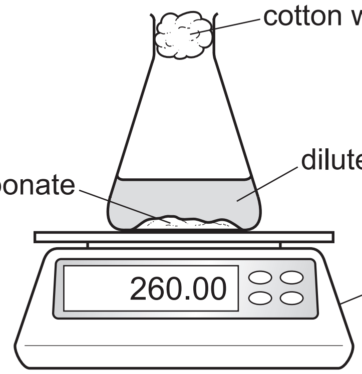
observations .... [1]

(ii) To the second portion of solution **F** approximately 2 cm^3 of aqueous copper(II) sulfate was added.

observations .... [1]

[Total: 8]

4 Dilute hydrochloric acid reacts with calcium carbonate to make carbon dioxide gas. The apparatus shown in the diagram can be used to follow the progress of the reaction. The carbon dioxide gas leaves the flask causing the mass shown on the balance to decrease.



Plan an investigation, using the apparatus shown in the diagram, to find out how the temperature of the dilute hydrochloric acid affects the rate of the reaction. Your plan should include how your results will show how the temperature of the dilute hydrochloric acid affects the rate of the reaction.

You are provided with dilute hydrochloric acid, calcium carbonate and common laboratory apparatus.

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....

.... [6]

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Cambridge IGCSE™

CHEMISTRY | **0620/61**

Paper 6 Alternative to Practical | **May/June 2021**

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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)

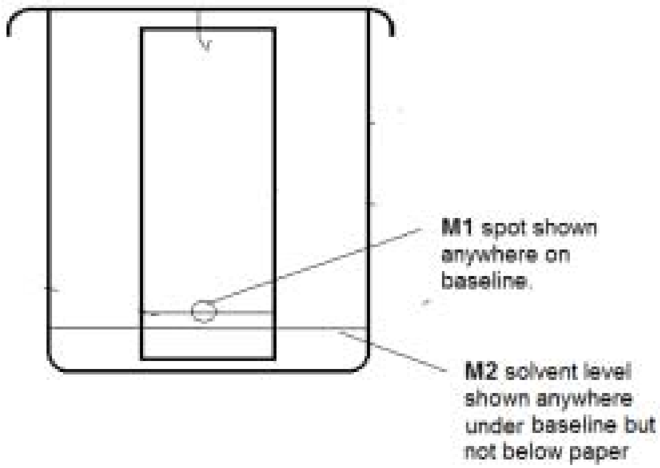
1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

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)	**A** mortar	**1**
	B tripod	**1**
	C (filter) funnel	**1**
1(b)(i)		**1** **1**
1(b)(ii)	pencil is not soluble / pencil does not run / smudge / dissolve / change results	**1**
1(c)(i)	two	**1**
1(c)(ii)	anthocyanin	**1**

Question	Answer	Marks
2(a)	all temperatures and temperature changes completed and all temperatures and temperature changes recorded to the same precision	**1**
	all temperatures recorded correctly (22.0, 22.0, 22.0, 22.5, 23.0, 23.0) and (19.5, 17.0, 14.5, 13.5, 14.0, 14.0)	**2**
	all temperature changes calculated correctly (2.5, 5.0, 7.5, 9.0, 9.0, 9.0)	**1**
2(b)	all points plotted correctly	**1**
	ruler drawn straight line through first 4 points	**1**
	(ruler) drawn straight line through last three points	**1**
	straight lines have been extended so that they meet / cross	**1**
2(c)(i)	values read correctly from graph (9.0 °C **and** 3.6 g)	**1**
	correct indication on graph	**1**
	units (°C **and** g)	**1**
2(c)(ii)	(all) acid used up / sodium hydrogen carbonate in excess	**1**
2(d)	correct line should be identical to plotted line up to 1.8 g and then becomes horizontal. temp change of between 4.0 and 5.0 where line becomes horizontal / levels off	**1**
	mass of between 1.0 and 2.5 where line becomes horizontal / levels off	**1**

Question	Answer	Marks
2(e)	change: use a pipette	**1**
	explanation: more accurate than a measuring cylinder	**1**
	change: use a polystyrene / styrofoam cup	**1**
	explanation: insulator / reduces heat gain	**1**
Tests on solid E		
3(a)	hydrated / contains water (of crystallisation)	**1**
3(b)	not a halide	**1**
3(c)	ammonium / NH_4^+	**1**
	aluminium / Al^{3+}	**1**
	sulfate / SO_4^{2-}	**1**
Tests on solid F		
3(d)	yellow	**1**
3(e)(i)	blue	**1**
3(e)(ii)	blue ppt	**1**

Question	Answer	Marks
4	Any 6 from: • stated / set / same / measured volume of acid • stated / set / same / measured mass of calcium carbonate • add / combine / put together **and** start timing • Repeat (with acid) at higher / lower temperature **then:** • graphical method: • measure / record mass at known / regular / specified times • plot graph • steepest line is fastest **OR** mass loss in a set time • measure / record mass at a specified time • calculate / measure mass lost • largest mass loss is fastest or calculates rate by mass loss ÷ time **OR** time to end of reaction • react until mass stops changing / reaction stops • record time • shortest time is fastest or calculates rate by mass loss ÷ time **OR** time to lose a set mass • react until it reaches / loses a certain mass • record time • shortest time is fastest or calculates rate by mass loss ÷ time **OR** mass of calcium carbonate left after a set time • filter after a set time • find mass of calcium carbonate left • lower mass of calcium carbonate is fastest or calculates rate by mass **loss** ÷ time	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

* 8 4 7 9 8 5 9 2 5 2 *

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

IB21 06_0620_43/3RP

1 Give the name of the process that is used:

(a) to produce large molecules from monomers

.... [1]

(b) to separate oxygen from liquid air

.... [1]

(c) to make ethanol from glucose

.... [1]

(d) to separate water from aqueous sodium chloride

.... [1]

(e) to produce aluminium from aluminium oxide in molten cryolite

.... [1]

(f) to separate the products of hydrolysis of long chain carbohydrates

.... [1]

(g) to separate an aqueous solution from an undissolved solid.

.... [1]

[Total: 7]

2 Complete the table to:

- deduce the number of protons, electrons and neutrons in the boron atom and chloride ion shown
- identify the atom or ion represented by the final row.

formula	number of protons	number of electrons	number of neutrons
$^{11}_{5}B$		5	
$^{35}_{17}Cl^{-}$	17		
	24	21	30

[Total: 5]

3 Sodium reacts with fluorine to form sodium fluoride, NaF.

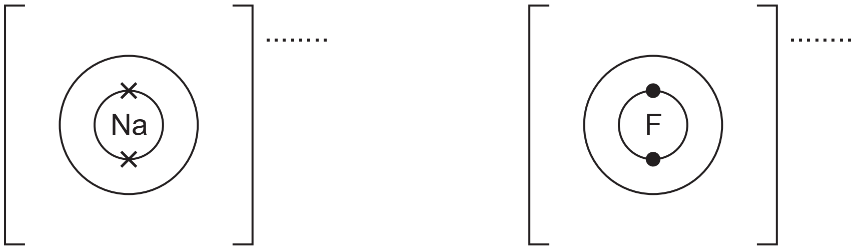
(a) Write a chemical equation for this reaction.

.... [2]

(b) Sodium fluoride is an ionic compound.

Complete the diagram to show the electron arrangement in the outer shells of the ions present in sodium fluoride.

Give the charges on both ions.



[3]

(c) Aqueous sodium fluoride undergoes electrolysis.

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

....

.... [2]

(ii) Name the products formed at the positive electrode (anode) and the negative electrode (cathode) when dilute aqueous sodium fluoride undergoes electrolysis.

anode ....

cathode ....

[2]

(d) Molten sodium fluoride undergoes electrolysis.

(i) Name the products formed at the positive electrode (anode) and the negative electrode (cathode) when molten sodium fluoride undergoes electrolysis.

anode ....

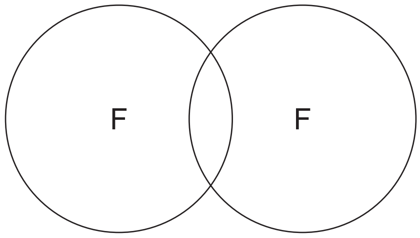
cathode ....

[2]

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

.... [1]

(e) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of fluorine, F_2.
Show the outer electrons only.



[1]

(f) The melting points and boiling points of fluorine and sodium fluoride are shown.

	melting point / °C	boiling point / °C
fluorine	–220	–188
sodium fluoride	993	1695

(i) Deduce the physical state of fluorine at –195 °C. Use the data in the table to explain your answer.

physical state ....

explanation ....

....
[2]

(ii) Explain, in terms of structure and bonding, why sodium fluoride has a much higher melting point than fluorine.

Your answer should refer to the:
- types of particle held together by the forces of attraction
- types of forces of attraction between particles
- relative strength of the forces of attraction.

....

....

....

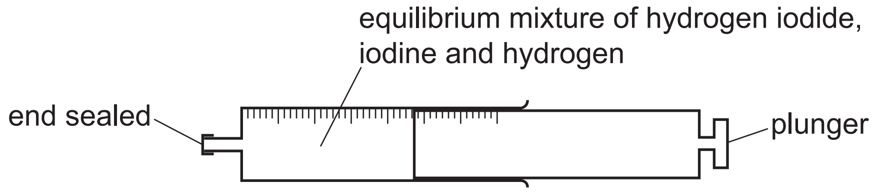
.... [3]

[Total: 18]

4 Hydrogen iodide, HI, decomposes into iodine and hydrogen. The reaction is reversible.

$2HI(g)$	$\rightleftharpoons$	$I_2(g)$	+	$H_2(g)$
colourless gas		purple gas		colourless gas

A gas syringe containing a mixture of hydrogen iodide, iodine and hydrogen gases was sealed. After reaching equilibrium the mixture was a pale purple colour.



(a) State what is meant by the term *equilibrium*.

....

....

.... [2]

(b) The plunger of the gas syringe is pushed in. The position of equilibrium does not change. The colour of the gaseous mixture turns darker purple.

The temperature remains constant.

$2HI(g)$	$\rightleftharpoons$	$I_2(g)$	+	$H_2(g)$
colourless gas		purple gas		colourless gas

(i) Explain why the position of equilibrium does **not** change.

.... [1]

(ii) Suggest why the colour of the gaseous mixture turns darker purple even though the position of equilibrium does not change.

.... [1]

(c) The forward reaction is endothermic.

(i) State what happens to the position of equilibrium when the temperature is decreased.

....

.... [1]

(ii) State what happens to the rate of the forward reaction and the rate of the backward reaction when the temperature of the mixture is decreased.

rate of the forward reaction ....

rate of the backward reaction ....
[2]

[Total: 7]

5 This question is about salts.

(a) Salts that are soluble in water can be made by the reaction between insoluble carbonates and dilute acids. Zinc sulfate is soluble in water.

You are provided with solid zinc carbonate, $ZnCO_3$, and dilute sulfuric acid, H_2SO_4.

Describe how you would make a pure sample of zinc sulfate crystals.

Your answer should include:

- practical details
- how you would make sure that all the dilute sulfuric acid has reacted
- a chemical equation for the reaction.

....

....

....

....

....

....

....

....

....

....

.... [5]

(b) Some sulfates decompose when heated.

When hydrated iron(II) sulfate is heated strongly, sulfur dioxide gas is given off.

(i) Describe a test for sulfur dioxide.

test ....

observations ....
[2]

(ii) Complete the equation for the decomposition of hydrated iron(II) sulfate.

$$.....FeSO_4{\bullet}7H_2O \rightarrow Fe_2O_3 + SO_2 + SO_3 + ...H_2O$$ [2]

(c) Some chlorides are hydrated.

When hydrated barium chloride crystals, $BaCl_2 \cdot \boldsymbol{x}H_2O$, are heated they give off water.

$$BaCl_2 \cdot \boldsymbol{x}H_2O(s) \rightarrow BaCl_2(s) + \boldsymbol{x}H_2O(g)$$

A student carries out an experiment to determine the value of ***x*** in $BaCl_2 \cdot \boldsymbol{x}H_2O$.

step 1 Hydrated barium chloride crystals are weighed.

step 2 The hydrated barium chloride crystals are then heated.

step 3 The remaining solid is weighed.

(i) Describe how the student can be sure that all the water is given off.

....

....

.... [2]

(ii) In an experiment, 4.88 g of $BaCl_2 \cdot \boldsymbol{x}H_2O$ is heated until all the water is given off. The mass of $BaCl_2$ remaining is 4.16 g.

[M_r: $BaCl_2$, 208; H_2O, 18]

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

- Calculate the number of moles of $BaCl_2$ remaining.

.... mol

- Calculate the mass of H_2O given off.

.... g

- Calculate the number of moles of H_2O given off.

.... mol

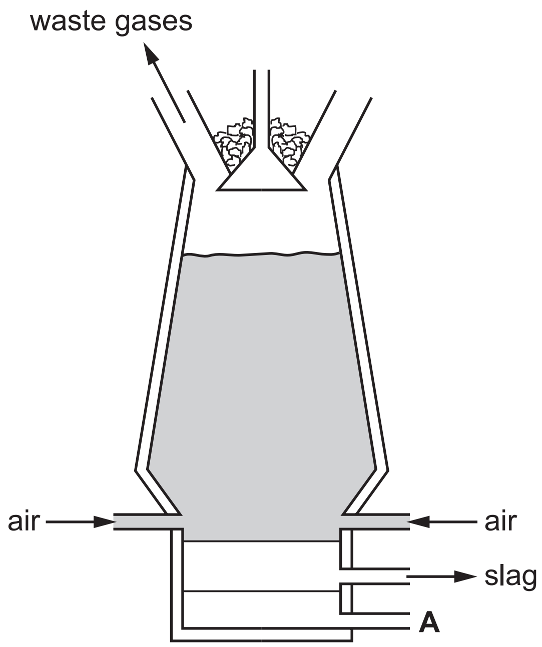
- Determine the value of ***x***.

x = ...
[4]

[Total: 15]

6 This question is about metals.

(a) Iron is extracted from its main ore in a blast furnace.



(i) Coke and iron ore are added at the top of the blast furnace.

Name one **other** substance that is added at the top of the blast furnace.

.... [1]

(ii) Name the substance that leaves the blast furnace at **A**.

.... [1]

(iii) Iron ore is mainly iron(III) oxide, Fe_2O_3.

Name a substance that reduces iron(III) oxide to iron in the blast furnace.

.... [1]

(iv) Temperatures inside a blast furnace can reach 2000 °C.

Name **two** substances that react together, in the blast furnace, to produce this high temperature.

.... [1]

(v) Name **two** waste gases that leave the blast furnace.

1 ....

2 ....
[2]

(b) Zinc is extracted from zinc blende.

(i) Name the main zinc compound that is present in zinc blende.

.... [1]

(ii) When zinc is extracted, it is formed as a gas.

The gaseous zinc is then converted into molten zinc.

State the name of this physical change.

.... [1]

(c) Name the alloy that contains zinc and copper only.

.... [1]

(d) Copper has the following properties.

- It has a high melting point.
- It has a high density.
- It is a good conductor of electricity.
- It has variable oxidation states.
- It forms a basic oxide.
- It forms soluble salts.

(i) Give **two** properties from the list in which copper differs from Group I elements.

1 ....

2 ....
[2]

(ii) Give **two** properties from the list in which copper is similar to Group I elements.

1 ....

2 ....
[2]

[Total: 13]

7 Many organic compounds contain carbon, hydrogen and oxygen only.

(a) An organic compound **R** has the following composition by mass.

C, 69.77%; H, 11.63%; O, 18.60%

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

empirical formula = ... [2]

(b) Compound **S** has the empirical formula CH_2O and a relative molecular mass of 60.

Calculate the molecular formula of compound **S**.

molecular formula = ... [2]

(c) Compounds **T** and **V** have the same molecular formula, $C_3H_6O_2$.

- Compound **T** is an ester.
- Compound **V** contains a –COOH functional group.

(i) State the name given to compounds with the same molecular formula but different structures.

.... [1]

(ii) Name the homologous series that **V** is a member of.

.... [1]

(iii) Draw a structure of compound **T**. Show all of the atoms and all of the bonds.

Name compound **T**.

name ....

[3]

(iv) Draw the structure of compound **V**. Show all of the atoms and all of the bonds.

Name compound **V**.

name ....

[2]

(d) Ethanol can be produced from long chain alkanes such as decane, $C_{10}H_{22}$, in a two-step process.

$$\text{decane} \xrightarrow{\textbf{step 1}} \text{ethene} \xrightarrow{\textbf{step 2}} \text{ethanol}$$

For each of the two steps:
- name the type of chemical reaction that occurs
- write a chemical equation.

step 1: decane to ethene

type of reaction ....

chemical equation ....

step 2: ethene to ethanol

type of reaction ....

chemical equation ....

[4]

[Total: 15]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2021**

MARK SCHEME

Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	polymerisation	**1**
1(b)	fractional distillation	**1**
1(c)	fermentation	**1**
1(d)	distillation	**1**
1(e)	electrolysis	**1**
1(f)	chromatography	**1**
1(g)	filtration	**1**

Question	Answer	Marks
2	B: 5 and 6 (1) Cl^-: 18 and 18 (1) 54 and 24 (1) Cr (1) 3^+ (1)	**5**

Question	Answer	Marks
3(a)	$2Na + F_2 \rightarrow 2NaF$ F_2 (1) equation fully correct (1)	**2**
3(b)	Na outer shell with 8 crosses (1) F outer shell with 7 dots and 1 cross (1) Na^+ and F^- (1)	**3**
3(c)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten / aqueous** (state) (1)	**2**

Question	Answer	Marks
3(c)(ii)	oxygen hydrogen	**2**
3(d)(i)	(anode) fluorine (1) (cathode) sodium (1)	**2**
3(d)(ii)	$Na^+ + e^{(-)} \rightarrow Na$	**1**
3(e)	one shared pair of electrons and 6 non-bonding electrons on each fluorine atom	**1**
3(f)(i)	liquid (1) **BOTH** melting point is below –195 °C **and** boiling point is above –195 °C **OR** –195 °C is in between melting point and boiling point / –220 °C and –188 °C (1) **OR** **BOTH** –195 °C is higher than **–**220 °C / melting point **AND** lower than –188 °C / boiling point	**2**
3(f)(ii)	**ionic bonds** in NaF (1) attraction **between molecules** in F_2 (1) weaker attraction (between particles) in F_2 **ORA** (1)	**3**

Question	Answer	Marks
4(a)	the **rate** of forward reaction equals (the rate of the) reverse reaction (1) concentrations of reactants and products are constant (1)	**2**
4(b)(i)	same number of gas moles on both sides of the equilibrium / same number of gas molecules on both sides of the equilibrium	**1**
4(b)(ii)	iodine **particles** or **molecules** (forced) closer together / same number of iodine **particles** or **molecules** in a smaller volume	**1**
4(c)(i)	shifted to the left	**1**
4(c)(ii)	decrease / slower (1) decrease / slower (1)	**2**

Question	Answer	Marks
5(a)	add zinc carbonate to sulfuric acid until • it stops dissolving **OR** • no more effervescence (1) filter (zinc carbonate) (1) evaporation of filtrate to form dry crystals (1) $ZnCO_3 + H_2SO_4 \rightarrow ZnSO_4 + CO_2 + H_2O$ CO_2 product in equation (1) rest of equation correct (1)	**5**
5(b)(i)	acidified aqueous potassium manganate(VII) (1) purple to colourless (1)	**2**
5(b)(ii)	**2** $FeSO_4.7H_2O$ (1) **14** H_2O (1)	**2**
5(c)(i)	heat + weigh + repeat (1) until mass is constant (1)	**2**
5(c)(ii)	**M1** 0.02 (1) **M2** 0.72 (1) **M3** M2 ÷ 18 = 0.72/18 = 0.04 (1) **M4** M3 ÷ M1 = 0.04 ÷ 0.02 = 2 (1)	**4**

Question	Answer	Marks
6(a)(i)	limestone	**1**
6(a)(ii)	(molten) iron	**1**
6(a)(iii)	coke / carbon / carbon monoxide	**1**
6(a)(iv)	(reaction between) coke / carbon and oxygen	**1**

Question	Answer	Marks
6(a)(v)	nitrogen (1) carbon dioxide (1)	**2**
6(b)(i)	zinc sulf**ide**	**1**
6(b)(ii)	condensation/condensing	**1**
6(c)	brass	**1**
6(d)(i)	any two from (copper has): • high density • high melting point • variable oxidation states	**2**
6(d)(ii)	any two from (copper): • good conductor of electricity • forms a basic oxide • soluble salts	**2**

Question	Answer	Marks
7(a)	11.63 / 1 69.77 / 12 18.6 /16 **Or evaluation** 11.63 5.81 1.16 **Or ratio** 10 : 5 : 1 (1) $C_5H_{10}O$ (1)	**2**
7(b)	(M_r of CH_2O =) 30 (1) $C_2H_4O_2$ (1)	**2**
7(c)(i)	structural isomers	**1**
7(c)(ii)	carboxylic acids	**1**

Question	Answer	Marks
7(c)(iii)	name of ester, corresponding to $C_3H_6O_2$: ethyl methanoate or methyl ethanoate (1) correctly displayed ester linkage (1) fully correct displayed formula corresponding to $C_3H_6O_2$ and matching named ester (1)	**3**
7(c)(iv)	displayed formula of propanoic acid (1) propanoic acid (1)	**2**
7(d)	**Step 1:** cracking (1) $C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$ (1) **Step 2:** (catalytic) addition (1) $C_2H_4 + H_2O \rightarrow C_2H_5OH$ (1)	**4**

Cambridge Assessment International Education

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CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

9904169354

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

IB21 06_0620_42/2RP

[Turn over

1 The symbols of the elements of Period 3 of the Periodic Table are shown.

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

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

Write the symbol of an element which:

(a) is malleable

.... [1]

(b) has only two electrons in its outermost shell

.... [1]

(c) forms an oxide which leads to acid rain

.... [1]

(d) forms an ion with a 2– charge

.... [1]

(e) is extracted from an ore called bauxite

.... [1]

(f) does **not** form an oxide

.... [1]

(g) forms an oxide with a macromolecular structure

.... [1]

(h) forms an amphoteric oxide

.... [1]

(i) exists as diatomic molecules

.... [1]

(j) forms a binary compound with hydrogen that is a strong acid.

.... [1]

[Total: 10]

2 Silver has an atomic number of 47.

(a) Naturally occurring atoms of silver are ^{107}Ag and ^{109}Ag.

(i) State the name given to atoms of the same element with different nucleon numbers.

.... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

	$^{107}_{47}Ag$	$^{109}_{47}Ag^{+}$
protons		
neutrons		
electrons		

[3]

(iii) Complete this definition of relative atomic mass.

Relative atomic mass is the .... mass of naturally occurring atoms of an element on a scale where the .... atom has a mass of exactly .... units.

[3]

(iv) A sample of silver has a relative atomic mass of 108.0.

Deduce the percentage of ^{107}Ag present in this sample of silver.

.... [1]

(b) Silver nitrate is a salt of silver made by reacting silver oxide with an acid.

Write the formula of the acid which reacts with silver oxide to form silver nitrate.

.... [1]

(c) 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 iodide, $NaI(aq)$.

.... [1]

(ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide.
Include state symbols.

.... [3]

(d) In the positive test for aqueous nitrate ions, aqueous sodium hydroxide and one other substance are warmed with the nitrate ions.

Name this other substance and the gas formed.

name of substance ....

name of gas ....
[2]

(e) When silver nitrate is exposed to sunlight, silver is formed.

Name the type of reaction which needs light to make it happen.

.... [1]

(f) Members of one homologous series only react with chlorine in the presence of sunlight.

(i) Name a member of this homologous series.

.... [1]

(ii) Name **two** products that form when the compound in **(i)** reacts with chlorine.

1 ....

2 ....
[2]

[Total: 19]

3 Sodium hydrogencarbonate is found in baking powder.

When sodium hydrogencarbonate is heated it forms three products.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Name the type of reaction that takes place when sodium hydrogencarbonate reacts in this way.

.... [1]

(b) Calculate the volume of carbon dioxide formed at room temperature and pressure when 12.6 g of $NaHCO_3$ is heated using the following steps:

- determine the mass of one mole of $NaHCO_3$

.... g

- calculate the number of moles of $NaHCO_3$ used

.... moles

- determine the number of moles of carbon dioxide formed

.... moles

- calculate the volume of carbon dioxide formed at room temperature and pressure.

.... dm^3
[4]

(c) Limewater is aqueous calcium hydroxide. Carbon dioxide turns limewater milky because a white precipitate forms.

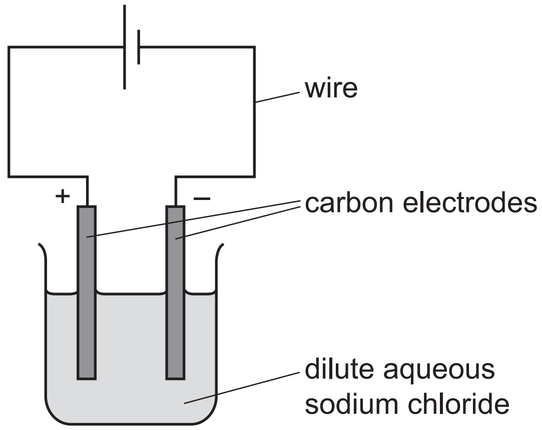
Write the formula of:

- calcium hydroxide ....
- the white precipitate that forms when limewater turns milky. ....

[2]

[Total: 7]

4 A student carries out an electrolysis experiment using the apparatus shown.



The student uses dilute aqueous sodium chloride.

(a) State the name given to any solution which undergoes electrolysis.

.... [1]

(b) Hydroxide ions are discharged at the anode.

(i) Complete the ionic half-equation for this reaction.

..........$OH^-(aq) \rightarrow$ .... + $O_2(g)$ + $4e^-$ [2]

(ii) Explain how the ionic half-equation shows the hydroxide ions are being oxidised.

.... [1]

(c) Describe what the student observes at the cathode.

.... [1]

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

.... [2]

(e) The student repeats the experiment using concentrated aqueous sodium chloride.

(i) Describe what the student observes at:

- the cathode ....
- the anode. ....

[2]

(ii) The student added litmus to the solution after the electrolysis of concentrated aqueous sodium chloride.

State the colour seen in the solution. Give a reason for your answer.

colour of solution ....

reason ....

[2]

(f) Carbon electrodes are used because they are inert.

State another element that can be used instead of carbon.

.... [1]

[Total: 12]

5 This question is about compounds of nitrogen.

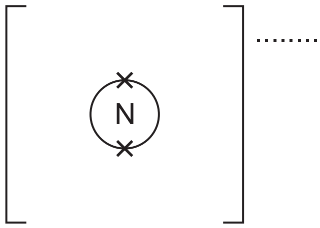
(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.

(i) Write the chemical equation for the reaction between lithium and nitrogen.

.... [2]

(ii) Lithium nitride is ionically bonded.

Complete the diagram to show the electronic structure of the nitride ion.
Show the charge on the nitride ion.



[2]

(b) Nitrogen reacts with fluorine to form nitrogen trifluoride, NF_3.

(i) The chemical equation can be represented as shown.

$$\mathrm{N{\equiv}N} \;+\; 3\,\mathrm{F{-}F} \;\rightarrow\; 2\,\mathrm{F{-}}\underset{\underset{\displaystyle \mathrm{F}}{|}}{\mathrm{N}}\mathrm{{-}F}$$

Some bond energies are shown in the table.

bond	bond energy in kJ / mol
N≡N	945
F–F	160
N–F	300

Calculate the energy change for the reaction between nitrogen and fluorine, using the following steps:

- energy taken in to break bonds

.... kJ

- energy released when bonds are formed

.... kJ

- energy change during the reaction.

.... kJ / mol
[3]

(ii) Use your answer to **(i)** to deduce whether this reaction is endothermic or exothermic. Explain your answer.

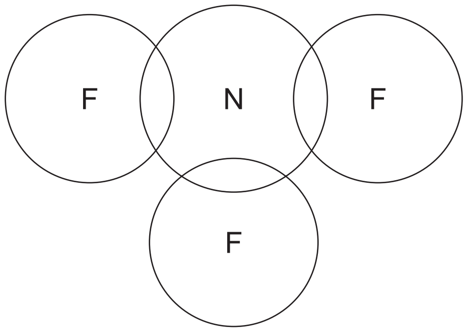
....

.... [1]

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.

Use dots for nitrogen electrons and crosses for fluorine electrons.

Show outer electrons only.



[3]

(c) Lithium nitride melts at 813 °C. Nitrogen trifluoride melts at –206 °C.

Explain in terms of attractive forces why lithium nitride has a much higher melting point than nitrogen trifluoride.

In your answer refer to the types of attractive forces between particles and their relative strengths.

....

....

....

.... [3]

(d) Ammonium nitrate, NH_4NO_3, is a compound of nitrogen.

(i) Calculate the percentage by mass of nitrogen in ammonium nitrate.

percentage by mass of nitrogen = ... [2]

(ii) State a use of ammonium nitrate in agriculture.

.... [1]

(iii) State the name of a compound that will displace ammonia from ammonium nitrate.

.... [1]

(e) Ammonia is a base which forms a weakly alkaline solution when dissolved in water.

(i) Define the term *base*.

.... [1]

(ii) Suggest the pH of aqueous ammonia.

.... [1]

[Total: 20]

6 Molecules **A** and **B** can form condensation polymers.

(a) Each molecule has two identical functional groups.

(i) Name the functional group in **B**.

.... [1]

(ii) Draw the part of the structure of the synthetic polymer that would form when two molecules of **A** and two molecules of **B** combine. Show all of the bonds in the linkages.

[3]

(iii) Name the other product formed when molecules of **A** and **B** undergo polymerisation.

.... [1]

(b) Molecule **A** is a simple sugar unit which can be made by hydrolysis of complex carbohydrates.

(i) Draw part of the complex carbohydrate that could be hydrolysed to make molecules of **A**.

Include **one** linkage and show all of the bonds in the linkage.

[1]

(ii) State **two** sets of conditions which could be used to hydrolyse the complex carbohydrate to form **A**.

1 ....

2 ....
[2]

(iii) Name the technique used to identify the individual sugar units made by the hydrolysis of a complex carbohydrate.

.... [1]

(c) Ethanol can be made from the simple sugar glucose, $C_6H_{12}O_6$.

(i) State the name of this process.

.... [1]

(ii) Complete the chemical equation for this reaction.

$C_6H_{12}O_6 \rightarrow$ [2]

[Total: 12]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY | **0620/42**
Paper 4 Theory (Extended) | **May/June 2021**
MARK SCHEME
Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **9** printed pages.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

6	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)	Na or Mg or A*l*	**1**
1(b)	Mg	**1**
1(c)	S	**1**
1(d)	S	**1**
1(e)	A*l*	**1**
1(f)	Ar	**1**
1(g)	Si	**1**
1(h)	Al	**1**
1(i)	C*l*	**1**
1(j)	C*l*	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>isotopes</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>mark by row
<table><tr><td></td><td>^{107}Ag</td><td>$^{109}Ag^{+}$</td></tr><tr><td>p</td><td>47</td><td>47</td></tr><tr><td>n</td><td>60</td><td>62</td></tr><tr><td>e</td><td>47</td><td>46</td></tr></table></td><td>3</td></tr>
</table>

Question	Answer	Marks
2(a)(iii)	average / mean ^{12}C 12	**3**
2(a)(iv)	50(%)	**1**
2(b)	HNO_3	**1**
2(c)(i)	yellow precipitate	**1**
2(c)(ii)	$Ag^+(aq)\ +\ vI^-(aq)\ \rightarrow\ AgI(s)$ AgI (as only product) (1) Ag^+ and I^- (as *only* reactants) (1) state symbols (1)	**3**
2(d)	aluminium (1) ammonia (1)	**2**
2(e)	photochemical	**1**
2(f)(i)	any **named** alkane	**1**
2(f)(ii)	name of organic product derived from **2(f)(i)** (1) hydrogen chloride / $HC\ell$ (1)	**2**

Question	Answer	Marks
3(a)	(thermal) decomposition	**1**
3(b)	84 (1) 12.6 / 84 = 0.15(00) (1) 0.15(00) / 2 = 0.075(00) (1) 0.075(0) × 24.0 = 1.8 (1)	**4**

Question	Answer	Marks
3(c)	$Ca(OH)_2$ (1) $CaCO_3$ (1)	**2**

Question	Answer	Marks
4(a)	electrolyte	**1**
4(b)(i)	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ balance of charge (1) rest of equation (1)	**2**
4(b)(ii)	(OH^-(aq) ions) lose electrons	**1**
4(c)	fizzing	**1**
4(d)	$2H^+ + 2e^- \rightarrow H_2$ species correct (1) fully correct equation (1)	**2**
4(e)(i)	fizzing (1) green gas (1)	**2**
4(e)(ii)	(litmus turns) blue **and** alkali / base forms (1) Sodium hydroxide / NaOH (forming) (1)	**2**
4(f)	platinum	**1**

Question	Answer	Marks
5(a)(i)	$6Li + N_2 \rightarrow 2Li_3N$ N_2 as reactant (1) rest of equation (1)	**2**
5(a)(ii)	new octet of 8 electrons consisting of 5 crosses and 3 dots in second shell (1) charge of 3– (1)	**2**

Question	Answer	Marks
5(b)(i)	bonds broken [945 + (3 × 160)] = 1425 (1) bonds formed (2 × 3 × 300) = 1800 (1) energy change = M1 – M2 = 1425 – 1800 = –375 (1)	**3**
5(b)(ii)	*Answer must reflect answer in **5(b)(i)*** exothermic **and** more energy released (in bond formation) than used/taken in (in bond breaking)	**1**
5(b)(iii)	N with 1 bonding pair with each F (1) 2 non-bonding dots for N (1) 6 non-bonding crosses for F (1)	**3**
5(c)	ionic bonds in Li_3N (1) attraction between molecules in NF_3 (1) weaker attraction (between particles) in NF_3 ORA (1)	**3**
5(d)(i)	rfm of NH_4NO_3 = 80 (1) mass of N = 2 × 14 = 28 and percentage N = 100 × 28 / 80 = 35% (1)	**2**
5(d)(ii)	fertiliser	**1**
5(d)(iii)	calcium hydroxide	**1**
5(e)(i)	proton acceptor	**1**
5(e)(ii)	$7 < \times \leqslant 11$	**1**

Question	Answer	Marks
6(a)(i)	carboxylic acid	**1**
6(a)(ii)	any correct displayed ester link between any two blocks showing all atoms and all bonds (1) correct orientation of three displayed inter-block ester links with correct orientation (1) continuation bonds on polyester (1)	**3**

Question	Answer	Marks
6(a)(iii)	water	**1**
6(b)(i)	two blocks linked by –O–	**1**
6(b)(ii)	acid (and heat) (1) enzymes (ignore names) (1)	**2**
6(b)(iii)	chromatography	**1**
6(c)(i)	fermentation	**1**
6(c)(ii)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ C_2H_5OH (1) rest of equation (1)	**2**

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0998164444

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

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

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

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

1 Give the name of the process that is used:

(a) to produce ammonia from nitrogen

.... [1]

(b) to separate nitrogen from liquid air

.... [1]

(c) to produce bromine from molten lead(II) bromide

.... [1]

(d) to separate an undissolved solid from an aqueous solution

.... [1]

(e) to produce amino acids from proteins

.... [1]

(f) to separate a mixture of amino acids.

.... [1]

[Total: 6]

2 Complete the table to:

- deduce the number of protons, electrons and neutrons in the magnesium atom and copper ion shown
- identify the atom or ion represented by the final row.

	number of protons	number of electrons	number of neutrons
$^{25}_{12}Mg$	12		
$^{65}_{29}Cu^{2+}$			36
	17	18	20

[Total: 5]

3 Potassium reacts with chlorine to form potassium chloride, KCl.

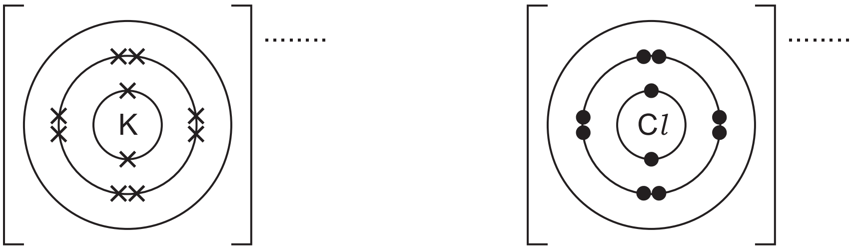
(a) Write a chemical equation for this reaction.

.... [2]

(b) Potassium chloride is an ionic compound.

Complete the diagram to show the electron arrangement in the outer shells of the ions present in potassium chloride.

Give the charges on both ions.



[3]

(c) Molten potassium chloride undergoes electrolysis.

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

....

.... [2]

(ii) Name the products formed at the positive electrode (anode) and negative electrode (cathode) when molten potassium chloride undergoes electrolysis.

anode ....

cathode ....
[2]

(d) Concentrated aqueous potassium chloride undergoes electrolysis.

(i) Write an ionic half-equation for the reaction at the negative electrode (cathode).

.... [2]

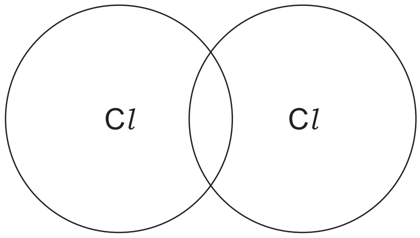
(ii) Name the product formed at the positive electrode (anode).

.... [1]

(iii) Name the potassium compound that remains in the solution after electrolysis.

.... [1]

(e) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of chlorine, Cl_2.
Show the outer electrons only.



[1]

(f) The melting points and boiling points of chlorine and potassium chloride are shown.

	melting point / °C	boiling point / °C
chlorine	–101	–35
potassium chloride	770	1500

(i) Deduce the physical state of chlorine at –75 °C. Use the data in the table to explain your answer.

physical state ....

explanation ....

....
[2]

(ii) Explain, in terms of structure and bonding, why potassium chloride has a much higher melting point than chlorine.

Your answer should refer to the:
- types of particle held together by the forces of attraction
- types of forces of attraction between particles
- relative strength of the forces of attraction.

....

....

....

....

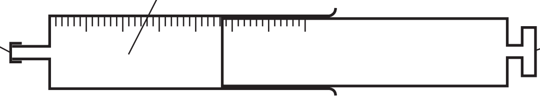
.... [3]

[Total: 19]

4 Dinitrogen tetroxide, N_2O_4, decomposes into nitrogen dioxide, NO_2. The reaction is reversible.

$$\underset{\text{colourless gas}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown gas}}{2NO_2(g)}$$

A gas syringe containing a mixture of dinitrogen tetroxide and nitrogen dioxide gases was sealed and heated. After reaching equilibrium the mixture was a pale brown colour.



(a) State what is meant by the term *equilibrium*.

....

....

.... [2]

(b) The plunger of the gas syringe is pushed in. The temperature does not change. The mixture initially turns darker brown. After a few seconds the mixture turns lighter brown because the equilibrium shifts to the left.

$$\underset{\text{colourless gas}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown gas}}{2NO_2(g)}$$

(i) Explain why the mixture initially turns darker brown.

.... [1]

(ii) Explain why the position of equilibrium shifts to the left.

.... [1]

(c) The forward reaction is endothermic.

(i) State what happens to the position of equilibrium when the temperature of the mixture is increased.

.... [1]

(ii) State what happens to the rate of the forward reaction and the rate of the backward reaction when the temperature of the mixture is increased.

rate of the forward reaction ....

rate of the backward reaction ....
[2]

[Total: 7]

5 This question is about salts.

(a) Salts that are insoluble in water are made by precipitation.

- Lead(II) iodide, PbI_2, is insoluble in water.
- All nitrates are soluble in water.
- All sodium salts are soluble in water.

You are provided with solid lead(II) nitrate, $Pb(NO_3)_2$, and solid sodium iodide, NaI.

Describe how you would make a pure sample of lead(II) iodide by precipitation.

Your answer should include:
- practical details
- a chemical equation for the precipitation reaction.

....

....

....

....

....

....

....

....

....

.... [5]

(b) Nitrates decompose when heated.

(i) When hydrated zinc nitrate is heated, oxygen gas is given off.

Describe a test for oxygen.

test ....

observations ....

[2]

(ii) Complete the equation for the decomposition of hydrated zinc nitrate.

$$2Zn(NO_3)_2{\bullet}6H_2O \rightarrow .....ZnO + ...NO_2 + O_2 + ...H_2O$$ [2]

(c) Some sulfates are hydrated.

When hydrated sodium sulfate crystals, $Na_2SO_4{\bullet}\boldsymbol{x}H_2O$, are heated, they give off water.

$$Na_2SO_4{\bullet}\boldsymbol{x}H_2O(s) \rightarrow Na_2SO_4(s) + \boldsymbol{x}H_2O(g)$$

A student carries out an experiment to determine the value of ***x*** in $Na_2SO_4{\bullet}\boldsymbol{x}H_2O$.

step 1 Hydrated sodium sulfate crystals are weighed.

step 2 The hydrated sodium sulfate crystals are then heated.

step 3 The remaining solid is weighed.

(i) Describe how the student can check that all the water has been given off.

....

....

.... [2]

(ii) In an experiment, 1.61 g of Na_2SO_4•$\boldsymbol{x}H_2O$ is heated until all the water is given off. The mass of Na_2SO_4 remaining is 0.71 g.

[M_r: Na_2SO_4,142; H_2O,18]

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

- Calculate the number of moles of Na_2SO_4 remaining.

.... mol

- Calculate the mass of H_2O given off.

.... g

- Calculate the number of moles of H_2O given off.

.... mol

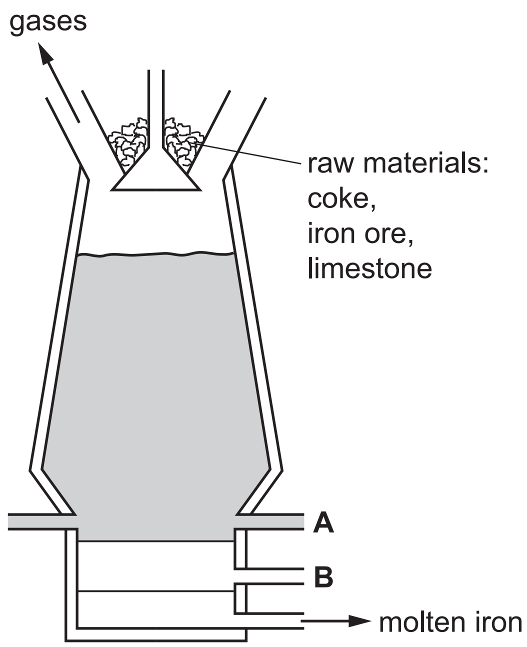
- Determine the value of ***x***.

x = ...
[4]

[Total: 15]

6 This question is about iron.

(a) Iron is extracted from its main ore in a blast furnace.



(i) Name the main ore of iron used in the blast furnace.

.... [1]

(ii) Name the substance that enters the blast furnace at **A**.

.... [1]

(iii) Name the substance that leaves the blast furnace at **B**.

.... [1]

(iv) Give **two** reasons for using coke in the blast furnace.

1 ....

2 ....
[2]

(b) Another ore of iron is iron pyrites, FeS_2. Iron pyrites contains the positive ion, Fe^{2+}.

Deduce the formula of the negative ion in FeS_2.

.... [1]

(c) Iron is a transition element.

A list of properties of iron is shown.

- Iron is a good conductor of electricity.
- Iron forms soluble salts.
- Iron forms coloured compounds.
- Iron has variable oxidation states.
- Iron acts as a catalyst.
- Iron forms a basic oxide.

(i) Give **two** properties from the list in which iron differs from Group I elements.

1 ....

2 ....
[2]

(ii) Give **two** properties from the list in which iron is similar to Group I elements.

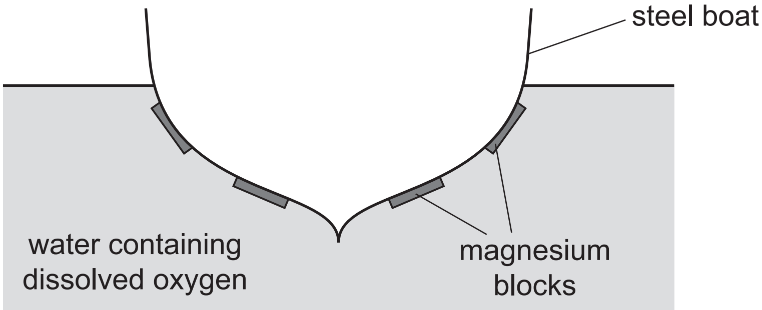
1 ....

2 ....
[2]

(d) Steel consists mainly of iron.

Iron forms rust when it reacts with water and oxygen.

Magnesium blocks can be attached to the bottom of steel boats. The magnesium does not completely cover the steel.



(i) Explain how the magnesium blocks prevent iron from rusting.

....

....

....

.... [2]

(ii) Explain why replacing the magnesium blocks with copper blocks will **not** prevent the bottom of the boat from rusting.

....

.... [1]

[Total: 13]

7 Many organic compounds contain carbon, hydrogen and oxygen only.

(a) An organic compound **V** has the following composition by mass.

C, 48.65%; H, 8.11%; O, 43.24%

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

empirical formula = ... [3]

(b) Compound **W** has the empirical formula CH_4O and a relative molecular mass of 32.

Calculate the molecular formula of compound **W**.

molecular formula = ... [1]

(c) Compounds **X** and **Y** have the same general formula.

X and **Y** are both carboxylic acids.

Compound **X** has the molecular formula $C_2H_4O_2$.

Compound **Y** has the molecular formula $C_4H_8O_2$.

(i) Deduce the general formula of compounds **X** and **Y**.

.... [1]

(ii) Draw the structure of compound **Y**. Show all of the atoms and all of the bonds.

Name compound **Y**.

name ....
[3]

(iii) Give the name used to describe a 'family' of similar compounds with the same general formula, similar chemical properties and the same functional group.

.... [1]

(d) Propene is an unsaturated hydrocarbon. The formula of propene is shown.

$$CH_3CH{=}CH_2$$

(i) State the colour change observed when propene is added to aqueous bromine.

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

(ii) Propene can be produced by cracking long chain alkanes.

Pentadecane, $C_{15}H_{32}$, is cracked to produce an alkane and propene in a 1 : 2 molar ratio.

Complete the chemical equation for this reaction.

$C_{15}H_{32} \rightarrow$ .... + ... [2]

(iii) Propene can be converted into poly(propene).

Name the type of polymerisation that occurs when propene is converted into poly(propene).

.... [1]

(iv) Complete the diagram to show a section of poly(propene).

[2]

[Total: 15]

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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

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 **0620/41**

Paper 4 Theory (Extended) **May/June 2021**

MARK SCHEME

Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	Haber (process)	**1**
1(b)	fractional distillation	**1**
1(c)	electrolysis	**1**
1(d)	filtration	**1**
1(e)	hydrolysis	**1**
1(f)	chromatography	**1**

Question	Answer	Marks
2	Mg: 12 **and** 13 (1) Cu^{2+}: 29 **and** 27 (1) 37(**above**) **and**17(**below**) (1) Cl (1) 1– (1)	**5**

Question	Answer	Marks
3(a)	$2K + Cl_2 \rightarrow 2KCl$ Cl_2 on left hand side (1) equation fully correct (1)	**2**
3(b)	K outer shell with **8 crosses** (1) Cl outer shell with **7 dots and 1 cross** (1) $^{+}$ and $^{-}$ (1)	**3**
3(c)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten or aqueous** (state) (1)	**2**

Question	Answer	Marks
3(c)(ii)	(anode) chlorine (cathode)potassium	**1**
3(d)(i)	$2H^+ + 2e^{(-)} \rightarrow H_2$ H+ and $e^{(-)}$ on left hand side (1) equation fully correct (1)	**2**
3(d)(ii)	chlorine	**1**
3(d)(iii)	potassium hydroxide (1)	**1**
3(e)	one shared pair of electrons and 6 non-bonding electrons on each chlorine atom	**1**
3(f)(i)	liquid (1) **BOTH** melting point is below –75 °C **AND** boiling point is above –75 °C **OR** **BOTH** –75 °C is higher than **–**101 °C / melting point **AND** lower than –35 °C / boiling point **OR** **–75 °C** is **between** melting point or –101 °C **and** boiling point or –35 °C	**2**
3(f)(ii)	**ionic bonds** in KCl (1) attraction **between molecules** in Cl_2 (1) weak**er** attraction (between particles) in Cl_2 **ORA** (1)	**3**

Question	Answer	Marks
4(a)	the **rate** of forward reaction equals the rate of the reverse reaction (1) **concentrations** of reactants and products are constant (1)	**2**
4(b)(i)	(increased pressure) nitrogen dioxide **particles** or **molecules** (forced) clos**er** together **OR** same number of nitrogen dioxide **particles** or **molecules** in a small**er** volume	**1**

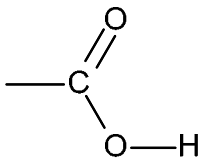
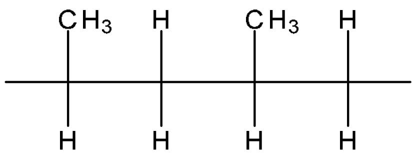
Question	Answer	Marks
4(b)(ii)	few**er** number of gas moles or molecules on **l**eft hand side or reactant side (of the equation) **ORA**	**1**
4(c)(i)	shifts to the right	**1**
4(c)(ii)	increase / faster (1) increase / faster (1)	**2**

Question	Answer	Marks
5(a)	(add) **water** (to both salts) (1) **dissolve** both salts / make **solutions** (1) **filter** (lead(II) iodide)(1) wash (residue of lead(II) iodide) with **water AND dry** e.g. with filter paper / description of washing and drying (1) $Pb(NO_3)_2 + 2NaI \rightarrow 2NaNO_3 + PbI_2$ **OR** $Pb^{2+} + 2I^- \rightarrow PbI_2$ (1)	**5**
5(b)(i)	glowing splint (1) relights / rekindles (1)	**2**
5(b)(ii)	**2**ZnO(s) **and 4**NO2(g) (1) **12**H2O(g) (1)	**2**
5(c)(i)	**heat** again **and weigh** again / repeat steps 2 and 3 (1) until mass is constant (1)	**2**
5(c)(ii)	0.005 (1) 0.9 (1) (0.9 ÷ 18 =) 0.05 (1) (0.05 ÷ 0.005 =) 10 (1)	**4**

Question	Answer	Marks
6(a)(i)	hematite	**1**
6(a)(ii)	air	**1**
6(a)(iii)	slag / calcium silicate	**1**
6(a)(iv)	any two from: • (coke) releases heat (when it reacts with oxygen or reacts in air) **OR** (acts as a) fuel **OR** increases temperature (in the furnace) / heats (the furnace) **OR** source of energy • (coke or carbon monoxide) reduces iron oxide **OR** is a reducing agent **OR** converts iron oxide to iron / removes oxygen from iron oxide • (coke) reacts with oxygen to **form** carbon monoxide **OR** reacts with carbon dioxide to **form** carbon monoxide	**2**
6(b)	S_2^{2-} **or** S^-	**1**
6(c)(i)	any two from: • (iron forms) coloured compounds • (iron has) variable oxidation states • (iron acts as a) catalyst	**2**
6(c)(ii)	any two from: • (iron is) good conductor of electricity • (iron) forms a basic oxide • (iron salts are) soluble (in water)	**2**

Question	Answer	Marks
6(d)(i)	magnesium is **more** reactive than iron / steel **ORA** (1) iron is not oxidised **OR** iron does not lose electrons **OR** magnesium loses electrons **more easily** than or **in preference** (to iron) **ORA** **OR** magnesium is oxidised **more easily or** reacts with oxygen **more easily or** corrodes **more easily** or **in preference** (to iron) **ORA** (1)	**2**
6(d)(ii)	copper is less reactive than iron / copper is lower in the reactivity series than iron **ORA**	**1**

Question	Answer	Marks
7(a)	48.65 / 12 8.11 / 1 43.24 / 16 (1) **OR evaluation** 4.05 8.11 2.7(0) divide all by smallest **OR** 1.5 : 3 : 1 **OR** 6 : 3 : 2 (1) $C_3H_6O_2$ (1) **ALLOW** symbols in any order	**3**
7(b)	(M_r of CH_4O = 32) CH_4O (1)	**1**
7(c)(i)	$C_nH_{2n}O_2$ **OR** C_nH_{2n+1} COOH	**1**

Question	Answer	Marks
7(c)(ii)	butanoic acid (1) fully displayed carboxylic acid group (1)  correct structure of butanoic acid showing all atoms and bonds (1)	**3**
7(c)(iii)	homologous series	**1**
7(d)(i)	brown to colourless	**1**
7(d)(ii)	C_9H_{20} (1) $2C_3H_6$ (1)	**2**
7(d)(iii)	addition	**1**
7(d)(iv)	 any one repeat unit (1) both repeat units fully correct (1)	**2**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2021**

45 minutes

You must answer on the multiple choice answer sheet.

5240957555

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

INSTRUCTIONS

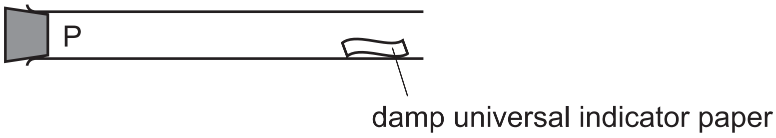
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the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

INFORMATION

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

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

1 A gas is released at point P in the apparatus shown.



Which gas turns the damp universal indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

2 A $1\,cm^3$ sample of substance X is taken. This is sample 1.

X is then converted to a different physical state and a $1\,cm^3$ sample is taken. This is sample 2.

Sample 2 contains more particles in the $1\,cm^3$ than sample 1.

Which process caused this increase in the number of particles in $1\,cm^3$?

A boiling of liquid X

B condensation of gaseous X

C evaporation of liquid X

D sublimation of solid X

3 Which statement about paper chromatography is correct?

A A solvent is needed to dissolve the paper.

B Paper chromatography separates mixtures of solvents.

C The solvent should cover the baseline.

D The baseline should be drawn in pencil.

4 Element X has 7 protons.

Element Y has 8 more protons than X.

Which statement about element Y is correct?

A Y has more electron shells than X.

B Y has more electrons in its outer shell than X.

C Y is in a different group of the Periodic Table from X.

D Y is in the same period of the Periodic Table as X.

5 A covalent molecule Q contains only six shared electrons.

What is Q?

A ammonia, NH_3

B chlorine, Cl_2

C methane, CH_4

D water, H_2O

6 Which statement explains why metals are malleable?

A The atoms release electrons to become cations.

B The electrons are free to move.

C The electrons and the cations are attracted to each other.

D The layers of ions can slide over each other.

7 Which statement about isotopes of the same element is correct?

A They have different numbers of electrons.

B They have different numbers of neutrons.

C They have different numbers of protons.

D They have the same mass number.

8 The element silicon has the same structure as diamond.

Which statement about silicon is correct?

A Every silicon atom is bonded to three other atoms only.

B Silicon has a high melting point.

C Silicon is a good conductor of electricity.

D Silicon is used as a lubricant.

9 Three ionic compounds of vanadium have the formulae V_2O, VCl_2 and V_2O_3.

What is the charge on the vanadium ion in each compound?

	V_2O	VCl_2	V_2O_3
A	+1	–2	+2
B	+1	+2	+3
C	+2	–2	+2
D	+2	+2	+3

10 In separate experiments, electricity was passed through concentrated aqueous sodium chloride and molten lead(II) bromide.

What would happen in **both** experiments?

A A halogen would be formed at the anode.

B A metal would be formed at the cathode.

C Hydrogen would be formed at the anode.

D Hydrogen would be formed at the cathode.

11 The equation for the decomposition of calcium carbonate is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

What mass of calcium oxide is produced when 10 g of calcium carbonate is heated?

A 4.4 g **B** 5.0 g **C** 5.6 g **D** 10.0 g

12 Gas syringe X contains 100 cm^3 of hydrogen bromide gas, HBr.

Gas syringe Y contains 100 cm^3 of carbon dioxide gas. The volume of each gas is measured at room temperature and pressure.

Which statement is correct?

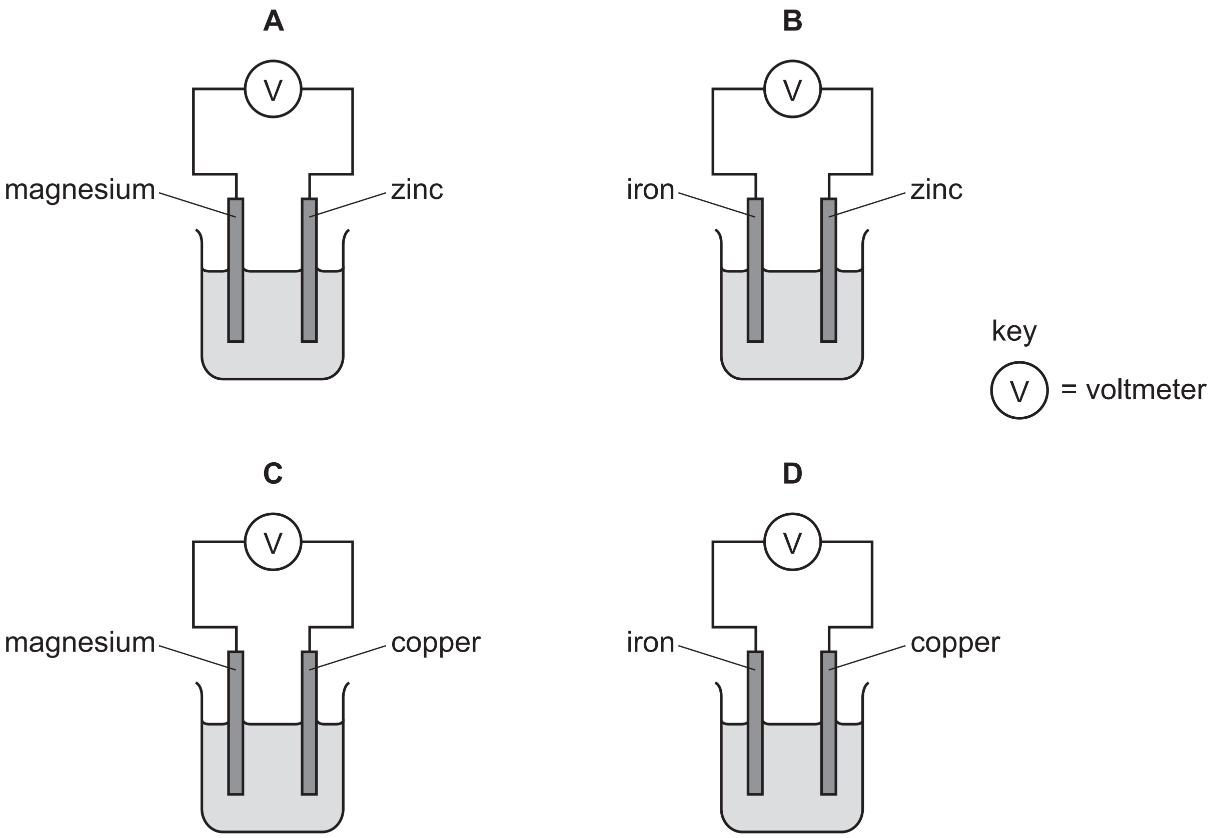
A The mass of HBr is less than the mass of CO_2.

B The number of molecules of HBr equals the number of molecules of CO_2.

C The gas in syringe X contains more atoms than the gas in syringe Y.

D The number of moles of HBr is more than the number of moles of CO_2.

13 Which simple cell produces the most electrical energy?



14 When sulfur is heated it undergoes a ......1...... change as it melts.

Further heating causes the sulfur to undergo a ......2...... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles per second.

4 There are more collisions which have energy greater than the activation energy.

Which statements are correct?

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

16 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidising agent and it oxidises Cu^{2+}.

B Zn is the oxidising agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidises Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

17 The equation for the decomposition of hydrogen iodide is shown.

$$2HI \rightarrow H_2 + I_2$$

Some bond energies are shown.

bond	bond energy in kJ / mol
H–H	440
I–I	150
H–I	300

What is the energy change for the reaction?

A –290 kJ / mol **B** –10 kJ / mol **C** +10 kJ / mol **D** +290 kJ / mol

18 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

	element X	nature of oxide, XO
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

19 Aqueous solutions of sodium sulfate and barium chloride are mixed.

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

Which process is used to separate a sample of barium sulfate from the reaction mixture?

A precipitation

B filtration

C evaporation

D distillation

20 Information about element J is shown.

- Its atoms have four electrons in their outer shell.
- It is a non-metal.
- Its oxide has a macromolecular structure.
- It has a high melting point.

What is J?

A beryllium

B carbon

C silicon

D sulfur

21 Which property is shown by transition elements?

A low density

B low melting point

C variable oxidation state

D white compounds

22 Helium and neon exist as monoatomic gases at room temperature and pressure.

statement 1 Helium and neon have eight electrons in their outer shell.

statement 2 Helium and neon are unreactive.

Which option is correct?

A Statement 1 and statement 2 are incorrect.

B Statement 1 is correct and explains statement 2.

C Statement 1 is correct, but does not explain statement 2.

D Statement 1 is incorrect, but statement 2 is correct.

23 What are possible effects of an inadequate water supply during a drought?

1 crop failure

2 wastage of water

3 human disease

4 death of farm animals

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

24 Which statement explains why galvanising prevents iron from rusting?

A Zinc is more reactive than iron and corrodes in preference to iron.

B Zinc is more reactive than iron and loses electrons less easily than iron.

C Zinc is less reactive than iron and corrodes in preference to iron.

D Zinc is less reactive than iron and loses electrons more easily than iron.

25 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

26 Which compounds are released by the extraction of zinc from zinc blende and by respiration?

	extraction of zinc	respiration
A	CO_2 and SO_2	CO_2 only
B	CO_2 and SO_2	CO_2 and H_2O
C	CO_2 only	CO_2 only
D	CO_2 only	CO_2 and H_2O

27 Which gas is an air pollutant that causes acid rain?

A argon

B carbon monoxide

C methane

D nitrogen dioxide

28 Ammonia is made from nitrogen and hydrogen. The equation for the reaction is shown.

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

The forward reaction is exothermic.

Which conditions give the greatest equilibrium yield of ammonia?

	temperature / °C	pressure / atm
A	200	15
B	200	150
C	500	15
D	500	150

29 Which reaction does **not** occur during the extraction of iron from hematite in a blast furnace?

A $C + O_2 \rightarrow CO_2$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $CO_2 + C \rightarrow 2CO$

D $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

30 Which substance is used as a catalyst in the manufacture of sulfuric acid by the Contact process?

A iron

B nickel

C phosphoric acid

D vanadium(V) oxide

31 Metal X is a good conductor of electricity and is used for electrical wiring.

Metal Y is used to make an alloy which is resistant to corrosion and is used to make cutlery.

Metal Z is light and strong and is used in the manufacture of aircraft.

What are X, Y and Z?

	X	Y	Z
A	aluminium	iron	copper
B	copper	iron	aluminium
C	aluminium	copper	iron
D	copper	aluminium	iron

32 The formulae of two compounds of manganese are MnO_2 and $KMnO_4$.

In these two compounds the oxidation state of potassium is +1 and the oxidation state of oxygen is –2.

What are the oxidation states of manganese in each of these two compounds?

	MnO_2	$KMnO_4$
A	+2	+3
B	+2	+7
C	+4	+3
D	+4	+7

33 Which statement about calcium carbonate is correct?

A It is made by the thermal decomposition of limestone.

B It is used to neutralise alkaline soils.

C It is a reactant in the test for carbon dioxide.

D It is used to remove impurities in iron extraction.

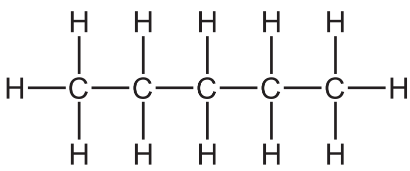
34 Ethanol is reacted with acidified potassium manganate(VII).

Which row describes the type of reaction and the type of organic compound formed?

	type of reaction	organic compound
A	oxidation	carboxylic acid
B	oxidation	alkene
C	dehydration	carboxylic acid
D	dehydration	alkene

35 The diagrams show the structural formulae of four compounds.

1



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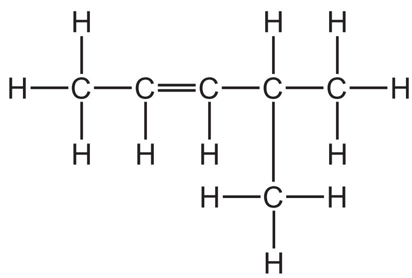

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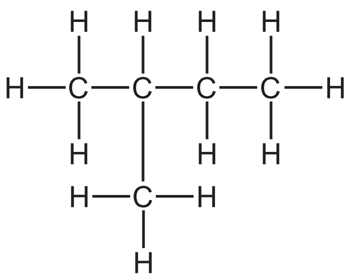

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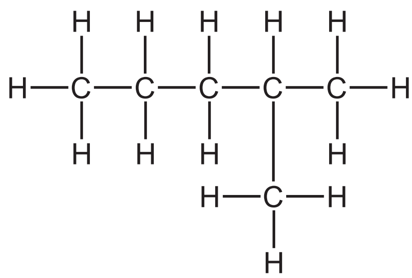


Which two compounds are structural isomers?

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

36 Which statement about alkanes is correct?

A They burn in oxygen.

B They contain carbon, hydrogen and oxygen atoms.

C They contain double bonds.

D They contain ionic bonds.

37 How much hydrogen is needed to react completely with 0.02 moles of butene to make butane?

A $0.24\,dm^3$ **B** $0.48\,dm^3$ **C** $0.96\,dm^3$ **D** $1.20\,dm^3$

38 What is an advantage of the fermentation process for producing ethanol compared with the catalytic addition of steam to ethene?

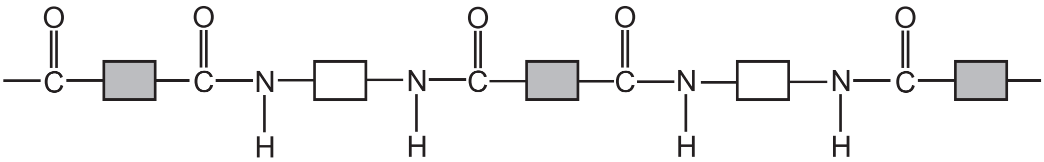
A Fermentation requires less heat energy.

B Ethanol from fermentation needs to be distilled.

C Raw materials for fermentation are non-renewable.

D The fermentation process is carried out in batches rather than continuously.

39 The structure of a synthetic polymer is shown.



The structure shows that it is a ......1...... . It is formed by ......2...... polymerisation.

Which words complete gaps 1 and 2?

	1	2
A	polyamide	addition
B	polyamide	condensation
C	polyester	addition
D	polyester	condensation

40 Which substance is a natural polymer?

A ethene

B *Terylene*

C nylon

D protein

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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 2021 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	C	**1**
2	B	**1**
3	D	**1**
4	A	**1**
5	A	**1**
6	D	**1**
7	B	**1**
8	B	**1**
9	B	**1**
10	A	**1**
11	C	**1**
12	B	**1**
13	C	**1**
14	C	**1**
15	C	**1**
16	D	**1**
17	C	**1**
18	B	**1**
19	B	**1**
20	C	**1**
21	C	**1**
22	D	**1**
23	C	**1**
24	A	**1**
25	C	**1**
26	B	**1**
27	D	**1**
28	B	**1**

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2021**

45 minutes

You must answer on the multiple choice answer sheet.

* 4 6 7 5 9 2 3 4 7 1 *

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

INSTRUCTIONS

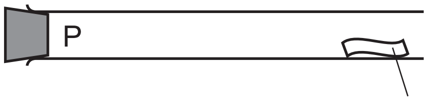
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the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

INFORMATION

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

IB21 06_0620_22/2RP

1 A gas is released at point P in the apparatus shown.



Which gas turns the damp universal indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

2 A mixture of colourless compounds is separated using chromatography.

Which type of reagent is used to detect these compounds after separation?

A a dehydrating agent

B a locating agent

C an oxidising agent

D a reducing agent

3 Which statement about paper chromatography is correct?

A A solvent is needed to dissolve the paper.

B Paper chromatography separates mixtures of solvents.

C The solvent should cover the baseline.

D The baseline should be drawn in pencil.

4 Element X has 7 protons.

Element Y has 8 more protons than X.

Which statement about element Y is correct?

A Y has more electron shells than X.

B Y has more electrons in its outer shell than X.

C Y is in a different group of the Periodic Table from X.

D Y is in the same period of the Periodic Table as X.

5 A covalent molecule Q contains only six shared electrons.

What is Q?

A ammonia, NH_3

B chlorine, Cl_2

C methane, CH_4

D water, H_2O

6 Information about four substances E, F, G and H is shown.

	melting point / °C	electrical conductivity
E	1710	does not conduct when solid
F	3500	conducts when solid
G	120	does not conduct
H	801	conducts when molten

E, F, G and H are graphite, poly(ethene), sodium chloride and silicon(IV) oxide but not in that order.

What are E, F, G and H?

	E	F	G	H
A	graphite	poly(ethene)	silicon(IV) oxide	sodium chloride
B	sodium chloride	graphite	poly(ethene)	silicon(IV) oxide
C	poly(ethene)	sodium chloride	graphite	silicon(IV) oxide
D	silicon(IV) oxide	graphite	poly(ethene)	sodium chloride

7 Chemical compounds formed from a Group I element and a Group VII element contain ionic bonds.

How are the ionic bonds formed?

A Electrons are transferred from Group VII atoms to Group I atoms.

B Electrons are shared between Group I atoms and Group VII atoms.

C Electrons are lost by Group I atoms and Group VII atoms.

D Electrons are transferred from Group I atoms to Group VII atoms.

8 Some information about particles P, Q, R and S is shown.

	nucleon number	number of neutrons	number of electrons
P	12	6	6
Q	24	12	10
R	16	8	10
S	14	8	6

Which two particles are isotopes of the same element?

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

9 Chlorine gas will react with iron metal.

Exactly 21.3 g of chlorine reacts with 11.2 g of iron.

How many iron atoms react with 30 molecules of chlorine?

A 10 **B** 15 **C** 20 **D** 30

10 In separate experiments, electricity was passed through concentrated aqueous sodium chloride and molten lead(II) bromide.

What would happen in **both** experiments?

A A halogen would be formed at the anode.

B A metal would be formed at the cathode.

C Hydrogen would be formed at the anode.

D Hydrogen would be formed at the cathode.

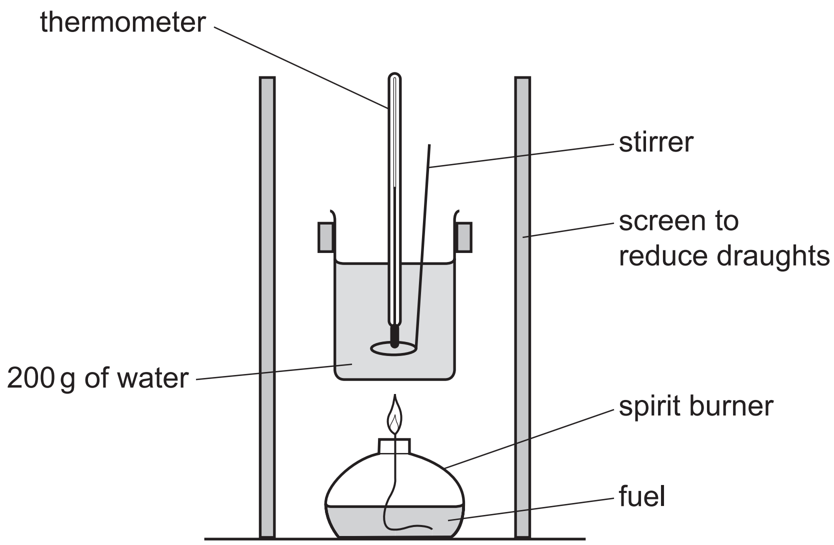
11 A reaction involving aluminium is shown.

$$xAl + yO_2 + 6H_2O \rightarrow xAl(OH)_3$$

Which values of x and y balance the equation?

	x	y
A	2	3
B	3	2
C	3	4
D	4	3

12 Four different fuels are used to heat a beaker of water, for the same amount of time, using the apparatus shown.



The initial temperature of the water and the temperature after heating by the fuel are recorded.

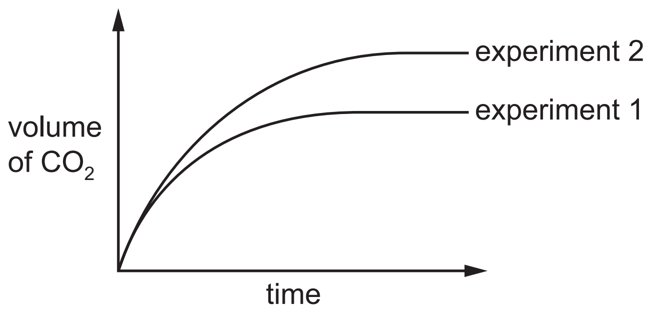
Which fuel releases the most heat energy?

	initial temperature / °C	temperature after heating / °C
A	17	46
B	24	52
C	26	61
D	30	62

13 An excess of calcium carbonate reacts with dilute hydrochloric acid. The volume of carbon dioxide produced is measured at regular time intervals. The results are shown as experiment 1.

The experiment is repeated with only **one** change to the reaction conditions.

The results are shown as experiment 2.



Which change is made in experiment 2?

A The concentration of the acid is increased.

B The volume of acid is increased.

C The mass of calcium carbonate is increased.

D The calcium carbonate is powdered.

14 When sulfur is heated it undergoes a ......1...... change as it melts.

Further heating causes the sulfur to undergo a ......2...... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles per second.

4 There are more collisions which have energy greater than the activation energy.

Which statements are correct?

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

16 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidising agent and it oxidises Cu^{2+}.

B Zn is the oxidising agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidises Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

17 When bismuth(III) chloride, $BiCl_3$, reacts with water, a white precipitate of bismuth(III) oxychloride, $BiOCl$, is formed. The equation for the reaction is shown.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2H^+(aq) + 2Cl^-(aq)$$

The reaction is in equilibrium.

Which changes cause the white precipitate to dissolve?

1 adding acid

2 adding water

3 adding sodium chloride solution

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

18 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

	element X	nature of oxide, XO
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

19 Information about the solubility of salts is shown.

salt	solubility
chlorides	soluble (except for lead(II) chloride and silver chloride)
nitrates	soluble
sulfates	soluble (except for barium sulfate and lead(II) sulfate)

Aqueous solutions of which two compounds would produce a precipitate when added together?

A $Ba(NO_3)_2$ and $CaCl_2$

B $CuSO_4$ and $Zn(NO_3)_2$

C KCl and Na_2SO_4

D $Pb(NO_3)_2$ and $MgSO_4$

20 The equation shows the reaction between hydrogen and oxygen.

$$2\,H–H \; + \; O=O \; \rightarrow \; 2\,H–O–H$$

The bond energies are shown.

	bond energy in kJ / mol
H–H	436
O=O	495
O–H	463

Which row shows the energy change and the type of reaction?

	energy change in kJ / mol	type of reaction
A	441	exothermic
B	441	endothermic
C	485	exothermic
D	485	endothermic

21 Burning fossil fuels releases sulfur dioxide which leads to acid rain.

Which ion in the rain water causes it to be acidic?

A H^+ **B** OH^- **C** O^{2-} **D** SO_4^{2-}

22 Which statement about the trends shown by the elements of Period 3 in the Periodic Table is **not** correct?

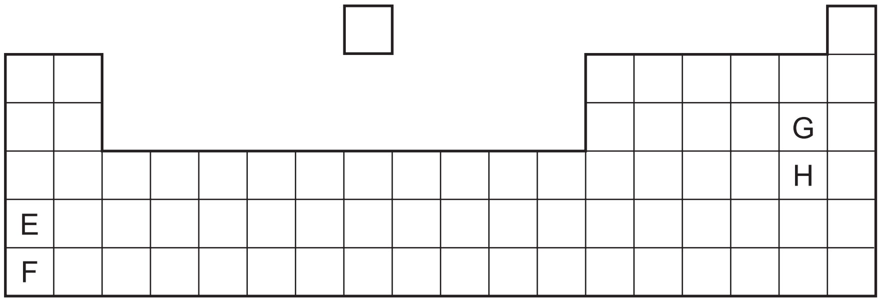
A The elements become less metallic across the period.

B The group number increases across the period.

C The number of electron shells increases across the period.

D The number of outer electrons increases across the period.

23 The diagram shows the positions of elements E, F, G and H in the Periodic Table.



Which statements about elements E, F, G and H are correct?

1 E has a higher density than F.

2 E has a higher melting point than F.

3 G has a darker colour than H.

4 G has a lower melting point than H.

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

24 When aqueous iodine is added to a solution of vanadium ions, V^{2+}, the V^{2+} ions each lose one electron.

Which property of transition elements is shown by this reaction?

A Transition elements have variable oxidation states.

B Transition elements form a stable 1+ ion.

C Transition elements are oxidising agents.

D Transition elements can act as catalysts.

25 A piece of aluminium is dropped into dilute hydrochloric acid.

No immediate reaction is observed.

Which statement explains this observation?

A Aluminium does not neutralise acids.

B Aluminium is a non-metal so does not react with acids.

C Aluminium is below hydrogen in the reactivity series.

D Aluminium is covered in an unreactive oxide layer.

26 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

27 Aluminium is extracted from its ore by electrolysis.

Which equation represents the reaction that occurs at the anode during the electrolysis?

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

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

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

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

28 Mild steel consists mostly of iron. Mild steel can be prevented from rusting by a process called galvanising.

Copper is not a very strong metal, however if it is mixed with a suitable metal a strong alloy called brass is produced.

Which statement is correct?

A Copper corrodes very quickly when wet and brass does not.

B Copper is mixed with zinc to produce brass.

C Galvanising mild steel changes it from a pure metal into an alloy.

D When a steel object is galvanised this means it is coated with a thin layer of tin.

29 Water is used for the irrigation of crops and for drinking water.

For which uses must water be chlorinated?

	irrigation	drinking
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

30 Which natural resource **cannot** provide a raw material for the manufacture of ammonia?

A air

B limestone

C petroleum

D water

31 Ammonia is made in the Haber process.

Which conditions are used in the Haber process?

	temperature / °C	pressure / atmospheres	catalyst used
A	450	200	iron
B	450	5	vanadium(V) oxide
C	200	450	iron
D	200	5	vanadium(V) oxide

32 Which process in the carbon cycle is responsible for removing carbon dioxide from the atmosphere?

A combustion

B decomposition

C photosynthesis

D respiration

33 The equations represent two reactions, P and Q, of lime (calcium oxide).

P $CaO + SiO_2 \rightarrow CaSiO_3$

Q $CaO + SO_2 \rightarrow CaSO_3$

In which processes do the reactions occur?

	P	Q
A	extraction of iron	extraction of iron
B	extraction of iron	flue gas desulfurisation
C	flue gas desulfurisation	extraction of iron
D	flue gas desulfurisation	flue gas desulfurisation

34 Which statement about ethanol is **not** correct?

- **A** Ethanol can be made by fermentation.
- **B** Ethanol is oxidised to make ethanoic acid.
- **C** Ethanol reacts with oxygen exothermically, making it a good fuel.
- **D** Ethanol reacts with propanoic acid to make propyl ethanoate.

35 Which pair of formulae represents two alkanes?

- **A** CH_4 and C_8H_{18}
- **B** C_2H_6 and C_5H_8
- **C** C_3H_6 and C_5H_{12}
- **D** $C_{10}H_8$ and C_4H_8

36 Which statement about alkanes is correct?

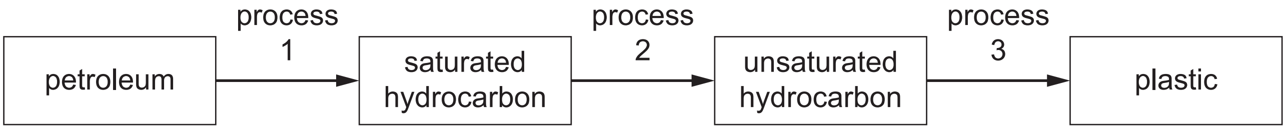
- **A** They burn in oxygen.
- **B** They contain carbon, hydrogen and oxygen atoms.
- **C** They contain double bonds.
- **D** They contain ionic bonds.

37 Which statements about ethanoic acid are correct?

1. It is a strong acid.
2. It reacts with ethanol to form an ester.
3. It has the formula CH_3COOH.

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

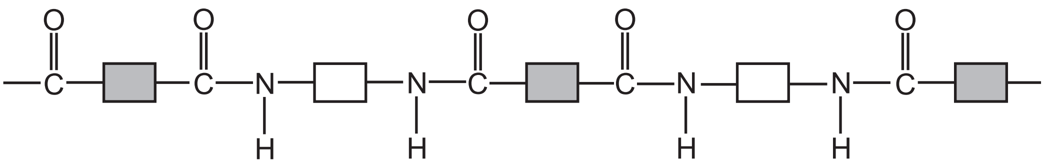
38 The flow chart shows how petroleum may be turned into a plastic.



What are processes 1, 2 and 3?

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

39 The structure of a synthetic polymer is shown.



The structure shows that it is a ......1...... . It is formed by ......2...... polymerisation.

Which words complete gaps 1 and 2?

	1	2
A	polyamide	addition
B	polyamide	condensation
C	polyester	addition
D	polyester	condensation

40 Which substance is a natural polymer?

A ethene

B *Terylene*

C nylon

D protein

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group

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

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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

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

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2021**

45 minutes

You must answer on the multiple choice answer sheet.

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

INSTRUCTIONS

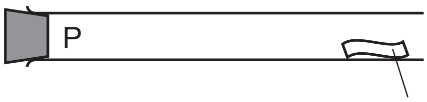
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the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

INFORMATION

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

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

1 A gas is released at point P in the apparatus shown.



Which gas turns the damp universal indicator paper red most quickly?

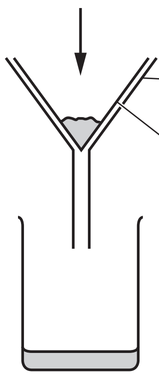
A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

2 A mixture is separated using the apparatus shown.



What is the mixture?

A aqueous copper(II) sulfate and aqueous sodium chloride

B aqueous copper(II) sulfate and copper

C copper and sulfur

D ethanol and ethanoic acid

3 Which statement about paper chromatography is correct?

A A solvent is needed to dissolve the paper.

B Paper chromatography separates mixtures of solvents.

C The solvent should cover the baseline.

D The baseline should be drawn in pencil.

4 Element X has 7 protons.

Element Y has 8 more protons than X.

Which statement about element Y is correct?

A Y has more electron shells than X.

B Y has more electrons in its outer shell than X.

C Y is in a different group of the Periodic Table from X.

D Y is in the same period of the Periodic Table as X.

5 A covalent molecule Q contains only six shared electrons.

What is Q?

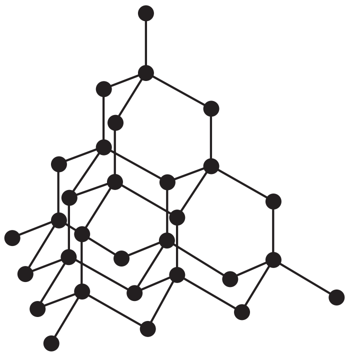
A ammonia, NH_3

B chlorine, Cl_2

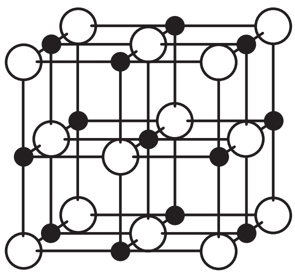
C methane, CH_4

D water, H_2O

6 The arrangement of particles in each of two solids, S and T, are shown.



S



T

What are S and T?

	S	T
A	diamond	silicon(IV) oxide
B	diamond	sodium chloride
C	graphite	silicon(IV) oxide
D	graphite	sodium chloride

7 Which statement about metals is correct?

A Metals conduct electricity when molten because negative ions are free to move.

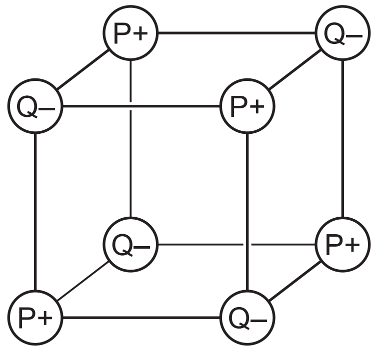
B Metals conduct electricity when solid because positive ions are free to move.

C Metals are malleable because the bonds between the atoms are weak.

D Metals are malleable because the layers of ions can slide over each other.

8 Two elements, P and Q, are in the same period of the Periodic Table.

P and Q react together to form an ionic compound. Part of the lattice of this compound is shown.



Which statement is correct?

A An ion of P has more electrons than an ion of Q.

B Element P is non-metallic.

C P is to the left of Q in the Periodic Table.

D The formula of the compound is P_4Q_4.

9 2.56 g of a metal oxide, MO_2, is reduced to 1.92 g of the metal, M.

What is the relative atomic mass of M?

A 48 **B** 96 **C** 128 **D** 192

10 In separate experiments, electricity was passed through concentrated aqueous sodium chloride and molten lead(II) bromide.

What would happen in **both** experiments?

A A halogen would be formed at the anode.

B A metal would be formed at the cathode.

C Hydrogen would be formed at the anode.

D Hydrogen would be formed at the cathode.

11 What is the ionic half-equation for the reaction that occurs at the cathode when molten lead(II) bromide is electrolysed?

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

B $2Br^{-} \rightarrow Br_2 + 2e^{-}$

C $Br_2 + 2e^{-} \rightarrow 2Br^{-}$

D $Pb \rightarrow Pb^{2+} + 2e^{-}$

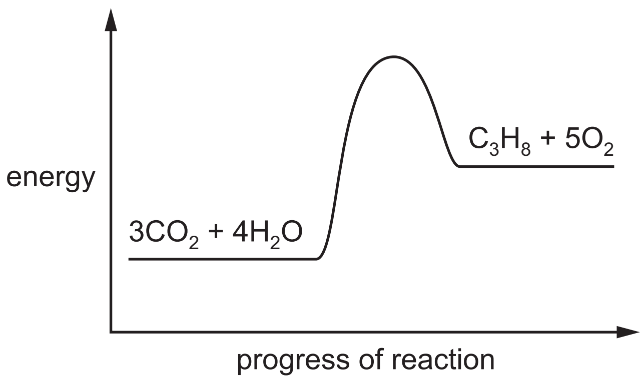
12 The complete combustion of propane is exothermic.

The equation for this reaction is shown.

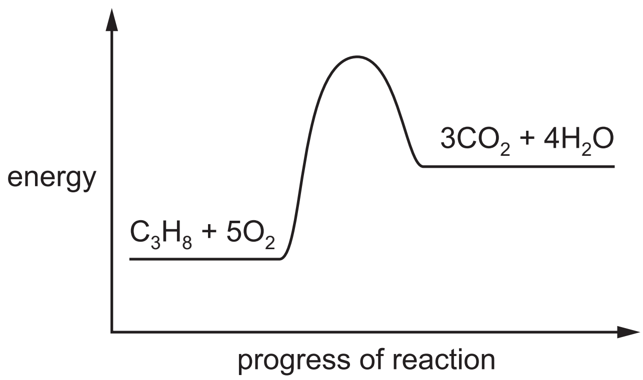
$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Which energy level diagram represents the complete combustion of propane?

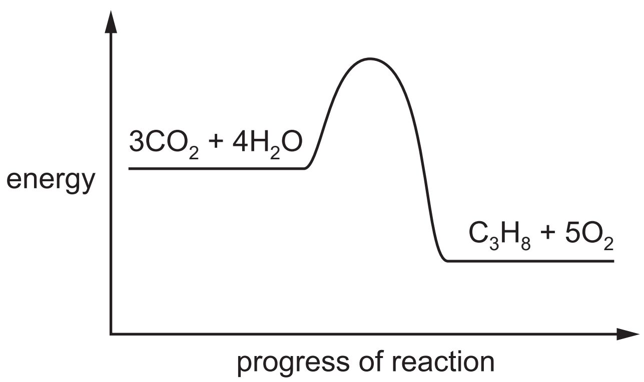
A



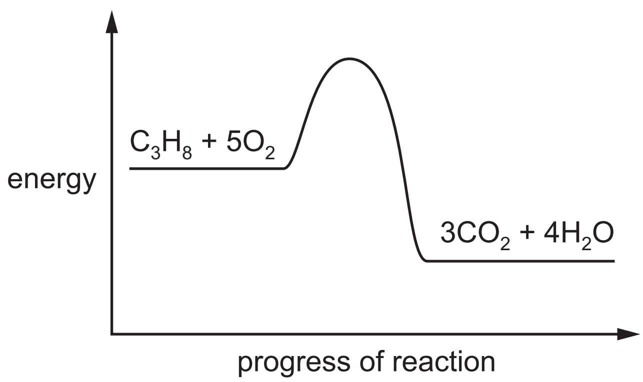
B



C



D



13 Which equation represents a reaction that takes place in a fuel cell?

A $C + O_2 \rightarrow CO_2$

B $2H_2 + O_2 \rightarrow 2H_2O$

C $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

D $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

14 When sulfur is heated it undergoes a ......1...... change as it melts.

Further heating causes the sulfur to undergo a ......2...... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles per second.

4 There are more collisions which have energy greater than the activation energy.

Which statements are correct?

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

16 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidising agent and it oxidises Cu^{2+}.

B Zn is the oxidising agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidises Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

17 Which statement about a reaction in equilibrium is correct?

A Both the forward and the backward reactions are proceeding at the same rate.

B Neither the forward nor the backward reaction is proceeding.

C The amount of product present is no longer affected by changes in temperature or pressure.

D The amount of product present is only affected by a change in pressure.

18 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

	element X	nature of oxide, XO
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

19 Copper(II) sulfate is prepared by adding excess copper(II) oxide to warm dilute sulfuric acid.

Which purification methods are used to obtain pure solid copper(II) sulfate from the reaction mixture?

1 crystallisation

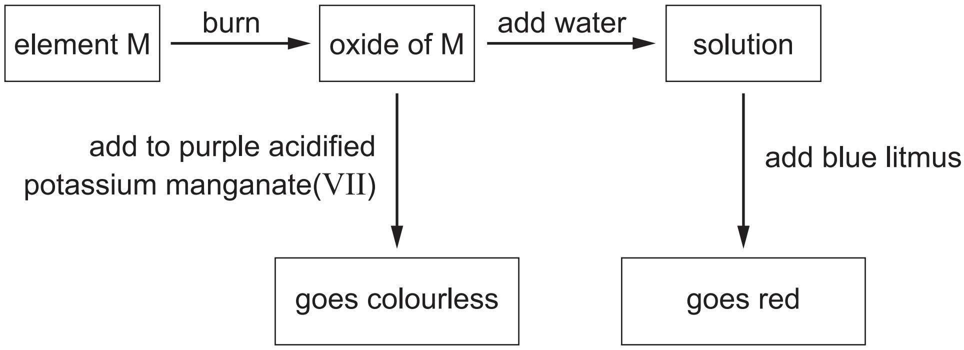
2 filtration

3 chromatography

4 distillation

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

20 Some reactions of element M are shown.



What is element M?

A carbon

B iron

C magnesium

D sulfur

21 In which equation is the underlined reactant acting as a base?

A $CH_3COO^- + \underline{H_3O^+} \rightarrow CH_3COOH + H_2O$

B $\underline{NH_4^+} + OH^- \rightarrow NH_3 + H_2O$

C $CO_2 + 2\underline{H_2O} \rightarrow H_3O^+ + HCO_3^-$

D $\underline{H^+} + OH^- \rightarrow H_2O$

22 Why is helium used to fill balloons?

A Helium is monoatomic.

B Helium is in Group VIII of the Periodic Table.

C Helium has a full outer electron shell.

D Helium is less dense than air.

23 Which elements in the table are transition elements?

element	property
E	forms E^{3+} ions only
F	forms F^+ and F^{2+} ions
G	forms only white salts
H	used in catalytic converters

A E and G **B** E and H **C** F and G **D** F and H

24 Element R forms a covalent compound R_2Si with silicon.

Which row describes R?

	metallic or non-metallic character	group number in the Periodic Table
A	metallic	II
B	metallic	VI
C	non-metallic	II
D	non-metallic	VI

25 Some properties of metal J are listed.

- J does not react with cold water.
- J reacts with dilute hydrochloric acid.
- No reaction occurs when the oxide of J is heated with carbon.

What is J?

A copper

B iron

C magnesium

D sodium

26 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

27 Which substances are used in the extraction of aluminium?

A bauxite and cryolite

B bauxite and hematite

C cryolite and zinc blende

D hematite and zinc blende

28 Different types of steel alloys are manufactured by changing the percentage of carbon in the alloy.

The properties of four steel alloys are shown.

alloy mixture	percentage of carbon in the alloy	strength of the alloy	hardness of the alloy
1	0.00 to 0.20	high	low
2	0.21 to 0.30	high	medium
3	0.31 to 0.40	medium	high
4	0.41 to 1.50	low	high

What are the properties of the steel alloy containing 0.23% of carbon?

	strength	hardness
A	high	low
B	low	high
C	high	medium
D	medium	high

29 Ammonia is made by reacting nitrogen with hydrogen in the Haber process.

The equation for the process is shown.

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

Which changes in reaction conditions would produce a greater yield of ammonia?

1 adding more iron catalyst

2 increasing the reaction pressure

3 increasing the particle size of the iron catalyst

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

30 Which process removes carbon dioxide from the atmosphere?

A combustion of fossil fuels

B fermentation

C photosynthesis

D respiration

31 Which catalyst is used in the Contact process?

A calcium oxide

B iron

C manganese(II) oxide

D vanadium(V) oxide

32 A white solid Z reacts with dilute hydrochloric acid to produce a gas.

The same gas is produced when compound Z is heated strongly.

What is Z?

A calcium

B calcium carbonate

C calcium hydroxide

D calcium oxide

33 What is the structure of butanoic acid?

A $CH_3CH_2CO_2H$

B $CH_3CH_2CH_2CO_2H$

C $CH_3CH_2CH_2CH_2CO_2H$

D $CH_3CH_2CH_2CO_2CH_3$

34 Compound Z contains carbon, hydrogen and oxygen.

Molecules of compound Z have four hydrogen atoms and two carbon atoms.

Compound Z can be made by oxidation of an alcohol.

What is compound Z?

A ethene

B ethanol

C ethanoic acid

D methyl methanoate

35 Which statement about homologous series and isomerism is correct?

A Butane and butene are structural isomers.

B Compounds in the same homologous series have the same general formula.

C Compounds in the same homologous series have the same molecular formula.

D Structural isomers have different molecular formulae.

36 Which statement about alkanes is correct?

A They burn in oxygen.

B They contain carbon, hydrogen and oxygen atoms.

C They contain double bonds.

D They contain ionic bonds.

37 What is an advantage of manufacturing ethanol by fermentation?

A The process is very fast.

B The ethanol requires no separation.

C The raw materials used are renewable.

D There are no other products formed.

38 P, Q, R and S are four organic compounds.

P is an unsaturated hydrocarbon.

Q burns but otherwise is unreactive.

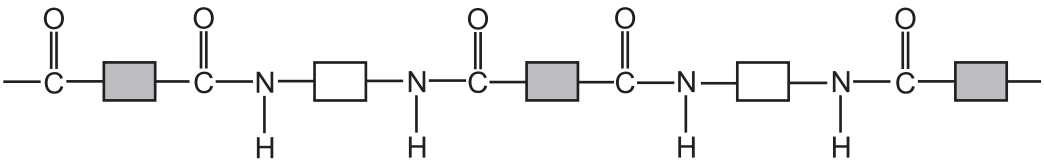
R contains a C–C single bond and a C=C double bond.

S undergoes addition polymerisation.

Which compounds are alkenes?

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

39 The structure of a synthetic polymer is shown.



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

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

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1587780154

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2021**

1 hour

You must answer on the question paper.

No additional materials are needed.

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

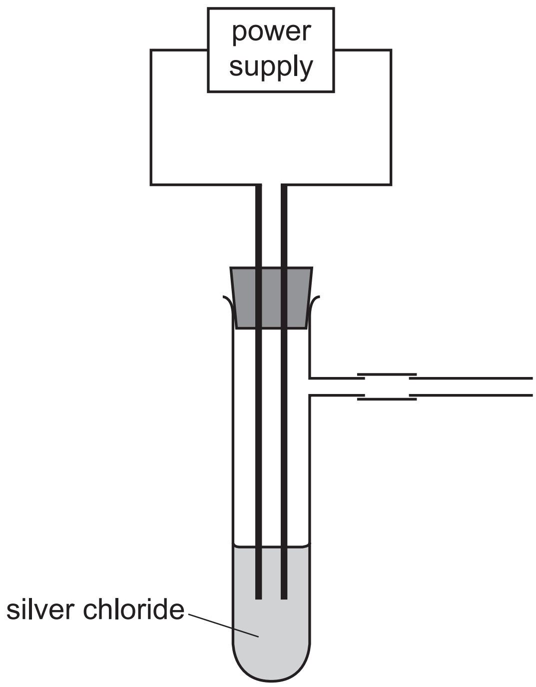
INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

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

IB21 03_0620_62/2RP

1 Silver chloride is an ionic compound and is insoluble in water. Molten silver chloride breaks down during electrolysis. The products are chlorine and silver.
Chlorine gas is soluble in water and toxic.

A student suggests using the apparatus shown to break down silver chloride.



(a) Draw an arrow on the diagram to show where heat must be applied so that the silver chloride can break down. [1]

(b) Complete the diagram to show how chlorine gas can be collected and the volume of the chlorine measured. Label any apparatus you have drawn. [2]

(c) Give **two** observations that are made as the silver chloride breaks down.

1 ....

2 ....
[2]

(d) The person doing the experiment followed all normal laboratory safety rules.

State **one** additional safety precaution that should be taken when doing this experiment. Give a reason for your answer.

safety precaution ....

reason ....
[2]

(e) Suggest **one** reason why zinc is **not** a suitable material to use as the electrodes.

....

.... [1]

(f) The chlorine gas was bubbled into an aqueous solution of a sodium salt. The colour of the solution changed from colourless to orange.

Identify the sodium salt and explain what has happened to cause the colour change.

sodium salt ....

explanation ....

....
[2]

[Total: 10]

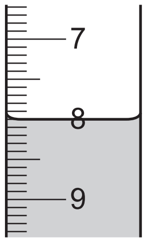
2 A student investigated the reaction between aqueous potassium hydroxide and two different aqueous solutions of hydrochloric acid labelled solution **A** and solution **B**.

Two experiments were done.

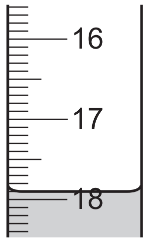
(a) *Experiment 1*

- A burette was filled with solution **A**. Some of solution **A** was run out of the burette so that the level of solution **A** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into a conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **A** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

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



initial reading



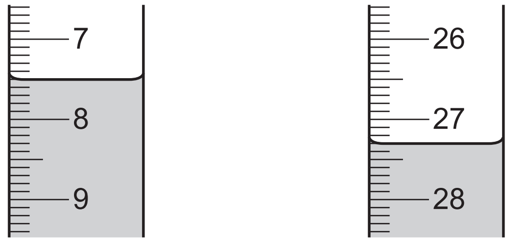
final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **A** added / cm^3	

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was emptied and rinsed with distilled water.
- The burette was rinsed with solution **B**.
- The burette was filled with solution **B**. Some of solution **B** was run out of the burette so that the level of solution **B** was on the burette scale.
- A measuring cylinder was used to measure 25 cm^3 of the aqueous potassium hydroxide.
- The aqueous potassium hydroxide was poured into the conical flask.
- Five drops of methyl orange indicator were added to the conical flask.
- Solution **B** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

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



initial reading　　　　final reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **B** added / cm^3	

[4]

(b) State the colour change observed in the conical flask at the end-point in Experiment 2.

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

(c) Before starting the titration in Experiment 2 the conical flask was rinsed with water.

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

.... [1]

(ii) The conical flask was **not** then rinsed with aqueous potassium hydroxide.

State how rinsing the conical flask with aqueous potassium hydroxide would change the volume of solution **B** needed. Explain your answer.

....

.... [2]

(d) (i) Deduce which aqueous solution of hydrochloric acid, **A** or **B**, was more concentrated. Explain your answer.

....

.... [1]

(ii) Deduce how many times more concentrated this solution of hydrochloric acid was than the other solution of hydrochloric acid.

.... [1]

(e) Explain why Experiment 1 and Experiment 2 should be repeated.

....

.... [1]

(f) Deduce the volume of solution **B** required if Experiment 2 is carried out with 50 cm^3 of aqueous potassium hydroxide.

....

.... [2]

(g) Describe **one** change that could be made to the apparatus to improve the accuracy of the results.

....

.... [1]

(h) Describe what effect using a larger conical flask would have on the results obtained.

.... [1]

[Total: 15]

3 Two solids, solid **C** and solid **D**, were analysed.
Tests were done on each solid.

tests on solid C

Tests were carried out and the following observations were made.

tests	**observations**
test 1 A flame test was carried out on solid **C**.	a red flame was seen
Solid **C** was dissolved in distilled water to produce solution **C**. **test 2** About 5 cm^3 of aqueous sodium hydroxide was added to solution **C**.	no change
test 3 A piece of aluminium foil was added to the mixture formed in **test 2**.The mixture was warmed gently and any gas produced was tested.	effervescence was seen; damp red litmus paper turned blue

(a) Name the gas that turned the damp red litmus paper blue in **test 3**.

.... [1]

(b) Identify solid **C**.

....

.... [2]

tests on solid D

Solid **D** was aluminium sulfate.

Complete the expected observations.

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

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

observations ....

.... [2]

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

observations ....

.... [2]

(e) About 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **D**.

observations .... [1]

(f) About 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the fourth portion of solution **D**.

observations .... [1]

[Total: 9]

4 Old concrete contains calcium carbonate. Calcium carbonate reacts with dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Plan an investigation to find which of two lumps of concrete contains the larger percentage of calcium carbonate. Your plan should include how you will use your results to determine which one of the two lumps has the larger percentage of calcium carbonate.

You have access to all common laboratory materials and a supply of dilute hydrochloric acid.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **March 2021**

MARK SCHEME

Maximum Mark: 40

Published

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

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

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

Cambridge International is publishing the mark schemes for the March 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	an arrow pointing to the bottom of the test tube.	**1**
1(b)	apparatus that looks like a gas syringe in approximately horizontal orientation connected to delivery tube 	**1**
	graduations shown OR labelled as (gas) syringe	**1**
1(c)	any 2 from: • yellow / green gas • bubbles / effervescence • shiny liquid / metal / solid / deposit / substance max 2	**2**
1(d)	M1 Precaution**:** use a fume cupboard / well ventilated space	**1**
	Reason**:** chlorine is toxic / poisonous M2 must link to M1 to score	**1**
1(e)	(zinc) reacts (with chlorine / silver chloride)	**1**
1(f)	sodium bromide	**1**
	bromine is displaced by chlorine OR chlorine is more reactive than bromine OR chlorine oxidises bromide	**1**

Question	Answer	Marks
2(a)	final and initial burette reading for Experiment 1 correct (17.9 and 8.0)	**1**
	final and initial burette reading for Experiment 2 correct (27.3 and 7.5)	**1**
	both titres correct (9.9 and 19.8)	**1**
	all volumes recorded to 1 dp or better	**1**
2(b)	(from) yellow (to) orange	**1**
2(c)(i)	to remove any residue from Experiment 1	**1**
2(c)(ii)	larger volume of solution B needed / it would increase	**1**
	(as there is) more potassium hydroxide / alkali	**1**
2(d)(i)	solution A as lower volume (required).	**1**
2(d)(ii)	2× / twice	**1**
2(e)	can spot anomalous results OR can find a mean/average	**1**
2(f)	39.6 / numerical answer which is twice titre in Experiment 2	**1**
	cm^3	**1**
2(g)	use a (volumetric) pipette to measure the volume of potassium hydroxide	**1**
2(h)	none	**1**

Question	Answer	Marks
3(a)	ammonia / NH_3	**1**
3(b)	lithium nitrate lithium (ions) / Li^+	**1**
	nitrate / NO_3^-	**1**
3(c)	white precipitate	**1**
	dissolves / disappears / forms colourless solution	**1**
3(d)	white precipitate	**1**
	remains / does not dissolve / no further change / white precipitate / nothing happens	**1**
3(e)	no change	**1**
3(f)	white precipitate	**1**

Question	Answer	Marks
4	any 6 from: 1 equal / known / stated mass of concrete 2 crush concrete / lumps 3 add **excess** hydrochloric acid **THEN** (mass left unreacted) 4 filter 5 wash and dry residue 6 find mass of residue 7 lower mass of residue has most calcium carbonate **OR** (volume of gas made by end / in a set time) 4 collect gas produced 5 suitable apparatus to collect gas and measure volume named/drawn 6 and measure volume / amount of gas formed 7 larger volume of gas means more calcium carbonate **OR** (mass lost) 4 place container on balance / weigh before 5 cotton wool in opening of container 6 measure mass loss / weigh after 7 bigger mass loss is more calcium carbonate **OR** (mass calcium chloride made) 4 filter 5 evaporate (filtrate) to dryness 6 measure mass solid calcium chloride 7 bigger mass is more calcium carbonate **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

* 1 4 4 3 1 8 0 4 0 7 *

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

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

1 The table shows the numbers of protons, neutrons and electrons in particles **A** to **I**.

particle	protons	neutrons	electrons
A	1	0	0
B	6	6	6
C	6	8	6
D	10	10	10
E	16	16	18
F	17	18	17
G	18	22	18
H	19	20	19
I	20	20	18

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

(a) State which of the particles **A** to **I**:

(i) is an anion .... [1]

(ii) are cations .... and .... [2]

(iii) are noble gas atoms .... and .... [2]

(iv) is a halogen atom .... [1]

(v) is a Group I atom .... [1]

(vi) have the same nucleon number .... and .... [1]

(vii) causes acidity in aqueous solutions .... [1]

(viii) is used to define the relative atomic mass of elements. .... [1]

(b) Explain why **B** and **C** are isotopes of the same element.

....

.... [2]

[Total: 12]

2 The elements shown are gases at room temperature and pressure.

hydrogen
nitrogen
oxygen
chlorine

(a) State which **one** of these gases is green.

.... [1]

(b) The gases shown exist as diatomic molecules.

State the name of **another** element which has diatomic molecules and is a gas at room temperature and pressure.

.... [1]

(c) When separate samples of each of these gases are placed in a container they will diffuse.

(i) Describe why these gases diffuse.

.... [1]

(ii) State which of these four gases has the highest rate of diffusion.

Explain your answer.

gas ....

explanation ....

....
[2]

(d) Nitrogen, oxygen and other substances are found in clean, dry air.

(i) State the percentage of nitrogen in clean, dry air.

.... [1]

(ii) Other than nitrogen and oxygen, identify another element found in clean, dry air.

.... [1]

(iii) Identify a compound found in clean, dry air.

.... [1]

(iv) Nitrogen and oxygen can be separated from liquid air.

State the name of this process.

.... [2]

[Total: 10]

3 This question is about ammonia.

(a) Nitrogen reacts with hydrogen to form ammonia in an industrial process.

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

(i) Name this industrial process.

.... [1]

(ii) State the meaning of the symbol $\rightleftharpoons$.

.... [1]

(iii) State the conditions used in this industrial process. Include units.

temperature ....

pressure ....

[2]

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

.... [1]

(v) If the pressure is increased, the yield of ammonia increases.

Explain why, in terms of equilibrium.

....

....

.... [2]

(vi) If the temperature is increased, the rate of reaction increases.

Explain why, in terms of particles.

....

....

....

....

.... [3]

(b) Ammonia reacts with sulfuric acid to make a compound which is used as a fertiliser.

Write the chemical equation for the reaction between ammonia and sulfuric acid.

.... [2]

[Total: 12]

4 A student wanted to make some zinc chloride crystals.

The student followed the procedure shown.

step 1 Add excess zinc powder to dilute hydrochloric acid to form aqueous zinc chloride.

step 2 Remove unreacted zinc powder from the aqueous zinc chloride.

step 3 Heat the solution until it is saturated.

step 4 Allow the saturated solution to cool and remove the crystals that form.

(a) Write the equation for the reaction in **step 1**. Include state symbols.

.... [3]

(b) Explain why **excess** zinc powder is added in **step 1**.

.... [1]

(c) Suggest how unreacted zinc powder is removed in **step 2**.

.... [1]

(d) A saturated solution is formed in **step 3**.

Suggest what is meant by the term *saturated solution*.

....

.... [2]

(e) Explain why crystals form as the solution cools in **step 4**.

.... [1]

(f) Name **two** zinc compounds which react with dilute hydrochloric acid to form zinc chloride.

....

.... [2]

(g) If excess calcium metal is used instead of excess zinc powder in **step 1**, pure calcium chloride crystals do **not** form.

Explain why.

....

.... [1]

(h) Some salts can be made by titration.

In a titration experiment, 20.0 cm^3 of aqueous sodium hydroxide reacts exactly with 25.0 cm^3 of 0.100 mol / dm^3 dilute sulfuric acid to make sodium sulfate.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(i) Circle the name of the type of reaction that takes place.

decomposition **neutralisation** **precipitation** **reduction**

[1]

(ii) Calculate the concentration of the aqueous sodium hydroxide in g / dm^3 using the following steps.

- Calculate the number of moles of dilute sulfuric acid used.

.... mol

- Determine the number of moles of sodium hydroxide which react with the dilute sulfuric acid.

.... mol

- Calculate the concentration of the aqueous sodium hydroxide in mol / dm^3.

.... mol / dm^3

- Calculate the concentration of the aqueous sodium hydroxide in g / dm^3.

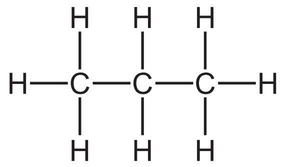
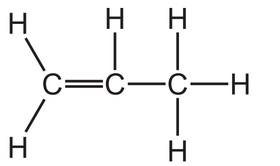
.... g / dm^3

[5]

[Total: 17]

QUESTION 5 STARTS ON THE NEXT PAGE.

5 The table shows the names or structures of organic compounds **P** to **U**.

P	**Q**	**R**
	propanoic acid	but-1-ene
S	**T**	**U**
propan-1-ol	methyl butanoate	

(a) Give the letters of the organic compounds, **P** to **U**, that are unsaturated hydrocarbons.

.... [2]

(b) Describe the test for an unsaturated hydrocarbon.

test ....

observations ....
[2]

(c) But-1-ene is an unbranched molecule.

(i) Name the unbranched isomer of but-1-ene.

.... [1]

(ii) Draw the structure of a branched isomer of but-1-ene. Show all of the atoms and all of the bonds.

[1]

(d) Dodecane is an alkane with 12 carbon atoms. Dodecane can be cracked.

(i) Write the formula of dodecane.

.... [1]

(ii) Give the letters of all the organic compounds, **P** to **U**, that can be formed when dodecane is cracked.

.... [2]

(e) Name the reagent and suggest the conditions needed to convert organic compound **U** into organic compound **S**.

reagent ....

conditions .... [3]

(f) Organic compound **S** can be converted to organic compound **Q** by reaction with an acidified reagent.

(i) Name the type of chemical change that happens to organic compound **S**.

.... [1]

(ii) Name the acidified reagent added to organic compound **S**.

.... [1]

(g) Organic compound **T** is made by reacting two compounds together.

(i) Name the homologous series that organic compound **T** belongs to.

.... [1]

(ii) Name the **two** compounds which react together to make organic compound **T**.

Draw the structures of each compound you have named. Show all of the atoms and all of the bonds.

name ....

structure

name ....

structure

[4]

(iii) Deduce the molecular formula of organic compound **T**.

.... [1]

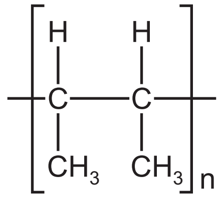
[Total: 20]

6 Polymers are large molecules built up from small molecules.

(a) State the name given to the small molecules from which polymers are made.

.... [1]

(b) The formula of a polymer is shown.



(i) Draw the structure of the small molecule from which this polymer is made. Show all of the atoms and all of the bonds.

[2]

(ii) State the type of polymerisation used to make this polymer.

.... [1]

(c) Three amino acids are shown. They combine to form part of a natural polymer.

(i) Name the type of natural polymer formed when amino acids combine.

.... [1]

(ii) Complete the diagram to show part of the structure of the natural polymer that forms when these three amino acids combine. Show all of the bonds in the linkages.

[3]

(iii) Name the type of chemical reaction that takes place when this natural polymer is converted back to amino acids.

.... [1]

[Total: 9]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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

Cambridge IGCSE™

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **March 2021**

MARK SCHEME

Maximum Mark: 80

Published

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

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

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

Cambridge International is publishing the mark schemes for the March 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

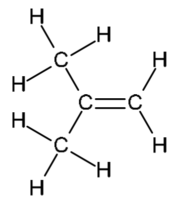
Question	Answer	Marks
1(a)(i)	E	**1**
1(a)(ii)	A I	**2**
1(a)(iii)	D G	**2**
1(a)(iv)	F	**1**
1(a)(v)	H	**1**
1(v)(i)	G **and** I	**1**
1(v)(ii)	A	**1**
1(v)(iii)	B	**1**
1(b)	same proton number different neutron number	**2**

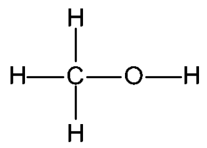
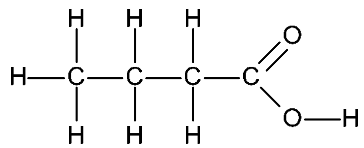
Question	Answer	Marks
2(a)	chlorine	**1**
2(b)	fluorine	**1**
2(c)(i)	random motion of **molecules / particles**	**1**
2(c)(ii)	hydrogen lowest (relative) molecular mass	**2**
2(d)(i)	78	**1**

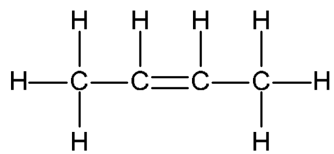
Question	Answer	Marks
2(d)(ii)	argon / Ar	**1**
2(d)(iii)	carbon dioxide	**1**
2(d)(iv)	fractional (1) distillation (1)	**2**

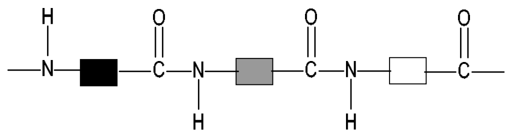
Question	Answer	Marks
3(a)(i)	Haber	**1**
3(a)(ii)	reversible / equilibrium	**1**
3(a)(iii)	450 °C (1) 200 atm (1)	**2**
3(a)(iv)	iron / Fe	**1**
3(a)(v)	equilibrium **shifts / moves** in forwards direction (1) fewer molecules / moles (of gas) on RHS (1)	**2**
3(a)(vi)	particles have more energy (1) more collisions (between particles) occur per second / per unit time (1) a greater percentage / proportion / fraction of collisions (of particles) are successful / have energy above activation energy / have energy equal to activation energy (1)	**3**
3(b)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ $(NH_4)_2SO_4$ (1) correct equation (1)	**2**

Question	Answer	Marks
4(a)	$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$ $ZnCl_2$ or H_2 as a product (1) correct equation (1) states (1)	**3**
4(b)	to make sure all the (hydrochloric) acid reacts	**1**
4(c)	filtration	**1**
4(d)	a solution that can dissolve no more solute (1) at a given temperature (1)	**2**
4(e)	solubility (of $ZnCl_2$ / solids) decreases (as temperature decreases)	**1**
4(f)	zinc oxide zinc carbonate	**2**
4(g)	Ca will also react with water	**1**
4(h)(i)	neutralisation	**1**
4(h)(ii)	$0.100 \times 25 / 1000 = 0.0025(0)$ (1) $0.0025 \times 2 = 0.005(00)$ (1) $0.005 \times 1000 / 20 = 0.25(0)$ (1) $M_r = 40$ (1) $0.25 \times 40 = 10.(0)$ (1)	**5**

Question	Answer	Marks
5(a)	R and U only	**2**
5(b)	aqueous bromine (1) turns colourless / decolourises (1)	**2**
5(c)(i)	but-2-ene	**1**
5(c)(ii)	structure of methyl propene 	**1**
5(d)(i)	$C_{12}H_{26}$	**1**
5(d)(ii)	P, R and U	**2**
5(e)	steam (1) catalyst (1) One other condition (1): either 60 atm **or** 300 °C	**3**
5(f)(i)	oxidation	**1**
5(f)(ii)	potassium manganate(VII)	**1**
5(g)(i)	ester	**1**

Question	Answer	Marks
5(g)(ii)	name = methanol structure =  name = butanoic acid structure = 	**4**
5(g)(iii)	$C_5H_{10}O_2$	**1**

Question	Answer	Marks
6(a)	monomers	**1**
6(b)(i)	any **hydrocarbon** with one C=C bond (with both C atoms having 4 bonds) (1) structure of but-2-ene (1) 	**2**
6(b)(ii)	addition	**1**

Question	Answer	Marks
6(c)(i)	protein	**1**
6(c)(ii)	 any correct amide link between any two blocks showing all atoms and all bonds (1) identical orientation of both inter-block amide links including terminal groups with correct orientation (if shown) (1) continuation bonds on polymer (1)	**3**
6(c)(iii)	hydrolysis (1)	**1**

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2021**

45 minutes

You must answer on the multiple choice answer sheet.

6167454403

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

INSTRUCTIONS

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

INFORMATION

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

This document has **20** pages. Any blank pages are indicated.

IB21 03_0620_22/3RP

1 Which row about a change of state is correct?

	change of state	energy change	process
A	solid $\rightarrow$ liquid	heat given out	melting
B	gas $\rightarrow$ liquid	heat taken in	evaporation
C	solid $\rightarrow$ gas	heat taken in	sublimation
D	liquid $\rightarrow$ solid	heat given out	condensing

2 Gases are separated from liquid air by fractional distillation.

The boiling points of four gases are shown.

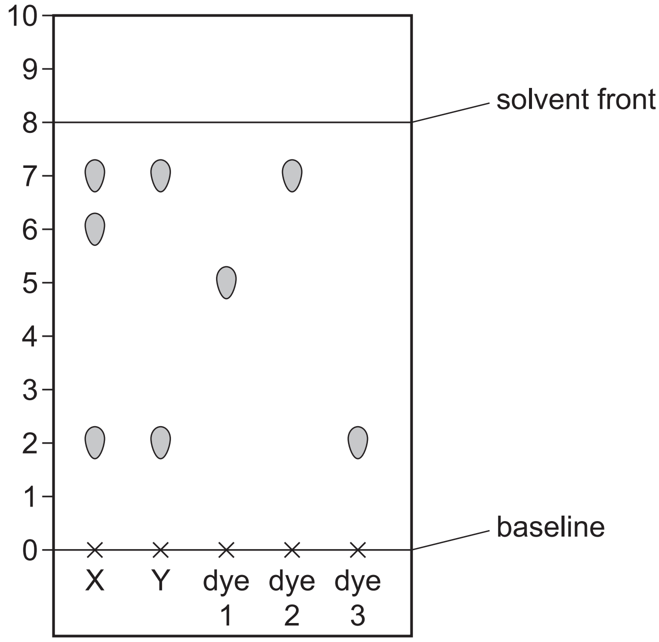
Which gas is both monoatomic and a liquid at –200 °C?

	gas	boiling point / °C
A	argon	–186
B	helium	–269
C	neon	–246
D	nitrogen	–196

3 Two different food colourings, X and Y, are tested using chromatography.

Three pure dyes, 1, 2 and 3, are also tested.

The chromatogram is shown.



Which statements are correct?

1 X and Y both contain two or more dyes.

2 Dyes 2 and 3 are present in both X and Y.

3 The R_f of dye 1 is 0.625.

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

4 Which statement about the atoms of all the isotopes of carbon is correct?

A They are all radioactive.

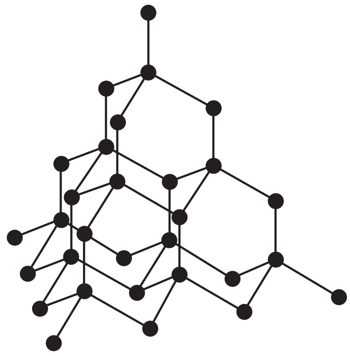
B They have the same mass.

C They have the same number of neutrons.

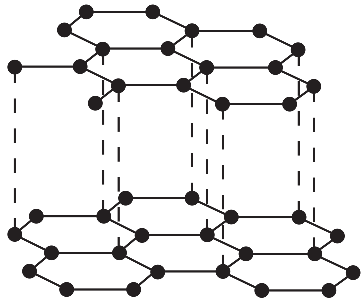
D They have the same number of electrons in the outer shell.

5 Which diagram represents the structure of silicon(IV) oxide?

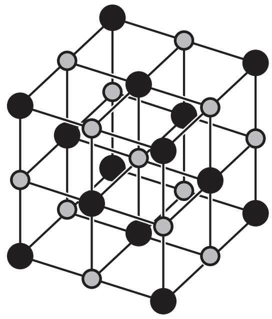
A



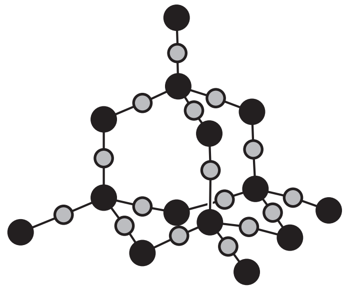
B



C



D



6 Lithium and fluorine react to form lithium fluoride.

A student writes three statements about the reaction.

1. Lithium atoms lose an electron when they react.
2. Each fluoride ion has one more electron than a fluorine atom.
3. Lithium fluoride is a mixture of elements.

Which statements are correct?

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

7 How many electrons are used to form covalent bonds in a molecule of methanol, CH_3OH?

A 5 **B** 6 **C** 8 **D** 10

8 Magnesium oxide has a high melting point.

Carbon dioxide has a low melting point.

Which row identifies the attractive forces that are broken when these compounds are melted?

	magnesium oxide	carbon dioxide
A	strong attractions between molecules	weak attractions between atoms
B	strong attractions between molecules	weak attractions between molecules
C	strong attractions between ions	weak attractions between atoms
D	strong attractions between ions	weak attractions between molecules

9 The ionic half-equation for the formation of oxygen during the electrolysis of aluminium oxide is shown.

$$xO^{2-} \rightarrow O_2 + ye^-$$

What are the values of *x* and *y*?

	x	*y*
A	1	2
B	1	4
C	2	2
D	2	4

10 A compound has the formula XF_2 and has a relative mass of 70.

What is element X?

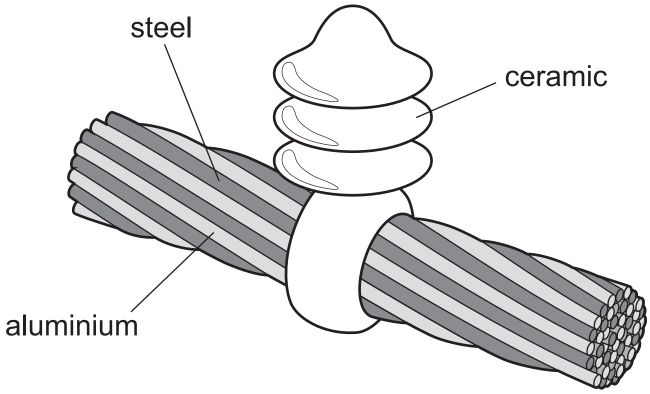
A gallium

B germanium

C sulfur

D ytterbium

11 The diagram shows a section of an overhead power cable.



Which statement explains why a particular substance is used?

A Aluminium has a low density and is a good conductor of electricity.

B Ceramic is a good conductor of electricity.

C Steel can rust in damp air.

D Steel is more dense than aluminium.

12 During the electrolysis of dilute sulfuric acid, hydrogen is collected at the cathode.

What is the ionic half-equation for this reaction?

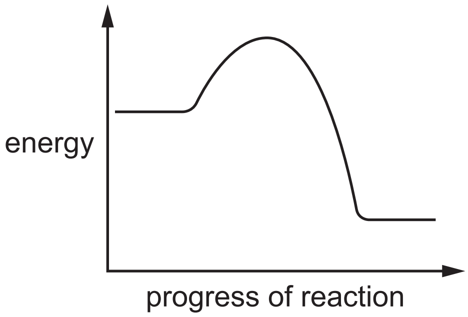
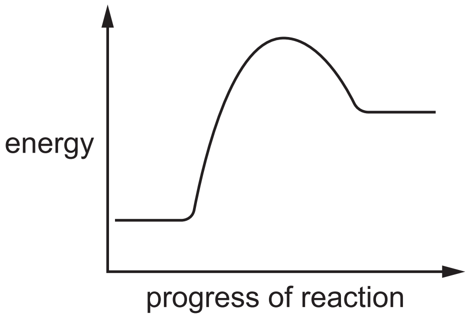
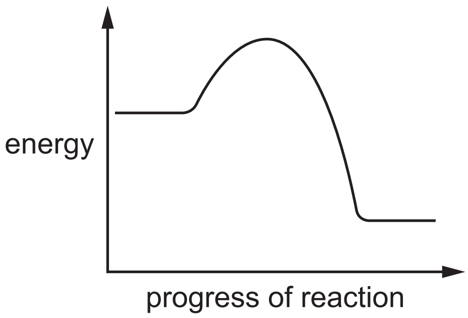
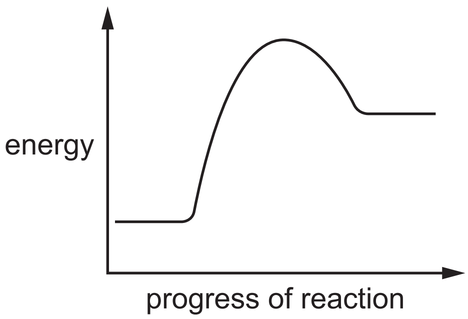
A $H^+ + e^- \rightarrow H$

B $H^+ \rightarrow H + e^-$

C $2H^+ + 2e^- \rightarrow H_2$

D $2H^+ \rightarrow H_2 + 2e^-$

13 Which row describes an endothermic reaction?

	energy level diagram	energy transfer
A		energy is transferred from the surroundings to the reaction
B		energy is transferred from the surroundings to the reaction
C		energy is transferred from the reaction to the surroundings
D		energy is transferred from the reaction to the surroundings

14 The equation for the complete combustion of methane is shown.

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

The bond energies are shown in the table.

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

What is the energy change for the reaction?

A –818 kJ / mol **B** –359 kJ / mol **C** –323 kJ / mol **D** +102 kJ / mol

15 Hydrogen fuel cells can be used to power cars.

Which statements about a fuel cell are correct?

1 The balanced equation for the reaction is $H_2 + O_2 \rightarrow H_2O$.

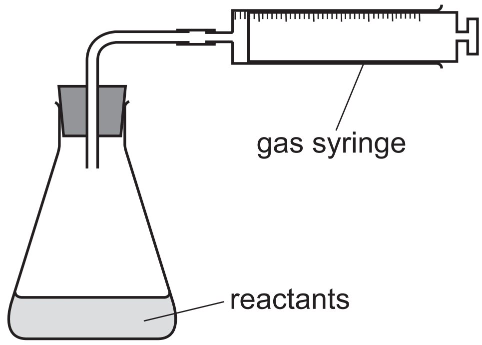
2 The fuel cell generates electricity.

3 In the fuel cell hydrogen is reduced.

4 The reactants are gases at room temperature.

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

16 The apparatus shown is used to measure the rate of a reaction.



Which equation represents a reaction where the rate can be measured using this apparatus?

A $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

B $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

C $Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$

D $2Na(s) + Br_2(l) \rightarrow 2NaBr(s)$

17 P is a hydrated metal salt with a blue colour. When P is heated, water is given off, leaving solid Q.

R is a hydrated metal salt with a pink colour. When R is heated, water is given off, leaving solid S.

Which row gives the name of P and the colour of S?

	name of P	colour of S
A	hydrated cobalt(II) chloride	blue
B	hydrated cobalt(II) chloride	white
C	hydrated copper(II) sulfate	blue
D	hydrated copper(II) sulfate	white

18 Magnesium reacts with copper(II) oxide to give magnesium oxide and copper.

Which substance is the oxidising agent in this reaction?

A copper

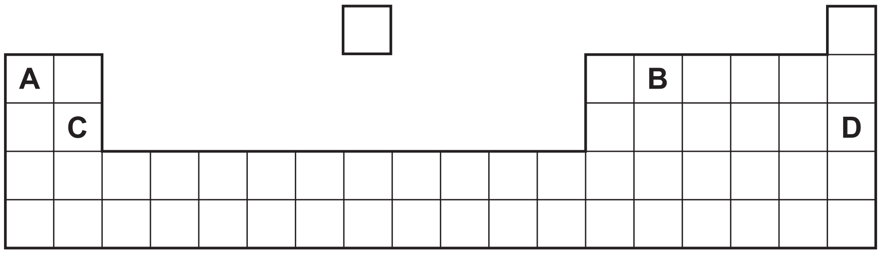
B copper(II) oxide

C magnesium

D magnesium oxide

19 Part of the Periodic Table is shown.

Which element forms an acidic oxide?



20 When aqueous sodium hydroxide is added to a solution of a metal ion, a grey-green precipitate forms, which dissolves in excess to form a dark green solution.

What is the identity of the metal ion?

A chromium(III)

B iron(II)

C iron(III)

D copper(II)

21 Which statements about strong acids are correct?

1 They have a high concentration of OH^- ions.

2 They have a pH value of 1.

3 They completely ionise in water.

4 They turn red litmus blue.

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

22 Metal X reacts with non-metal Y to form an ionic compound with the formula X_2Y.

Which statements are correct?

1 X is in Group I of the Periodic Table.

2 X is in Group II of the Periodic Table.

3 Y is in Group VI of the Periodic Table.

4 Y is in Group VII of the Periodic Table.

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

23 The table gives some properties of Group IV elements.

element	density g/cm^3	boiling point / °C
carbon	2.2	4827
silicon		
germanium	5.3	2830
tin	5.8	2270
lead	11.3	1755

Which row describes the properties of silicon?

	density g/cm^3	boiling point / °C
A	2.3	3265
B	3.1	1997
C	6.2	2920
D	24.6	11682

24 The metal beryllium does not react with cold water.

It reacts with hydrochloric acid but cannot be extracted from its ore by using carbon.

Where is beryllium placed in the reactivity series?

magnesium
A
zinc
B
iron
C
copper
D

25 Why is cryolite used in the extraction of aluminium from bauxite?

A as a catalyst for the process

B as a solvent for aluminium oxide

C it stops the carbon anodes burning away

D it reduces aluminium ions in aluminium oxide

26 Which statements about the uses of metals are correct?

1 Iron is used to make aircraft because iron has a low density.

2 Copper is used to make electric cables because copper is a good conductor of electricity.

3 Aluminium is used to make brass because aluminium is strong and hard.

4 Iron is mixed with additives to make an alloy used in chemical plant.

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

27 Which row describes the reactions of magnesium hydroxide and magnesium oxide?

	effect of heat on hydroxide	effect of heating oxide with carbon
A	forms magnesium oxide	magnesium and carbon dioxide formed
B	forms magnesium oxide	no reaction
C	no reaction	magnesium and carbon dioxide formed
D	no reaction	no reaction

28 The properties of an element are listed.

Its melting point is 3414 °C.

Some of its compounds are catalysts.

It has variable oxidation states.

Where is the element found in the Periodic Table?

A alkali metals

B halogens

C noble gases

D transition elements

29 Petrol burns in a car engine to produce waste gases which leave through the car exhaust.

One of these waste gases is an oxide of nitrogen.

Which statement describes how this oxide of nitrogen is formed?

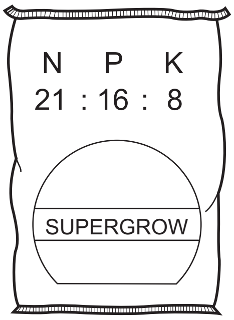
A Carbon dioxide reacts with nitrogen in the catalytic converter.

B Nitrogen reacts with oxygen in the car engine.

C Nitrogen reacts with oxygen in the catalytic converter.

D Petrol combines with nitrogen in the car engine.

30 Which combination of chemical compounds can be used to produce the fertiliser shown?



A $(NH_4)_3PO_4$, KCl

B NH_4NO_3, $Ca_3(PO_4)_2$

C NH_4NO_3, $CO(NH_2)_2$

D NH_4NO_3, K_2SO_4, $(NH_4)_2SO_4$

31 Which process does **not** produce carbon dioxide?

A combustion of a hydrocarbon

B photosynthesis

C reaction between an acid and a metal carbonate

D respiration

32 Which substance is used as a bleach in the manufacture of paper?

A carbon dioxide

B nitrogen dioxide

C silicon dioxide

D sulfur dioxide

33 What is an industrial use of calcium carbonate?

A cracking of hydrocarbons

B manufacture of aluminium

C manufacture of cement

D purification of water

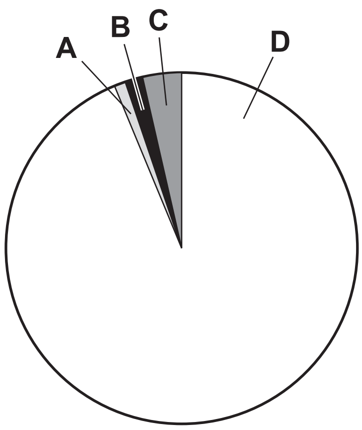
34 Propane reacts with chlorine.

Which row shows a condition required for this reaction and identifies the type of reaction?

	condition	type of reaction
A	phosphoric acid catalyst	addition
B	phosphoric acid catalyst	substitution
C	ultraviolet light	addition
D	ultraviolet light	substitution

35 The pie chart represents the composition of natural gas.

Which sector represents methane?



36 Which statement describes the reaction between ethene and steam?

A a cracking reaction which produces ethane and hydrogen gas as products

B an addition reaction which produces ethanol as the only product

C an oxidation reaction which produces ethanoic acid as the only product

D a slow reaction producing ethanol and carbon dioxide

37 The formula of a hydrocarbon is C_xH_y.

The equation for its complete combustion is shown.

$$C_xH_y + 8O_2 \rightarrow 5CO_2 + 6H_2O$$

What are the values of x and y?

	x	y
A	5	6
B	5	12
C	6	5
D	12	5

38 The formula of an ester is $CH_3CH_2CH_2COOCH_2CH_2CH_3$.

Which acid and alcohol react together to make the ester?

	acid	alcohol
A	butanoic acid	butanol
B	butanoic acid	propanol
C	propanoic acid	butanol
D	propanoic acid	propanol

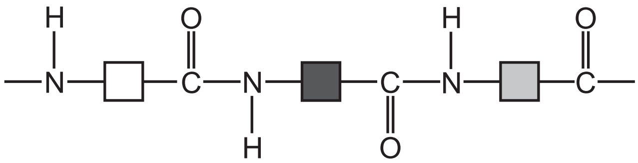
39 Molecule 1 undergoes a process to make molecule 2.

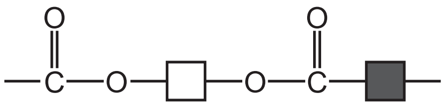
$$\text{molecule 1} \xrightarrow{\text{process}} \text{molecule 2}$$

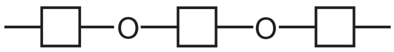
Which row describes the molecules and the process?

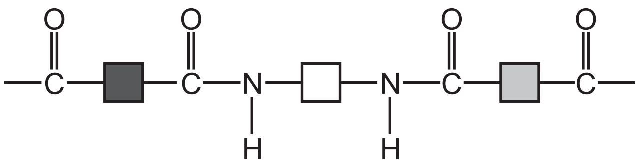
	molecule 1	process	molecule 2
A	monomer	cracking	polymer
B	monomer	polymerisation	polymer
C	small molecule	polymerisation	monomer
D	small molecule	cracking	monomer

40 Which structure represents a protein?

A 

B 

C 

D 

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The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

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

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

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

Cambridge IGCSE™

CHEMISTRY	**0620/22**
Paper 2 Multiple Choice (Extended)	**March 2021**
MARK SCHEME	
Maximum Mark: 40	

Published

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

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

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

Cambridge International is publishing the mark schemes for the March 2021 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	A	**1**
3	C	**1**
4	D	**1**
5	D	**1**
6	A	**1**
7	D	**1**
8	D	**1**
9	D	**1**
10	C	**1**
11	A	**1**
12	C	**1**
13	B	**1**
14	A	**1**
15	C	**1**
16	A	**1**
17	C	**1**
18	B	**1**
19	B	**1**
20	A	**1**
21	C	**1**
22	A	**1**
23	A	**1**
24	A	**1**
25	B	**1**
26	D	**1**
27	B	**1**
28	D	**1**

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

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3930589971

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2020**

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.

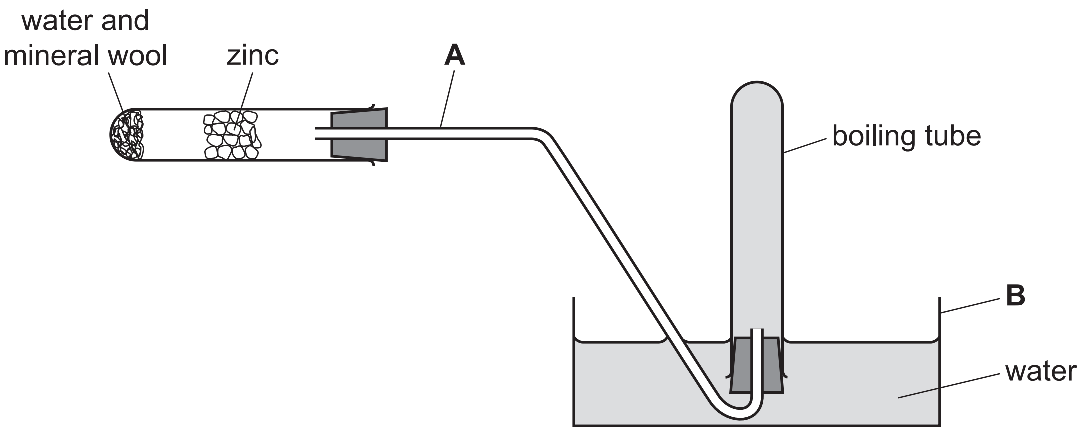
INFORMATION

- 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. Blank pages are indicated.

1 Hot zinc reacts with steam to make zinc oxide and hydrogen gas.

A student wanted to use the apparatus shown to react zinc with steam and to collect the hydrogen.



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

A ....

B ....
[2]

(b) State the purpose of the mineral wool.

....

.... [1]

(c) The apparatus shown is dangerous to use because of an error in the way it has been set up.

Identify this error.

Explain why this error makes it dangerous to use the apparatus.

error ....

....

explanation ....

....
[2]

(d) Add **two** arrows to the diagram to show the two places where the apparatus should be heated once the error in **(c)** has been corrected. [1]

(e) Describe the test for hydrogen gas.

test ....

result ....

[2]

[Total: 8]

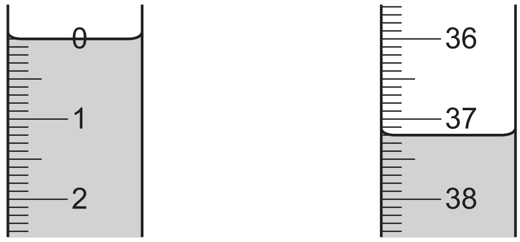
2 A student investigated the reaction between dilute ethanoic acid and two different solutions of sodium hydroxide labelled solution **A** and solution **B**.

Two experiments were done.

(a) *Experiment 1*

- A burette was rinsed with solution **A**.
- The burette was filled with solution **A**. Some of solution **A** was run out of the burette so that the level of solution **A** was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of dilute ethanoic acid was poured into a conical flask.
- Five drops of thymolphthalein indicator were added to the conical flask.
- Solution **A** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

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



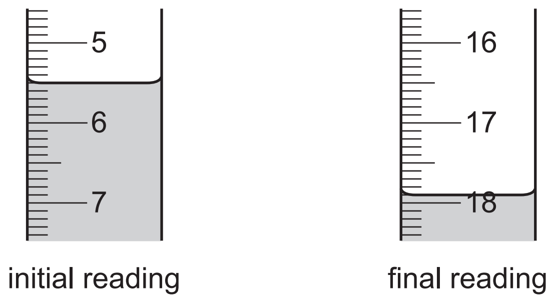
initial reading final reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **A** added / cm^3	

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- The burette was emptied and rinsed with distilled water.
- The burette was rinsed with solution **B**.
- The burette was filled with solution **B**. Some of solution **B** was run out of the burette so that the level of solution **B** was on the burette scale.
- Using a measuring cylinder, 25 cm^3 of dilute ethanoic acid was poured into a conical flask.
- Five drops of thymolphthalein indicator were added to the conical flask.
- Solution **B** was added slowly from the burette to the conical flask, while the flask was swirled, until the solution just changed colour.

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



	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
volume of solution **B** added / cm^3	

[4]

(b) Explain why universal indicator is **not** a suitable indicator to use in this titration.

....

.... [1]

(c) **(i)** State which solution of sodium hydroxide, solution **A** or solution **B**, was the more concentrated.
Explain your answer.

....

.... [1]

(ii) State how many times more concentrated this solution of sodium hydroxide was than the other solution of sodium hydroxide.

....

.... [1]

(d) Determine the volume of solution **B** that would be required if Experiment 2 was repeated with $10\,cm^3$ of dilute ethanoic acid.

....

.... [2]

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

....

.... [1]

(f) A $25\,cm^3$ pipette can be used to measure the volume of a solution.

(i) Describe an advantage of using a $25\,cm^3$ pipette to measure the volume of the dilute ethanoic acid.

....

.... [1]

(ii) Explain why a $25\,cm^3$ pipette could **not** be used to measure the volume of solution **A**.

....

.... [1]

(g) **(i)** Explain why the burette was rinsed with distilled water in Experiment 2.

....

.... [1]

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

....

.... [1]

(iii) State the effect that **not** rinsing the burette with solution **B** would have on the final burette reading.
Explain your answer.

effect ....

explanation ....

....
[2]

[Total: 16]

3 Two solids, solid **C** and solid **D**, were analysed.
Tests were done on each solid.

tests on solid C

Tests were done and the following observations were made.

tests on solid **C**	observations
test 1 Half of solid **C** was placed in a test-tube. The solid was heated gently and then strongly.	steam was given off and condensation appeared at the mouth of the test-tube, the remaining solid became black
The remaining solid **C** was dissolved in distilled water to produce solution **C**. The solution was divided into two equal portions in two test-tubes. **test 2** A few drops of universal indicator solution were added to the first portion of solution **C**.	the solution became orange
test 3 A spatula measure of solid sodium carbonate was added to the second portion of solution **C**. Any gas produced was tested.	effervescence was seen, the gas turned limewater milky

(a) Suggest the pH of solution **C**.

pH = ... [1]

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

.... [1]

(c) What conclusions can you make about solid **C**?

....

.... [2]

tests on solid D

Solid **D** was calcium chloride.

Complete the expected observations.

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

(d) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **D**.

observations .... [1]

(ii) An excess of aqueous sodium hydroxide was added to the mixture from **(d)(i)**.

observations .... [1]

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

observations ....

.... [2]

(f) About 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **D**.

observations .... [1]

(g) About 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the fourth portion of solution **D**.

observations .... [1]

[Total: 10]

4 A toothpaste contains:

- sodium fluoride
- calcium carbonate
- silica
- mint flavouring.

Sodium fluoride and the mint flavouring are soluble in water.
Calcium carbonate and silica are insoluble in water.
Calcium carbonate reacts with dilute hydrochloric acid to form the soluble salt calcium chloride.

Plan an investigation to find the percentage by mass of silica in the toothpaste.

In your answer you should include how you will calculate the percentage by mass of silica in the toothpaste.

You have access to normal laboratory apparatus.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

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

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	**A** delivery tube	**1**
	B trough	**1**
1(b)	to hold / absorb / soak up the water	**1**
1(c)	error: bung in (collecting) tube / the apparatus is sealed / water cannot get out of the boiling tube	**1**
	explanation: (pressure would increase and so the apparatus / tube would) explode / break	**1**
1(d)	arrows under both zinc and mineral wool	**1**
1(e)	test: lighted splint	**1**
	result: pops	**1**

Question	Answer	Marks
2(a)	Experiment 1 readings correct and readings recorded correctly with final > initial (37.2; 0.0)	**1**
	Experiment 2 readings correct and readings recorded correctly with final > initial (17.9; 5.5)	**1**
	both subtractions to get volume added correct (37.2; 12.4)	**1**
	all results figures for both experiments recorded to 1 dp or better	**1**
2(b)	many colour changes / keeps changing colour / hard to determine the end point	**1**
2(c)(i)	B (Experiment 2) **and** volume (of B) was less (than volume of A)	**1**
2(c)(ii)	3 (times more concentrated)	**1**
2(d)	12.4 ÷ 2.5 = 4.96 or 5(.0)	**1**
	cm^3	**1**

Question	Answer	Marks
2(e)	repeat **and** compare the results	**1**
2(f)(i)	more accurate / more precise (than a measuring cylinder)	**1**
2(f)(ii)	(pipette measures a) fixed volume / 25 cm^3	**1**
2(g)(i)	to remove solution A	**1**
2(g)(ii)	to remove (distilled) water	**1**
2(g)(iii)	larger / higher / bigger	**1**
	the water dilutes solution B / makes solution B less concentrated	**1**

Question	Answer	Marks
3(a)	4	**1**
3(b)	carbon dioxide / CO_2	**1**
3(c)	hydrated	**1**
	acid / contains H^+ / hydrogen ions	**1**
3(d)(i)	white precipitate	**1**
3(d)(ii)	no change **OR** remains **OR** does not dissolve	**1**

Question	Answer	Marks
3(e)	drops: no reaction **OR** no change **OR** remains colourless **OR** faint / slight (white) precipitate	**1**
	excess: no reaction **OR** no change **OR** remains colourless **OR** faint / slight (white) precipitate / precipitate remains / does not dissolve	**1**
3(f)	white precipitate	**1**
3(g)	no reaction **OR** no change **OR** remains colourless	**1**

Question	Answer	Marks
4	any 6 from: • weigh toothpaste • add (dilute) hydrochloric acid • to excess / until no more fizzing • filter • wash residue / silica (with water) and dry • weigh residue / silica • (mass silica / initial mass) × 100(%) **max 6**	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME										
CENTRE NUMBER						CANDIDATE NUMBER				

8955238231

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2020**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

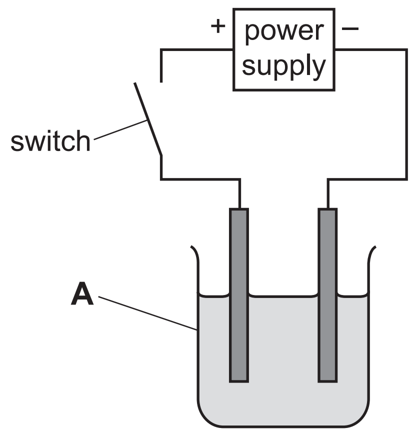
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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. Blank pages are indicated.

1 The diagram shows the apparatus used to pass an electric current through concentrated hydrochloric acid. Hydrogen and chlorine were formed at the electrodes.



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

.... [1]

(b) The electrodes were made of platinum.

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

1 ....

2 ....
[2]

(ii) Suggest another material suitable to use as electrodes in this experiment.

.... [1]

(c) The teacher doing this experiment wore safety glasses, gloves, had their hair tied back and stood up throughout the experiment.

State **one** other safety precaution that should be taken when doing this experiment.
Explain your answer.

safety precaution ....

explanation ....
[2]

[Total: 6]

2 A student investigated the rate of a reaction between sodium metabisulfite and potassium iodate. In the reaction, starch was used as an indicator. At first the reacting mixture remained colourless but then suddenly changed to a blue-black colour.

Five experiments were done. In each experiment the total volume of liquid was 45 cm^3.

Experiment 1

- Using a 10 cm^3 measuring cylinder, 5 cm^3 of aqueous sodium metabisulfite was poured into a beaker.
- Using another 10 cm^3 measuring cylinder, 5 cm^3 of aqueous starch was poured into the beaker.
- Using a 25 cm^3 measuring cylinder, 15 cm^3 of distilled water was poured into the beaker.
- Using another 25 cm^3 measuring cylinder, 20 cm^3 of aqueous potassium iodate was poured into the beaker. At the same time a stop-clock was started.
- The mixture in the beaker was stirred until a sudden colour change was seen.
- The stop-clock was immediately stopped and the time recorded.
- The beaker was rinsed with water.

Experiment 2

- Experiment 1 was repeated using 17 cm^3 of distilled water and 18 cm^3 of aqueous potassium iodate.

Experiment 3

- Experiment 1 was repeated using 21 cm^3 of distilled water and 14 cm^3 of aqueous potassium iodate.

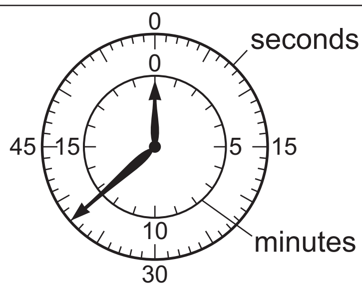
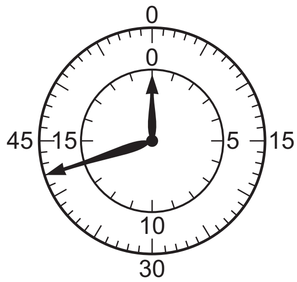
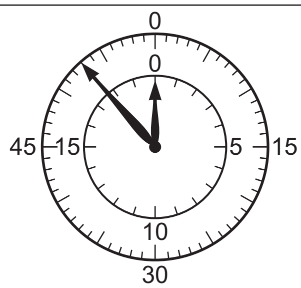
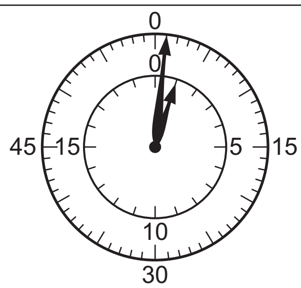
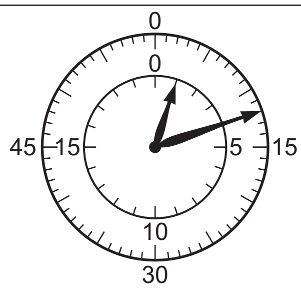
Experiment 4

- Experiment 1 was repeated using 23 cm^3 of distilled water and 12 cm^3 of aqueous potassium iodate.

Experiment 5

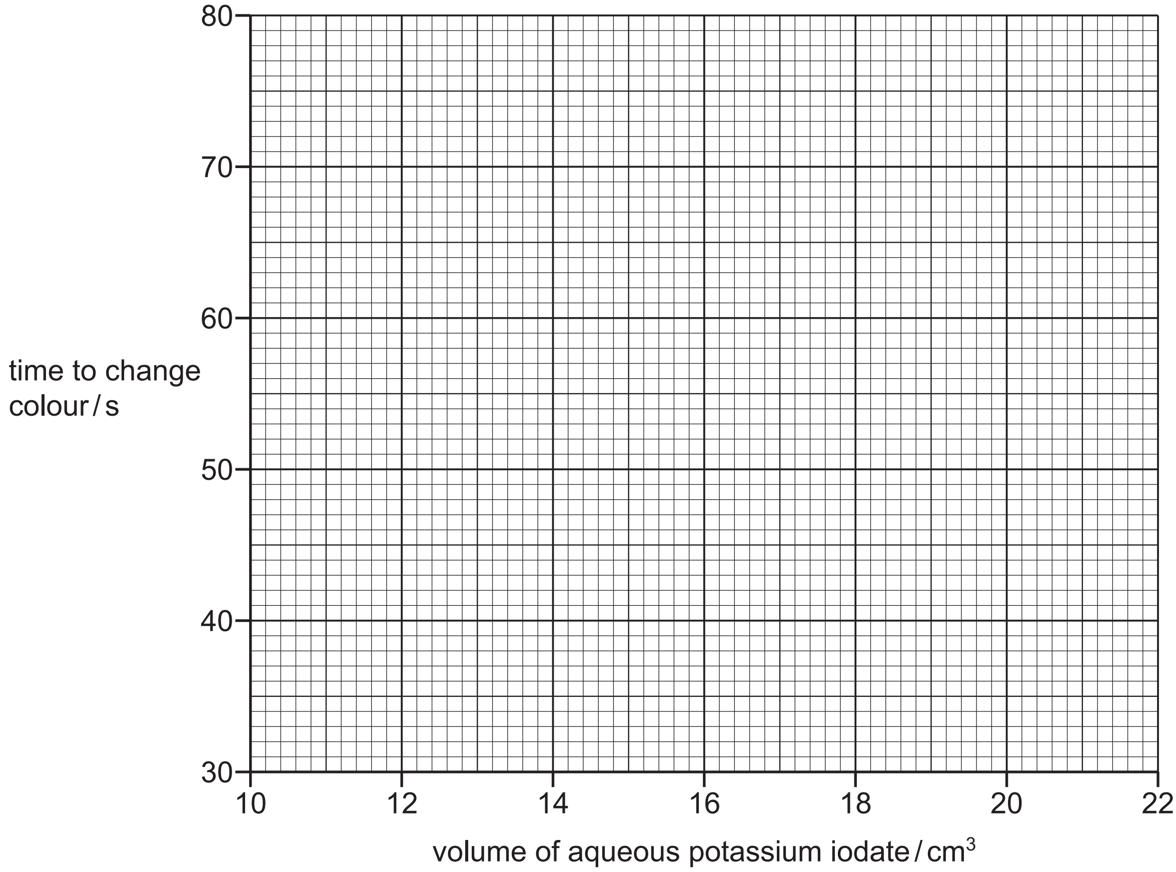
- Experiment 1 was repeated using 25 cm^3 of distilled water and 10 cm^3 of aqueous potassium iodate.

(a) Use the information in the description of the experiments and the stop-clock diagrams to complete the table. Record the times in **seconds**.

experiment	volume of aqueous sodium metabisulfite / cm^3	volume of distilled water / cm^3	volume of aqueous potassium iodate / cm^3	stop-clock diagram	time to change colour / s
1			20		
2			18		
3			14		
4			12		
5			10		

[5]

(b) Plot the results from Experiments 1 to 5 on the grid.
Draw a smooth curve of best fit.



[3]

(c) **(i)** **From your graph**, predict the time to change colour if 16 cm^3 of aqueous potassium iodate was used.
Show clearly **on the grid** how you worked out your answer.

time to change colour = ... s [2]

(ii) Calculate the volume of distilled water required if 16 cm^3 of aqueous potassium iodate was used.

volume of distilled water = ... cm^3 [1]

(d) Sketch **on the grid** the graph you would expect if Experiments 1 to 5 were repeated at a higher temperature. [1]

(e) The concentration of potassium iodate in the reaction mixture in each experiment can be calculated using the equation shown.

$$\text{concentration} = \frac{0.05 \times \text{volume of aqueous potassium iodate}}{45}$$

(i) Calculate the concentration of potassium iodate in the reaction mixture in Experiment 2.

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

(ii) State which experiment, 1, 2, 3, 4 or 5, had the fastest rate of reaction.

.... [1]

(f) Suggest why the volume of distilled water added to each experiment was increased as the volume of aqueous potassium iodate was decreased.

....

.... [1]

(g) Give **one** change you could make to the apparatus used which would improve the results. Explain your answer.

change to apparatus ....

....

explanation ....

....
[2]

(h) How could the reliability of the results of this investigation be checked?

....

.... [1]

[Total: 18]

3 Solid **Q** and solid **R** were analysed. Solid **Q** was zinc carbonate.
Tests were done on each solid.

tests on solid Q

Complete the expected observations.

(a) Solid **Q** was placed in a boiling tube. About 10 cm^3 of dilute sulfuric acid was added to the boiling tube. Any gas produced was tested.
The contents of the boiling tube were kept for **(c)**.

observations ....

....

.... [3]

(b) Identify the gas given off in **(a)**.

.... [1]

(c) The reaction mixture from **(a)** was filtered.
The filtrate was solution **S**. 1 cm depth of solution **S** was poured into a boiling tube.

(i) Aqueous sodium hydroxide was added dropwise and then in excess to solution **S** in the boiling tube.

observations ....

....

.... [2]

(ii) Explain why it is **not** possible to identify the cation contained in solution **S** from your observations in **(c)(i)**.

....

.... [1]

(iii) Suggest an additional test that can be done on solution **S** to confirm the cation was Zn^{2+}.

....

.... [1]

tests on solid R

Tests were done and the following observations were made.

tests on solid **R**	observations
test 1 A flame test was done on solid **R**.	yellow flame
Solid **R** was dissolved in distilled water to produce solution **R**. The solution was divided into two equal portions in two test-tubes. **test 2** About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate were added to the first portion of solution **R**.	yellow precipitate formed
test 3 The second portion of solution **R** was added to 1 cm^3 of aqueous bromine in a test-tube.	the solution changed colour from orange to brown

(d) Identify solid **R**.

....

.... [2]

[Total: 10]

4 Brass is a mixture of two metals, copper and zinc.

Copper does not react with dilute sulfuric acid. Zinc reacts with hot dilute sulfuric acid to form the soluble salt zinc sulfate.

Plan an investigation to find the percentage by mass of zinc in a sample of brass.
In your answer you should include how to calculate the percentage by mass of zinc.

You have access to normal laboratory apparatus.

....

....

....

....

....

....

....

....

....

....

....

....

.... [6]

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Cambridge IGCSE™

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2020**

MARK SCHEME

Maximum Mark: 40

Published

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

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)	beaker	**1**
1(b)(i)	conduct electricity	**1**
	inert	**1**
1(b)(ii)	carbon / graphite	**1**
1(d)	use a fume cupboard	**1**
	chlorine is toxic	**1**

Question	Answer	Marks
2(a)	all volumes of sodium metabisulfite completed as 5	**1**
	all volumes of water (15, 17, 21, 23, 25) correct.	**1**
	all times recorded correctly (38, 42, 53, 61, 72)	**2**
	all five times in seconds only	**1**
2(b)	all 5 points plotted correctly	**2**
	suitable best fit curve drawn. Line must go through / within half a square of correctly plotted points	**1**
2(c)(i)	correct working shown on graph	**1**
	time correct for their working	**1**
2(c)(ii)	19	**1**
2(d)	line is below plotted line and does not meet / touch plotted line.	**1**
2(e)(i)	0.02	**1**

Question	Answer	Marks
2(e)(ii)	1	**1**
2(f)	to keep total volume constant / so concentration of sodium metabisulphite does not change	**1**
2(g)	change: use a pipette / burette (in place of a measuring cylinder)	**1**
	explanation: more accurate / precise (than a measuring cylinder)	**1**
2(h)	repeat **and** compare the results	**1**

Question	Answer	Marks
3	**Tests on solid Q**	
3(a)	fizzing / effervescence / bubbles	**1**
	(some of the) solid dissolves / disappears **OR** colourless solution	**1**
	limewater turns milky	**1**
3(b)	carbon dioxide / CO_2	**1**
3(c)(i)	white precipitate	**1**
	dissolves / forms a colourless solution	**1**
3(c)(ii)	aluminium (ions) give the same result	**1**
3(c)(iii)	add (excess) ammonia (solution)	**1**
3(d)	**Tests on solid R**	
	sodium / Na^+	**1**
	iodide / I^-	**1**

Question	Answer	Marks
4	Any 6 from: • weigh brass / known mass of brass • add (dilute) <u>sulfuric</u> acid and heat / hot / warm • excess acid • filter • wash and dry residue / solid • weigh (copper) residue / solid (copper) • percentage zinc calculated correctly	**6**

Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

9389523754

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2020**

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. Blank pages are indicated.

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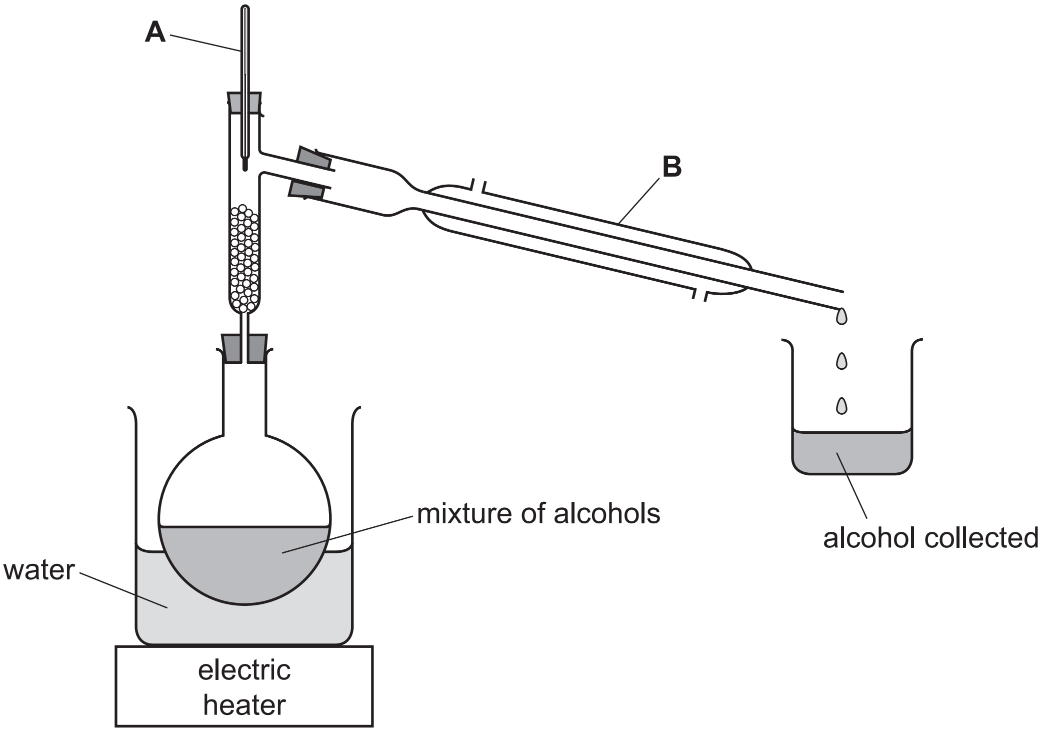
1 The table gives the boiling points of four alcohols.

alcohol	boiling point / °C
butanol	117
ethanol	79
pentanol	138
propanol	97

The apparatus shown can be used to obtain propanol from a mixture containing butanol, ethanol, pentanol and propanol.



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

A ....

B .... [2]

(b) Name this method of separation.

.... [2]

(c) Explain why it is safer to heat the mixture of alcohols in the way shown rather than with a Bunsen burner.

.... [1]

(d) Describe how propanol can be obtained from the mixture. Use data from the table.

....

....

.... [2]

(e) Explain why the apparatus in the diagram **cannot** be used to obtain butanol from the mixture.

....

.... [1]

[Total: 8]

2 A student investigated the mass of lead(II) iodide precipitate formed when aqueous potassium iodide reacts with aqueous lead(II) nitrate.

The equation for the reaction is shown.

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

The student did seven experiments.

Experiment 1

- Using a 50 cm^3 measuring cylinder, 25 cm^3 of aqueous potassium iodide was poured into a beaker.
- Using a clean 50 cm^3 measuring cylinder, 10 cm^3 of aqueous lead(II) nitrate was added to the aqueous potassium iodide in the beaker. The solutions were mixed together.
- The mass of the precipitate of lead(II) iodide formed was found.

Experiment 2

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 1.

Experiment 3

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 2.

Experiment 4

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 3.

Experiment 5

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 4.

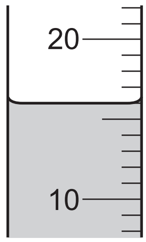
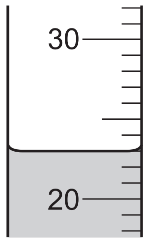
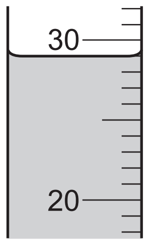
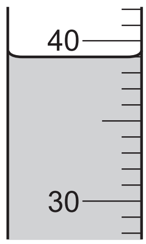
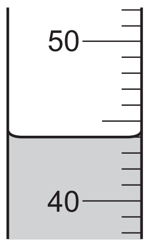
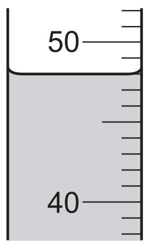
Experiment 6

- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 5.

Experiment 7

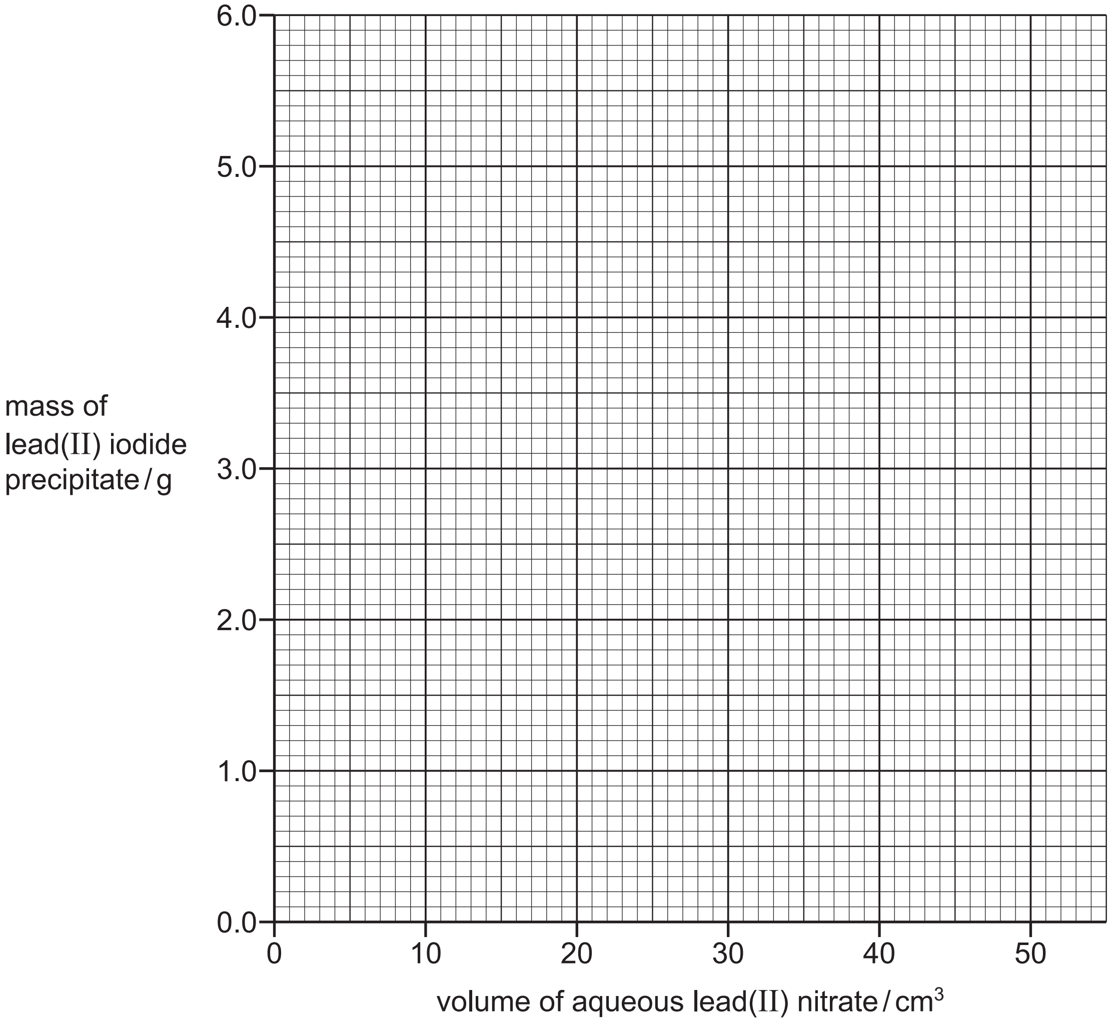
- Experiment 1 was repeated using a larger volume of aqueous lead(II) nitrate than in Experiment 6.

(a) Use the measuring cylinder diagrams to complete the table.

experiment	volume of aqueous potassium iodide / cm^3	measuring cylinder diagram for aqueous lead(II) nitrate	volume of aqueous lead(II) nitrate / cm^3	mass of lead(II) iodide precipitate / g
1	25		10	1.4
2	25			2.3
3	25			3.3
4	25			4.1
5	25			5.1
6	25			5.1
7	25			5.1

[2]

(b) Plot the results from Experiments 1 to 7 on the grid. Draw two straight lines through the points. Extend your straight lines so that they meet.



[5]

(c) **From your graph**, deduce the mass of lead(II) iodide precipitate that would be formed if Experiment 1 was repeated using 20 cm^3 of aqueous lead(II) nitrate.

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

mass = ... g [2]

(d) Explain why the same mass of precipitate is formed in Experiment 5, Experiment 6 and Experiment 7.

....

.... [1]

(e) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using aqueous potassium iodide with half the concentration. [2]

(f) **(i)** State why using a 25.0 cm^3 pipette to measure the volume of aqueous potassium iodide would be an improvement.

....

.... [1]

(ii) State why a 25.0 cm^3 pipette could **not** be used to measure the volume of aqueous lead(II) nitrate in each experiment.

....

.... [1]

(g) Describe how the solid lead(II) iodide can be separated from the reaction mixture and its mass found.

....

....

....

....

....

.... [3]

[Total: 17]

3 Solid **Y** and solid **Z** were analysed.
Tests were done on each solid.

tests on solid **Y**	observations
Solid **Y** was dissolved in distilled water to form solution **Y**. Solution **Y** was divided into four portions in four boiling tubes. **test 1** Aqueous ammonia was added dropwise and then in excess to the first portion of solution **Y**.	a white precipitate formed which was insoluble in excess
test 2 Aqueous sodium hydroxide was added dropwise and then in excess to the second portion of solution **Y**.	a white precipitate formed which dissolved in excess to form a colourless solution
test 3 A piece of aluminium foil was added to the solution formed in **test 2**. The mixture was warmed and any gas given off was tested.	the gas turned damp red litmus paper blue
test 4 About 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **Y**.	the solution remained colourless, no precipitate formed

(a) Name the gas given off in **test 3**.

.... [1]

(b) Identify solid **Y**.

....

.... [2]

(c) A strip of universal indicator paper was dipped into the fourth portion of solution **Y**.
The universal indicator paper turned orange.

What additional information does this give about solution **Y**?

.... [1]

tests on solid Z

Solid **Z** was iron(II) sulfate.

Complete the expected observations.

Solid **Z** was dissolved in water to produce solution **Z**. Solution **Z** was split into three equal portions in three boiling tubes.

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

observations ....

....

.... [2]

(e) About 2 cm^3 of dilute hydrochloric acid was added to the second portion of solution **Z**.

observations .... [1]

(f) The solution from **(e)** was warmed and a piece of filter paper soaked in acidified aqueous potassium manganate(VII) was held at the mouth of the boiling tube.

observations .... [1]

(g) About 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate were added to the third portion of solution **Z**.

observations .... [1]

[Total: 9]

4 A mixture contains three solid compounds:
- copper(II) sulfate
- cetyl alcohol
- silicon dioxide.

The table gives some information on the solubility of these three solids.

name of compound	solubility in water	solubility in propanone
copper(II) sulfate	soluble	insoluble
cetyl alcohol	insoluble	soluble
silicon dioxide	insoluble	insoluble

Plan a method to obtain a pure sample of each of the three solids, copper(II) sulfate, cetyl alcohol and silicon dioxide, from the mixture.

You have access to normal laboratory apparatus.

....

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....

....

.... [6]

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2020**

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4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	<u>'List rule' guidance</u> For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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

Examples of how to apply the list rule

State **three** reasons ... [3]

A

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

B **(4 responses)**

1. Correct, Correct	✓, ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C **(4 responses)**

1. Correct	✓	**2**
2. Correct, Wrong	✓, ×	
3. Correct	ignore	

D **(4 responses)**

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

E **(4 responses)**

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F **(4 responses)**

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

G **(5 responses)**

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

H **(4 responses)**

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

I **(4 responses)**

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

Question	Answer	Marks
1(a)	**A** thermometer	**1**
	B (Liebig) condenser	**1**
1(b)	fractional	**1**
	distillation	**1**
1(c)	alcohols are flammable	**1**
1(d)	heat to remove the ethanol	**1**
	collect propanol at 97 °C	**1**
1(e)	water boils at 100 °C / water bath will not go above 100 °C **OR** butanol boils at over 100 °C / butanol boils at 117 °C	**1**

Question	Answer	Marks
2(a)	Measuring cylinder readings: 16; 23; 29; 39; 44; 48	**2**
2(b)	**M1** and **M2** all points plotted correctly **M3** ruler drawn straight line through first 4 points **M4** ruler drawn straight line through last three points **M5** straight lines have been extended so that they meet / cross	**5**
2(c)	working on graph	**1**
	correct reading from their working on graph	**1**
2(d)	all potassium iodide reacted / used-up	**1**
2(e)	maximum mass of precipitate is 2.55 g	**1**
	maximum mass reached at half volume of plotted graph	**1**
2(f)(i)	(more) accurate / precise (than a measuring cylinder)	**1**
2(f)(ii)	(pipette measures a) fixed volume / 25 cm^3	**1**
2(g)	filter	**1**
	wash / rinse residue	**1**
	dry **and** weigh	**1**

Question	Answer	Marks
Tests on solid Y		
3(a)	ammonia	**1**
3(b)	aluminium / Al^{3+}	**1**
	nitrate / NO_3^-	**1**
3(c)	(weakly) acidic	**1**
Tests on solid Z		
3(d)	green precipitate	**1**
	precipitate insoluble / remains / no further change	**1**
3(e)	no change	**1**
3(f)	no change / remains purple	**1**
3(g)	white precipitate	**1**

Question	Answer	Marks
4	**M1** whatever method is used, suitable apparatus – such as a flask or beaker – has been used. *Copper(II) sulfate first* **M2** add water (to dissolve copper sulfate) **and** later adds propanone (to dissolve cetyl alcohol) **M3** stir / swirl / mix **M4** filter (to remove silicon dioxide and cetyl alcohol) **M5** evaporate solvent from filtrate or description. This must be done for the solutions obtained using both solvents. **M6** filter and wash / rinse residue after adding the second solvent **M7** dry residue (silicon dioxide) **OR** *cetyl alcohol first* **M2** add propanone (to dissolve cetyl alcohol) **and** later adds water (to dissolve copper(II) sulfate) **M3** stir / swirl / mix **M4** filter (to remove silicon dioxide and copper(II) sulfate) **M5** evaporate solvent from filtrate or description. This must be done for the solutions obtained using both solvents. **M6** filter and wash residue after adding the second solvent **M7** dry residue (silicon dioxide) **max 6**	**6**