YEARLY PAST PAPERS
WITH TOPICAL QUESTIONS TRACKER

Cambridge IGCSE

Chemistry (0620) Paper 4

[Structured questions]

SAMPLE EDITION
2020 QUESTION PAPERS & MARK SCHEMES

Note:

Provided for preview purposes to demonstrate format, organisation, and content quality. The full edition contains all examination years listed. For more information, visit:
Cambridge IGCSE Chemistry (0620) Product Page

Introduction

Topical Questions Tracker: An Efficient Study Tool

A Topical Questions Tracker is a powerful tool, integrated as an appendix to Yearly Past Papers, enhancing the functionality of utilising Past Papers. This tool allows you to locate specific questions by topic, providing a much more efficient way to study for exams.

How the Topical Questions Tracker Works

The Topical Questions Tracker is organized according to the latest syllabus of the subject. Each topic includes a comprehensive list of all relevant questions from the yearly past papers. For each question, the tracker provides:

- The paper's code
- The question number
- The sub-question number (if applicable)
- The page number where the question is located, which is hyperlinked for easy navigation

By clicking on the linked page number, you can jump directly to the corresponding page in the document, making it quick and simple to find the exact question you're looking for.

Advantages of Topical Questions Trackers Over Traditional Past Papers

While traditional Topical Past Papers classify entire questions under a single topic, many questions contain sub-questions that may cover different topics. This can make it difficult to find specific practice material for a particular area of study.

The Topical Questions Tracker overcomes this limitation by categorizing each sub-question individually. This precise classification ensures that each part of the question is assigned to the appropriate topic, providing a more targeted and effective revision tool.

Efficient Navigation Tips

While the Topical Questions Tracker allows you to jump directly to specific questions by clicking on the linked page numbers, navigating back to the previous page to find the next question can be time-consuming and somewhat frustrating. To streamline this process, you can utilize the 'Previous View' and 'Next View' commands in Adobe Reader.

To access these commands, navigate to the menu and select View » Go to » Previous View or Next View. Alternatively, you can use the shortcut keys for quicker navigation:

- Previous View: ALT + Left Arrow
- Next View: ALT + Right Arrow

These commands enable you to seamlessly move back and forth between the last two pages visited, enhancing your study efficiency by minimizing unnecessary navigation steps.

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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1792185691

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2020**

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.

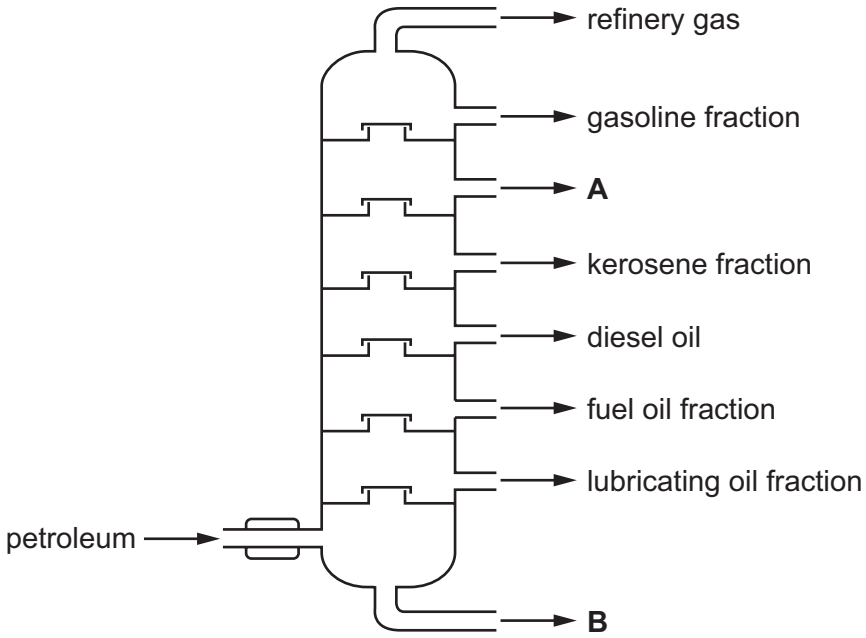
INFORMATION

- 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. Blank pages are indicated.

1 Petroleum is a useful natural resource.

The diagram shows how petroleum can be separated into useful substances.



(a) What is the name of the separation process shown in the diagram?

..... [2]

(b) Name the fraction leaving at:

A .....

B .....
[2]

(c) Refinery gas is a mixture of hydrocarbons.

One refinery gas is butane, C_4H_{10}.

(i) Suggest the names of **two** other refinery gases.

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

(ii) Write the chemical equation for the complete combustion of butane.

..... [2]

(iii) Name the toxic gas produced by the incomplete combustion of butane.

..... [1]

(d) Gasoline and kerosene are both fuels. They have different properties.

(i) Describe the differences in the properties given.

viscosity of the fuel .....

.....

flammability of the fuel .....

.....
[2]

(ii) What difference in the molecules of gasoline and kerosene causes these differences in properties?

..... [1]

(e) Hydrogen fuel cells can be used to power vehicles.

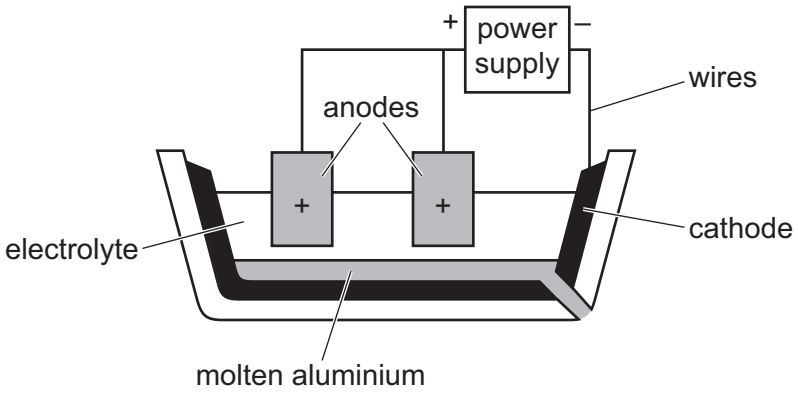
Write the word equation for the overall reaction that takes place in a hydrogen fuel cell.

..... [1]

[Total: 13]

[Turn over

2 Aluminium is extracted from its ore. The ore is converted into pure aluminium oxide, which then undergoes electrolysis as shown.



(a) (i) Name an ore of aluminium.

..... [1]

(ii) What is meant by the term *electrolysis*?

.....

..... [2]

(b) Aluminium oxide has a melting point of about 2000 °C, but the electrolysis process operates at about 900 °C.

(i) Name the compound added to aluminium oxide to reduce the operating temperature.

..... [1]

(ii) Suggest **one** benefit to the environment of reducing the operating temperature.

.....

..... [1]

(iii) Write the ionic half-equation for the reaction taking place at:

the negative electrode (cathode) .....

the positive electrode (anode) .....
[4]

(iv) Explain why the anodes need frequent replacement.

.....

..... [2]

(c) Aluminium oxide reacts with acids and with alkalis.

(i) What term is used to describe an oxide that reacts with acids and with alkalis?

..... [1]

(ii) Aluminium oxide reacts with dilute sulfuric acid to form a salt.

State the name and write the formula of the salt formed.

name .....

formula .....
[2]

(iii) Aluminium oxide reacts with dilute sodium hydroxide to form a salt and one other product.

Name the other product.

..... [1]

(iv) Aluminium hydroxide, $Al(OH)_3$, decomposes when heated to form aluminium oxide and water.

Write the chemical equation for this reaction.

..... [2]

(v) Suggest the names of **two** other aluminium compounds that decompose when heated to form aluminium oxide.

.....

..... [2]

[Total: 19]

[Turn over

3 The Periodic Table is a method of classifying elements.

(a) Identify the element which is in Group VI and Period 4.

..... [1]

(b) Calcium is in Group II and chlorine is in Group VII of the Periodic Table.

Explain, in terms of number of outer shell electrons and electron transfer, how calcium atoms and chlorine atoms form ions. Give the formulae of the ions formed.

.....

.....

.....

.....

.....

.....

..... [5]

(c) Group V chlorides are covalent molecules. The boiling points of some Group V chlorides are shown.

chloride	boiling point / °C
NCl_3	71
PCl_3	
$AsCl_3$	130
$SbCl_3$	283

(i) Suggest the approximate boiling point of PCl_3.

..... [1]

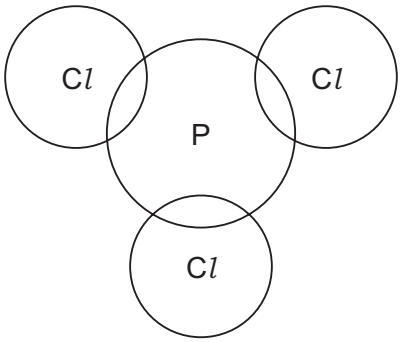
(ii) Explain the trend in boiling points in terms of attractive forces between particles.

.....

..... [2]

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of PCl_3.

Show outer electrons only.



[3]

(d) PCl_3 reacts with chlorine, Cl_2, to form PCl_5. This reaction is exothermic and reaches an equilibrium.

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

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

.....

.....

..... [2]

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

temperature is increased .....

.....

pressure is increased .....

.....
[4]

(iii) Explain, in terms of particles, what happens to the rate of the forward reaction when the reaction mixture is heated.

.....

.....

.....

.....

..... [3]

[Turn over

(e) PCl_5 reacts with lithium fluoride, LiF, to form $LiPF_6$.

$$PCl_5 + 6LiF \rightarrow LiPF_6 + 5LiCl$$

Calculate the mass of LiF needed to form 3.04 g of $LiPF_6$ using the following steps.

- Calculate the number of moles of $LiPF_6$ formed.
  [M_r: $LiPF_6$, 152]

number of moles = ...

- Deduce the number of moles of LiF needed.

number of moles = ...

- Calculate the mass of LiF needed.

mass = ... g
[3]

(f) Lithium fluoride has ionic bonding.

(i) What is an ionic bond?

.....

..... [2]

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

.....

..... [2]

[Total: 28]

4 Iron is a typical transition element.

Iron:
- acts as a catalyst
- forms coloured compounds
- has more than one oxidation state.

(a) Name **one** major industrial process that uses iron as a catalyst and name the product made in this process.

process .....

product made .....
[2]

(b) When aqueous sodium hydroxide is added to aqueous iron(II) sulfate, a precipitate forms.

(i) What colour is this precipitate?

..... [1]

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

..... [3]

(c) Iron(II) sulfate can be converted to iron(III) sulfate by potassium manganate(VII) at room temperature.

(i) What is the role of potassium manganate(VII) in this reaction?

..... [1]

(ii) What condition must be used for this reaction to occur?

..... [1]

(iii) In terms of electron transfer, what happens to the iron(II) ions in this reaction?

..... [1]

(iv) State the colour change seen during this reaction.

from purple to ..... [1]

(d) Deduce the charge on the iron ion in each of these compounds.

FeF_3 .....

$Fe(NO_3)_3$ .....
[2]

[Total: 12]

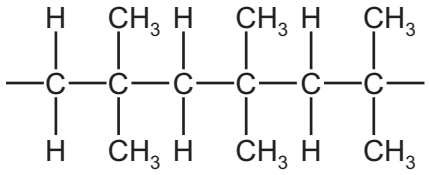
5 There are two types of polymers.

(a) Addition polymers are made from many identical small units.

(i) What is the term used to describe these small units?

..... [1]

(ii) A section of an addition polymer is shown.



Draw the structure of the small unit used to make this addition polymer.

Show all of the atoms and all of the bonds.

[2]

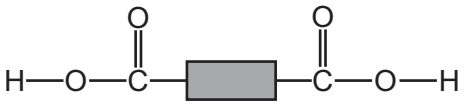
(b) Polyamides are condensation polymers.

What does the term *condensation* mean when used to describe this type of polymer?

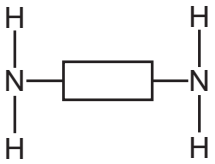
..... [1]

(c) A polyamide can be made from two different molecules.

A simplified structure of octanedioic acid is shown.



A simplified structure of 1,6-diaminohexane is shown.



(i) Complete the diagram to show a section of polyamide manufactured from octanedioic acid and 1,6-diaminohexane. Include all of the atoms and all of the bonds in the linkages.

[3]

(ii) State the name of a synthetic polyamide.

..... [1]

[Total: 8]

The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **March 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

[Turn over

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.

5 'List rule' guidance (see examples below)

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)	distillation (1) fractional (1)	**2**
1(b)	naphtha (1) bitumen (1)	**2**
1(c)(i)	any **two** from: methane ethane propane	**2**
1(c)(ii)	$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ CO_2 and H_2O as products (1) correct equation (1)	**2**
1(c)(iii)	carbon monoxide	**1**
1(d)(i)	kerosene is more viscous gasoline is more flammable	**2**
1(d)(ii)	kerosene has molecules with a longer carbon chain	**1**
1(e)	hydrogen + oxygen → water	**1**

Question	Answer	Marks
2(a)(i)	bauxite	**1**
2(a)(ii)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten / aqueous** (state) (1)	**2**
2(b)(i)	cryolite	**1**
2(b)(ii)	less CO_2 emission	**1**

Question	Answer	Marks
2(b)(iii)	$Al^{3+} + 3e^- \rightarrow Al$ any positive Al species gaining electron(s) (1) correct species and balance (1) $2O^{2-} \rightarrow O_2 + 4e^-$ any negative O species losing electron(s) (1) correct species and balance (1)	**4**
2(b)(iv)	anodes **or** carbon / graphite react with oxygen / O_2 (1) (form) carbon dioxide (1)	**2**
2(c)(i)	amphoteric	**1**
2(c)(ii)	aluminium sulfate (1) $Al_2(SO_4)_3$ (1)	**2**
2(c)(iii)	water	**1**
2(c)(iv)	$2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$ species (1) balance (1)	**2**
2(c)(v)	aluminium carbonate (1) aluminium nitrate (1)	**2**

Question	Answer	Marks
3(a)	selenium / Se	**1**
3(b)	Ca has 2 and Cl has outer electrons 7 (1) Ca (atoms) lose electrons (1) Cl (atoms) gain electrons (1) Ca^{2+} (ions) (1) Cl^- (ions) (1)	**5**

Question	Answer	Marks
3(c)(i)	any number in the range 72 – 129°C	**1**
3(c)(ii)	attraction increase (1) between molecules (1)	**2**
3(c)(iii)	3 P – Cl dot cross bonds (1) 2 (only) non-bonding electrons to make an octet on P (1) 6 (only) non-bonding electrons to make an octet on each Cl (1)	**3**
3(d)(i)	constant concentrations (1) rate of forward reaction = rate of reverse reaction (1)	**2**
3(d)(ii)	*increased temperature*: (equilibrium) shifts to LHS (1) (forward) reaction is exothermic (1) *increased pressure*: (equilibrium) shifts to RHS (1) fewer moles (of gas) on RHS (1)	**4**
3(d)(iii)	rate increases **and** particles have more energy (1) more collisions (between particles) occur per second / per unit time more (of the) particles / collisions have energy greater than activation energy **or** more (of the) particles / collisions have sufficient energy to react **or** a greater percentage / proportion / fraction of collisions (of particles) are successful	**3**
3(e)	mol of $LiPF_6$ = 3.04 / 152 = 0.02(00) (1) mol of LiF = 0.02(00) $\times$ 6 = 0.12(0) (1) mass of LiF = 3.12 g (1)	**3**

Question	Answer	Marks
3(f)(i)	oppositely charged ions (ions) are attracted	**2**
3(f)(ii)	any two from: *physical constants*: high boiling point / melting point *conductivity*: conduct (electricity) when aqueous or conduct (electricity) when molten *solubility*: soluble in water	**2**

Question	Answer	Marks
4(a)	Haber (process) (1) ammonia (1)	**2**
4(b)(i)	green	**1**
4(b)(ii)	$Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$ $Fe(OH)_2$ (as only product) (1) Fe^{2+} and $2OH^{-}$ (as reactants) (1) state symbols (1)	**3**
4(c)(i)	oxidising agent	**1**
4(c)(ii)	presence of an acid	**1**
4(c)(iii)	lose an electron	**1**
4(c)(iv)	colourless	**1**
4(d)	3+ 3+	**2**

Question	Answer	Marks
5(a)(i)	monomer	**1**
5(a)(ii)	any **hydrocarbon** with one C=C bond (with both C atoms having 4 bonds) (1) structure of methylpropene (1)	**2**
5(b)	water is a product (when polymer is made)	**1**
5(c)(i)	any correct amide link between any two blocks showing all atoms and all bonds (1) correct orientation of 3 inter-block amide links (1) continuation bonds (1)	**3**
5(c)(ii)	nylon	**1**

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5	e	Organic chemistry	Formulae, functional groups and terminology	34	46
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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2337870270

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2020**

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. Blank pages are indicated.

[Turn over

1 This question is about elements **X**, **Y** and **Z**.

(a) An atom of element **X** is represented as $^{34}_{16}\mathbf{X}$.

(i) Name the different types of particles found in the nucleus of this atom of **X**.

.....

..... [2]

(ii) What is the term for the total number of particles in the nucleus of an atom?

..... [1]

(iii) What is the total number of particles in the nucleus of an atom of $^{34}_{16}\mathbf{X}$?

..... [1]

(iv) What is the electronic structure of the ion $\mathbf{X}^{2-}$?

..... [1]

(v) Suggest the formula of the compound formed between aluminium and **X**.

..... [1]

(b) (i) What term is used to describe atoms of the same element with different numbers of particles in the nucleus?

..... [1]

(ii) Identify the atom against which the relative masses of all other atoms are compared.

..... [1]

(iii) What is the name of the amount of any substance that contains 6.02×10^{23} particles?

..... [1]

(iv) The constant 6.02×10^{23} has a name.

What is the name of this constant?

..... [1]

(c) Part of the definition of relative atomic mass is 'the average mass of naturally occurring atoms of an element'.

Some relative atomic masses are not whole numbers.

Element **Y** has only two different types of atom, ^{69}**Y** and ^{71}**Y**.

The ratio of atoms present in element **Y** is shown.

$$^{69}\mathbf{Y} : {}^{71}\mathbf{Y} = 3 : 2$$

- Calculate the relative atomic mass of element **Y** to **one decimal place**.

relative atomic mass = ...

- Identify element **Y**.

.....
[3]

(d) Element **Z** is in Period 3 and Group V.

(i) Identify element **Z**.

..... [1]

(ii) Explain in terms of electron transfer why **Z** behaves chemically as a non-metal.

.....

..... [2]

[Total: 16]

[Turn over

2 Magnesium is a metal.

(a) Name and describe the bonding in magnesium.

name .....

description of bonding .....

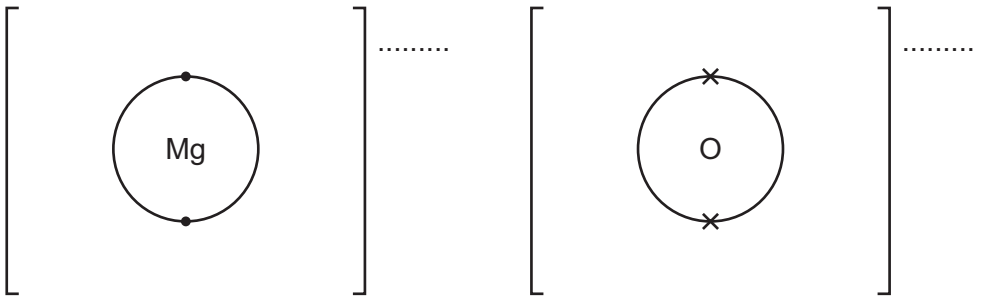
.....

.....

[4]

(b) Magnesium oxide, MgO, is formed when magnesium burns in oxygen.

(i) Complete the dot-and-cross diagram to show the electron arrangement of the ions in magnesium oxide.
The inner shells have been drawn.
Give the charges on the ions.



[3]

(ii) Write the chemical equation for the reaction that occurs when magnesium burns in oxygen.

..... [2]

(c) Magnesium oxide also forms when magnesium nitrate, $Mg(NO_3)_2$, is heated strongly. This is an endothermic reaction.

(i) Write the chemical equation for this reaction.

..... [2]

(ii) What type of reaction is this?

..... [1]

(iii) Name **two** other compounds of magnesium that form magnesium oxide when heated.

.....

..... [2]

[Total: 14]

3 Sulfur dioxide, SO_2, is used in the manufacture of sulfuric acid.

(a) In the first stage of the process, sulfur dioxide is obtained from sulfur-containing ores.

Name **one** of these ores.

..... [1]

(b) The next stage of the process is a reaction which can reach equilibrium.

The equation for this stage is shown.

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

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

.....

..... [2]

(ii) Name the catalyst used in this stage.

..... [1]

(iii) Why is a catalyst used?

..... [1]

(iv) Explain, in terms of particles, why a high temperature increases the rate of this reaction.

.....

.....

.....

.....

..... [3]

(v) In this stage, only a moderate temperature of 450 °C is used.

What does this suggest about the forward reaction?

..... [1]

(vi) Calculate the percentage by mass of sulfur in sulfur trioxide, SO_3.

percentage = ... [2]

[Turn over

(c) Concentrated sulfuric acid is a dehydrating agent which can chemically remove water from substances.

Both hydrated copper(II) sulfate crystals and sucrose (a sugar), $C_{12}H_{22}O_{11}$, can be completely dehydrated by concentrated sulfuric acid.

Name the solid product formed in each case.

hydrated copper(II) sulfate crystals .....

sucrose .....
[2]

(d) When propan-1-ol is heated with concentrated sulfuric acid as a catalyst an unsaturated hydrocarbon of relative molecular mass 42 is formed and one other product.

(i) What is meant by the term *unsaturated*?

..... [1]

(ii) Write the chemical equation for this reaction.

..... [2]

(iii) Name the unsaturated hydrocarbon formed.

..... [1]

[Total: 17]

4 This question is about reactions of bases and acids.

(a) Ammonia is a gas at room temperature.

What is the test for ammonia gas? Describe the positive result of this test.

test .....

result .....
[2]

(b) Ammonia reacts with water to form ions.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

(i) How does this equation show that ammonia, NH_3, behaves as a base?

..... [1]

(ii) Aqueous ammonia is described as a weak base.

Suggest the pH of aqueous ammonia.

pH = ... [1]

(iii) Describe what is seen when aqueous ammonia is added to aqueous copper(II) sulfate, until no further change is seen.

.....

.....

..... [3]

(c) Aqueous sodium hydroxide, NaOH(aq), is a strong alkali that reacts with dilute sulfuric acid exothermically.

(i) What type of reaction is this?

..... [1]

(ii) Complete the equation for the reaction between aqueous sodium hydroxide and dilute sulfuric acid.

$2NaOH + H_2SO_4 \rightarrow$ ..... + ...

[2]

(d) A student wanted to find the concentration of some dilute sulfuric acid by titration. The student found that 25.0 cm^3 of 0.0400 mol/dm^3 NaOH(aq) reacted exactly with 20.0 cm^3 of H_2SO_4(aq).

(i) Name a suitable indicator to use in this titration.

..... [1]

(ii) Calculate the concentration of the H_2SO_4(aq) in mol/dm^3 using the following steps.

- Calculate the number of moles of NaOH in 25.0 cm^3.

moles = ...

- Deduce the number of moles of H_2SO_4 that reacted with the 25.0 cm^3 of NaOH(aq).

moles = ...

- Calculate the concentration of H_2SO_4(aq) in mol/dm^3.

concentration = ... mol/dm^3

[3]

(iii) Calculate the concentration of the 0.0400 mol/dm^3 NaOH(aq) in g/dm^3.

concentration = ... g/dm^3 [2]

[Total: 16]

5 Ethanol is manufactured by two different processes.

(a) For each process, name the organic reactant and state the type of reaction.

organic reactant ..... type of reaction .....

organic reactant ..... type of reaction .....

[4]

(b) Alcohols can be oxidised to form carboxylic acids.

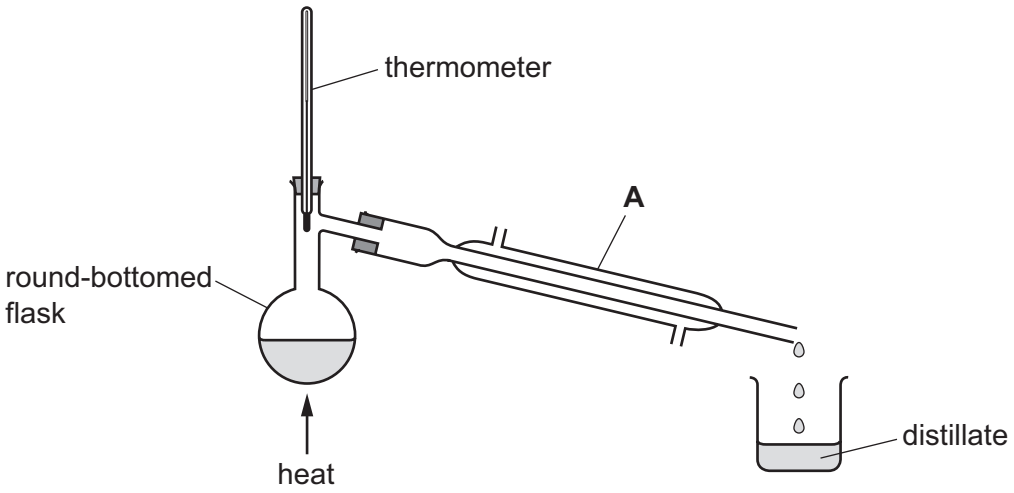
Name a suitable oxidising agent for this reaction.

..... [1]

(c) Alcohols can be partially oxidised to form aldehydes.

Aldehydes are a homologous series of organic compounds.

Partial oxidation is achieved by reacting an alcohol with the oxidising agent in distillation apparatus as shown.



(i) Name apparatus **A**.

..... [1]

(ii) On the diagram, use **one** arrow to show where water enters apparatus **A**. [1]

(d) The table shows some information about aldehydes.

(i) Complete the table.

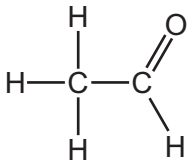
name	.....	ethanal	propanal	butanal
molecular formula	CH_2O	C_2H_4O	C_3H_6O	.....

[2]

(ii) Deduce the general formula of aldehydes.

..... [1]

(e) The structural formula of ethanal is shown.

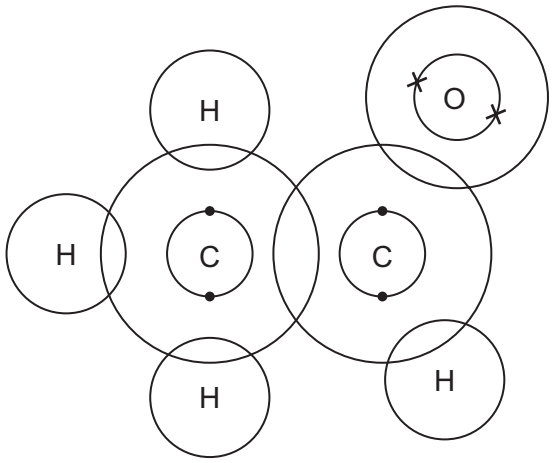


The C=O group in aldehydes is at the end of the carbon chain.
This is a reactive part of the molecule.

(i) What is the name given to the reactive part of any organic molecule?

..... [1]

(ii) Complete the dot-and-cross diagram to show the electron arrangement of a molecule of ethanal. Inner shells have been drawn.



[3]

(f) Propanone belongs to a homologous series called ketones. Ketones have the same C=O group as aldehydes but the C=O group is not at the end of the carbon chain. Propanone has the same molecular formula as propanal, C_3H_6O.

(i) What term is used to describe molecules with different structures but with the same molecular formula?

..... [1]

(ii) Suggest the structure of propanone, C_3H_6O. Show all of the atoms and all of the bonds.

[2]

[Total: 17]

The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

2.1 2020 | May/Jun | Variant 1 | 0620_s20_ms_41

Cambridge Assessment International Education

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CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2020**

MARK SCHEME

Maximum Mark: 80

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.

5 'List rule' guidance (see examples below)

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)	protons	**1**
	neutrons	**1**
1(a)(ii)	nucleon number	**1**
1(a)(iii)	34	**1**
1(a)(iv)	2 : 8 : 8	**1**
1(a)(v)	AlX_3	**1**
1(b)(i)	isotopes	**1**
1(b)(ii)	^{12}C	**1**
1(b)(iii)	a mole	**1**
1(b)(iv)	Avogadro constant	**1**
1(c)	M1 $(3 \times 69) + (2 \times 71)$ M2 $= \frac{349}{5} = 69.8$ M3 Y = Ga / gallium	**3**
1(d)(i)	phosphorus / P	**1**
1(d)(ii)	gains electrons three electrons (when forming ion)	**2**

Question	Answer	Marks
2(a)	metallic (bonding)	1
	sea of electrons	1
	positive ions	1
	attraction between	1
2(b)(i)	Mg octet of eight dots	1
	O octet of six crosses and two dots.	1
	correct charges on both ions	1
2(b)(ii)	$2Mg + O_2 \rightarrow 2MgO$ M1 species M2 balancing	2
2(c)(i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$ M1 product species M2 balancing	2
2(c)(ii)	(thermal) decomposition	1
2(c)(iii)	magnesium carbonate	1
	magnesium hydroxide	1

Question	Answer	Marks
3(a)	zinc blende	1
3(b)(i)	reaction is reversible rate of forward reaction = rate of reverse reaction	2
3(b)(ii)	vanadium(V) oxide	1

Question	Answer	Marks
3(b)(iii)	increases the rate of reaction	**1**
3(b)(iv)	particles have more energy (E)	**1**
	rate of collisions increase	**1**
	a higher proportion of particles have energy greater than activation energy ($E > E_A$)	**1**
3(b)(v)	exothermic	**1**
3(b)(vi)	M_r of SO_3 = 80	**1**
	$100 \times \frac{32}{80} = 40\%$	**1**
3(c)	anhydrous copper(II) sulfate carbon	**2**
3(d)(i)	not all (C–C) bonds are single	**1**
3(d)(ii)	$C_3H_7OH \rightarrow C_3H_6 + H_2O$ M1 C_3H_6 M2 rest of the equation	**2**
3(d)(iii)	propene	**1**

Question	Answer	Marks
4(a)	(damp) litmus	**1**
	(turns) blue	**1**
4(b)(i)	proton acceptor	**1**
4(b)(ii)	Above pH 7 up to 11	**1**

Question	Answer	Marks
4(b)(iii)	blue precipitate	1
	precipitate dissolves	1
	deep blue solution remains	1
4(c)(i)	neutralisation	1
4(c)(ii)	Na_2SO_4	1
	$2H_2O$	1
4(d)(i)	methyl orange	1
4(d)(ii)	M1 mol of NaOH $= 0.0400 \times \frac{25.0}{1000} = 0.001(00)$ mol M2 mol of H_2SO_4 $= \frac{M1}{2} = \frac{0.001}{2} = 0.0005(00)$ M3 M2 $\times \frac{1000}{20.0} = 0.0005 \times \frac{1000}{20.0} = 0.025$ (mol / dm^3) allow ecf	3
4(d)(iii)	M1 use of 40 g/mol M2 $40 \times 0.04 = 1.6$ (g/dm^3)	2

Question	Answer	Marks
5(a)	M1 sugar(s) M2 fermentation M3 ethene M4 hydration	4

Question	Answer	Marks
5(b)	(acidified) potassium manganate(VII)	**1**
5(c)(i)	(Liebig) condenser	**1**
5(c)(ii)	arrow at the lower inlet	**1**
5(d)(i)	methanal	**1**
	C_4H_8O	**1**
5(d)(ii)	$C_nH_{2n}O$	**1**
5(e)(i)	functional group	**1**
5(e)(ii)	M1 4 × C–H dot cross bonds and 1 C–C dot cross bond M2 1 × C=O dot cross bond M3 non-bonding electrons on O	**3**
5(f)(i)	(structural) isomers	**1**
5(f)(ii)	M1 any structure with correct valencies and formula of C_3H_6O M2 C=O bond on second carbon (of a chain of 3)	**2**

3 2020 | May/Jun | Variant 2 | 0620_s20_qp_42

Topic & Sub-topic Index of Questions

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2	c	Atoms, elements and compounds	Ions and ionic bonds	51	70
3	a	Acids, bases and salts	Oxides	52	70
3	b	Chemical reactions	Reversible reactions and equilibrium	52	70
3	c	Chemical reactions	Reversible reactions and equilibrium	52	70
3	d	Stoichiometry	Formulae	53	70
3	e	Experimental techniques and chemical analysis	Identification of ions and gases	53	70
3	f	Acids, bases and salts	Preparation of salts	53	70
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4	a	Chemical reactions	Rate of reaction	54	71
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5	e	Electrochemistry	Electrolysis	56	72
6	a	Organic chemistry	Alkanes	57	72
6	b	Organic chemistry	Alkenes	57	72

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7336615318

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2020**

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. Blank pages are indicated.

1 **(a)** Give the name of the process that:

(i) occurs when a gas turns into a liquid

..... [1]

(ii) occurs when a solid turns into a gas without first forming a liquid

..... [1]

(iii) is used to separate a mixture of liquids with different boiling points

..... [1]

(iv) is used to extract aluminium from aluminium oxide

..... [1]

(v) is used to separate a mixture of amino acids.

..... [1]

(b) The symbols of the elements in Period 2 of the Periodic Table are shown.

Li Be B C N O F Ne

For each of the following, give the symbol of an element from Period 2 which matches the description.

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

Which element:

(i) combines with hydrogen to produce ammonia

..... [1]

(ii) makes up approximately 21% of clean, dry air

..... [1]

(iii) has atoms with only two electrons in the outer shell

..... [1]

(iv) has atoms with only seven protons

..... [1]

(v) is a monoatomic gas

..... [1]

(vi) is a soft metal stored in oil?

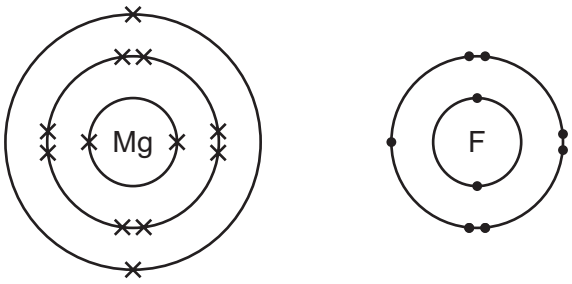
..... [1]

[Total: 11]

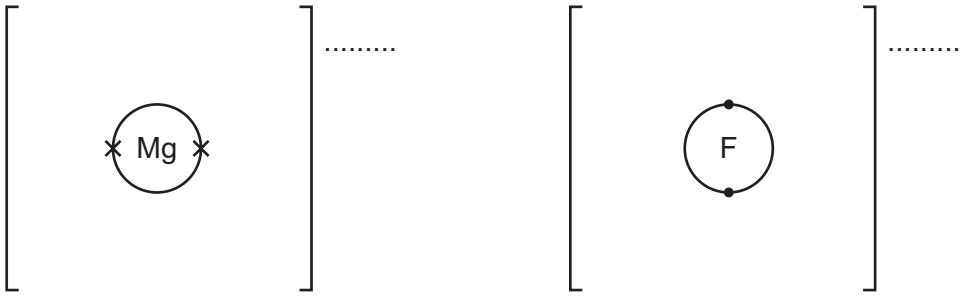
2 Fluorine forms both ionic and covalent compounds.

(a) Magnesium reacts with fluorine to form the ionic compound magnesium fluoride.

The electronic structures of an atom of magnesium and an atom of fluorine are shown.



(i) Complete the dot-and-cross diagrams to show the electronic structures of one magnesium ion and one fluoride ion. Show the charges on the ions.



[3]

(ii) What is the formula of magnesium fluoride?

..... [1]

(iii) Magnesium fluoride does **not** conduct electricity when it is solid.

What can be done to solid magnesium fluoride to make it conduct electricity?

In your answer explain why magnesium fluoride conducts electricity when this change is made.

.....

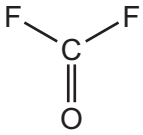
.....

.....

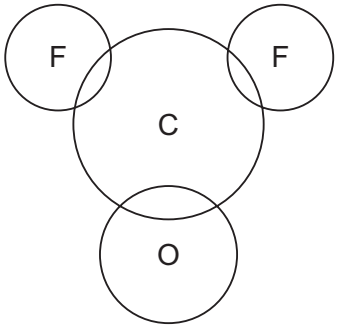
..... [2]

[Turn over

(b) Carbonyl fluoride, COF_2, is a covalent compound. The structure of a molecule of COF_2 is shown.



Complete the dot-and-cross diagram to show the electron arrangement in a molecule of carbonyl fluoride. Show outer shell electrons only.



[3]

(c) The melting points of magnesium fluoride and carbonyl fluoride are shown.

	melting point / °C
magnesium fluoride	1263
carbonyl fluoride	–111

(i) Explain, using your knowledge of structure and bonding, why magnesium fluoride has a high melting point.

.....

.....

.....

..... [2]

(ii) Explain, using your knowledge of structure and bonding, why carbonyl fluoride has a low melting point.

.....

.....

.....

..... [2]

[Total: 13]

3 **(a)** Sulfuric acid is made from sulfur in a four-stage process.

stage 1 Sulfur is converted into sulfur dioxide.

stage 2 Sulfur dioxide is converted into sulfur trioxide.

stage 3 Sulfur trioxide is converted into oleum.

stage 4 Oleum is converted into sulfuric acid.

(i) How is sulfur converted into sulfur dioxide in **stage 1**?

..... [1]

(ii) Describe how sulfur dioxide is converted into sulfur trioxide in **stage 2**.

Your answer should include:

- an equation for the reaction
- the temperature used
- the name of the catalyst used.

.....

.....

.....

..... [3]

(iii) The reaction in **stage 2** can reach equilibrium.

What is meant by the term *equilibrium*?

.....

.....

..... [2]

(b) Sulfur trioxide is converted into oleum, $H_2S_2O_7$, in **stage 3**.

What is sulfur trioxide reacted with to convert it into oleum?

..... [1]

(c) Oleum is converted into sulfuric acid in **stage 4**.

Write a chemical equation for the conversion of oleum, $H_2S_2O_7$, into sulfuric acid.

..... [2]

[Turn over

(d) When copper is reacted with hot concentrated sulfuric acid, sulfur dioxide gas is formed.

Balance the chemical equation for this reaction.

$$Cu + ...H_2SO_4 \rightarrow CuSO_4 + SO_2 + ...H_2O$$ [1]

(e) Sulfur dioxide is a reducing agent.

Give the colour change that occurs when excess sulfur dioxide is bubbled into acidified aqueous potassium manganate(VII).

starting colour of the solution .....

final colour of the solution .....
[1]

(f) When sulfuric acid reacts with ammonia the salt produced is ammonium sulfate.

Write the chemical equation for this reaction.

..... [2]

(g) Barium sulfate is an insoluble salt.

Barium sulfate can be made from aqueous ammonium sulfate using a precipitation reaction.

(i) Name a solution that can be added to aqueous ammonium sulfate to produce a precipitate of barium sulfate.

..... [1]

(ii) Write an ionic equation for this precipitation reaction. Include state symbols.

..... [2]

[Total: 16]

4 Oxygen is produced by the decomposition of hydrogen peroxide. Manganese(IV) oxide is the catalyst for this reaction.

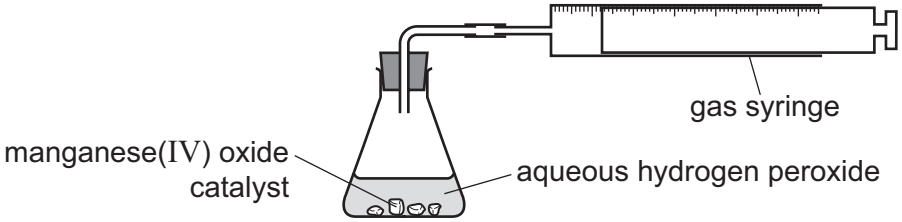
(a) What is meant by the term *catalyst*?

.....

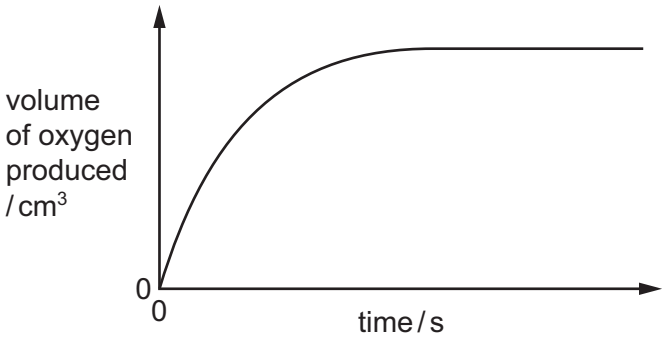
.....

..... [2]

(b) A student measures the volume of oxygen produced at regular time intervals using the apparatus shown. Large lumps of manganese(IV) oxide are used.



A graph of the results is shown.



What happens to the **rate** of this reaction as time increases?
In your answer, explain why the rate changes in this way.

.....

.....

.....

.....

..... [4]

(c) The experiment is repeated using the same mass of manganese(IV) oxide. Powdered manganese(IV) oxide is used instead of large lumps. All other conditions stay the same.

Sketch a graph on the axes in **(b)** to show how the volume of oxygen changes with time. [2]

[Turn over

(d) In terms of particles, explain what happens to the rate of this reaction when the temperature is increased.

.....

.....

.....

.....

..... [3]

(e) The equation for the decomposition of hydrogen peroxide is shown.

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

25.0 cm^3 of aqueous hydrogen peroxide forms 48.0 cm^3 of oxygen at room temperature and pressure (r.t.p.).

Calculate the concentration of aqueous hydrogen peroxide at the start of the experiment using the following steps.

- Calculate the number of moles of oxygen formed.

..... mol

- Deduce the number of moles of hydrogen peroxide that decomposed.

..... mol

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

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

(f) Oxygen can also be produced by the decomposition of potassium chlorate(V), $KClO_3$.

The only products of this decomposition are potassium chloride and oxygen.

Write a chemical equation for this decomposition.

..... [2]

[Total: 16]

5 Electrolysis of concentrated aqueous sodium chloride using inert electrodes forms chlorine, hydrogen and sodium hydroxide.

(a) What is meant by the term *electrolysis*?

.....

.....

..... [2]

(b) Name a substance that can be used as the inert electrodes.

..... [1]

(c) Write an ionic half-equation for the formation of hydrogen during this electrolysis.

..... [1]

(d) Give the formulae of the **four** ions present in concentrated aqueous sodium chloride.

..... [2]

(e) Explain how sodium hydroxide is formed during this electrolysis.

.....

.....

..... [2]

[Total: 8]

6 **(a)** Propane reacts with chlorine in a photochemical reaction as shown.

$$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$$

(i) What type of reaction is this?

..... [1]

(ii) What condition is needed for this photochemical reaction to occur?

..... [1]

(iii) Draw **two** structural isomers of compounds with the formula C_3H_7Cl.
Show all of the atoms and all of the bonds.

[2]

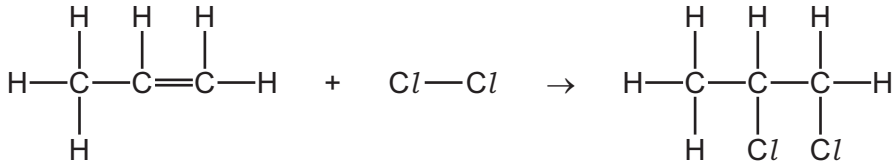
(b) Propene reacts with chlorine in an addition reaction as shown.

$$C_3H_6 + Cl_2 \rightarrow C_3H_6Cl_2$$

(i) State why this is an addition reaction.

..... [1]

(ii) The structures of the reactants and products of this reaction are shown.



Some bond energies are shown in the table.

bond	bond energy in kJ / mol
C–C	347
C=C	612
C–H	413
C–C*l*	339
C*l*–C*l*	242

Calculate the energy change for the reaction between propene and chlorine using the following steps.

- Calculate the energy needed to break the bonds.

..... kJ

- Calculate the energy released when bonds are formed.

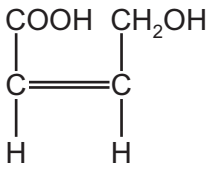
..... kJ

- Calculate the energy change for the reaction between propene and chlorine.

..... kJ / mol
[3]

(c) There are three functional groups in compound **A**.

compound **A**



(i) Name the homologous series of compounds that contains the following structures.

C=C .....

–OH .....

–COOH .....

[3]

(ii) What would you observe when compound **A** is added to:

aqueous bromine .....

aqueous sodium carbonate? .....

[2]

(d) Compound **A** can be used as a single monomer to produce two different polymers.

(i) Draw **one** repeat unit of the addition polymer formed from compound **A**.

[2]

(ii) What type of condensation polymer is formed from compound **A**?

..... [1]

[Total: 16]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

3.1 2020 | May/Jun | Variant 2 | 0620_s20_ms_42

Cambridge Assessment International Education

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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2020**

MARK SCHEME

Maximum Mark: 80

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

[Turn over

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.

5 'List rule' guidance (see examples below)

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)	condensation	**1**
1(a)(ii)	sublimation	**1**
1(a)(iii)	fractional distillation	**1**
1(a)(iv)	electrolysis	**1**
1(a)(v)	chromatography	**1**
1(b)(i)	N	**1**
1(b)(ii)	O	**1**
1(b)(iii)	Be	**1**
1(b)(iv)	N	**1**
1(b)(v)	Ne	**1**
1(b)(vi)	Li	**1**

Question	Answer	Marks
2(a)(i)	magnesium 2.8 (all crosses) (1) fluorine 2.8 (seven dots and one cross in outer shell) (1) Mg^{2+} **and** F^{-}(1)	**3**
2(a)(ii)	MgF_2	**1**
2(a)(iii)	heat until molten **or** dissolve in water (1) moving ions / mobile ions (1)	**2**

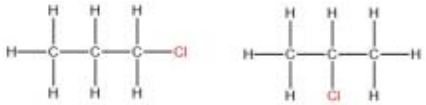
Question	Answer	Marks
2(b)	two single bonds (1) one double bond (1) six non-bonding electrons on both F atoms and four non- bonding electrons on O atom to complete the octet in each case (1)	**3**
2(c)(i)	forces of attraction between oppositely charged ions / ionic bonds (1) strong / need a lot of energy to break / weaken (1)	**2**
2(c)(ii)	forces of attraction between molecules (1) weak / need a small of energy to break / weaken (1)	**2**

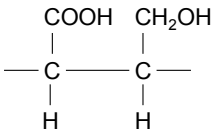
Question	Answer	Marks
3(a)(i)	heat in air	**1**
3(a)(ii)	$2SO_2 + O_2 \rightarrow 2SO_3$ (1) 450°C (1) vanadium(V) oxide (1)	**3**
3(a)(iii)	rate of forward reaction and rate of backward reaction are equal (1) concentrations of reactants and products are constant (1)	**3**
3(b)	concentrated sulfuric acid	**1**
3(c)	$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	**2**
3(d)	$Cu + \mathbf{2}H_2SO_4 \rightarrow CuSO_4 + SO_2 + \mathbf{2}H_2O$	**1**
3(e)	purple to colourless	**1**
3(f)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	**2**
3(g)(i)	barium nitrate / barium chloride	**1**
3(g)(ii)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ formulae (1) state symbols (1)	**2**

Question	Answer	Marks
4(a)	substance that speeds up a reaction / increases rate (1) unchanged (chemically) at the end **OR** not used up **OR** lowers activation energy **OR** provides alternative pathway (1)	**2**
4(b)	rate decreases (1) particles further apart / less particles per unit volume (1) fewer collisions per unit time / lower collision frequency (1) reaction stops because all hydrogen peroxide is used up	**4**
4(c)	steeper gradient (1) reaches same volume of oxygen (1)	**2**
4(d)	particles gain kinetic energy / particles move faster (1) greater number of collisions with activation energy (or more) / greater number of particles with activation energy (or more) / greater number of particles with energy required for reaction (1) more collisions are successful / more collisions are fruitful / more collisions lead to reaction (1)	**3**
4(e)	**M1** moles of oxygen $= \frac{48.0}{24\,000}$ or moles of oxygen = 0.002 (1) **M2** moles of hydrogen peroxide = **M1** $\times 2$ or moles of hydrogen peroxide = 0.004 (1) **M3** concentration = **M2** $\times 40$ = 0.16 mol / dm^3 (1) allow ECF	**3**
4(f)	$2KClO_3 \rightarrow 2KCl + 3O_2$ **ALL** formulae correct (1) balancing (1)	**2**

Question	Answer	Marks
5(a)	**breakdown** of an ionic **compound** when molten or in aqueous solution (1) (using) electricity / electric current / electrical energy (1)	**2**
5(b)	platinum / graphite	**1**
5(c)	$2H^+ + 2e \rightarrow H_2$	**1**

Question	Answer	Marks
5(d)	Na^+ H^+ Cl^- OH^- all four (2) 3 or 2 (1)	**2**
5(e)	H^+ and Cl^- are discharged / removed (1) Na^+ and OH^- remain (1)	**2**

Question	Answer	Marks
6(a)(i)	substitution	**1**
6(a)(ii)	ultraviolet light / ultraviolet radiation	**1**
6(a)(iii)		**2**
6(b)(i)	only one product / double bond becomes single bond / two molecules join (to make one molecule)	**1**
6(b)(ii)	(energy required to break bonds =) 854 (1) (energy given out when bonds form =) 1025 (1) overall energy change 854 – 1025 = –171 (1)	**3**

Question	Answer	Marks
6(c)(i)	alkene (1) alcohols / alkanols (1) carboxylic acids/alkanoic acids (1)	**3**
6(c)(ii)	turns colourless / decolourised (1) bubbles / fizzing / effervescence (1)	**2**
6(d)(i)	 C–C (1) each C bonded to $–CH_2OH$ / –COOH and H with no other atoms + extension bonds (1)	**2**
6(d)(ii)	polyester	**1**

4 2020 | May/Jun | Variant 3 | 0620_s20_qp_43

Topic & Sub-topic Index of Questions

No.	Sub Q.	Topic	Subtopic	QP Page	MS Page
1	a	Organic chemistry	Carboxylic acids	76	96
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2	a	Chemical reactions	Reversible reactions and equilibrium	78	96
2	b	Chemical reactions	Reversible reactions and equilibrium	78	96
2	c	Chemical reactions	Reversible reactions and equilibrium	78	97
2	d	Chemistry of the environment	Air quality and climate	79	97
2	e	Chemical energetics	Exothermic and endothermic reactions	80	97
3	a	Atoms, elements and compounds	Isotopes	81	97
3	b	The Periodic Table	Group VII properties	81	97
3	c	Metals	Reactivity series	81	98
3	d	Chemical energetics	Exothermic and endothermic reactions	82	98
4	a	Chemistry of the environment	Water	83	98
4	b	Chemistry of the environment	Water	83	98
4	c	Experimental techniques and chemical analysis	Chromatography	83	98
5	a	States of matter	Solids, liquids and gases	84	99
5	b	States of matter	Solids, liquids and gases	84	99
5	c	States of matter	Diffusion	84	99
6	a	Metals	Extraction of metals	85	99
6	b	Experimental techniques and chemical analysis	Identification of ions and gases	85	99
7	a	Electrochemistry	Electrolysis	86	99
7	b	Metals	Extraction of metals	86	99
7	c	Metals	Extraction of metals	86	99
7	d	Metals	Uses of metals	86	100
7	e	Metals	Extraction of metals	87	100
8	a	Organic chemistry	Polymers	88	100
8	b	Organic chemistry	Polymers	88	101
8	c	Organic chemistry	Polymers	88	101

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6591584314

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2020**

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

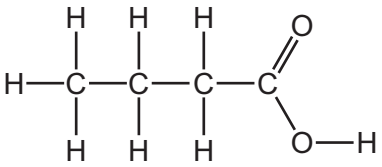
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Blank pages are indicated.

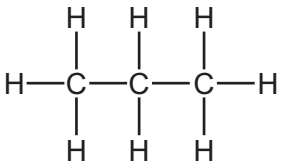
1 **(a)** The structures of five organic compounds, **A**, **B**, **C**, **D** and **E**, are shown.

Answer the questions that follow.
Each letter may be used once, more than once or not at all.

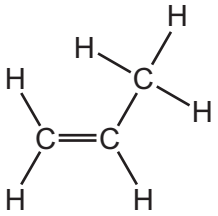
A



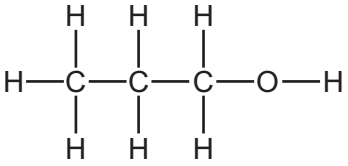
B



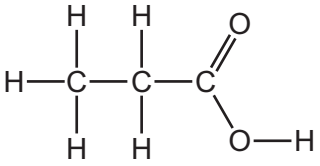
C



D



E



(i) Give the letter of the compound that is propan-1-ol.

..... [1]

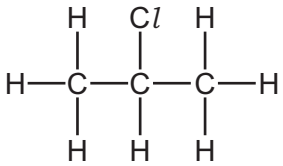
(ii) Give the letter of the compound that has the empirical formula CH_2.

..... [1]

(iii) Give the letter of **one** compound that reacts with bromine in an addition reaction.

..... [1]

(iv) Give the letter of **one** compound that reacts with chlorine to form the compound shown.



..... [1]

(v) Give the letters of **two** compounds that can react with each other to form an ester.

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

(vi) Give the letter of the compound that is in the same homologous series as hex-1-ene.

..... [1]

(vii) Give the letter of **one** compound that is an acid.

..... [1]

(viii) Draw a structural isomer of compound **D**.

Show all of the atoms and all of the bonds.

[1]

(b) Some acids are described as weak acids.

State the meaning of the term *weak acid*.

weak .....

acid .....

[2]

[Total: 10]

2 Ammonia is manufactured by the Haber process.

(a) The equation for the reaction is shown.

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

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

..... [1]

(ii) State **one** source of hydrogen used in the manufacture of ammonia.

..... [1]

(b) The table shows some data for the production of ammonia.

pressure / atm	temperature / °C	percentage yield of ammonia
250	350	58
100	450	28
400	450	42
250	550	20

Deduce the effect on the percentage yield of ammonia of:

- increasing the pressure of the reaction

.....

- increasing the temperature of the reaction.

.....
[2]

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

.....

.....

.....

.....

.....

..... [3]

(d) Ammonia, NH_3, is used to produce nitric acid, HNO_3. This happens in a three-stage process.

Stage 1 is a redox reaction.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

(i) Identify what is oxidised in **stage 1**.

Give a reason for your answer.

substance oxidised .....

reason .....

.....

[2]

(ii) In this reaction the predicted yield of NO is 512 g. The actual yield is 384 g.

Calculate the percentage yield of NO in this reaction.

percentage yield of NO = ... [1]

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

$$2NO + O_2 \rightarrow 2NO_2$$

Which major environmental problem does NO_2 cause if it is released into the atmosphere?

.....

..... [1]

[Turn over

(iv) The equation for the reaction in **stage 3** is shown.

$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

Calculate the volume of O_2 gas, at room temperature and pressure (r.t.p.), needed to produce 1260 g of HNO_3.
Use the following steps.

- Calculate the number of moles of HNO_3.

moles of HNO_3 = ...

- Deduce the number of moles of O_2 that reacted.

moles of O_2 = ...

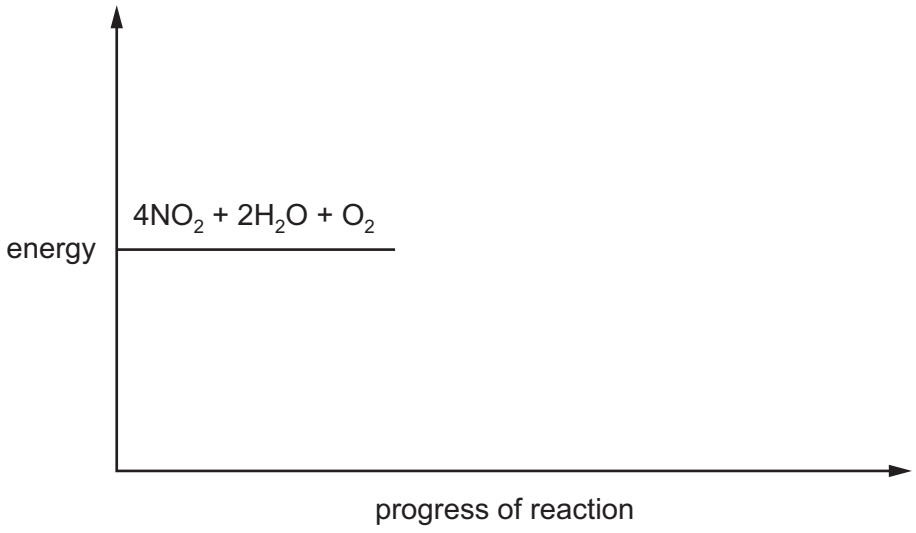
- Calculate the volume of O_2 gas that reacts at room temperature and pressure (r.t.p.).

volume of O_2 gas = ... dm^3
[4]

(e) The reaction in **stage 3** is exothermic.

$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

Complete the energy level diagram for this reaction. Include an arrow that clearly shows the energy change during the reaction.



[3]

[Total: 18]

3 Chlorine is in Group VII of the Periodic Table.

(a) Two isotopes of chlorine are chlorine-35 and chlorine-37.

(i) State why these two isotopes of chlorine have the same chemical properties.

.....

.....

..... [2]

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

	number of electrons	number of neutrons	number of protons
$^{35}_{17}Cl$			
$^{37}_{17}Cl^-$			

[3]

(b) (i) Chlorine reacts with aqueous sodium bromide.

The equation for the reaction is shown.

$$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$$

State the type of reaction shown.

..... [1]

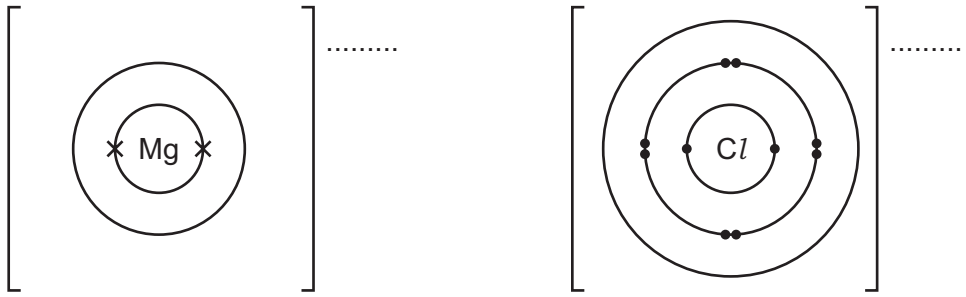
(ii) Why is there **no** reaction between iodine and aqueous sodium bromide?

..... [1]

(c) Magnesium reacts with chlorine to form magnesium chloride.

Complete the dot-and-cross diagram to show the electron arrangement of the ions in magnesium chloride. Give the charges on the ions.

The inner shells have been completed.



[3]

(d) Hydrogen and chlorine react to form hydrogen chloride gas, as shown in the equation.

$$H_2 + Cl_2 \rightarrow 2HCl$$

This equation can be represented as shown.

$$H–H + Cl–Cl \rightarrow 2H–Cl$$

Some bond energies are shown in the table.

bond	bond energy in kJ / mol
H–H	436
Cl–Cl	243
H–Cl	432

Calculate the energy change for the reaction between hydrogen and chlorine, using the following steps.

- Calculate the energy needed to break the bonds.

..... kJ

- Calculate the energy released when bonds are formed.

..... kJ

- Calculate the energy change for the reaction.

..... kJ / mol
[3]

[Total: 13]

4 **(a)** Filtration and chlorination are two stages in water treatment.

State the purpose of each stage.

filtration .....

.....

chlorination .....

.....

[2]

(b) A student uses anhydrous copper(II) sulfate to test for the presence of water.

(i) What colour change is seen if water is present?

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

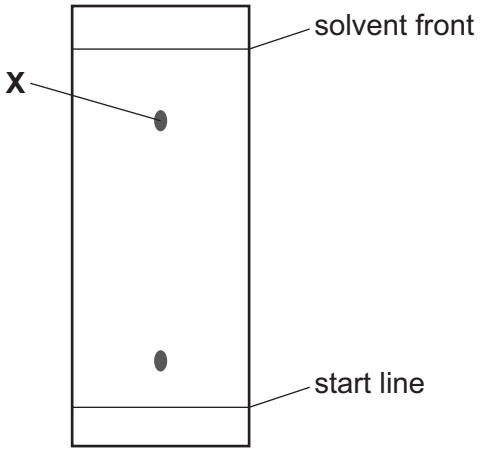
(ii) The purity of a sample of water can be assessed by measuring its boiling point.

How is the boiling point of water affected by impurities?

..... [1]

(c) Chromatography can be used to test the purity of substances.

The diagram shows the chromatogram of a coloured substance.



(i) How does this chromatogram show that this substance is **not** pure?

..... [1]

(ii) Draw a circle round the correct R_f value for the spot labelled **X**.

0.2 0.4 0.8 1.2 [1]

(iii) State how a colourless substance can be made visible on a chromatogram.

..... [1]

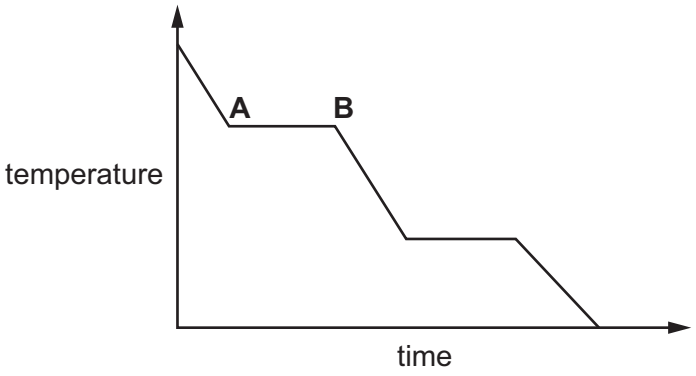
[Total: 8]

5 **(a)** Complete the table about solids, liquids and gases.

	particle separation	particle arrangement	type of motion
solid		regular	vibrate only
liquid	touching		random
gas	apart	random	

[3]

(b) The graph shows the change in temperature as a sample of a gas is cooled.



Name the change of state taking place between **A** and **B**.

..... [1]

(c) A bottle of liquid perfume is left open at the front of a room.

After some time, the perfume is smelt at the back of the room.

Name the **two** physical processes taking place.

1 .....

2 .....

[2]

[Total: 6]

6 **(a)** An endothermic reaction occurs when calcium nitrate is heated.

(i) Balance the equation for this reaction.

$$.....Ca(NO_3)_2 \rightarrow .....CaO + ...NO_2 + ...O_2$$ [1]

(ii) State the type of reaction shown by the equation.

..... [1]

(b) Describe the test for a nitrate ion.

test .....

.....

result .....

.....

[3]

[Total: 5]

7 Aluminium is extracted by electrolysis. Iron is extracted from its ore by reduction with carbon.

(a) What is meant by the term *electrolysis*?

.....

..... [2]

(b) Name the main ore of aluminium.

..... [1]

(c) (i) Explain why aluminium **cannot** be extracted by reduction with carbon.

..... [1]

(ii) Describe the role of cryolite in the extraction of aluminium by electrolysis.

..... [1]

(iii) Name the product formed at the positive electrode.

..... [1]

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

..... [2]

(d) Aluminium is used in overhead electricity cables.

Give **two** properties of aluminium that make it suitable for use in overhead electricity cables.

1 .....

2 .....
[2]

(e) Iron is a transition element.

(i) Iron forms hydrated iron(III) oxide when it rusts.

Write a word equation to represent the formation of rust.

..... [2]

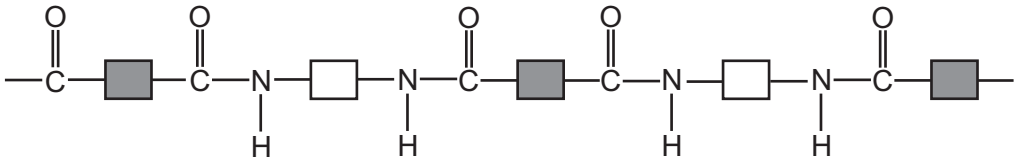
(ii) Give **two** ways in which the properties of transition elements differ from the properties of Group I metals.

1 .....

2 .....
[2]

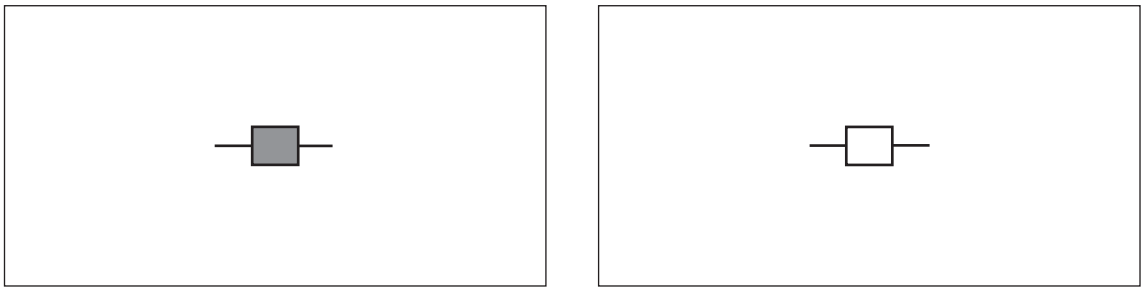
[Total: 14]

8 **(a)** Part of the synthetic polymer, nylon, is shown in the diagram.



(i) Circle **one** amide linkage **on the diagram**. [1]

(ii) Complete the structures of the **two** monomers that react to form nylon.



[2]

(iii) Name the other product formed when nylon is produced.

..... [1]

(b) Items made from nylon are often disposed of by burying them in the ground. This is called landfill.

Why is the disposal of nylon using landfill a problem?

.....

..... [1]

(c) Give the name of a natural polymer.

..... [1]

[Total: 6]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

4.1 2020 | May/Jun | Variant 3 | 0620_s20_ms_43

Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2020**

MARK SCHEME

Maximum Mark: 80

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

[Turn over

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.

5 'List rule' guidance (see examples below)

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.

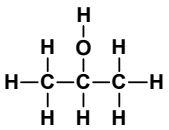
For answers given in standard form, (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

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)	**D**	**1**
1(a)(ii)	**C**	**1**
1(a)(iii)	**C**	**1**
1(a)(iv)	**B**	**1**
1(a)(v)	**D** AND **E** or **A**	**1**
1(a)(vi)	**C**	**1**
1(a)(vii)	**A** or **E**	**1**
1(a)(viii)		**1**
1(b)	donate or lose protons does not fully ionise / partially ionises / forms an equilibrium mixture	**2**

Question	Answer	Marks
2(a)(i)	reversible reaction	**1**
2(a)(ii)	hydrocarbons (reacting with steam)	**1**
2(b)	[increasing pressure] increases yield [increasing temperature] decreases yield	**2**

Question	Answer	Marks
2(c)	(particles) have more energy OR (particles) move faster more collisions per second OR greater collision rate more (of the) particles OR collisions have sufficient energy / activation energy to react OR a greater percentage / proportion / fraction of collisions are successful	**3**
2(d)(i)	N / NH_3 change in oxidation state of N from –3 to +2 / increase in oxidation number / gain in oxygen / loss of electrons	**2**
2(d)(ii)	75	**1**
2(d)(iii)	(it could react with rain water to) form nitric acid / acid rain	**1**
2(d)(iv)	(M_r of HNO_3 =) 63 (1) 20 (1) 5 (1) 120 (dm^3) (1)	**4**
2(e)	• horizontal product energy line at lower energy level than reactant • label of product • correct direction of vertical arrow – arrow must start level with reactant energy and finish level with product level and one arrow head ONLY	**3**

Question	Answer	Marks
3(a)(i)	same number of electrons same electronic configuration	**2**
3(a)(ii)	<table><tr><td></td><td>number of electrons</td><td>number of neutrons</td><td>number of protons</td></tr><tr><td>$^{35}_{17}Cl$</td><td>17</td><td>18</td><td>17</td></tr><tr><td>$^{37}_{17}Cl^-$</td><td>18</td><td>20</td><td>17</td></tr></table>	**3**
3(b)(i)	displacement / redox	**1**

Question	Answer	Marks
3(b)(ii)	iodine is less reactive than bromine	**1**
3(c)	magnesium ion has an outer shell with eight crosses chloride ion has an outer shell with seven dots **and** one cross chloride has a charge of 1– **and** magnesium has a charge 2+	**3**
3(d)	energy needed to break bonds = 436 + 243 = 679 energy released when bonds formed = 2 × 432 = 864 energy change = 679 – 864 = – **AND** 185	**3**

Question	Answer	Marks
4(a)	(filtration:) remove solids from water / remove insoluble substances (chlorination:) sterilises / kill microbes / prevent illness	**2**
4(b)(i)	white to blue	**2**
4(b)(ii)	higher boiling point / greater than 100°C	**1**
4(c)(i)	more than one spot	**1**
4(c)(ii)	0.8 (circled)	**1**
4(c)(iii)	use a locating agent	**1**

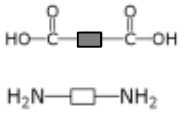
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>
<table>
<tr><th></th><th>particle separation</th><th>particle arrangement</th><th>type of motion</th></tr>
<tr><td>solid</td><td>touching</td><td></td><td></td></tr>
<tr><td>liquid</td><td></td><td>random</td><td></td></tr>
<tr><td>gas</td><td></td><td></td><td>random</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>5(b)</td><td>condensing</td><td>1</td></tr>
<tr><td>5(c)</td><td>evaporation
diffusion</td><td>2</td></tr>
</table>

Question	Answer	Marks
6(a)(i)	2, 2, 4, 1	1
6(a)(ii)	thermal decomposition	1
6(b)	• add aqueous sodium hydroxide • then (reduction with) aluminium (foil) (and warm) • (ammonia gas produced which) turns damp red litmus blue	3

Question	Answer	Marks
7(a)	breakdown of a molten / or aqueous ionic compound by the passage of electricity	2
7(b)	bauxite	1
7(c)(i)	it is above carbon in the reactivity series / more reactive than carbon	1

Question	Answer	Marks
7(c)(ii)	any **one** from: • aluminium oxide has high melting point / cryolite has lower melting point than aluminium oxide • using cryolite reduces costs / expensive to melt aluminium	**1**
7(c)(iii)	oxygen	**1**
7(c)(iv)	$Al^{3+} + 3e^- \rightarrow Al$	**2**
7(d)	any **two** related to use as electricity cables: • ductile / malleable • conducts (electricity) • low density • protective oxide layer	**2**
7(e)(i)	iron + water + oxygen → (hydrated) iron oxide	**2**
7(e)(ii)	any **two** from: • act as catalysts • variable oxidation numbers • form coloured compounds / coloured ions • higher melting point • higher density • harder	**2**

Question	Answer	Marks
8(a)(i)		**1**

Question	Answer	Marks
8(a)(ii)		**2**
8(a)(iii)	water	**1**
8(b)	non-biodegradable / running out of space / toxic / leaching	**1**
8(c)	(complex) carbohydrate / protein	**1**

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Topic & Sub-topic Index of Questions

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2	a	Metals	Extraction of metals	106	128
2	b	Metals	Reactivity series	106	128
2	c	Metals	Alloys and their properties	106	129
3	a	Stoichiometry	The mole and the Avogadro constant	107	129
3	b	Stoichiometry	The mole and the Avogadro constant	107	129
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6	a	Organic chemistry	Naming organic compounds	114	131
6	b	Stoichiometry	The mole and the Avogadro constant	114	131
6	c	Organic chemistry	Alkanes	114	132
6	d	Organic chemistry	Alkenes	115	132
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7	a	Organic chemistry	Alcohols	117	133
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Cambridge Assessment International Education

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1787085567

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

This document has **20** pages. Blank pages are indicated.

1 **(a)** This question is about elements.

aluminium
carbon
iron
hydrogen
oxygen
silicon
sodium
sulfur

Answer the following questions about these elements.

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

(i) Name the element that can be used as a fuel.

..... [1]

(ii) Name the element that forms an oxide with a similar structure to diamond.

..... [1]

(iii) Name the element that forms an amphoteric oxide.

..... [1]

(iv) Name the element that has oxidation states of +2 and +3.

..... [1]

(v) Name the element extracted from bauxite.

..... [1]

(vi) Name the element that has atoms with the electronic structure 2,6.

..... [1]

(b) Iron rusts when it is in contact with oxygen and water.

(i) Explain how sacrificial protection prevents rusting.

.....

.....

.....

..... [2]

(ii) State one **other** method of rust prevention.

..... [1]

[Total: 9]

2 Zinc is extracted from an ore containing zinc sulfide.

(a) State the name of this zinc ore.

..... [1]

(b) This ore is converted to zinc oxide, ZnO.

Zinc oxide is then reacted with carbon.

(i) Write a chemical equation for the reaction of zinc oxide with carbon.

..... [1]

(ii) State what type of chemical change happens to the zinc in zinc oxide in this reaction.

Explain your answer.

chemical change .....

explanation .....

.....

.....

[2]

(iii) Explain why aluminium is **not** extracted from aluminium oxide by heating with carbon.

.....

..... [1]

(iv) Suggest an alternative method for the extraction of zinc from zinc oxide.

..... [1]

(c) Brass is an alloy of zinc.

Explain, in terms of particles, why brass is harder than pure zinc.

.....

.....

.....

.....

..... [3]

[Total: 9]

3 **(a)** Aqueous ammonium sulfate, $(NH_4)_2SO_4$, is warmed with aqueous sodium hydroxide.

The pungent-smelling gas ammonia, NH_3, is produced.

Balance the equation for this reaction.

$$(NH_4)_2SO_4 + ...NaOH \rightarrow .....NH_3 + ...H_2O + Na_2SO_4$$ [1]

(b) A 2.8 g sample of impure ammonium sulfate is found to contain 0.7 g of impurities.

Calculate the percentage of ammonium sulfate in this sample.

percentage of ammonium sulfate = ... % [1]

(c) Describe a test for ammonia gas.

test .....

result .....
[2]

(d) Ammonia gas is prepared at the front of a laboratory.

The pungent smell of ammonia spreads throughout the laboratory slowly.

(i) Name the process that occurs when ammonia gas spreads throughout the laboratory.

..... [1]

(ii) Explain, using ideas about particles, why ammonia gas spreads throughout the laboratory.

.....

.....

.....

..... [2]

(iii) Explain why carbon dioxide gas, CO_2, will spread throughout the laboratory at a slower rate than ammonia gas, NH_3.

.....

..... [1]

[Turn over

(e) Ammonia is produced in the Haber process.

The equation for the reaction is shown.

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

(i) In the Haber process, a temperature of 450 °C and a pressure of 200 atmospheres are used in the presence of finely-divided iron.

A larger equilibrium yield of ammonia would be produced if a lower temperature and a higher pressure are used.

Explain why a lower temperature and a higher pressure are **not** used.

lower temperature .....

.....

higher pressure .....

.....

[2]

(ii) State the role of iron in the Haber process.

..... [1]

(f) Ammonia is a weak base.

(i) Explain the meaning of the term *base*.

.....

..... [1]

(ii) Suggest the pH of aqueous ammonia.

..... [1]

[Total: 13]

4 Air is a mixture of gases.

(a) State the percentage of clean dry air which is oxygen. Give your answer to the nearest whole number.

..... % [1]

(b) Oxygen and nitrogen are useful gases that can be obtained from air.

(i) Name the process used to separate oxygen and nitrogen from liquid air.

..... [2]

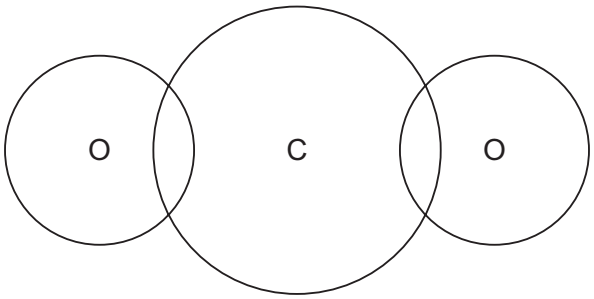
(ii) State the property of oxygen and nitrogen that allows these gases to be separated using this process.

..... [1]

(c) Carbon dioxide, CO_2, is a covalent molecule.

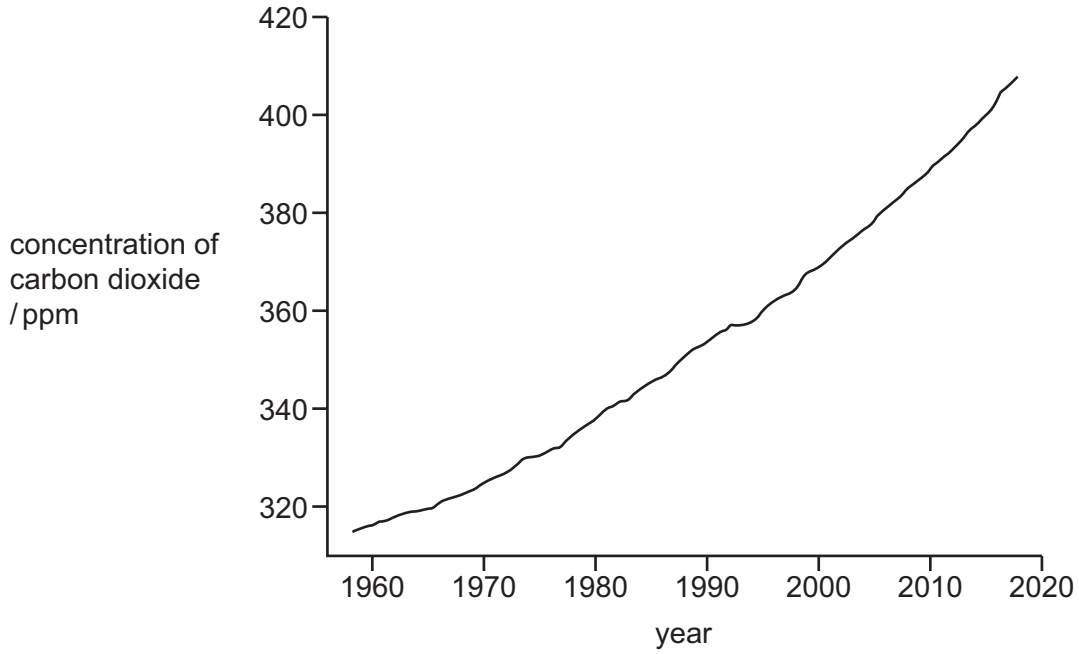
Complete the diagram to show the electron arrangement in one molecule of CO_2.

Show only the outer electrons.



[2]

(d) The graph shows the concentration of carbon dioxide in the atmosphere over a 60-year period, measured in parts per million (ppm).



The data shown in the graph is of global concern.

Explain why.

.....

.....

.....

.....

.....

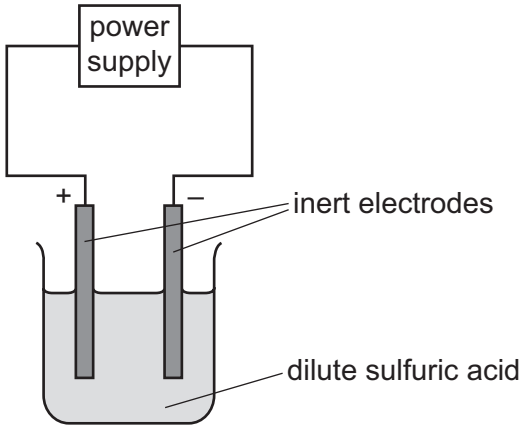
..... [3]

(e) Name the process in the carbon cycle by which plants remove carbon dioxide from the atmosphere.

..... [1]

[Total: 10]

5 **(a)** Dilute sulfuric acid is electrolysed using the apparatus shown in the diagram.



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

.....

.....

..... [2]

(ii) Explain why inert electrodes are used.

.....

..... [1]

(iii) Name the products formed at each electrode.

negative electrode .....

positive electrode .....

[2]

(iv) Write an ionic half-equation for the reaction at the negative electrode.

..... [2]

(b) Sulfuric acid is manufactured using the Contact process. This manufacture involves four stages.

(i) **Stage 1** involves the combustion of sulfur to form sulfur dioxide.

Write the chemical equation for **stage 1**.

..... [1]

(ii) The equation for **stage 2** is shown.

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

The reaction can reach equilibrium.

Explain what is meant by the term *equilibrium*.

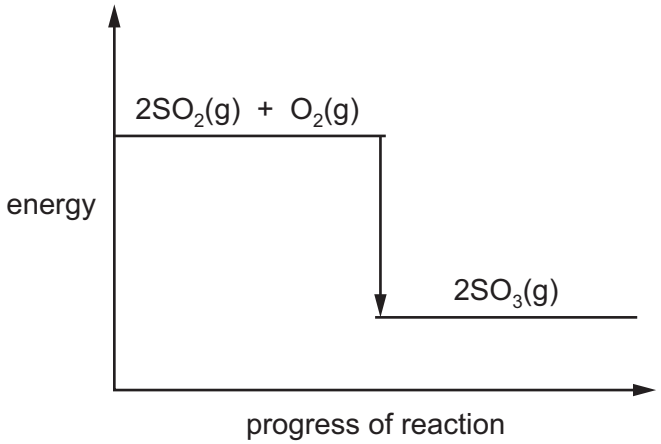
.....

.....

.....

..... [2]

(iii) The energy level diagram for the forward reaction in **stage 2** is shown.



Explain what the diagram shows about the energy changes in the forward reaction.

.....

.....

.....

..... [2]

(c) In **stage 3** sulfur trioxide, SO_3, is converted to oleum, $H_2S_2O_7$.

In **stage 4** oleum reacts to form sulfuric acid, H_2SO_4.

State what oleum reacts with in **stage 4**.

..... [1]

(d) A sample of sulfuric acid, H_2SO_4, has a concentration of 0.75 mol / dm^3.

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

..... g / dm^3 [2]

[Total: 15]

6 **(a)** Ethane, propane and butane are members of the same homologous series.

(i) Name this homologous series.

..... [1]

(ii) State **two** ways members of the same homologous series are similar.

1 .....

2 .....
[2]

(b) One mole of ethane, C_2H_6, contains 6.02×10^{23} molecules.

Calculate how many molecules are in 15 g of ethane.

number of ethane molecules = ... [1]

(c) Propane reacts with chlorine.

(i) Write the formula of the product which does not contain carbon.

..... [1]

(ii) Draw the structure of an organic product formed. Show all of the atoms and all of the bonds.

[1]

(iii) State the name of this type of reaction.

..... [1]

(d) (i) Aqueous bromine was added to a sample of ethene.

Give the colour change seen.

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

(ii) Explain, in terms of bonding, why there is no colour change when aqueous bromine is added to ethane.

.....

..... [1]

(e) There are two structural isomers with the formula C_4H_{10}.

(i) Draw the structures of both of these isomers, showing all of the atoms and all of the bonds.

[2]

(ii) Butane is formed when longer chain hydrocarbons are cracked.

Complete the chemical equation to show the other product when butane is formed by cracking.

$$C_6H_{14} \rightarrow C_4H_{10} + ...$$ [1]

(f) A compound contains 85.7% carbon and 14.3% hydrogen by mass.

(i) Calculate the empirical formula of this compound.

Show your working.

..... [2]

(ii) The molecular mass of the compound is 112.

Calculate the molecular formula of this compound.

..... [1]

[Total: 16]

7 **(a)** Ethanol can be manufactured by two different methods.

Method 1: fermentation of a sugar, $C_6H_{12}O_6$

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

Method 2: reaction of ethene with steam

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(i) Give **one** advantage of using fermentation compared with Method 2.

.....

..... [1]

(ii) Give **one** disadvantage of using fermentation compared with Method 2.

.....

..... [1]

(b) Ethanol reacts with acidified potassium manganate(VII) to form water and a product that turns litmus red.

(i) State the name of the product that turns the litmus red.

..... [1]

(ii) State the type of reaction that ethanol undergoes when it reacts with acidified potassium manganate(VII).

..... [1]

(c) Ethanol reacts with methanoic acid to form an ester.

(i) Name the ester formed in this reaction.

..... [1]

(ii) Draw the structure of the ester formed.
Show all of the atoms and all of the bonds.

[1]

[Turn over

(d) The table shows the melting points of ethanol and sodium chloride.

substance	melting point / °C
ethanol	–114
sodium chloride	801

The difference in melting points is due to differences in attractive forces between particles in these substances.

Name the type of attractive force in each substance, which is responsible for the difference in melting points.

ethanol .....

sodium chloride .....
[2]

[Total: 8]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

[Turn over

PUBLISHED

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)(i)	hydrogen / carbon	**1**
1(a)(ii)	silicon	**1**
1(a)(iii)	aluminium	**1**
1(a)(iv)	iron	**1**
1(a)(v)	aluminium	**1**
1(a)(vi)	oxygen	**1**
1(b)(i)	metal higher in reactivity series / metal more reactive (than iron) / allow named metal e.g. magnesium or zinc (1) zinc corrodes/oxidises/reacts in preference to iron (1)	**2**
1(b)(ii)	any barrier method e.g. painting	**1**

Question	Answer	Marks
2(a)	zinc blende	**1**
2(b)(i)	$ZnO + C \rightarrow Zn + CO$ **or** $2ZnO + C \rightarrow 2Zn + CO_2$	**1**
2(b)(ii)	chemical change: reduction (1) explanation: oxygen is lost (1)	**2**
2(b)(iii)	aluminium is more reactive than carbon	**1**
2(b)(iv)	electrolysis	**1**

Question	Answer	Marks
2(c)	exists as layers (1) (alloy) contains different sized (copper) atoms (1) makes it more difficult for layers (of atoms) to slide over each slip/shift other (1)	**3**

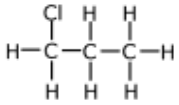
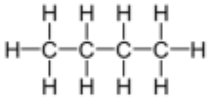
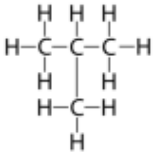
Question	Answer	Marks
3(a)(i)	$2 \rightarrow 2 + 2$	**1**
3(b)	75(%)	**1**
3(c)	test: (damp red) litmus paper (1) result: (litmus goes) blue (1)	**2**
3(d)(i)	diffusion	**1**
3(d)(ii)	particles move from an area of high to low concentration particles move randomly	**2**
3(d)(iii)	CO_2 **molecules** are heavier (than NH_3)	**1**
3(e)(i)	lower temperature: (rate of reaction) slower (1) higher pressure: expensive/specialist equipment	**2**
3(e)(ii)	catalyst	**1**
3(f)(i)	proton acceptor	**1**
3(f)(ii)	any value greater than 7 up to 12	**1**

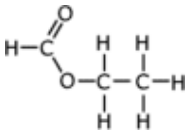
Question	Answer	Marks
4(a)	21	1
4(b)(i)	fractional (1) distillation (1)	2
4(b)(ii)	(different) boiling point	1
4(c)	2 double bonds (1) whole molecule correct (2 pairs of lone pairs on each O) (1)	2
4(d)	increase in (concentrations of) carbon dioxide (carbon dioxide is) greenhouse gas/greenhouse effect contributes to climate change/global warming	3
4(e)	photosynthesis	1

Question	Answer	Marks
5(a)(i)	breakdown by (the passage of) electricity (1) of an ionic compound in molten/aqueous (state) (1)	2
5(a)(ii)	they do not react	1
5(a)(iii)	negative electrode: hydrogen (gas) (1) positive electrode: oxygen (gas) (1)	2

Question	Answer	Marks
5(a)(iv)	$H^+ + e(^-)$ as the only species on the left (1) equation fully correct (1) $2H^+ + 2e(^-) \rightarrow H_2$ (scores 2)	**2**
5(b)(i)	$S + O_2 \rightarrow SO_2$	**1**
5(b)(ii)	rate of forward reaction is equal to rate of reverse reaction (1) constant concentration (of reactants and products) (1)	**2**
5(b)(iii)	exothermic / heat / energy is released / surroundings warm up products have lower energy than reactants / ORA	**2**
5(c)	water / H_2O	**1**
5(d)	(M_r =) 98 (0.75×98 =) 73.5	**2**

Question	Answer	Marks
6(a)(i)	alkanes	**1**
6(a)(ii)	one mark each for any two of: • same chemical properties • same functional group • same general formula • (consecutive members) differ by CH_2 • common (allow similar) methods of preparation • physical properties vary in predictable manner / show trends / gradually change OR example of a physical property variation i.e. melting point / boiling point / volatility (1)	**2**
6(b)	3.01×10^{23} (molecules)	**1**

Question	Answer	Marks
6(c)(i)	HC*l*	**1**
6(c)(ii)		**1**
6(c)(ii)	substitution	**1**
6(d)(i)	from: orange (1) to: colourless (1)	**2**
6(d)(ii)	contains no double bonds/ethane **only** contains single bonds	**1**
6(e)(i)	 (1)  (1)	**2**
6(e)(ii)	C_2H_4	**1**
6(f)(i)	(C = 85.7, H = 14.3, M_r 112) C = $\frac{85.7}{12}$ = 7.14 H = $\frac{14.3}{1}$ = 14.3 (1) (ratio = 7.13 : 14.3 = 1 : 2) CH_2 (2)	**2**
6(f)(ii)	C_8H_{16}	**1**

Question	Answer	Marks
7(a)(i)	sugar or $C_6H_{12}O_6$, is renewable / sustainable	**1**
7(a)(ii)	slow(er) process	**1**
7(b)(i)	ethanoic acid	**1**
7(b)(ii)	oxidation	**1**
7(c)(i)	ethyl methanoate	**1**
7(c)(ii)		**1**
7(d)	ethanol: (forces of attraction) between molecules (1) sodium chloride: (force of attraction) between positive and negative ions/ionic bonding (1)	**2**

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Topic & Sub-topic Index of Questions

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1	c	Atoms, elements and compounds	Ions and ionic bonds	136	152
1	d	The Periodic Table	Arrangement of elements	136	152
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Cambridge Assessment International Education

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7179838283

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

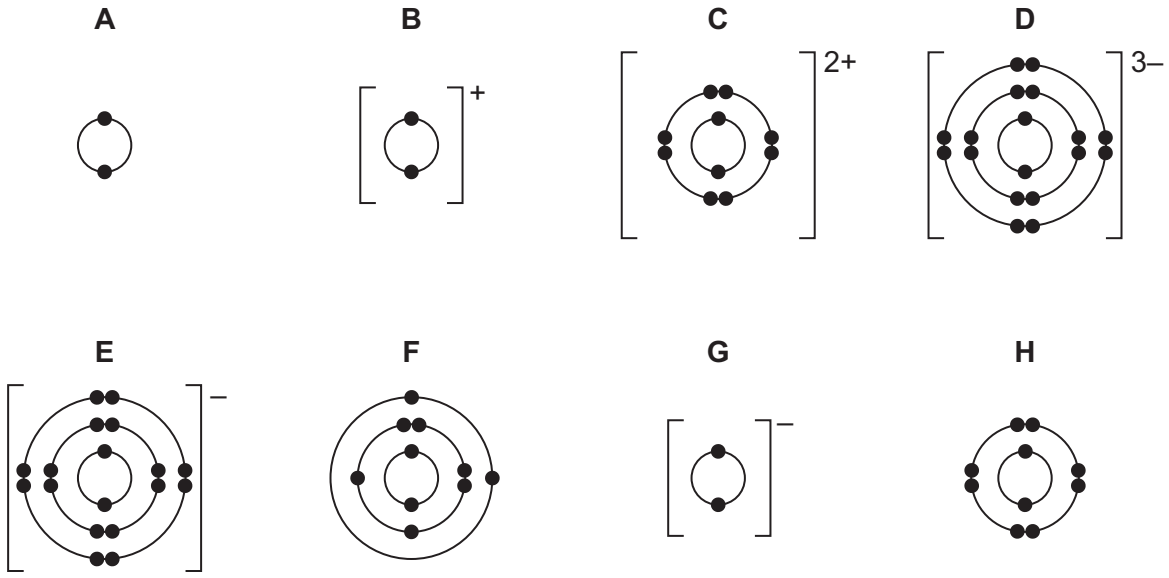
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction 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. Blank pages are indicated.

1 The electronic structures of some atoms and ions are shown.



(a) Write the letters, **A**, **B**, **C**, **D**, **E**, **F**, **G** or **H**, of the electronic structures which show:

(i) atoms of two different noble gases ..... and ..... [2]

(ii) an ion of a Group I element ..... [1]

(iii) an ion of a Group V element ..... [1]

(iv) a pair of ions that could form a compound with the formula XY_2. ..... and ..... [1]

(b) State which electronic structure, **A**, **B**, **C**, **D**, **E**, **F**, **G** or **H**, is incorrect.

Explain why.

incorrect electronic structure .....

explanation .....

..... [2]

(c) State how many protons are found in the nucleus of ion **C**. ..... [1]

(d) Use the Periodic Table to deduce:

(i) the chemical symbol for ion **G** ..... [1]

(ii) the element which forms an ion with a 3+ charge and the same electronic structure as **H**.

..... [1]

[Total: 10]

2 Soluble salts can be made by adding a metal carbonate to a dilute acid.

(a) Give the formula of the dilute acid which reacts with a metal carbonate to form a nitrate salt.

..... [1]

(b) A student wanted to make hydrated iron(II) sulfate crystals, $FeSO_4 \cdot xH_2O$, by adding excess iron(II) carbonate to dilute sulfuric acid. The student followed the procedure shown.

step 1 Add dilute sulfuric acid to a beaker.

step 2 Add small amounts of iron(II) carbonate to the dilute sulfuric acid in the beaker until the iron(II) carbonate is in excess.

step 3 Filter the mixture formed in **step 2**.

step 4 Heat the filtrate until it is a saturated solution. Allow to cool.

step 5 Once cold, pour away the remaining solution. Dry the crystals between filter papers.

(i) Why must the iron(II) carbonate be added in excess in **step 2**?

..... [1]

(ii) State **two** observations in **step 2** that would show that iron(II) carbonate was in excess.

1 .....

2 .....
[2]

(iii) Describe what should be done during **step 3** to ensure there is a maximum yield of crystals.

..... [1]

(iv) A saturated solution is formed in **step 4**.

Describe what a saturated solution is.

.....

..... [2]

(v) Name a different compound that could be used instead of iron(II) carbonate to produce hydrated iron(II) sulfate crystals from dilute sulfuric acid.

..... [1]

[Turn over

(c) On analysing the crystals, the student found that one mole of the hydrated iron(II) sulfate crystals, $FeSO_4 \bullet xH2O$, had a mass of 278 g.

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

- calculate the mass of one mole of $FeSO_4$

mass = ... g

- calculate the mass of H_2O present in one mole of $FeSO_4 \bullet xH_2O$

mass of H_2O = ... g

- determine the value of *x*.

x = ...
[3]

(d) Insoluble salts can be made by mixing solutions of two soluble salts.

A student followed the procedure shown to make silver bromide, an insoluble salt.

step 1 Add aqueous silver nitrate to a beaker. Then add aqueous potassium bromide and stir.

step 2 Filter the mixture formed in **step 1**.

step 3 Dry the residue.

(i) State the term used to describe this method of making salts.

..... [1]

(ii) Give the observation the student would make during **step 1**.

..... [1]

(iii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous potassium bromide.

Include state symbols.

..... [3]

(e) Sodium chloride is an ionic salt. It can be made by reacting sodium with chlorine gas.

The equation for this reaction is shown.

$$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$$

Calculate the volume of chlorine gas, in cm^3, that reacts to form 2.34 g of $NaCl$.

The reaction takes place at room temperature and pressure.

volume of chlorine gas = ... cm^3 [3]

(f) Sodium chloride does not conduct electricity when solid, but does conduct electricity when molten.

(i) Explain why, in terms of structure and bonding.

.....

.....

.....

..... [3]

(ii) Name the product formed at the positive electrode when electricity is passed through molten sodium chloride.

..... [1]

(iii) State the type of change that occurs at the positive electrode in **(ii)**.

Explain your answer in terms of electron transfer.

type of change .....

explanation .....
[2]

(iv) Describe what else can be done to sodium chloride to allow it to conduct electricity.

..... [1]

[Total: 26]

3 Group I metals are very reactive. Transition elements are also metals but are less reactive than Group I metals.

(a) State **two** physical properties of Group I metals which are similar to those of transition metals.

1 .....

2 .....
[2]

(b) Describe **two** ways in which the physical properties of Group I metals are different from those of transition metals.

1 .....

.....

2 .....

.....
[2]

(c) When Group I metals are added to water they fizz and an alkaline solution forms.

(i) Name the gas given off.

..... [1]

(ii) Identify the ion present in the solution which makes the solution alkaline.

..... [1]

(iii) Write the chemical equation for the reaction between sodium and water.

..... [2]

(d) When the transition element iron is added to water the iron rusts.

When an iron object is coated with a layer of zinc, rusting is prevented.

(i) Name this process of coating iron objects with a layer of zinc.

..... [1]

(ii) Explain how completely coating an iron object with a layer of zinc prevents rusting.

..... [1]

(iii) Rusting of iron ships can be prevented by attaching zinc blocks to the hull of the ship.

Explain how this prevents rusting.

.....

..... [2]

[Total: 12]

4 Alkenes and alkanes are homologous series of compounds containing carbon and hydrogen atoms.

(a) State the name of the type of compound made from carbon and hydrogen atoms only.

..... [1]

(b) Alkenes take part in addition reactions.

(i) Describe what is meant by the term *addition reaction*.

..... [1]

(ii) Draw the structure of the product made in the addition reaction between propene and bromine. Show all of the atoms and all of the bonds.

[2]

(iii) Describe the colour change seen when propene is added to aqueous bromine.

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

(iv) Draw the structures of molecules of **two** different alkenes which both undergo an addition reaction with steam to form butan-2-ol. Show all of the atoms and all of the bonds.

[2]

(c) Propane undergoes a substitution reaction with chlorine.

Write the chemical equation for the reaction between one molecule of propane and one molecule of chlorine.

..... [2]

[Total: 10]

[Turn over

5 This question is about alcohols, carboxylic acids and esters.

(a) Ethanol will react with hot aqueous potassium manganate(VII) to form ethanoic acid.

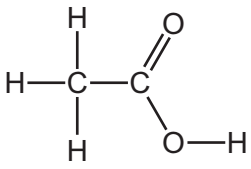
(i) State the other condition needed for this reaction to take place.

..... [1]

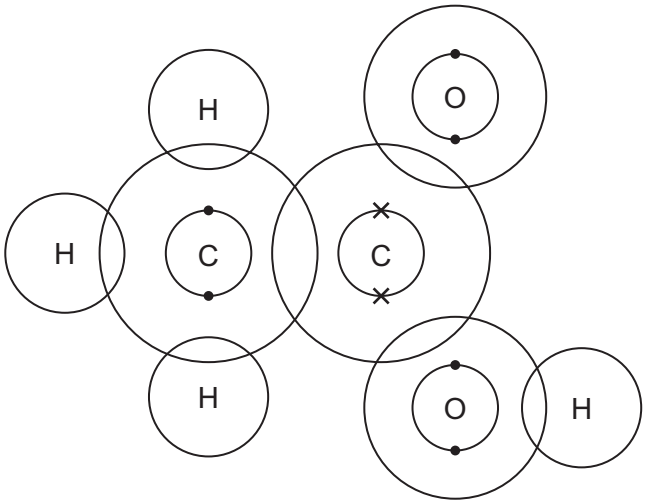
(ii) State the type of chemical change that happens to the ethanol during this reaction.

..... [1]

(iii) The structure of ethanoic acid is shown.



Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanoic acid.



[3]

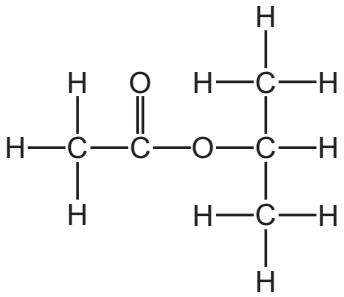
(b) Ethanoic acid is a weak acid and hydrochloric acid is a strong acid.

Complete the table to show the similarities and differences in the properties of samples of these two acids of equal concentration.

	dilute ethanoic acid	dilute hydrochloric acid
extent of dissociation		
colour after adding universal indicator solution		
observation when magnesium ribbon is added		

[6]

(c) Ethanoic acid will react with an alcohol to form the ester shown.



(i) Name the **other** product formed when ethanoic acid reacts with an alcohol to make this ester.

..... [1]

(ii) Give **one** condition needed when ethanoic acid reacts with the alcohol to make this ester.

..... [1]

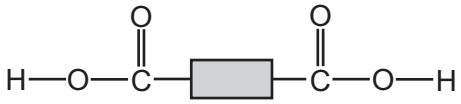
(iii) Draw the structure of the alcohol which was added to ethanoic acid to make this ester. Show all of the atoms and all of the bonds.

[2]

(d) Polyesters can be manufactured from carboxylic acids and alcohols.

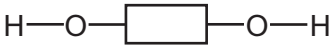
Hexanedioic acid has the structure: $HOOC–CH_2–CH_2–CH_2–CH_2–COOH$.

This structure can be simplified as shown.



Ethanediol has the structure: $HO–CH_2–CH_2–OH$.

This structure can be simplified as shown.



The functional groups are found at the end of each molecule.

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

..... [1]

(ii) Determine the empirical formula of hexanedioic acid.

..... [1]

(iii) Calculate the percentage by mass of oxygen present in ethanediol.

Give your answer to the nearest whole number.

..... % [2]

(iv) Complete the diagram to show a section of polyester manufactured from hexanedioic acid and ethanediol. Include all of the atoms and all of the bonds in the linkages.

[2]

(v) State the name of a polyester.

..... [1]

[Total: 22]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

[Turn over

PUBLISHED

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.

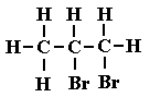
Question	Answer	Marks
1(a)(i)	A (1) H (1)	**2**
1(a)(ii)	B	**1**
1(a)(iii)	D	**1**
1(a)(iv	C **and** G **OR** C **and** E	**1**
1(b)	F (1) third / outer shell is being filled before second shell is full; second shell has 6 electrons: it should have 8 electrons (1)	**2**
1(c)	12	**1**
1(d)(i)	H^-	**1**
1(d)(ii)	aluminium / Al	**1**

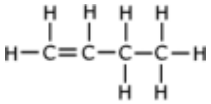
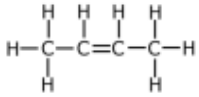
Question	Answer	Marks
2(a)	HNO_3	**1**
2(b)(i)	to make sure all the (sulfuric) acid reacts	**1**
2(b)(ii)	no (more) fizzing (1) ($FeCO_3$) stops dissolving or a solid remains / is visible (in the mixture) (1)	**2**
2(b)(iii)	rinse the residue (with distilled water)	**1**
2(b)(iv	a solution that can dissolve no more solute (1) at the specified temperature (1)	**2**
2(b)(v)	iron(II) oxide / iron(II) hydroxide	**1**

Question	Answer	Marks
2(c)	mass of $FeSO_4$ = 152 (1) mass of H_2O = 278 – 152 = 126 (1) mol of H_2O = 126 / 18 **and** x = 7 (1)	**3**
2(d)(i)	precipitation	**1**
2(d)(ii)	cream precipitate	**1**
2(d)(iii)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ AgBr (as only product) (1) Ag^+ and Br^- (as reactants)(1) state symbols(1)	**3**
2(e)	M1 mol of $NaCl$ = 2.34 / 58.5 = 0.04(00) M2 mol of Cl_2 = M1/2 = 0.04(00)/2 = 0.02(00) M3 0.02(00) × 24000 = 480 (cm^3)	**3**
2(f)(i)	ions (1) (ions) are fixed (in a lattice) (1) ions are mobile (1)	**3**
2(f)(ii)	chlorine	**1**
2(f)(iii)	oxidation (1) electrons are lost (1)	**2**
2(f)(iv)	dissolve it (in water)	**1**

Question	Answer	Marks
3(a)	any **two** from: • shiny / lustrous • conduct electricity • conduct heat	**2**

Question	Answer	Marks
3(b)	low(er) density (1) low(er) melting points (1)	**2**
3(c)(i)	hydrogen	**1**
3(c)(ii)	hydroxide / OH^-	**1**
3(c)(iii)	$2Na + 2H_2O \rightarrow 2NaOH + H_2$ NaOH (as a product) (1) rest of equation (1)	**2**
3(d)(i)	galvanising	**1**
3(d)(ii)	prevents water or / and oxygen reaching iron	**1**
3(d)(iii)	zinc more reactive (than iron) (1) zinc corrodes / oxidises / reacts in preference to iron (1)	**2**

Question	Answer	Marks
4(a)	hydrocarbon	**1**
4(b)(i)	(only) one product is formed	**1**
4(b)(ii)	 3 single bonded C atoms entire molecule correct	**2**
4(b)(iii)	orange (1) to colourless (1)	**2**

Question	Answer	Marks
4(b)(iv	structure of but-1-ene  structure of but-2-ene 	**2**
4(c)	$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$ HCl as product rest of equation	**2**

Question	Answer	Marks
5(a)(i)	presence of an acid	**1**
5(a)(ii)	oxidation	**1**
5(a)(iii)	all single bonding dot and cross pairs correct (1) double C=O bond dot and cross pairs are correct (1) Complete diagram is correct (1)	**3**
5(b)	partial (dissociation) (1) full / 100% (dissociation) (1) both acid colours (1) HCl indicating a lower pH acid colour than CH_3COOH (1) fizzing **OR** dissolving / disappearing in both (1) either observation happens quicker with HCl (1)	**6**

Question	Answer	Marks
5(c)(i)	water	**1**
5(c)(ii)	acid (catalyst)	**1**
5(c)(iii)	any one alcohol group on a molecule (1) structure of propan-2-ol (1)	**2**
5(d)(i)	the atoms / group of atoms which give (any molecule its) **chemical** properties	**1**
5(d)(ii)	$C_3H_5O_2$	**1**
5(d)(iii)	M_r of HO–CH_2–CH_2–OH = 62 (1) %ge = 100 × 32/62 = 52% (1)	**2**
5(d)(iv)	any correct ester link between any two blocks showing all atoms and all bonds (1)  correct orientation of 3 inter-block ester links and continuation bonds (1)	**2**
5(d)(v)	Terylene	**1**

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Topic & Sub-topic Index of Questions

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2020**

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. Blank pages are indicated.

1 The names of nine substances are shown.

aluminium oxide

ammonia

carbon monoxide

anhydrous cobalt(II) chloride

hydrated copper(II) sulfate

iron(III) oxide

nitrogen dioxide

silver

steel

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

Name the substance that is:

(a) the main constituent of hematite ..... [1]

(b) a gas produced in car engines which causes acid rain ..... [1]

(c) an alkaline gas ..... [1]

(d) an element ..... [1]

(e) a gas formed by the incomplete combustion of fossil fuels ..... [1]

(f) used to test for the presence of water. ..... [1]

[Total: 6]

2 The table gives information about five particles, **A**, **B**, **C**, **D** and **E**.

particle	number of electrons	number of neutrons	number of protons
A	10	13	11
B	18	20	18
C	18	18	18
D	10	12	8
E	10	10	10

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

..... [1]

(b) State the nucleon number of **B**.

..... [1]

(c) Write the electronic structure of **C**.

..... [1]

(d) Give the letters of all the particles which are:

(i) atoms ..... [1]

(ii) positive ions ..... [1]

(iii) negative ions ..... [1]

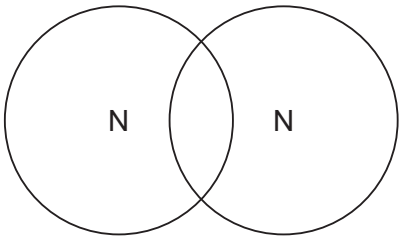
(iv) isotopes of each other. ..... [1]

[Total: 7]

[Turn over

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

(a) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of nitrogen, N_2.
Show the outer shell electrons only.



[2]

(b) Nitrogen can be converted into ammonia by the Haber process.

(i) Describe how nitrogen is obtained for the Haber process.

.....

..... [2]

(ii) Give the essential reaction conditions and write a chemical equation for the reaction occurring in the Haber process.

chemical equation: .....

.....

reaction conditions: .....

.....

.....

.....

.....
[5]

(c) Some of the ammonia made by the Haber process is converted into nitric acid.

The first stage of this process is the oxidation of ammonia to make nitrogen monoxide.

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

The process is carried out at 900 °C and a pressure of 5 atmospheres using an alloy of platinum and rhodium as a catalyst.

The forward reaction is exothermic.

(i) State the meaning of the term *catalyst*.

.....

..... [2]

(ii) State the meaning of the term *oxidation*.

..... [1]

(iii) Complete the table using the words **increase**, **decrease** or **no change**.

	effect on the rate of the forward reaction	effect on the equilibrium yield of NO(g)
increasing the temperature		
increasing the pressure		

[4]

(d) Nitrogen monoxide, NO, is converted into nitrogen dioxide, NO_2.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The nitrogen dioxide reacts with oxygen and water to produce nitric acid as the only product.

Write a chemical equation for this reaction.

..... [2]

[Turn over

(e) Ammonium nitrate, NH_4NO_3, is a fertiliser.

Calculate the percentage by mass of nitrogen in ammonium nitrate.

..... % [2]

[Total: 20]

4 Zinc is manufactured from zinc blende. Zinc blende is an ore which consists mainly of zinc sulfide, ZnS.

(a) Zinc blende is roasted in air. One of the products is zinc oxide.

Name the **other** product formed in this reaction.

..... [1]

(b) Zinc oxide is then converted into zinc.

Zinc oxide and coke, a source of carbon, are heated in a furnace. Hot air is blown into the furnace.

(i) Give **two** reasons why coke is needed.

1 .....

2 .....
[2]

(ii) Write a chemical equation for the formation of zinc in the furnace.

..... [1]

(iii) Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is 1200 °C.

Explain how this information shows that the zinc produced inside the furnace is a gas.

..... [1]

(iv) The gaseous zinc is converted to molten zinc.

Name this change of state.

..... [1]

[Turn over

(c) Zinc reacts with dilute sulfuric acid to produce aqueous zinc sulfate.

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

Hydrated zinc sulfate crystals are made from aqueous zinc sulfate.

Step 1 Solid zinc is added to dilute sulfuric acid until zinc is in excess.

Step 2 Excess zinc is separated from aqueous zinc sulfate by filtration.

Step 3 Aqueous zinc sulfate is heated until the solution is saturated.

Step 4 The saturated solution is allowed to cool and crystallise.

Step 5 The crystals are removed and dried.

(i) Name the residue in **step 2**.

..... [1]

(ii) In **step 3**, a saturated solution is produced.

Describe what a saturated solution is.

.....

.....

..... [2]

(iii) Name **two** compounds each of which react with dilute sulfuric acid to produce aqueous zinc sulfate.

1 .....

2 .....
[2]

(d) When hydrated magnesium sulfate crystals, $MgSO_4 \bullet xH_2O$, are heated they give off water.

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

A student carries out an experiment to determine the value of x in $MgSO_4 \bullet xH_2O$.

Step 1 Hydrated magnesium sulfate crystals were weighed.

Step 2 Hydrated magnesium sulfate crystals were heated.

Step 3 The remaining solid was weighed.

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

.....

.....

..... [2]

(ii) In an experiment, all the water was removed from 1.23 g of $MgSO_4 \bullet xH_2O$. The mass of $MgSO_4$ remaining was 0.60 g.

M_r: $MgSO_4$ = 120; M_r: H_2O = 18

Determine the value of x using the following steps.

- Calculate the number of moles of $MgSO_4$ remaining.

moles of $MgSO_4$ = ...

- Calculate the mass of H_2O given off.

mass of H_2O = ... g

- Calculate the moles of H_2O given off.

moles of H_2O = ...

- Determine the value of x.

x = ...
[4]

[Total: 17]

5 Group I elements, Group VII elements and transition elements are found in different parts of the Periodic Table.

(a) Describe the trend in the reactivity of Group I elements.

.....

..... [1]

(b) When potassium is added to water a chemical reaction occurs.

(i) State **two** observations that can be made when potassium is added to water.

.....

..... [2]

(ii) Write a chemical equation for the reaction of potassium with water.

..... [2]

(c) Excess aqueous potassium iodide is added to chlorine.

(i) Write a chemical equation for the reaction that occurs when aqueous potassium iodide is added to chlorine.

..... [2]

(ii) State the final colour of the reaction mixture.

..... [1]

(d) Sodium is extracted from sodium chloride by electrolysis.

(i) State the meaning of the term *electrolysis*.

.....

..... [2]

(ii) State what must be done to sodium chloride before it can be electrolysed to produce sodium.

..... [1]

(iii) Write an ionic half-equation for the change that occurs at the cathode during this electrolysis.

..... [1]

(e) Chromium is a transition element.

- Chromium has a high melting point.
- Chromium is a good conductor of electricity.
- Many chromium compounds are soluble in water.
- Hydrated chromium(III) sulfate is green.
- Chromium forms the chlorides $CrCl_2$ and $CrCl_3$.
- Oxides of chromium act as catalysts in the manufacture of poly(ethene).

(i) Use this information to give **two** properties of chromium which are different from properties of Group I elements such as sodium.

1 .....

2 .....
[2]

(ii) Use this information to give **two** properties of chromium which are similar to properties of Group I elements such as sodium.

1 .....

2 .....
[2]

[Total: 16]

6 **(a)** A carboxylic acid and an ester are structural isomers.

(i) State the meaning of the term *structural isomers*.

.....

.....

..... [2]

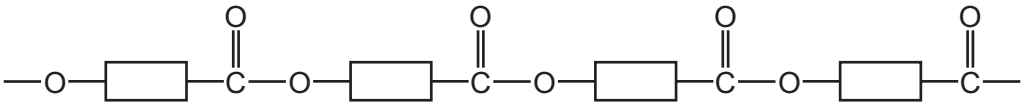
(ii) Draw the structures of the carboxylic acid and the ester which both contain two carbon atoms.
Show all of the atoms and all of the bonds.

Name the carboxylic acid and the ester.

carboxylic acid	ester
name	name .....

[4]

(b) Part of a polyester chain is shown. This polyester is made from one monomer.

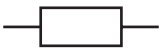


(i) **On the diagram** draw a ring around one unit of the polymer that is repeated. [1]

(ii) Name the type of polymerisation that produces polyesters.

..... [1]

(iii) Complete the diagram to show the structure of the monomer used to produce this polyester.
Show all of the atoms and all of the bonds in the functional groups.



[2]

(c) A polyamide is made from the two monomers shown.

Complete the diagram to show a section of the polyamide made from the two monomers.
Show all of the atoms and all of the bonds in the linkages.

[2]

(d) Naturally occurring polyamides are constituents of food.

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

..... [1]

(ii) Name the monomers which form naturally occurring polyamides.

..... [1]

[Total: 14]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2020**

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 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

PUBLISHED

Generic Marking Principles

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

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

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

GENERIC MARKING PRINCIPLE 2:

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

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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

GENERIC MARKING PRINCIPLE 4:

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

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

Science-Specific Marking Principles

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

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

Question	Answer	Marks
1(a)	iron(III) oxide	**1**
1(b)	nitrogen dioxide	**1**
1(c)	ammonia	**1**
1(d)	silver	**1**
1(e)	carbon monoxide	**1**
1(f)	anhydrous cobalt(II) chloride	**1**

Question	Answer	Marks
2(a)	11	**1**
2(b)	38	**1**
2(c)	2,8,8	**1**
2(d)(i)	B, C and E	**1**
2(d)(ii)	A	**1**
2(d)(iii)	D	**1**
2(d)(iv)	B and C	**1**

Question	Answer	Marks
3(a)	triple bond (1) diagram completely correct (1)	**2**
3(b)(i)	**METHOD 1** **liquid** air (1) **fractional** distillation (1) **METHOD 2** hydrogen burns in **air** (to remove the oxygen and then scrub out the carbon dioxide)	**2**
3(b)(ii)	(pressure) 200 atmospheres (1) (temperature) 450 °C (1) iron **catalyst** (1) $N_2 + 3H_2 \rightarrow 2NH_3$ (1) equilibrium / reversible (1)	**5**
3(c)(i)	substance that speeds up a reaction / increases rate (1) unchanged (chemically) at the end **OR** not used **up** **OR** lowers activation energy (1)	**2**
3(c)(ii)	gain of oxygen / loss of hydrogen / electron loss / increase in oxidation state (oxidation number)	**1**

Question	Answer	Marks
3(c)(iii)	<table><tr><th>effect on the rate of the forward reaction</th><th>effect on the equilibrium yield of NO(g)</th></tr><tr><td>increase (1)</td><td>decrease (1)</td></tr><tr><td>increase (1)</td><td>decrease (1)</td></tr></table>	**4**
3(d)	$4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$ all formulae (1) equation fully correct(1)	**2**
3(e)	(M_r of NH_4NO_3 =) 80 (1) 35% (1)	**2**

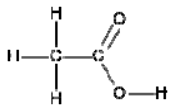
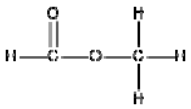
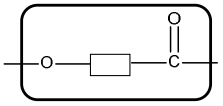
Question	Answer	Marks
4(a)	sulfur dioxide	**1**
4(b)(i)	**Any two from** (coke) • releases heat **or** releases energy(when it reacts with oxygen or burns in air) / (acts as a) fuel / increases temperature (in the furnace) / heats (the furnace) / source of energy (coke) • reduces zinc oxide / is a reducing agent / converts zinc oxide to zinc / removes oxygen from zinc oxide (coke) • (reacts with oxygen) to produce carbon monoxide / reacts with carbon dioxide to form carbon monoxide • carbon monoxide reduces zinc oxide / converts zinc oxide to zinc / removes oxygen from zinc oxide	**2**

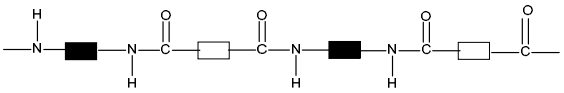
Question	Answer	Marks
4(b)(ii)	$ZnO + CO \rightarrow Zn + CO_2$ **OR** $2ZnO + C \rightarrow 2Zn + CO_2$ **OR** $ZnO + C \rightarrow Zn + CO$	**1**
4(b)(iii)	temperature inside furnace is above / higher than 907 (°C) **OR** temperature is above / higher than the boiling point (of zinc) **ORA** **OR** 1200 (°C) is above / higher than the boiling point (of zinc) **ORA** **OR** 1200 (°C) is above / higher than 907 (°C) **ORA**	**1**
4(b)(iv)	condensation / condensing	**1**
4(c)(i)	zinc	**1**
4(c)(ii)	(a solution containing the) **maximum** amount of solute **dissolved** / **no more** solute can **dissolve** (1) at a given temperature (1)	**2**
4(c)(iii)	one mark for each of any two from: • zinc oxide • zinc hydroxide • zinc carbonate	**2**
4(d)(i)	**heat** again and **weigh** again / repeat steps 2 and 3 (1) until **mass** is **constant** (1)	**2**

Question	Answer	Marks
4(d)(ii)	(moles of $MgSO_4$ =) $0.005 / 5 \times 10^{-3}$ (1) mass of water = 0.63 g (1) moles of water = $0.63 \div 18 = 0.035 / 3.5 \times 10^{-2}$ (1) (x = $0.035 \div 0.005$) = 7 (1)	**4**

Question	Answer	Marks
5(a)	become more reactive down the group **ORA** (1)	**1**
5(b)(i)	one mark each for **any two** of: • floats • dissolves / disappears / melts • moves • bubbles / fizzes / effervesces • lilac flame	**2**
5(b)(ii)	$2K + 2H_2O \rightarrow 2KOH + H_2$ all formulae (1) equation fully correct (1)	**2**
5(c)(i)	$Cl_2 + 2KI \rightarrow 2KCl + I_2$ **OR** $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ all formulae (1) equation fully correct (1)	**2**
5(c)(ii)	brown / black	**1**
5(d)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten or aqueous** (state) (1)	**2**

Question	Answer	Marks
5(d)(ii)	heat until it melts / heat to or above melting point	**1**
5(d)(iii)	$Na^+ + e \rightarrow Na$	**1**
5(e)(i)	one mark for each of any two from: • (chromium has) high melting point **ORA** • (chromium forms) coloured ions / coloured compounds **ORA** • (chromium has) variable valency / variable oxidation state / variable oxidation number **ORA** • catalytic behaviour **ORA** **ORA ALLOW** group 1 **or** sodium **if stated** • no colour **or** white **or** colourless ions or compounds • fixed valency / +1 charge **only or one** oxidation state / forms **one** chloride • low melting point • doesn't behave as a catalyst	**2**
5(e)(ii)	one mark for each of any two from: • (chromium / sodium) **conducts** electricity • (chromium / sodium) compounds are **soluble** (in water) • (chromium / sodium) form hydrated salts / form hydrated compounds	**2**

Question	Answer	Marks
6(a)(i)	compounds with the same molecular formula (1) different structural formula (1)	**2**
6(a)(ii)	  diagram (1) diagram (1) ethanoic **acid** (1) methyl methanoate (1)	**4**
6(b)(i)		**1**
6(b)(ii)	condensation	**1**
6(b)(iii)	 1 for each correct functional group	**2**

Question	Answer	Marks
6(c)	 one correct linkage fully displayed (1) the whole structure fully correct (1)	**2**
6(d)(i)	proteins	**1**
6(d)(ii)	amino acids	**1**

A Topical Questions Tracker

A.1 States of matter

A.1.1 Solids, liquids and gases

0620_s20_qp_43 Question: 5 a QP Page: 87 MS Page: 102
0620_s20_qp_43 Question: 5 b QP Page: 87 MS Page: 102

A.1.2 Diffusion

0620_s20_qp_43 Question: 5 c QP Page: 87 MS Page: 102
0620_w20_qp_41 Question: 3 d QP Page: 110 MS Page: 132

A.2 Atoms, elements and compounds

A.2.1 Elements, compounds and mixtures

0620_w20_qp_43 Question: 1 d QP Page: 162 MS Page: 182

A.2.2 Atomic structure and the Periodic Table

0620_m20_qp_42 Question: 3 a QP Page: 10 MS Page: 23
0620_m20_qp_42 Question: 3 b QP Page: 10 MS Page: 23
0620_s20_qp_42 Question: 2 b QP Page: 54 MS Page: 73
0620_w20_qp_41 Question: 4 c QP Page: 112 MS Page: 133
0620_w20_qp_42 Question: 1 b QP Page: 139 MS Page: 155
0620_w20_qp_43 Question: 3 a QP Page: 164 MS Page: 183

A.2.3 Isotopes

0620_s20_qp_43 Question: 3 a QP Page: 84 MS Page: 100

A.2.4 Ions and ionic bonds

0620_m20_qp_42 Question: 3 f QP Page: 12 MS Page: 25
0620_s20_qp_42 Question: 2 a QP Page: 53 MS Page: 72
0620_s20_qp_42 Question: 2 c QP Page: 54 MS Page: 73
0620_w20_qp_42 Question: 1 a QP Page: 139 MS Page: 155
0620_w20_qp_42 Question: 1 c QP Page: 139 MS Page: 155
0620_w20_qp_43 Question: 2 d QP Page: 163 MS Page: 182

A.2.5 Simple molecules and covalent bonds

0620_m20_qp_42 Question: 3 c QP Page: 10 MS Page: 24

A.2.6 Metallic bonding

0620_s20_qp_41 Question: 2 a QP Page: 31 MS Page: 46

A.3 Stoichiometry

A.3.1 Formulae

0620_m20_qp_42 Question: 4 d QP Page: 13 MS Page: 25
0620_s20_qp_41 Question: 1 a QP Page: 29 MS Page: 45
0620_s20_qp_41 Question: 2 b QP Page: 31 MS Page: 46
0620_s20_qp_42 Question: 3 d QP Page: 56 MS Page: 73
0620_s20_qp_42 Question: 4 e QP Page: 58 MS Page: 74
0620_w20_qp_41 Question: 6 f QP Page: 119 MS Page: 135
0620_w20_qp_43 Question: 3 d QP Page: 165 MS Page: 184

A.3.2 The mole and the Avogadro constant

0620_m20_qp_42 Question: 3 e QP Page: 12 MS Page: 24
0620_s20_qp_41 Question: 1 b QP Page: 29 MS Page: 45
0620_s20_qp_42 Question: 4 d QP Page: 58 MS Page: 74
0620_w20_qp_41 Question: 3 a QP Page: 110 MS Page: 132
0620_w20_qp_41 Question: 3 b QP Page: 110 MS Page: 132
0620_w20_qp_41 Question: 6 b QP Page: 117 MS Page: 134
0620_w20_qp_42 Question: 2 c QP Page: 141 MS Page: 156

A.4 Electrochemistry

A.4.1 Electrolysis

0620_s20_qp_42 Question: 4 f QP Page: 58 MS Page: 74
0620_s20_qp_42 Question: 5 a QP Page: 59 MS Page: 74
0620_s20_qp_42 Question: 5 b QP Page: 59 MS Page: 74
0620_s20_qp_42 Question: 5 c QP Page: 59 MS Page: 74
0620_s20_qp_42 Question: 5 d QP Page: 59 MS Page: 75
0620_s20_qp_42 Question: 5 e QP Page: 59 MS Page: 75
0620_s20_qp_43 Question: 7 a QP Page: 89 MS Page: 102
0620_w20_qp_41 Question: 5 a QP Page: 114 MS Page: 133
0620_w20_qp_43 Question: 5 d QP Page: 170 MS Page: 186

A.5 Chemical energetics

A.5.1 Exothermic and endothermic reactions

0620_s20_qp_43 Question: 2 e QP Page: 83 MS Page: 100
0620_s20_qp_43 Question: 3 d QP Page: 85 MS Page: 101

A.6 Chemical reactions

A.6.1 Rate of reaction

0620_s20_qp_42 Question: 4 a QP Page: 57 MS Page: 74
0620_s20_qp_42 Question: 4 b QP Page: 57 MS Page: 74
0620_s20_qp_42 Question: 4 c QP Page: 57 MS Page: 74

A.6.2 Reversible reactions and equilibrium

0620_m20_qp_42 Question: 3 d QP Page: 11 MS Page: 24
0620_m20_qp_42 Question: 4 a QP Page: 13 MS Page: 25

0620_s20_qp_41 Question: 3 b QP Page: 32 MS Page: 46
0620_s20_qp_42 Question: 3 b QP Page: 55 MS Page: 73
0620_s20_qp_42 Question: 3 c QP Page: 55 MS Page: 73
0620_s20_qp_43 Question: 2 a QP Page: 81 MS Page: 99
0620_s20_qp_43 Question: 2 b QP Page: 81 MS Page: 99
0620_s20_qp_43 Question: 2 c QP Page: 81 MS Page: 100
0620_w20_qp_41 Question: 3 e QP Page: 111 MS Page: 132
0620_w20_qp_41 Question: 5 b QP Page: 115 MS Page: 134
0620_w20_qp_41 Question: 5 c QP Page: 116 MS Page: 134
0620_w20_qp_41 Question: 5 d QP Page: 116 MS Page: 134
0620_w20_qp_43 Question: 1 c QP Page: 162 MS Page: 182
0620_w20_qp_43 Question: 3 b QP Page: 164 MS Page: 183

A.6.3 Redox

0620_m20_qp_42 Question: 4 c QP Page: 13 MS Page: 25
0620_w20_qp_43 Question: 3 c QP Page: 165 MS Page: 183
0620_w20_qp_43 Question: 5 c QP Page: 170 MS Page: 186

A.7 Acids, bases and salts

A.7.1 The characteristic properties of acids and bases

0620_s20_qp_41 Question: 4 c QP Page: 35 MS Page: 48
0620_s20_qp_43 Question: 1 b QP Page: 80 MS Page: 99
0620_w20_qp_41 Question: 3 f QP Page: 111 MS Page: 132

A.7.2 Oxides

0620_s20_qp_42 Question: 3 a QP Page: 55 MS Page: 73

A.7.3 Preparation of salts

0620_s20_qp_42 Question: 3 f QP Page: 56 MS Page: 73
0620_s20_qp_42 Question: 3 g QP Page: 56 MS Page: 73
0620_w20_qp_42 Question: 2 a QP Page: 140 MS Page: 155
0620_w20_qp_42 Question: 2 d QP Page: 141 MS Page: 156
0620_w20_qp_42 Question: 2 e QP Page: 142 MS Page: 156

A.8 The Periodic Table

A.8.1 Arrangement of elements

0620_w20_qp_42 Question: 1 d QP Page: 139 MS Page: 155
0620_w20_qp_43 Question: 2 a QP Page: 163 MS Page: 182
0620_w20_qp_43 Question: 2 b QP Page: 163 MS Page: 182
0620_w20_qp_43 Question: 2 c QP Page: 163 MS Page: 182
0620_w20_qp_43 Question: 5 a QP Page: 170 MS Page: 186

A.8.2 Group VII properties

0620_s20_qp_43 Question: 3 b QP Page: 84 MS Page: 100

A.8.3 Transition elements

0620_w20_qp_42 Question: 3 a QP Page: 143 MS Page: 156
0620_w20_qp_42 Question: 3 b QP Page: 143 MS Page: 157
0620_w20_qp_43 Question: 5 e QP Page: 171 MS Page: 187

A.9 Metals

A.9.1 Uses of metals

0620_s20_qp_43 Question: 7 d QP Page: 89 MS Page: 103

A.9.2 Alloys and their properties

0620_w20_qp_41 Question: 2 c QP Page: 109 MS Page: 132

A.9.3 Reactivity series

0620_s20_qp_43 Question: 3 c QP Page: 84 MS Page: 101
0620_w20_qp_41 Question: 2 b QP Page: 109 MS Page: 131
0620_w20_qp_42 Question: 3 c QP Page: 143 MS Page: 157

A.9.4 Corrosion of metals

0620_w20_qp_41 Question: 1 b QP Page: 108 MS Page: 131
0620_w20_qp_42 Question: 3 d QP Page: 143 MS Page: 157

A.9.5 Extraction of metals

0620_m20_qp_42 Question: 2 a QP Page: 8 MS Page: 22
0620_m20_qp_42 Question: 2 b QP Page: 8 MS Page: 22
0620_m20_qp_42 Question: 2 c QP Page: 9 MS Page: 23
0620_s20_qp_41 Question: 2 c QP Page: 31 MS Page: 46
0620_s20_qp_41 Question: 3 a QP Page: 32 MS Page: 46
0620_s20_qp_43 Question: 6 a QP Page: 88 MS Page: 102
0620_s20_qp_43 Question: 7 b QP Page: 89 MS Page: 102
0620_s20_qp_43 Question: 7 c QP Page: 89 MS Page: 102
0620_s20_qp_43 Question: 7 e QP Page: 90 MS Page: 103
0620_w20_qp_41 Question: 2 a QP Page: 109 MS Page: 131
0620_w20_qp_43 Question: 1 a QP Page: 162 MS Page: 182
0620_w20_qp_43 Question: 4 a QP Page: 167 MS Page: 184

A.10 Chemistry of the environment

A.10.1 Water

0620_s20_qp_41 Question: 3 c QP Page: 33 MS Page: 47
0620_s20_qp_43 Question: 4 a QP Page: 86 MS Page: 101
0620_s20_qp_43 Question: 4 b QP Page: 86 MS Page: 101
0620_w20_qp_43 Question: 1 f QP Page: 162 MS Page: 182

A.10.2 Fertilisers

0620_w20_qp_43 Question: 3 e QP Page: 166 MS Page: 184

A.10.3 Air quality and climate

0620_s20_qp_42 Question: 1 b QP Page: 52 MS Page: 72
0620_s20_qp_43 Question: 2 d QP Page: 82 MS Page: 100
0620_w20_qp_41 Question: 4 a QP Page: 112 MS Page: 133
0620_w20_qp_41 Question: 4 b QP Page: 112 MS Page: 133
0620_w20_qp_41 Question: 4 d QP Page: 113 MS Page: 133
0620_w20_qp_41 Question: 4 e QP Page: 113 MS Page: 133
0620_w20_qp_43 Question: 1 b QP Page: 162 MS Page: 182

A.11 Organic chemistry

A.11.1 Formulae, functional groups and terminology

0620_s20_qp_41 Question: 5 e QP Page: 37 MS Page: 49
0620_s20_qp_41 Question: 5 f QP Page: 38 MS Page: 49
0620_w20_qp_42 Question: 4 a QP Page: 144 MS Page: 157

A.11.2 Naming organic compounds

0620_s20_qp_41 Question: 5 d QP Page: 37 MS Page: 49
0620_w20_qp_41 Question: 6 a QP Page: 117 MS Page: 134

A.11.3 Fuels

0620_m20_qp_42 Question: 1 a QP Page: 6 MS Page: 22
0620_m20_qp_42 Question: 1 b QP Page: 6 MS Page: 22
0620_m20_qp_42 Question: 1 c QP Page: 6 MS Page: 22
0620_m20_qp_42 Question: 1 d QP Page: 7 MS Page: 22
0620_m20_qp_42 Question: 1 e QP Page: 7 MS Page: 22
0620_w20_qp_41 Question: 1 a QP Page: 107 MS Page: 131
0620_w20_qp_41 Question: 6 e QP Page: 118 MS Page: 135
0620_w20_qp_43 Question: 1 e QP Page: 162 MS Page: 182

A.11.4 Alkanes

0620_s20_qp_42 Question: 6 a QP Page: 60 MS Page: 75
0620_w20_qp_41 Question: 6 c QP Page: 117 MS Page: 135
0620_w20_qp_42 Question: 4 c QP Page: 144 MS Page: 158

A.11.5 Alkenes

0620_s20_qp_42 Question: 6 b QP Page: 60 MS Page: 75
0620_w20_qp_41 Question: 6 d QP Page: 118 MS Page: 135

A.11.6 Alcohols

0620_s20_qp_41 Question: 3 d QP Page: 33 MS Page: 47
0620_s20_qp_41 Question: 5 a QP Page: 36 MS Page: 48
0620_w20_qp_41 Question: 7 a QP Page: 120 MS Page: 136
0620_w20_qp_41 Question: 7 d QP Page: 121 MS Page: 136
0620_w20_qp_42 Question: 4 b QP Page: 144 MS Page: 157

A.11.7 Carboxylic acids

0620_s20_qp_41 Question: 5 b QP Page: 36 MS Page: 49
0620_s20_qp_43 Question: 1 a QP Page: 79 MS Page: 99
0620_w20_qp_41 Question: 7 b QP Page: 120 MS Page: 136
0620_w20_qp_41 Question: 7 c QP Page: 120 MS Page: 136
0620_w20_qp_42 Question: 5 a QP Page: 145 MS Page: 158
0620_w20_qp_42 Question: 5 b QP Page: 146 MS Page: 158
0620_w20_qp_42 Question: 5 c QP Page: 146 MS Page: 159
0620_w20_qp_43 Question: 6 a QP Page: 172 MS Page: 188

A.11.8 Polymers

0620_m20_qp_42 Question: 5 a QP Page: 14 MS Page: 26
0620_m20_qp_42 Question: 5 b QP Page: 14 MS Page: 26
0620_m20_qp_42 Question: 5 c QP Page: 15 MS Page: 26
0620_s20_qp_43 Question: 8 a QP Page: 91 MS Page: 103
0620_s20_qp_43 Question: 8 b QP Page: 91 MS Page: 104
0620_s20_qp_43 Question: 8 c QP Page: 91 MS Page: 104
0620_w20_qp_42 Question: 5 d QP Page: 147 MS Page: 159
0620_w20_qp_43 Question: 4 b QP Page: 167 MS Page: 184
0620_w20_qp_43 Question: 6 b QP Page: 173 MS Page: 188
0620_w20_qp_43 Question: 6 c QP Page: 173 MS Page: 189
0620_w20_qp_43 Question: 6 d QP Page: 173 MS Page: 189

A.12 Experimental techniques and chemical analysis

A.12.1 Experimental design

0620_s20_qp_41 Question: 5 c QP Page: 36 MS Page: 49
0620_w20_qp_42 Question: 2 b QP Page: 140 MS Page: 155
0620_w20_qp_42 Question: 2 f QP Page: 142 MS Page: 156
0620_w20_qp_43 Question: 4 c QP Page: 168 MS Page: 185
0620_w20_qp_43 Question: 4 d QP Page: 169 MS Page: 185
0620_w20_qp_43 Question: 5 b QP Page: 170 MS Page: 186

A.12.2 Acid–base titrations

0620_s20_qp_41 Question: 4 d QP Page: 35 MS Page: 48

A.12.3 Chromatography

0620_s20_qp_43 Question: 4 c QP Page: 86 MS Page: 101

A.12.4 Separation and purification

0620_s20_qp_42 Question: 1 a QP Page: 52 MS Page: 72

A.12.5 Identification of ions and gases

0620_m20_qp_42 Question: 4 b QP Page: 13 MS Page: 25
0620_s20_qp_41 Question: 1 c QP Page: 30 MS Page: 45
0620_s20_qp_41 Question: 1 d QP Page: 30 MS Page: 45
0620_s20_qp_41 Question: 4 a QP Page: 34 MS Page: 47
0620_s20_qp_41 Question: 4 b QP Page: 34 MS Page: 47
0620_s20_qp_42 Question: 3 e QP Page: 56 MS Page: 73
0620_s20_qp_43 Question: 6 b QP Page: 88 MS Page: 102
0620_w20_qp_41 Question: 3 c QP Page: 110 MS Page: 132