

**Cambridge IGCSE™**CANDIDATE
NAMECENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY**0620/31**

Paper 3 Theory (Core)

May/June 2025**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

This document has **20** pages. Any blank pages are indicated.



1 A list of substances is shown.

aluminium
ammonia
argon
bromine
carbon dioxide
fluorine
iron
magnesium
magnesium chloride
nitrogen
oxygen
potassium

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

State which substance is:

(a) an element which forms an ion with a 1+ charge

..... [1]

(b) a metal that is extracted in the blast furnace

..... [1]

(c) a soft metal that is more reactive than sodium

..... [1]

(d) approximately 78% of clean, dry air

..... [1]

(e) a gas that is identified using damp red litmus paper

..... [1]

(f) a liquid at room temperature and pressure

..... [1]

(g) an element used in food containers because of its resistance to corrosion

..... [1]

(h) a transition element.

..... [1]

[Total: 8]



2 This question is about sea water and the substances found in sea water.

- (a) Table 2.1 shows the masses of the compounds formed when 1000 cm^3 of sea water is evaporated.

Table 2.1

compound	formula	mass of compound / g
sodium chloride	NaCl	14.0
magnesium sulfate	MgSO_4	3.0
potassium chloride	KCl	1.0
	CaCO_3	1.0

Answer these questions, using the information from Table 2.1.

- (i) State the chemical name of CaCO_3 .

..... [1]

- (ii) The total mass of compounds formed from 1000 cm^3 of sea water is 19.0 g.

Calculate the total mass of compounds formed from 1750 cm^3 of sea water.

mass = ... g [1]

- (iii) Magnesium sulfate is soluble in water.

Choose **one other** compound that is soluble in water.

Tick (✓) **one** box.

lead(II) chloride

☐

magnesium carbonate

☐

potassium hydroxide

☐

silver chloride

☐

[1]





(b) Potassium chloride is found in sea water and contains chloride ions.

Describe a test for chloride ions.

test

.....

observations

.....

[2]

(c) Sodium ions are in sea water.

Complete Fig. 2.1 to show:

- the electronic configuration of a sodium ion
- the charge on the ion.

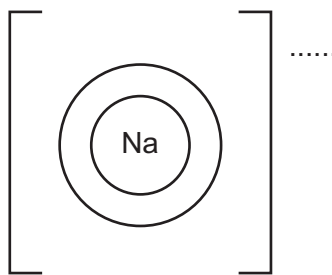


Fig. 2.1

[2]

(d) Sodium chloride forms a liquid when heated.

Describe the arrangement and motion of the particles in a liquid.

arrangement

.....

motion

.....

[2]

(e) Sodium chloride is an ionic compound that dissolves in water.

State **two other** properties of an ionic compound.

1

2

[2]





(f) Sea water contains dissolved gases.

Name the gas that is essential for aquatic life.

..... [1]

[Total: 12]



3 This question is about sulfur and its compounds.

(a) (i) Explain why sulfur is placed in Group VI of the Periodic Table.

.....
 [1]

(ii) Two isotopes of sulfur are shown in Fig. 3.1.



Fig. 3.1

Complete Table 3.1 to show the number of protons, neutrons and electrons in one atom of these isotopes.

Table 3.1

	protons	neutrons	electrons
${}^{33}_{16}\text{S}$			
${}^{36}_{16}\text{S}$			

[3]

(b) Sulfur dioxide is an air pollutant.

(i) State **one** source of sulfur dioxide in the air.

..... [1]

(ii) State **one** adverse effect on the environment of sulfur dioxide.

..... [1]

(iii) Sulfur dioxide reacts with hydrogen sulfide.

Complete the symbol equation for this reaction.



(iv) State the type of bonding between the atoms in sulfur dioxide.

..... [1]





(c) A compound of sulfur has the formula $Al_2(SO_4)_3$.

Complete Table 3.2 to calculate the relative formula mass of $Al_2(SO_4)_3$.

Table 3.2

atom	number of atoms	relative atomic mass	
oxygen	12	16	$12 \times 16 = 192$
aluminium		27	
sulfur		32	

relative formula mass = ...
[2]

[Total: 11]



4 This question is about organic chemistry.

(a) (i) Name the process that separates petroleum into its useful components.

..... [1]

(ii) Fuel oil is obtained from petroleum.

State **one** use of fuel oil.

..... [1]

(iii) Natural gas is a fossil fuel.

Draw a circle around **one** compound that is the main constituent of natural gas.

carbon dioxide **ethane** **ethanol** **methane** [1]

(b) (i) Describe how long chain hydrocarbon molecules can be made into short chain molecules.

Include in your answer:

- the name of this process
- the conditions needed for this process to take place
- the products of this process.

.....
.....
.....
.....
.....
.....
.....
..... [4]

(ii) State **one** reason why long chain hydrocarbon molecules are made into short chain hydrocarbon molecules.

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





(c) Draw the displayed formula of a molecule of ethane.

[1]

(d) (i) Ethanol is manufactured by fermentation of aqueous glucose.

State **two** conditions for fermentation.

1

2 [2]

(ii) State **one** use of ethanol.

..... [1]

(e) Fig. 4.1 shows the displayed formula of an organic molecule.

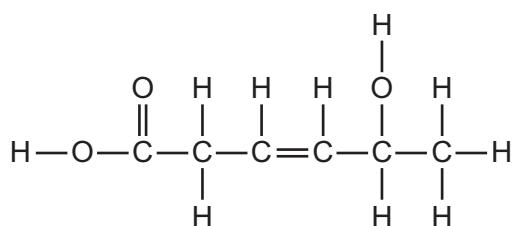


Fig. 4.1

(i) Deduce the molecular formula of this molecule.

..... [1]

(ii) Explain why the molecule in Fig. 4.1 is unsaturated.

..... [1]

[Total: 14]





5 This question is about metals and their reactions.

- (a) A student investigates the reaction of four different metals, **A**, **B**, **C** and **D**, with dilute hydrochloric acid.

All other conditions are the same in each test-tube.

The results of the experiment are shown in Fig. 5.1.

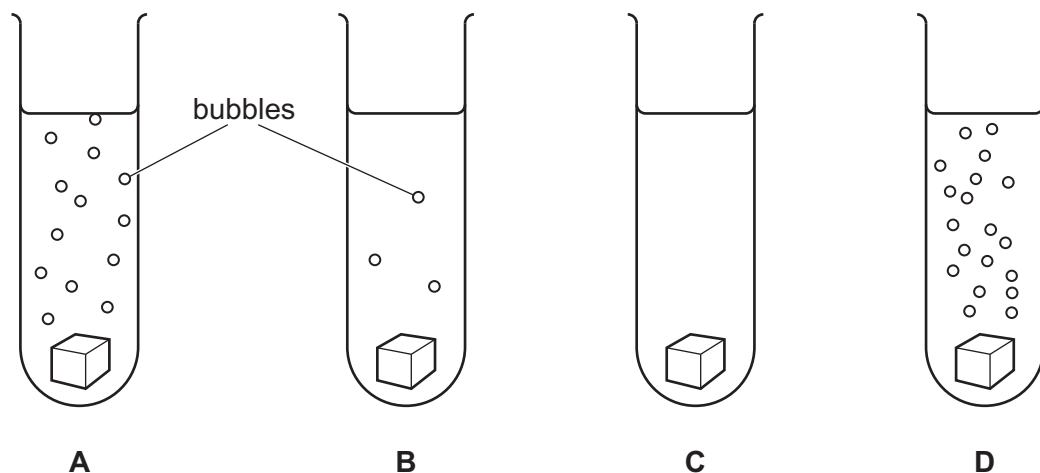


Fig. 5.1

- (i) Put the metals, **A**, **B**, **C** and **D**, in their order of reactivity.

most reactive	
↓	
	
least reactive	

[1]

- (ii) One way the student can increase the rate of the reaction in the experiment is to use a higher concentration of acid.

State **two other** ways to increase the rate of this reaction.

1

2

[2]

- (iii) Hydrogen gas is produced in this experiment.

Describe a test for hydrogen gas.

test

observations

.....

[1]





(iv) State the formula of the ion that is present in all acids.

..... [1]

(b) Stainless steel is an alloy.

(i) State the meaning of the term alloy.

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

(ii) State **one** property of stainless steel that makes it suitable for cutlery.

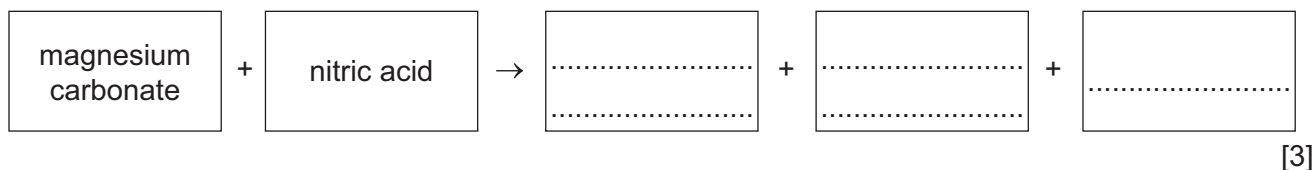
..... [1]

[Total: 7]



6 This question is about ionic and covalent compounds.

(a) Complete the word equation to show the reaction between magnesium carbonate and nitric acid.



(b) Crystals of copper(II) chloride are prepared by adding excess copper(II) oxide powder to dilute hydrochloric acid.

Describe how to prepare a sample of pure, dry copper(II) chloride crystals **after** the reaction is complete.

In your answer, describe how to:

- remove the excess copper(II) oxide from the reaction mixture
- crystallise the copper(II) chloride
- dry the crystals.

.....

.....

.....

.....

.....

.....

[3]

(c) (i) Fig. 6.1 shows the apparatus for the electrolysis of molten lithium iodide, using inert electrodes.

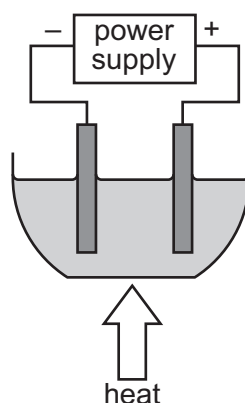


Fig. 6.1

Label Fig. 6.1 to show the:

- anode
- molten lithium iodide.



- (ii) Platinum metal is used as an inert electrode in this electrolysis experiment.

Name **one other** suitable material that can be used as an inert electrode.

..... [1]

- (iii) Name the products formed at the positive and negative electrodes when molten lithium iodide is electrolysed.

positive electrode

negative electrode

[2]

- (d) Table 6.2 shows some properties of five compounds, **A**, **B**, **C**, **D** and **E**.

Table 6.2

compound	electrical conductivity when molten	density in g/cm ³	melting point in °C
A	does not conduct	3.53	1856
B	does not conduct	1.57	–157
C	conducts	1.93	110
D	conducts	3.03	1256
E	does not conduct	4.93	–83

State which **two** of the compounds, **A**, **B**, **C**, **D** and **E**, are simple molecules.
Give **two** reasons for your answer.

compounds and

reason 1

reason 2

[3]

[Total: 14]



7 This question is about energy changes in reactions.

(a) Table 7.1 shows the results of four experiments.

Table 7.1

experiment	initial temperature / °C	final temperature / °C
1	17	23
2	21	13
3	18	14
4	19	26

(i) State which experiment shows the greatest temperature change.

..... [1]

(ii) In experiment 4, zinc was added to dilute hydrochloric acid.

Complete the symbol equation.



(iii) Fig. 7.1 shows the incomplete reaction pathway diagram for the reaction in Experiment 4.

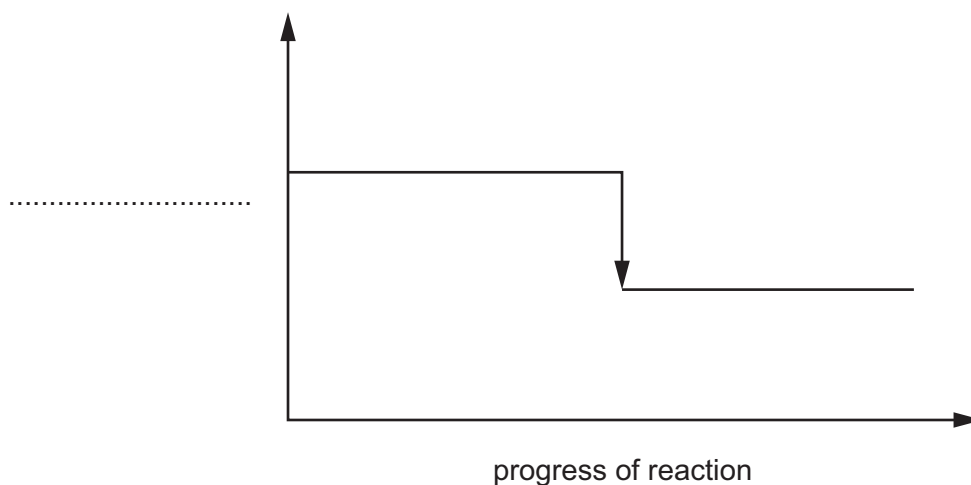


Fig. 7.1

Complete Fig. 7.1 by labelling:

- the vertical axis
- the reactants
- the products.

[2]





(b) Fig. 7.2 shows the changes of state of copper.

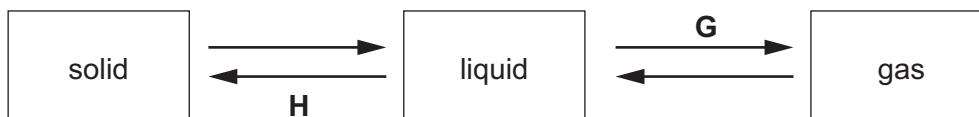


Fig. 7.2

Name the changes of state labelled **G** and **H**.

G

H

[2]

[Total: 7]





8 This question is about water and air.

(a) River water needs to be treated to make it safe to drink.

Two of the stages used in the treatment of domestic water are the addition of carbon and chlorination.

Describe the reason for each of these stages.

addition of carbon

.....

chlorination

.....

[2]

(b) Describe how to test whether a sample of water is pure using boiling point.

.....

.....

..... [2]

(c) Explain why distilled water is used in practical chemistry rather than tap water.

.....

..... [1]

(d) A sample of polluted air contains carbon monoxide and methane.

State **one** harmful effect of each of these air pollutants.

carbon monoxide

methane

[2]

[Total: 7]









Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



The Periodic Table of Elements

Group																						
I	II														III	IV	V	VI	VII	VIII		
3 Li lithium 7	4 Be beryllium 9		Key atomic number atomic symbol name relative atomic mass														1 H hydrogen 1				2 He helium 4	
	11 Na sodium 23	12 Mg magnesium 24		5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20													
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84					
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131					
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —					
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —					

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

**Cambridge IGCSE™**CANDIDATE
NAMECENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY**0620/32**

Paper 3 Theory (Core)

May/June 2025**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

This document has **20** pages. Any blank pages are indicated.



1 A list of substances is shown.

aluminium
bromine
calcium
carbon dioxide
iron
magnesium
magnesium oxide
neon
oxygen
potassium
sulfur dioxide

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

State which substance is:

(a) an element which forms an ion with a 2– charge

..... [1]

(b) an ionic compound

..... [1]

(c) used as a catalyst

..... [1]

(d) approximately 21% of clean, dry air

..... [1]

(e) a gas needed for photosynthesis

..... [1]

(f) the most reactive metal in the list

..... [1]

(g) a gas that is tested for using acidified aqueous potassium manganate(VII)

..... [1]

(h) a noble gas

..... [1]

(i) in Group VII.

..... [1]

[Total: 9]



2 This question is about sea water and the substances found in sea water.

- (a) Table 2.1 shows the masses of some of the compounds formed when 500 cm^3 of sea water is evaporated.

Table 2.1

compound	formula	mass of compound / g
sodium chloride	NaCl	7.0
	MgSO_4	2.5
potassium bromide	KBr	1.5
calcium carbonate	CaCO_3	1.0

Answer these questions using the information from Table 2.1.

- (i) State the chemical name of MgSO_4 .

..... [1]

- (ii) The total mass of compounds formed from 500 cm^3 of sea water is 12.0 g.

Calculate the total mass of compounds formed from 750 cm^3 of sea water.

mass = ... g [1]

- (iii) State which compound in Table 2.1 reacts with an acid to produce carbon dioxide.

..... [1]

- (b) Potassium bromide is found in sea water and contains bromide ions.

Describe a test for bromide ions.

test

.....

observations

.....

[2]





(c) Calcium ions are in sea water.

Complete Fig. 2.1 to show:

- the electronic configuration of a calcium ion
- the charge on the ion.

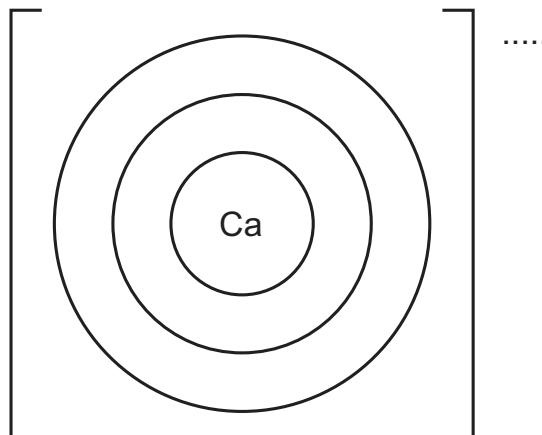


Fig. 2.1

[2]

(d) Sodium chloride is a solid at room temperature.

Describe the arrangement and motion of the particles in a solid.

arrangement

.....

motion

.....

[2]

(e) Sea water contains dissolved nitrate ions.

State **one** source of nitrate ions.

..... [1]

[Total: 10]



3 This question is about phosphorus and its compounds.

(a) (i) Phosphorus is in Group V of the Periodic Table.

Explain why phosphorus is placed in this group.

.....
 [1]

(ii) Two isotopes of phosphorus are shown in Fig. 3.1.



Fig. 3.1

Complete Table 3.1 to show the number of protons, neutrons and electrons in one atom of these isotopes.

Table 3.1

	protons	neutrons	electrons
${}_{15}^{31}\text{P}$			
${}_{15}^{32}\text{P}$			

[3]

(iii) Phosphorus burns in oxygen to produce phosphorus(V) oxide.

Complete the symbol equation for this reaction.



(iv) State whether phosphorus(V) oxide is an acidic oxide or a basic oxide.

Give a reason for your answer.

.....
 [1]





(b) (i) Phosphorus is one element in NPK fertilisers.

Draw a circle around **one other** element that is also in NPK fertilisers.

krypton

nickel

platinum

potassium

[1]

(ii) State why farmers use fertilisers on fields where crops are grown.

..... [1]

(c) A compound of phosphorus has the formula $\text{Ca}_3(\text{PO}_4)_2$.

Complete Table 3.2 to calculate the relative formula mass of $\text{Ca}_3(\text{PO}_4)_2$.

Table 3.2

atom	number of atoms	relative atomic mass	
oxygen	8	16	$8 \times 16 = 128$
calcium		40	
phosphorus		31	

relative formula mass = ... [2]

[Total: 11]



4 This question is about organic chemistry.

(a) (i) State the meaning of the term hydrocarbon.

.....
 [1]

(ii) Petroleum is a mixture of hydrocarbons.

Outline how petroleum is separated into its useful components.

Include in your answer:

- the name of the separation technique
- the property of the hydrocarbons which allows them to be separated
- a description of how this technique separates the petroleum into its useful components.

.....

 [4]

(iii) Some of the products obtained from petroleum are shown.

Draw a line from each product to its use.

product	use
kerosene	making roads
bitumen	fuel for cars
gasoline	jet fuel

[2]





(b) Ethanol is an organic molecule.

(i) Draw the displayed formula of a molecule of ethanol.

[2]

(ii) Ethanol is manufactured by the reaction of steam with ethene.

State **two** conditions for this process.

1

2

[2]

(c) Fig. 4.1 shows the displayed formula of tetramethylsilane.

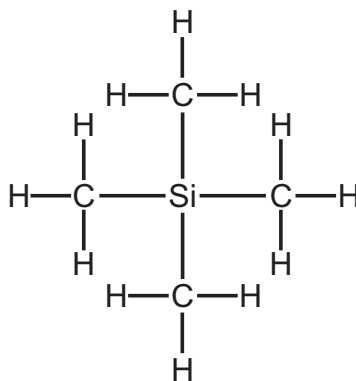


Fig. 4.1

(i) Deduce the molecular formula of tetramethylsilane.

..... [1]

(ii) Name the **two** elements in tetramethylsilane that are in the same group in the Periodic Table.

..... and [1]

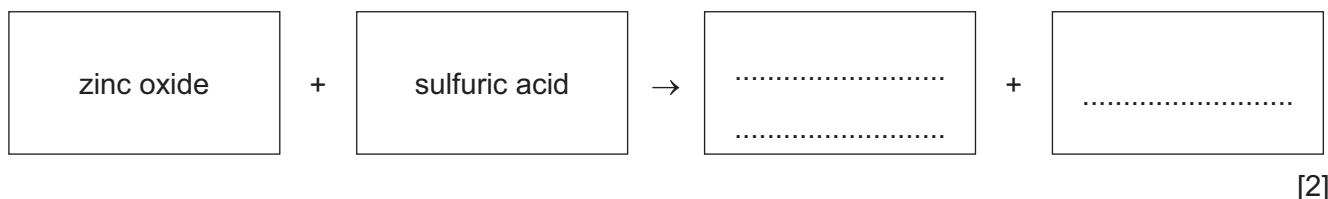
[Total: 13]



5 This question is about zinc salts.

(a) Excess solid zinc oxide is added to dilute sulfuric acid to produce a salt.

(i) Complete the word equation for this reaction.



(ii) Name the method used to remove excess solid zinc oxide from the reaction mixture.

..... [1]

(iii) Describe how crystals of the pure salt are made from an aqueous solution of the salt formed.

.....

.....

.....

..... [2]

(b) Fig. 5.1 shows the apparatus for the electrolysis of molten zinc chloride using inert electrodes.

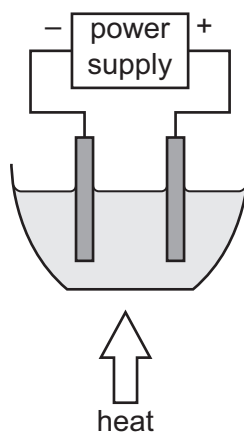


Fig. 5.1

(i) Label Fig. 5.1 to show the:

- cathode
- electrolyte.

[2]





(ii) Name a suitable material for the inert electrodes.

..... [1]

(iii) Name the products formed at the positive and negative electrodes.

positive electrode

negative electrode

[2]

(c) Zinc chloride has ionic bonds.

State the meaning of the term ionic bond.

.....

..... [2]

[Total: 12]



6 This question is about metals.

- (a) (i) A student investigates the reaction of four different metals, **A**, **B**, **C** and **D**, with dilute hydrochloric acid.

All other conditions are the same in each test-tube.

The results of the experiment are shown in Fig. 6.1.

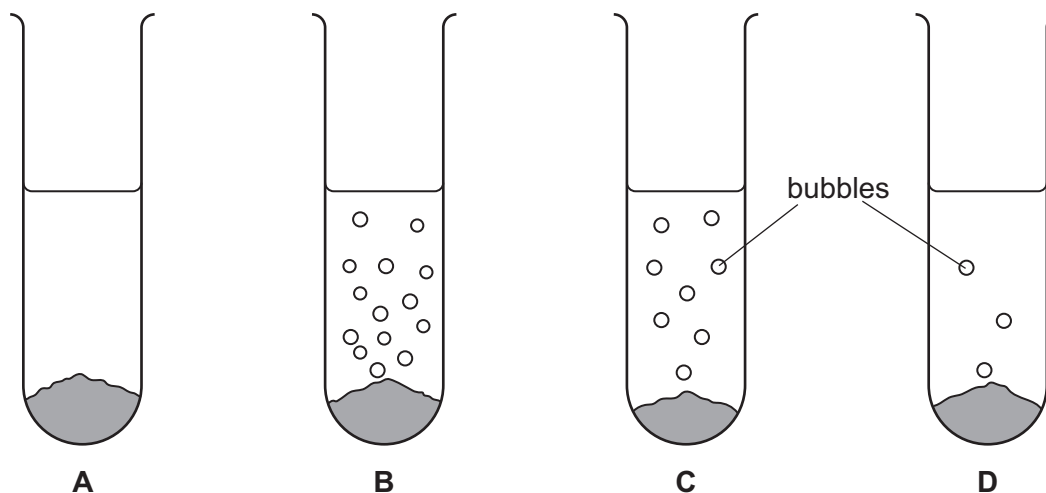


Fig. 6.1

Put the metals, **A**, **B**, **C** and **D**, in order of their reactivity.

most reactive



least reactive

[1]

- (ii) The student wants to decrease the rate of the reaction in the experiment.

State **two** ways to decrease the rate of this reaction.

1

2

[2]

- (b) In another experiment, a student adds potassium carbonate to dilute hydrochloric acid.

State the colour seen in the flame test for potassium ions.

..... [1]





(c) Brass is a mixture of two metals.

(i) State the name given to a mixture of metals such as brass.

..... [1]

(ii) Name the **two** metals in brass.

..... and [2]

(iii) Magnalium is a mixture of magnesium and aluminium.

Suggest **one** property of magnalium that makes it more useful than pure magnesium metal.

..... [1]

[Total: 8]





- 7 (a) Select **two** processes that show a chemical change.

Tick (✓) **two** boxes.

boiling water

☐

burning methane

☐

dissolving salt

☐

mixing ink and water

☐

rusting of iron

☐

[2]

- (b) The reaction of hydrogen with nitrogen is a reversible reaction.

Write the symbol that shows a reversible reaction.

..... [1]

- (c) Table 7.1 shows the results of four experiments.

Table 7.1

experiment	initial temperature / °C	final temperature / °C
1	18	23
2	19	17
3	18	14
4	19	29

- (i) State which experiment shows the greatest temperature change.

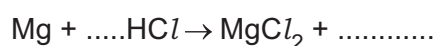
..... [1]

- (ii) State which experiment is the most endothermic.

..... [1]

- (iii) In experiment 4, magnesium was added to dilute hydrochloric acid.

Complete the symbol equation.



[2]





(iv) Fig. 7.1 shows an incomplete reaction pathway diagram for an endothermic reaction.

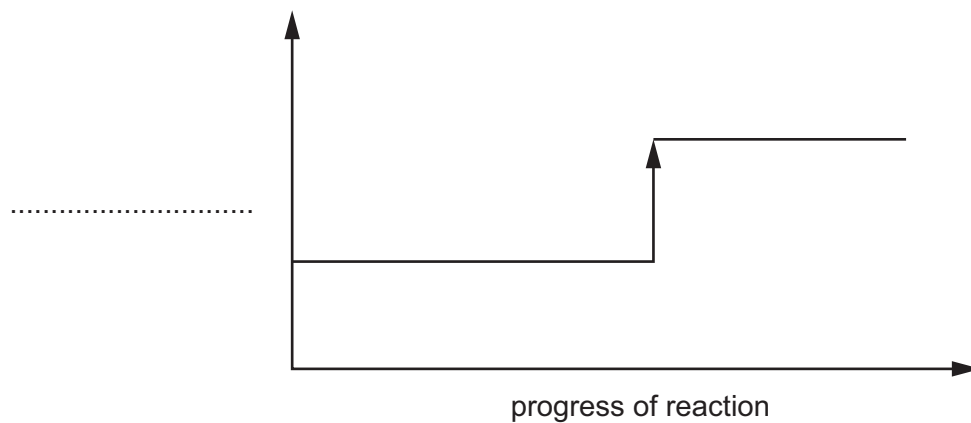


Fig. 7.1

Complete Fig. 7.1 by labelling:

- the vertical axis
- the reactants
- the products.

[2]

[Total: 9]



8 This question is about water and air.

(a) Water needs to be treated to make it safe to drink.

Draw a line from each stage in the treatment of domestic water to the reason why it is carried out.

stage	reason
addition of carbon	to kill microbes
sedimentation	to remove tastes and odours
chlorination	to remove solids

[2]

(b) Describe how to test whether a sample of water is pure using melting point.

.....

 [2]

(c) Air may contain sulfur dioxide and particulates.

(i) State **one** harmful effect of each of these air pollutants.

sulfur dioxide
 particulates [2]

(ii) Describe how flue gas desulfurisation reduces emissions of sulfur dioxide gas.

.....

 [2]

[Total: 8]









Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass										1 H hydrogen 1						
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	2 He helium 4	
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids		72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids		104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
	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 dm³ at room temperature and pressure (r.t.p.).



**Cambridge IGCSE™**CANDIDATE
NAMECENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY**0620/33**

Paper 3 Theory (Core)

May/June 2025**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

This document has **20** pages. Any blank pages are indicated.



1 A list of substances is shown.

calcium
calcium oxide
carbon
carbon dioxide
chlorine
copper
gold
iodine
neon
nitrogen
oxygen
potassium
sulfur dioxide

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

State which substance is:

(a) an element which forms an ion with a 3– charge

..... [1]

(b) a transition element

..... [1]

(c) a gas that is identified using limewater

..... [1]

(d) approximately 78% of clean, dry air

..... [1]

(e) used in electrical wiring

..... [1]

(f) the least reactive metal in the list

..... [1]





(g) a diatomic molecule which is a solid at room temperature and pressure

..... [1]

(h) a compound that reacts with impurities in the blast furnace to form slag

..... [1]

(i) an element with a relative atomic mass of 12.

..... [1]

[Total: 9]



2 This question is about sea water and the substances found in sea water.

- (a) Table 2.1 shows the masses of the compounds present when a 2000 cm^3 sample of sea water is evaporated.

Table 2.1

compound	formula	mass of compound / g
sodium chloride	NaCl	28.0
	MgSO_4	5.5
potassium chloride	KCl	2.5
calcium carbonate	CaCO_3	2.0

Answer these questions using the information from Table 2.1.

- (i) State the chemical name of MgSO_4 .

..... [1]

- (ii) The total mass of compounds formed from 2000 cm^3 of sea water is 38.0 g. Calculate the total mass of compounds present in 800 cm^3 of sea water.

mass = ... g [1]

- (iii) Potassium chloride is soluble in water.

Choose **one other** compound that is soluble in water.

Tick (✓) **one** box.

lead(II) sulfate

☐

magnesium carbonate

☐

silver chloride

☐

sodium hydroxide

☐

[1]



- (b) Potassium iodide is also found in sea water and contains iodide ions.

Describe a test for iodide ions.

test

.....

observations

.....

[2]

- (c) Potassium chloride contains potassium ions.

Complete Fig. 2.1 to show:

- the electronic configuration of a potassium ion
- the charge on the ion.

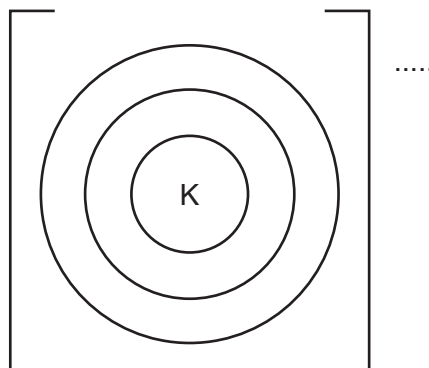


Fig. 2.1

[2]

- (d) Sodium chloride is a solid at room temperature.

Describe the separation and motion of the particles in a solid.

separation

.....

motion

.....

[2]





- (e) Sea water contains dissolved phosphate ions.

State **one** source of phosphate ions.

..... [1]

- (f) Water is a simple molecular compound.

Complete the dot-and-cross diagram in Fig. 2.2 for a molecule of water.

Show outer electrons only.

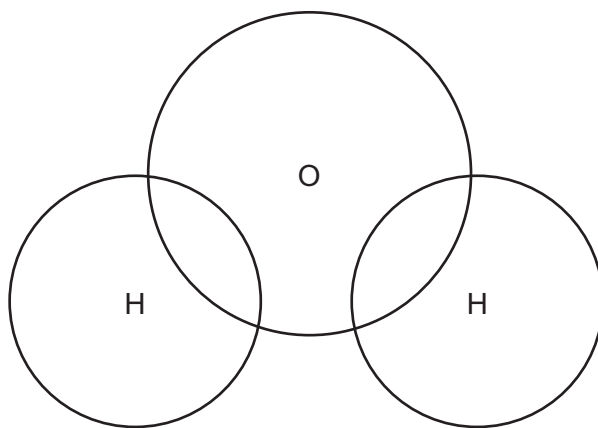


Fig. 2.2

[2]

[Total: 12]





3 This question is about organic chemistry.

(a) Petroleum is a mixture of hydrocarbons and is separated by fractional distillation in an industrial process.

(i) State which physical property of hydrocarbons allows them to be separated by fractional distillation.

..... [1]

(ii) Describe how petroleum is separated into fractions by fractional distillation.

.....

.....

..... [2]

(iii) Name the process that breaks down long chain hydrocarbon molecules to form short chain hydrocarbon molecules.

..... [1]

(iv) Some of the fractions obtained from petroleum are shown.

Draw a line from each fraction to its use.

fraction	use
bitumen	waxes and polishes
lubricating oil	making roads
naphtha	chemical feedstock

[2]





(b) Ethanoic acid is an organic molecule.

(i) Draw the displayed formula of a molecule of ethanoic acid.

[2]

(ii) Ethanoic acid reacts with sodium carbonate.

Name the salt produced in this reaction.

[1]

(c) Ethane is burned in excess oxygen.

Name the **two** products of this process.

[2]

(d) Ethanol is another organic molecule.

State **two** ways to manufacture ethanol.

1

2

[2]





(e) Fig. 3.1 shows the displayed formula of an organic molecule.

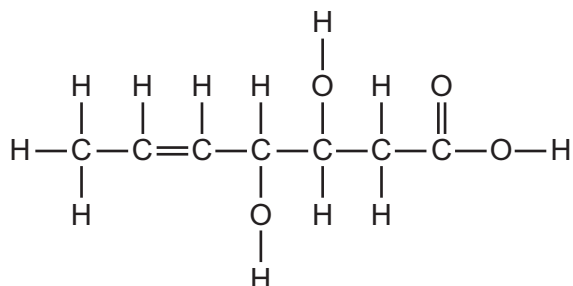


Fig. 3.1

- (i) Deduce the molecular formula of the molecule in Fig. 3.1.

..... [1]

- (ii) Explain why the molecule in Fig. 3.1 is unsaturated.

..... [1]

[Total: 15]



4 This question is about nitrogen and its compounds.

(a) (i) Explain why nitrogen is in Group V of the Periodic Table.

.....
 [1]

(ii) Two isotopes of nitrogen are shown in Fig. 4.1.



Fig. 4.1

Complete Table 4.1 to show the number of protons, neutrons and electrons in one atom of these isotopes.

Table 4.1

	protons	neutrons	electrons
${}^{14}_{7}\text{N}$			
${}^{15}_{7}\text{N}$			

[3]

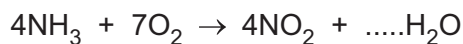
(b) Oxides of nitrogen are air pollutants.

(i) State **one** source of oxides of nitrogen in the air.

..... [1]

(ii) Ammonia reacts with oxygen to form nitrogen dioxide and water.

Complete the symbol equation for this reaction.



[1]

(iii) State the type of bonding between the atoms in nitrogen dioxide.

..... [1]





(iv) State whether nitrogen dioxide is an acidic or basic oxide.

Give a reason for your answer.

.....
 [1]

(c) A compound of nitrogen has the formula $Al(NO_3)_3$.

Complete Table 4.2 to calculate the relative formula mass of $Al(NO_3)_3$.

Table 4.2

atom	number of atoms	relative atomic mass	
oxygen	9	16	$9 \times 16 = 144$
aluminium		27	
nitrogen		14	

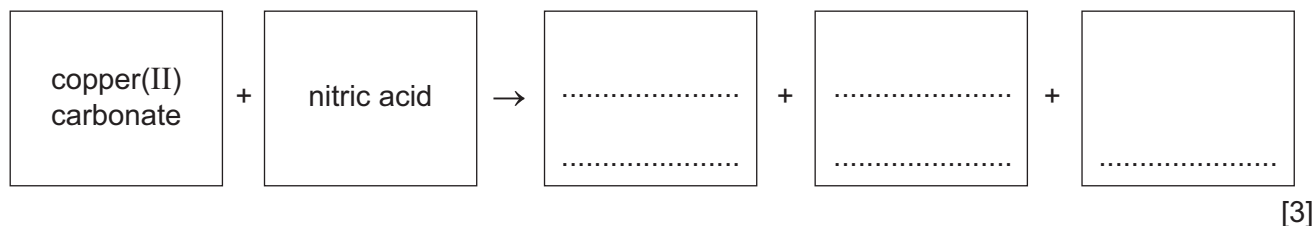
relative formula mass = ... [2]

[Total: 10]



5 This question is about ionic compounds and simple molecular compounds.

(a) Complete the word equation to show the reaction between copper(II) carbonate and nitric acid.



(b) Aqueous magnesium chloride is prepared by adding excess magnesium oxide powder to dilute hydrochloric acid.

Describe how to prepare a sample of pure, dry magnesium chloride crystals **after** the reaction is complete.

In your answer describe how to:

- remove the excess magnesium oxide from the reaction mixture
- crystallise the magnesium chloride
- dry the crystals.

.....

.....

.....

.....

.....

.....

[3]

(c) Fig. 5.1 shows the apparatus for the electrolysis of molten cobalt(II) bromide using inert electrodes.

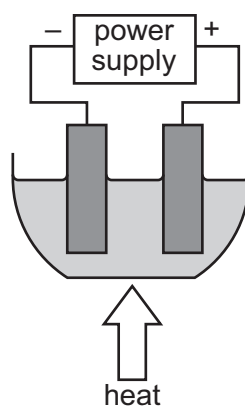


Fig. 5.1

(i) Label Fig. 5.1 to show the:

- anode
- electrolyte.



(ii) Name the products formed at the positive and negative electrodes.

positive electrode

negative electrode

[2]

(d) Table 5.1 shows some properties of five compounds, **A**, **B**, **C**, **D** and **E**.

Table 5.1

compound	electrical conductivity when molten	density in g/cm ³	melting point in °C
A	conducts	1.85	115
B	does not conduct	2.65	1713
C	does not conduct	0.42	–182
D	conducts	2.99	1190
E	does not conduct	1.56	–101

State which **two** of the compounds, **A**, **B**, **C**, **D** and **E**, are simple molecules.

Give **two** reasons for your answer.

compounds and

reason 1

reason 2

[3]

[Total: 13]



6 This question is about chemical reactions and their energy changes.

(a) Tick (✓) **one** box that shows a chemical change.

boiling ethanol

☐

decomposing vegetation

☐

dissolving salt

☐

mixing ink and water

☐

[1]

(b) Table 6.1 shows the results of four experiments.

Table 6.1

experiment	initial temperature / °C	final temperature / °C
1	20	14
2	18	26
3	19	25
4	17	12

(i) State which experiment shows the greatest temperature change.

..... [1]

(ii) State which experiment is the most endothermic.

..... [1]



(iii) Fig. 6.1 shows an incomplete reaction pathway diagram for an exothermic reaction.

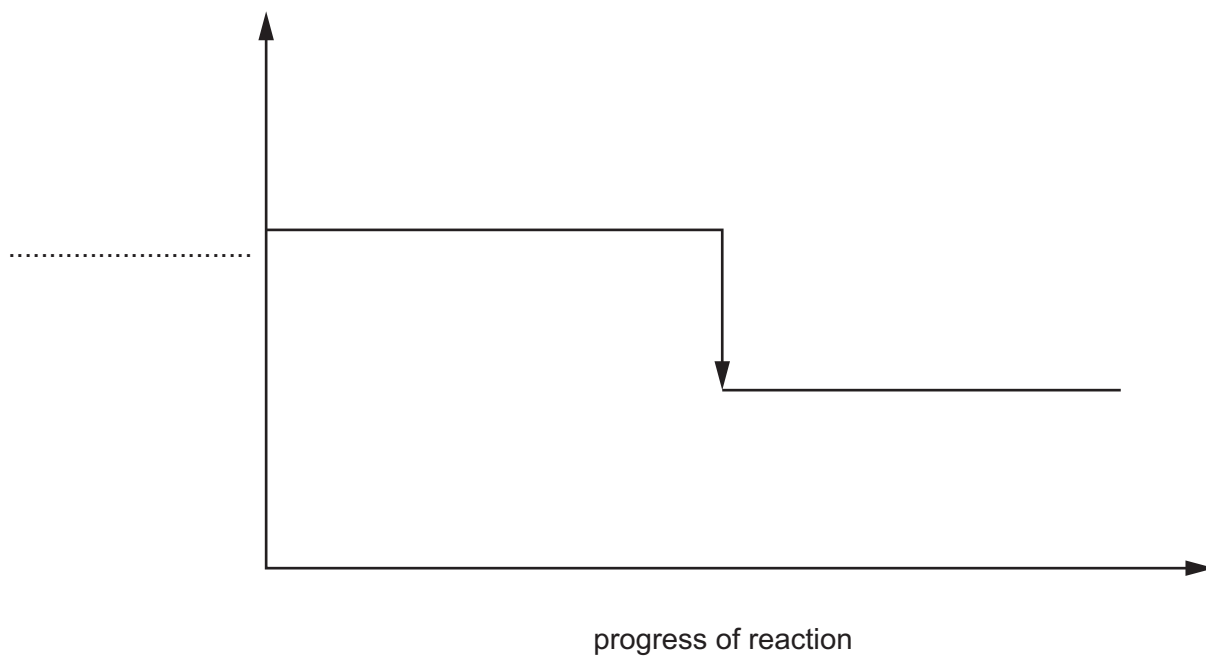


Fig. 6.1

Complete Fig. 6.1 by labelling:

- the vertical axis
- the reactants
- the products.

[2]

[Total: 5]



7 This question is about air and water.

(a) Water needs to be treated to make it safe to drink.

Complete Fig. 7.1 to show the three stages needed in the treatment of domestic water. The second stage has been completed.

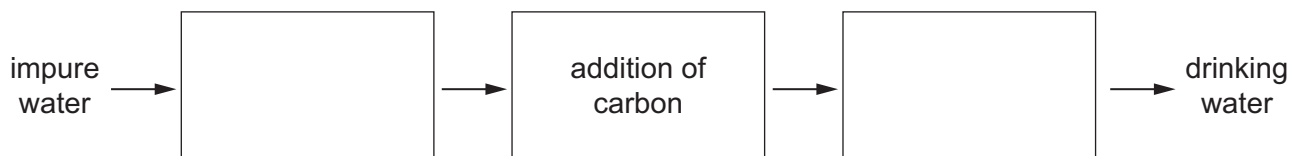


Fig. 7.1

[2]

(b) Describe a chemical test for the presence of water.

test

.....

observations

.....

[2]

(c) A sample of air contains carbon dioxide and oxides of nitrogen.

State **one** harmful effect of each of these air pollutants.

carbon dioxide

oxides of nitrogen

[2]

[Total: 6]



8 This question is about metals.

- (a) (i) A student investigates the reaction of four different metals, **A**, **B**, **C** and **D**, with dilute sulfuric acid.

All other conditions are the same.

The results of the experiments are shown in Table 8.1.

Table 8.1

metal	observations
A	lots of bubbles at room temperature
B	no bubbles
C	few bubbles on warming
D	lots of bubbles on warming

Put the metals, **A**, **B**, **C** and **D**, in order of their reactivity.

most reactive



least reactive

[1]

- (ii) Increasing the temperature of the acid increases the rate of reaction.

State **two other** ways to increase the rate of this reaction.

1

.....

2

.....

[2]





(b) In another experiment, a student adds lithium to water. An alkaline solution is formed.

(i) State the colour seen in the flame test for lithium ions.

..... [1]

(ii) State the ion that all aqueous alkalis contain.

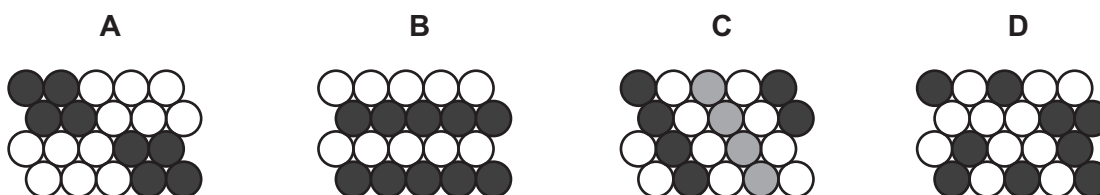
..... [1]

(iii) State the colour of thymolphthalein in an aqueous alkali.

..... [1]

(c) Pewter is an alloy that contains tin.

(i) State which **one** of these diagrams, **A**, **B**, **C** or **D**, best represents an alloy.



..... [1]

(ii) Suggest **one** property of pewter that makes it more useful than pure tin.

..... [1]

(d) Metals are good thermal conductors.

Describe **two other** physical properties that are typical of metals.

1

2

[2]

[Total: 10]





Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



The Periodic Table of Elements

Group																																																					
I	II											III	IV	V	VI	VII	VIII																																				
												1 H hydrogen 1																																									
												Key atomic number atomic symbol name relative atomic mass																																									
3 Li lithium 7	4 Be beryllium 9																																																				
11 Na sodium 23	12 Mg magnesium 24	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84																						
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —	87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —

lanthanoids

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
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 —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).