Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

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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.

[Turn over

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.

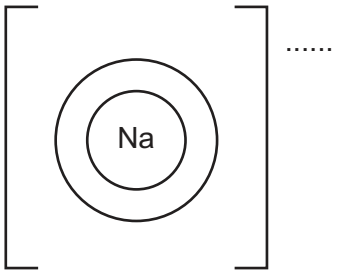

Fig. 2.1

[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.

$^{33}_{16}S$ $^{36}_{16}S$

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
$^{33}_{16}S$			
$^{36}_{16}S$			

[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.

$$SO_2 + 2H_2S \rightarrow .....S + ...H_2O$$ [2]

(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 × 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.

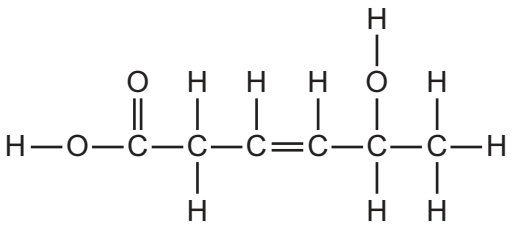

Fig. 4.1

(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.

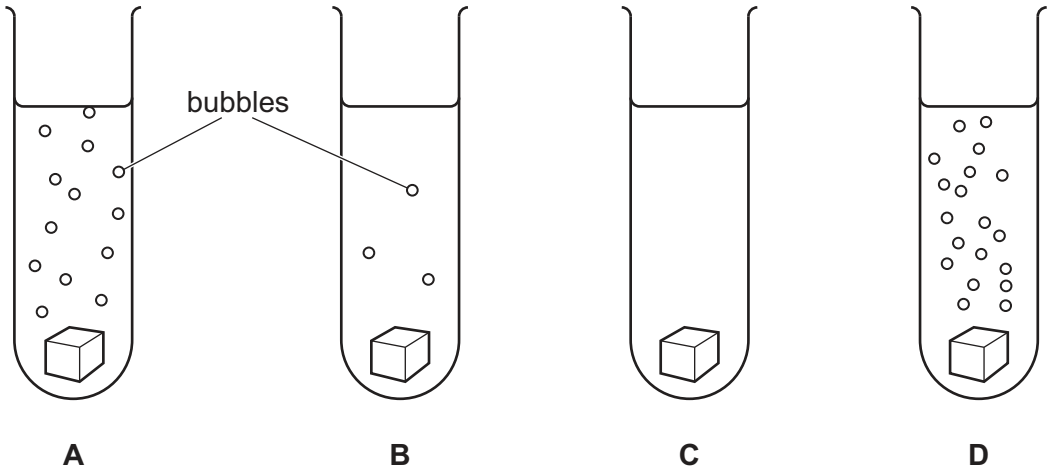

Fig. 5.1

(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.

magnesium carbonate	+	nitric acid	→	....	+	....	+	.....

[3]

(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.

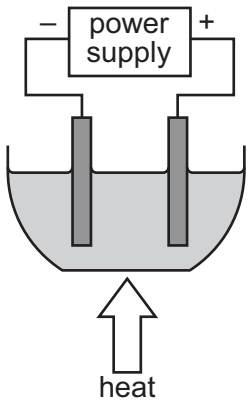

Fig. 6.1

Label Fig. 6.1 to show the:

- anode
- molten lithium iodide.

[2]

(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.

$$Zn + ...HCl \rightarrow ZnCl_2 + ...$$ [2]

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

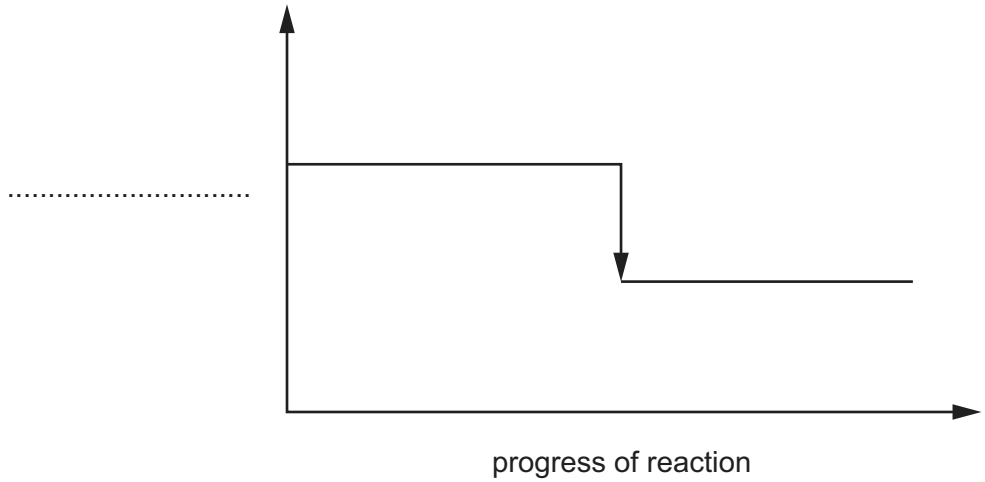

Fig. 7.1

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.

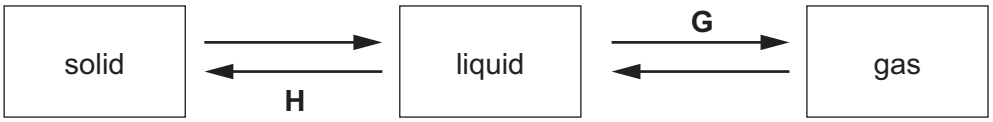

Fig. 7.2

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]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

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

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