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CANDIDATE NAME

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5654995948

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.

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[Turn over

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]

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(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]

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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]

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

Describe a test for iodide ions.

test .....

.....

observations .....

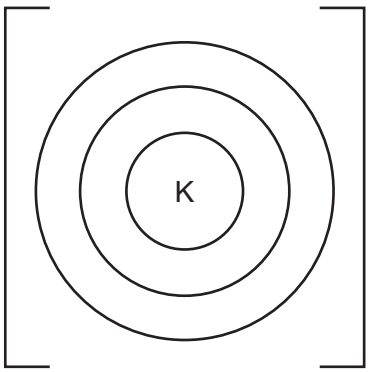
.....

[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]

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(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.

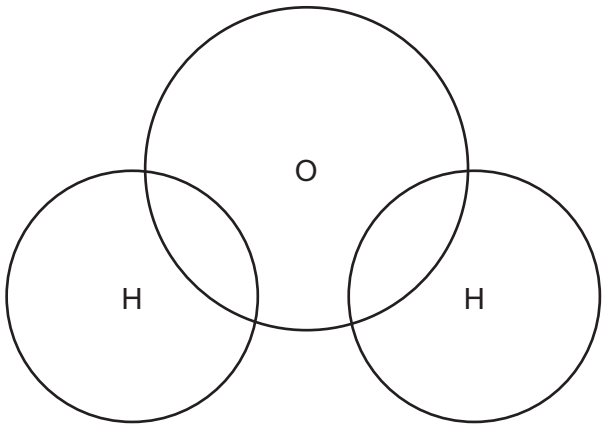


Fig. 2.2

[2]

[Total: 12]

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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]

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(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.

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

(d) Ethanol is another organic molecule.

State **two** ways to manufacture ethanol.

1 .....

2 .....
[2]

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

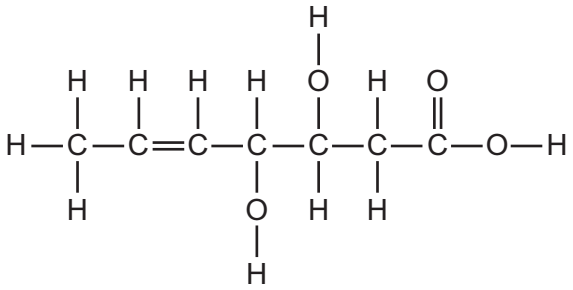


Fig. 3.1

(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]

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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.

$^{14}_{7}N$ $^{15}_{7}N$

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
$^{14}_{7}N$			
$^{15}_{7}N$			

[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.

$$4NH_3 + 7O_2 \rightarrow 4NO_2 + ...H_2O$$

[1]

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

..... [1]

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(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 × 16 = 144
aluminium		27	
nitrogen		14	

relative formula mass = ...
[2]

[Total: 10]

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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.

copper(II) carbonate	+	nitric acid	→	....	+	....	+	.....

[3]

(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.

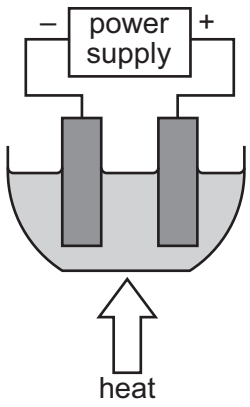


Fig. 5.1

(i) Label Fig. 5.1 to show the:

- anode
- electrolyte.

[2]

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(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]

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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]

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

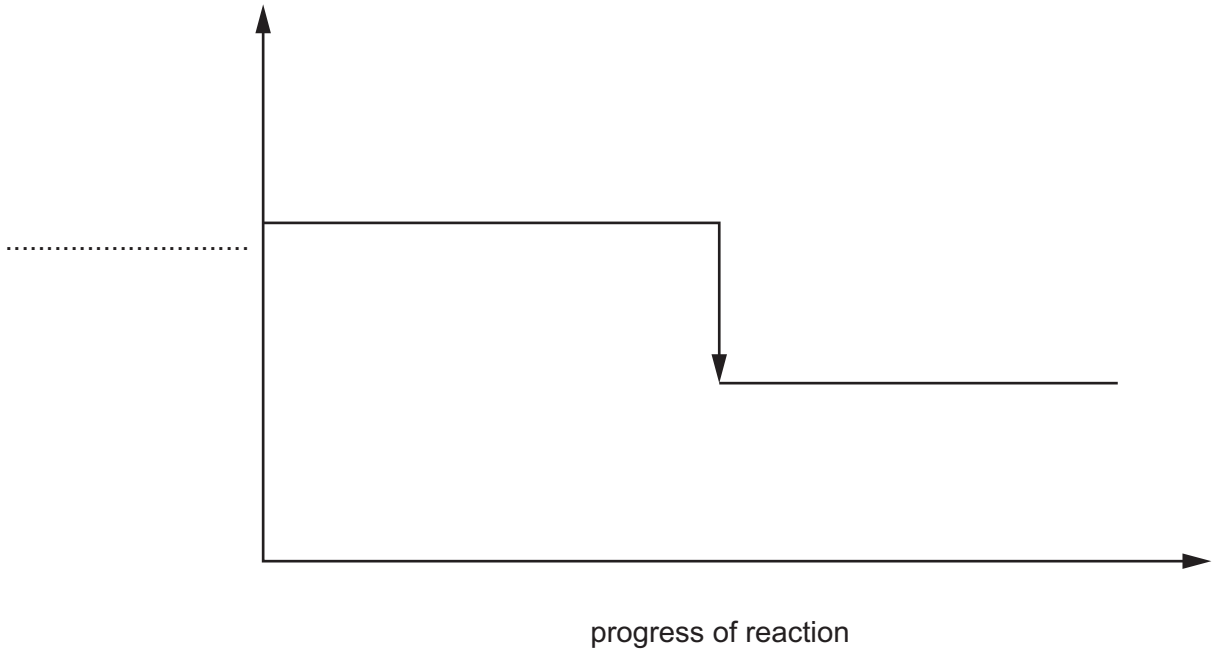


Fig. 6.1

Complete Fig. 6.1 by labelling:

- the vertical axis
- the reactants
- the products. [2]

[Total: 5]

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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.

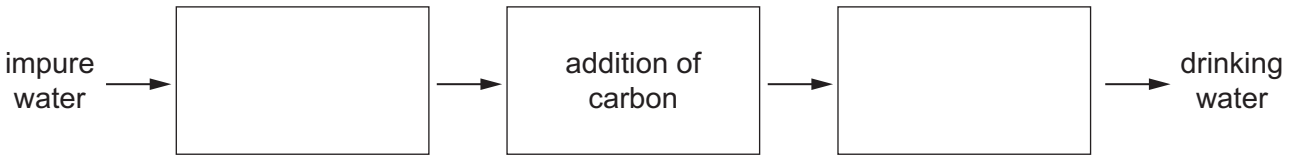


Fig. 7.1

[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]

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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]

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(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]

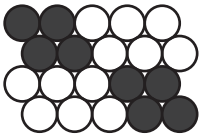
(iii) State the colour of thymolphthalein in an aqueous alkali.

..... [1]

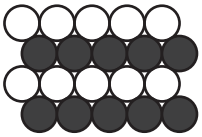
(c) Pewter is an alloy that contains tin.

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

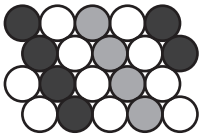
A



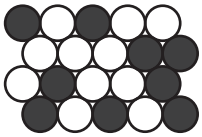
B



C



D



..... [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]

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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.).

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