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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

8643090581

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2022**

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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1 **(a)** A list of symbols and formulae is shown.

Al_2O_3
C_2H_5OH
CO_2
Fe_2O_3
H_2
He
K^+
Li^+
N_2
Na^+
O^{2-}

Answer the following questions using these symbols or formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(i) an element that is monoatomic

..... [1]

(ii) an ion that gives a red colour in a flame test

..... [1]

(iii) an element that can be used as a fuel

..... [1]

(iv) a gas that contributes to climate change

..... [1]

(v) an ion that is formed when an atom gains electrons.

..... [1]

(b) Complete the table to show the relative charges of a proton, neutron and electron.

type of particle	relative charge
proton	
neutron	0
electron	

[2]

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(c) Choose the two correct statements about nitrogen and hydrogen in a mixture.
Tick (✓) **two** boxes.

The nitrogen and hydrogen mixture can be separated by physical means.	☐
The nitrogen and hydrogen mixture is liquid at room temperature.	☐
The atoms of nitrogen and hydrogen in the mixture are chemically combined.	☐
Air is mainly a mixture of nitrogen and hydrogen.	☐
The bonding in both nitrogen and hydrogen molecules is covalent.	☐

[2]

[Total: 9]

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2 The table shows the masses of some ions in a 1000 cm^3 sample of toothpaste.

name of ion	formula of ion	mass of ion in 1000 cm^3 of toothpaste / g
	NH_4^+	0.2
calcium	Ca^{2+}	0.8
	CO_3^{2-}	0.7
chloride	Cl^-	0.9
fluoride	F^-	2.2
magnesium	Mg^{2+}	2.0
phosphate	PO_4^{3-}	24.4
sodium	Na^+	34.2
sulfate	SO_4^{2-}	10.1
tin(II)	Sn^{2+}	0.4
zinc	Zn^{2+}	0.1

(a) Answer these questions using only the information in the table.

(i) State which negative ion has the highest mass in 1000 cm^3 of toothpaste.

..... [1]

(ii) Name the compound that contains NH_4^+ and CO_3^{2-} ions.

..... [1]

(iii) Calculate the mass of fluoride ions in 250 cm^3 of toothpaste.

mass = ... g [1]

(b) Describe the observations when aqueous ammonia is added drop by drop to a solution containing zinc ions until the ammonia is in excess.

observations with a few drops of ammonia

.....

observations with ammonia in excess

.....
[2]

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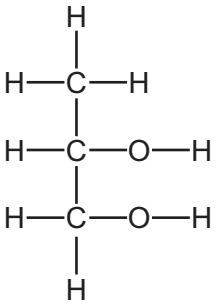
(c) Toothpaste also contains compound **A**.
The structure of compound **A** is shown.



Deduce the formula of compound **A** to show the number of atoms of carbon, hydrogen and oxygen.

..... [1]

(d) Compound **A** is an alcohol.
Ethanol, C_2H_5OH, is also an alcohol.

(i) Complete these sentences about ethanol using words from the list.

different **formula** **group** **identical** **molecule** **similar**

Ethanol is part of the alcohol homologous series.

Each member of the alcohol homologous series has the same functional ..... .

Members of the same homologous series have chemical properties that are ..... .
[2]

(ii) When ethanol undergoes incomplete combustion, a small amount of carbon dioxide is produced.

Name two **other** substances that are produced when ethanol undergoes incomplete combustion.

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

[Total: 10]

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3 This question is about Group I and Group VII elements.

(a) Deduce the number of electrons, neutrons and protons in one atom of the isotope of sodium shown.

$^{23}_{11}Na$

number of electrons .....

number of neutrons .....

number of protons .....
[3]

(b) Sodium reacts with chlorine to produce sodium chloride.

(i) State the colour of chlorine gas.

..... [1]

(ii) Chlorine is a diatomic molecule.

State the meaning of the term *diatomic*.

..... [1]

(iii) Complete the chemical equation for the reaction of sodium with chlorine.

2Na + ... → .....NaC*l* [2]

(iv) Sodium chloride is an ionic compound.

Describe **two** physical properties of ionic compounds.

1 .....

2 .....
[2]

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(c) The table shows some properties of four Group I elements.

element	melting point / °C	boiling point / °C	atomic radius / nm
lithium	181	1342	0.157
sodium	98	883	.....
potassium	.....	760	0.235
rubidium	39	686	0.250

(i) Complete the table by predicting:
- the melting point of potassium
- the atomic radius of sodium. [2]

(ii) Predict the physical state of rubidium at 700 °C.
Give a reason for your answer.

.....

..... [2]

(iii) Give **two** physical properties of Group I metals that are different from transition elements and state how they are different.

1 .....

.....

2 .....

.....
[2]

(d) Aqueous chlorine reacts with aqueous sodium iodide.

$$Cl_2 + 2NaI \rightarrow 2NaCl + I_2$$

Explain how this equation shows that chlorine is more reactive than iodine.

.....

..... [1]

[Total: 16]

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4 This question is about acids and carbonates.

(a) Describe the colour change when excess acid is added to a solution of methyl orange in alkaline solution.

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

(b) Complete the word equation for the reaction of hydrochloric acid with calcium carbonate.

hydrochloric acid	+	calcium carbonate	→	....	+	....	+	water

[2]

(c) Calcium carbonate decomposes when heated.

calcium carbonate → calcium oxide + carbon dioxide

(i) Calcium carbonate is used in the manufacture of lime (calcium oxide).

State one **other** use of calcium carbonate.

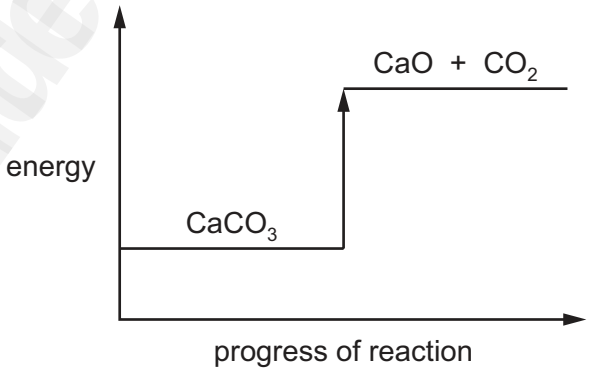
..... [1]

(ii) The decomposition of calcium carbonate is endothermic.

State the meaning of the term *endothermic*.

..... [1]

(iii) The energy level diagram for the decomposition of calcium carbonate is shown.



Explain how the energy level diagram shows that this reaction is endothermic.

.....

..... [1]

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(iv) When 0.50 g of calcium carbonate decomposes, 120 cm^3 of carbon dioxide gas is produced.

Calculate the volume of carbon dioxide gas produced when 0.10 g of calcium carbonate is used.

volume of carbon dioxide gas = ... cm^3 [1]

[Total: 8]

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5 This question is about Group VI elements and their compounds.

(a) Name the changes of physical state when:

- oxygen gas is converted to liquid oxygen

.....

- solid sulfur is converted directly to sulfur gas.

.....
[2]

(b) Use the kinetic particle model to describe the differences between solid sulfur and sulfur gas in terms of:

- the arrangement of the particles

.....

.....

- the motion of the particles.

.....

.....
[4]

(c) Deduce the electronic structure of sulfur.

Use the Periodic Table to help you.

..... [1]

(d) Sulfur is used in the manufacture of sulfuric acid.
The equation shows one of the reactions.

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

(i) State the meaning of the symbol $\rightleftharpoons$.

..... [1]

(ii) Give **one** use of sulfur dioxide other than in making sulfuric acid.

..... [1]

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(e) Acid rain is formed when sulfur dioxide reacts with water vapour in the atmosphere.

(i) Choose the pH value which is acidic.

Draw a circle around your chosen answer.

pH 4 **pH 7** **pH 10** **pH 14** [1]

(ii) Describe **one** effect of acid rain on buildings.

..... [1]

[Total: 11]

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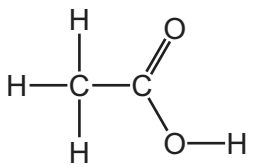
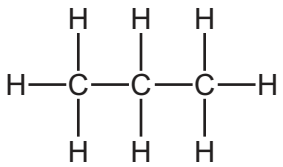
6 **(a)** The structures of four organic compounds, **B**, **C**, **D** and **E**, are shown.

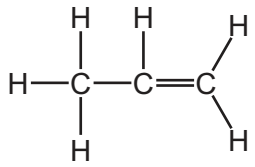
B



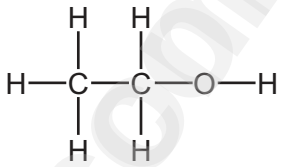
C



D



E



(i) State which compound, **B**, **C**, **D** or **E**, dissolves in water to form an acidic solution.

..... [1]

(ii) State which compound, **B**, **C**, **D** or **E**, is a saturated hydrocarbon.

..... [1]

(iii) State which compound, **B**, **C**, **D** or **E**, is an unreactive compound except in terms of burning.

..... [1]

(iv) State which compound, **B**, **C**, **D** or **E**, decolourises aqueous bromine.

..... [1]

(b) Ethanol can be manufactured from ethene and one other reactant.

Describe the manufacture of ethanol from ethene to include:

- the formula of ethene

.....

- the name of the other reactant

.....

- the conditions needed.

.....

.....

[4]

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(c) Complete the table to show the name and uses of some petroleum fractions.

name of fraction	use of fraction
	making chemicals
kerosene	
fuel oil	

[3]

[Total: 11]

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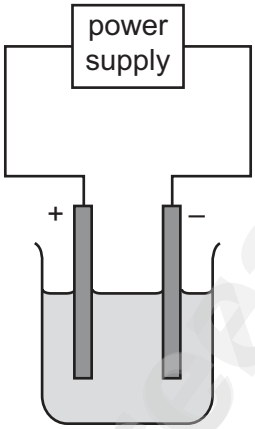
7 This question is about lithium and compounds of lithium.

(a) Lithium reacts with nitrogen to produce lithium nitride, Li_3N.

Complete the chemical equation for this reaction.

$$.....Li + N_2 \rightarrow .....Li_3N$$ [2]

(b) Molten lithium bromide is electrolysed using carbon electrodes.
The apparatus is shown.



(i) Complete the diagram by labelling:
- the anode
- the electrolyte. [2]

(ii) Name the products formed at each electrode.

positive electrode .....

negative electrode .....
[2]

(iii) The carbon electrodes conduct electricity.

Give one **other** property that these electrodes must have.

..... [1]

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(c) A compound of lithium has the formula $C_3H_5O_2Li_2$.

Complete the table to calculate the relative molecular mass of $C_3H_5O_2Li_2$.

atom	number of atoms	relative atomic mass	
carbon	3	12	$3 \times 12 = 36$
hydrogen		1	
oxygen		16	
lithium		7	

relative molecular mass = ... [2]

[Total: 9]

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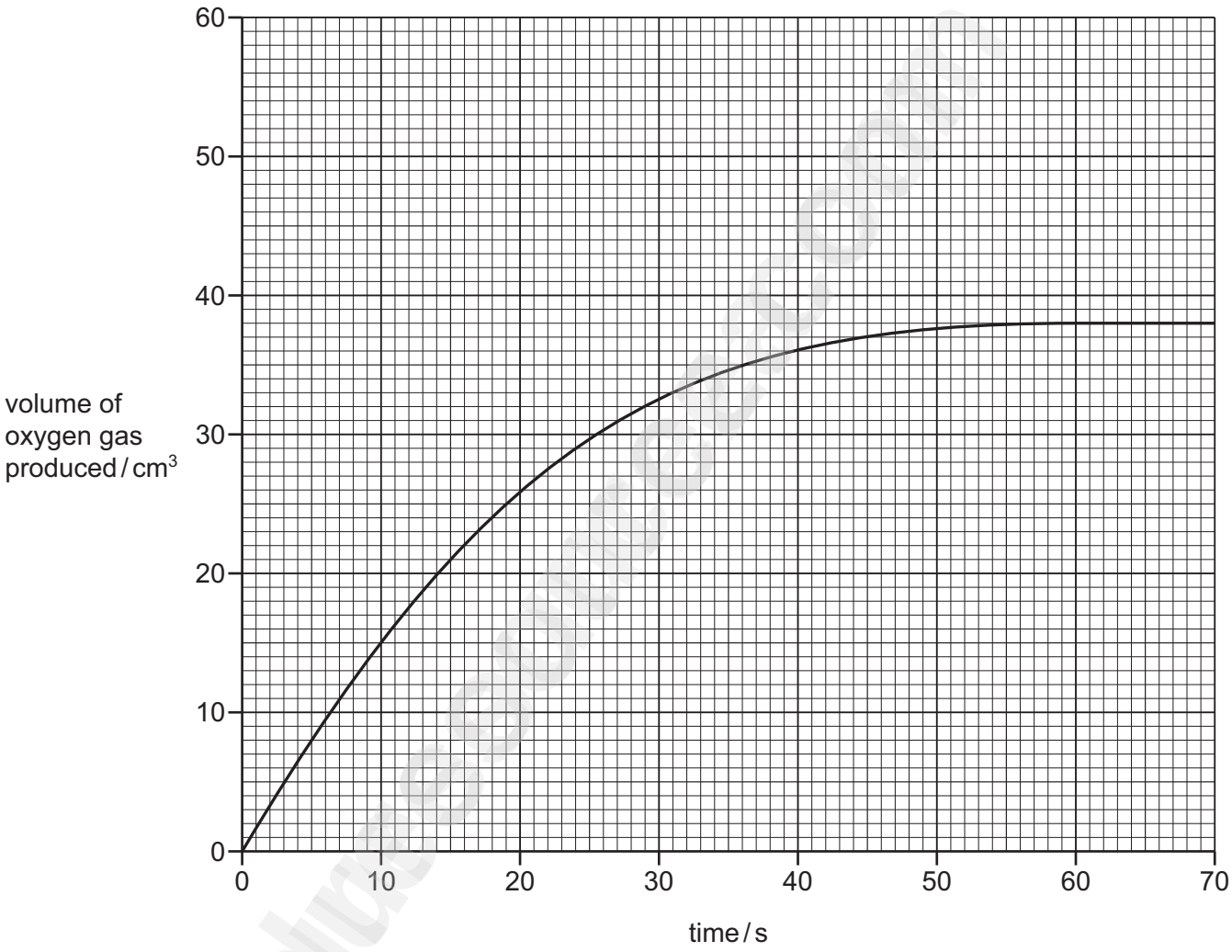
8 A student investigates the rate of decomposition of aqueous hydrogen peroxide using 0.2 g of a catalyst.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The rate of reaction is found by measuring the volume of oxygen gas produced as time increases.

The results are shown on the graph.



(a) Deduce the time taken to collect 35 cm^3 of oxygen gas.

time = ... s [1]

(b) The experiment is repeated using 0.2 g of smaller pieces of the catalyst.

All other conditions stay the same.

Draw a line **on the grid** to show how the volume of oxygen gas produced changes as time increases. [2]

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(c) Describe the effect each of the following has on the rate of decomposition of hydrogen peroxide.

All other conditions stay the same.

- The reaction is carried out at a higher temperature.

.....

- The reaction is carried out using a lower concentration of hydrogen peroxide.

.....
[2]

(d) Hydrogen peroxide reduces sodium chlorate(I), NaC*l*O, to sodium chloride.

$$H_2O_2 + NaClO \rightarrow NaCl + H_2O + O_2$$

Describe how this equation shows that sodium chlorate(I) has been reduced.

..... [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.).

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