



Cambridge IGCSE™

CANDIDATE
NAME
CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

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.

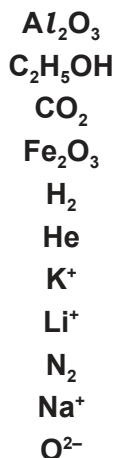
INFORMATION

- 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.

2

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



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]

3

- (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]

4

- 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

.....

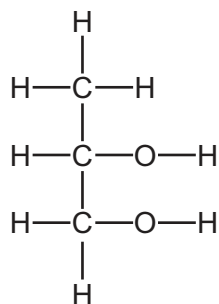
observations with ammonia in excess

.....

[2]

5

- (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, $\text{C}_2\text{H}_5\text{OH}$, 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]

6

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.



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.



- (iv) Sodium chloride is an ionic compound.

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

1

2

[2]

7

(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.

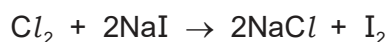
.....
 [2]

- (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.



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

.....
 [1]

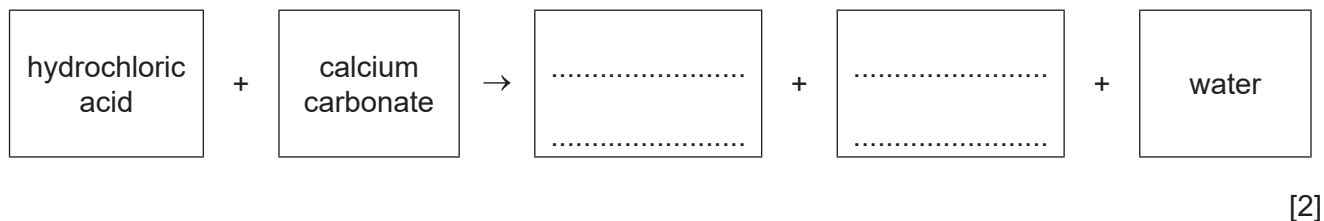
[Total: 16]

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.



- (c) Calcium carbonate decomposes when heated.



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

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

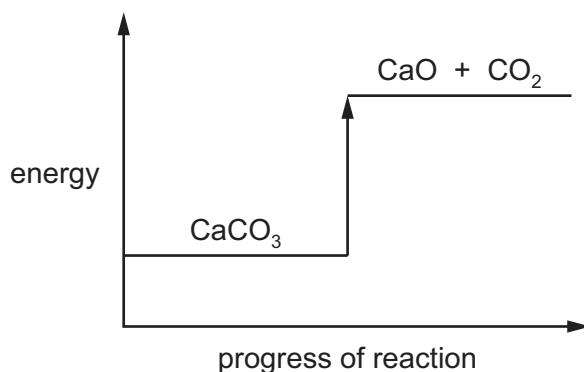
..... [1]

- (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]

9

- (iv)** When 0.50 g of calcium carbonate decomposes, 120 cm³ 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 = cm³ [1]

[Total: 8]

10

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.

.....

.....

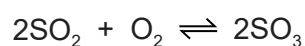
[4]

(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.



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

..... [1]

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

..... [1]

11

(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]

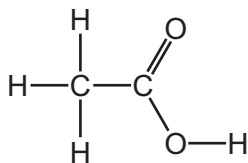
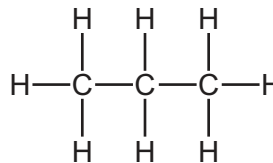
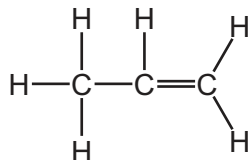
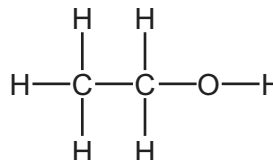
(ii) Describe **one** effect of acid rain on buildings.

..... [1]

[Total: 11]

12

- 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]

13

(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]

14

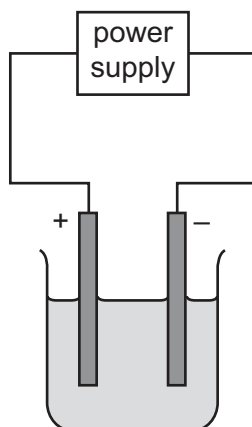
7 This question is about lithium and compounds of lithium.

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

Complete the chemical equation for this reaction.



(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]

15

(c) A compound of lithium has the formula $\text{C}_3\text{H}_5\text{O}_2\text{Li}_2$.

Complete the table to calculate the relative molecular mass of $\text{C}_3\text{H}_5\text{O}_2\text{Li}_2$.

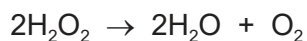
atom	number of atoms	relative atomic mass	
carbon	3	12	$3 \times 12 = 36$
hydrogen		1	
oxygen		16	
lithium		7	

relative molecular mass = [2]

[Total: 9]

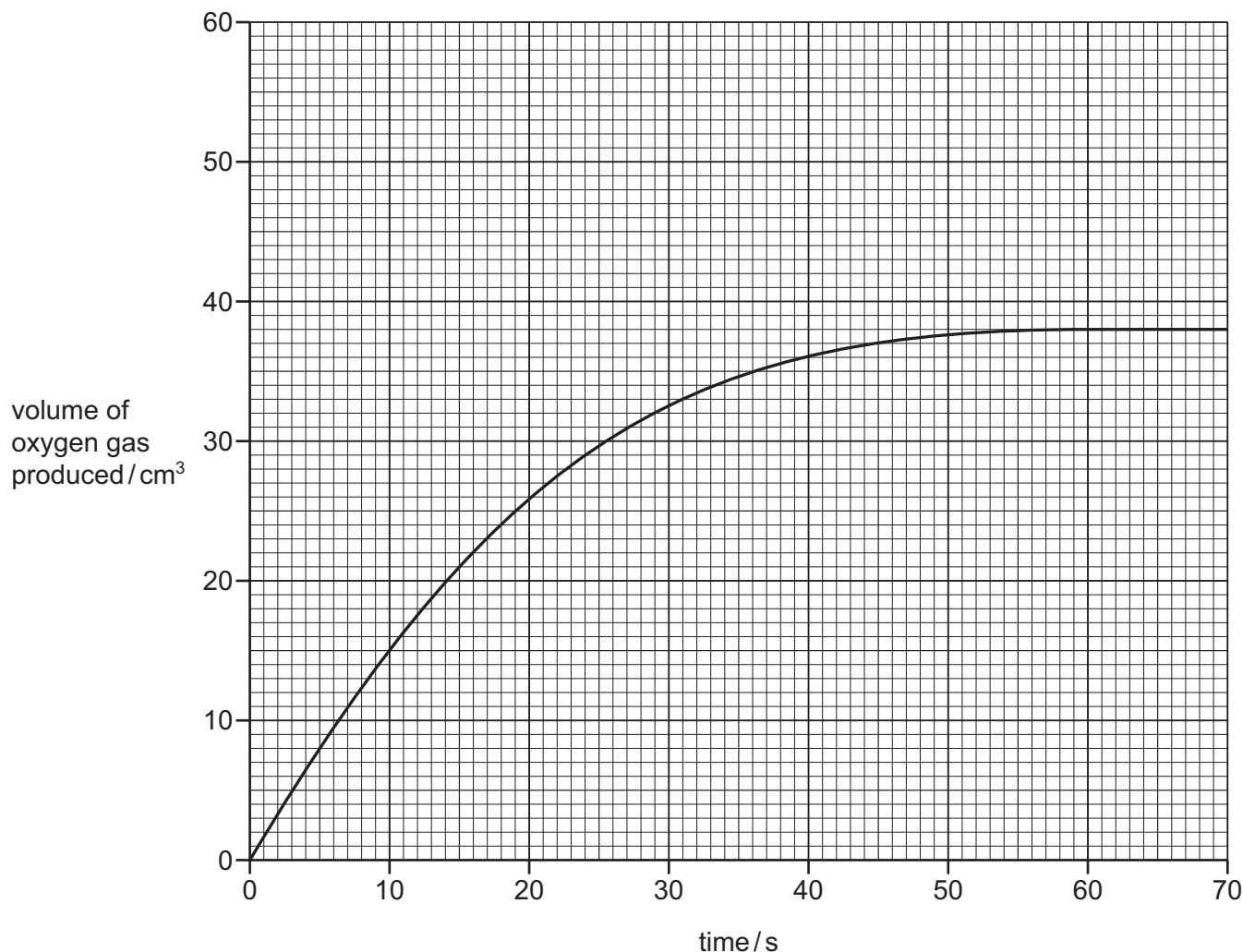
16

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



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 cm³ 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]

17

(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.

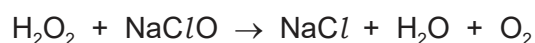
.....

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

.....

[2]

(d) Hydrogen peroxide reduces sodium chlorate(I), NaClO , to sodium chloride.



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

..... [1]

[Total: 6]

BLANK PAGE

BLANK PAGE

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.

Group

$${}^1_1\text{H}$$

atomic number	atomic symbol	name	relative atomic mass
---------------	---------------	------	----------------------

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	europlum	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 dm^3 at room temperature and pressure (r.t.p.).