Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8718554281

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **October/November 2021**

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)** A list of formulae is shown.

$CaCO_3$
CaO
Cl_2
CH_4
C_2H_5OH
C_2H_6
$CuSO_4$
H_2
H_2O
MgO
$NaCl$
SO_2

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

State which formula represents:

(i) a compound that is the main constituent of natural gas

..... [1]

(ii) an element that is used in water treatment

..... [1]

(iii) an element that bleaches damp litmus paper

..... [1]

(iv) a compound that contains an ion with a single negative charge

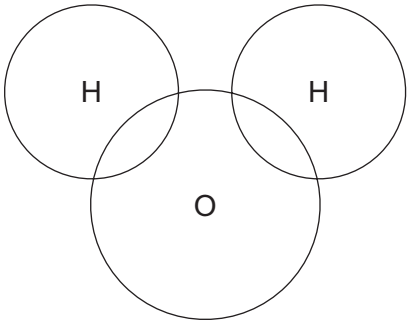
..... [1]

(v) a hydrocarbon that is formed by the decomposition of vegetation.

..... [1]

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(b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of water.



[2]

(c) State whether calcium oxide is a basic oxide or an acidic oxide.
Give a reason for your answer.

.....

..... [1]

[Total: 8]

2 The table shows the masses of some of the ions in 1000 cm^3 of water taken from a lake.

name of ion	formula of ion	mass of ion in 1000 cm^3 of lake water / mg
calcium	Ca^{2+}	0.41
chloride	Cl^-	4.40
magnesium	Mg^{2+}	0.39
	NO_3^-	0.03
potassium	K^+	0.30
silicate	SiO_3^{2-}	0.02
	Na^+	2.90
sulfate	SO_4^{2-}	2.80

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

(i) State which of the negative ions has the lowest concentration.

..... [1]

(ii) Name the compound containing Na^+ and NO_3^- ions.

..... [1]

(iii) Calculate the mass of chloride ions in 250 cm^3 of lake water.

mass = ... mg [1]

(b) Describe a test for sulfate ions.

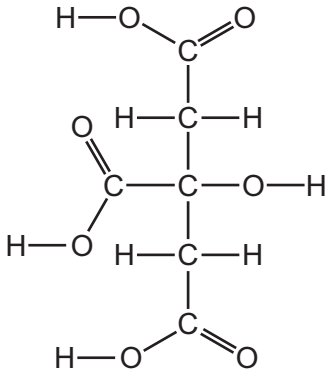
test .....

observations .....
[2]

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(c) Citric acid is also present in the lake water.

The structure of citric acid is shown.



(i) Deduce the number of carboxylic acid groups in one molecule of citric acid.

..... [1]

(ii) The formula of citric acid is $C_6H_8O_7$.

Complete the table to calculate the relative molecular mass of citric acid.

type of atom	number of atoms	relative atomic mass	
carbon	6	12	$6 \times 12 = 72$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

[Total: 8]

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[Turn over

3 Iron is extracted from iron ore in a blast furnace.

(a) Name an ore of iron.

..... [1]

(b) (i) Complete the chemical equation for the reduction of iron(III) oxide in the blast furnace.

$$Fe_2O_3 + ...CO \rightarrow .....Fe + 3CO_2$$ [2]

(ii) State the meaning of the term *reduction*.

..... [1]

(c) Calcium carbonate (limestone) is added to the blast furnace.
The calcium carbonate undergoes thermal decomposition.

State the meaning of the term *thermal decomposition*.

.....

..... [2]

(d) Iron can be made into stainless steel.

(i) Give **one** use of stainless steel.

..... [1]

(ii) Describe **one** advantage of stainless steel compared with pure iron.

.....

..... [1]

(e) The symbol for an isotope of iron is shown.

$$^{57}_{26}Fe$$

Deduce the number of electrons, neutrons and protons in one atom of this isotope of iron.

number of electrons .....

number of neutrons .....

number of protons .....
[3]

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(f) Iron is a good conductor of heat and electricity.

Give two **other** physical properties of iron that are characteristic of **all** metals.

1 .....

2 .....
[2]

(g) Iron rusts.

Name the **two** substances needed for iron to rust.

1 .....

2 .....
[2]

[Total: 15]

4 The table shows some properties of the Group I elements.

element	melting point / °C	density in g / cm^3	observations during reaction with water
lithium	181	0.53	
sodium	98		rapid bubbling no flame
potassium		0.86	rapid bubbling lilac flame
rubidium	39	1.53	very rapid bubbling red flame
caesium	29	1.88	explodes
francium	27		

(a) (i) Complete the table by predicting:

- the melting point of potassium
- the density of francium. [2]

(ii) Describe the observations when lithium reacts with water.

.....

..... [1]

(b) (i) Deduce the electronic structure of sodium.
Use the Periodic Table to help you.

..... [1]

(ii) Explain why a potassium ion has a single positive charge.

.....

..... [1]

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(c) Sodium reacts with water to produce aqueous sodium hydroxide and a gas which 'pops' with a lighted splint.

(i) Complete the chemical equation for this reaction.

$$2Na + 2H_2O \rightarrow .....NaOH + ...$$ [2]

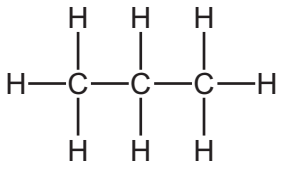
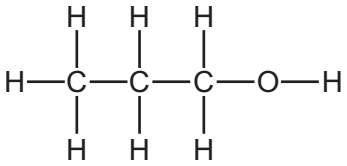
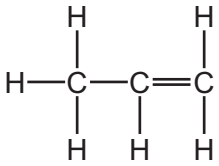
(ii) Choose **one** value from the list that best describes the pH of aqueous sodium hydroxide.

Draw a circle around the correct answer.

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

[Total: 8]

5 The table shows the structures of some organic compounds.

compound	structure of compound	homologous series
G		alkane
H		
J		

(a) Complete the table by naming the homologous series.
The first one has been done for you. [2]

(b) Draw the structure of a compound containing two carbon atoms which belongs to the same homologous series as compound **H**.
Show all of the atoms and all of the bonds.

[1]

(c) Describe the colour change when an excess of compound **J** is added to aqueous bromine.

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

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(d) (i) Compound **J** can be obtained by cracking petroleum fractions.

State the conditions needed for cracking.

.....

..... [2]

(ii) Complete this sentence about cracking using a word from the list.

bitumen **hydrogen** **oxygen** **petroleum**

The chemicals manufactured by cracking include alkanes, alkenes and ..... .
[1]

(e) Compound **G** is propane.

Complete the word equation for the complete combustion of propane.

propane	+	oxygen	→	....	+	.....

[2]

(f) Compound **J** can form polymers.

(i) State the meaning of the term *polymer*.

.....

..... [2]

(ii) Nylon is also a polymer.

Give **one** use of nylon.

..... [1]

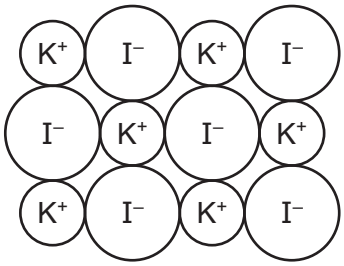
(iii) Describe **one** pollution problem caused by non-biodegradable plastics.

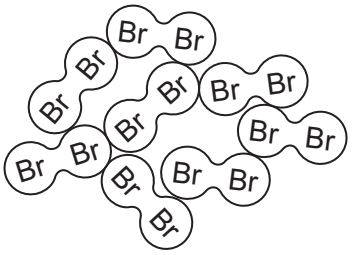
.....

..... [1]

[Total: 14]

6 The diagrams show part of the structures of potassium iodide and bromine at room temperature and pressure.





(a) Describe the physical properties of these substances in terms of:

- volatility

potassium iodide .....

bromine .....

- solubility in water

potassium iodide .....

bromine .....

- electrical conductivity when molten (liquid).

potassium iodide .....

bromine .....

[5]

(b) Molten potassium iodide is electrolysed using carbon (graphite) electrodes.

(i) Name the substance produced at the positive electrode.

..... [1]

(ii) Aqueous potassium iodide reacts with aqueous bromine.

Complete the word equation for this reaction.

potassium iodide	+	bromine	→	....	+	.....

[2]

(iii) Explain in terms of the reactivity of the halogens why aqueous potassium chloride does **not** react with aqueous bromine.

.....

..... [1]

(c) Name the change of state when liquid bromine changes to solid bromine.

..... [1]

[Total: 10]

7 This question is about sulfur and compounds of sulfur.

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

- the arrangement of the particles

.....

.....

.....

- the separation of the particles.

.....

.....

.....

[4]

(b) Give the major use of sulfur in industry.

..... [1]

(c) Sulfur dioxide is a pollutant in the air that contributes to acid rain.

(i) State **one** adverse effect of sulfur dioxide on health.

..... [1]

(ii) Name one **other** oxide that contributes to acid rain.

..... [1]

(iii) Sulfur dioxide reacts with water to produce sulfurous acid.
The reaction is reversible.

Draw the symbol for a reversible reaction in the box.

$$SO_2 + H_2O \boxed{} H_2SO_3$$ [1]

(d) The equation for the reaction of sodium sulfite with zinc is shown.

$$Na_2SO_3 + 3Zn \rightarrow Na_2S + 3ZnO$$

Explain how this equation shows that zinc is oxidised.

.....

..... [1]

[Total: 9]

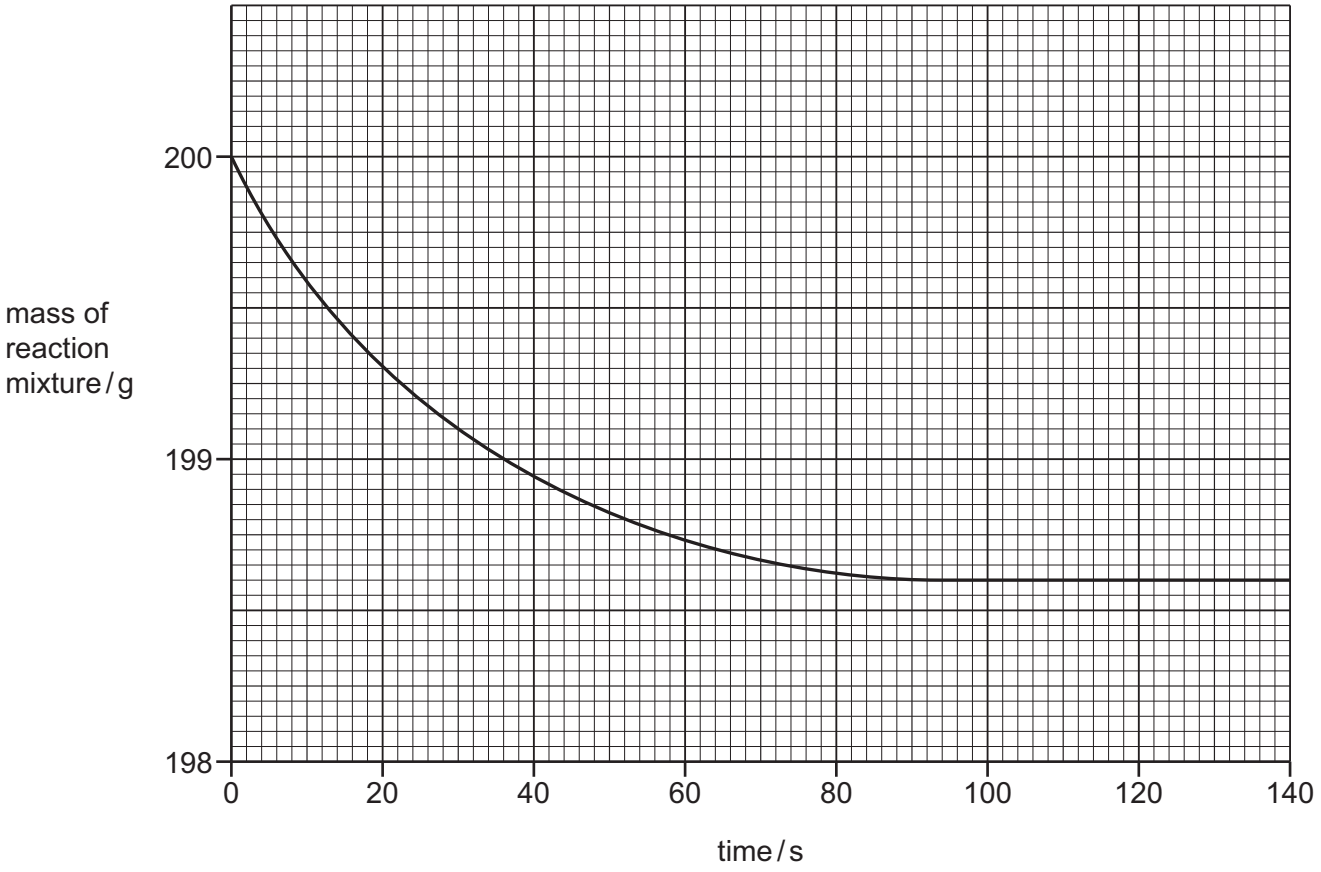
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8 A student investigated the reaction of small pieces of calcium carbonate with dilute hydrochloric acid. The hydrochloric acid was in excess.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

The rate of reaction is found by measuring the decrease in the mass of the reaction mixture with time.

The results are shown on the graph.



(a) Deduce the time taken from the beginning of the experiment for the mass of the reaction mixture to decrease by 1.0 g.

time = ... s [1]

(b) The experiment was repeated using dilute hydrochloric acid of a higher concentration.

All other conditions stayed the same.

Draw a line **on the grid** to show how the mass of the reaction mixture changes with time using acid of a higher concentration. [2]

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[Turn over

(c) Describe the effect each of the following has on the rate of reaction of calcium carbonate with hydrochloric acid.

All other conditions stay the same.

- The reaction is carried out at a higher temperature.

.....

- The reaction is carried out using large pieces of calcium carbonate instead of small pieces of calcium carbonate.

.....

[2]

(d) When 0.44 g of calcium carbonate is used, 100 cm^3 of carbon dioxide gas is formed.

Calculate the mass of calcium carbonate needed to produce 25 cm^3 of carbon dioxide gas.

mass of calcium carbonate = ... g [1]

(e) The table compares the reaction of four metals with dilute hydrochloric acid.

metal	observations
iron	bubbles produced slowly
magnesium	bubbles produced very rapidly
nickel	bubbles produced very slowly
silver	no bubbles produced

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive → most reactive

[2]

[Total: 8]

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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.).