Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5071615272

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 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.

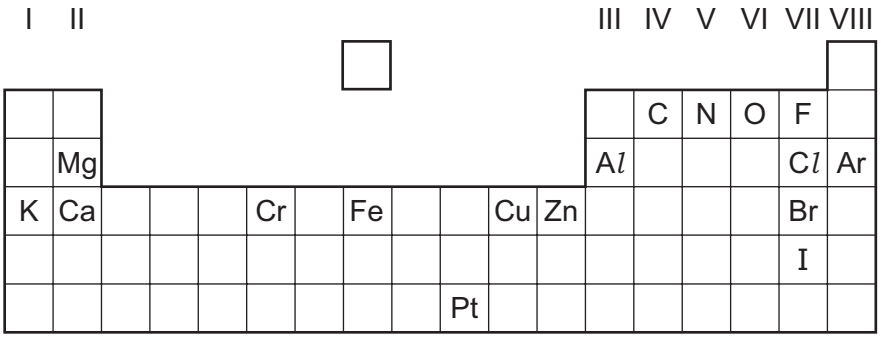
INFORMATION

- 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 **16** pages. Any blank pages are indicated.

© UCLES 2021
[Turn over

1 The diagram shows part of the Periodic Table.



Answer the following questions using only the symbols of the elements in the diagram. Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(a) is extracted from bauxite

..... [1]

(b) forms 21% of clean, dry air

..... [1]

(c) forms an oxide which contributes to acid rain

..... [1]

(d) forms an aqueous ion that gives a red-brown precipitate on addition of aqueous sodium hydroxide

..... [1]

(e) has an atom with a complete outer electron shell.

..... [1]

[Total: 5]

© UCLES 2021

2 The table shows the mass of some of the ions in a 1000 cm^3 sample of sea water.

name of ion	formula of ion	mass of ion in 1000 cm^3 of sea water / mg
bromide	Br^-	65
calcium	Ca^{2+}	400
chloride	Cl^-	18 980
hydrogencarbonate	HCO_3^-	140
magnesium	Mg^{2+}	1262
metaborate	$B_3O_6^{3-}$	26
	K^+	380
sodium	Na^+	10 556
strontium	Sr^{2+}	13
	SO_4^{2-}	2649

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

(i) State which negative ion has the lowest mass in 1000 cm^3 of sea water.

..... [1]

(ii) Give the formulae of the ions in potassium sulfate.

..... and ..... [1]

(iii) Calculate the mass of calcium ions in 200 cm^3 of this sample of sea water.

mass = ... mg [1]

(iv) A sample of this sea water is evaporated.

State the name of the compound which is present in the greatest quantity when this sample is evaporated.

..... [1]

(v) Give the name of the ion which reacts with aqueous silver nitrate to give a cream precipitate.

..... [1]

© UCLES 2021

[Turn over

(b) The $B_3O_6^{3-}$ ion can be converted to boric acid, H_3BO_3.

Boric acid is also produced when boron trichloride, BCl_3, reacts with water.

Complete the equation for this reaction.

$$BCl_3 + ...H_2O \rightarrow H_3BO_3 + ...HCl$$ [2]

(c) The symbol of a strontium ion is shown.

$$^{87}_{38}Sr^{2+}$$

Deduce the number of electrons, protons and neutrons in one atom of this strontium ion.

number of electrons .....

number of protons .....

number of neutrons .....

[3]

(d) Some isotopes of strontium are radioactive.

(i) Give **one** medical use of radioactive isotopes.

..... [1]

(ii) The isotope ^{235}U is also radioactive.

State the major use of this isotope of uranium.

..... [1]

[Total: 12]

© UCLES 2021

3 The table shows some properties of four halogens.

element	melting point in °C	boiling point in °C	density of liquid at melting point in g / cm^3
fluorine	–220	–188	
chlorine	–101		1.56
bromine	–7	59	3.12
iodine	114	184	4.93

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

- the boiling point of chlorine
- the density of fluorine at its melting point.

[2]

(ii) Describe the trend in the melting points of the halogens down the group.

..... [1]

(iii) Deduce the physical state of iodine at 130 °C.
Explain your answer.

.....

.....

..... [2]

(b) (i) Give the electronic structure of a fluorine atom.

..... [1]

(ii) Explain why a fluoride ion has a single negative charge.

.....

..... [1]

(c) Magnesium reacts with excess fluorine to produce magnesium fluoride.
When 2.40 g of magnesium is reacted, 6.20 g of magnesium fluoride is produced.

Calculate the mass of magnesium needed to produce 1.24 g of magnesium fluoride.

mass of magnesium = ... g [1]

[Total: 8]

© UCLES 2021

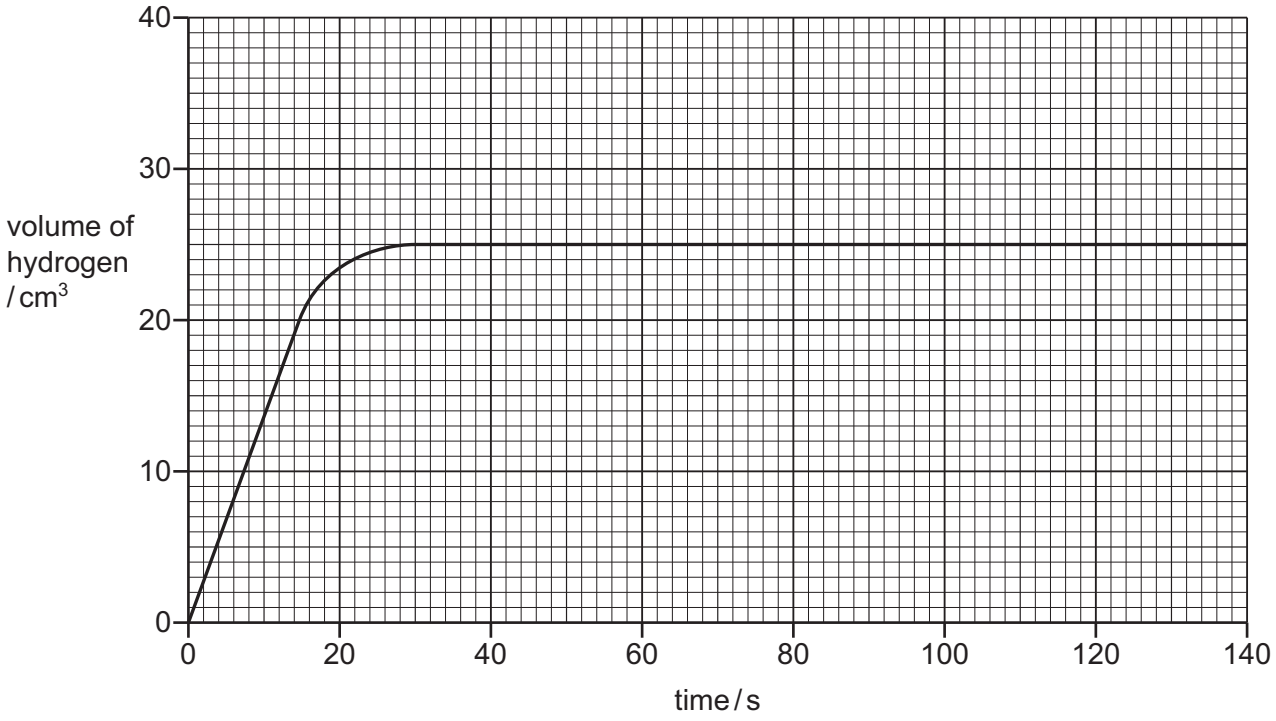
[Turn over

4 A student investigates the reaction of magnesium powder with dilute hydrochloric acid. The magnesium is in excess.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

The rate of reaction can be found by measuring the increase in volume of hydrogen with time.

The results are shown on the graph.



(a) Deduce the time taken for the reaction to finish.

time taken = ... s [1]

(b) The experiment is repeated using dilute hydrochloric acid of a lower concentration.

Draw a line **on the grid** to show how the volume of hydrogen changes with time using dilute hydrochloric acid of a lower concentration.

All other conditions stay the same. [2]

© UCLES 2021

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

- The temperature is increased.

  All other conditions stay the same.

  .....

- Magnesium ribbon is used instead of magnesium powder.

  All other conditions stay the same.

  .....

[2]

(d) Hydrochloric acid reacts with calcium carbonate.

Name the products of this reaction and give the observations.

products .....

.....

observations .....

.....

[4]

[Total: 9]

5 This question is about sulfur and compounds of sulfur.

(a) Sulfur is a non-metal.

Describe **three** physical properties which are typical of non-metals.

1 .....

2 .....

3 .....

[3]

(b) Name **one** source of sulfur.

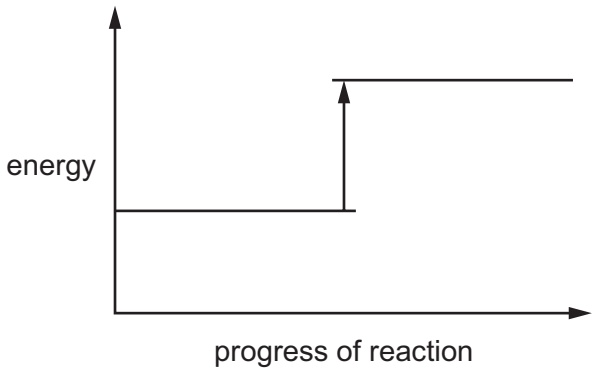
..... [1]

(c) When carbon is heated with sulfur, carbon disulfide, CS_2, is produced.

$$C + 2S \rightarrow CS_2$$

(i) Complete the energy level diagram for the production of carbon disulfide by writing these formulae on the diagram:

- $C + 2S$
- CS_2.



[1]

(ii) Explain, using information on the energy level diagram, how you know that this reaction is endothermic.

..... [1]

(d) Carbon disulfide is a liquid at room temperature.

Describe the separation and motion of the particles in carbon disulfide liquid.

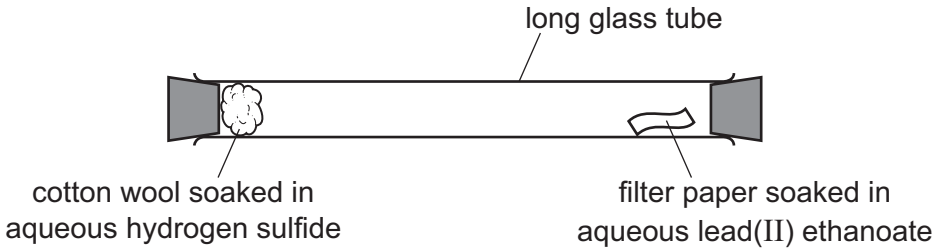
separation .....

motion .....
[2]

(e) Hydrogen sulfide is a gas which turns filter paper soaked in aqueous lead(II) ethanoate from white to black.

Hydrogen sulfide is slightly soluble in water.

A long glass tube is set up as shown.



At first, the filter paper soaked in aqueous lead(II) ethanoate does not turn black.
After a short time, the filter paper soaked in aqueous lead(II) ethanoate turns black.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(f) Sulfur dioxide is a pollutant in the air.

(i) Give **one** adverse effect of sulfur dioxide on buildings.

..... [1]

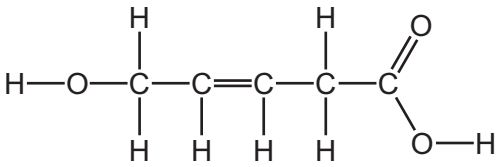
(ii) Sulfur dioxide is used to bleach paper.

Give one **other** use of sulfur dioxide.

..... [1]

[Total: 13]

6 The structure of compound **A** is shown.



(a) (i) On the structure of compound **A**, draw a circle around the carboxylic acid functional group. [1]

(ii) State the name of the carboxylic acid that has only two carbon atoms.

..... [1]

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

..... [1]

(iv) Explain, by referring to its structure, why compound **A** is described as unsaturated.

..... [1]

(b) Ethene is an unsaturated hydrocarbon.

Draw the structure of ethene to show all of the atoms and all of the bonds.

[2]

(c) Ethene can be produced by cracking hydrocarbons.

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

.....

..... [1]

(ii) Give the conditions required for cracking.

1 .....

2 .....
[2]

(d) Ethene can be polymerised.

Complete these sentences about the polymerisation of ethene using words from the list.

addition **decomposition** **neutralisation** **poly(ethene)**

poly(ethane) **reduction** ***Terylene***

When ethene polymerises, it produces a molecule called ..... .

The type of reaction which occurs is ..... .

[2]

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

..... [1]

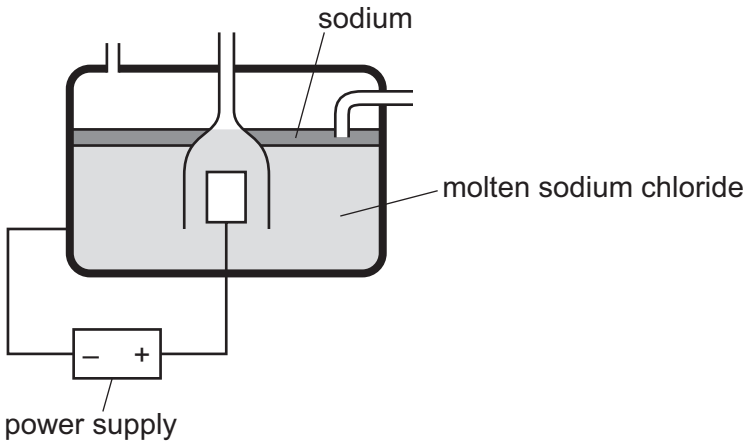
[Total: 12]

7 Sodium is manufactured by electrolysis.

(a) Explain why sodium is manufactured by electrolysis and **not** by reduction with carbon.

..... [1]

(b) The diagram shows the equipment for the production of sodium.



(i) The anode is inert.

Suggest a suitable substance that can be used for the anode.

..... [1]

(ii) Label the anode **on the diagram**. [1]

(iii) Describe, by reference to the diagram, how you know that sodium is less dense than molten sodium chloride.

..... [1]

(c) When concentrated aqueous sodium chloride is electrolysed, gases are produced at each electrode.

State the names of the products and give the observations at each electrode.

product at the negative electrode .....

observations at the negative electrode .....

.....

product at the positive electrode .....

observations at the positive electrode .....

.....

[4]

(d) Give **two** ways in which the physical properties of sodium are different from the physical properties of transition elements.

1 .....

2 .....

[2]

(e) The symbol equation for the production of sodium hydride is shown.

$$2Na + H_2 \rightarrow 2NaH$$

(i) Write a word equation for this reaction.

..... [1]

(ii) Suggest why the hydrogen must be dry.

..... [1]

(iii) Sodium hydride reduces iron(III) oxide to iron.

$$Fe_2O_3 + 3NaH \rightarrow 2Fe + 3NaOH$$

Explain how this equation shows that iron(III) oxide is reduced.

..... [1]

(f) State the colour observed in the flame test for sodium.

..... [1]

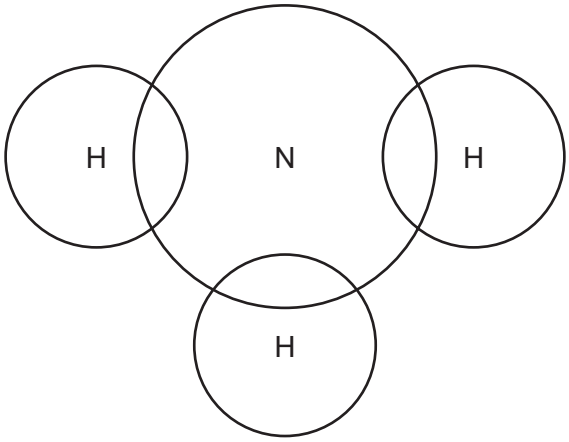
[Total: 14]

© UCLES 2021

[Turn over

8 Aqueous ammonia is an alkali.

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



[2]

(b) Complete the word equation for the reaction of aqueous ammonia with dilute hydrochloric acid.

ammonia	+	hydrochloric acid	→	....

[1]

(c) Describe the colour change when excess aqueous ammonia is added to an acidified solution of methyl orange.

from ..... to ..... [1]

(d) Aqueous ammonia reacts with aqueous copper(II) ions to produce compound **B**.

The formula of compound **B** is $CuN_4H_{16}O_2$.

Complete the table to calculate the relative molecular mass of compound **B**.

type of atom	number of atoms	relative atomic mass	
copper	1	64	$1 \times 64 = 64$
nitrogen	4	14	$4 \times 14 = 56$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

(e) Ammonia is used in the production of fertilisers.

State why farmers put fertilisers on the soil where crops are to be grown.

..... [1]

[Total: 7]

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 the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

© UCLES 2021

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.).