Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8693358623

CHEMISTRY **0620/32**

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

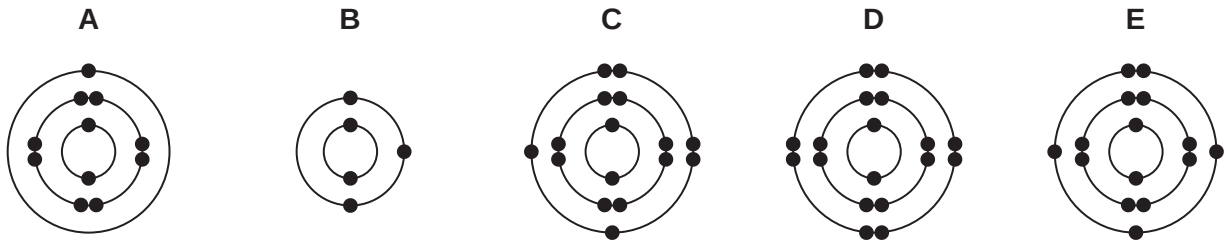
INFORMATION

- 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.

[Turn over

1 **(a)** The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(i) an atom in Group III of the Periodic Table

..... [1]

(ii) an atom of a noble gas

..... [1]

(iii) an atom that forms a stable ion with a single positive charge

..... [1]

(iv) an atom that contains only two shells of electrons

..... [1]

(v) an atom with a proton number of 16.

..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the silicon atom and sodium ion shown.

	number of electrons	number of neutrons	number of protons
$^{30}_{14}Si$	14		
$^{23}_{11}Na^{+}$		12	

[3]

[Total: 8]

2 The table shows the masses of some of the ions in 1000 cm^3 of fruit juice.

name of ion	formula of ion	mass of ion in 1000 cm^3 of fruit juice / mg
ammonium	NH_4^+	15
	Ca^{2+}	71
chloride	Cl^-	135
magnesium	Mg^{2+}	160
nitrate	NO_3^-	2
phosphate	PO_4^{3-}	63
potassium	K^+	184
sodium	Na^+	3
	SO_4^{2-}	85

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

(i) State which positive ion has the lowest mass in 1000 cm^3 of fruit juice.

..... [1]

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

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

(iii) Calculate the mass of magnesium ions in 250 cm^3 of fruit juice.

mass = ... mg [1]

(b) Describe a test for calcium ions.

test .....

observations .....
[2]

(c) Ammonium ions, NH_4^+, are present in most fertilisers. Ammonium ions contain nitrogen.

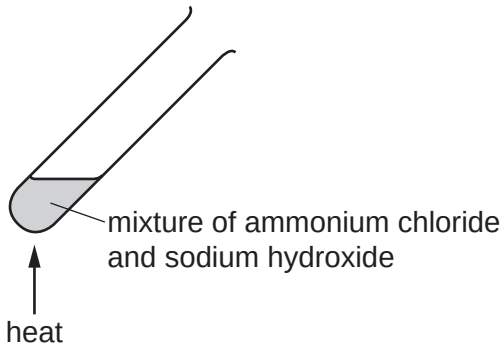
Name two **other** elements present in most fertilisers.

1 .....

2 .....
[2]

(d) A student heated a mixture of ammonium chloride and sodium hydroxide in a test-tube.

$$NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$$



Pungent-smelling ammonia gas is given off.

Describe one **other** observation that can be made.

..... [1]

(e) Ammonia reacts with chlorine.

Complete the equation for this reaction.

$$.....NH_3 + ...Cl_2 \rightarrow N_2 + 6HCl$$ [2]

(f) A small beaker of aqueous ammonia is placed at the front of a classroom.

At first, the students at the back of the class do not smell the ammonia gas.
After a short time, the students at the back of the class smell the ammonia.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

[Total: 13]

3 The table shows some properties of four halogens.

element	melting point / °C	boiling point / °C	density of liquid at boiling point in g / cm^3	colour
chlorine	–101	–35	1.56	light green
bromine	–7		3.12	red-brown
iodine	114	184		dark grey
astatine	302	337	6.35	black

(a) (i) Complete the table by predicting:
- the boiling point of bromine
- the density of liquid iodine at its boiling point.

[2]

(ii) Describe the trend in the depth of colour of the halogens down the group.

..... [1]

(iii) Deduce the state of chlorine at –50 °C.
Explain your answer.

.....

.....

..... [2]

(b) The halogens have molecules that are diatomic.

Explain the meaning of the term *diatomic*.

..... [1]

(c) Astatine is a radioactive element. One isotope of astatine has a nucleon number of 209.

(i) Define *nucleon number*.

..... [1]

(ii) State **one** medical use of radioactive isotopes.

..... [1]

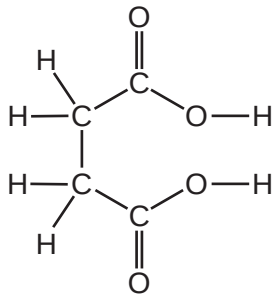
(iii) The isotope ^{235}U is also radioactive.

State the major use of this isotope of uranium.

..... [1]

[Total: 9]

4 The structure of succinic acid is shown.



(a) (i) On the structure draw a circle around one carboxylic acid functional group. [1]

(ii) Deduce the formula of succinic acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(b) When succinic acid is heated it undergoes sublimation.

State the meaning of the term *sublimation*.

.....

..... [1]

(c) Succinic acid is heated with compound **F**.

Compound **F** has the formula $HOCH_2CH_2OH$.

(i) State the name of the –OH functional group in compound **F**.

..... [1]

(ii) A polymer is formed when succinic acid is heated with compound **F**.

Choose **one** word from the list that best describes the small molecules that react together to form a polymer.

Draw a circle around the correct answer.

bases **ceramics** **monomers** **plastics** [1]

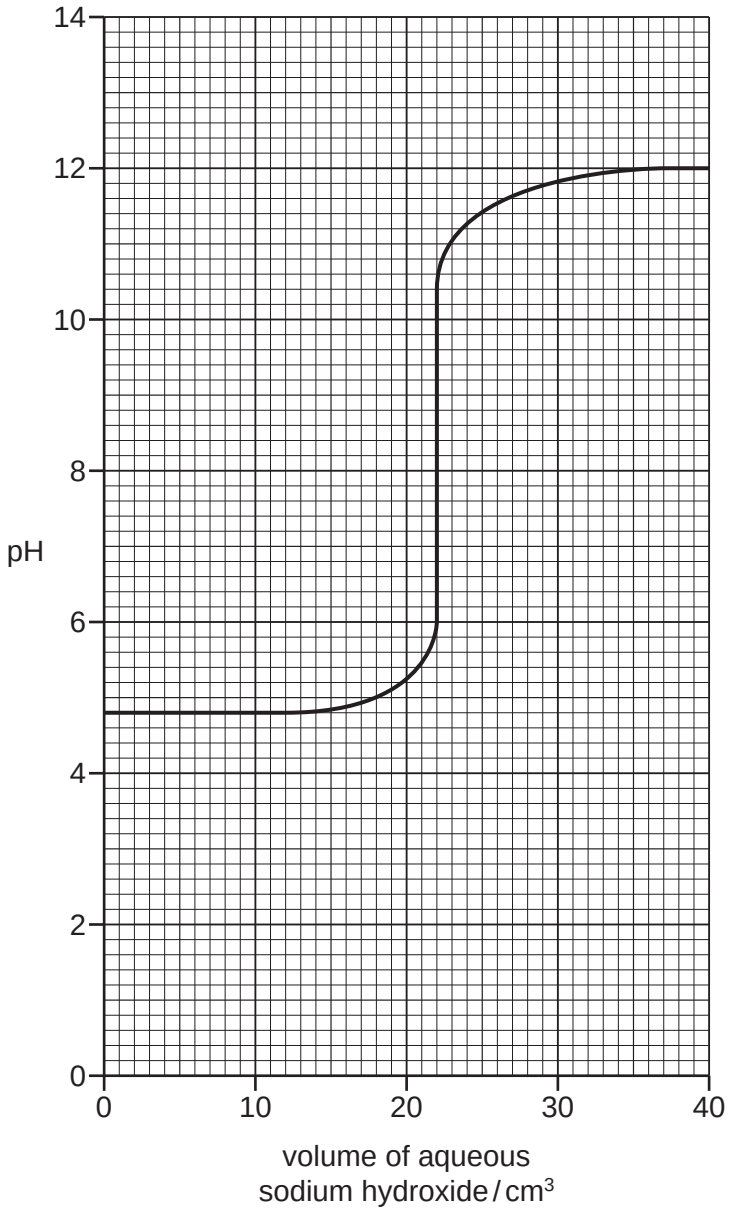
(d) Ethanoic acid is also a carboxylic acid.

Describe the observations made when ethanoic acid reacts with:

blue litmus paper .....

calcium carbonate. .....
[2]

(e) A student's graph of how the pH changes when aqueous sodium hydroxide is added slowly to dilute ethanoic acid is shown.



(i) Deduce the pH of the dilute ethanoic acid before the addition of aqueous sodium hydroxide.

pH = ... [1]

(ii) Deduce the volume of aqueous sodium hydroxide added when the pH is neutral.

..... cm^3 [1]

[Total: 9]

5 **(a)** Calcium carbonate is heated in a closed container.

$$CaCO_3 \rightleftharpoons CaO + CO_2$$

(i) State the name of a rock which is mainly calcium carbonate.

..... [1]

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

..... [1]

(iii) CaO is lime. Lime is used for neutralising acidic industrial waste.

Give one **other** use of lime.

..... [1]

(iv) Describe a test for carbon dioxide.

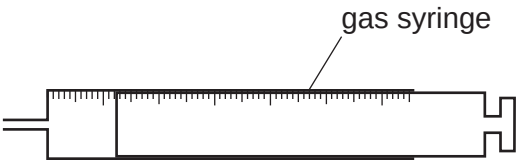
test .....

observations .....
[2]

(b) Carbon dioxide is produced when dilute hydrochloric acid reacts with calcium carbonate.

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

(i) Complete the diagram to show the apparatus used to investigate the volume of carbon dioxide produced during this reaction.



[2]

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

- The temperature is decreased.

All other conditions stay the same.

.....

- Calcium carbonate powder is used instead of large pieces of calcium carbonate.

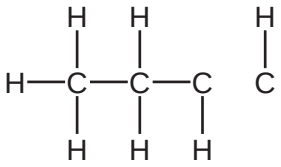
All other conditions stay the same.

.....
[2]

(c) Carbon dioxide is also formed when the hydrocarbon C_4H_8 is completely combusted.

(i) The hydrocarbon C_4H_8 is an alkene.

Complete the structure of this alkene by adding the missing bonds and atom.



[2]

(ii) The incomplete combustion of C_4H_8 produces carbon monoxide.

State the meaning of the term *incomplete combustion*.

.....

..... [1]

[Total: 12]

6 This question is about air and gases.

(a) (i) State the percentage of oxygen in clean, dry air.

..... % [1]

(ii) Name **two** other elements in clean, dry air.

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

(b) Lead and sulfur dioxide are pollutants of air.

For each of these pollutants state the source of the pollutant and an adverse effect of the pollutant.

source of lead .....

adverse effect .....

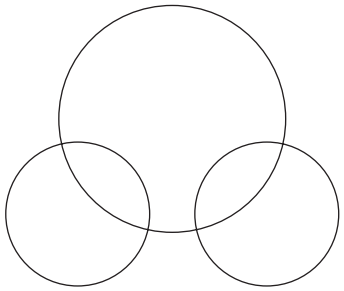
source of sulfur dioxide .....

adverse effect .....

[4]

(c) Water is present in the atmosphere.

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



[2]

(ii) Anhydrous copper(II) sulfate is used to test for water.

State the colour change in this test.

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

[Total: 11]

7 **(a)** Dilute sulfuric acid is electrolysed using carbon electrodes.

State the products of this electrolysis at:

the negative electrode .....

the positive electrode. .....
[2]

(b) Graphite is a form of carbon. Graphite has a giant structure with covalent bonds.

(i) State the meaning of the term *covalent bond*.

.....

..... [2]

(ii) Graphite is a solid.

Describe the arrangement and motion of the particles in a solid.

arrangement .....

.....

motion .....

.....
[2]

(c) Graphite is one form of solid carbon.

Name one **other** form of solid carbon.

..... [1]

[Total: 7]

8 This question is about elements in the Periodic Table.

(a) The table shows some properties of five elements, **P**, **Q**, **R**, **S** and **T**.

element	melting point / °C	density in g / cm^3	electrical conductivity of the solid	atomic radius / nm
P	63	0.86	very good	0.235
Q	–7	3.12	does not conduct	0.114
R	839	1.54	very good	0.174
S	1495	8.9	very good	0.126
T	–157	0.0035	does not conduct	0.110

Use only the elements shown in the table to answer this question.

State which two of the elements, **P**, **Q**, **R**, **S** and **T**, are covalent molecules.
Give **two** reasons for your answer.

elements ..... and .....

reason 1 .....

reason 2 .....

[3]

(b) Describe how the metallic character of the elements depends on their position in the Periodic Table.

.....

..... [1]

(c) Potassium is an element in Group I of the Periodic Table. Cobalt is a transition element.

Cobalt has a higher density than potassium.

Give **two** other ways in which the properties of transition elements differ from the properties of Group I elements.

1 .....

2 .....

[2]

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

..... [1]

(e) The table compares the ease of reduction of four metal oxides when heated with carbon.

metal oxide	details of reduction
chromium(III) oxide	reduced at 1200 °C
manganese(IV) oxide	reduced at 1400 °C
potassium oxide	not reduced at 1400 °C
zinc oxide	reduced at 850 °C

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

least reactive → most reactive

[2]

(f) Describe how aqueous sodium hydroxide is used to test for chromium(III) ions, Cr^{3+}.

.....

.....

..... [2]

[Total: 11]

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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.).