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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 6 6 0 9 4 7 6 1 4 2 *

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **May/June 2023**

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 Fig. 1.1 shows part of the Periodic Table.

I	II											III	IV	V	VI	VII	VIII
																	He
													C	N	O		Ne
																Cl	
K	Ca				Cr					Cu	Zn					Br	
	Sr															I	

Fig. 1.1

Answer the following questions using only the elements in Fig. 1.1.
Each symbol of the element may be used once, more than once or not at all.

Give the symbol of the element that:

(a) forms 21% by volume of clean, dry air

..... [1]

(b) has an atom with only three occupied electron shells

..... [1]

(c) has an atom with only one electron in its outer shell

..... [1]

(d) is a grey-black solid at room temperature

..... [1]

(e) forms an ion that gives a green precipitate on addition of aqueous ammonia

..... [1]

(f) is used in electrical wiring because of its good ductility.

..... [1]

[Total: 6]

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2 **(a)** Table 2.1 shows some properties of the halogens.

Table 2.1

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g/cm^3
chlorine	–101	–35	0.003
bromine	–7	+59	3.12
iodine	+114		4.93
astatine	+302	+337	

Use the information in Table 2.1 to predict:

(i) the boiling point of iodine ..... [1]

(ii) the density of astatine at room temperature and pressure ..... [1]

(iii) the physical state of bromine at +50 °C. Give a reason for your answer.

physical state .....

reason .....

.....
[2]

(b) Aqueous bromine reacts with aqueous potassium iodide.

(i) Complete the word equation for this reaction.

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

[2]

(ii) Explain why aqueous iodine does **not** react with aqueous potassium bromide.

..... [1]

(iii) Describe a test for iodide ions.

test .....

observations .....
[2]

[Total: 9]

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3 **(a)** Water from natural sources can contain metal compounds and phosphates.

(i) Name two **other** substances found in water which are harmful to aquatic life.

1 .....

2 .....
[2]

(ii) State why phosphates are harmful to aquatic life.

..... [1]

(b) Table 3.1 shows the masses of ions, in mg, present in a 1000 cm^3 sample of polluted water.

Table 3.1

name of ion	formula of ion	mass of ion present in mg / 1000 cm^3 of polluted water
ammonium	NH_4^+	0.5
calcium	Ca^{2+}	1.8
chloride	Cl^-	2.0
copper(II)	Cu^{2+}	0.3
hydrogencarbonate	HCO_3^-	8.0
magnesium	Mg^{2+}	1.6
	NO_3^-	0.6
potassium	K^+	8.3
silicate	SiO_3^{2-}	5.0
sodium	Na^+	5.2
sulfate	SO_4^{2-}	0.2

Answer these questions using information from Table 3.1.

(i) Name the positive ion present in the highest concentration.

..... [1]

(ii) State the name of the NO_3^- ion.

..... [1]

(iii) Calculate the mass of magnesium ions present in 250 cm^3 of polluted water.

mass = ... mg [1]

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(c) Water is produced when blue copper(II) sulfate is heated.

$$\underset{\text{blue copper(II) sulfate}}{CuSO_4{\bullet}5H_2O(s)} \rightleftharpoons \underset{\text{white copper(II) sulfate}}{CuSO_4(s)} + 5H_2O(l)$$

(i) Describe how white copper(II) sulfate can be changed to blue copper(II) sulfate.

..... [1]

(ii) Choose a word from the list which best describes white copper(II) sulfate.

Draw a circle around your chosen answer.

anhydrous **aqueous** **hydrated** **oxidised** [1]

(d) Complete the symbol equation for the reaction of calcium with water.

$$Ca + ...H_2O \rightarrow Ca(OH)_2 + ...$$ [2]

[Total: 10]

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4 This question is about chlorine and compounds of chlorine.

(a) Chlorine has diatomic molecules.

Define the term diatomic.

..... [1]

(b) Deduce the number of protons, neutrons and electrons in the chloride ion shown.

$^{37}_{17}Cl^{-}$

number of protons .....

number of neutrons .....

number of electrons .....
[3]

(c) Chlorine reacts with hydrogen to produce hydrogen chloride. The reaction is exothermic.

(i) State the meaning of the term exothermic.

.....

..... [2]

(ii) Fig. 4.1 shows an incomplete reaction pathway diagram for the reaction of chlorine with hydrogen.

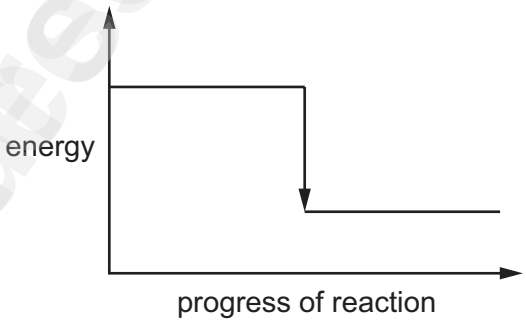

Fig. 4.1

Complete Fig. 4.1 by writing these formulae on the diagram:
- Cl_2 + H_2
- $2HCl$. [1]

(iii) Explain how Fig. 4.1 shows that the reaction is exothermic.

.....

..... [1]

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(d) A few drops of methyl orange indicator are added to dilute hydrochloric acid.

State the colour of the solution.

..... [1]

(e) Dilute hydrochloric acid reacts with sodium hydroxide.

(i) Complete the word equation for this reaction.

hydrochloric acid	+	sodium hydroxide	→	....	+	.....

[2]

(ii) Sodium hydroxide is an alkali.

Write the formula of the ion present in all alkalis.

..... [1]

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(f) Fig. 4.2 shows the apparatus used for the electrolysis of concentrated aqueous sodium chloride using graphite electrodes.

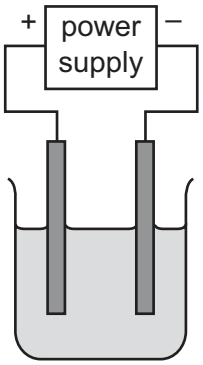

Fig. 4.2

(i) Label Fig. 4.2 to show:
- the anode
- the electrolyte. [2]

(ii) Name the products and state the observations at the positive and negative electrodes.

product at the positive electrode

.....

observations at the positive electrode

.....

product at the negative electrode

.....

observations at the negative electrode

.....
[4]

[Total: 18]

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5 This question is about metals.

(a) Carbon is used to extract iron from iron ore in a blast furnace.

(i) Name the main ore of iron.

..... [1]

(ii) Iron(III) oxide in the iron ore is reduced by carbon monoxide.

Name the **two** substances which react in the blast furnace to produce carbon monoxide.

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

(b) Iron rusts in the presence of oxygen and water.

State **one** method of preventing rusting.

..... [1]

(c) Table 5.1 shows some information about the reaction of four metals with steam.

Table 5.1

metal	reaction with steam when metal is cold
beryllium	reacts slowly
chromium	reacts slowly only when the metal is very hot
magnesium	reacts rapidly
silver	no reaction

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

least reactive → most reactive

[2]

[Total: 6]

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6 **(a)** A student investigates the reaction of different-sized pieces of calcium carbonate with dilute hydrochloric acid.

The sizes of the pieces of calcium carbonate are:
- large
- medium
- small.

All other conditions stay the same.

Table 6.1 shows the time taken for each reaction to finish.

Table 6.1

size of pieces of calcium carbonate	time taken for the reaction to finish / s
	160
	50
	450

(i) Complete Table 6.1 by writing the sizes of the pieces of calcium carbonate in the first column. [1]

(ii) Describe the effect on the time taken for small pieces of calcium carbonate to finish reacting with dilute hydrochloric acid when the temperature is increased.

All other conditions stay the same.

..... [1]

(iii) Describe the effect on the time taken for small pieces of calcium carbonate to finish reacting with dilute hydrochloric acid when the concentration of hydrochloric acid is decreased.

All other conditions stay the same.

..... [1]

(b) Crystals of calcium chloride can be prepared by reacting excess calcium carbonate with dilute hydrochloric acid.

Name the process used to separate the unreacted calcium carbonate from the rest of the reaction mixture.

..... [1]

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(c) Calcium carbonate is insoluble in water.

Choose one **other** compound that is insoluble in water.

Tick (✓) **one** box.

- ammonium sulfate ☐
- potassium nitrate ☐
- silver chloride ☐
- sodium hydroxide ☐

[1]

[Total: 5]

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7 **(a)** Fig. 7.1 shows the displayed formula of compound **D**.

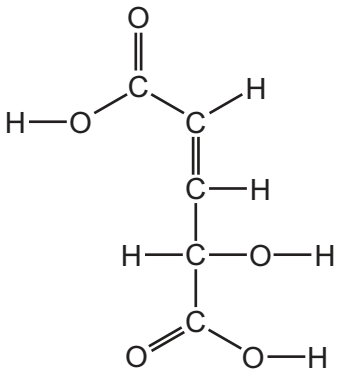

Fig. 7.1

(i) On Fig. 7.1 draw a circle around the alcohol functional group. [1]

(ii) Deduce the molecular formula of compound **D**.

..... [1]

(iii) Explain, by referring to the structure in Fig. 7.1, why compound **D** is unsaturated.

..... [1]

(b) Ethene is also an unsaturated compound.

(i) Draw the displayed formula of ethene.

[1]

(ii) Describe a test for unsaturated compounds.

test .....

observations .....

[2]

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(c) Ethene can be manufactured by cracking larger alkane molecules.

(i) State **two** conditions for cracking.

1 .....

2 .....
[2]

(ii) Complete the symbol equation for the cracking of decane, $C_{10}H_{22}$, to produce ethene and one other hydrocarbon.

$$C_{10}H_{22} \rightarrow C_2H_4 + \text{.....}$$ [1]

(d) Ethanol can be manufactured by the reaction of ethene with steam.

Name one **other** method of manufacturing ethanol.

..... [1]

(e) Ethanol can be oxidised to ethanoic acid.

Ethanoic acid reacts with sodium.

Name the salt formed when ethanoic acid reacts with sodium.

..... [1]

(f) Ethanoic acid reacts with propanol.
The organic product has the molecular formula $C_5H_{10}O_2$.

Complete Table 7.1 to calculate the relative molecular mass of $C_5H_{10}O_2$.

Table 7.1

atom	number of atoms	relative atomic mass	
carbon		12	
hydrogen		1	
oxygen	2	16	$2 \times 16 = 32$

relative molecular mass = ... [2]

[Total: 13]

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8 This question is about non-metals and compounds of non-metals.

(a) Describe **two** physical properties which are typical of non-metals.

1 .....

2 .....
[2]

(b) Methane is a compound of carbon and hydrogen.

(i) Complete Fig. 8.1 to show the dot-and-cross diagram for a molecule of methane.

Show outer shell electrons only.

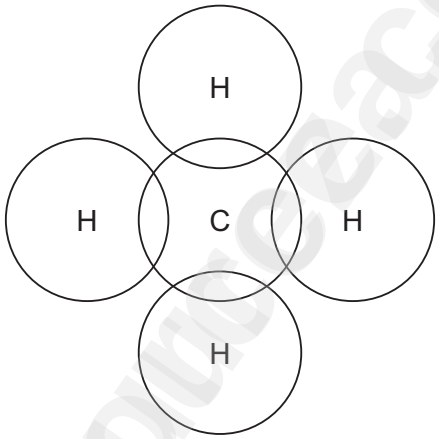

Fig. 8.1

[1]

(ii) Methane is an alkane.

Write the general formula for alkanes.

..... [1]

(iii) Methane is an air pollutant.

State **one** source of methane in the air.

..... [1]

(iv) State **one** adverse effect of methane in the air.

..... [1]

(v) Carbon particulates and water are two of the products of the incomplete combustion of methane.

Name one **other** compound formed during the incomplete combustion of methane.

..... [1]

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(c) Sulfur dioxide is an air pollutant which contributes to acid rain.

(i) Choose from the list the pH value that is acidic.

Draw a circle around your chosen answer.

pH 4 **pH 7** **pH 9** **pH 13** [1]

(ii) State **two** methods of reducing acid rain.

1 .....

2 .....
[2]

(iii) Sulfur dioxide gas turns aqueous acidified potassium manganate(VII) from purple to colourless.

Fig. 8.2 shows a gas jar of sulfur dioxide separated from a gas jar of air by a glass plate. A piece of filter paper soaked in aqueous acidified potassium manganate(VII) is glued to the top of the gas jar of air.

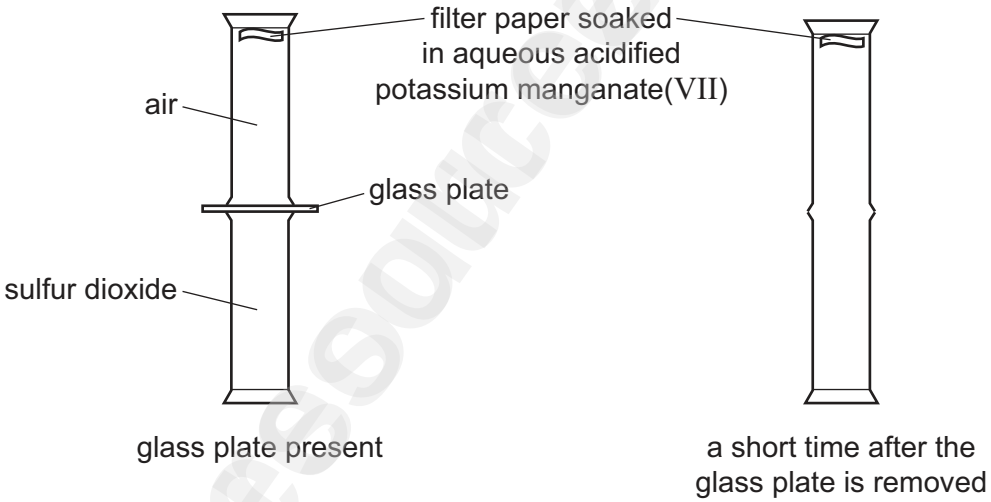

Fig. 8.2

The glass plate is removed.
At first, the filter paper remains purple.
After a short time, the filter paper turns colourless.

Explain these results in terms of the kinetic particle theory.

.....

.....

.....

.....

..... [3]

[Total: 13]

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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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