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Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 6 8 6 3 9 3 9 7 2 9 *

CHEMISTRY **0620/33**

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
Li													C	N	O	F	
												Al					Ar
	Ca				Cr		Fe			Cu						Br	
																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) is present in diamond

..... [1]

(b) forms an oxide that contributes to acid rain

..... [1]

(c) has an atom with five occupied electron shells

..... [1]

(d) forms an ion with a charge of 1+

..... [1]

(e) forms an ion that gives a red-brown precipitate on addition of aqueous ammonia

..... [1]

(f) is used in the manufacture of aircraft because of its low density.

..... [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
fluorine	–220	–188	
chlorine	–101		0.003
bromine	–7	+59	3.12
iodine	+114	+184	4.93

Use the information in Table 2.1 to predict:

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

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

(iii) the physical state of iodine at +100 °C. Give a reason for your answer.

physical state .....

reason .....

.....
[2]

(b) Aqueous chlorine reacts with aqueous sodium bromide.

(i) Complete the word equation for this reaction.

chlorine	+	sodium bromide	→	.....	+	....

[2]

(ii) State a test for sodium ions.

test .....

observations .....
[2]

[Total: 8]

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3 **(a)** Polluted water can contain harmful substances such as metal compounds, nitrates and sewage.

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

1 .....

2 .....
[2]

(ii) State why sewage can cause disease.

..... [1]

(b) Table 3.1 shows the masses of ions, in mg, present in 1000 cm^3 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^+	1.2
calcium	Ca^{2+}	2.2
chloride	Cl^-	2.5
hydrogencarbonate	HCO_3^-	13.0
magnesium	Mg^{2+}	1.0
nickel(II)	Ni^{2+}	0.2
nitrate	NO_3^-	0.4
potassium	K^+	6.3
silicate	SiO_3^{2-}	8.0
sodium	Na^+	12.2
	SO_4^{2-}	0.1

Answer these questions using information from Table 3.1.

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

..... [1]

(ii) State the name of the ion SO_4^{2-}.

..... [1]

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

mass = ... mg [1]

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(c) Cobalt(II) chloride can be used to test for the presence of water.

$$CoCl_2(s) + 6H_2O(l) \rightleftharpoons CoCl_2{\bullet}6H_2O(s)$$

blue cobalt(II) chloride — pink cobalt(II) chloride

(i) Describe how pink cobalt(II) chloride can be changed to blue cobalt(II) chloride.

..... [1]

(ii) Choose a word from the list which best describes pink cobalt(II) chloride.

Draw a circle around your chosen answer.

anhydrous **hydrated** **liquid** **reduced** [1]

(d) Iron reacts with steam to form Fe_3O_4 and a gas which pops with a lighted splint.

Complete the symbol equation for this reaction.

$$3Fe + ...H_2O \rightarrow Fe_3O_4 + 4.....$$ [2]

[Total: 10]

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4 This question is about bromine and compounds of bromine.

(a) Deduce the number of protons, neutrons and electrons in the bromide ion shown.

$^{81}_{35}Br^{-}$

number of protons .....

number of neutrons .....

number of electrons .....
[3]

(b) Hydrogen bromide decomposes to hydrogen and bromine when heated.

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

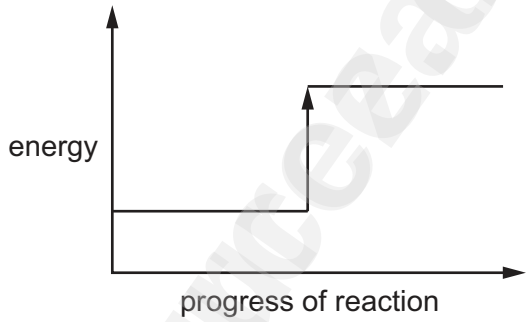

Fig. 4.1

(i) Complete Fig. 4.1 by writing these formulae on the diagram:
- 2HBr
- H_2 + Br_2. [1]

(ii) Explain how Fig. 4.1 shows that the reaction is endothermic.

.....

..... [1]

(iii) Complete this sentence about an endothermic reaction using a word from the list.

products **reactants** **bromine** **surroundings**

An endothermic reaction transfers thermal energy from the ..... . [1]

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(c) Hydrobromic acid is formed when hydrogen bromide dissolves in water.

(i) Write the formula of the ion which is present in all acids.

..... [1]

(ii) Complete the word equation for the reaction of any acid with any carbonate.

acid	+	carbonate	→	.....	+	.....	+	....

[3]

(iii) A few drops of litmus indicator are added to a dilute acid.

State the colour of the solution.

..... [1]

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(d) Fig. 4.2 shows the apparatus used for the electrolysis of molten lead(II) bromide using graphite electrodes.

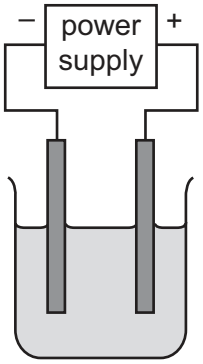

Fig. 4.2

(i) Label Fig. 4.2 to show:
- the cathode
- 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]

(iii) State **one** property of graphite that makes it useful as an electrode.

..... [1]

[Total: 18]

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5 This question is about metals.

(a) Nickel is a transition element. Sodium is an element in Group I of the Periodic Table.

State **two** differences in the physical properties of nickel compared to sodium.

1 .....

2 .....
[2]

(b) Stainless steel is an alloy that is used to make cutlery.

Give **one** reason why stainless steel is used to make cutlery.

..... [1]

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

Table 5.1

metal	reaction with oxygen
gold	no reaction
lanthanum	forms a layer of oxide rapidly but does not burn
magnesium	burns rapidly to form an oxide
nickel	forms a layer of oxide slowly but does not burn

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

least reactive → most reactive

[2]

(d) Complete the diagram in Fig. 5.1 to show the electronic configuration of a magnesium atom.

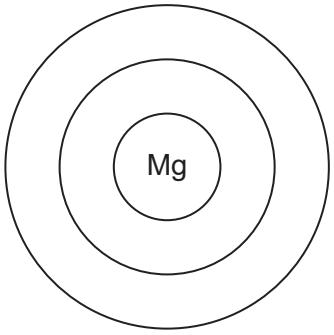

Fig. 5.1

[1]

[Total: 6]

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6 **(a)** A student investigates the reaction of magnesium with dilute hydrochloric acid at three different temperatures.

The temperatures are:
- 20 °C
- 30 °C
- 40 °C.

All other conditions stay the same.

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

Table 6.1

temperature / °C	time taken for the reaction to finish / s
	45
	210
	95

(i) Complete Table 6.1 by writing the temperatures in the first column. [1]

(ii) Describe the effect on the time taken for the magnesium to finish reacting with dilute hydrochloric acid when the surface area of the magnesium is increased.

All other conditions stay the same.

..... [1]

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

All other conditions stay the same.

..... [1]

(b) Describe how crystals of magnesium chloride can be prepared after reacting excess magnesium with dilute hydrochloric acid.

.....

.....

..... [2]

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(c) Magnesium chloride is soluble in water.

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

Tick (✓) **one** box.

- ammonium sulfate ☐
- calcium carbonate ☐
- iron(II) hydroxide ☐
- silver chloride ☐

[1]

[Total: 6]

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

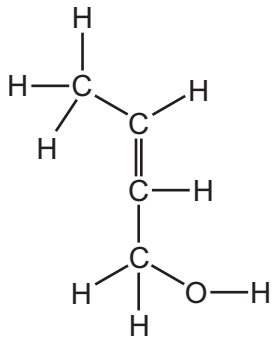

Fig. 7.1

(i) On Fig. 7.1 draw a circle around the functional group that makes compound **E** unsaturated. [1]

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

..... [1]

(iii) Describe a chemical test to distinguish between a saturated and an unsaturated compound.

test .....

observations with saturated compound .....

.....

observations with unsaturated compound .....

..... [3]

(b) Alcohols have an –OH functional group.

(i) Write the general formula for the alcohol homologous series.

..... [1]

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(ii) Ethanol is an alcohol with two carbon atoms in each molecule.

Draw the displayed formula of ethanol.

[1]

(c) Ethanol reacts to form a compound with the formula $C_6H_{12}O_2$.

Complete Table 7.1 to calculate the relative molecular mass of $C_6H_{12}O_2$.

Table 7.1

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

relative molecular mass = ... [2]

(d) Ethanol can be manufactured by the fermentation of aqueous glucose.

State **two** conditions for fermentation.

1 .....

2 .....

[2]

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(e) Ethanol can be oxidised to ethanoic acid.

Complete the word equation for the reaction of ethanoic acid with sodium.

ethanoic acid	+	sodium	→	....	+	.....		

[2]

[Total: 13]

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8 This question is about non-metals.

(a) Non-metals are poor thermal conductors.

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

1 .....

2 .....
[2]

(b) Carbon dioxide contributes to increased global warming which leads to climate change.

State **two** strategies which help to reduce climate change caused by carbon dioxide.

1 .....

2 .....
[2]

(c) Water is a simple molecular compound.

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

Show outer shell electrons only.

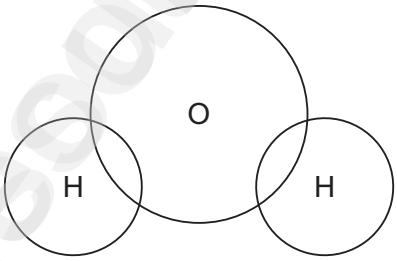

Fig. 8.1

[2]

(ii) State **two** properties of simple molecular compounds.

1 .....

2 .....
[2]

(iii) Water is a good solvent.

State the meaning of the term solvent.

..... [1]

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(iv) Pure water has a neutral pH value.

Choose from the list, the pH value that is neutral.

Draw a circle around your chosen answer.

pH 1 **pH 3** **pH 7** **pH 14** [1]

(v) A crystal of blue copper(II) sulfate is placed at the bottom of a beaker of water as shown in Fig. 8.2.

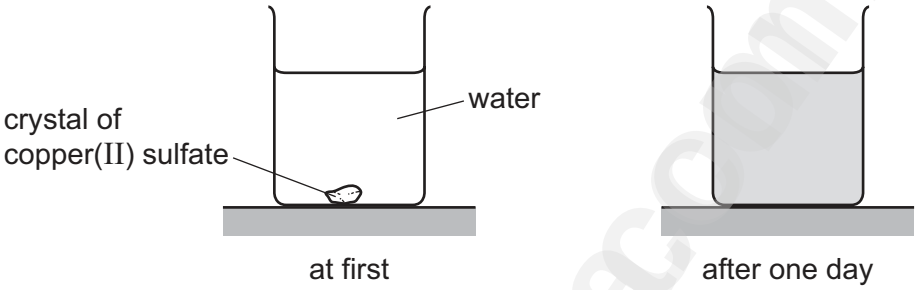

Fig. 8.2

After one day, the blue colour has spread throughout the water in the beaker.

Explain these results in terms of the kinetic particle theory.

.....

.....

.....

..... [3]

[Total: 13]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 –

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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