

**Cambridge IGCSE™**CANDIDATE
NAMECENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY**0620/43**

Paper 4 Theory (Extended)

October/November 2024**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.



1 A list of substances is shown.

bauxite
carbon dioxide
cryolite
ethane
ethanol
ethene
graphite
helium
hematite
hydrogen
silicon(IV) oxide
sodium chloride

Answer the following questions using only the substances from the list.

Each substance may be used once, more than once or not at all.

State which substance:

(a) is manufactured by fermentation

..... [1]

(b) is monatomic

..... [1]

(c) is a reactant in photosynthesis

..... [1]

(d) is a solvent in the extraction of aluminium

..... [1]

(e) is an ore of iron

..... [1]

(f) is manufactured from methane

..... [1]





(g) is a compound with a giant covalent structure

..... [1]

(h) is used as a lubricant

..... [1]

(i) is tested for with limewater.

..... [1]

[Total: 9]





2 This question is about electrolysis.

(a) State the meaning of the term electrolysis.

.....
 [2]

(b) Table 2.1 gives some information about the electrolysis of two electrolytes using graphite electrodes.

Table 2.1

	anode (positive electrode)		cathode (negative electrode)	
electrolyte	observation	name of product	observation	name of product
concentrated aqueous potassium iodide			bubbles of colourless gas	
aqueous copper(II) sulfate	bubbles of colourless gas	oxygen	pink-brown solid	

(i) Complete Table 2.1. [4]

(ii) Oxygen is produced at the anode by the electrolysis of aqueous copper(II) sulfate.

Write the ionic half-equation for this reaction.

..... [2]

(c) Aqueous copper(II) sulfate is electrolysed using copper electrodes instead of graphite electrodes.

(i) Explain why the mass of the anode decreases during this electrolysis.

..... [1]

(ii) Name the product formed at the cathode.

..... [1]

(iii) State what change, if any, is observed in the appearance of the aqueous copper(II) sulfate.

..... [1]

[Total: 11]





3 This question is about compounds of tin.

(a) Tin(IV) oxide has the formula SnO_2 .

The relative formula mass, M_r , of SnO_2 is 151.

Calculate the percentage by mass of tin in SnO_2 .

percentage by mass of tin in SnO_2 =% [1]

(b) SnO_2 is an amphoteric oxide.

SnO_2 reacts with aqueous sodium hydroxide, NaOH , to form a sodium salt and water only.
The sodium salt contains a negative ion with the formula SnO_3^{2-} .

(i) State the meaning of the term amphoteric.

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

(ii) Write the symbol equation for the reaction between SnO_2 and NaOH .

..... [2]

(c) Tin is a metal that forms both covalent and ionic compounds.

Suggest why this is unusual for a metal.

..... [1]





(d) (i) Tin(IV) chloride, SnCl_4 , is covalently bonded.

A tin atom has four electrons in its outer shell.

Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of SnCl_4 .
Show the outer shell electrons only.

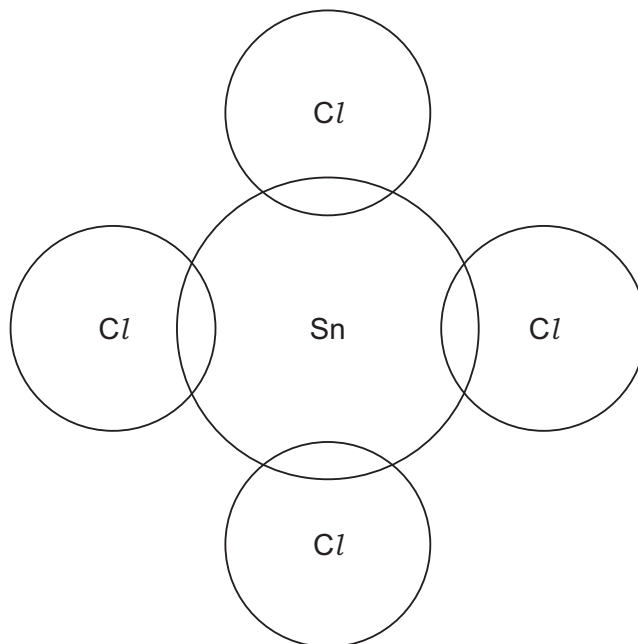


Fig. 3.1

[2]

(ii) Tin(II) oxide, SnO , is ionically bonded.

The melting points of SnCl_4 and SnO are shown in Table 3.1.

Table 3.1

	melting point/ $^{\circ}\text{C}$
SnCl_4	-33
SnO	1080

Explain, in terms of structure and bonding, why SnCl_4 has a much lower melting point than SnO .

.....

.....

.....

.....

..... [3]





(e) Part of the reactivity series is shown.

magnesium	most reactive
aluminium	↑
tin	
copper	least reactive

- (i) When aluminium foil is added to aqueous tin(II) sulfate, a reaction does **not** occur even though aluminium is above tin in the reactivity series.

Explain why a reaction does **not** occur.

.....
 [1]

- (ii) An aqueous solution of tin(II) sulfate contains Sn^{2+} ions.

Two experiments are carried out.

Experiment 1 Copper is added to aqueous tin(II) sulfate.

Experiment 2 Magnesium is added to aqueous tin(II) sulfate.

Write an ionic equation for any reaction that occurs in each experiment.
 If no reaction occurs, write 'no reaction'.

Experiment 1
 Experiment 2 [2]

- (f) Hydrated tin(II) nitrate, $\text{Sn}(\text{NO}_3)_2 \cdot 20\text{H}_2\text{O}$, decomposes when it is heated.

- (i) State what is meant by the term hydrated.

.....
 [1]

- (ii) Complete the equation for the decomposition of $\text{Sn}(\text{NO}_3)_2 \cdot 20\text{H}_2\text{O}$.



[2]

[Total: 16]





4 This question is about sulfuric acid, H_2SO_4 .

- (a) Dilute sulfuric acid and aqueous sodium hydroxide can be used to prepare sodium sulfate crystals using a method that involves titration.

The apparatus for titration is shown in Fig. 4.1.

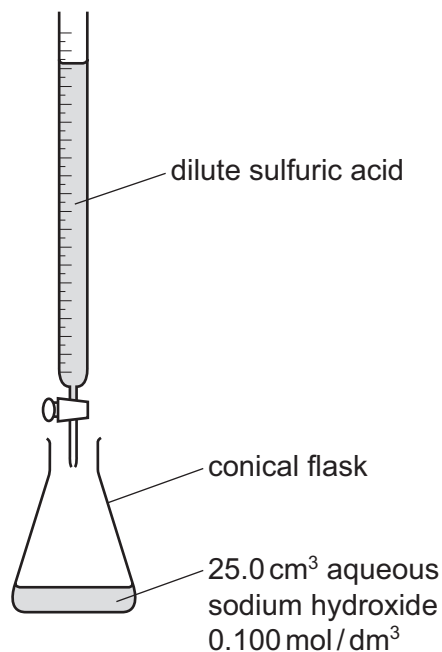


Fig. 4.1

Thymolphthalein is used as an indicator for this titration.

- (i) State the colour change of thymolphthalein at the end-point of this titration.

from to [2]

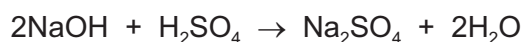
- (ii) Suggest why universal indicator is **not** used for this titration.

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



- (b) 25.0 cm³ of aqueous sodium hydroxide, NaOH, of concentration 0.100 mol/dm³ is neutralised by 20.0 cm³ of dilute sulfuric acid, H₂SO₄.

The equation for the reaction is shown.



Calculate the concentration of H₂SO₄ using the following steps.

- Calculate the number of moles of NaOH used.

..... mol

- Determine the number of moles of H₂SO₄ that react with the NaOH.

..... mol

- Calculate the concentration of H₂SO₄.

..... mol/dm³
[3]

- (c) A student is provided with an aqueous solution of sodium sulfate.

Describe how to prepare a **pure** sample of sodium sulfate crystals from this solution.

.....
.....
.....
.....
..... [3]

- (d) Potassium hydrogen sulfate, KHSO₄, can be prepared by a reaction between aqueous potassium hydroxide and dilute sulfuric acid. Water is the only other product.

Write a symbol equation for this reaction.

..... [1]





(e) Potassium hydrogen sulfate, KHSO_4 , dissolves in water to form solution **X**.

Solution **X** contains K^+ , H^+ and SO_4^{2-} ions.

(i) Name the **type** of solution that contains H^+ ions.

..... [1]

(ii) State the observations when the following tests are done.

- A flame test is carried out on **X**.

.....

- Solid copper(II) carbonate is added to **X**.

.....

.....

.....

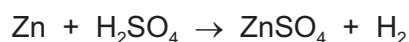
- Aqueous barium nitrate acidified with dilute nitric acid is added to **X**.

.....

[5]

(f) 0.325 g of Zn is added to dilute sulfuric acid which contains 0.0100 moles of H_2SO_4 .

The equation for this reaction is shown.



(i) Determine whether Zn or H_2SO_4 is the limiting reactant.
Explain your answer.

.....

.....

.....

..... [2]





- (ii) In another experiment, 48.0 cm^3 of hydrogen gas, H_2 , is produced. The experiment is carried out at room temperature and pressure, r.t.p.

Calculate the number of molecules in 48.0 cm^3 of H_2 gas measured at r.t.p.

The value of the Avogadro constant is 6.02×10^{23} .

..... molecules [2]

[Total: 20]





5 This question is about rate of reaction and equilibrium.

A student investigates the rate of decomposition of aqueous hydrogen peroxide, H_2O_2 , using manganese(IV) oxide as a catalyst.

The equation for the reaction is shown.



The student uses the apparatus shown in Fig. 5.1.

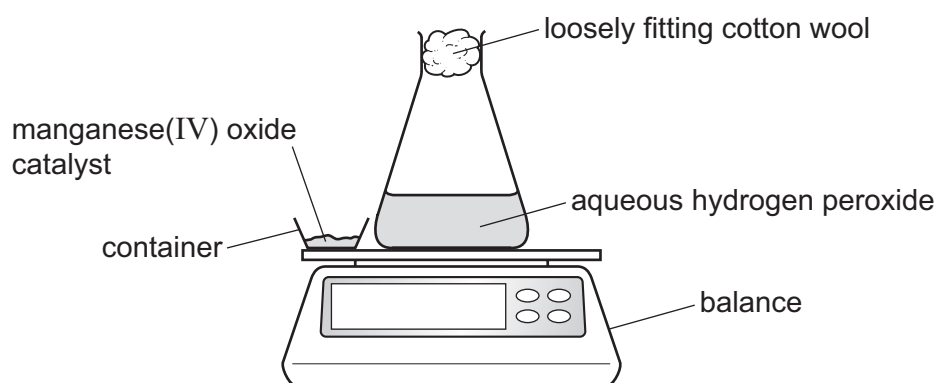


Fig. 5.1

The student:

- adds the catalyst to the aqueous hydrogen peroxide
- replaces the container on the balance
- starts a stop-watch
- records the mass at regular time intervals.

(a) Table 5.1 shows the mass recorded at regular time intervals.

Table 5.1

time/s	mass/g
0	50.64
30	49.80
60	49.38
90	49.17
120	49.07
150	49.02
180	48.99
210	48.97
240	48.97
270	48.97

(i) Suggest why the mass decreases as time increases.

..... [1]



- (ii) After a certain time the reaction stops.

Explain why the reaction stops.

..... [1]

- (iii) Suggest why it is **not** possible to use the results in Table 5.1 to determine the **exact** time when the reaction stops.

.....
 [1]

- (b) Fig. 5.2 shows a graph of the mass against time.

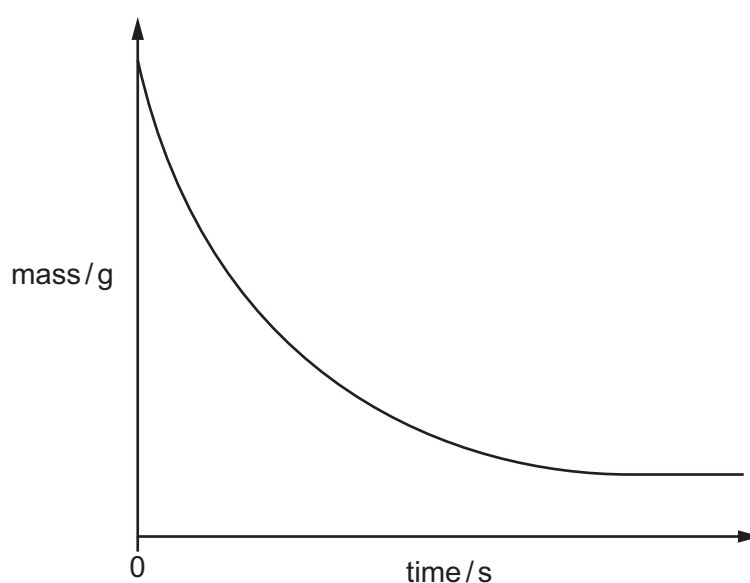


Fig. 5.2

The experiment is repeated at a higher temperature.
 All other conditions remain the same.

- (i) Explain, in terms of collision theory, why the rate of reaction is higher at a higher temperature.

.....

 [3]

- (ii) On Fig. 5.2, sketch the line expected when the experiment is repeated at a higher temperature. [2]





(c) Manganese(IV) oxide is the catalyst in this reaction.

(i) Explain the meaning of (IV) in manganese(IV) oxide.

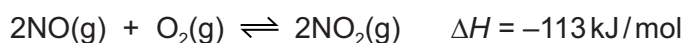
.....
 [2]

(ii) State how the mass of the **catalyst** has changed, if at all, at the end of the experiment.

..... [1]

(d) Nitrogen monoxide gas, NO, and oxygen gas, O₂, react to produce nitrogen dioxide gas, NO₂, at room temperature.

The reaction can reach equilibrium. The equation is shown.



NO(g) and O₂(g) are passed into a beaker as shown in Fig. 5.3.

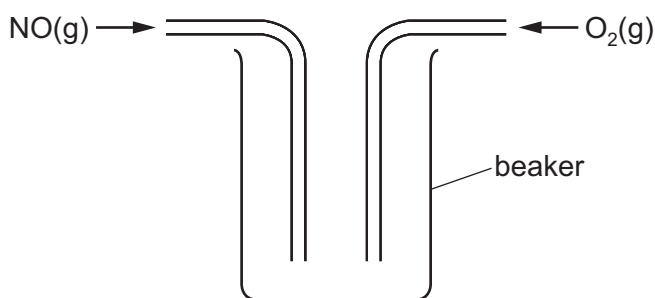


Fig. 5.3

(i) Explain why the method shown in Fig. 5.3 will **not** allow the reaction to reach equilibrium.

..... [1]

(ii) The apparatus is changed and equilibrium is reached.

The temperature of the equilibrium system is then increased and the position of equilibrium shifts to the left.

Explain why the position of equilibrium shifts to the left.

..... [1]





(iii) The pressure of the equilibrium system is then increased.

State the direction, if any, in which the position of equilibrium shifts.
Explain your answer.

direction

explanation

[2]

[Total: 15]





6 This question is about hydrocarbons.

(a) State the meaning of the term hydrocarbon.

..... [1]

(b) Propene, C_3H_6 , can be made from long-chain alkanes such as dodecane.
Dodecane contains 12 carbon atoms.

(i) Deduce the molecular formula of dodecane.

..... [1]

(ii) Name the type of reaction that occurs when long-chain alkanes are converted into shorter chain alkenes.

..... [1]

(c) Propene is an unsaturated hydrocarbon.
Propene reacts with bromine.

(i) State the meaning of the term unsaturated.

..... [1]

(ii) Write the molecular formula of the product formed when propene reacts with bromine.

..... [1]





(d) A styrene molecule is represented as shown in Fig. 6.1.

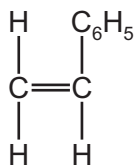


Fig. 6.1

- (i) The molecular formula of styrene is C_8H_8 .

Determine the empirical formula of styrene.

..... [1]

- (ii) Styrene can be polymerised into poly(styrene).

State the type of polymerisation that occurs when styrene is converted into poly(styrene).

..... [1]

- (iii) Draw the structure of **one** repeat unit of poly(styrene). Include all of the atoms and all of the bonds.

The C_6H_5 group should be represented as C_6H_5 .

[2]

[Total: 9]







DO NOT WRITE IN THIS MARGIN

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



Group

Group											
I	II										
3 Li lithium 7	4 Be beryllium 9	atomic number atomic symbol name relative atomic mass	1 H hydrogen 1		III	IV	V	VI	VII	VIII	
			5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	2 He helium 4			
			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			
			31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84			
			49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131			
			81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium	85 At astatine	86 Rn radon			
			113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesesson			
			101 Md mendelevium	102 No nobelium	103 Lr lawrencium	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			
			116 Lv livermorium	117 Ts tennessine	118 Og oganesesson	119 Uue ununoctium	120 Uub unbibium	121 Uut untrium			
122 Uuq unquadium	123 Uubh unbium	124 Uuhc unhexium	125 Uuhk unheptium	126 Uuql unseptium	127 Uuqo unoktium						
128 Uuo unoctium	129 Uuql unseptium	130 Uuqo unoktium	131 Uuql unseptium	132 Uuqo unoktium	133 Uuql unseptium						
134 Uuql unseptium	135 Uuqo unoktium	136 Uuql unseptium	137 Uuqo unoktium	138 Uuql unseptium	139 Uuqo unoktium						
140 Uuql unseptium	141 Uuqo unoktium	142 Uuql unseptium	143 Uuqo unoktium	144 Uuql unseptium	145 Uuqo unoktium						
146 Uuql unseptium	147 Uuqo unoktium	148 Uuql unseptium	149 Uuqo unoktium	150 Uuql unseptium	151 Uuqo unoktium						
152 Uuql unseptium	153 Uuqo unoktium	154 Uuql unseptium	155 Uuqo unoktium	156 Uuql unseptium	157 Uuqo unoktium						
158 Uuql unseptium	159 Uuqo unoktium	160 Uuql unseptium	161 Uuqo unoktium	162 Uuql unseptium	163 Uuqo unoktium						
164 Uuql unseptium	165 Uuqo unoktium	166 Uuql unseptium	167 Uuqo unoktium	168 Uuql unseptium	169 Uuqo unoktium						
170 Uuql unseptium	171 Uuqo unoktium	172 Uuql unseptium	173 Uuqo unoktium	174 Uuql unseptium	175 Uuqo unoktium						
176 Uuql unseptium	177 Uuqo unoktium	178 Uuql unseptium	179 Uuqo unoktium	180 Uuql unseptium	181 Uuqo unoktium						
182 Uuql unseptium	183 Uuqo unoktium	184 Uuql unseptium	185 Uuqo unoktium	186 Uuql unseptium	187 Uuqo unoktium						
188 Uuql unseptium	189 Uuqo unoktium	190 Uuql unseptium	191 Uuqo unoktium	192 Uuql unseptium	193 Uuqo unoktium						
194 Uuql unseptium	195 Uuqo unoktium	196 Uuql unseptium	197 Uuqo unoktium	198 Uuql unseptium	199 Uuqo unoktium						
200 Uuql unseptium	201 Uuqo unoktium	202 Uuql unseptium	203 Uuqo unoktium	204 Uuql unseptium	205 Uuqo unoktium						
206 Uuql unseptium	207 Uuqo unoktium	208 Uuql unseptium	209 Uuqo unoktium	210 Uuql unseptium	211 Uuqo unoktium						
212 Uuql unseptium	213 Uuqo unoktium	214 Uuql unseptium	215 Uuqo unoktium	216 Uuql unseptium	217 Uuqo unoktium						
218 Uuql unseptium	219 Uuqo unoktium	220 Uuql unseptium	221 Uuqo unoktium	222 Uuql unseptium	223 Uuqo unoktium						
224 Uuql unseptium	225 Uuqo unoktium	226 Uuql unseptium	227 Uuqo unoktium	228 Uuql unseptium	229 Uuqo unoktium						
230 Uuql unseptium	231 Uuqo unoktium	232 Uuql unseptium	233 Uuqo unoktium	234 Uuql unseptium	235 Uuqo unoktium						
236 Uuql unseptium	237 Uuqo unoktium	238 Uuql unseptium	239 Uuqo unoktium	240 Uuql unseptium	241 Uuqo unoktium						
242 Uuql unseptium	243 Uuqo unoktium	244 Uuql unseptium	245 Uuqo unoktium	246 Uuql unseptium	247 Uuqo unoktium						
248 Uuql unseptium	249 Uuqo unoktium	250 Uuql unseptium	251 Uuqo unoktium	252 Uuql unseptium	253 Uuqo unoktium						
254 Uuql unseptium	255 Uuqo unoktium	256 Uuql unseptium	257 Uuqo unoktium	258 Uuql unseptium	259 Uuqo unoktium						
260 Uuql unseptium	261 Uuqo unoktium	262 Uuql unseptium	263 Uuqo unoktium	264 Uuql unseptium	265 Uuqo unoktium						
266 Uuql unseptium	267 Uuqo unoktium	268 Uuql unseptium	269 Uuqo unoktium	270 Uuql unseptium	271 Uuqo unoktium						
272											

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	euporium	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
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	femium	—	101	Md	mendeleevium	—	102	No	nobelium	—	103	Lr	lawrencium	—

actinoids

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN

DO NOT WRITE IN THIS MARGIN