Cambridge International Examinations
Cambridge International General Certificate of Secondary Education (9–1)

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

0123456789

CHEMISTRY **0971/03**

Paper 3 Theory (Core) **For Examination from 2018**

SPECIMEN PAPER

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

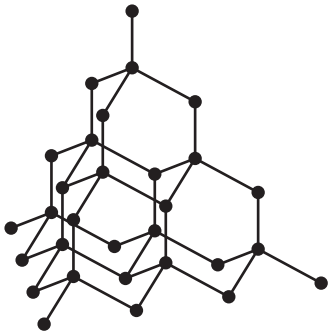
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

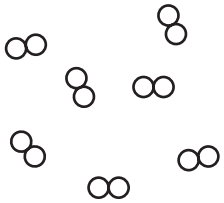
This document consists of **15** printed pages and **1** blank page.

1 The structures of diamond and chlorine are shown below.



diamond

● = carbon atom



chlorine

○ = chlorine atom

(a) Describe the structure of these two substances.
Use the list of words to help you.

covalent diatomic giant macromolecule molecule structure

diamond .....

.....

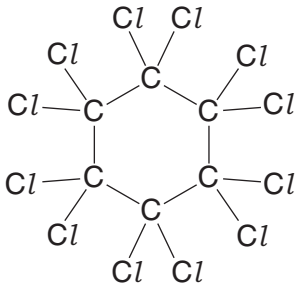
.....

chlorine .....

.....

..... [4]

(b) The structure of a compound containing carbon and chlorine is shown below.



What is the molecular formula of this compound?

..... [1]

(c) Chlorine is a halogen.

(i) State the colour of chlorine.

..... [1]

The table shows some properties of the halogens.

element	boiling point / °C	density in liquid state / g per cm^3	colour
fluorine	–188	1.51	yellow
chlorine	–35	1.56	
bromine	–7		red-brown
iodine	+114	4.93	grey-black

Use the information in the table to answer the following questions.

(ii) Predict the density of liquid bromine.

..... [1]

(iii) Describe the trend in boiling point of the halogens down the group.

..... [1]

(d) **(i)** Complete the word equation for the reaction of bromine with aqueous potassium iodide.

bromine + potassium iodide → **……..** + **……..**

…….. [2]

(ii) Suggest why bromine does not react with aqueous potassium chloride.

..... [1]

(e) Potassium chloride is an ionic substance but iodine is a molecular substance.
How do most ionic and molecular substances differ in their

solubility in water? .....

.....

electrical conductivity? .....

..... [2]

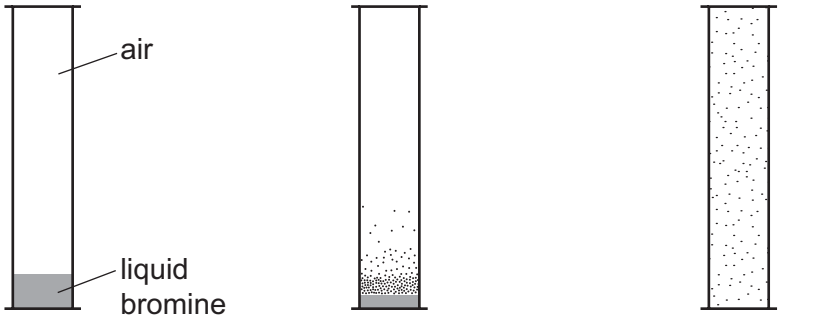
[Total: 13]

2 Bromine is an element in Group VII of the Periodic Table.

(a) State the formula for a molecule of bromine.

.....[1]

(b) A teacher placed a small amount of liquid bromine in the bottom of a sealed gas jar of air. After two minutes red-brown fumes were seen just above the liquid surface. After one hour the red-brown colour had spread completely throughout the gas jar.



Use the kinetic particle model of matter to explain these observations.

.....

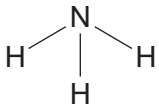
.....

.....[3]

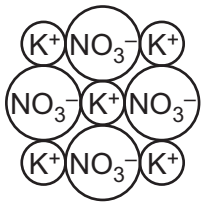
[Total: 4]

3 The structures of some substances containing nitrogen are shown below.

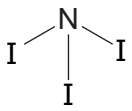
A



B

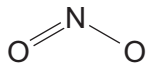


C



D

E



Answer the following questions by choosing from the structures **A**, **B**, **C**, **D** or **E**. You can use each structure once, more than once or not at all.

Which structure represents

(a) an acidic oxide, ☐ [1]

(b) an ionic structure, ☐ [1]

(c) a gas which turns damp red litmus paper blue, ☐ [1]

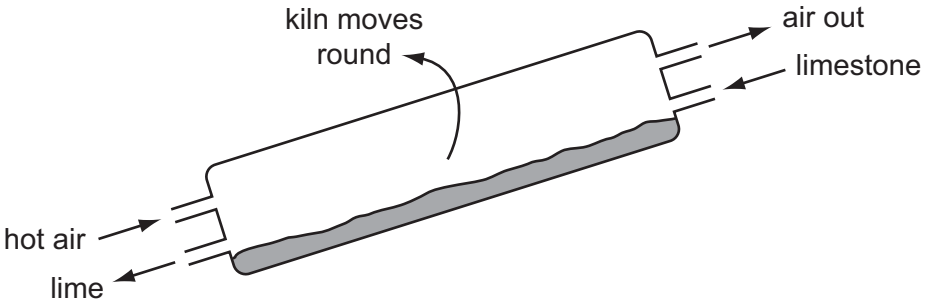
(d) a compound which is formed under conditions of high temperature and pressure in car engines, ☐ [1]

(e) a molecule containing halogen atoms, ☐ [1]

(f) a salt? ☐ [1]

[Total: 6]

4 The diagram shows a rotary lime kiln used to make lime from limestone.
Limestone is fed in at the top of the kiln and lime comes out at the bottom.



(a) State the chemical name for lime.

.....

[1]

(b) State the name of the type of chemical reaction that takes place in the kiln.

.....

[1]

(c) Suggest why the air coming out of the kiln has a greater percentage of carbon dioxide than the air entering the kiln.

.....

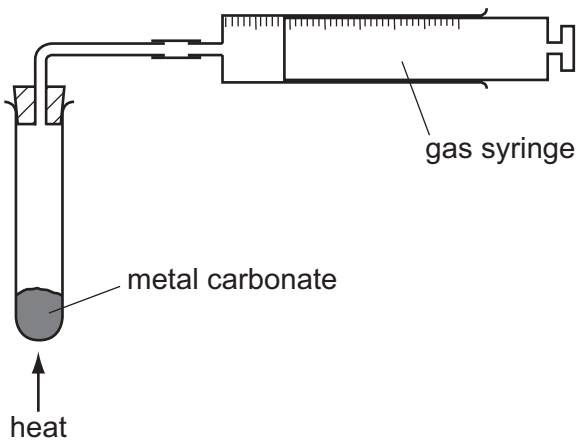
[1]

(d) State **one** use for lime.

.....

[1]

(e) A student compared the rates of reaction of three metal carbonates.
She measured the volume of gas released using the apparatus shown.

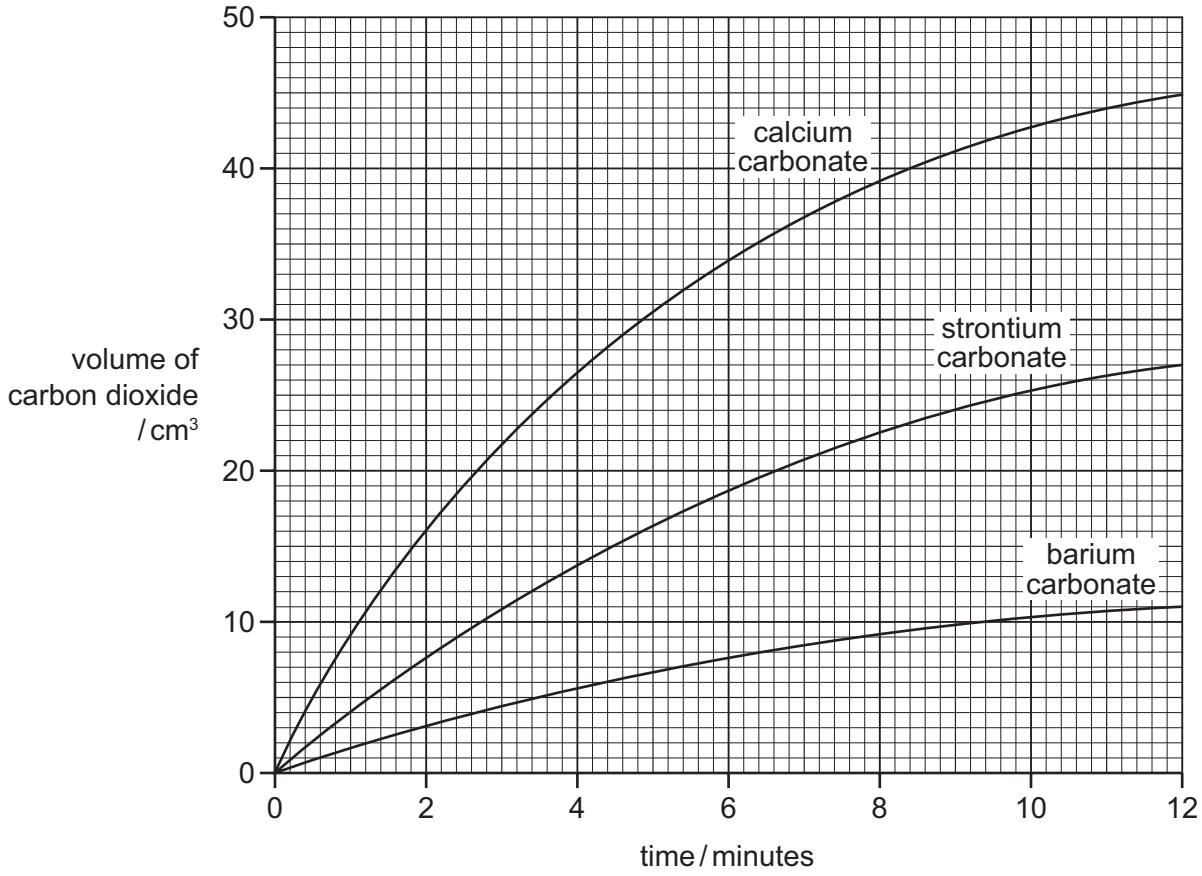


State **one** thing that must be kept constant if the rates of the three reactions are to be compared in a fair way.

.....

[1]

(f) The graph shows the volume of carbon dioxide released when the three metal carbonates were heated.



(i) Which carbonate produced carbon dioxide at the highest rate?

.....

[1]

(ii) What volume of carbon dioxide was produced by strontium carbonate in twelve minutes?

.....

[1]

(iii) How do the rates of the reactions of these three metal carbonates relate to the position of calcium, strontium and barium in the Periodic Table?

.....

.....

[2]

(g) Describe how hydrochloric acid and limewater can be used to show that carbonate ions are present in calcium carbonate.

.....

.....

.....

[3]

[Total: 12]

5 Iron is a transition element.

(a) State **three** properties of transition elements which are **not** shown by the Group I elements.

1. .....

2. .....

3. ..... [3]

(b) The symbols for two isotopes of iron are shown below.

$^{54}_{26}Fe$ $^{57}_{26}Fe$

(i) How do these two isotopes differ in their atomic structure?

..... [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{57}_{26}Fe$.

..... [1]

(iii) Determine the number of electrons in one Fe^{3+} ion.

..... [1]

(c) Pure iron rusts very easily.

Describe and explain **one** method of preventing rusting.

method .....

explain why this method works .....

..... [2]

(d) Iron can be recycled.

Explain **two** advantages of recycling metals.

.....

.....

.....

..... [2]

(e) In the blast furnace, iron(III) oxide reacts with carbon monoxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Which substance gets reduced in this reaction?
Explain your answer.

substance .....

explanation .....

..... [2]

(f) **(i)** Carbon monoxide is a pollutant gas produced in motor car engines.
State why carbon monoxide is formed.

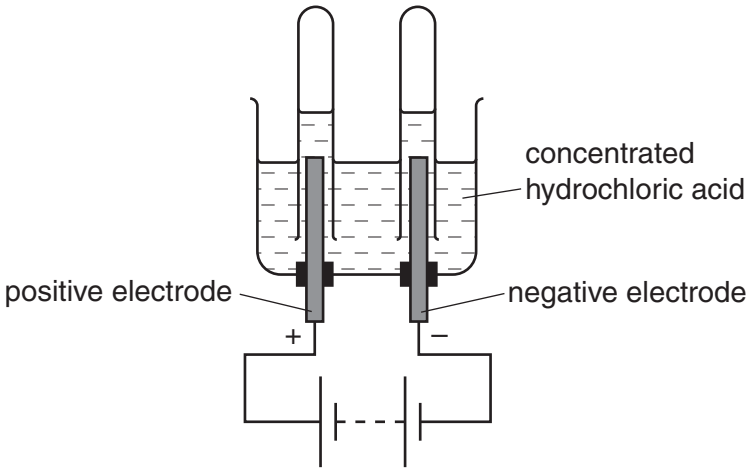
..... [1]

(ii) State **one** harmful effect of carbon monoxide.

..... [1]

[Total: 14]

6 Concentrated hydrochloric acid can be electrolysed using the apparatus shown.



(a) Define the term *electrolysis?*

.....

..... [1]

(b) What is the name given to the positive electrode?
Put a ring around the correct answer.

anion **anode** **cathode** **cation** **electrolyte**

[1]

(c) State the name of the gas given off at the negative electrode.

..... [1]

(d) Complete the following sentence about electrolysis using words from the list.

inert **magnesium** **platinum** **reactive** **solid**

Electrodes made of graphite or ..... are generally used in electrolysis because they are ..... . [2]

(e) When concentrated hydrochloric acid is electrolysed, chlorine is released.

(i) Draw the shells and the electronic structure in an atom of chlorine.

[1]

(ii) Draw the electronic structure of a chlorine molecule.
Show only the outer electron shells.

[2]

(iii) Describe a test for chlorine.

test .....

result ..... [2]

(f) Hydrochloric acid reacts with the base calcium hydroxide.

(i) Complete the word equation for this reaction.

hydrochloric acid + calcium hydroxide → ..... + ...

..... [2]

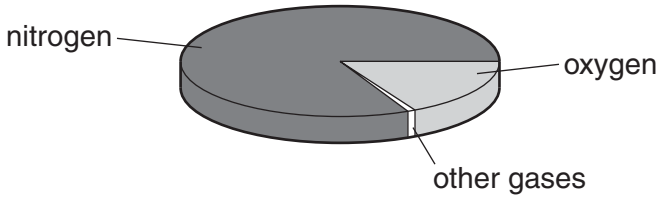
(ii) Hydrochloric acid also reacts with zinc.
Complete the symbol equation for this reaction.

$$Zn + ...HCl \rightarrow ZnCl_2 + ...$$

[2]

[Total: 14]

7 The pie chart shows the composition of air.



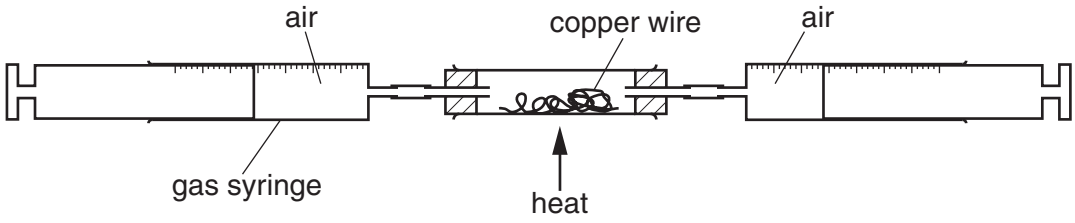
(a) **(i)** What is the percentage of nitrogen in the air?

..... [1]

(ii) Apart from nitrogen and oxygen, state the names of **two** gases present in unpolluted air.

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

(b) The percentage of oxygen in air can be found using the apparatus shown below.



Air is passed backwards and forwards over the heated copper using the syringes. The copper reacts with oxygen in the air.

$$\text{copper} + \text{oxygen} \rightarrow \text{copper(II) oxide}$$

As the experiment proceeds, suggest what happens to

(i) the total volume of air in the gas syringes,

..... [1]

(ii) the mass of the wire in the tube.

..... [1]

(c) State **one** use of copper.

..... [1]

[Total: 6]

8 Ethene, C_2H_4, is manufactured by cracking petroleum fractions.

(a) (i) What do you understand by the term *fraction?*

.....

..... [1]

(ii) Complete the symbol equation for the manufacture of ethene from dodecane, $C_{12}H_{26}$.

$$C_{12}H_{26} \rightarrow C_2H_4 + \text{.....}$$

[1]

(b) Two fractions obtained from the distillation of petroleum are refinery gas and gasoline.
State **one** use of each of these fractions.

refinery gas .....

gasoline ..... [2]

(c) Ethene is an unsaturated hydrocarbon.
What do you understand by the following terms?

unsaturated .....

hydrocarbon ..... [2]

(d) Ethene is used to make ethanol.

(i) Which of these reactions is used to make ethanol from ethene?
Tick one box.

catalytic addition of steam	☐
fermentation	☐
oxidation using oxygen	☐
reduction using hydrogen	☐

[1]

(ii) Draw the structure of ethanol, showing all atoms and bonds.

[2]

(e) Ethene is used to make poly(ethene).
Complete the following sentences about this reaction.
Use words from the list below.

additions **carbohydrates** **catalysts** **monomers** **polymers**

The ethene molecules which join to form poly(ethene) are the ..... .

The poly(ethene) molecules formed are ..... . [2]

[Total: 11]

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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.)