Cambridge IGCSE

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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5972482976

CHEMISTRY **0971/32**

Paper 3 Theory (Core) **October/November 2019**

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 or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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

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 **16** printed pages.

1 This question is about solids, liquids and gases.

(a) The list gives the names of nine substances.

aqueous copper(II) sulfate
aqueous potassium manganate(VII)
aqueous sodium chloride
dilute hydrochloric acid
ethanol
hexene
mercury
octane
water

Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

State which substance:

(i) is an alkane

..... [1]

(ii) is used, when acidified, to test for sulfur dioxide

..... [1]

(iii) turns blue litmus red

..... [1]

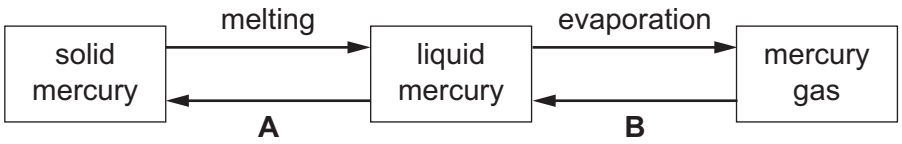
(iv) reacts with sodium to produce only aqueous sodium hydroxide and hydrogen

..... [1]

(v) is produced by the addition of steam to ethene.

..... [1]

(b) Some changes of state of mercury are shown.



(i) State the names of the changes of state represented by **A** and **B**.

A .....

B .....

[2]

(ii) Use the kinetic particle model to describe the motion **and** separation of the particles in:

liquid mercury .....

.....

.....

mercury gas. .....

.....

.....

[4]

[Total: 11]

2 Biogas is made by fermenting animal and vegetable waste.

(a) The table shows the percentage composition of the gases present in a sample of biogas.

substance present	percentage present in biogas
carbon dioxide	
hydrogen	1.0
methane	61.5
nitrogen	8.5
water vapour	2.2
other substances	0.1
total	100.0

Deduce the percentage of carbon dioxide present in this sample of biogas.

..... [1]

(b) (i) During the fermentation, carbon dioxide reacts with hydrogen to produce methane and water.

Complete the chemical equation for this reaction.

$$CO_2 + ...H_2 \rightarrow CH_4 + ...H_2O$$ [2]

(ii) Methane and ethane are in the same homologous series.

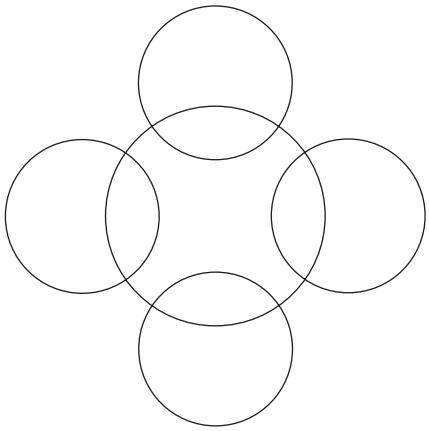
What is meant by the term *homologous series*?

.....

.....

..... [2]

(iii) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of methane, CH_4. Show outer shell electrons only.



[2]

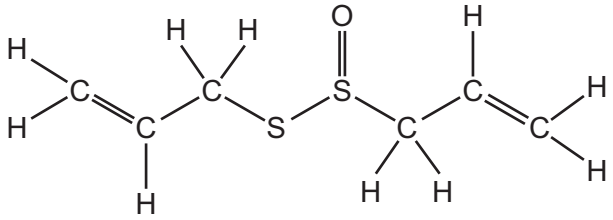
(c) Helium and hydrogen can both be used to fill balloons.

Suggest **one** advantage of using helium rather than hydrogen to fill balloons.

..... [1]

(d) The biogas fermentation mixture contains a small amount of compound **C**.

The structure of compound **C** is shown.



(i) On the structure shown, draw a circle around a functional group which reacts with aqueous bromine. [1]

(ii) How many different types of atoms are present in compound **C**?

..... [1]

(e) Ethanol is produced by fermentation of a mixture of plant sugars.

Describe how ethanol can be separated from the rest of the fermentation mixture by fractional distillation.
In your answer:

- describe how to do the fractional distillation
- explain how ethanol is separated from the rest of the fermentation mixture using fractional distillation.

.....

.....

.....

.....

.....

.....

.....

..... [4]

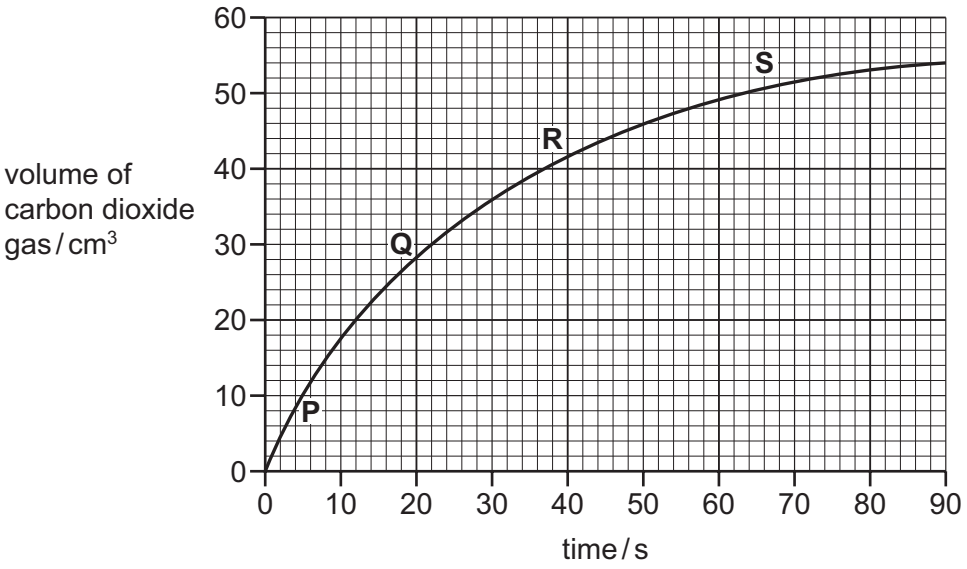
[Total: 14]

[Turn over

3 **(a)** A student investigated the reaction of calcium carbonate with an excess of dilute hydrochloric acid by measuring the volume of carbon dioxide produced at 10 second intervals.

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

The results are shown on the graph.



(i) How long did it take from the start of the experiment to collect 30 cm^3 of carbon dioxide?

..... s [1]

(ii) At which point on the graph, **P**, **Q**, **R** or **S**, was the rate of reaction fastest?
Use the graph to explain your answer.

.....

..... [2]

(iii) When 0.225 g of calcium carbonate is used, 54.0 cm^3 of carbon dioxide is formed.

Determine the mass of calcium carbonate needed to form 216 cm^3 of carbon dioxide.

mass of calcium carbonate = ... g [1]

(iv) What effect do the following have on the rate of this reaction?

- Increasing the temperature of the reaction mixture.
  All other conditions are kept the same.

.....

- Using larger pieces of calcium carbonate.
  All other conditions are kept the same.

.....
[2]

(b) In industry, calcium oxide is made from calcium carbonate by thermal decomposition.

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$$

(i) Why is this described as *thermal decomposition*?

.....

..... [2]

(ii) State **one** other use of calcium carbonate in industry.

..... [1]

(iii) Calcium oxide is used to treat acidic industrial waste.

State the type of chemical reaction that occurs.

..... [1]

[Total: 10]

[Turn over

4 An isotope of calcium is written as shown.

$^{44}_{20}Ca$

(a) (i) Deduce the number of protons, electrons and neutrons in this isotope of calcium.

number of protons .....

number of electrons .....

number of neutrons .....

[3]

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

..... [1]

(b) Draw the electronic structure of a calcium atom.

[2]

(c) The table shows some information about the reaction of four metals with dry air at room temperature and on heating.

metal	reaction with dry air at room temperature	reaction with dry air on heating
iron	no reaction	only burns when in the form of a fine wire or powder
copper	no reaction	does not burn but the surface oxidises slowly
samarium	surface oxidises slowly	burns easily
sodium	surface oxidises rapidly	burns easily

Use this information to put the **four** metals in order of their reactivity.
Put the least reactive metal first.

least reactive ⟶ most reactive

[2]

[Total: 8]

5 This question is about the halogens and compounds of the halogens.

(a) The properties of some halogens are shown in the table.

element	melting point in °C	boiling point in °C	density of liquid at boiling point in g / cm^3	colour
fluorine	–220	–188	1.51	
chlorine	–101	.....	1.56	light green
bromine	–7	59	3.12	red-brown
iodine	114	184	.....	grey-black

(i) Complete the table to estimate:

- the boiling point of chlorine
- the density of iodine.

[2]

(ii) Describe the trend in the melting points of the halogens down the group.

..... [1]

(iii) Predict the physical state of bromine at –20 °C.

..... [1]

(iv) Which **one** of the following is most likely to be the colour of fluorine?
Tick **one** box.

dark green	☐
light grey-black	☐
light yellow	☐
purple	☐

[1]

[Turn over

(b) Chlorine reacts with an aqueous potassium salt to form iodine and a different potassium salt.

(i) Complete the word equation for this reaction.

chlorine	+	....	→	iodine	+	....

[2]

(ii) When aqueous sodium fluoride is added to chlorine, no reaction occurs.

Explain, using ideas about the reactivity of the halogens, why **no** reaction occurs.

.....

..... [1]

(iii) State **one** use of chlorine.

..... [1]

(c) Aqueous silver nitrate is used to test for chloride ions and iodide ions.

(i) The solutions are first acidified with dilute nitric acid.

Explain why dilute hydrochloric acid is **not** used to acidify the solutions.

..... [1]

(ii) Complete the table to show the expected observations.

ion	observations on adding aqueous silver nitrate
chloride (Cl^-)	
iodide (I^-)	

[3]

(d) A compound of chlorine has the formula $C_6H_4Cl_2$.

Complete the table to calculate the relative molecular mass of $C_6H_4Cl_2$.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
carbon	6	12	6 × 12 = 72
hydrogen			
chlorine			

relative molecular mass = ...
[2]

[Total: 15]

[Turn over

6 This question is about compounds of nitrogen.

(a) Aqueous ammonia is alkaline.

(i) Which **one** of the following pH values could be the pH of aqueous ammonia?

Draw a circle around the correct answer.

pH 1 **pH 5** **pH 7** **pH 9** [1]

(ii) Ammonia has a strong smell.
A beaker of aqueous ammonia was placed in front of a class of students.
At first, the students at the back of the class could not smell the ammonia.
After a few minutes they could smell the ammonia.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) Ammonia is used in the manufacture of nitric acid.

(i) Balance the chemical equation for the first step in the process.

$$4NH_3 + 5O_2 \rightarrow .....NO + 6H_2O$$ [1]

(ii) The reaction is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

(iii) The NO produced in the first step then reacts with oxygen to produce nitrogen dioxide, NO_2.

$$2NO + O_2 \rightarrow 2NO_2$$

How does this equation show that NO is oxidised?

.....

..... [1]

(iv) Is nitrogen dioxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

(c) Oxides of nitrogen are atmospheric pollutants.

State **one** adverse effect of oxides of nitrogen on health.

..... [1]

(d) Ammonia reacts with nitric acid to form a salt which is present in many fertilisers.

Name the salt formed when ammonia reacts with nitric acid.

..... [1]

[Total: 10]

[Turn over

7 **(a)** Concentrated hydrochloric acid is electrolysed using graphite electrodes.

(i) Name the products of this electrolysis at:

the positive electrode .....

the negative electrode. .....
[2]

(ii) Suggest **one** observation that is made at the negative electrode.

..... [1]

(b) Dilute hydrochloric acid reacts with zinc.

Complete the word equation for this reaction.

zinc	+	hydrochloric acid	→	....	+	.....

[2]

(c) The following statements are about the procedure for making crystals of hydrated zinc sulfate from zinc and dilute sulfuric acid.

A Warm the mixture until no more bubbles are seen.
B Add excess zinc to dilute sulfuric acid.
C Warm the filtrate to the point of crystallisation.
D Leave the mixture at room temperature to form more crystals.
E Filter off the excess zinc.
F Filter off the crystals and dry between filter papers.

Put the statements **A**, **B**, **C**, **D**, **E** and **F** in the correct order.
The first one has been done for you.

B					

[2]

(d) Zinc is a metal.

(i) Describe **three** physical properties which are characteristic of metals.

1 .....

2 .....

3 .....

[3]

(ii) An alloy of zinc, copper and nickel is used to make coins.

Suggest **two** reasons why an alloy is used to make coins and **not** pure copper alone.

1 .....

2 .....

[2]

[Total: 12]

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.).