Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6072633725

CHEMISTRY **0620/31**

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 syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

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[Turn over

1 This question is about solids, liquids and gases.

(a) The list gives the names of nine substances which are solids at room temperature.

a ceramic
aluminium
anhydrous cobalt(II) chloride
anhydrous copper(II) sulfate
calcium oxide
graphite
iodine
iron
sodium

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

State which substance:

(i) turns pink when water is added to it

..... [1]

(ii) is a non-metal which is used as a lubricant

..... [1]

(iii) is used to neutralise acidic industrial waste

..... [1]

(iv) is extracted from bauxite

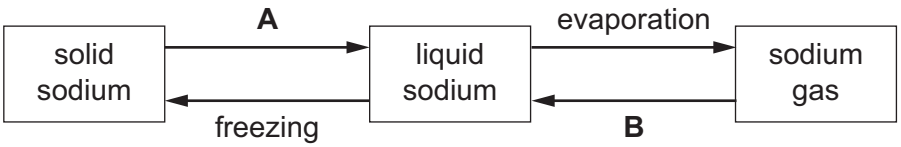
..... [1]

(v) is used as an electrical insulator.

..... [1]

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(b) Some changes of state of sodium 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 arrangement **and** separation of the particles in:

solid sodium .....

.....

.....

liquid sodium. .....

.....

.....

[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	28.5
hydrogen	1.0
methane	62.0
nitrogen	
water vapour	2.4
other substances	0.1
total	100.0

Deduce the percentage of nitrogen present in this sample of biogas.

..... [1]

(b) (i) Balance the chemical equation for the complete combustion of methane.

$$CH_4 + ...O_2 \rightarrow CO_2 + ...H_2O$$ [2]

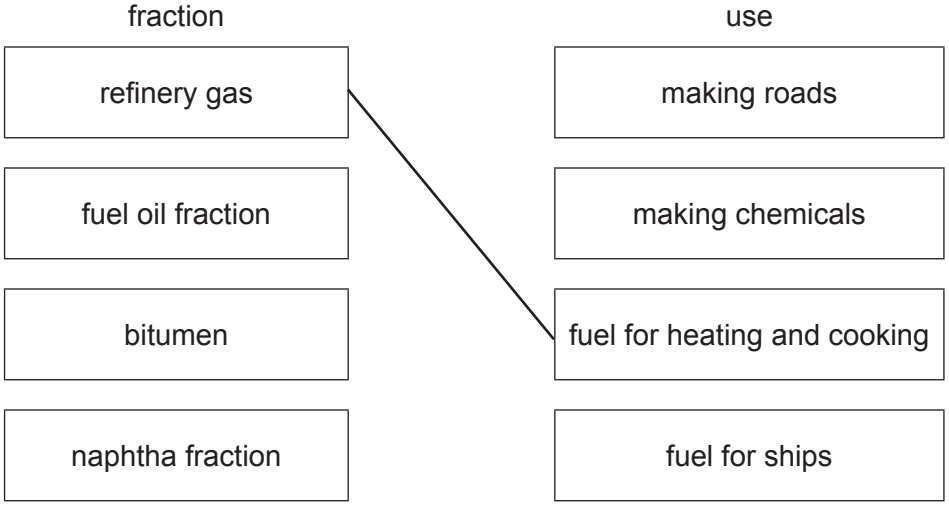
(ii) Which **one** of these compounds belongs to the same homologous series as methane?

Draw a circle around the correct answer.

methanoic acid **methanol** **propane** **propanol** **propene** [1]

(iii) Methane is present in the refinery gas fraction produced by the fractional distillation of petroleum.

Match the fractions on the left with their uses on the right.
The first one has been done for you.



[2]

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(c) (i) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen.

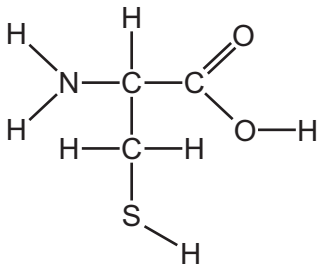
[1]

(ii) State **one** use of hydrogen.

..... [1]

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

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



(i) On the structure shown, draw a circle around the carboxylic acid functional group. [1]

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

..... [1]

(e) Describe the manufacture of ethanol by fermentation.
In your answer include:

- the names of the substances needed for fermentation
- the conditions needed for fermentation.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

3 A student investigated the reaction between zinc carbonate and an excess of dilute hydrochloric acid.

$$ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + H_2O$$

The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

(a) Describe **one** other practical method for measuring the rate of this reaction.

.....

.....

.....

.....

..... [3]

(b) When 6.25 g of zinc carbonate is used, 2.20 g of carbon dioxide is formed.

Calculate the mass of zinc carbonate that forms 11.00 g of carbon dioxide.

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

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

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

.....

- Increasing the concentration of hydrochloric acid.
  All other conditions are kept the same.

.....
[2]

(d) Carbon dioxide is formed:

- when an acid reacts with a carbonate
- as a product of the complete combustion of carbon-containing substances.

State **two** other sources of carbon dioxide.

1 .....

2 .....
[2]

[Total: 8]

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4 An isotope of sodium is written as shown.

$$^{23}_{11}Na$$

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

number of protons .....

number of electrons .....

number of neutrons .....

[3]

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

..... [1]

(b) (i) Draw the electronic structure of a sodium atom.

[2]

(ii) State the name of the particle which is lost when a sodium atom forms a sodium ion.

..... [1]

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[Turn over

(c) Sodium reacts with water to form:

- an alkaline solution
- a gas which 'pops' with a lighted splint.

(i) Complete the word equation for the reaction of sodium with water.

sodium	+	water	→	....	+	.....

[2]

(ii) The reaction of sodium with water is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

(iii) Sodium reacts with oxygen to form sodium oxide.

Is sodium oxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

(d) The table shows some observations for the reaction of four metals with cold water and with hot water.

metal	reaction with cold water	reaction with hot water
calcium	bubbles form rapidly	bubbles form very rapidly
lanthanum	bubbles form slowly	bubbles form very rapidly
manganese	no bubbles form	bubbles form very slowly
uranium	bubbles form slowly	bubbles form rapidly

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: 13]

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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 its boiling point in g / cm^3	atomic radius in nm
chlorine	–101	–35	.....	0.099
bromine	–7	59	3.12	0.114
iodine	114	.....	4.93	0.133
astatine	302	337	6.35	

(i) Complete the table to estimate:

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

[2]

(ii) Describe the trend in the atomic radius of the halogens down the group.

..... [1]

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

.....

.....

..... [2]

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

Complete the word equation for this reaction.

bromine	+	....	→	iodine	+	....

[2]

(c) Fluorine is above chlorine in Group VII of the Periodic Table.

(i) Explain, using ideas about the reactivity of the halogens, why chlorine does **not** react with aqueous sodium fluoride.

.....

..... [1]

(ii) Balance the chemical equation for the reaction of fluorine with ammonia.

$$.....NH_3 + ...F_2 \rightarrow N_2 + 6HF$$ [2]

(iii) A compound of fluorine has the formula XeO_3F_2.

Complete the table to calculate the relative molecular mass of XeO_3F_2.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
xenon			
oxygen	3	16	$3 \times 16 = 48$
fluorine			

relative molecular mass = ...
[2]

(iv) The compound XeO_3F_2 readily undergoes reduction.

What is meant by the term *reduction*?

..... [1]

[Total: 13]

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6 This question is about ammonia.

(a) When ammonia gas reacts with hydrogen chloride gas, white fumes of ammonium chloride are formed.

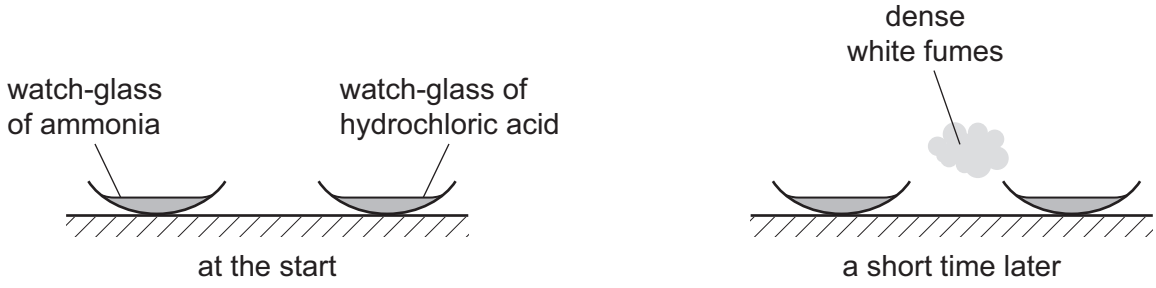
$$NH_3 + HCl \rightarrow NH_4Cl$$

(i) What type of chemical reaction is this?

Draw a circle around the correct answer.

decomposition **neutralisation** **oxidation** **reduction** [1]

(ii) Watch-glasses of aqueous ammonia and concentrated hydrochloric acid were placed near each other on a table.
At first no white fumes were seen.
After a short time, white fumes were seen between the watch-glasses.



Explain these observations using the kinetic particle model.

.....

.....

.....

.....

.....

..... [3]

(b) Ammonia is used in the manufacture of fertilisers.

Name the **three** elements present in most fertilisers which improve plant growth.

1 .....

2 .....

3 .....
[3]

(c) Aqueous ammonia can be used to test for aluminium ions and zinc ions.

Complete the table to show the expected observations.

ion	observation on adding a small volume of aqueous ammonia	observation on adding an excess of aqueous ammonia
aluminium (Al^{3+})		
zinc (Zn^{2+})		

[3]

[Total: 10]

7 **(a)** Magnesium is manufactured by the electrolysis of molten magnesium chloride.

(i) The negative electrode is made of iron.

Suggest a non-metal which could be used for the positive electrode.
Give a reason for your answer.

.....

..... [2]

(ii) Predict the products of the electrolysis of molten magnesium chloride at:

the positive electrode .....

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

(b) The following statements are about the procedure for making crystals of hydrated magnesium chloride from magnesium and dilute hydrochloric acid.

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

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

C					

[2]

(c) Magnesium is a metal in Group II of the Periodic Table.
Copper is a transition element.
Copper has a higher melting point and a higher boiling point than magnesium.

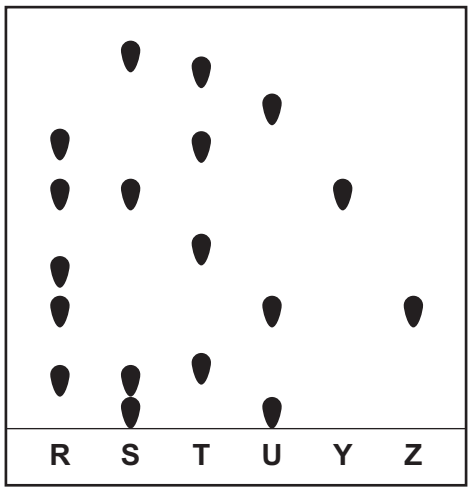
Describe **two** other properties of copper which are different from those of magnesium.

1 .....

2 .....
[2]

(d) Chromatography can be used to separate a mixture of ions from different transition element compounds.
Four samples, **R**, **S**, **T** and **U**, each containing transition element ions, were placed on a piece of chromatography paper.
Two solutions, **Y** and **Z**, each containing only one type of transition element ion were also placed on the same piece of chromatography paper.

The results of the chromatography are shown.



(i) Which sample, **R**, **S**, **T** or **U**, contains the same ions as both solution **Y and** solution **Z**?

..... [1]

(ii) Which sample, **R**, **S**, **T** or **U**, does **not** contain the same ions as either solution **Y** or solution **Z**?

..... [1]

(iii) In which sample, **R**, **S**, **T** or **U**, has the greatest number of transition element ions been separated?

..... [1]

[Total: 11]

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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 –		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.).