Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4655089752

CHEMISTRY **0620/33**

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 20.
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 **17** printed pages and **3** blank pages.

1 This question is about solids and gases.

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

ammonia
butane
carbon dioxide
carbon monoxide
chlorine
methane
propene
sulfur dioxide

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

State which gas:

(i) is a poisonous product formed by the incomplete combustion of carbon

..... [1]

(ii) is an alkene

..... [1]

(iii) is formed when limestone is thermally decomposed

..... [1]

(iv) is an element

..... [1]

(v) causes acid rain.

..... [1]

(b) When a piece of solid carbon dioxide is placed in a warm room, it undergoes sublimation.

(i) What is meant by the term *sublimation*?

.....

..... [2]

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

solid carbon dioxide .....

.....

.....

carbon dioxide gas. .....

.....

.....

[4]

[Total: 11]

2 Biogas is made by fermenting animal and vegetable waste.

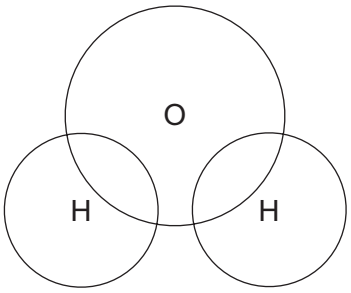
(a) The table shows the percentage composition of the gases present in a sample of biogas.

substance present	percentage present in biogas
carbon dioxide	36.8
hydrogen	0.6
methane	54.5
nitrogen	6.5
water vapour	
other substances	0.1
total	100.0

(i) Deduce the percentage of water vapour present in this sample of biogas.

..... [1]

(ii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of water. Show outer shell electrons only.



[2]

(iii) Describe a chemical test for water.

test .....

observation .....

[2]

(b) (i) Balance the chemical equation for the oxidation of methane to form hydrogen.

$$.....CH_4 + O_2 \rightarrow 2CO + ...H_2$$ [2]

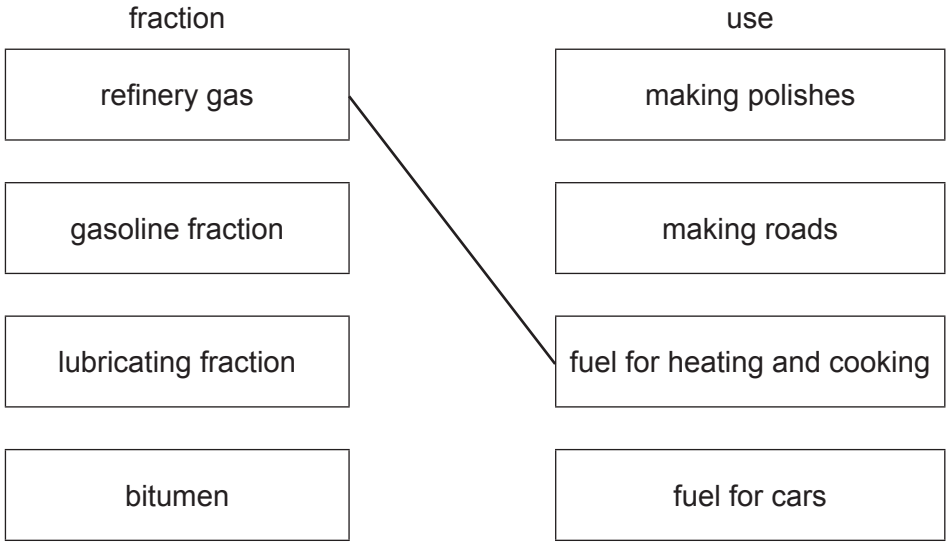
(ii) Which **one** of these compounds belongs to the same homologous series as methane?

Draw a circle around the correct answer.

butane **butene** **methanoic acid** **methanol** [1]

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

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



[2]

(ii) Describe the fractional distillation of petroleum.
In your answer:

- state the physical property on which the separation of the fractions depends
- describe how the distillation is done to separate the fractions.

.....

.....

.....

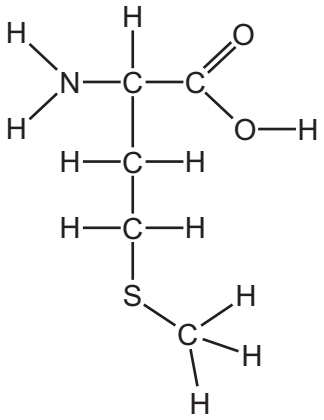
.....

.....

..... [3]

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

The structure of compound **M** 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 **M**?

..... [1]

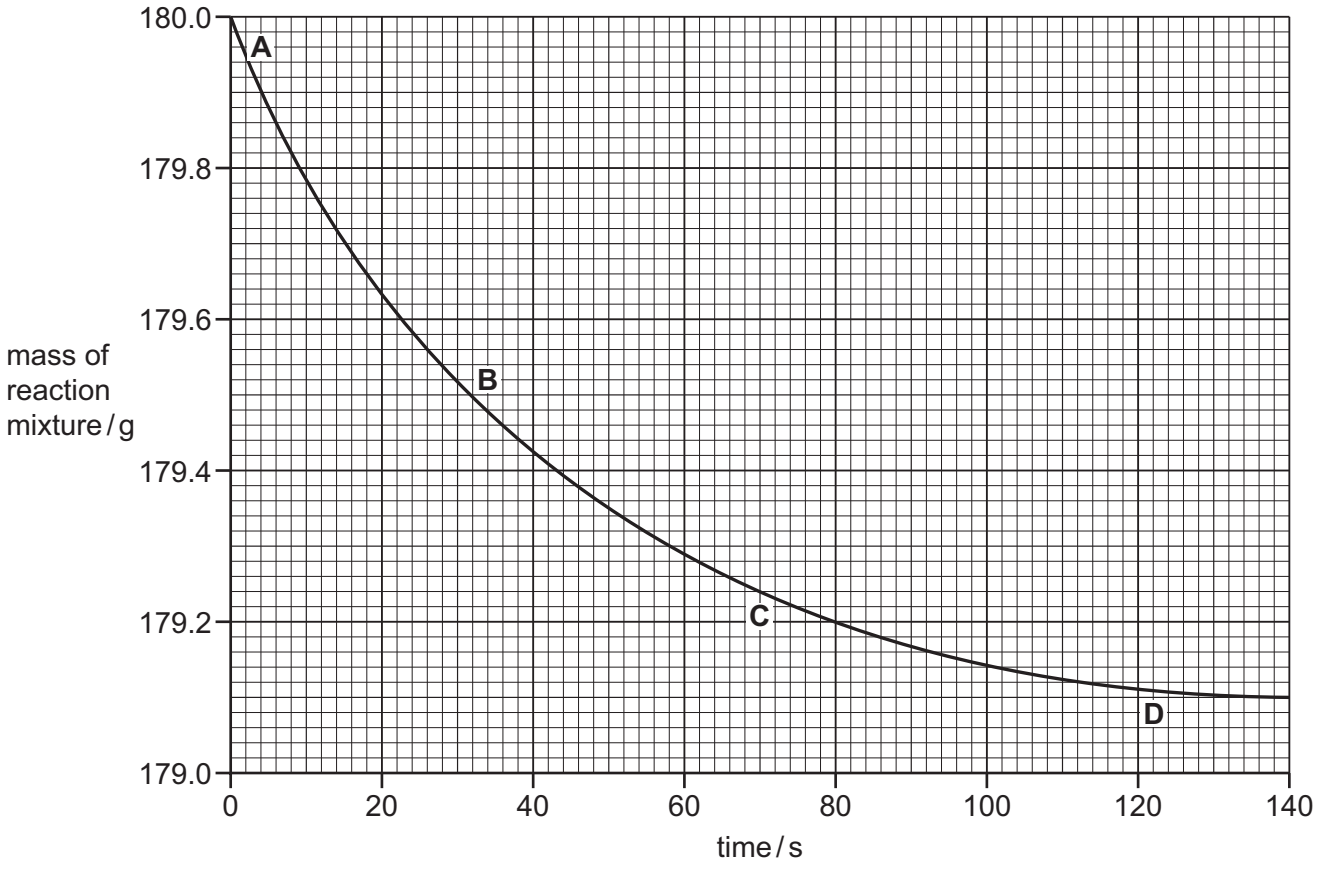
[Total: 15]

3 A student investigated the reaction of magnesium carbonate with an excess of dilute hydrochloric acid.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$$

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

The results are shown on the graph.



(a) Determine the mass of the reaction mixture after 58 seconds.

..... [1]

(b) At which point on the graph, **A**, **B**, **C** or **D**, was the rate of reaction the fastest?
Use the graph to explain your answer.

.....

..... [2]

(c) When 0.42 g of magnesium carbonate is used, 120 cm^3 of carbon dioxide is formed.

Determine the volume of carbon dioxide produced when 1.26 g of magnesium carbonate reacts completely.

volume of carbon dioxide = ... cm^3 [1]

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

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

.....

- Using smaller pieces of magnesium carbonate.
  All other conditions are kept the same.

.....
[2]

[Total: 6]

4 This question is about sulfur and compounds of sulfur.

An isotope of sulfur is written as shown.

$^{33}_{16}S$

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

number of protons .....

number of electrons .....

number of neutrons .....

[3]

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

[2]

(c) The table shows some observations made when four metals are heated with liquid sulfur.

metal	observations
copper	turns black very slowly
gold	no reaction
sodium	reacts explosively
tin	turns black slowly

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

least reactive ⟶ most reactive

[2]

(d) Name **one** source of sulfur.

..... [1]

(e) Sulfur is used in the manufacture of sulfur dioxide and sulfuric acid.

(i) Give **one** different use of sulfur dioxide.

..... [1]

(ii) Complete the word equation for the reaction of dilute sulfuric acid with magnesium.

sulfuric acid	+	magnesium	→	....	+	.....

[2]

[Total: 11]

5 This question is about Group I elements.

(a) The properties of some Group I elements are shown in the table.

element	melting point in °C	boiling point in °C	relative thermal conductivity	atomic radius / pm
lithium	.....	1342	84	152
sodium	97	883	142	186
potassium	63	760	102	.....
rubidium	39	686	58	248

(i) Complete the table to estimate:

- the melting point of lithium
- the atomic radius of potassium.

[2]

(ii) Describe the trend in the boiling points of the Group I elements down the group.

..... [1]

(iii) Caesium is below rubidium in Group I.

Use the information in the table to suggest why it is difficult to predict the thermal conductivity of caesium.

.....

..... [1]

(iv) Predict the physical state of rubidium at 45 °C.
Give a reason for your answer.

.....

..... [2]

[Turn over

(b) Lithium reacts with oxygen to form lithium oxide.

(i) Balance the chemical equation for this reaction.

$$.....Li + O_2 \rightarrow .....Li_2O$$ [2]

(ii) Is lithium oxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

.....

..... [1]

(iii) State the name of the particle which is lost from a lithium atom when it forms a lithium ion.

..... [1]

(iv) A compound of lithium has the formula C_2H_5Li.

Complete the table to calculate the relative molecular mass of C_2H_5Li.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
carbon			
hydrogen	5	1	$5 \times 1 = 5$
lithium			

relative molecular mass = ...
[2]

[Total: 12]

6 Sodium hydroxide and ammonia are both bases. They both turn red litmus blue.

(a) The chemical equation shows a reaction that produces sodium hydroxide.

$$Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$$

Complete the word equation for this reaction.

....	+	....	→	sodium hydroxide	+	....

[2]

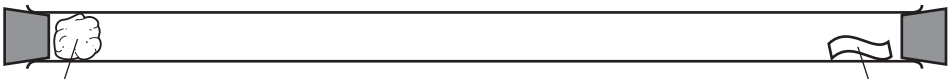
(b) Aqueous sodium hydroxide can be used to test for chromium(III) ions and iron(II) ions.

Complete the table to show the expected observations.

ion	observation on adding a small volume of aqueous sodium hydroxide	observation on adding an excess of aqueous sodium hydroxide
chromium(III) (Cr^{3+})		
iron(II) (Fe^{2+})		

[3]

(c) A student set up a long glass tube as shown.



cotton wool soaked in aqueous ammonia

damp red litmus paper

At first, the litmus paper remained red.
After a short time the litmus paper was completely blue.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

.....

..... [3]

(d) Oxides of nitrogen are formed when ammonia is heated with oxygen in the presence of a catalyst.

(i) Suggest why a catalyst is used.

..... [1]

(ii) State **one** other process which puts oxides of nitrogen into the atmosphere.

..... [1]

(iii) State **one** adverse effect of oxides of nitrogen on health.

..... [1]

(e) Ammonium nitrate is present in many fertilisers.

Which **one** of these compounds is also present in many fertilisers?
Tick **one** box.

barium hydroxide	☐
potassium phosphate	☐
sodium chloride	☐
tin(II) sulfate	☐

[1]

(f) When ammonium chloride dissolves in water, the temperature of the solution decreases.

What is the name for a reaction where the temperature of the solution decreases?

..... [1]

[Total: 13]

7 Aluminium is manufactured by the electrolysis of molten aluminium oxide.

(a) Predict the products of the electrolysis of molten aluminium oxide at:

the positive electrode .....

the negative electrode. .....

[2]

(b) Complete these sentences about the uses of aluminium using words from the list.

conductivity	**corrosion**	**density**	**heavy**
malleability	**reduction**	**strong**	**weak**

Aluminium is used in the manufacture of aircraft because it is relatively ..... and has a low ..... . Aluminium is used for food containers because of its resistance to ..... .

[3]

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

A Filter off the excess aluminium hydroxide.
B Filter off the crystals and dry between filter papers.
C Warm the filtrate to the point of crystallisation.
D Add aluminium hydroxide to warm dilute sulfuric acid and stir.
E Leave the mixture at room temperature to form more crystals.
F Add more aluminium hydroxide to the sulfuric acid until the aluminium hydroxide is in excess.

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

D					

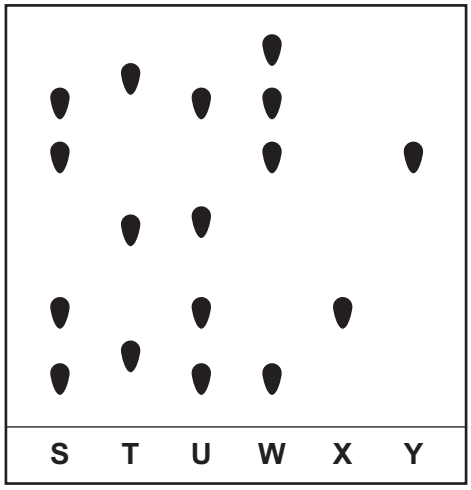
[2]

[Total: 7]

8 This question is about dyes.

(a) Chromatography can be used to separate a mixture of dyes.
S, **T**, **U** and **W** are four different mixtures of dyes.
S, **T**, **U** and **W** were placed on a piece of chromatography paper.
Two pure dyes, **X** and **Y**, were also placed on the same piece of chromatography paper.

The results of the chromatography are shown.



(i) Which mixture, **S**, **T**, **U** or **W**, contains dye **X** but **not** dye **Y**?

..... [1]

(ii) Which mixture, **S**, **T**, **U** or **W**, contains the smallest number of dyes?

..... [1]

(iii) Which mixture, **S**, **T**, **U** or **W**, contains neither dye **X** nor dye **Y**?

..... [1]

(b) Indigo is a blue dye.

When an alkaline solution of indigo undergoes reduction, it turns colourless.

(i) What is meant by the term *reduction*?

..... [1]

(ii) A piece of white cloth is soaked in the colourless solution.
When the cloth is left in the air it turns blue.

What type of chemical reaction occurs?

Draw a circle around the correct answer.

decomposition **fermentation** **oxidation** **polymerisation** [1]

[Total: 5]

BLANK PAGE

BLANK PAGE

BLANK PAGE

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.).