Cambridge
O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6621221853

CHEMISTRY **5070/21**

Paper 2 Theory **October/November 2019**

1 hour 30 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

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 20.

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 **18** printed pages and **2** blank pages.

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Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

1 The diagram shows part of the Periodic Table.

												B	C	
	Mg											A*l*	Si	P
				V			Fe			Cu	Zn			

Answer the questions using only the elements shown in the diagram.

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

Write the symbol for an element which:

(a) forms a stable ion by gaining three electrons

..... [1]

(b) is extracted from haematite

..... [1]

(c) forms an ion which gives a red-brown precipitate on addition of aqueous ammonia

..... [1]

(d) has chemical properties similar to those of calcium

..... [1]

(e) can have lubricating properties.

..... [1]

[Total: 5]

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2 Sodium is a metal.

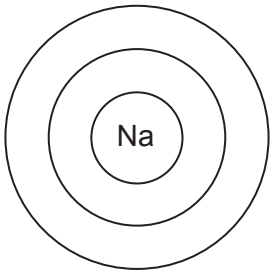
(a) State two physical properties of sodium which are different from most other metals.

1 .....

2 .....

[2]

(b) Complete the electronic configuration of a sodium atom. Show all electrons.



[1]

(c) The equation shows the reaction of sodium with water.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Calculate the minimum mass of sodium, in grams, needed to produce 300 cm^3 of hydrogen gas at room temperature and pressure.

Give your answer to **three** significant figures.

mass of sodium ..... g [3]

(d) Sodium reacts with oxygen to form the ionic solid sodium oxide, Na_2O.

Explain, in terms of movement of electrons, how Na_2O is formed by the reaction of sodium with oxygen.

.....

.....

.....

..... [3]

(e) Sodium chloride is an ionic compound which is a solid at room temperature. It is soluble in water.

(i) Suggest one other physical property of sodium chloride.

..... [1]

(ii) State the products formed at the anode and cathode when concentrated aqueous sodium chloride is electrolysed.

product at anode .....

product at cathode .....
[1]

(iii) Describe a test for chloride ions.

test .....

observation .....
[2]

[Total: 13]

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3 Water can be removed from aqueous copper(II) sulfate by distillation.

(a) Describe how and explain why water can be separated from aqueous copper(II) sulfate by distillation.

In your answer include a description of distillation.

You may draw a labelled diagram.

.....

.....

.....

.....

.....

..... [3]

(b) Copper(II) sulfate can be prepared by heating excess copper(II) oxide with dilute sulfuric acid.

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

What method is used to separate excess copper(II) oxide from the reaction mixture?

..... [1]

(c) A copper compound contains 21.09% copper, 43.82% caesium and 35.09% chlorine by mass. Use this information to deduce the empirical formula of this copper compound.

empirical formula ..... [2]

[Total: 6]

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[Turn over

4 This question is about compounds containing chlorine.

(a) The equation shows the reaction of aqueous methanol with hydrochloric acid.

$$CH_3OH(aq) + HCl(aq) \longrightarrow CH_3Cl(g) + H_2O(l)$$

The progress of this reaction can be followed by taking small samples of the reaction mixture every hour and determining the concentration of hydrochloric acid.

Describe a practical method by which the concentration of hydrochloric acid can be determined in a sample.

.....

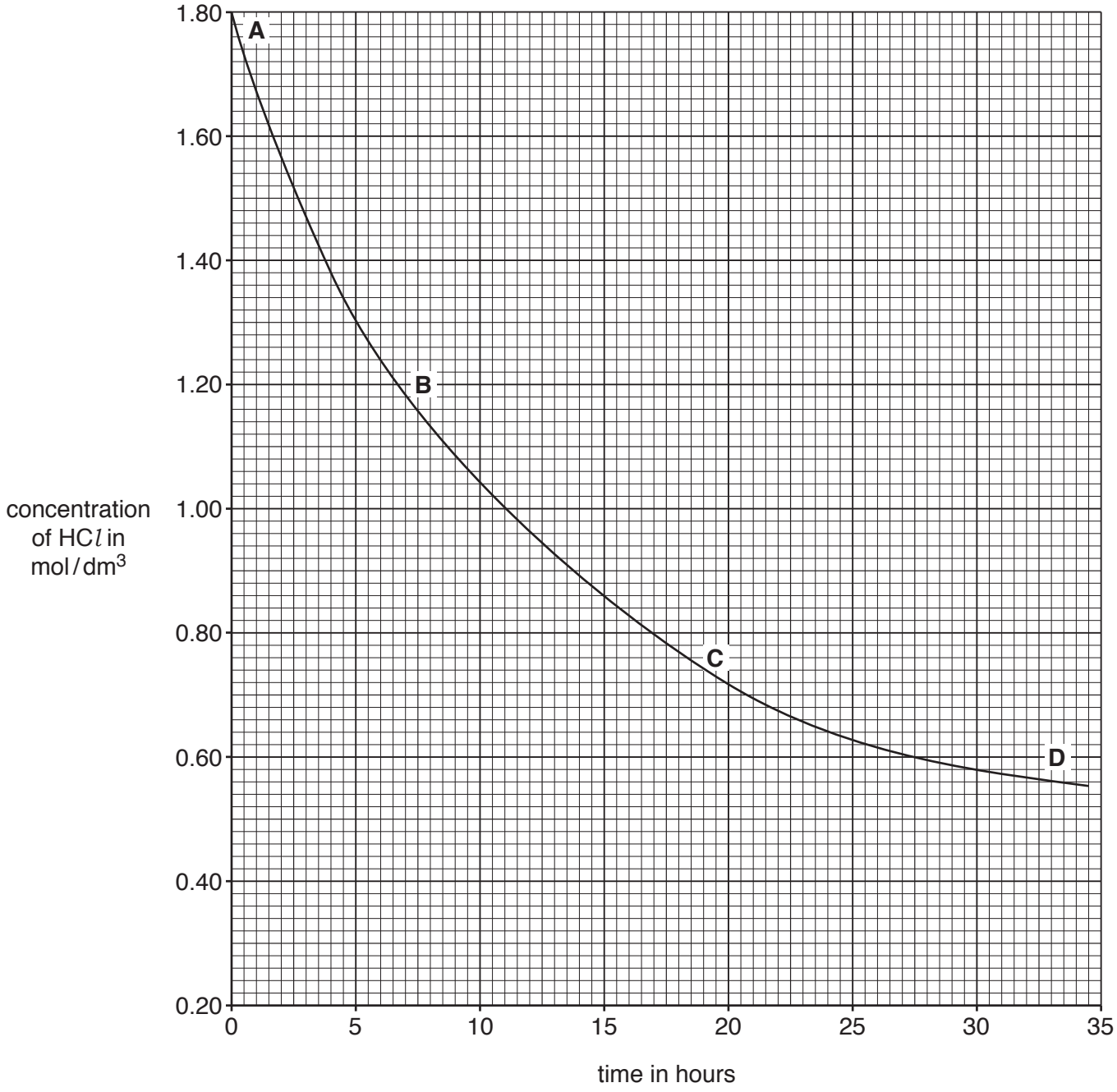
.....

.....

.....

..... [3]

(b) The graph shows how the concentration of hydrochloric acid changes as the reaction proceeds.



(i) Deduce the concentration of hydrochloric acid four hours from the start of the experiment.

.....mol / dm^3 [1]

(ii) At which point on the graph, **A**, **B**, **C** or **D**, is the rate of reaction fastest?

Give a reason for your answer by referring to the graph.

.....

..... [2]

(c) Describe and explain, using ideas about collisions between particles, how the rate of a reaction changes when the temperature is decreased.

All other conditions stay the same.

.....

.....

.....

.....

..... [3]

(d) Describe the effect of hydrochloric acid on Universal Indicator paper.

..... [1]

(e) Name a metal chloride that is insoluble in water.

..... [1]

(f) Chlorofluorocarbons (CFCs) diffuse into the atmosphere.

Describe the effect of CFCs on the atmosphere and explain why this is a problem.

effect .....

.....

explanation .....

.....

[2]

[Total: 13]

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5 The table shows some properties of four Group VII elements.

element	melting point in °C	boiling point in °C	density of liquid at boiling point in g/cm^3	colour
chlorine	–101	–35		light green
bromine	–7		3.12	red-brown
iodine	114	184	4.93	grey-black
astatine	302	337	6.35	

(a) (i) Complete the table by estimating

- the boiling point of bromine
- the density of liquid chlorine at its boiling point.

[2]

(ii) Use the information in the table to suggest the colour of astatine.

..... [1]

(b) Explain why chlorine is used in water treatment.

..... [1]

(c) Chlorine reacts with aqueous potassium iodide. The products are aqueous potassium chloride and aqueous iodine.

(i) Construct the ionic equation for this reaction.

..... [1]

(ii) Explain why potassium chloride does not react with iodine.

..... [1]

(d) Hydrated nickel(II) chloride has the formula $NiCl_2.xH_2O$.
It has a relative formula mass of 238.

Calculate the value of x in this formula.
[The relative atomic mass of nickel, Ni, is 59]

x = ... [2]

[Total: 8]

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[Turn over

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

6 Ethanoic acid, CH_3COOH, is a weak acid.

(a) What is the meaning of the term *weak* when applied to acids?

.....

..... [1]

(b) Ethanoic acid is solid at 16.0 °C.

Describe the arrangement and movement of the particles in a solid.

arrangement .....

movement .....

[2]

(c) The melting point of ethanoic acid is 16.7 °C.

The boiling point of ethanoic acid is 118.0 °C.

Deduce the physical state of ethanoic acid at 130.0 °C.

Explain your answer.

.....

..... [1]

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(d) The equation for the reaction of ethanoic acid with sodium carbonate is shown.

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$$

A student added 3.18 g of sodium carbonate to 224 cm^3 of 0.250 mol / dm^3 ethanoic acid.

Show by calculation that sodium carbonate is in excess.

[3]

(e) Calcium reacts with ethanoic acid.

The products are calcium ethanoate and hydrogen.

Construct the equation for this reaction.

..... [1]

(f) Ethanoic acid reacts with butanol, C_4H_9OH, to produce an ester.

(i) Name the ester formed when ethanoic acid reacts with butanol.

..... [1]

(ii) Draw the structure of this ester.

[1]

[Total: 10]

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[Turn over

7 Hydrogen can be produced when steam and carbon monoxide are passed over a catalyst.

$$H_2O(g) + CO(g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H = -41\,kJ/mol$$

(a) (i) The temperature of the equilibrium mixture is decreased.
The pressure on the equilibrium mixture is kept constant.

Describe how and explain why the position of equilibrium changes.

.....

.....

..... [2]

(ii) The pressure on the equilibrium mixture is increased.
The temperature of the equilibrium mixture is kept constant.

Explain why the change in pressure has no effect on this equilibrium.

.....

..... [1]

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(b) Hydrogen is also produced when steam is passed over hot coke (carbon).

This reaction is endothermic.

$$H_2O(g) + C(s) \rightarrow CO(g) + H_2(g)$$

(i) On the axes below draw a labelled energy profile diagram for the reaction to show:

- the reactants and products
- the enthalpy change for the reaction
- the activation energy of the reaction.



[3]

(ii) The mixture of gases produced when steam is passed over hot coke also contains hydrogen sulfide, H_2S, as an impurity.

This can be removed by reacting the gas with moist iron(III) hydroxide.

Complete the equation for this reaction.

$$\ldots\ldots Fe(OH)_3 + \ldots\ldots H_2S \rightarrow Fe_2S_3 + \ldots\ldots H_2O$$ [1]

(c) Fossil fuels contain small amounts of sulfur.

(i) Describe how the combustion of fossil fuels leads to the formation of acid rain.

.....

.....

..... [2]

(ii) Describe one effect of acid rain on buildings.

..... [1]

[Total: 10]

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[Turn over

8 Silicon is an element in Group IV of the Periodic Table.

(a) One of the isotopes of silicon is:

$$^{30}_{14}Si$$

Deduce the number of electrons, neutrons and protons in one atom of this isotope of silicon.

number of electrons .....

number of neutrons .....

number of protons .....

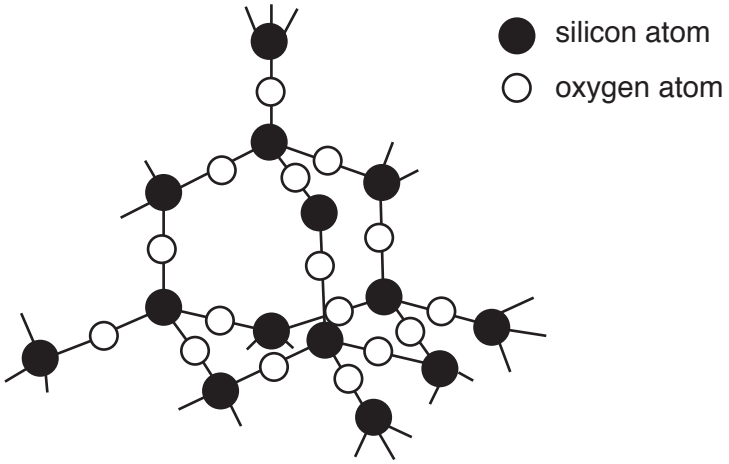
[3]

(b) Silicon reacts with nitrogen when heated to produce silicon nitride, Si_3N_4.

Construct the equation for this reaction.

..... [1]

(c) The structure of silicon dioxide is shown.



(i) Describe two similarities in the structures of silicon dioxide and diamond.

1 .....

.....

2 .....

.....

[2]

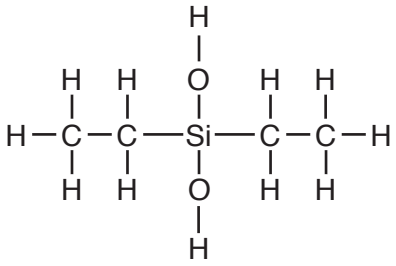
(ii) Explain why silicon dioxide has a high melting point.

.....

.....

..... [2]

(d) The structure of a compound of silicon is shown.



Deduce the molecular formula of this compound.

..... [1]

(e) Draw a 'dot-and-cross' diagram for a silicon(IV) chloride molecule, $SiCl_4$.

Only include the outer shell electrons.

[1]

[Total: 10]

9 This question is about polymers.

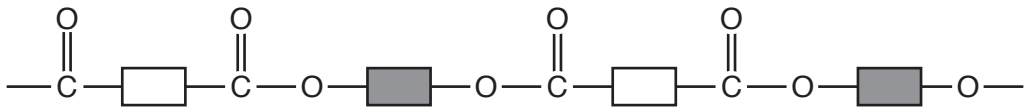
(a) Polyesters and polyamides are both polymers formed by condensation reactions.

What is meant by the term *condensation reaction*?

.....

..... [1]

(b) The partial structure of a polyester is shown.



(i) On the diagram, draw a circle around an ester linkage. [1]

(ii) Draw the structures of the **two** monomers used to produce this polymer.

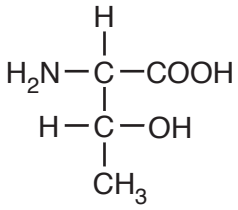
[2]

(iii) *Terylene* is a polyester.

State one common use of *Terylene*.

..... [1]

(c) The structure of the amino acid threonine is shown.



Threonine can be polymerised.

Explain, by referring to the groups present, why polymers with different linkages can be formed from threonine.

.....

.....

..... [2]

(d) Poly(ethene) is made from ethene monomers.

(i) Draw the structure of ethene, showing all of the atoms and all of the bonds.

[1]

(ii) Poly(ethene) is a non-biodegradable plastic.

What is meant by the term *non-biodegradable*?

.....

..... [1]

(iii) Describe one pollution problem caused by the disposal of non-biodegradable plastics.

.....

..... [1]

[Total: 10]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).