Cambridge
O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **5070/22**

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 **19** printed pages and **1** blank page.

Cambridge Assessment International Education

[Turn over

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.

					He
B	C	N	O	F	Ne
A*l*	Si	P	S	C*l*	Ar
Ga	Ge	As	Se	Br	Kr
				I	Xe

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 of type X^{2-}

..... [1]

(b) is a light green gas at room temperature

..... [1]

(c) forms an ion which gives a yellow precipitate on addition of aqueous silver nitrate

..... [1]

(d) is used to make food containers

..... [1]

(e) is a diatomic gas which forms 78% of dry air.

..... [1]

[Total: 5]

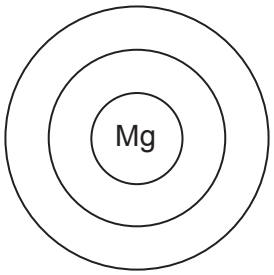
2 Magnesium is a metal.

(a) State two properties which are characteristic of most metals.

1 .....

2 .....
[2]

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



[1]

(c) Magnesium reacts with bromine to form magnesium bromide, $MgBr_2$.

Magnesium bromide is an ionic solid at room temperature.

(i) Explain, in terms of movement of electrons, how magnesium bromide is formed by the reaction of magnesium with bromine.

.....

.....

.....

..... [3]

(ii) Magnesium bromide is soluble in water.

Suggest one other physical property of magnesium bromide.

..... [1]

(d) Deduce the products formed at the anode and cathode when concentrated aqueous magnesium bromide is electrolysed.

product at anode .....

product at cathode .....
[1]

[Turn over

(e) Chlorine reacts with aqueous magnesium bromide.

The products are aqueous magnesium chloride and aqueous bromine.

(i) Construct the ionic equation for this reaction.

..... [1]

(ii) Explain why aqueous magnesium chloride does not react with aqueous bromine.

..... [1]

[Total: 10]

3 Petroleum (crude oil) is a mixture of hydrocarbons.

(a) Describe and explain how petroleum is separated into different hydrocarbon fractions.

In your answer include a description of fractional distillation in an oil refinery.

You may draw a labelled diagram.

.....

.....

.....

.....

.....

..... [3]

(b) State one use for each of these hydrocarbon fractions:

kerosene .....

naphtha .....

[2]

(c) The refinery gas fraction contains methane, ethane and propane.

(i) To which homologous series do these hydrocarbons belong?

..... [1]

(ii) Give the general formula for the homologous series which contains methane, ethane and propane.

..... [1]

(d) The exhaust from diesel engines contains carbon monoxide.

(i) Explain how carbon monoxide is formed in the diesel engine.

..... [1]

(ii) Describe one effect of carbon monoxide on human health.

..... [1]

[Total: 9]

[Turn over

4 The equation shows the reaction of calcium carbonate with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) The rate of this reaction can be determined by measuring the decrease in mass of the reaction mixture.

Describe one **other** method of following the progress of this reaction.

.....

.....

..... [2]

(b) Describe and explain, using ideas about collisions between particles, how the rate of reaction changes when the same mass of calcium carbonate is used in **smaller** pieces.

All other conditions stay the same.

.....

.....

..... [2]

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

All other conditions stay the same.

.....

.....

.....

.....

..... [3]

(d) Calculate the minimum mass of calcium carbonate, in grams, needed to produce 16.8 cm^3 of carbon dioxide at room temperature and pressure.

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

mass of calcium carbonate ..... g [2]

(e) Describe a test for carbon dioxide.

test .....

observation .....
[2]

(f) Calcium hydroxide can be used to control the pH of the soil.

Explain how calcium hydroxide controls the pH of the soil.

.....

.....

..... [2]

[Total: 13]

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

element	melting point /°C	relative thermal conductivity	atomic radius /nm
lithium	181	84	0.157
sodium		142	0.191
potassium	63		0.235
rubidium	39	58	

(a) **(i)** Complete the table by estimating:

- the melting point of sodium
- the atomic radius of rubidium. [2]

(ii) Use the information in the table to suggest why it is difficult to predict the relative thermal conductivity of potassium.

.....

..... [1]

(b) Sodium reacts with oxygen to produce sodium oxide, Na_2O.

(i) Construct the equation for this reaction.

..... [1]

(ii) What type of oxide, acidic or basic, is sodium oxide?

Give a reason for your answer.

type of oxide: .....

reason: .....

.....
[1]

(c) Explain, in terms of ease of formation of ions, why copper does not react with aqueous sodium sulfate.

.....

..... [1]

(d) Hydrated sodium iodate(V) has the formula $NaIO_3.xH_2O$.
It has a relative formula mass of 288.

Calculate the value of x in this formula.

x = ... [2]

[Total: 8]

Section B

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

The total mark for this section is 30.

6 Butanoic acid, C_3H_7COOH, is a carboxylic acid.

(a) Draw the structure of butanoic acid to show all of the atoms and all of the bonds.

[1]

(b) Describe the movement and arrangement of the particles in liquid butanoic acid.

movement .....

arrangement .....

[2]

(c) The melting point of butanoic acid is –4 °C.

The boiling point of butanoic acid is 166 °C.

Deduce the physical state of butanoic acid at 0 °C. Explain your answer.

physical state: .....

explanation: .....

.....

[1]

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

$$2C_3H_7COOH + Na_2CO_3 \rightarrow 2C_3H_7COONa + CO_2 + H_2O$$

A student added 5.28 g of butanoic acid to 56.0 cm^3 of 0.500 mol / dm^3 sodium carbonate.

Show by calculation that butanoic acid is in excess.

[3]

(e) Magnesium reacts with butanoic acid.

The products are magnesium butanoate and hydrogen.

Construct the equation for this reaction.

..... [1]

(f) One method of determining the pH of aqueous butanoic acid is by using a pH meter.

Describe a different method of determining the pH of aqueous butanoic acid.

.....

.....

..... [2]

[Total: 10]

[Turn over

7 Sulfuric acid is made by the Contact process.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -197\,kJ/mol$$

(a) Name the catalyst used in the Contact process.

..... [1]

(b) Describe how and explain why the position of equilibrium in the reaction is altered when:

(i) the temperature of the equilibrium mixture is increased at constant pressure

.....

.....

..... [2]

(ii) the pressure of the equilibrium mixture is increased at constant temperature.

.....

.....

..... [2]

(c) The final step in the manufacture of sulfuric acid is an exothermic reaction.

$$H_2S_2O_7 + H_2O \rightleftharpoons 2H_2SO_4$$

On the axes, draw a labelled energy profile diagram for this exothermic reaction.

Show:

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

[3]

(d) Air is a raw material used in the manufacture of sulfuric acid.

Name one other raw material used in the manufacture of sulfuric acid.

..... [1]

(e) State one major use of sulfuric acid.

..... [1]

[Total: 10]

[Turn over

8 Phosphorus is an element in Group V of the Periodic Table.

(a) One of the isotopes of phosphorus is:

$$^{31}_{15}P$$

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

number of electrons .....

number of neutrons .....

number of protons .....

[3]

(ii) What is the meaning of the term *isotopes*?

.....

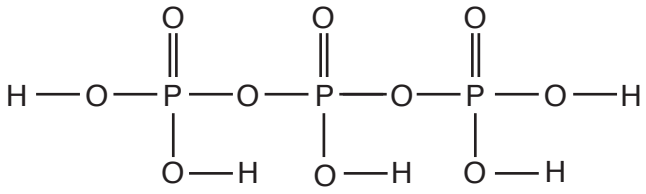
..... [1]

(b) Phosphorus reacts with potassium chlorate(V) to form potassium chloride and phosphorus(V) oxide.

Complete the equation for this reaction.

.... $KClO_3$ + ... P $\rightarrow$ .... KCl + ... P_2O_5 [1]

(c) The structure of a compound of phosphorus is shown.



Deduce the molecular formula of this compound.

..... [1]

(d) Phosphorus reacts with chlorine to form phosphorus trichloride, PCl_3.

Draw a dot-and-cross diagram for a molecule of phosphorus trichloride.
Only include the outer shell electrons.

[2]

(e) The equation for the reaction of phosphorus with copper(II) ions is shown.

$$2P + 5Cu^{2+} + 8H_2O \longrightarrow 5Cu + 2PO_4^{3-} + 16H^+$$

Identify the oxidising agent. Explain your answer.

oxidising agent: .....

explanation: .....

.....

[2]

[Total: 10]

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9 Proteins are natural polymers.

(a) Name one other natural polymer.

..... [1]

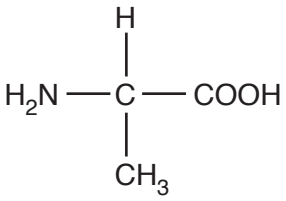
(b) Describe how proteins can be hydrolysed to amino acids.

.....

.....

..... [2]

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

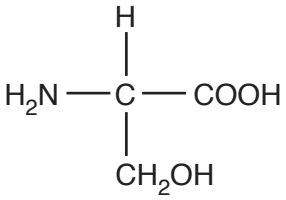


Alanine can be polymerised to form poly(alanine).

Draw the partial structure of poly(alanine) to show **two** repeat units.

[2]

(d) The structure of the amino acid serine is shown.



Serine can form polymers with amide linkages.

Serine can also form polymers with a different linkage.

Name this linkage and explain how it is formed.

linkage .....

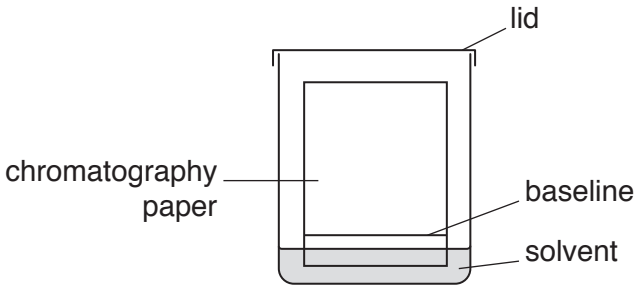
explanation .....

.....

[2]

(e) Paper chromatography can be used to separate a mixture of amino acids.

The apparatus used is shown.



(i) Why should the baseline be drawn in pencil and not in ink?

.....

..... [1]

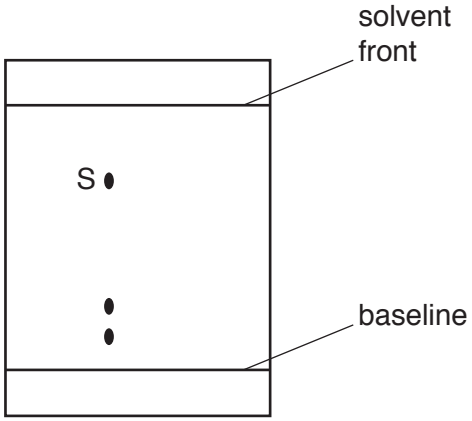
(ii) When the separation of the amino acids is complete, the chromatography paper is sprayed with a locating agent.

Explain why.

.....

..... [1]

(iii) The diagram shows the chromatography paper after it has been sprayed with a locating agent.



Calculate the R_f value of the amino acid labelled S.

R_f value ..... [1]

[Total: 10]

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.).