Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4832897448

CHEMISTRY **5070/22**

Paper 2 Theory **October/November 2022**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **three** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

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[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.

I	II											III	IV	V	VI	VII	VIII
													C	N	O	F	
	Mg											Al				Cl	Ar
K	Ca				Cr		Fe			Cu	Zn					Br	
																I	
									Pt								

Answer the following questions using only the symbols of the elements in the diagram.

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

Give the symbol of the element that:

(a) is a catalyst in the Haber process

..... [1]

(b) is used to make food containers because of its resistance to corrosion

..... [1]

(c) is about one percent by volume of dry air

..... [1]

(d) is extracted from haematite

..... [1]

(e) forms an ion with a charge of –2.

..... [1]

[Total: 5]

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2 This question is about halogens and halogen compounds.

(a) **(i)** Draw a dot-and-cross diagram to show the arrangement of electrons in a chlorine molecule.

Show only the outer shell electrons.

[2]

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

..... [1]

(b) Aqueous chlorine reacts with aqueous potassium bromide.

$$Cl_2(aq) + 2KBr(aq) \rightarrow Br_2(aq) + 2KCl(aq)$$

(i) State the colour of $Br_2(aq)$.

..... [1]

(ii) Explain, using ideas about the reactivity of the halogens, why aqueous bromine does **not** react with aqueous potassium chloride.

..... [1]

(c) Bromine is a liquid at room temperature.

Describe the arrangement and separation of the particles in a liquid.

arrangement .....

separation .....

[2]

(d) Chlorofluorocarbons (CFCs) are atmospheric pollutants which deplete the ozone layer.

Explain the importance of the ozone layer.

Describe **one** problem caused by the depletion of the ozone layer.

importance .....

.....

problem .....

.....

[2]

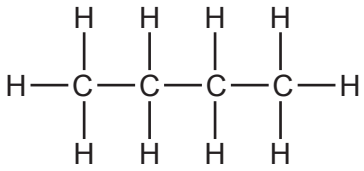
[Total: 9]

3 The alkanes are a homologous series of hydrocarbons.

(a) Give the general formula for the alkanes.

..... [1]

(b) The structure of one isomer of an alkane is shown.



(i) Name this alkane.

..... [1]

(ii) Draw the structure of a different isomer of this alkane. Show all of the atoms and all of the bonds.

[1]

(c) The fractional distillation of petroleum (crude oil) produces fractions containing alkanes of different chain lengths.

(i) Separation by fractional distillation depends on a physical property of the fractions.

Name this physical property.

..... [1]

(ii) Naphtha is one fraction separated from petroleum (crude oil).

State the main use of the naphtha fraction.

..... [1]

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(d) Larger alkane molecules are cracked to form smaller alkane molecules.

(i) Explain the importance of cracking larger alkanes into smaller alkanes.

.....

..... [1]

(ii) State two conditions needed for cracking.

1 .....

2 .....
[2]

(e) Alkanes react with chlorine in the presence of ultraviolet light to form compounds that contain carbon, hydrogen and chlorine.

A compound contains 37.8% carbon, 6.30% hydrogen and 55.9% chlorine by mass.

Calculate the empirical formula of this compound.

empirical formula ..... [2]

[Total: 10]

4 This question is about ammonium sulfate, $(NH_4)_2SO_4$.

(a) Ammonium sulfate is a fertiliser.

Explain why farmers put fertilisers on soil where crops are grown.

..... [1]

(b) Explain why farmers do **not** add calcium hydroxide to the soil immediately after adding ammonium sulfate.

.....

..... [2]

(c) Calculate the percentage by mass of nitrogen in ammonium sulfate.

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

percentage by mass ..... [3]

(d) Complete the equation for the reaction of ammonium sulfate with aqueous sodium hydroxide.

$(NH_4)_2SO_4 + 2NaOH \rightarrow$ ..... + ... + ... [2]

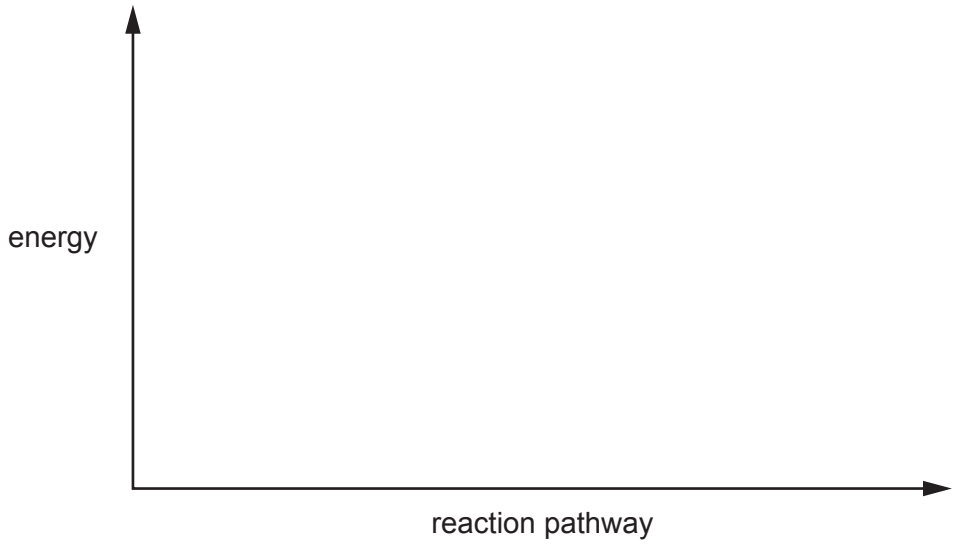
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(e) Ammonium sulfate decomposes when heated. The reaction is endothermic.

$$3(NH_4)_2SO_4 \rightarrow 4NH_3 + 3SO_2 + N_2 + 6H_2O$$

Complete and label the energy profile diagram for this reaction to include:

- the reactant and products
- the enthalpy change of the reaction.



[2]

[Total: 10]

5 This question is about metals and metal compounds.

(a) Zinc reacts with aqueous copper(II) ions.

$$Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$$

Explain why this reaction involves **both** oxidation and reduction.

Use the equation and ideas about electron transfer in your answer.

.....

.....

..... [2]

(b) Aqueous ammonia is added to aqueous zinc ions.

Describe the observations when:

a few drops of aqueous ammonia are added

.....

excess aqueous ammonia is added.

.....
[2]

(c) Molten zinc chloride conducts electricity.

(i) Predict the products formed at the anode and the cathode when molten zinc chloride is electrolysed.

anode .....

cathode .....
[2]

(ii) Explain, in terms of structure and bonding, why zinc chloride has a high melting point.

.....

.....

..... [2]

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(d) Aluminium is extracted from its ore by electrolysis.

(i) State why aluminium is extracted by electrolysis and **not** by reduction with carbon.

..... [1]

(ii) State **one** property of aluminium which makes it suitable for the construction of aircraft.

..... [1]

(iii) State **one** advantage of recycling metals such as aluminium and copper.

..... [1]

[Total: 11]

Section B

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

The total mark for this section is 30.

6 This question is about nitrogen and oxides of nitrogen.

(a) State the percentage of nitrogen by volume in dry air.

..... [1]

(b) The equation represents the equilibrium between nitrogen and oxygen at a high temperature in a closed container.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

(i) Predict what happens to the position of equilibrium when the pressure is increased.

Explain your answer.

prediction .....

explanation .....

.....

.....

[2]

(ii) The table shows the concentration of nitrogen(II) oxide, NO, in the closed container at three different temperatures.

temperature in °C	concentration of NO in mol / dm^3
800	0.02
1000	0.20
1200	20.00

State what this information shows about the enthalpy change of the forward reaction.

Explain your answer.

enthalpy change .....

explanation .....

.....

.....

[2]

(c) Nitrogen(II) oxide, NO, reacts with hydrogen to produce ammonia and water.

Construct the equation for this reaction.

..... [2]

(d) Nitrogen oxides are pollutants in the atmosphere.

(i) State **one** source of nitrogen oxides in the atmosphere.

..... [1]

(ii) Nitrogen oxides contribute to acid rain.

State **one** effect of acid rain on buildings.

..... [1]

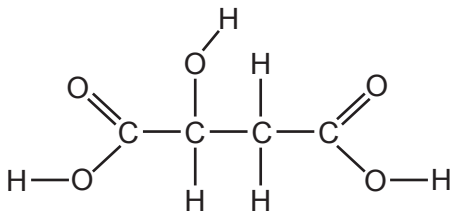
(iii) State the formula of the ion that is present in all acids.

..... [1]

[Total: 10]

7 This question is about carboxylic acids and polymers.

(a) The structure of an organic compound is shown.



Deduce the molecular formula of this compound.

..... [1]

(b) Propanoic acid, C_2H_5COOH, reacts with methanol, CH_3OH, to form an ester.

(i) Name this ester.

Draw the structure of this ester showing all atoms and all bonds.

name of ester .....

structure of ester

[2]

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

..... [1]

(c) Ethanoic acid can be produced by the bacterial oxidation of ethanol.

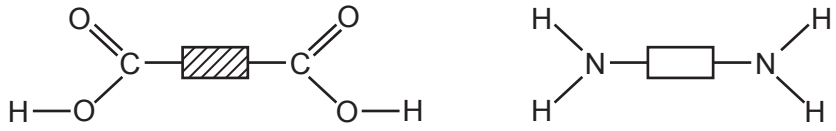
Give one **other** method of oxidising ethanol to produce ethanoic acid.

.....

..... [2]

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(d) The simplified structures of a dicarboxylic acid monomer and a diamine monomer are shown.



(i) Draw the partial structure of the condensation polymer formed from these two monomers to show:

- two repeat units
- all of the atoms and all of the bonds in the amide linkages.

[2]

(ii) State the meaning of the term *condensation* in condensation polymerisation.

.....

..... [1]

(e) Proteins have amide linkages.

Proteins are hydrolysed using dilute acid.

Name the type of compound produced by this hydrolysis.

..... [1]

[Total: 10]

8 This question is about metals and metal compounds.

(a) Describe, with the aid of a labelled diagram, the structure and bonding in metals.

.....

.....

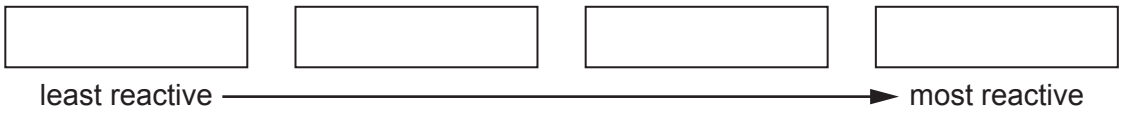
.....

..... [3]

(b) The table shows the reactivity of four metals with cold water and with steam.

metal	reactivity with cold water	reactivity with steam
cerium	slow	fast
nickel	none	very slow
rubidium	very fast	explosive
zinc	none	fast

Put the four metals in order of increasing reactivity.



[1]

(c) The full symbol of an ion of cerium is shown.

$$^{140}_{58}Ce^{3+}$$

Deduce the number of electrons and neutrons in this ion.

number of electrons .....

number of neutrons .....

[2]

(d) Zinc reacts with aqueous silver nitrate, $AgNO_3$, to produce aqueous zinc nitrate and silver.

Construct the ionic equation, including state symbols, for this reaction.

..... [2]

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(e) The effect of heat on crystals of green nickel(II) chloride, $NiCl_2 \cdot 6H_2O$ is shown in the equation.

$$\underset{\text{green nickel(II) chloride}}{NiCl_2 \cdot 6H_2O} \rightleftharpoons \underset{\text{yellow nickel(II) chloride}}{NiCl_2} + 6H_2O$$

(i) State the term used to describe salts, such as $NiCl_2$, which contain no water of crystallisation.

..... [1]

(ii) Describe how to change yellow nickel(II) chloride back to green nickel(II) chloride.

..... [1]

[Total: 10]

9 **(a)** Magnesium carbonate reacts with dilute hydrochloric acid.

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

When 25.0 cm^3 of dilute hydrochloric acid is added to excess magnesium carbonate, the volume of carbon dioxide gas produced at room temperature and pressure is 120 cm^3.

(i) Calculate the concentration, in mol / dm^3, of the dilute hydrochloric acid.

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

(ii) The reaction is repeated at a higher temperature. All other conditions stay the same.

Describe how the rate of reaction changes.

Explain your answer using ideas about collisions between particles.

.....

.....

..... [2]

(iii) The reaction is repeated using a higher concentration of hydrochloric acid. All other conditions stay the same.

Describe how the rate of reaction changes.

Explain your answer using ideas about collisions between particles.

.....

.....

..... [2]

(b) Duralumin is an alloy of aluminium, magnesium, copper and manganese.

State the meaning of the term *alloy*.

.....

..... [1]

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(c) Copper is purified by electrolysis using an impure copper anode and a pure copper cathode.

Construct the ionic equation for the reaction taking place at the cathode.

..... [1]

(d) A metal object can be electroplated with another metal.

State **one** use of electroplating.

..... [1]

[Total: 10]

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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.).