Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER			

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.

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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.

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

[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

..............Fe... [1]

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

...............Al.. [1]

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

...............Ar.. [1]

(d) is extracted from haematite

...............Fe... [1]

(e) forms an ion with a charge of −2.

...............O... [1]
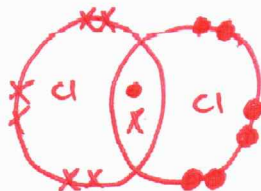
[Total: 5]

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.

It is used in water treatment to kill bacteria. [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 $Br_2(aq)$.

Orange [1]

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

Chlorine is more reactive than bromine. [1]

(c) Bromine is a liquid at room temperature.

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

arrangement The Particles are randomly and not ordered.

separation The Particles are closer together and some Particles touching. [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 It reduces the amount of ultraviolet radiation reaching Earth.

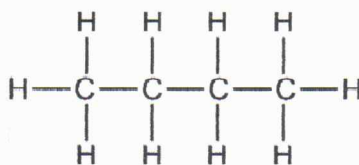problem More exposure leads to skin cancer and sunburns. [2]

[Total: 9]

4

3   The alkanes are a homologous series of hydrocarbons.

(a) Give the general formula for the alkanes.

C_nH_{2n+2}
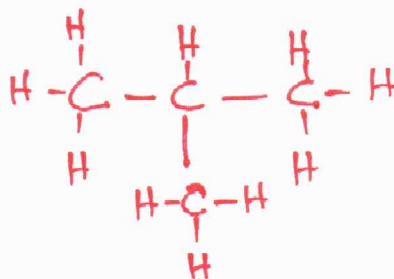
.... [1]

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

$$\begin{array}{cccc} H & H & H & H \\ | & | & | & | \\ H-C-&C-&C-&C-H \\ | & | & | & | \\ H & H & H & H \end{array}$$

(i)   Name this alkane.

...............butane... [1]

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

$$\begin{array}{c} H-C-C-C-H \\ (with\ H-C-H\ branch) \end{array}$$

[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.

.......They have different boiling points.............................. [1]

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

State the main use of the naphtha fraction.

.......Naphtha is used in Making chemicals.... [1]

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5

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

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

Cracking produces shorter chain fractions that are more in demand and produces more fuels compared to long chains. [1]

(ii) State two conditions needed for cracking.

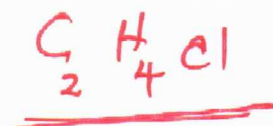1 *High temperatures about 600-700°C.*

2 *Catalyst (alumina / silica)*

[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.

Element	C	H	Cl
%Mass	37.8	6.30	55.9
R.AM	12	1	35.5
Moles	$\frac{37.8}{12}$	$\frac{6.30}{1}$	$\frac{55.9}{35.5}$
	3.15	6.3	1.57
Mole ratio	$\frac{3.15}{1.57}$	$\frac{6.3}{1.57}$	$\frac{1.57}{1.57}$

empirical formula C_2H_4Cl [2]

C_2H_4Cl

[Total: 10]

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6

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.

They use to improve crop yields and add minerals lost when plants are harvested. [1]

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

Ammonia is produced and escapes from the soil. [2]

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

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

$(NH_4)_2SO_4$

$R.FM = (14 \times 2) + (4 \times 2) + 32 + (16 \times 4)$
$= 28 + 8 + 32 + 64$
$= 132$

Percentage of nitrogen $= \frac{28}{132} \times 100\% = 21.2\%$

21.2

percentage by mass .... 21.2 [3]

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

$(NH_4)_2SO_4 + 2NaOH \rightarrow$ $2NH_3$ + Na_2SO_4 + $2H_2O$ [2]

7

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

$$3(NH_4)_2SO_4 \rightarrow 4NH_3 + 3SO_2 + N_2 + 6H_2O$$
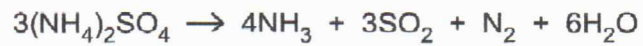
Complete and label the energy profile diagram for this reaction to include:

- the reactant and products
- the enthalpy change of the reaction.
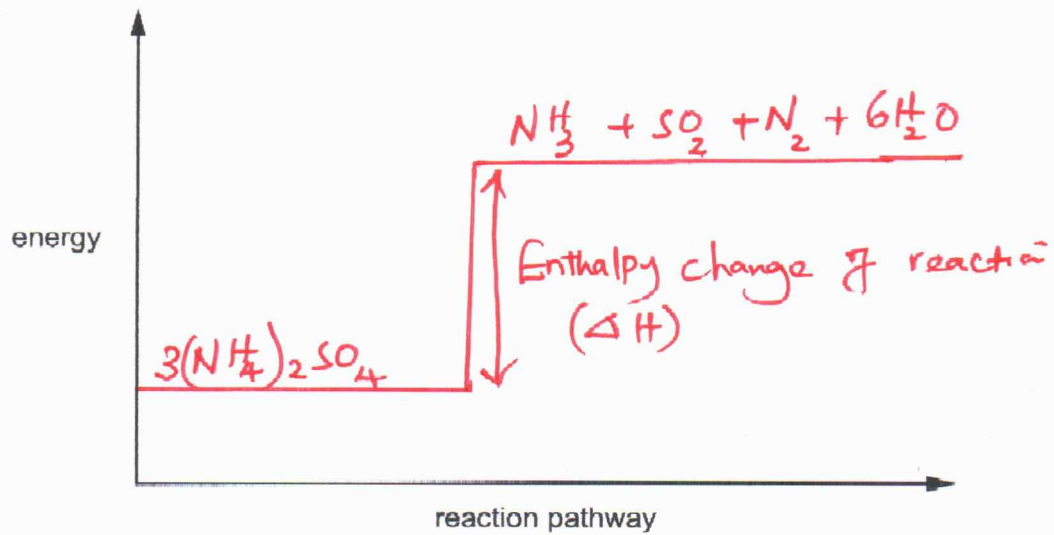
[2]

[Total: 10]

5 This question is about metals and metal compounds.

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

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

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

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

Zinc loses electrons which is oxidation and Copper(ii) ions gains electrons which is reduction. (OIL RIG) . [2]

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

Describe the observations when:

a few drops of aqueous ammonia are added

A white precipitate is formed.

excess aqueous ammonia is added.

The precipitate dissolves and turns colourless. [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 Chlorine

cathode Zinc [2]

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

Zinc chloride has giant ionic structure and has strong forces of attraction between positive and negative ions, thus alot of energy [2] required to break the bonds.

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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.

Aluminium is very reactive and alot of energy will be lost. [1]

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

It has low density. [1]

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

It helps in conservation of the ores. [1]

[Total: 11]

10

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.

........78%.. [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 ...There is no effect on position of equilbrium

explanation ...It has equal number of moles of gas on each side of the equation and volumes of gas are equal.

[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 ...The reaction is endothermic.

explanation ...there is a higher concentration of No at higher temperatures and lower concentration temperatures of N_2 and O_2 at lower temperatures.

[2]

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

Construct the equation for this reaction.

$$2NO + 5H_2 \longrightarrow 2NH_3 + 2H_2O$$

.... [2]

(d) Nitrogen oxides are pollutants in the atmosphere.

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

   - Car exhaust fumes.
   .... [1]
   - Fossil fuel powered power stations.

   (ii) Nitrogen oxides contribute to acid rain.

   State **one** effect of acid rain on buildings.
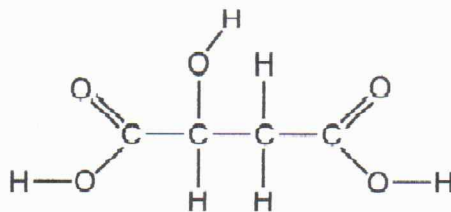
   They result in corrosion.
   .... [1]

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

   H^+
   .... [1]

[Total: 10]

7   This question is about carboxylic acids and polymers.

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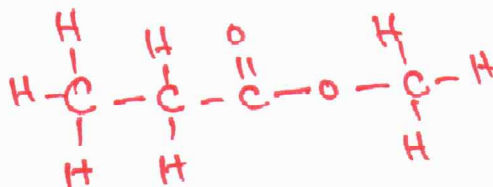

Deduce the molecular formula of this compound.

...... $C_4H_6O_5$ ...... [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 ...... Methyl propanoate ......

structure of ester

[2]

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

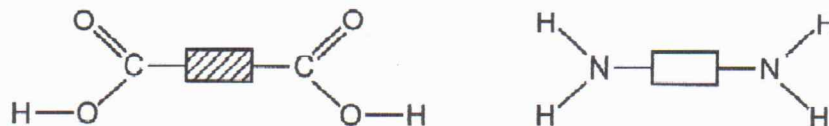...... −Used in solvents. ...... [1]

− Used in perfumes and flavourings.

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

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

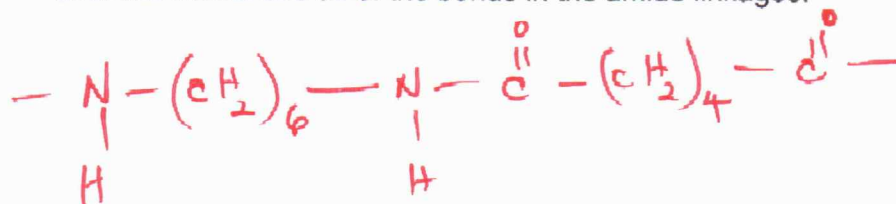...... Use of acidified Potassium Manganate(VII) (KMnO$_4$). ......

...... [2]

(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.

$$-N-(CH_2)_6 \longrightarrow N-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-$$

(with H below each N)

[2]

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

It is the Joining of two compounds with elimination of a small molecule. [1]

(e) Proteins have amide linkages.
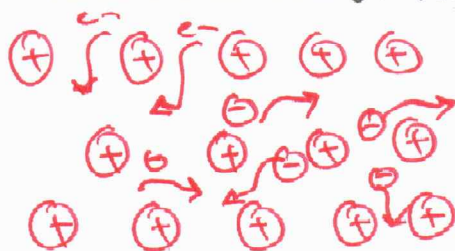
Proteins are hydrolysed using dilute acid.

Name the type of compound produced by this hydrolysis.

Amino acids. [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.

[handwritten diagram showing positive ions (⊕) and delocalised electrons (⊖) with arrows]

Metal atoms are held together strongly by Metallic bonding in a giant Metallic Lattice. Within the Metallic lattice the atoms lose the electrons from their outer shell and become positively charged and the outer electron no longer belong to a particular Metal thus delocalised [3]

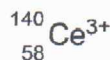**(b)** The table shows the reactivity of four metals with cold water and with steam.

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.

Nickel		Zinc		Cerium		rubidium

least reactive ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯→ most reactive
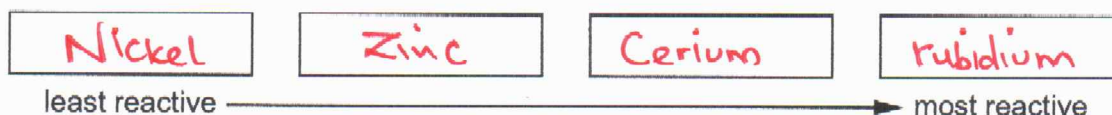
[1]

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

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

[handwritten note] Number of electrons are lost in outermost energy level.

Deduce the number of electrons and neutrons in this ion.

number of electrons ....55.......

number of neutrons ....82.......

[handwritten note] Neutron = Mass number − Atomic number. [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.

$$Zn(s) + 2Ag^+(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$$ [2]

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

$$NiCl_2 \cdot 6H_2O \rightleftharpoons NiCl_2 + 6H_2O$$

green
nickel(II) chloride

yellow
nickel(II) chloride

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

...........Anhydrous (without water).......................... [1]

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

...........Required to add water............. [1]

[Total: 10]

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

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

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.

1 Mole of any gas = 24000 cm^3.

No. of Moles of CO$_2$ = $\frac{120}{24000}$ = 0.005 moles

using Mole ratio HCl : CO$_2$

moles of HCl = $\frac{2}{3}$: 1 = 0.005×2 = 0.01

Concentration = $\frac{25}{1000}$ = 0.025

Conc HCl = $\frac{0.01}{0.025}$ = 0.4 mol/dm^3

concentration ....0.4.............. 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.

The rate of reaction Increases, and the Particles Move faster and have More kinetic energy thus more successful collisions, greater than the activation energy. [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.

The rate of reaction Increases and the Particles are More Crowded and being Closer together, there is higher greater Collision frequency. [2]

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

State the meaning of the term alloy.

It is a mixture of a metal with another element. [1]

(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.

$$Cu^{2+} + 2\bar{e} \longrightarrow Cu(s).$$ [1]

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

State **one** use of electroplating.

It Makes object More resistant to [1]
Corrosion and their surfaces harder.

[Total: 10]