Cambridge O Level

**Cambridge International Examinations**
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



**CHEMISTRY** **5070/22**

Paper 2 Theory **May/June 2017**

**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.




CAMBRIDGE International Examinations

**[Turn over**

## Section A

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

The total mark for this section is 45.

**A1** Choose from the following chlorides to answer the questions.

**ammonium chloride**

**calcium chloride**

**carbon tetrachloride**

**copper(II) chloride**

**hydrogen chloride**

**magnesium chloride**

**zinc chloride**

Each chloride can be used once, more than once or not at all.

Which chloride

**(a)** is a coloured solid,

.....[1]

**(b)** reacts with warm aqueous sodium hydroxide to produce a gas that turns damp red litmus paper blue,

.....[1]

**(c)** reacts with water to form a strong acid,

.....[1]

**(d)** contains a cation with a charge of +1,

.....[1]

**(e)** has a simple molecular structure similar to methane?

.....[1]

[Total: 5]

**A2** The table shows some information about six particles.

**(a)** Complete the table.

| particle | proton (atomic) number | number of neutrons in particle | number of electrons in particle |
|---|---|---|---|
| $^{35}Cl$ | 17 | 18 | ..... |
| ..... | 17 | 20 | 17 |
| $^{39}K^{+}$ | 19 | ..... | 18 |
| $^{79}Br^{-}$ | ..... | 44 | 36 |
| $^{81}Br$ | 35 | ..... | 35 |
| ..... | 37 | 48 | 36 |

[6]

**(b)** **(i)** What is meant by the term *isotopes*?

.....

.....

.....[1]

**(ii)** Identify two **atoms** which are isotopes of the same element.

..... and .....[1]

[Total: 8]





**[Turn over**

**A3** Acids are neutralised by insoluble bases.

**(a)** Magnesium chloride is a soluble salt that can be prepared from an insoluble base.

**(i)** Name the acid and an insoluble base that can be used to make magnesium chloride.

.....[1]

**(ii)** Describe the experimental method used to prepare pure crystals of magnesium chloride from this acid and base.

.....

.....

.....

.....

.....

.....

.....[4]

**(b)** Aqueous barium chloride and aqueous potassium sulfate can be used to prepare barium sulfate in a precipitation reaction.

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

.....[2]

**(c)** Potassium sulfate can be prepared by reacting aqueous potassium hydroxide with dilute sulfuric acid.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

In an experiment, 20.0 $cm^3$ of 0.650 $mol/dm^3$ sulfuric acid is just neutralised by aqueous potassium hydroxide.

**(i)** Calculate the maximum mass of potassium sulfate, $K_2SO_4$, that could be prepared.

[The relative formula mass of $K_2SO_4$ is 174.]

maximum mass of potassium sulfate = ..... g [2]

**(ii)** After crystallisation, 1.72 g of dry potassium sulfate was obtained. Calculate the percentage yield of potassium sulfate.

percentage yield of potassium sulfate = ..... % [1]

[Total: 10]





**[Turn over**

**A4** Sodium oxide, $Na_2O$, is an ionic compound.

**(a)** State the electronic configuration for each of the ions in sodium oxide.

sodium ion .....

oxide ion .....
[2]

**(b)** When **molten** sodium oxide is electrolysed, sodium and oxygen are formed.

Construct equations for the two electrode reactions.

reaction at the negative electrode

.....

reaction at the positive electrode

.....
[2]

**(c)** Explain how molten sodium oxide conducts electricity.

.....

.....[1]

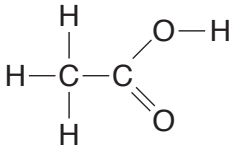
**(d)** Sodium oxide reacts with water to give sodium hydroxide.

Construct the equation for this reaction.

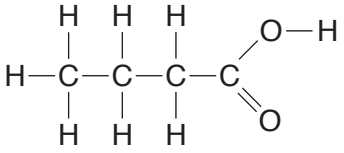
.....[1]

[Total: 6]

**A5** Ethanoic acid and butanoic acid are both carboxylic acids.



**ethanoic acid**



**butanoic acid**

**(a)** Name a reagent that can be used to make ethanoic acid from ethanol.

.....[1]

**(b)** Dilute ethanoic acid reacts with all carbonates and with some metals.

**(i)** Name one metal that will react with dilute ethanoic acid and name the products of this reaction.

name of metal .....

products .....
[2]

**(ii)** Construct an equation to show the reaction of dilute ethanoic acid with calcium carbonate.

.....[2]

**(c)** Draw the structure of a carboxylic acid that is an isomer of butanoic acid.

Show all of the atoms and all of the bonds.

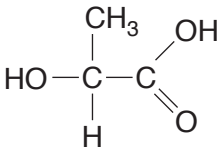
[1]





**[Turn over**

**(d)** Lactic acid is both an alcohol and a carboxylic acid.




Lactic acid is a monomer that can be polymerised to form a polyester.

**(i)** What type of polymerisation occurs during this reaction?

.....[1]

**(ii)** This polyester is biodegradable.

Suggest an advantage of a polymer being biodegradable.

.....

.....[1]

[Total: 8]

**A6** Respiration is a reaction that takes place in living cells to release energy.

The overall reaction involves the oxidation of glucose.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

The reaction is exothermic and is catalysed by enzymes.

**(a)** Draw an energy profile diagram for respiration using the axes shown.

Label
- the axes,
- the enthalpy change,
- the reactants and products.

[3]

**(b)** Explain how a catalyst such as an enzyme can speed up a chemical reaction.

.....

.....

.....[2]

**(c)** Respiration, combustion and photosynthesis are important processes in the carbon cycle.

Describe how the carbon cycle regulates the amount of carbon dioxide in the atmosphere.

.....

.....

.....

.....[3]

[Total: 8]





**[Turn over**

## Section B

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

The total mark for this section is 30.

**B7** Copper reacts with hot concentrated aqueous sulfuric acid.

$$Cu(s) + 2H_2SO_4(aq) \rightarrow CuSO_4(aq) + SO_2(g) + 2H_2O(l)$$

**(a)** Suggest what you would observe when copper reacts with hot concentrated aqueous sulfuric acid.

.....

.....[1]

**(b)** **(i)** Name the salt of formula $CuSO_4$.

.....[1]

**(ii)** Copper is oxidised when it reacts with concentrated sulfuric acid.

Use the equation to explain that copper has been oxidised.

.....

.....[1]

**(c)** An excess of copper is added to 25.0 $cm^3$ of hot 14.0 mol / $dm^3$ $H_2SO_4$.

Use this information, together with the equation, to calculate the maximum volume of $SO_2$ formed.

The gas volume is measured at room temperature and pressure.

volume of $SO_2$ = .....[3]

**(d)** To a small sample of $CuSO_4(aq)$, a student adds aqueous sodium hydroxide drop by drop until it is in excess.

**(i)** Describe what would be observed.

.....

.....[1]

**(ii)** The student repeats the experiment but adds aqueous ammonia instead of aqueous sodium hydroxide.

Describe what would be observed.

.....

.....

.....[2]

**(e)** Copper(I) chloride, CuCl, decomposes to form $CuCl_2$ and Cu.

Construct the equation for this reaction.

.....[1]

[Total: 10]





**[Turn over**

**B8** Nitrogen dioxide, $NO_2$, reacts with itself to make dinitrogen tetroxide, $N_2O_4$, in an exothermic reaction.

This reaction is investigated at 140 °C in a sealed container.

A dynamic equilibrium mixture is established.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

$NO_2(g)$ is a dark brown gas.

$N_2O_4(g)$ is a colourless gas.

**(a)** What is the meaning of the symbol $\rightleftharpoons$ ?

.....[1]

**(b)** What is an exothermic reaction?

.....

.....[1]

**(c)** Suggest why a sealed container must be used to establish any equilibrium.

.....

.....[1]

**(d)** The pressure of the equilibrium mixture is decreased.

The temperature is kept at 140 °C.

Predict and explain what will happen to the colour of the equilibrium mixture.

.....

.....

.....

.....

.....[2]

**(e)** The temperature of the equilibrium mixture is increased.

The pressure is kept constant.

Predict and explain what will happen to the colour of the equilibrium mixture.

.....

.....

.....

.....

.....[2]

**(f)** Nitrogen dioxide reacts with water to make nitric acid, $HNO_3$, and nitrous acid, $HNO_2$.

Nitric acid is a strong acid and nitrous acid is a weak acid.

**(i)** Describe an experiment to distinguish between separate solutions of a strong acid and a weak acid.

.....

.....

.....

.....[2]

**(ii)** Nitrogen dioxide reacts with aqueous potassium hydroxide.

Give the formula of each of the two salts formed in this reaction.

..... and .....[1]

[Total: 10]





**[Turn over**

**B9** Methane, ethane and propane are all gases at room temperature.

**(a)** State a use of methane.

.....[1]

**(b)** Describe one source of methane in the atmosphere.

.....

.....[1]

**(c)** State one possible environmental consequence of the presence of methane in the atmosphere.

.....

.....[1]

**(d)** Ethane reacts with chlorine in the presence of ultraviolet light to give a number of different compounds.

A 1.00 g sample of one of these compounds contains 0.040 g of hydrogen, 0.242 g of carbon and 0.718 g of chlorine.

**(i)** Calculate the empirical formula of this compound.

empirical formula .....[2]

**(ii)** The relative molecular mass of the compound is 99.

Deduce the molecular formula of the compound.

.....[1]

**(e) (i)** What is meant by the term *diffusion*?

.....

.....

.....[1]

**(ii)** Explain why propane diffuses faster at 100 °C than at 60 °C.

.....

.....[1]

**(iii)** Explain why diffusion could be used to separate a mixture of methane and propane.

.....

.....

.....[2]

[Total: 10]

**B10** The table shows some information about the homologous series of unbranched alcohols.

| name | structure | boiling point / °C |
|---|---|---|
| methanol | $CH_3OH$ | 65 |
| ethanol | $CH_3CH_2OH$ | 79 |
| propanol | $CH_3CH_2CH_2OH$ | 97 |
| butanol | $CH_3CH_2CH_2CH_2OH$ | 117 |
| pentanol | $CH_3CH_2CH_2CH_2CH_2OH$ | 138 |

**(a)** One of the characteristics of a homologous series is that it has a general formula.

**(i)** What is the general formula for the homologous series of unbranched alcohols?

.....[1]

**(ii)** Predict the boiling point of hexanol, an alcohol with six carbon atoms per molecule.

..... °C [1]

**(b)** Describe the manufacture of ethanol by the fermentation of aqueous glucose.

.....

.....

.....

.....

.....

.....[3]

**(c)** Butanol reacts with ethanoic acid to make an ester.

Name and draw the structure of this ester.

Show all of the atoms and all of the bonds within the ester linkage.

name .....

structure

[2]

**(d)** Ethanol is a gas at 100 °C.

Describe the changes in the arrangement and movement of the molecules when ethanol is cooled from 100 °C to 25 °C.

.....

.....

.....

.....

.....

[3]

[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.)