Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

2777059949

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.

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CAMBRIDGE
International Examinations

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]

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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]

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]

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(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]

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[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.

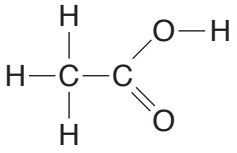
Construct the equation for this reaction.

.....[1]

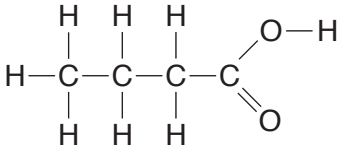
[Total: 6]

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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.

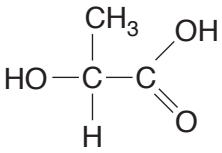
.....[2]

(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]

(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]

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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]

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]

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(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]

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]

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(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]

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]

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(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]

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(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.)