

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

CHEMISTRY

Paper 2 Theory

5070/22

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.

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
$^{39}\text{K}^+$	19	18
$^{79}\text{Br}^-$	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.

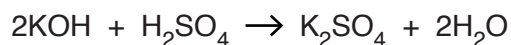
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[4]

(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]

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



In an experiment, 20.0 cm³ of 0.650 mol/dm³ sulfuric acid is just neutralised by aqueous potassium hydroxide.

- (i) Calculate the maximum mass of potassium sulfate, K₂SO₄, that could be prepared.

[The relative formula mass of K₂SO₄ is 174.]

maximum mass of potassium sulfate = g [2]

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

percentage yield of potassium sulfate = % [1]

[Total: 10]

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]

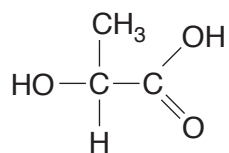
(d) Sodium oxide reacts with water to give sodium hydroxide.

Construct the equation for this reaction.

..... [1]

[Total: 6]

(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.

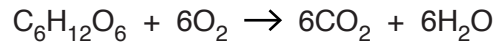
.....

.....[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.



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]

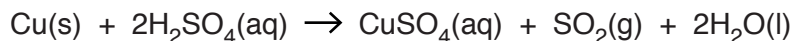
[Total: 8]

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.



(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 $14.0 \text{ mol/dm}^3 \text{ H}_2\text{SO}_4$.

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 $\text{SO}_2 = \dots\dots\dots$ [3]

(d) To a small sample of $\text{CuSO}_4(\text{aq})$, 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.

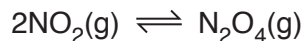
.....[1]

[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.



$\text{NO}_2(\text{g})$ is a dark brown gas.

$\text{N}_2\text{O}_4(\text{g})$ 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]

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 ₃ OH	65
ethanol	CH ₃ CH ₂ OH	79
propanol	CH ₃ CH ₂ CH ₂ OH	97
butanol	CH ₃ CH ₂ CH ₂ CH ₂ OH	117
pentanol	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ OH	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]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

