Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

2803287614

CHEMISTRY **5070/21**

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 **20** printed pages.

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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 oxides to answer the questions.

calcium oxide

carbon dioxide

copper(II) oxide

silicon dioxide

sodium oxide

sulfur dioxide

sulfur trioxide

zinc oxide

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

Which oxide

(a) has a giant covalent structure,

.....[1]

(b) reacts with both acids and alkalis,

.....[1]

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

.....[1]

(d) contains a cation with a charge of +1?

.....[1]

[Total: 4]

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A2 **(a)** Atoms and ions contain three types of sub-atomic particle.

Complete the table about these sub-atomic particles.

sub-atomic particle	relative charge	relative mass
electron		
neutron		1
proton	+1	

[3]

(b) The table shows some information about six particles.

particle	number of protons in particle	number of neutrons in particle	number of electrons in particle
A	37	48	37
B	53	74	54
C	92	143	92
D	92	143	89
E	92	146	92
F	94	150	92

(i) What is the nucleon number for particle **A**?

.....[1]

(ii) Explain why particle **B** is a negative ion.

.....

.....[1]

(iii) Which two **atoms** are isotopes of the same element?

..... and .....

Explain your answer.

.....

.....

[2]

[Total: 7]

A3 Acids are neutralised by alkalis.

(a) Write the ionic equation for the reaction between an acid and an alkali.

.....[1]

(b) Sodium sulfate is a soluble salt that can be prepared using a titration method.

(i) Name a sodium compound and the acid that can be used to make sodium sulfate by this method.

.....[1]

(ii) Describe how the titration method is used to prepare a colourless solution of sodium sulfate.

.....

.....

.....

.....

.....

.....

.....[3]

(iii) Describe how a sample of pure sodium sulfate crystals can be made from aqueous sodium sulfate.

.....

.....

.....

.....

.....[2]

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(c) Aqueous sodium sulfate can be used to prepare barium sulfate.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

In an experiment, 20.0 cm^3 of 0.550 mol/dm^3 of barium nitrate was added to excess aqueous sodium sulfate.

(i) Calculate the maximum mass of barium sulfate that could be made.

[The relative formula mass of $BaSO_4$ is 233.]

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

(ii) A mass of 1.92 g of dry barium sulfate was obtained. Calculate the percentage yield of barium sulfate.

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

[Total: 10]

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[Turn over

A4 Calcium chloride, $CaCl_2$, is an ionic compound.

(a) State the electronic configuration for each of the ions in calcium chloride.

calcium ion .....

chloride ion .....
[2]

(b) When **molten** calcium chloride is electrolysed, calcium and chlorine are formed.

Construct equations for the two electrode reactions.

reaction at the negative electrode

.....

reaction at the positive electrode

.....
[2]

(c) Predict the products of the electrolysis of concentrated **aqueous** calcium chloride.

.....[1]

(d) Explain, using ideas about structure and bonding, why calcium chloride has a high melting point.

.....

.....

.....

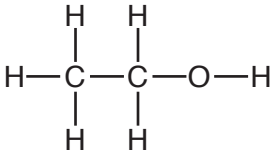
.....[2]

[Total: 7]

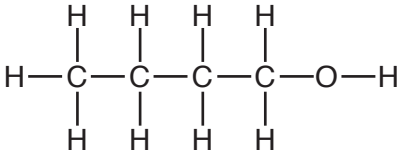
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PLEASE TURN OVER.

A5 Ethanol and butanol are both alcohols.



ethanol



butanol

(a) Describe the manufacture of ethanol from ethene.

.....

.....

.....[2]

(b) Ethanol is used as a fuel and as a constituent of alcoholic beverages.

(i) State one **other** use of ethanol.

.....[1]

(ii) Construct an equation to show the **incomplete** combustion of ethanol.

.....[2]

(c) Ethanol can be oxidised to form ethanoic acid.

Name a reagent that can be used for this oxidation.

.....[1]

(d) Draw the structure of an alcohol that is an isomer of butanol.

Show all of the atoms and all of the bonds.

[1]

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(e) Butanol can be converted into an alkene by loss of a molecule of water.

Draw the structure of the alkene formed.

Show all of the atoms and all of the bonds.

[1]

(f) Butene can be polymerised to give poly(butene).

(i) What type of polymerisation occurs?

.....[1]

(ii) Poly(butene) is non-biodegradable.

What does the term *non-biodegradable* mean?

.....

.....

.....[1]

[Total: 10]

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[Turn over

A6 Photosynthesis is a reaction that occurs in the leaves of green plants.

Carbon dioxide and water are converted into glucose and oxygen.

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

The reaction is endothermic and is catalysed by enzymes.

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

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



[3]

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(b) (i) What is an enzyme?

.....

.....[1]

(ii) State the effect of enzymes on reactions.

.....

.....[1]

(c) Explain why the rate of photosynthesis increases as the temperature increases.

.....

.....

.....

.....[2]

[Total: 7]

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[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 concentrated nitric acid.

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

(a) Suggest what you would observe when copper reacts with concentrated nitric acid.

.....

.....[1]

(b) **(i)** Suggest the name of the salt of formula $Cu(NO_3)_2$.

.....[1]

(ii) Copper is oxidised when it reacts with concentrated nitric 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 16.0 mol/dm^3 HNO_3.

Use this information, together with the equation above, to calculate the volume of NO_2 formed.

The gas volume is measured at room temperature and pressure.

volume of NO_2 = ...[3]

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(d) When heated, $Cu(NO_3)_2$ decomposes to form CuO, NO_2 and O_2.

Construct the equation for this reaction.

.....[1]

(e) To a sample of $Cu(NO_3)_2(aq)$, a student adds aqueous ammonia drop by drop until it is in excess.

(i) Describe what is observed.

.....

.....

.....

.....[2]

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

Describe what is observed.

.....

.....[1]

[Total: 10]

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[Turn over

B8 Iodine reacts with chlorine to form iodine(I) chloride, ICl.

$$I_2 + Cl_2 \rightarrow 2ICl$$

Iodine(I) chloride reacts in a similar way to both iodine and chlorine.

(a) Sodium reacts with iodine(I) chloride.

Construct the equation for the reaction between sodium and iodine(I) chloride.

.....[1]

(b) Iodine(I) chloride reacts with ethene.

Draw the structure of the product of this reaction.

Show all of the atoms and all of the bonds.

[1]

(c) Iodine(I) chloride reacts with ethane in the presence of ultraviolet light.

Deduce the type of reaction that takes place and construct an equation for this reaction.

type of reaction .....

equation .....

[2]

(d) Draw a 'dot-and-cross' diagram to show a molecule of iodine(I) chloride.

Only show the outer shell electrons.

[1]

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(e) Iodine(I) chloride reacts with chlorine to form iodine(III) chloride.

This reaction is investigated at 200 °C in a sealed container.

A dynamic equilibrium mixture is established.

$$ICl(g) + Cl_2(g) \rightleftharpoons ICl_3(g)$$

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

$ICl_3(g)$ is a yellow gas.

(i) What is meant by the term *dynamic equilibrium*?

Refer to both rate of reaction and concentration in your answer.

.....

.....

.....

.....

.....[3]

(ii) The pressure of the equilibrium mixture is increased.

The temperature is kept at 200 °C.

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

.....

.....

.....

.....

.....[2]

[Total: 10]

B9 Neon, argon, krypton and xenon are four of the noble gases. They are monatomic elements.

(a) State a use of argon.

.....

.....[1]

(b) What is meant by the term *monatomic*?

.....

.....[1]

(c) Explain why the noble gases are very unreactive.

.....

.....[1]

(d) Chemists have discovered that some noble gases can form compounds.

A 1.000 g sample of one of these compounds contains 0.549 g of xenon, 0.134 g of oxygen and 0.317 g of fluorine.

(i) Calculate the empirical formula of this compound.

empirical formula .....[2]

(ii) What extra information is needed to deduce the molecular formula of this compound?

.....[1]

(e) Describe and explain how fractional distillation can be used to separate a mixture of neon, argon, krypton and xenon.

.....

.....

.....

.....[3]

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(f) A mixture of neon, argon, krypton and xenon can also be separated by diffusion.

Explain why.

.....

.....[1]

[Total: 10]

B10 The table shows some information about the homologous series of unbranched carboxylic acids.

name	structure	boiling point/°C
methanoic acid	HCO_2H	101
ethanoic acid	CH_3CO_2H	118
propanoic acid	$CH_3CH_2CO_2H$	141
butanoic acid	$CH_3CH_2CH_2CO_2H$	164
pentanoic acid	$CH_3CH_2CH_2CH_2CO_2H$	186

(a) A homologous series has a general formula.

(i) Deduce the general formula for the homologous series of unbranched carboxylic acids.

.....[1]

(ii) Describe two **other** properties of a homologous series.

1. .....

.....

2. .....

.....

[2]

(b) An aqueous solution of propanoic acid is a weak acid.

(i) What is the meaning of the term *weak acid*?

.....

.....[1]

(ii) Aqueous propanoic acid reacts with magnesium carbonate.

Construct the equation for this reaction.

.....[1]

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(c) Butanoic acid reacts with ethanol 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) Ethanoic acid is a liquid at room temperature and has a boiling point of 118 °C.

Describe the changes in both the arrangement and movement of the molecules when ethanoic acid is heated from room temperature to 120 °C.

.....

.....

.....

.....

.....

.....[3]

[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.)