Cambridge
O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3228958698

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2019**

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 **17** printed pages and **3** blank 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.

1 Choose from the particles shown to answer the questions.

CH_4	Cl^-
Fe^{2+}	H^+
H_2S	MnO_4^-
NH_4^+	P^{3-}

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

(a) Which particle has only eighteen protons?

..... [1]

(b) Which particle is used to test for a reducing agent?

..... [1]

(c) Which particle is an ion that contains only ten electrons?

..... [1]

[Total: 3]

2 The table shows some of the properties of the elements in Group III of the Periodic Table.

element	proton (atomic) number	atomic radius /nm	melting point /°C
B	5	0.080	2306
A*l*	13	0.125	660
Ga	31	0.125	30
In	49	0.150	157
T*l*	81	0.155	304
Nh	113		

(a) Nihonium, Nh, has only recently been discovered.

It has not been possible to measure its atomic radius and melting point because it is too radioactive.

(i) Estimate the atomic radius of Nh.

.....nm [1]

(ii) Explain, using data from the table, why it is difficult to estimate the melting point of nihonium.

.....

..... [1]

(b) Boron has a giant covalent structure.

Explain why boron has a high melting point.

.....

..... [1]

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(c) Aluminium is produced by the electrolysis of molten aluminium oxide.

Aluminium oxide contains Al^{3+} and O^{2-} ions.

(i) Describe the composition of the electrolyte used in this electrolysis.

..... [1]

(ii) Name the material used for the electrodes in this electrolysis.

..... [1]

(iii) Construct equations for the reactions taking place at the:

negative electrode .....

positive electrode. .....

[2]

(d) Aluminium reacts with aqueous copper(II) chloride in a redox reaction.

$$2Al(s) + 3Cu^{2+}(aq) \longrightarrow 2Al^{3+}(aq) + 3Cu(s)$$

Which particle is oxidised? .....

Explain your answer. .....

..... [1]

(e) Explain why a piece of aluminium in water does not react.

.....

.....

..... [2]

(f) Aluminium chloride is a soluble salt.

Describe how a pure sample of aluminium chloride crystals can be made from aluminium.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

3 Titanium, Ti, is a metallic element.

(a) Suggest one physical property of titanium.

..... [1]

(b) Titanium(IV) chloride, $TiCl_4$, is a colourless liquid that has a low boiling point.

(i) Suggest the structure and bonding in $TiCl_4$.

..... [1]

(ii) Titanium(IV) chloride reacts with water to form hydrochloric acid and a precipitate of titanium(IV) oxide.

Construct the equation, including state symbols, for this reaction.

..... [2]

(c) Titanium is made by reducing $TiCl_4$ using magnesium.

$$TiCl_4 + 2Mg \longrightarrow 2MgCl_2 + Ti$$

Calculate the mass of titanium made from 1000 g of $TiCl_4$.

The reaction has a 90% percentage yield.

Give the answer to **two** significant figures.

[The relative atomic mass of titanium, Ti, is 48.]

mass of Ti ..... g [3]

[Total: 7]

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4 Petroleum (crude oil) is an important source of many chemicals.

(a) Outline the separation of petroleum (crude oil) into fractions such as petrol, diesel and bitumen.

.....

.....

.....

.....

.....

..... [3]

(b) State one large scale use of bitumen.

..... [1]

(c) Long chain hydrocarbons can be cracked to produce hydrogen.

(i) A long chain hydrocarbon has the molecular formula $C_{12}H_{26}$.

Explain how the formula shows that this hydrocarbon is an alkane.

.....

..... [1]

(ii) Construct an equation to show the cracking of $C_{12}H_{26}$ to make hydrogen and at least one alkene.

..... [1]

(d) Hydrogen and petrol are both used as fuels.

State and explain one advantage of using hydrogen rather than petrol as a fuel.

.....

.....

.....

..... [2]

[Total: 8]

5 **W** is a compound containing carbon, hydrogen and oxygen.

(a) **W** contains 57.1% carbon and 4.8% hydrogen by mass.

Calculate the empirical formula of **W**.

empirical formula ..... [3]

(b) A 0.194 g sample of **W** reacts completely with 18.5 cm^3 of 0.250 mol/dm^3 KOH.

One mole of **W** reacts with three moles of KOH.

Calculate the relative formula mass of **W**.

relative formula mass ..... [3]

(c) Deduce the molecular formula of **W**.

..... [1]

[Total: 7]

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6 Drinking water is obtained by purification of sea water and river water.

(a) Desalination is used to convert sea water into drinking water.

What is desalination?

.....

..... [1]

(b) River water is often polluted by phosphates and nitrates.

(i) Give the source of these two pollutants.

..... [1]

(ii) Name one environmental effect caused by these pollutants in river water.

..... [1]

(c) River water can be converted into drinking water.

(i) Describe how insoluble solids are removed from river water.

.....

..... [1]

(ii) Name the substance used to remove bad tastes and odours from river water.

..... [1]

(iii) Name the substance used to disinfect river water so it is safe to drink.

..... [1]

[Total: 6]

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Section B

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

The total mark for this section is 30.

7 Ammonium iodide, NH_4I, is a white solid which decomposes when heated.

$$NH_4I(s) \longrightarrow NH_3(g) + HI(g)$$

(a) A small sample of ammonium iodide is heated in a test-tube.

Describe how you would know when all the ammonium iodide has decomposed.

.....

..... [1]

(b) Calculate the volume of gas, measured at room temperature and pressure, formed when 2.90 g of ammonium iodide is completely decomposed.

volume of gas ..... [3]

(c) Describe a chemical test for the iodide ion.

test .....

observation .....

.....
[2]

(d) Aqueous ammonium iodide reacts with aqueous bromine.

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

..... [2]

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(e) Solid ammonium iodide does not conduct electricity.

Aqueous ammonium iodide conducts electricity.

Explain these two observations.

.....

.....

..... [2]

[Total: 10]

8 Nitrogen monoxide reacts with oxygen to form nitrogen dioxide.

If this reaction is investigated in a closed system, a dynamic equilibrium is established.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

(a) Explain why it is important to have a closed system to establish a dynamic equilibrium.

.....

.....

..... [1]

(b) The pressure of the equilibrium mixture is decreased.

The temperature of the equilibrium mixture is kept constant.

Predict and explain what will happen, if anything, to the **composition** of the equilibrium mixture.

prediction .....

.....

explanation .....

.....

.....

[2]

(c) The temperature of the equilibrium mixture is decreased.

The pressure of the equilibrium mixture is kept constant.

(i) Suggest why the position of equilibrium moves to the right.

..... [1]

(ii) Explain why the rate of reaction decreases.

.....

.....

..... [2]

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(d) Draw the 'dot-and-cross' diagram for a molecule of O_2.

Only include the outer shell electrons.

[1]

(e) Nitrogen dioxide reacts with water to form nitric acid, HNO_3, and nitrous acid, HNO_2.

Construct an equation for this reaction.

..... [1]

(f) Nitric acid is a strong acid and nitrous acid is a weak acid.

Describe the difference between a strong acid and a weak acid.

.....

.....

.....

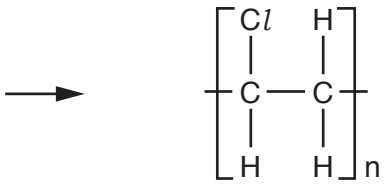
..... [2]

[Total: 10]

9 A sample of waste includes plastic and copper.

(a) One of the plastics is the addition polymer poly(chloroethene).

Complete the equation to show the formation of poly(chloroethene).



[2]

(b) Plastic waste is disposed of by combustion.

(i) Complete the equation to show the complete combustion of poly(chloroethene).

The empirical formula of poly(chloroethene), C_2H_3Cl, is used in the equation.

..... C_2H_3Cl + ... O_2 → .....CO_2 + ...H_2O + …… HCl

[1]

(ii) Suggest why the combustion of poly(chloroethene) will contribute to the formation of acid rain.

.....

..... [1]

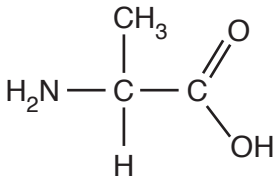
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(c) Some waste plastics, such as nylon, are polyamides.

(i) Give one large scale use of nylon.

..... [1]

(ii) The structure shows a monomer that can be used to make a polyamide.



Draw the partial structure of this polyamide. Show two repeat units.

[1]

(d) Copper waste is melted and then cooled to make new objects.

Use the kinetic particle theory to describe the changes in movement and arrangement of the particles when a liquid cools to become a solid.

.....

.....

.....

.....

..... [2]

(e) Explain, in terms of structure and bonding, why copper has a high melting point.

.....

.....

.....

.....

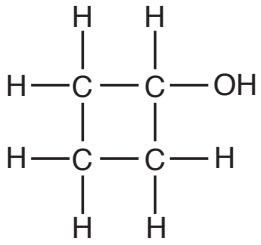
..... [2]

[Total: 10]

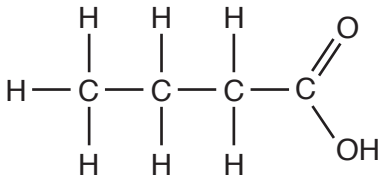
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[Turn over

10 The structures of cyclobutanol and butanoic acid are shown.



cyclobutanol



butanoic acid

(a) Explain why cyclobutanol is **not** a hydrocarbon.

.....

..... [1]

(b) Explain why butanoic acid is a saturated compound.

.....

..... [1]

(c) Describe a chemical test that can distinguish cyclobutanol from butanoic acid.

test .....

result for cyclobutanol .....

result for butanoic acid .....

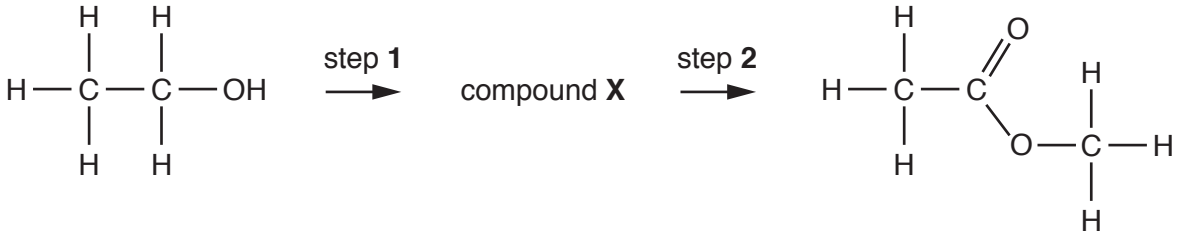
[3]

(d) Calculate the percentage by mass of carbon in cyclobutanol.

percentage by mass ..... [2]

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(e) Ethanol can be converted into methyl ethanoate in a two-step process.



(i) Identify compound **X**.

..... [1]

(ii) Identify the reagent used in step **1**.

..... [1]

(iii) Identify the reagent used in step **2**.

..... [1]

[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.).