Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4319721342

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2018**

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.

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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 gases to answer the questions.

argon
carbon dioxide
carbon monoxide
ethane
hydrogen
methane
neon
ozone
sulfur dioxide
sulfur trioxide

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

Which gas:

(a) is used to manufacture margarine

.....[1]

(b) is used as a food preservative

.....[1]

(c) has a molecule that contains only eight atoms

.....[1]

(d) is formed from bacterial decay of vegetable matter

.....[1]

(e) is formed in photochemical smog

.....[1]

(f) completely combusts to form only a gas that turns limewater milky?

.....[1]

[Total: 6]

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[Turn over

2 The elements in Group VII of the Periodic Table are called the halogens.

(a) Explain why the elements in Group VII have similar chemical properties.

.....

.....[1]

(b) A redox reaction happens when chlorine gas is bubbled through aqueous potassium iodide.

$$Cl_2(g) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

(i) Describe what is observed during this reaction.

.....[1]

(ii) Use the equation to explain that oxidation takes place in this reaction.

.....

.....[1]

(iii) Use the equation to explain that reduction takes place in this reaction.

.....

.....[1]

(c) Describe the chemical test for chlorine gas.

test .....

observation .....

.....
[2]

(d) Chlorine reacts with iron to form iron(III) chloride in a closed container.

(i) The pressure of chlorine is increased.

Describe and explain what happens to the rate of this reaction.

.....

.....

.....

.....[2]

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(ii) Iron(III) chloride can act as a catalyst for some reactions.

Explain how a catalyst increases the rate of a reaction.

.....

.....

.....

.....[2]

[Total: 10]

3 Barium chloride is a soluble salt and barium sulfate is an insoluble salt.

(a) Barium sulfate can be prepared by the reaction between aqueous barium chloride and dilute sulfuric acid.

(i) Describe the preparation of a pure, dry sample of barium sulfate from aqueous barium chloride and dilute sulfuric acid.

.....

.....

.....

.....

.....[3]

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

.....[2]

(b) Barium chloride can be prepared by reacting barium carbonate with dilute hydrochloric acid.

$$BaCO_3 + 2HCl \longrightarrow BaCl_2 + H_2O + CO_2$$

Excess barium carbonate is reacted with 40.0 cm^3 of 1.50 mol / dm^3 hydrochloric acid.

After purification the percentage yield of barium chloride was 75.0 %.

Calculate the mass of barium chloride prepared.

Give your answer to **three** significant figures.

[M_r: $BaCl_2$, 208]

mass of barium chloride ..... g [3]

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(c) A barium ion has the formula $^{138}_{56}Ba^{2+}$.

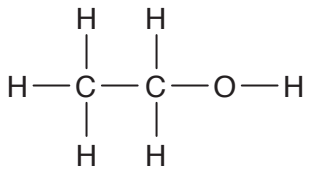
Complete the table about this ion.

subatomic particles	number of subatomic particles
electrons	.....
neutrons	.....
protons	.....

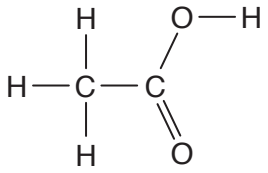
[3]

[Total: 11]

4 This question is about ethanol and ethanoic acid.



ethanol



ethanoic acid

(a) Describe the manufacture of ethanol by fermentation.

.....

.....

.....

.....

.....

.....[3]

(b) Ethanol can be oxidised by oxygen to form ethanoic acid.

Construct the equation for this reaction.

.....[1]

(c) A sample of ethanol is heated with ethanoic acid in the presence of concentrated sulfuric acid catalyst.

Draw the structure of the product of this reaction.

Show all of the atoms and all of the bonds.

[1]

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(d) Ethanol is used as a fuel.

$$C_2H_5OH + 3O_2 \rightarrow 3H_2O + 2CO_2$$

The complete combustion of one mole of ethanol releases 1350 kJ of energy.

A sample of ethanol reacts with excess oxygen to make 0.240 dm^3 of carbon dioxide, measured at room temperature and pressure.

Calculate the energy released, in kJ, in this reaction.

energy released ..... kJ [2]

[Total: 7]

5 Silicon is a non-metal found in Group IV of the Periodic Table.

(a) Silicon is manufactured by the reduction of silicon dioxide with carbon.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

What is the maximum mass of silicon that can be made from 300 g of silicon dioxide?

mass of silicon ..... g [2]

(b) Silicon has a giant molecular structure.

Suggest **two** physical properties of silicon.

1 .....

2 .....

[2]

(c) Silane has the molecular formula SiH_4.

(i) Draw the 'dot-and-cross' diagram for silane.

You only need to show the outer shell electrons of silicon.

[1]

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(ii) Using ideas about structure and bonding, suggest why silane has a low boiling point.

.....

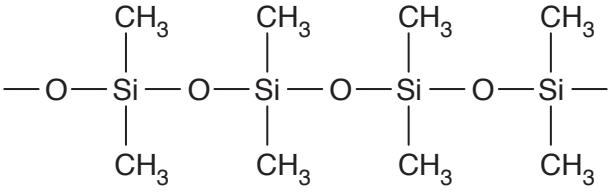
.....

.....

.....[2]

(d) Siloxanes are condensation polymers.

The partial structure of a siloxane can be represented as shown.



(i) What is meant by the term *condensation polymerisation*?

.....

.....

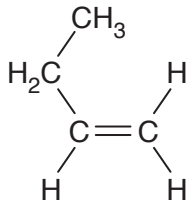
.....

.....[2]

(ii) Draw the repeat unit of this siloxane.

[1]

(e) Butene forms an addition polymer called poly(butene).



butene

Draw a partial structure for poly(butene). You must show at least two repeat units.

[1]

[Total: 11]

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Section B

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

The total mark for this section is 30.

6 Copper pyrites is an ore containing compounds of copper. One of the compounds in the ore is $CuFeS_2$.

(a) Calculate the mass of copper in 20.0 tonnes of $CuFeS_2$.

mass of copper ..... tonnes [2]

(b) $CuFeS_2$ is heated in air. Copper(II) oxide, iron(III) oxide and sulfur dioxide are formed.

Construct the equation for this reaction.

.....[2]

(c) Copper(II) oxide can be reduced by heating with carbon to form copper.

Construct the equation for this reaction.

.....[1]

(d) Copper made by this reduction is impure.

Impure copper can be purified using electrolysis.

(i) Name the electrolyte used.

.....[1]

(ii) What are the electrodes made from?

positive electrode (anode) .....

negative electrode (cathode) .....
[2]

(iii) Write the equations for the reactions at both electrodes.

positive electrode (anode) .....

negative electrode (cathode) .....
[2]

[Total: 10]

7 A scientist investigates the reaction of iron with steam in a closed system.

A dynamic equilibrium mixture is established.

$$3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$$

(a) Explain why the concentrations of steam and of hydrogen do not change once the dynamic equilibrium mixture has been established.

.....

.....

.....[1]

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

The temperature of the closed system is kept constant.

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

.....

.....

.....

.....[2]

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

The pressure within the closed system is kept constant.

(i) The position of equilibrium shifts to the left hand side.

What conclusion can be made about the enthalpy change of the reaction?

.....[1]

(ii) Describe and explain what happens to the rate of reaction.

.....

.....

.....[1]

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(d) Dilute sulfuric acid reacts with Fe_3O_4 to form three compounds, **A**, **B** and **C**.

- **A** is iron(II) sulfate.
- **B** is iron(III) sulfate.
- **C** is a colourless liquid.

(i) Name compound **C**.

.....[1]

(ii) Construct the equation for this reaction.

.....[2]

(iii) Describe a chemical test for iron(III) ions.

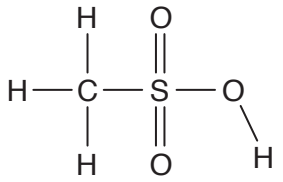
test .....

observation .....

.....
[2]

[Total: 10]

8 Methanesulfonic acid has the structure shown.



(a) Write the molecular formula for methanesulfonic acid.

.....[1]

(b) Methanesulfonic acid is a stronger acid than ethanoic acid.

Explain the meaning of this statement.

.....

.....

.....[1]

(c) What is the difference between an aqueous acid and an aqueous alkali, in terms of the ions present?

.....

.....

.....[2]

(d) What is the mass of methanesulfonic acid needed to make 150 cm^3 of a 0.150 mol/dm^3 solution?

mass ..... g [3]

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(e) In a titration, 0.00150 moles of NaOH is exactly neutralised by 0.175 mol / dm^3 methanesulfonic acid.

One mole of sodium hydroxide reacts with one mole of methanesulfonic acid.

Calculate the volume, in cm^3, of aqueous methanesulfonic acid needed in this titration.

volume ..... cm^3 [1]

(f) Methanesulfonic acid reacts with magnesium to make a salt and a gas.

(i) Name the gas made in this reaction.

.....[1]

(ii) The formula of the anion in the salt is $CH_3SO_3^-$.

Write the formula of the salt formed.

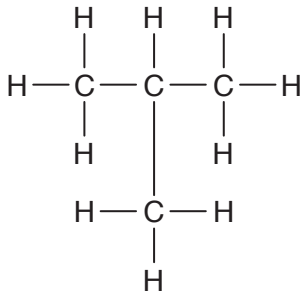
.....[1]

[Total: 10]

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[Turn over

9 Methylpropane is a saturated hydrocarbon.



methylpropane

(a) Methylpropane reacts with chlorine in the presence of ultraviolet light to give several compounds.

(i) One of these compounds has a relative molecular mass of 127.

What is the molecular formula of this compound?

molecular formula .....

Suggest a structure for this compound. Show all of the atoms and all of the bonds.

[2]

(ii) Another compound formed has the percentage composition by mass:

29.7% carbon; 4.3% hydrogen; 65.9% chlorine.

Calculate the molecular formula for this compound.

molecular formula .....[2]

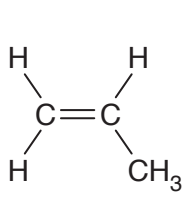
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(iii) A compound is formed when one molecule of methylpropane reacts with five molecules of chlorine.

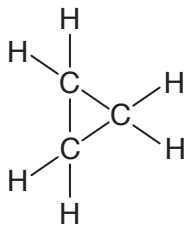
Write the molecular formula for this compound.

.....[1]

(b) The structures of propene and cyclopropane are shown.



propene



cyclopropane

These two compounds are isomers of each other.

(i) What is meant by the term *isomerism*?

.....

.....[1]

(ii) Both compounds are hydrocarbons.

What is meant by the term *hydrocarbons*?

.....

.....[1]

(iii) Propene is an unsaturated hydrocarbon and cyclopropane is a saturated hydrocarbon.

What is the difference between an unsaturated and a saturated hydrocarbon?

.....

.....[1]

(iv) Describe a chemical test to distinguish between unsaturated and saturated hydrocarbons.

.....

.....

.....[2]

[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.).