Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0083225865

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2016**

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 **19** printed pages and **1** blank page.

CAMBRIDGE International Examinations

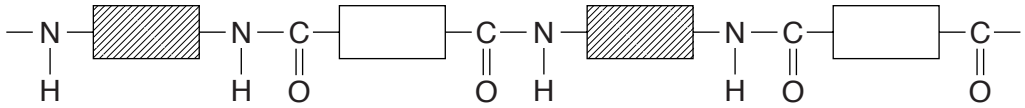
Section A

Answer **all** the questions in this section in the spaces provided.

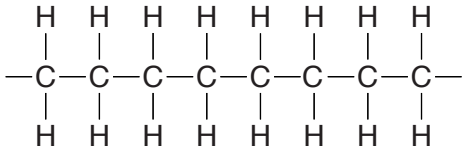
The total mark for this section is 45.

A1 Choose from the following polymers to answer the questions.

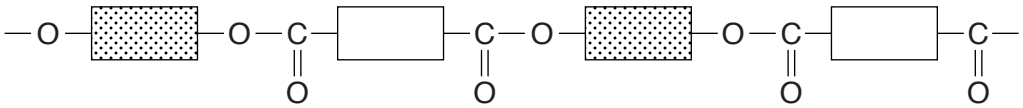
polymer A



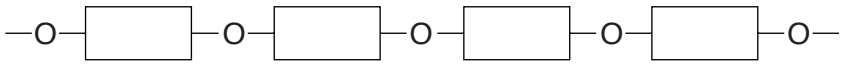
polymer B



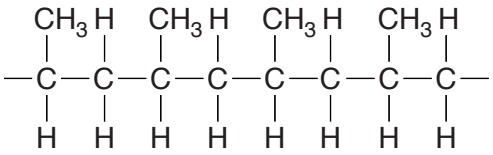
polymer C



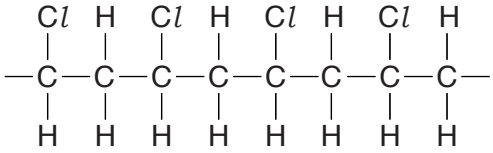
polymer D



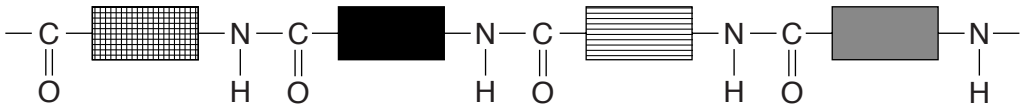
polymer E



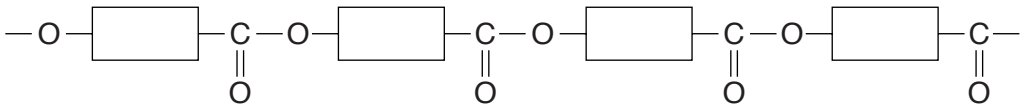
polymer F



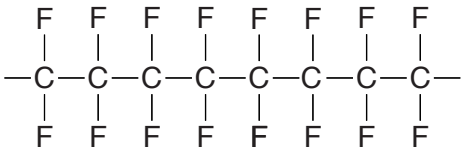
polymer G



polymer H



polymer I



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

(a) Which **two** polymers are polyesters?

..... and ..... [1]

(b) Which polymer is used to make both clingfilm and plastic bags?

..... [1]

(c) Give the letter of an addition polymer. .....

Give the letter of a condensation polymer. ..... [1]

(d) Give the letter of a polymer that is a saturated hydrocarbon.

..... [1]

(e) Which polymer could be part of a protein?

..... [1]

[Total: 5]

A2 Hydrogen fluoride, HF, has a simple molecular structure. It is soluble in water.

(a) Suggest **one** other physical property of hydrogen fluoride.

..... [1]

(b) Hydrogen fluoride dissociates in water to form dilute hydrofluoric acid.

(i) Write an equation to show the dissociation of hydrogen fluoride.

..... [1]

(ii) Explain why an acidic solution is formed when hydrogen fluoride dissociates in water.

.....

..... [1]

(c) Dilute hydrofluoric acid reacts with aqueous calcium hydroxide.

$$2HF(aq) + Ca(OH)_2(aq) \longrightarrow CaF_2(aq) + 2H_2O(l)$$

What is the minimum volume, in cm^3, of 0.150 mol / dm^3 $Ca(OH)_2$ required to react completely with a solution containing 0.200 g of HF?

volume of $Ca(OH)_2(aq)$ = ... cm^3 [3]

(d) Magnesium reacts with fluorine to make the ionic compound magnesium fluoride.

(i) Predict **two** physical properties of magnesium fluoride.

1. .....

2. .....
[2]

(ii) Explain, in terms of electrons, how a magnesium atom reacts with a fluorine molecule, F_2, to make a magnesium ion and two fluoride ions.

.....

.....

.....

..... [2]

[Total: 10]

A3 Esters are used as food flavourings and solvents.

(a) Draw the structure of ethyl methanoate, showing all of the atoms and all of the bonds.

[1]

(b) Ethyl ethanoate evaporates at room temperature.

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

.....

.....

..... [1]

(ii) A sample of ethyl ethanoate in a beaker is moved into a colder room.

Explain, in terms of the kinetic particle theory, why this results in a decrease in the rate of evaporation.

.....

.....

.....

..... [2]

(iii) The table shows some information about different esters.

name	structure	relative molecular mass (M_r)
methyl ethanoate	$CH_3CO_2CH_3$	74
ethyl ethanoate	$CH_3CO_2C_2H_5$	88
propyl ethanoate	$CH_3CO_2C_3H_7$	102
butyl ethanoate	$CH_3CO_2C_4H_9$	116
pentyl ethanoate	$CH_3CO_2C_5H_{11}$	130

Which ester has the **lowest** rate of evaporation at room temperature and pressure?

.....

Explain your answer.

.....

.....

[2]

[Total: 6]

A4 Sulfuric acid is manufactured by the contact process.

(a) State the conditions used in the contact process.

temperature .....

pressure .....

catalyst .....

[2]

(b) In the contact process, sulfur dioxide reacts with oxygen.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Describe and explain the effect of increasing the concentration of oxygen on the **rate** of this reaction.

.....

.....

.....

..... [2]

(c) The catalyst used in the contact process increases the rate of the reaction.
Describe one other advantage of using a catalyst in an industrial process.

.....

..... [1]

(d) Sulfuric acid is used to make the fertiliser potassium sulfate, K_2SO_4.

Calculate the percentage by mass of potassium in this fertiliser.

[2]

[Total: 7]

A5 The statements give some of the chemical properties of cobalt and its compounds.

- Cobalt does not react with cold water.
- Cobalt fizzes slowly with dilute hydrochloric acid.
- Cobalt does not react with aqueous zinc nitrate.
- Cobalt reacts with aqueous silver nitrate.
- Cobalt(II) oxide reacts with magnesium to form cobalt.

(a) Use the information to help arrange the following metals in order of reactivity.

cobalt, magnesium, silver, sodium and zinc

most reactive .....

.....

.....

.....

least reactive ..... [2]

(b) Construct the equation for the reaction between cobalt(II) oxide, CoO, and magnesium.

..... [1]

(c) Predict what happens when cobalt(II) carbonate is heated strongly.

..... [1]

(d) Cobalt has a melting point of 1495 °C.

Explain, in terms of structure and bonding, why a metal such as cobalt has a high melting point. You may use a labelled diagram in your answer.

.....

.....

..... [2]

(e) The symbol for one isotope of cobalt is $^{57}_{27}Co$.

Another isotope of cobalt has a nucleon number of 59.

Write its symbol.

..... [1]

[Total: 7]

A6 River water contains dissolved minerals and gases.

(a) Carbon dioxide is one of the gases dissolved in river water.

Draw the 'dot-and-cross' diagram to show the bonding in a molecule of carbon dioxide. Only draw the outer-shell electrons.

[1]

(b) River water often contains dissolved compounds such as ammonium nitrate and calcium phosphate.

(i) State **one** source of both of these compounds.

..... [1]

(ii) Describe and explain the environmental effect of the presence of these dissolved compounds in river water.

.....

.....

.....

.....

.....

.....

..... [3]

(c) River water is often purified for use as drinking water.

Describe **three** processes involved in the purification of river water.

process 1 .....

.....

.....

process 2 .....

.....

.....

process 3 .....

.....

.....

[3]

(d) Water has a low melting point and is neutral (pH = 7).

(i) Explain why water has a low melting point.

.....

..... [1]

(ii) A pH meter can be used to confirm that water is neutral.

Describe another way in which a student can confirm that water is neutral.

.....

.....

..... [1]

[Total: 10]

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Section B

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

The total mark for this section is 30.

B7 The formula of lead(II) nitrate is $Pb(NO_3)_2$.

(a) Describe how a pure sample of lead(II) nitrate crystals can be prepared from lead(II) oxide, which is insoluble in water.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Aqueous potassium iodide is added to a sample of aqueous lead(II) nitrate. A precipitate of lead(II) iodide is formed.

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

..... [2]

(c) Aqueous lead(II) nitrate is electrolysed using graphite electrodes. Bubbles of colourless gas are formed at both electrodes.

(i) Identify the gas formed at each electrode.

negative electrode (cathode) .....

positive electrode (anode) .....
[2]

(ii) Construct the equation for the reaction at the cathode.

..... [1]

(d) On heating, lead(II) nitrate decomposes to form PbO, NO_2 and O_2.

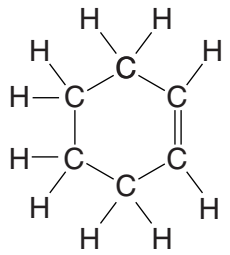
Construct the equation for this reaction.

..... [1]

[Total: 10]

B8 Cyclohexene, C_6H_{10}, is a cycloalkene.

Cycloalkenes react in a similar way to alkenes.



cyclohexene

(a) Cyclohexene is an unsaturated hydrocarbon.

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

.....

..... [1]

(ii) What is meant by the term *hydrocarbon*?

.....

..... [1]

(b) Construct the equation for the complete combustion of cyclohexene.

..... [1]

(c) Cyclohexene reacts with bromine.

This is an addition reaction.

(i) Write the molecular formula of the product of this reaction.

..... [1]

(ii) What would be observed in this reaction?

..... [1]

(d) Cyclohexene can be manufactured from hexane as shown in the equation.

$$C_6H_{14} \rightarrow C_6H_{10} + 2H_2$$

Calculate the mass of cyclohexene that can be made from 258 g of hexane.
[M_r of cyclohexene = 82]

mass of cyclohexene = ... g [2]

(e) Another cycloalkene has the following percentage composition by mass.

C, 88.2%; H, 11.8%

(i) Use the percentage composition by mass to show that the empirical formula of this cycloalkene is C_5H_8.

[2]

(ii) The cycloalkene has a relative molecular mass, M_r, of 68.

Draw the structure of the cycloalkene, showing all of the atoms and all of the bonds.

[1]

[Total: 10]

B9 Carbon monoxide reacts with hydrogen in a reversible reaction.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -91\,kJ/mol$$

The reaction reaches an equilibrium if carried out in a closed container.

(a) Explain, in terms of bond breaking and bond forming, why this reaction is exothermic.

.....

.....

.....

..... [2]

(b) When one mole of methanol, CH_3OH, is formed, 91 kJ of energy is released.

Calculate the amount of energy released when 160 g of methanol is formed.
[M_r of methanol = 32]

energy released = ... kJ [2]

(c) Predict, with a reason, how the **position of equilibrium** of this reaction changes as the

(i) pressure is increased at constant temperature,

.....

.....

..... [2]

(ii) temperature is increased at constant pressure.

.....

.....

..... [2]

(d) Methanol and compound **X** react together to form methyl butanoate.

(i) Name **X**.

..... [1]

(ii) The reaction is normally carried out using a catalyst.

Name a suitable catalyst for this reaction.

..... [1]

[Total: 10]

B10 Manganese(IV) oxide, MnO_2, can be used in the preparation of both chlorine and oxygen.

Reaction 1 $MnO_2(s) + 4HCl(aq) \rightarrow Cl_2(g) + 2H_2O(l) + MnCl_2(aq)$

Reaction 2 $2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$

In **reaction 2** manganese(IV) oxide acts as a catalyst.

(a) **Reaction 1** converts chloride ions into chlorine molecules.

Explain why this is an example of oxidation.

.....

..... [1]

(b) **Reaction 1** is investigated using different masses of MnO_2. The results are shown in the table.

volume of HCl /cm^3	concentration of $HCl(aq)$ in mol/dm^3	mass of MnO_2 used /g	volume of Cl_2 formed at room temperature and pressure /dm^3
100	1.0	1.74	0.48
100	1.0	0.87	0.24

Explain the difference in the volume of chlorine formed.

.....

.....

.....

..... [2]

(c) **Reaction 2** is investigated using different masses of MnO_2. The results are shown in the table.

volume of $H_2O_2(aq)$ /cm^3	concentration of H_2O_2 in mol/dm^3	mass of MnO_2 used /g	volume of O_2 formed at room temperature and pressure /dm^3
100	1.0	1.74	1.20
100	1.0	0.87	

Predict the volume of oxygen, measured at room temperature and pressure, when 0.87 g of MnO_2 is used. Write your answer in the table. [1]

(d) Chlorine is bubbled through aqueous iron(II) chloride to form iron(III) chloride.

Explain, with the aid of equations, how aqueous sodium hydroxide can be used to distinguish between aqueous iron(II) chloride and aqueous iron(III) chloride.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(e) Describe the chemical test for chlorine.

test .....

.....

observation .....

.....

[2]

[Total: 10]

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.)