Cambridge O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

CHEMISTRY **5070/21**

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.

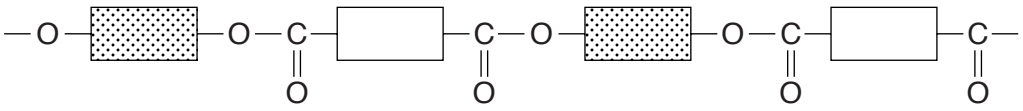
Section A

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

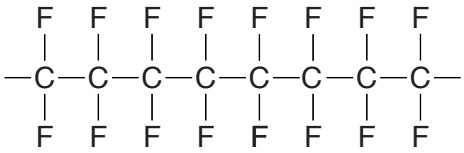
The total mark for this section is 45.

A1 Choose from the following polymers to answer the questions.

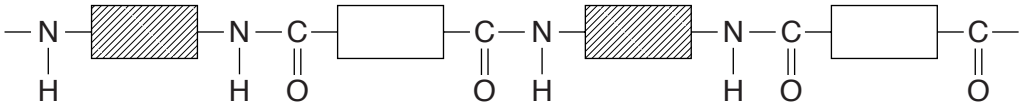
Terylene



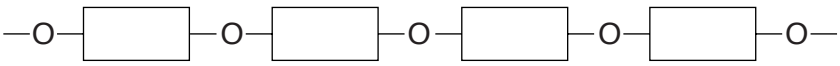
PTFE



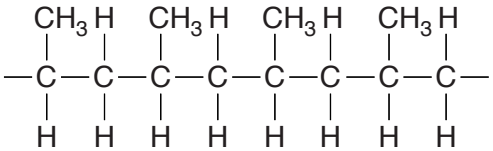
nylon



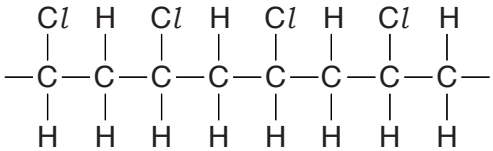
starch



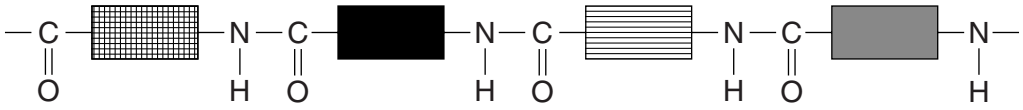
poly(propene)



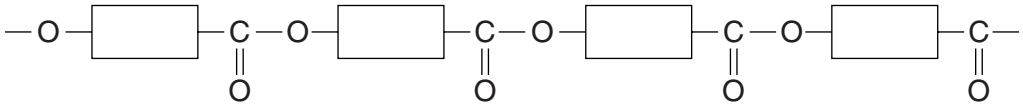
PVC



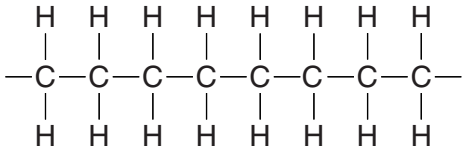
protein



polyester



poly(ethene)



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

Which is a polymer that

(a) is made from propene,

..... [1]

(b) will form hydrogen chloride when combusted,

..... [1]

(c) can be hydrolysed to form amino acids,

..... [1]

(d) can be hydrolysed to make simple sugars,

..... [1]

(e) contains the same linkage as that present in a fat?

..... [1]

[Total: 5]

[Turn over

A2 Hydrogen sulfide, H_2S, has a simple molecular structure. It is soluble in water.

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

..... [1]

(b) Aqueous hydrogen sulfide is a weak acid.

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

..... [1]

(ii) Why is aqueous hydrogen sulfide described as a weak acid?

.....

..... [1]

(c) Aqueous hydrogen sulfide reacts with aqueous potassium hydroxide.

$$H_2S(aq) + 2KOH(aq) \rightarrow K_2S(aq) + 2H_2O(l)$$

What is the minimum volume, in cm^3, of $0.150\,mol/dm^3$ KOH required to completely react with a solution containing 0.170 g of H_2S?

volume of KOH(aq) = ... cm^3 [3]

(d) Magnesium reacts with sulfur to make the ionic compound magnesium sulfide.

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

1. .....

2. .....

[2]

(ii) Explain, in terms of electrons, how a magnesium atom reacts with a sulfur atom to make a magnesium ion and a sulfide ion.

.....

.....

.....

..... [2]

[Total: 10]

A3 Esters, such as propyl ethanoate, are often used as solvents.

(a) Give **one** other use for esters such as propyl ethanoate.

..... [1]

(b) Draw the structure of propyl ethanoate, showing all of the atoms and all of the bonds.

[1]

(c) A bottle of propyl ethanoate is opened in a room. Some of the propyl ethanoate evaporates and then diffuses into the room.

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

.....

.....

..... [1]

(ii) What happens to the rate of diffusion of propyl ethanoate as the temperature of the room increases?

Explain your answer in terms of the kinetic particle theory.

.....

.....

..... [2]

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

name	structure	relative molecular mass (M_r)
methyl methanoate	HCO_2CH_3	60
ethyl methanoate	$HCO_2C_2H_5$	74
propyl methanoate	$HCO_2C_3H_7$	88
butyl methanoate	$HCO_2C_4H_9$	102
pentyl methanoate	$HCO_2C_5H_{11}$	116

Which ester has the **greatest** rate of diffusion at room temperature and pressure?

.....

Explain your answer.

.....

.....

[2]

[Total: 7]

A4 Ammonia is manufactured by the reaction between hydrogen and nitrogen in the Haber process.

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

temperature .....

pressure .....

catalyst ..... [2]

(b) Describe and explain the effect of increasing the pressure on the **rate** of this reaction.

.....

.....

.....

..... [2]

(c) Explain how a catalyst speeds up the rate of a chemical reaction.

.....

..... [1]

(d) Ammonia is used to make fertilisers.

The table gives some information about two fertilisers made from ammonia.

fertiliser	formula	relative formula mass (M_r)
ammonium nitrate	NH_4NO_3	80
urea	$(NH_2)_2CO$	60

Use the data in the table to show that urea contains a greater percentage by mass of nitrogen than ammonium nitrate.

[2]

[Total: 7]

A5 The statements give some of the chemical properties of metal *X* and its compounds.

- *X* does not react with cold water.
- *X* fizzes slowly with dilute hydrochloric acid.
- *X* does not react with aqueous sodium chloride.
- *X* reacts with aqueous lead(II) nitrate.
- *X* reacts with aqueous silver nitrate.
- *X*O reacts with magnesium to form *X*.

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

lead, magnesium, silver, sodium and *X*

most reactive .....

.....

.....

.....

least reactive ..... [2]

(b) Suggest a possible identity for *X*.

..... [1]

(c) Construct the equation for the reaction between the oxide, *X*O, and magnesium.

..... [1]

(d) Construct the ionic equation for the reaction between *X* and aqueous lead(II) nitrate, $Pb(NO_3)_2(aq)$.

..... [1]

(e) Metal *X* is a good electrical conductor and has a high melting point.

Explain why *X*

- conducts electricity, ...

  .....

  .....

- has a high melting point. .....

  .....

  .....

[3]

[Total: 8]

[Turn over

A6 The atmosphere contains a large number of gases including oxygen, nitrogen, carbon dioxide, sulfur dioxide, oxides of nitrogen, methane and chlorofluorocarbons (CFCs).

(a) Carbon dioxide, methane and CFCs are greenhouse gases.

(i) State **one** effect of an increase in the atmospheric concentration of carbon dioxide and methane.

.....

..... [1]

(ii) State **one** source of methane gas.

..... [1]

(iii) State one **other** environmental effect of the presence of CFCs in the atmosphere.

..... [1]

(b) The formula of one chlorofluorocarbon is $CFCl_3$.

Draw the 'dot-and-cross' diagram to show the bonding in a molecule of $CFCl_3$. Only draw the outer-shell electrons.

[1]

(c) Oxides of nitrogen are produced during the combustion of petrol (gasoline) in a car engine.

(i) Describe the chemical reaction that takes place within a car engine to form nitric oxide, NO.

.....

..... [1]

(ii) Most of the nitric oxide and other pollutants present in the exhaust gases of a car are removed in a catalytic converter.

Describe the redox reactions that happen within a catalytic converter.

.....

.....

.....

..... [2]

(d) Nitrogen dioxide is one of the causes of acid rain.

Two moles of nitrogen dioxide react with one mole of water to make an aqueous solution of two acids only.

One of these acids is nitric acid.

Deduce the formula of the other acid.

..... [1]

[Total: 8]

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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 Silver nitrate has the formula $AgNO_3$.

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

.....

.....

.....

.....

.....

.....

..... [4]

(b) Aqueous zinc chloride is added to a sample of acidified aqueous silver nitrate.

(i) Describe what you would observe.

..... [1]

(ii) Construct the ionic equation, with state symbols, for the reaction that occurs.

..... [2]

(c) Aqueous silver nitrate is electrolysed using graphite electrodes.

(i) Identify the product formed at the cathode (negative electrode).

..... [1]

(ii) Oxygen and water are formed at the anode (positive electrode).

Construct the equation for the reaction at the anode.

..... [1]

(d) Silver nitrate decomposes on heating to form Ag_2O, NO_2 and O_2.

Construct the equation for this reaction.

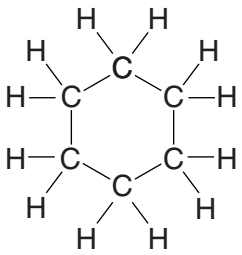
..... [1]

[Total: 10]

[Turn over

B8 Cyclohexane, C_6H_{12}, is a cycloalkane.

Cycloalkanes react in a similar way to alkanes.



cyclohexane

(a) Cyclohexane is a saturated hydrocarbon.

(i) What is the meaning of the term *saturated*?

.....

..... [1]

(ii) What is the meaning of the term *hydrocarbon*?

.....

..... [1]

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

..... [1]

(c) Cyclohexane reacts with chlorine in the presence of ultraviolet light.

This is a substitution reaction.

Write the molecular formulae of **two** products of this reaction.

..... [2]

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

$$C_6H_{14} \rightarrow C_6H_{12} + H_2$$

Calculate the mass of cyclohexane that can be made from 258 g of hexane.
[M_r of cyclohexane = 84]

mass of cyclohexane = ... g [2]

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

C, 85.7%; H, 14.3%

(i) Use the percentage composition by mass to show that the empirical formula of the cycloalkane is CH_2.

[2]

(ii) Draw the structure of the cycloalkane with an M_r of 56, showing all of the atoms and all of the bonds.

[1]

[Total:10]

B9 Carbon reacts with steam in a reversible reaction.

$$C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g) \quad \Delta H = +131\,kJ/mol$$

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 endothermic.

.....

.....

.....

..... [2]

(b) When one mole of hydrogen, H_2, is formed, 131 kJ of energy is absorbed.

Calculate the amount of energy absorbed when 240 dm^3 of hydrogen, measured at room temperature and pressure, is formed.

energy absorbed = ... 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) The reaction between carbon and steam is a possible source of hydrogen.

(i) Suggest one disadvantage of using this reaction as a source of hydrogen.

.....

..... [1]

(ii) Another source of hydrogen is the cracking of hydrocarbons from crude oil.

Give one advantage of manufacturing hydrogen from the reaction of carbon with steam rather than from crude oil.

.....

..... [1]

[Total: 10]

B10 Both zinc and iron react with dilute sulfuric acid.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

$$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$$

(a) A 0.65 g sample of zinc is reacted with excess sulfuric acid.

(i) Calculate the volume of hydrogen, measured at room temperature and pressure, formed in this reaction.

volume of hydrogen = ... dm^3 [2]

(ii) Explain why a different volume of hydrogen, measured at room temperature and pressure, is formed when 0.65 g of iron is reacted with excess sulfuric acid.

.....

..... [1]

(b) A mixture of iron powder and zinc powder is added to excess sulfuric acid.

When the reaction stops, aqueous sodium hydroxide is added drop by drop to the reaction mixture until it is in excess.

Describe what you would observe during the addition of aqueous sodium hydroxide and explain the reactions taking place.

observations

.....

.....

explanations

.....

.....

.....

.....

[4]

(c) The products of heating iron(II) sulfate are iron(III) oxide, sulfur dioxide and sulfur trioxide.

(i) Explain how you can tell that the reaction involves an oxidation.

.....

..... [1]

(ii) Describe the chemical test for sulfur dioxide.

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.)