



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

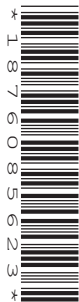
CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

Paper 2 Theory

5070/22

May/June 2012

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 a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, 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.

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.

For Examiner's Use	
Section A	
B6	
B7	
B8	
B9	
Total	

This document consists of **19** printed pages and **1** blank page.



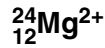
Section A

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

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The total mark for this section is 45.

A1 Choose from the following particles to answer the questions below.



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

Which particle

(a) has only eight electrons,

..... [1]

(b) is attracted to the cathode during electrolysis,

..... [1]

(c) has only four electrons in its outer shell,

..... [1]

(d) has only eight neutrons,

..... [1]

(e) has only ten protons,

..... [1]

(f) has four occupied electron shells?

..... [1]

[Total: 6]

A2 Small pieces of a silver coloured metal, **X**, were added to concentrated nitric acid. A brown gas, **Z**, and a colourless solution containing salt **Y** were formed.

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Analysis of a 0.0914 mol sample of **Z** showed it contained 1.28 g of nitrogen and 2.93 g of oxygen.

The small sample of the colourless solution was diluted with water and then divided into two portions.

- To one portion, aqueous sodium hydroxide was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess sodium hydroxide.
- To the other portion, aqueous ammonia was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess ammonia.

(a) (i) Name the white precipitate, **W**.

..... [1]

(ii) Construct the ionic equation, with state symbols, for the formation of **W**.

..... [2]

(b) Name **X** and **Y**.

X is

Y is [2]

(c) (i) Calculate the relative formula mass, M_r , for gas **Z**.

$M_r =$ [2]

(ii) Determine the molecular formula for **Z**.

molecular formula is [2]

[Total: 9]

A3 The typical composition of solid domestic waste in a city is shown below.

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type of solid waste	percentage by mass
glass	9
metals	8
organic waste including food	22
paper	38
plastics	9
textiles	2
other	12

- (a) The most abundant metals in the solid waste are aluminium, copper and iron. Describe **two** advantages of recycling these metals.

.....

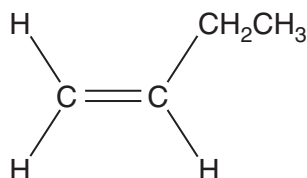
.....

.....

.....

..... [2]

- (b) One of the polymer molecules in the plastic waste is made from the monomer shown below.



Draw the partial structure of the polymer formed from this monomer showing two repeats.

[2]

(c) Many of the polymers found in the plastic waste are non-biodegradable.

Describe **two** pollution problems caused by the disposal of non-biodegradable polymers.

.....

.....

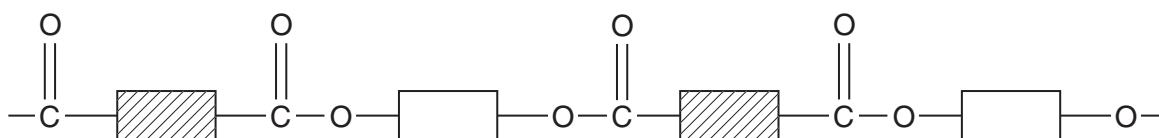
.....

.....

..... [2]

(d) *Terylene* and nylon are two of the textiles present in the solid waste.

The partial structure of *Terylene* is shown below.



(i) *Terylene* is a polyester.

What type of polymerisation is used to make *Terylene*?

..... [1]

(ii) Complete the diagram below to show the partial structure for nylon.



[1]

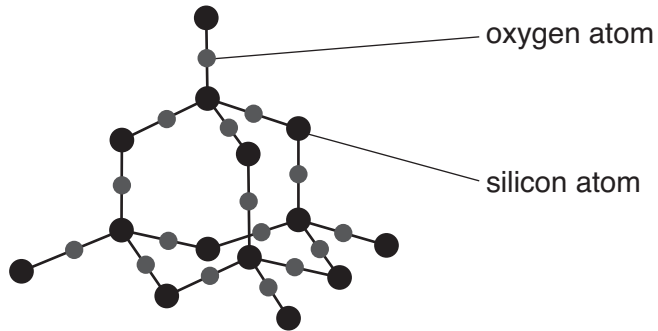
(iii) Give the name of one **type** of food that has molecules containing the same linkages as *Terylene*.

..... [1]

(e) Glass is made from sand.

Pure sand has a giant molecular structure.

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Use



(i) What is the formula for pure sand?

..... [1]

(ii) Explain why sand has a very high melting point.

.....
.....
.....
..... [2]

(iii) Explain why sand does not conduct electricity.

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

[Total: 13]

- A4** Many electricity generating power stations burn fossil fuels. The combustion of these fuels produces waste gases called flue gas.

The flue gas contains nitrogen oxides, sulfur dioxide and carbon dioxide.

Nitrogen oxides and sulfur dioxide contribute towards acid rain and must be removed from the flue gas before it is allowed to reach the atmosphere.

- (a)** One of the nitrogen oxides is nitrogen monoxide, NO.

- (i)** Nitrogen monoxide is formed by the direct reaction between oxygen and nitrogen.

Construct the equation for this reaction.

..... [1]

- (ii)** When cold nitrogen monoxide comes into contact with oxygen it forms nitrogen dioxide, NO₂.

Construct the equation for this reaction.

..... [1]

- (b)** Some power stations spray the flue gas with seawater. This removes about 99% of the nitrogen dioxide and sulfur dioxide.

The gases react with water to form aqueous acids. Nitrogen dioxide forms nitric acid and another acid with the formula, HNO₂.

Construct the equation for this reaction.

..... [1]

- (c)** In other power stations the flue gases are reacted with moist calcium carbonate. This removes about 90% of the nitrogen dioxide and sulfur dioxide from the flue gas.

- (i)** Sulfur dioxide reacts with calcium carbonate to form solid calcium sulfite, CaSO₃. Suggest the name of the other product of this reaction.

..... [1]

- (ii)** Nitrogen dioxide reacts with calcium carbonate to form two salts. Suggest the name and formula of one of these salts.

name

formula [2]

- (d) Suggest **two** advantages of treating flue gas with seawater rather than calcium carbonate.

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.....
.....
.....
..... [2]

- (e) Carbon dioxide is a greenhouse gas. This is because its covalent bonds can absorb infra-red radiation.

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

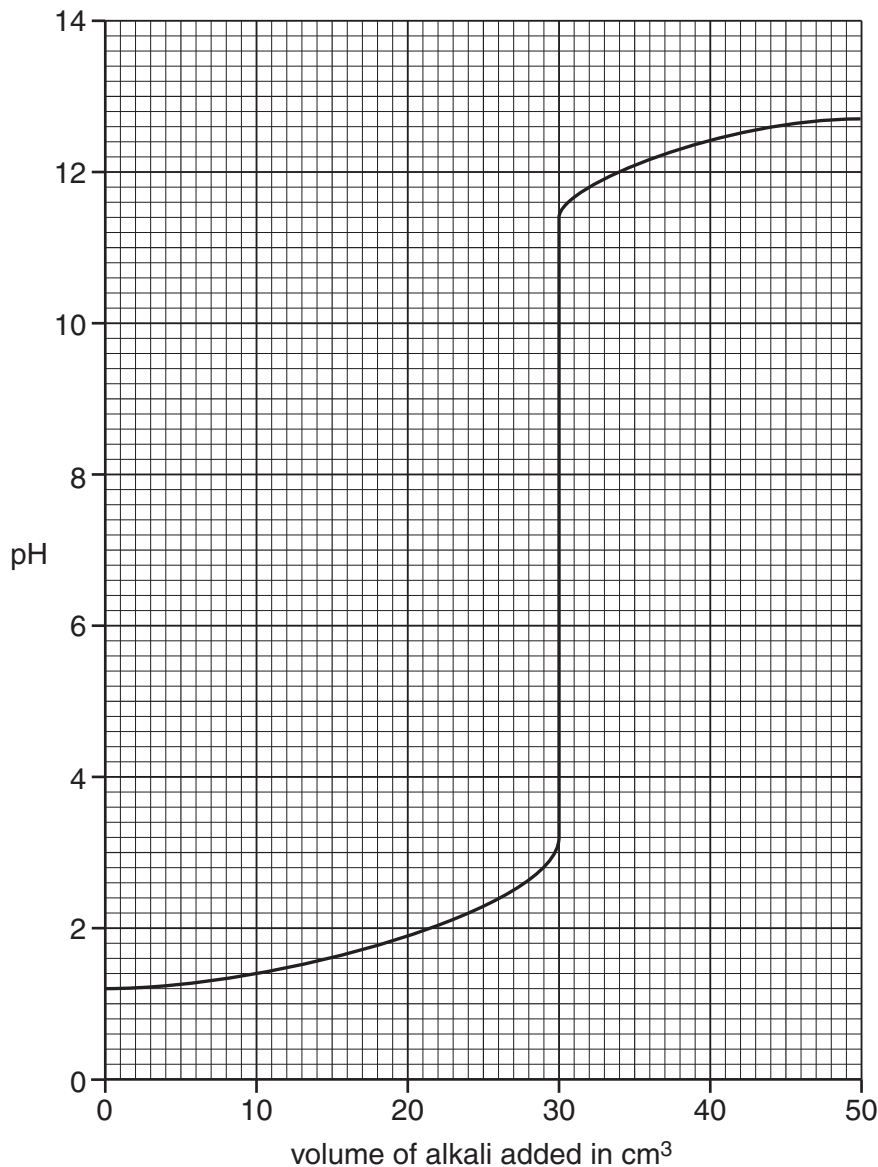
[1]

[Total: 9]

- A5** Aqueous potassium hydroxide, KOH, is added slowly from a burette into a flask containing 25.0cm^3 of 0.0500mol/dm^3 dilute sulfuric acid, H_2SO_4 . At the same time the pH of the contents of the flask is measured until all of the aqueous potassium hydroxide has been added.

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The graph shows how the pH changes with the addition of the aqueous potassium hydroxide.



- (a)** What is the pH of 0.0500mol/dm^3 sulfuric acid?

..... [1]

- (b)** Construct the equation for the reaction between sulfuric acid and potassium hydroxide.

..... [1]

- (c) (i) What volume of aqueous potassium hydroxide has been added when the mixture has a pH of 7?

volume = cm³ [1]

- (ii) Calculate the concentration, in mol/dm³, of the aqueous potassium hydroxide.

concentration = mol/dm³ [3]

- (d) The experiment is repeated with 25.0 cm³ of 0.0500 mol/dm³ ethanoic acid, CH₃COOH, instead of 25.0 cm³ of 0.0500 mol/dm³ sulfuric acid.

Describe and explain any differences in the graph which would be obtained.

.....
.....
.....
..... [2]

[Total: 8]

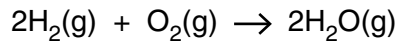
Section B

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

The total mark for this section is 30.

- B6** Hydrogen-oxygen fuel cells are used to generate electricity. The overall reaction in a hydrogen-oxygen fuel cell is shown below.



This reaction is exothermic.

- (a)** Explain the meaning of the term *exothermic*.

.....
 [1]

- (b)** Explain, in terms of the energy changes associated with bond breaking and bond forming, why the reaction is exothermic.

.....

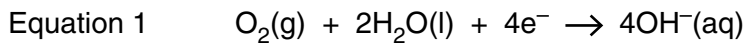
 [2]

- (c)** A hydrogen-oxygen fuel cell uses 2000 dm³ of hydrogen measured at room temperature and pressure. Calculate the volume of oxygen, measured at room temperature and pressure, used by the fuel cell. [One mole of any gas at room temperature and pressure occupies a volume of 24 dm³.]

.....

volume of oxygen = dm³ [2]

(d) The electrode reactions in an oxygen-hydrogen fuel cell are shown below.



Explain why the reaction in a fuel cell involves both oxidation **and** reduction.

.....
.....
.....
..... [2]

(e) Name one source of the hydrogen needed for a fuel-cell.

..... [1]

(f) State one advantage and one disadvantage of using an oxygen-hydrogen fuel cell.

advantage

.....

disadvantage

..... [2]

[Total: 10]

B7 Many carbonates thermally decompose to form carbon dioxide and an oxide.

Copper carbonate forms carbon dioxide and copper oxide.



Six 2.00 g samples of carbonates are heated strongly until there is no further change in mass. The table shows the mass of solid remaining at the end of the heating.

carbonate	mass before heating/g	mass after heating/g
calcium carbonate	2.00	1.12
copper(II) carbonate	2.00	1.29
iron(II) carbonate	2.00	1.24
magnesium carbonate	2.00	0.95
sodium carbonate	2.00	2.00
zinc carbonate	2.00	1.30

(a) What is the mass of carbon dioxide formed when 2.00 g of copper(II) carbonate is heated?

mass of carbon dioxide = g [1]

(b) The thermal stability of the carbonates is related to the reactivity of the metal. Which carbonate is the **least** thermally stable?

..... [1]

(c) For each carbonate, a 2.00 g sample was heated. Explain why the mass of carbon dioxide formed is different for each carbonate.

.....
 [1]

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Use

(d) The decomposition of calcium carbonate forms carbon dioxide and calcium oxide.

(i) Draw the electronic configuration and state the charge on each of the ions in calcium oxide.

[2]

(ii) Explain why calcium oxide is used in a blast furnace.

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

(e) Copper(II) chloride can be prepared by the reaction between copper(II) carbonate and hydrochloric acid.

(i) Construct the ionic equation for this reaction.

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

(ii) Describe the essential practical details for the preparation of a crystalline sample of copper(II) chloride.

.....
.....
.....
.....
.....
.....
..... [3]

[Total: 10]

- B8** Alkenes are a homologous series of organic compounds.
The table shows some information about the first six alkenes.

For
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Use

name	molecular formula	melting point/°C	boiling point/°C
ethene	C ₂ H ₄	-169	-104
propene	C ₃ H ₆	-185	-48
butene	C ₄ H ₈	-185	-6
pentene	C ₅ H ₁₀	-165	30
hexene	C ₆ H ₁₂	-139	63
heptene	C ₇ H ₁₄		

- (a) Draw the structure, showing all the atoms and bonds, of propene.

Use the structure to explain why propene is both a *hydrocarbon* and *unsaturated*.

.....

 [3]

- (b) There are several compounds with molecular formula C₄H₈, each has a different structure.
What name is given to compounds with the same molecular formula but different structures?

..... [1]

- (c) Deduce the molecular formula for decene, an alkene with 10 carbon atoms per molecule.

..... [1]

- (d) Explain why it is easier to predict the boiling point of heptene rather than its melting point.

.....

 [1]

- (e) What is the physical state for butene at room temperature and pressure? Explain your answer.

physical state

explanation

..... [1]

- (f) Many alkenes are manufactured by the cracking of long chain alkanes such as hexadecane, $C_{16}H_{34}$.
Construct an equation to show the cracking of hexadecane to form butane and butene only.

..... [1]

- (g) Butene reacts with bromine and with steam.

- (i) Give the molecular formula of the product with bromine.

..... [1]

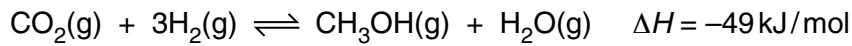
- (ii) Suggest the name of the product with steam.

..... [1]

[Total: 10]

For
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B9 Methanol, CH₃OH, is manufactured from carbon dioxide and hydrogen.



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The reaction is carried out in the presence of a catalyst containing copper. The conditions used are 70 atmospheres pressure and a temperature of 250 °C.

(a) If the temperature of the reaction mixture is **increased** to 400 °C, explain, in terms of collisions between reacting particles, what happens to the speed of the forward reaction.

.....

 [2]

(b) If the pressure of the reaction mixture is **decreased** to 50 atmospheres, explain what happens to the position of equilibrium.

.....

 [2]

(c) In the reaction when 3.0 moles of hydrogen react, 49 kJ of heat energy is released.

Calculate how much heat energy is released when 500 kg of hydrogen react.

heat energy = kJ [2]

(d) Methanol can be used as a fuel.

Construct the equation for the complete combustion of methanol.

..... [1]

(e) Methanol can be oxidised to form methanoic acid.

(i) State the reagents and conditions needed for this reaction.

.....
..... [2]

(ii) Draw the structure of methanoic acid.

[1]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

Group																																																																																																																																																																														
I	II	III	IV	V	VI	VII	0																																																																																																																																																																							
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulfur 16	17 Cl Chlorine 17	18 Ar Argon 18	20 Ne Neon 10	23 Na Sodium 11	24 Mg Magnesium 12	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Ca Calcium 20	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Tl Thallium 81	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	58 Ce Cerium 58	59 Pr Praseodymium 59	60 Nd Neodymium 60	61 Pm Promethium 61	62 Sm Samarium 62	63 Eu Europium 63	64 Gd Gadolinium 64	65 Tb Terbium 65	66 Dy Dysprosium 66	67 Ho Holmium 67	68 Er Erbium 68	69 Tm Thulium 69	70 Yb Ytterbium 70	71 Lu Lutetium 71	72 Fr Francium 87	73 Ra Radium 88	74 Ac Actinium 89	75 Th Thorium 90	76 Pa Protactinium 91	77 U Uranium 92	78 Np Neptunium 93	79 Pu Plutonium 94	80 Am Americium 95	81 Cm Curium 96	82 Bk Berkelium 97	83 Cf Californium 98	84 Es Einsteinium 99	85 Fm Fermium 100	86 Md Mendelevium 101	87 No Nobelium 102	88 Lr Lawrencium 103	89 Fr Francium 87	90 Ra Radium 88	91 Ac Actinium 89	92 Th Thorium 90	93 Pa Protactinium 91	94 U Uranium 92	95 Np Neptunium 93	96 Pu Plutonium 94	97 Am Americium 95	98 Cm Curium 96	99 Bk Berkelium 97	100 Cf Californium 98	101 Es Einsteinium 99	102 Fm Fermium 100	103 Md Mendelevium 101	104 No Nobelium 102	105 Lr Lawrencium 103	106 Fr Francium 87	107 Ra Radium 88	108 Ac Actinium 89	109 Th Thorium 90	110 Pa Protactinium 91	111 U Uranium 92	112 Np Neptunium 93	113 Pu Plutonium 94	114 Am Americium 95	115 Cm Curium 96	116 Bk Berkelium 97	117 Cf Californium 98	118 Es Einsteinium 99	119 Fm Fermium 100	120 Md Mendelevium 101	121 No Nobelium 102	122 Lr Lawrencium 103	123 Fr Francium 87	124 Ra Radium 88	125 Ac Actinium 89	126 Th Thorium 90	127 Pa Protactinium 91	128 U Uranium 92	129 Np Neptunium 93	130 Pu Plutonium 94	131 Am Americium 95	132 Cm Curium 96	133 Bk Berkelium 97	134 Cf Californium 98	135 Es Einsteinium 99	136 Fm Fermium 100	137 Md Mendelevium 101	138 No Nobelium 102	139 Lr Lawrencium 103	140 Ce Cerium 58	141 Pr Praseodymium 59	142 Nd Neodymium 60	143 Pm Promethium 61	144 Sm Samarium 62	145 Eu Europium 63	146 Gd Gadolinium 64	147 Tb Terbium 65	148 Dy Dysprosium 66	149 Ho Holmium 67	150 Er Erbium 68	151 Tm Thulium 69	152 Yb Ytterbium 70	153 Lu Lutetium 71	154 Fr Francium 87	155 Ra Radium 88	156 Ac Actinium 89	157 Th Thorium 90	158 Pa Protactinium 91	159 U Uranium 92	160 Np Neptunium 93	161 Pu Plutonium 94	162 Am Americium 95	163 Cm Curium 96	164 Bk Berkelium 97	165 Cf Californium 98	166 Es Einsteinium 99	167 Fm Fermium 100	168 Md Mendelevium 101	169 No Nobelium 102	170 Lr Lawrencium 103	171 Fr Francium 87	172 Ra Radium 88	173 Ac Actinium 89	174 Th Thorium 90	175 Pa Protactinium 91	176 U Uranium 92	177 Np Neptunium 93	178 Pu Plutonium 94	179 Am Americium 95	180 Cm Curium 96	181 Bk Berkelium 97	182 Cf Californium 98	183 Es Einsteinium 99	184 Fm Fermium 100	185 Md Mendelevium 101	186 No Nobelium 102	187 Lr Lawrencium 103

The volume of one mole of any gas is 24dm³ at room temperature and pressure (r.t.p.).

* 58–71 Lanthanoid series
† 90–103 Actinoid series

a	X	a = relative atomic mass
X	b	X = atomic symbol
		b = atomic (proton) number