



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

October/November 2011

1 hour 15 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 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.

Answer **all** questions.

A copy of the Periodic Table is printed on page 16.

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	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **15** printed pages and **1** blank page.



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1 This question is concerned with the following oxides.

- sulfur dioxide
- carbon monoxide
- lithium oxide
- aluminium oxide
- nitrogen dioxide
- strontium oxide

(a) (i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

..... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

..... [1]

(iii) Which of the above oxides will react with both hydrochloric acid and aqueous sodium hydroxide?

..... [1]

(iv) Which of the above oxides will not react with hydrochloric acid or with aqueous sodium hydroxide?

..... [1]

(b) Two of the oxides are responsible for acid rain. Identify the **two** oxides and explain their presence in the atmosphere.

.....
.....
.....
.....
..... [5]

(c) Lithium oxide is an ionic compound.

(i) Identify another ionic oxide in the list on page 3.

..... [1]

(ii) Draw a diagram which shows the formula of lithium oxide, the charges on the ions and the arrangement of the valency electrons around the negative ion.
Use x to represent an electron from an atom of oxygen.
Use o to represent an electron from an atom of lithium.

[2]

[Total: 12]

2 Two important greenhouse gases are methane and carbon dioxide.

(a) Methane is twenty times more effective as a greenhouse gas than carbon dioxide. The methane in the atmosphere comes from both natural and industrial sources.

(i) Describe **two** natural sources of methane.

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

(ii) Although methane can persist in the atmosphere for up to 15 years, it is eventually removed by oxidation. What are the products of this oxidation?

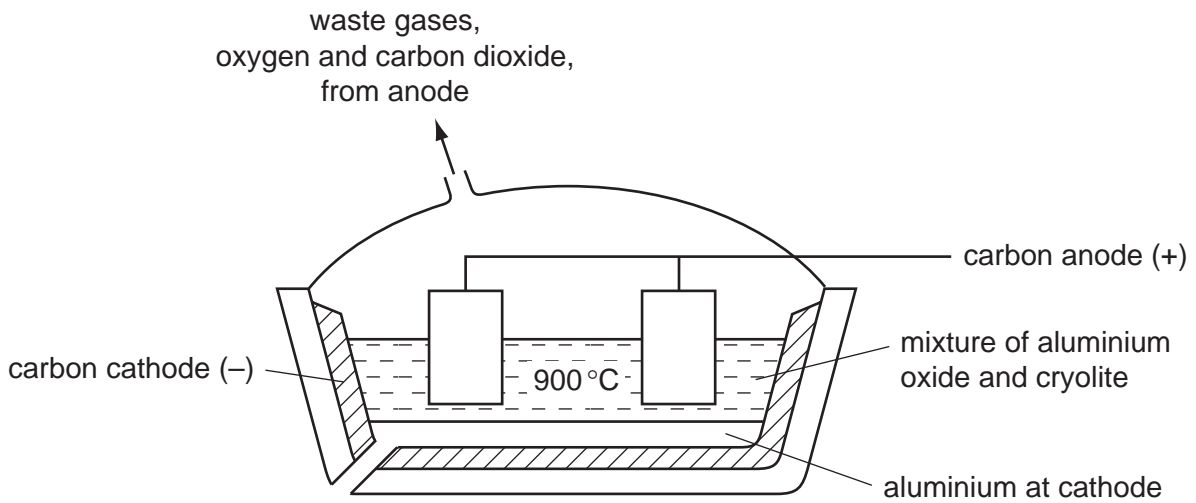
..... [2]

(b) How do the processes of respiration, combustion and photosynthesis determine the percentage of carbon dioxide in the atmosphere?

.....
.....
.....
..... [4]

[Total: 8]

- 3 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



- (a) (i) Alumina is obtained from the main ore of aluminium.
Name this ore.

..... [1]

- (ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.

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

- (iii) Copper can be extracted by the electrolysis of an aqueous solution.
Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

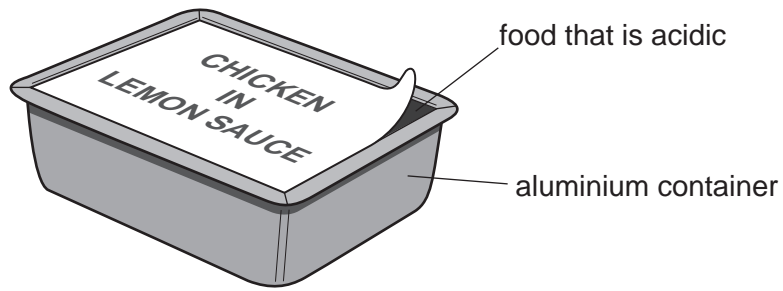
.....
.....
..... [2]

- (b) The ions which are involved in the electrolysis are Al^{3+} and O^{2-} . The products of this electrolysis are given on the diagram.
Explain how they are formed. Use equations where appropriate.

.....
.....
.....
..... [4]

(c) The uses of a metal are determined by its properties.

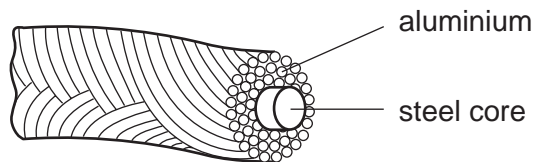
(i) Foods which are acidic can be supplied in aluminium containers.



Explain why the acid in the food does not react with the aluminium.

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

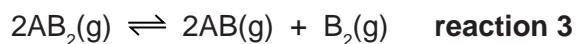
(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



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

[Total: 13]

4 Reversible reactions can come to equilibrium. The following are three examples of types of gaseous equilibria.



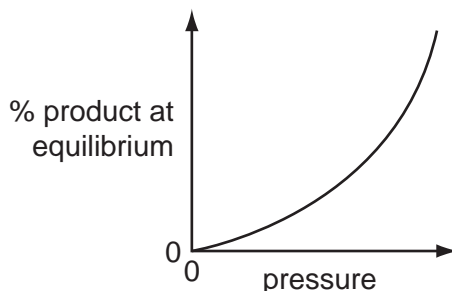
(a) Explain the term *equilibrium*.

.....
 [2]

(b) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.

For each graph, decide whether the percentage of products decreases, increases or stays the same when the pressure is **increased**, then match each graph to one of the above reactions and give a reason for your choice.

(i)



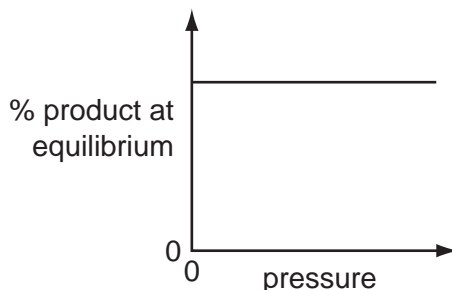
effect on percentage of products

reaction

reason

..... [3]

(ii)



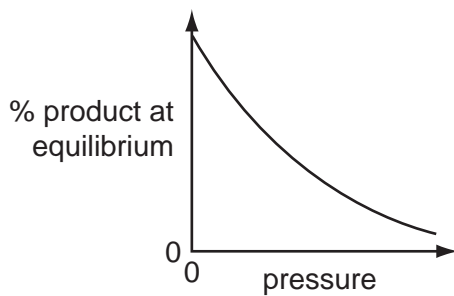
effect on percentage of products

reaction

reason

..... [3]

(iii)



effect on percentage of products

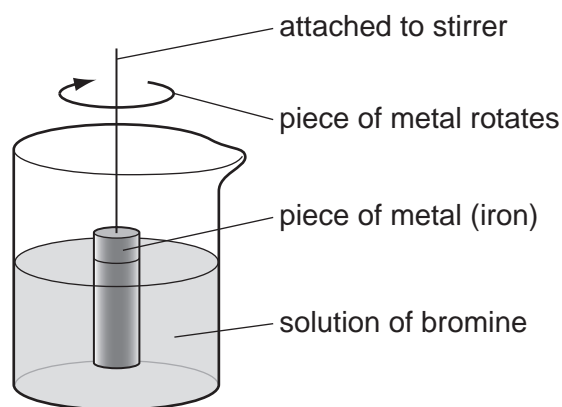
reaction

reason

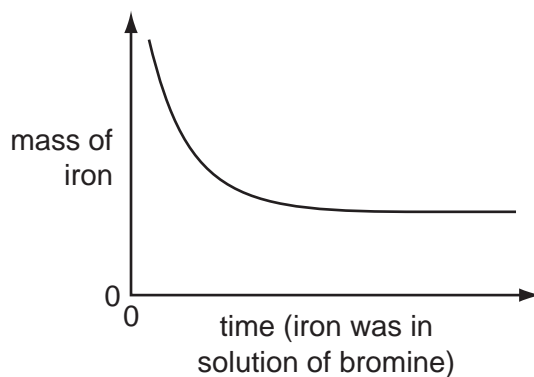
..... [3]

[Total: 11]

- 5 The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



- (a) A piece of iron was weighed and placed in the apparatus. It was removed at regular intervals and the clock was paused. The piece of iron was washed, dried, weighed and replaced. The clock was restarted. This was continued until the solution was colourless. The mass of iron was plotted against time. The graph shows the results obtained.



- (i) Suggest an explanation for the shape of the graph.

.....

 [3]

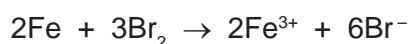
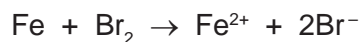
- (ii) Predict the shape of the graph if a similar piece of iron with a much rougher surface had been used. Explain your answer.

.....
 [2]

- (iii) Describe how you could find out if the rate of this reaction depended on the speed of stirring.

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

- (b) Iron has two oxidation states +2 and +3. There are two possible equations for the redox reaction between iron and bromine.



- (i) Indicate, on the first equation, the change which is oxidation. Give a reason for your choice.

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

- (ii) Which substance in the first equation is the reductant (reducing agent)?

..... [1]

- (c) Describe how you could test the solution to find out which ion, Fe^{2+} or Fe^{3+} , is present.

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

[Total: 13]

6 Structural formulae are an essential part of Organic Chemistry.

(a) Draw the structural formula of each of the following. Show all the bonds in the structure.

(i) ethanoic acid

[1]

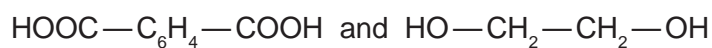
(ii) ethanol

[1]

(b) (i) Ethanoic acid and ethanol react to form an ester.
What is the name of this ester?

..... [1]

(ii) The same linkage is found in polyesters. Draw the structure of the polyester which can be formed from the monomers shown below.



[3]

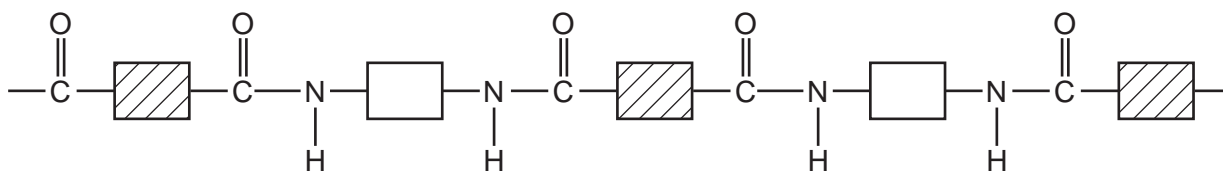
(iii) Describe the pollution problems caused by non-biodegradable polymers.

.....

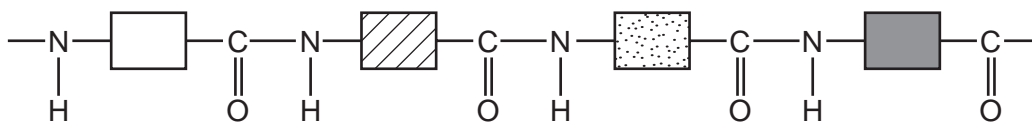
.....

..... [2]

(c) Two macromolecules have the same amide linkage.
Nylon, a synthetic polymer, has the following structure.



Protein, a natural macromolecule, has the following structure.



How are they different?

.....

.....

..... [2]

[Total: 10]

7 Some hydroxides, nitrates and carbonates decompose when heated.

(a) (i) Name a metal hydroxide which does not decompose when heated.

..... [1]

(ii) Write the equation for the thermal decomposition of copper(II) hydroxide.

..... [2]

(iii) Suggest why these two hydroxides behave differently.

..... [1]

(b) (i) Metal nitrates, except those of the Group 1 metals, form three products when heated. Name the products formed when zinc nitrate is heated.

.....

..... [2]

(ii) Write the equation for the thermal decomposition of potassium nitrate.

..... [2]

(c) There are three possible equations for the thermal decomposition of sodium hydrogencarbonate.



The following experiment was carried out to determine which one of the above is the correct equation.

A known mass of sodium hydrogencarbonate was heated for ten minutes. It was then allowed to cool and weighed.

Results

Mass of sodium hydrogencarbonate = 3.36 g

Mass of the residue = 2.12 g

Calculation

M_r for $\text{NaHCO}_3 = 84 \text{ g}$; M_r for $\text{Na}_2\text{O} = 62 \text{ g}$; M_r for $\text{NaOH} = 40 \text{ g}$

M_r for $\text{Na}_2\text{CO}_3 = 106 \text{ g}$

(i) Number of moles of NaHCO_3 used = [1]

(ii) If residue is Na_2O , number of moles of Na_2O =

If residue is NaOH , number of moles of NaOH =

If residue is Na_2CO_3 , number of moles of Na_2CO_3 = [2]

(iii) Use the number of moles calculated in (i) and (ii) to decide which one of the three equations is correct. Explain your choice.

.....

.....

..... [2]

[Total: 13]

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 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	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 Zr Zirconium 40	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 Sn Tin 50	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	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	†	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	212 Po Polonium 84	214 At Astatine 85	216 Rn Radon 86	226 Ra Radium 88	227 Ac Actinium 89	†	232 Th Thorium 90	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71

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

Key

a	X
b	

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

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

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