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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 0 2 7 9 9 4 1 7 3 8 *

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.

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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]

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(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]

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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]

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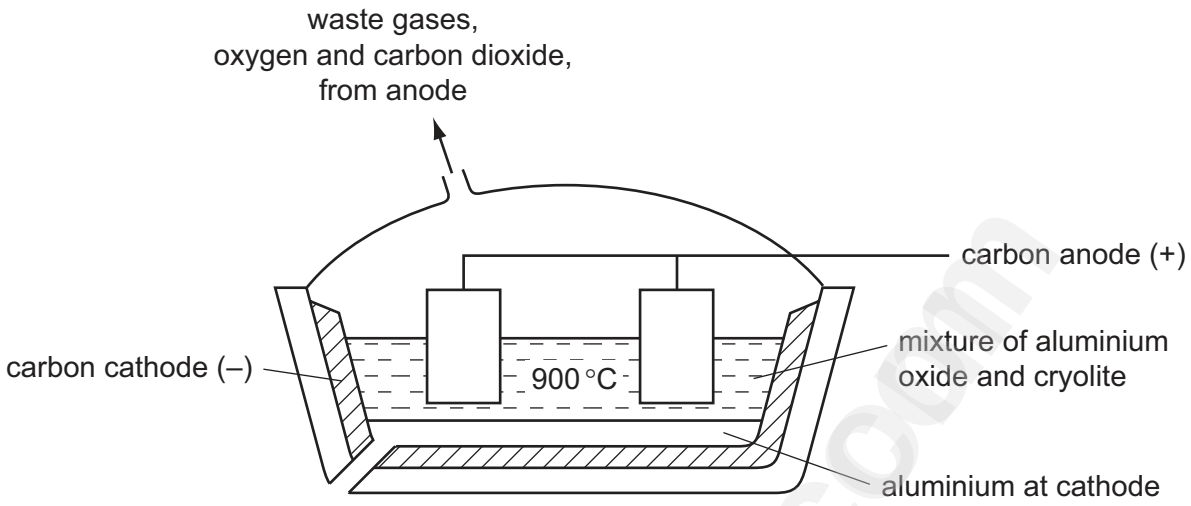
3 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



(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]

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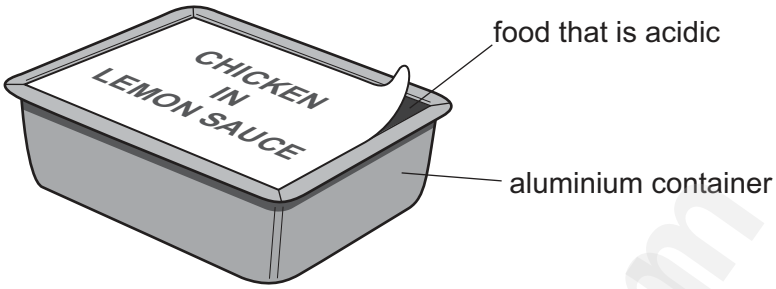
(c) The uses of a metal are determined by its properties.

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

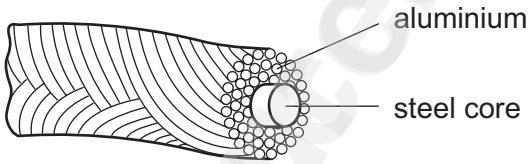


Explain why the acid in the food does not react with the aluminium.

.....

..... [1]

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



.....

.....

..... [3]

[Total: 13]

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

$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$ **reaction 1**

$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g)$ **reaction 2**

$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$ **reaction 3**

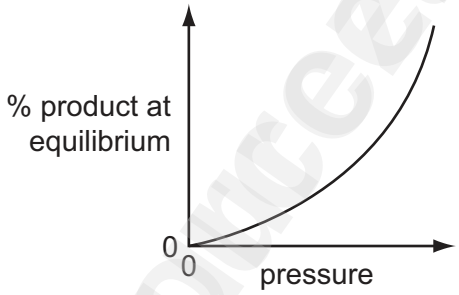
(a) Explain the term *equilibrium*.

.....

..... [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)



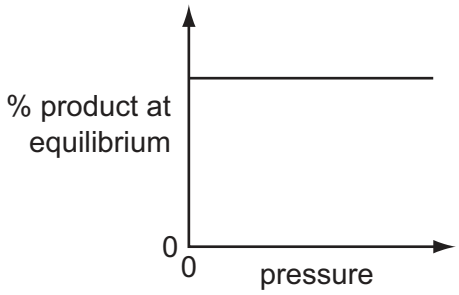
effect on percentage of products .....

reaction .....

reason .....

..... [3]

(ii)



effect on percentage of products .....

reaction .....

reason .....

..... [3]

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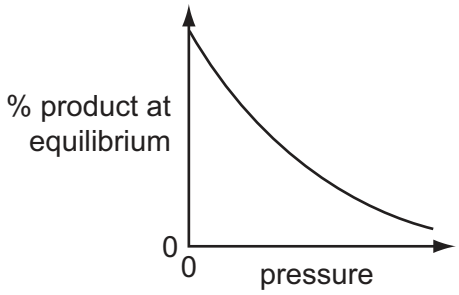
(iii)



effect on percentage of products .....

reaction .....

reason .....

..... [3]

[Total: 11]

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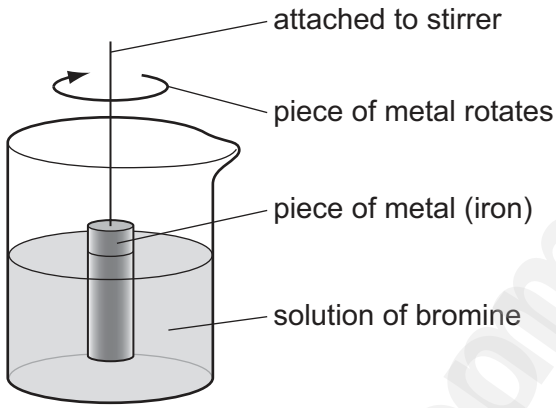
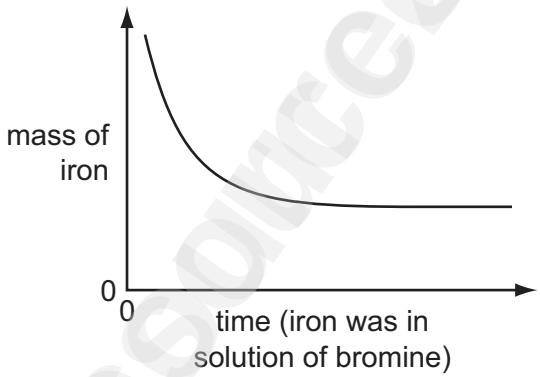
5 The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



(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]

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(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.

$$Fe + Br_2 \rightarrow Fe^{2+} + 2Br^-$$

$$2Fe + 3Br_2 \rightarrow 2Fe^{3+} + 6Br^-$$

(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]

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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.

$HOOC—C_6H_4—COOH$ and $HO—CH_2—CH_2—OH$

[3]

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

.....

.....

..... [2]

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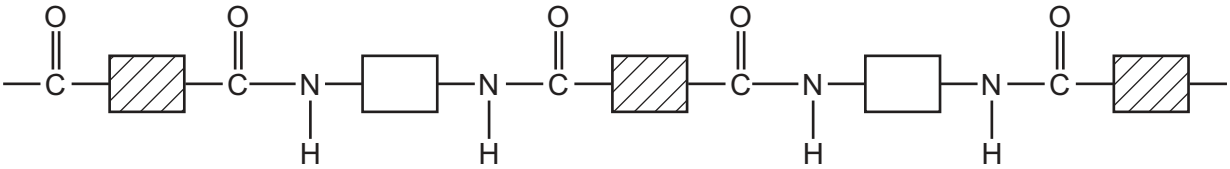
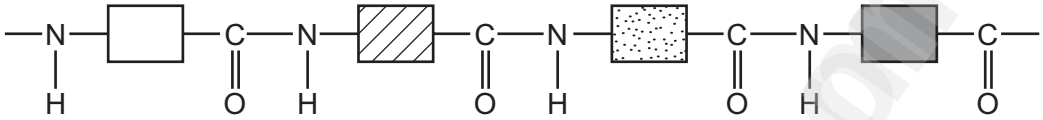
(c) Two macromolecules have the same amide linkage.
Nylon, a synthetic polymer, has the following structure.



Protein, a natural macromolecule, has the following structure.



How are they different?

.....

.....

..... [2]

[Total: 10]

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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.

$2NaHCO_3(s) \rightarrow Na_2O(s) + 2CO_2(g) + H_2O(g)$ **equation 1**

$NaHCO_3(s) \rightarrow NaOH(s) + CO_2(g)$ **equation 2**

$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$ **equation 3**

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 $NaHCO_3$ = 84 g; M_r for Na_2O = 62 g; M_r for NaOH = 40 g
M_r for Na_2CO_3 = 106 g

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

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(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]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	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
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*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 dm^3 at room temperature and pressure (r.t.p.).

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