



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CHEMISTRY**

**0620/31**

Paper 3 (Extended)

**May/June 2012**

**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 12.

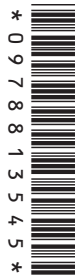
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

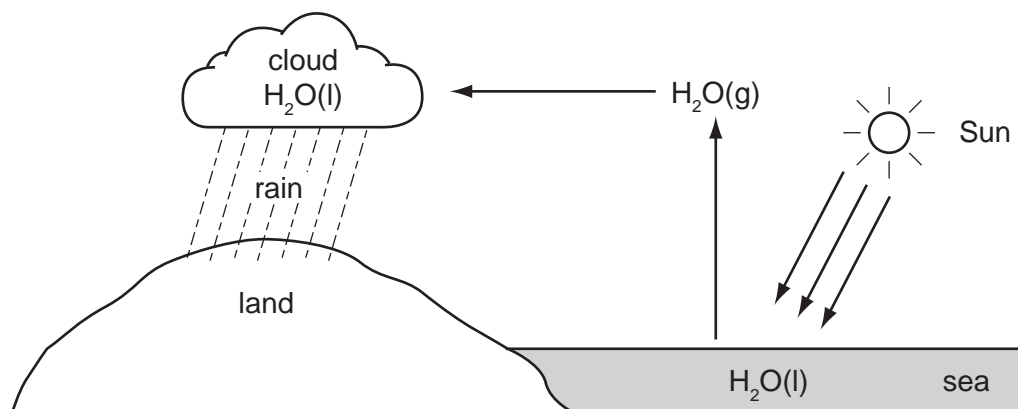
**For Examiner's Use**

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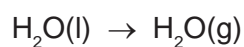
This document consists of **11** printed pages and **1** blank page.



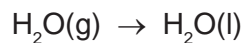
- 1 The diagram below shows part of the Water Cycle.



- (a) (i) State the name of each of the following changes of state.



name .....



name .....

[2]

- (ii) Which **one** of the above changes of state is exothermic? Explain your choice.

.....

..... [1]

- (b) The rain drains into rivers and then into reservoirs. Describe how water is treated before it enters the water supply.

.....

..... [2]

- (c) (i) Explain how acid rain is formed.

.....

.....

.....

..... [4]

- (ii) Fish live in water which is neutral (neither acidic nor alkaline). Acid rain decreases the pH of water in lakes and rivers. Both of the bases, calcium oxide and calcium carbonate, can neutralise this acid and increase the pH. Explain why calcium carbonate is a better choice.

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

[Total: 11]

2 Three ways of making salts are

- titration using a soluble base or carbonate
- neutralisation using an insoluble base or carbonate
- precipitation.

(a) Complete the following table of salt preparations.

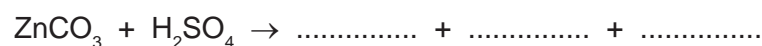
method	reagent 1	reagent 2	salt
titration	..... .....	..... .....	sodium nitrate
neutralisation	nitric acid	..... .....	copper(II) nitrate
precipitation	..... .....	..... .....	silver(I) chloride
neutralisation	sulfuric acid	zinc(II) carbonate	..... .....

[6]

(b) (i) Write an ionic equation with state symbols for the preparation of silver(I) chloride.

..... [2]

(ii) Complete the following equation.



[2]

[Total: 10]

3 The Group I metals show trends in both their physical and chemical properties.

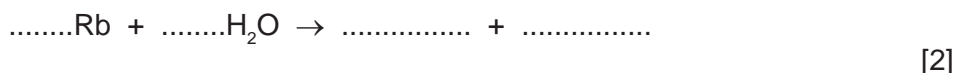
(a) (i) How do their melting points vary down the Group?

..... [1]

(ii) Which element in the Group has the highest density?

..... [1]

(iii) All Group I metals react with cold water. Complete the following equation.



(b) Lithium reacts with nitrogen to form the ionic compound, lithium nitride.

(i) State the formula of the lithium ion. .... [1]

(ii) Deduce the formula of the nitride ion. .... [1]

(iii) In all solid ionic compounds, the ions are held together in a lattice.  
Explain the term *lattice*.

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

(iv) What is the ratio of lithium ions to nitride ions in the lattice of lithium nitride?  
Give a reason for your answer.

..... lithium ions : ..... nitride ions  
.....  
..... [2]

[Total: 9]

4 Vanadium is a transition element. It has more than one oxidation state.  
The element and its compounds are often used as catalysts.

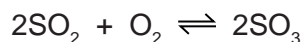
(a) Complete the electron distribution of vanadium by inserting one number.

2 + 8 + ..... + 2 [1]

(b) Predict **three** physical properties of vanadium which are typical of transition elements.

1. ....
2. ....
3. .... [2]

- (c) Vanadium(V) oxide is used to catalyse the exothermic reaction between sulfur dioxide and oxygen in the Contact Process.



The rate of this reaction can be increased either by using a catalyst or by increasing the temperature. Explain why a catalyst is used and not a higher temperature.

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

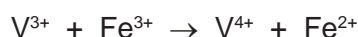
- (d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

- (i) Indicate on the following equation which reactant is the oxidant.



[1]

- (ii) Which change in the following equation is oxidation?  
 Explain your choice.



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

[Total: 8]

- 5 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

sodium	most reactive
calcium	
zinc	↓
copper	
silver	least reactive

- (a) Sodium hydroxide and sodium carbonate do not decompose when heated. The corresponding calcium compounds do decompose when heated. Complete the following equations.

calcium carbonate → ..... + .....

$\text{Ca}(\text{OH})_2 \rightarrow \dots + \dots$  [2]

(b) All nitrates decompose when heated.

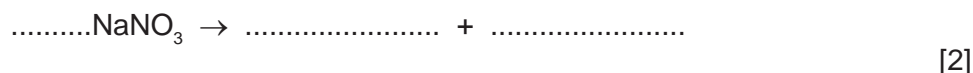
(i) The equation for the thermal decomposition of silver(I) nitrate is given below.



What are the products formed when copper(II) nitrate is heated?

..... [1]

(ii) Complete the equation for the action of heat on sodium nitrate.



(c) Which of the metals in the list on page 5 have oxides which are not reduced by carbon?

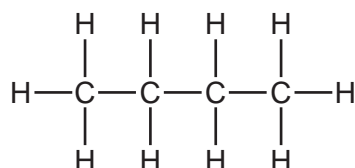
..... [1]

(d) Choose from the list on page 5, metals whose ions would react with zinc.

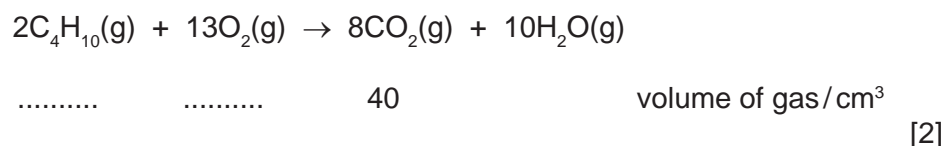
..... [2]

[Total: 8]

6 Butane is an alkane. It has the following structural formula.



(a) The equation for the complete combustion of butane is given below. Insert the two missing volumes.



(b) Butane reacts with chlorine to form two isomers of chlorobutane.

(i) What type of reaction is this?

..... [1]

(ii) Explain the term *isomer*.

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

(iii) Draw the structural formulae of these two chlorobutanes.

[2]

(c) One of the chlorobutanes reacts with sodium hydroxide to form butan-1-ol. Butan-1-ol can be oxidised to a carboxylic acid.

(i) State a reagent, other than oxygen, which will oxidise butan-1-ol to a carboxylic acid.

..... [1]

(ii) Name the carboxylic acid formed.

..... [1]

(iii) Butan-1-ol reacts with ethanoic acid to form an ester. Name this ester and give its structural formula showing all the individual bonds.

name ..... [1]

structural formula

[2]

[Total: 12]

7 Plastics are polymers. They are formed from their monomers by polymerisation.

(a) Two methods for the disposal of waste plastics are

- burning
- recycling.

Describe one advantage **and** one disadvantage of each method.

burning .....

.....

.....

recycling .....

.....

..... [4]

(b) (i) There are two types of polymerisation reaction. Give their names and explain the differences between them.

.....

.....

.....

..... [4]

(ii) Give the structural formula of a polymer which is formed from two different monomers.

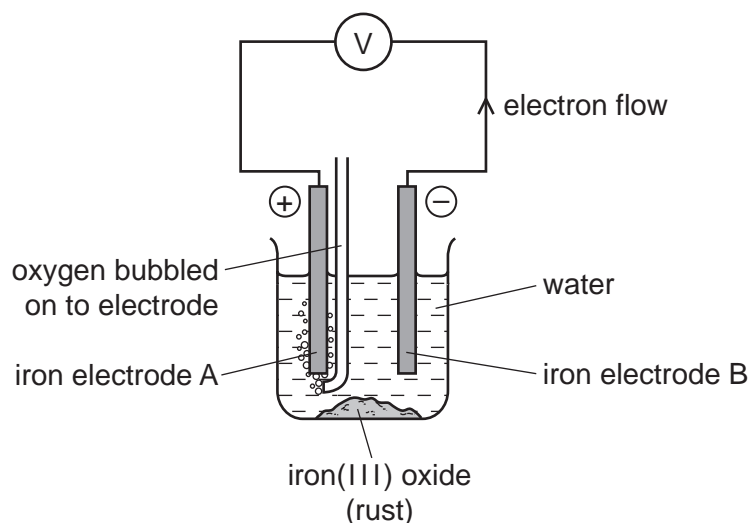
[2]

[Total: 10]



8 Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxide.

(a) The following cell can be used to investigate rusting.



(i) What is a cell?

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

(ii) Which electrode will be oxidised and become smaller? Explain your choice.

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

(iii) What measurements would you need make to find the rate of rusting of the electrode you have chosen in (ii)?

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

(iv) Suggest an explanation why the addition of salt to the water increases the rate of rusting.

..... [1]

(b) A sample of rust had the following composition:

51.85 g of iron                  22.22 g of oxygen                  16.67 g of water.

Calculate the following and then write the formula for this sample of rust.

number of moles of iron atoms, Fe = ..... [1]

number of moles of oxygen atoms, O = ..... [1]

number of moles of water molecules, H<sub>2</sub>O = ..... [1]

simplest mole ratio Fe:O:H<sub>2</sub>O is ..... : ..... : .....

formula for this sample of rust is ..... [1]

[Total: 12]



**DATA SHEET**  
**The Periodic Table of the Elements**

Group																	
I	II											III	IV	V	VI	VII	0
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1										11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10
													28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12											27 <b>Al</b> Aluminium 13	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	115 <b>In</b> Indium 49	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	101 <b>Ru</b> Ruthenium 44	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	204 <b>Tl</b> Thallium 81	209 <b>Bi</b> Bismuth 83	207 <b>Pb</b> Lead 82	210 <b>Po</b> Polonium 84	210 <b>Po</b> Polonium 84
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	210 <b>Po</b> Polonium 84	210 <b>Po</b> Polonium 84	210 <b>Po</b> Polonium 84	210 <b>Po</b> Polonium 84	210 <b>Po</b> Polonium 84
87 <b>Fr</b> Francium	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89															
58-71 Lanthanoid series																	
90-103 Actinoid series																	
140 <b>Ce</b> Cerium 58																	
141 <b>Pr</b> Praseodymium 59																	
144 <b>Nd</b> Neodymium 60																	
150 <b>Sm</b> Samarium 62																	
152 <b>Eu</b> Europium 63																	
157 <b>Gd</b> Gadolinium 64																	
159 <b>Tb</b> Terbium 65																	
162 <b>Dy</b> Dysprosium 66																	
165 <b>Ho</b> Holmium 67																	
167 <b>Er</b> Erbium 68																	
169 <b>Tm</b> Thulium 69																	
173 <b>Yb</b> Ytterbium 70																	
175 <b>Lu</b> Lutetium 71																	
232 <b>Th</b> Thorium 90																	
238 <b>U</b> Uranium 92																	
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The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

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