



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

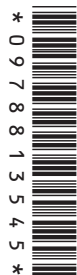
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**CHEMISTRY**

**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.

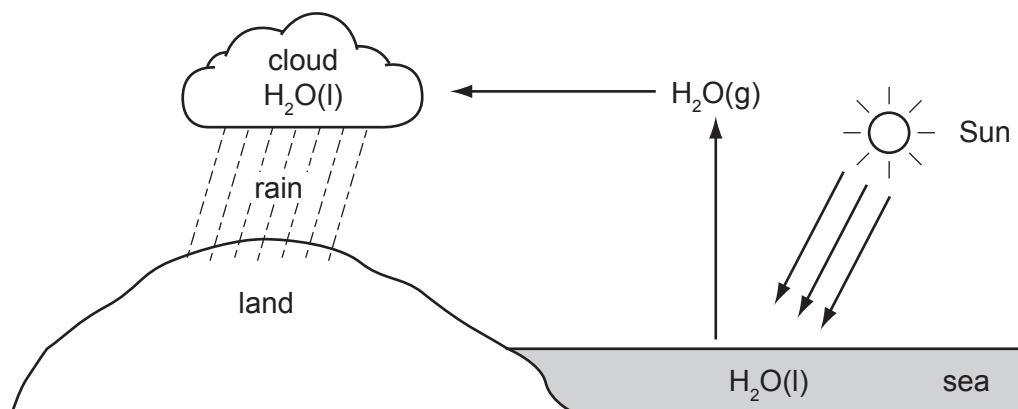
**For Examiner's Use**

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| 1     |  |
| 2     |  |
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| 4     |  |
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| 6     |  |
| 7     |  |
| 8     |  |
| Total |  |

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



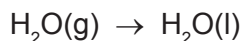
- 1 The diagram below shows part of the Water Cycle.



- (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.

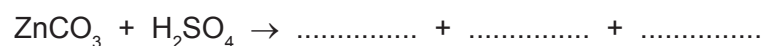
| method         | reagent 1      | reagent 2          | salt               |
|----------------|----------------|--------------------|--------------------|
| titration      | .....<br>..... | .....<br>.....     | sodium nitrate     |
| neutralisation | nitric acid    | .....<br>.....     | copper(II)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

[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.

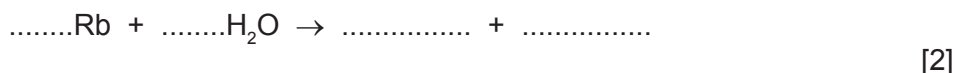
(a) (i) How do their melting points vary down the Group?

..... [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.

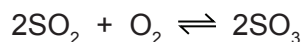
(a) Complete the electron distribution of vanadium by inserting one number.

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]

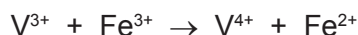
- (d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

- (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.

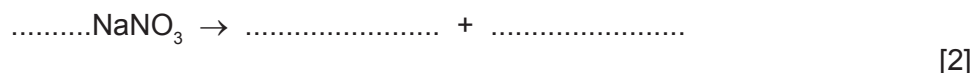
(i) The equation for the thermal decomposition of silver(I) nitrate is given below.



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?

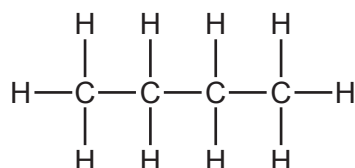
..... [1]

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

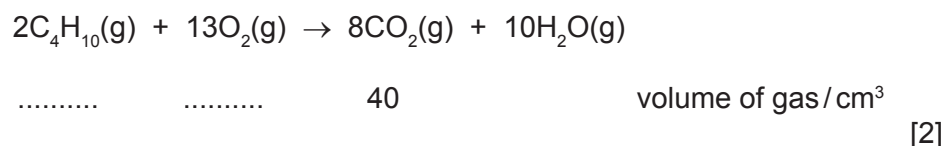
..... [2]

[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]

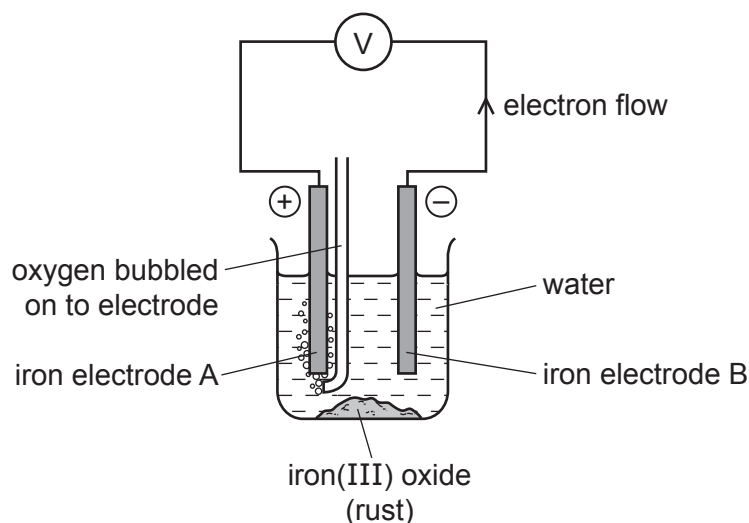
(ii) Give the structural formula of a polymer which is formed from two different monomers.

[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]



The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.).

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