



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

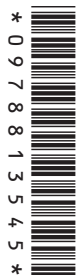
CANDIDATE
NAME

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NUMBER

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CANDIDATE
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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.

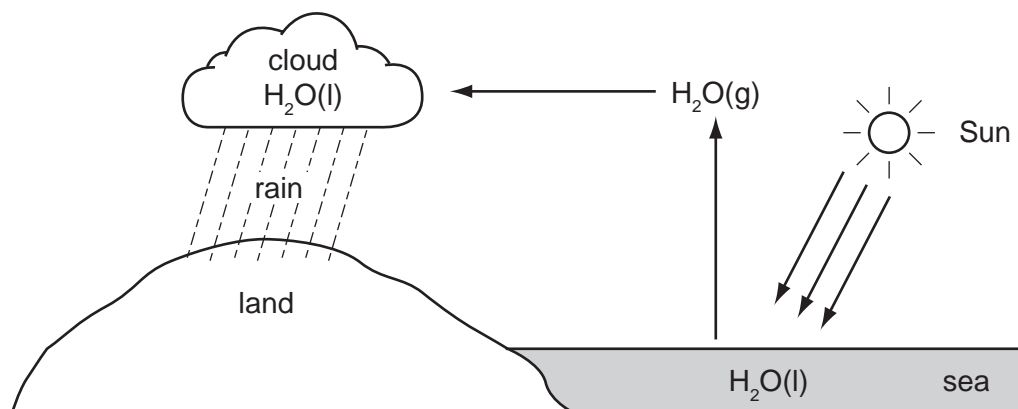
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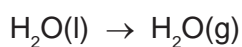
This document consists of **11** printed pages and **1** blank page.



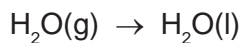
- 1 The diagram below shows part of the Water Cycle.



- (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.

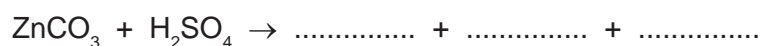
method	reagent 1	reagent 2	salt
titration	sodium nitrate
neutralisation	nitric acid	copper(II) nitrate
precipitation	silver(I) chloride
neutralisation	sulfuric acid	zinc(II) carbonate

[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.

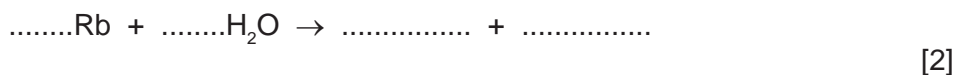
(a) (i) How do their melting points vary down the Group?

..... [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.



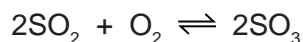
(b) Predict **three** physical properties of vanadium which are typical of transition elements.

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]

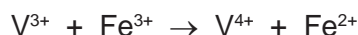
- (d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

- (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.

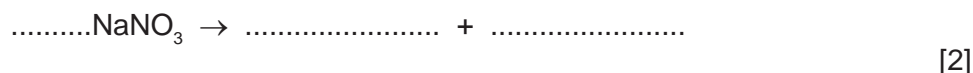
(i) The equation for the thermal decomposition of silver(I) nitrate is given below.



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?

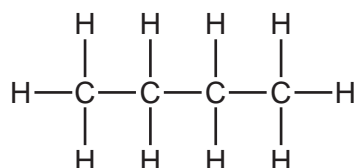
..... [1]

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

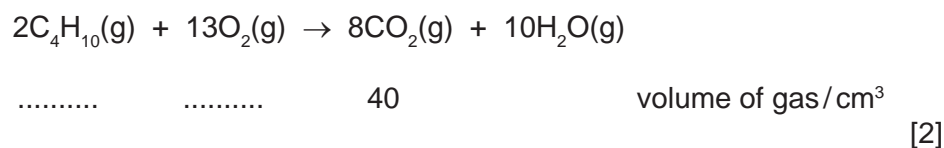
..... [2]

[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]

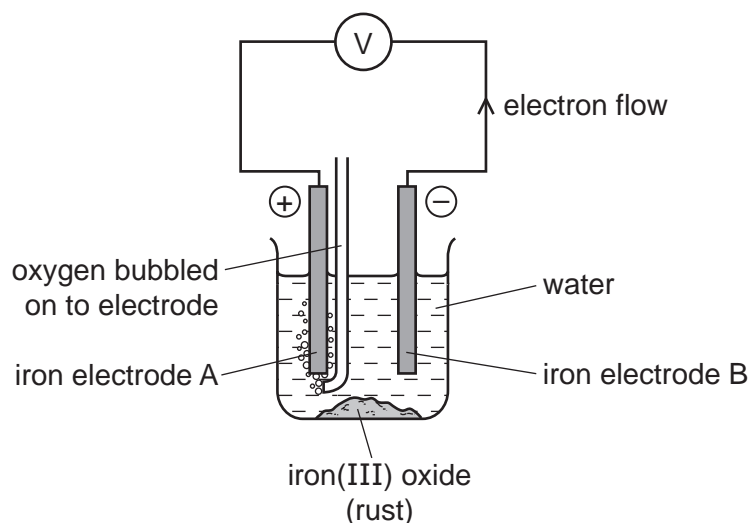
(ii) Give the structural formula of a polymer which is formed from two different monomers.

[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, H₂O = [1]

simplest mole ratio Fe:O:H₂O 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																														
		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		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		91 Ti Titanium 22	92 Zr Zirconium 40	93 Nb Niobium 41	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		148 Ta Tantalum 73	181 Ta Tantalum 73	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	210 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86																					
87 Fr Francium	226 Ra Radium	227 Ac Actinium											175 Lu Lutetium	173 Yb Ytterbium	169 Tm Thulium	167 Er Erbium	165 Ho Holmium	162 Dy Dysprosium	159 Tb Terbium	157 Gd Gadolinium	152 Eu Europium	150 Sm Samarium	144 Nd Neodymium	141 Pr Praseodymium	140 Ce Cerium	232 Th Thorium	238 U Uranium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

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

a	X
b	

Key
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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