

## UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS International General Certificate of Secondary Education

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CANDIDATE NAME		
CENTRE NUMBER	CANDIDATE NUMBER	

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.

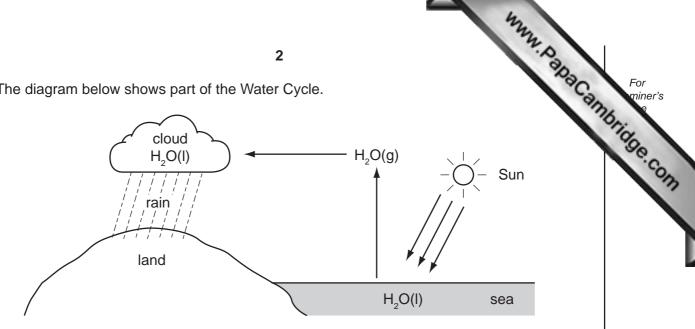
At the end of the examination, fasten all your work securely together.

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

For Exam	iner's Use
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Total	

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





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

$$H_2O(I) \rightarrow H_2O(g)$$

$$H_2O(g) \rightarrow H_2O(l)$$

[2]

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

(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.

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

Write an ionic equation with state symbols for the preparation of silver(I) chloride	€.
	[2]
Complete the following equation.	
$ZnCO_3 \; + \; H_2SO_4 \; \rightarrow \; \dots \dots  + \; \dots \dots  + \; \dots \dots$	[2]
	Complete the following equation.

[Total: 10]

[6]

	4 Page	1
The G	roup I metals show trends in both their physical and chemical properties.	Can
(a) (i)		[4]
(ii)	Which element in the Group has the highest density:	
(iii)	All Group I metals react with cold water. Complete the following equation.	ניו
	Rb + $H_2O \rightarrow$ +	[2]
<b>(b)</b> Lit	hium 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 <i>lattice</i> .	
(iv)	What is the ratio of lithium ions to nitride ions in the lattice of lithium nitride? Give a reason for your answer.	ניו
	lithium ions : nitride ions	
		[2]
	[Total:	9]
	um is a transition element. It has more than one oxidation state. ement and its compounds are often used as catalysts.	
(a) Co	emplete the electron distribution of vanadium by inserting one number.	
	2 + 8 + + 2	[1]
<b>(b)</b> Pr	edict <b>three</b> physical properties of vanadium which are typical of transition elements	S.
1.		
2.		
3.		[2]

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

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

www.PapaCambridge.com 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.

$$2V^{3+}$$
 +  $Zn$   $\rightarrow$   $2V^{2+}$  +  $Zn^{2+}$ 

[1]

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

$$V^{3+}$$
 +  $Fe^{3+}$   $\rightarrow$   $V^{4+}$  +  $Fe^{2+}$ 

[Total: 8]

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

 $\mathsf{Ca}(\mathsf{OH})_{_2} \, \rightarrow \, \dots \dots \quad + \, \dots \dots$ [2]

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- (b) All nitrates decompose when heated.
- www.PapaCambridge.com (i) The equation for the thermal decomposition of silver(I) nitrate is given below.

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

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

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

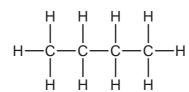
......NaNO $_3$   $\rightarrow$  ...... + .....

- (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.

[Total: 8]

[2]

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.

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

40 volume of gas/cm<sup>3</sup>

[2]

- (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.

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		[2]
(c)		e of the chlorobutanes reacts with sodium hydroxide to form butan-1-ol. Butan-1-ol 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.

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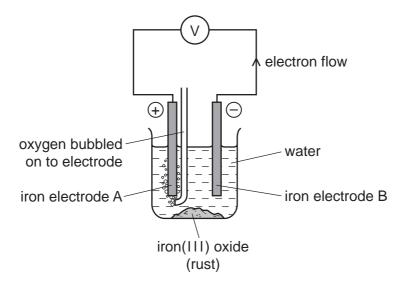
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Pla	stics	are polymers. They are formed from their monomers by polymerisation.	For miner's
(a)	Two	o methods for the disposal of waste plastics are	Tax
	•	are polymers. They are formed from their monomers by polymerisation.  o methods for the disposal of waste plastics are  burning recycling.	Se. COM
	Des	scribe one advantage <b>and</b> one disadvantage of each method.	
	buri	ning	
	recy	ycling	
		[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]

www.PapaCambridge.com Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxic 8

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



(i)	What is a cell?	
(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 electro you have chosen in (ii)?	de
		[2]
(iv)	Suggest an explanation why the addition of salt to the water increases the rate rusting.	of
		[1]

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

www.PapaCambridge.com 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 = ..... number of moles of oxygen atoms, O = ..... [1] number of moles of water molecules, H<sub>2</sub>O = ..... [1] simplest mole ratio  $Fe:O:H_2O$  is .....:: : ....... formula for this sample of rust is ..... [1]

[Total: 12]

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

	0	4 <b>He</b> Helium	20 <b>Neon</b> 10	40 <b>Ar</b> Argon	84 <b>K</b> Krypton 36	Xe Xenon 554	<b>Rn</b> Radon 86		175 <b>Lu</b> Lutetium
	II/		19 Fluorine	35.5 <b>C1</b> Chlorine	80 Br Bromine	127 	At Astatine 85		173 <b>Yb</b> Ytterbium
	IN		16 Oxygen 8	32 <b>S</b> Suffur 16	79 Se Selenium 34	128 <b>Te</b> Tellurium 52	<b>Po</b> Polonium 84		169 <b>Tm</b> Thullum
	Λ		14 <b>N</b> Nitrogen 7	31  Phosphorus 15	75 <b>AS</b> Arsenic 33	Sb Antimony 51	209 <b>Bi</b> Bismuth		167 <b>Er</b> Erbium
	ΛΙ		12 Carbon 6	28 <b>Si</b> Silicon	73 <b>Ge</b> Germanium	<b>Sn</b> Tnn 50	207 <b>Pb</b> Lead 82		165 <b>Ho</b> Holmium
	Ш		11 Boron 5	27 <b>A1</b> Aluminium 13	70 <b>Ga</b> Gallium 31	115   n   Indium   49	204 <b>T t</b> Thallium 81		162 <b>Dy</b> Dysprosium
					65 <b>Zn</b> Zinc 30	112 <b>Cd</b> Cadmium 48	201 <b>Hg</b> Mercury 80		159 <b>Tb</b> Terbium
					64 Copper 29	108 <b>Ag</b> Silver 47	197 <b>Au</b> Gold 79		Gd Gadolinium
Group					59 Nickel	106 Pd Palladium 46	195 <b>Pt</b> Platinum 78		152 <b>Eu</b> Europium
Gre					59 <b>Co</b> Cobalt	103 <b>Rh</b> Rhodium 45	192   <b>  F</b>		Sm Samarium
		1 <b>T</b> Hydrogen			56 Fe Iron	Ruthenium 44	190 <b>Os</b> Osmium 76		Pm Promethium
					Manganese	Tc Technetium 43	186 <b>Re</b> Rhenium		144 Neodymium
					Chromium 24	96 <b>Mo</b> Molybdenum 42	184 <b>W</b> Tungsten 74		Praseodymium
					51 V Vanadium 23	93 <b>Nb</b> Niobium 41	181 <b>Ta</b> Tantalum 73		140 <b>Ce</b>
					48 <b>T</b> Titanium	2 <b>r</b> Zirconium 40	178 <b>Hafnium</b> *		1
					Scandium 21	89 <b>Y</b>	139 <b>La</b> Lanthanum 57 *	227 <b>Ac</b> Actinium 89	Series
	=		Be Beryllium	Mg Magnesium	40 <b>Ca</b> Calcium	Strontium	137 <b>Ba</b> Barium 56	226 <b>Ra</b> Radium 88	*58-71 Lanthanoid series 190-103 Actinoid series
	_		7 Lithium 3	23 <b>Na</b> Sodium	39 <b>K</b> Potassium 19	Rb Rubidium 37	Caesium 55	<b>Fr</b> Francium 87	*58-71 Li

anoid series oid series	140 <b>Ce</b>	141 <b>Pr</b> seodymium		Pm	Samarium	152 <b>Eu</b> Europium	157 <b>Gd</b> Gadolinium	159 <b>Tb</b> Ferbium	162 <b>Dy</b> Dysprosium	165 <b>5</b> Holmium	167 <b>Er</b> Erbium	169 <b>Tm</b> Thulium	Yb Ytterbium	175 <b>Lu</b> Lutetium	
	28	59	09	61	62	63	64	65	99	29	89	69	70	7.1	
a = relative atomic mass	232	ć	238		ć		(	ā	č	i	Ĺ		ž		4
X = atomic symbol	_	J B	>	Q Z	J D	Am	<u>ج</u>	ğ	כֿ	ES	Ē	Ø	o Z	ב	2
b = proton (atomic) number	Thorium 90	Protactinium 91	Uranium 92	Neptunium 93	Plutonium 94	Americium 95	Curium 96	Berkelium 97	Californium 98	Einsteinium 99	Fermium 100	Mendelevium 101	Nobelium 102	Lawrendum 103	n.
	The v	The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).	one mole	of any ga	s is 24 dr	n³ at roor	n tempera	ature and	pressure	(r.t.p.).		13	Ste. Co.	Cambric	Sana Cambridge Com

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