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#### **Location Entry Codes**

As part of CIE's continual commitment to maintaining best practice in assessment, CIE uses different variants of some question papers for our most popular assessments with large and widespread candidature. The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions is unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiners' Reports that are available.

#### **Question Paper**

# Introduction First variant Question Paper Second variant Question Paper

#### Mark Scheme

Introduction

First variant Mark Scheme
Second variant Mark
Scheme

### Principal Examiner's Report

Report
Introduction
First variant Principal Examiner's Report
Second variant Principal Examiner's Report

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The titles for the variant items should correspond with the table above, so that at the top of the first page of the relevant part of the document and on the header, it has the words:

• First variant Question Paper / Mark Scheme / Principal Examiner's Report

or

Second variant Question Paper / Mark Scheme / Principal Examiner's Report

as appropriate.





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

			1 hour 15 minutes
Paper 3 (Exten	ided)		May/June 2009
CHEMISTRY			0620/31
CENTRE NUMBER		CANDIDATE NUMBER	
CANDIDATE NAME			

#### **READ THESE INSTRUCTIONS FIRST**

No Additional Materials are required.

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.

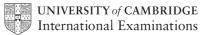
A copy of the Periodic Table is printed on page 16.

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 questions.

For Examiner's Use		
1		
2		
3		
4		
5		
6		
7		
8		
9		
Total		

This document consists of **15** printed pages and **1** blank pages.



1 Some grass is crushed and mixed with the solvent, propanone. The colour pigments extracted to give a deep green solution.				
	(a)	(i)	Draw a labelled diagram to describe how you could show that there is more than one coloured pigment in the green solution.	
			[3]	
		(ii)	Given a pure sample of chlorophyll, how could you show that the green solution from the grass contained chlorophyll?	
			[2]	
	(b)	Exp	lain the role of chlorophyll in green plants.	
			[3]	
			[Total: 8]	

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2 The results of experiments on electrolysis using inert electrodes are given in the table.

For Examiner's Use

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
	potassium formed	iodine formed	used up
dilute aqueous sodium chloride			
aqueous copper(II) sulfate			
	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

3 The following is a list of the electron distributions of atoms of unknown elements.

For Examiner's Use

[Total: 10]

element	electron distribution	
Α	2,5	
В	2,8,4	
<b>C</b> 2,8,8,2		
D	2,8,18,8	
E	2,8,18,8,1	
F	2,8,18,18,7	

	F	2,8,18,18,7					
(a) Choo	(a) Choose an element from the list for each of the following descriptions.						
(i) It is	s a noble gas.						
(ii) It is	s a soft metal with a	a low density.					
(iii) It c	an form a covalent	compound with element A.					
(iv) It h	as a giant covalent	structure similar to diamond.					
( <b>v</b> ) It c	an form a negative	ion of the type X <sup>3</sup>	[5]				
(i) [	Draw a diagram tha and the arrangement Use <b>o</b> to represent	orm an ionic compound.  It shows the formula of this cont of the valency electrons around electron from an atom of Content an electron from an atom of F.					
(ii) l	Predict <b>two</b> propert	ies of this compound.	[3]				
u							
11			[0]				
			[2]				

0620/31/M/J/09

4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked \*, their common oxidation states are given.

For Examiner's Use

* barium	Ва
* lanthanum	La (+3)
magnesium	
zinc	
* chromium	Cr (+2), (+3), (+6)
iron	
copper	
* palladium	(+2)

Choose metal(s) from the above list to answer the following questions.

(i)	Which <b>two</b> metals would not react with dilute hydrochloric acid?	
		[2]
(ii)	Which <b>two</b> unfamiliar metals (*) would react with cold water?	
		[2]
(iii)	What is the oxidation state of barium?	
		[1]
(iv)	Name an unfamiliar metal (*) whose oxide cannot be reduced by carbon.	
		[1]
(v)	Why should you be able to predict that metals such as iron and chromium had more than one oxidation state?	ave
		[1]
	[Total	: 7]

5	Insoluble salts are	made by	precipitation.
---	---------------------	---------	----------------

(a) A preparation of the insoluble salt calcium fluoride is described below.

To  $15~\rm cm^3$  of aqueous calcium chloride,  $30~\rm cm^3$  of aqueous sodium fluoride is added. The concentration of both solutions is  $1.00~\rm mol$  /  $dm^3$ . The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

/: Y	Com	-1-1-	41		4:
"	i Com	niete	TNA	ear	lation
۱.	,	picto		VY	autioi i.

Ca <sup>2+</sup>	+	F	$\longrightarrow$	 [2	2]
Ca	٠.			L4	ر ۷

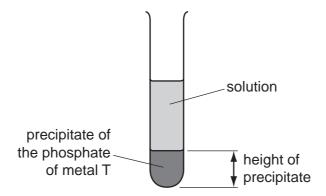
(ii)	Why is the volume of sodium fluoride solution double that of the calcium chlor solution?	ide
		F.43
		[1]
(iii)	Why is the mixture washed with distilled water?	
		[1]
(iv)	Why is the solid heated?	
		[1]

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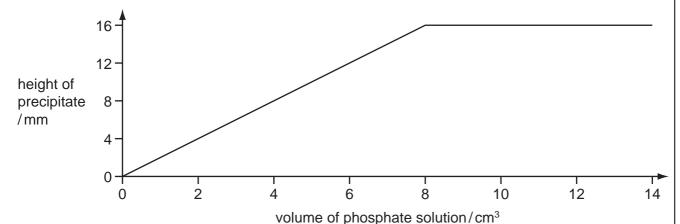
(b) The formulae of insoluble compounds can be found by precipitation reactions.

For Examiner's Use

To  $12.0~\text{cm}^3$  of an aqueous solution of the nitrate of metal T was added  $2.0~\text{cm}^3$  of aqueous sodium phosphate,  $Na_3PO_4$ . The concentration of both solutions was  $1.00~\text{mol/dm}^3$ . When the precipitate had settled, its height was measured.



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal T? Give your reasoning.

[3]

[Total: 8]

8 Ammonia is manufactured by the Haber process. 6  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$  the forward reaction is exothermic (a) (i) Name the raw materials from which nitrogen and hydrogen are obtained. nitrogen from [1] hydrogen from [1] ...... (ii) Name the catalyst used in this process. [1] (iii) What is the most important use of ammonia? [1] (b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with temperature. % ammonia at equilibrium 0 temperature (i) Explain the term equilibrium.

For Examiner's Use

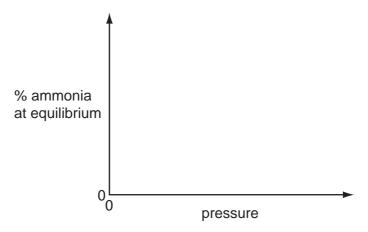
(ii) How does the percentage of ammonia vary with temperature?

[1]

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(c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with pressure.

For Examiner's Use



[1]

(ii)	Explain why the graph has the shape shown.	
		••••
		[2

[Total: 10]

7 Hydrogen reacts with the halogens to form hydrogen halides.

For Examiner's Use

(a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ/mol
H—H	+436
C <i>l</i> —C <i>l</i>	+242
H–Cl	+431

U	se	the	abo	ove	dat	a to	sh	ow	that	the	fol	llowing	rea	action	ıis	exo.	the	erm	iİC
---	----	-----	-----	-----	-----	------	----	----	------	-----	-----	---------	-----	--------	-----	------	-----	-----	-----

H—H + C <i>l</i> —C <i>l</i>	→ 2H—C <i>l</i>	
		[3]

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<b>(b)</b> T	he	y react with wa	iter to fo	orm	acidic	solutio	ons.		
			HC/	+	H <sub>2</sub> O	$\rightleftharpoons$	H <sub>3</sub> O+	+	C/ <sup>-</sup>
			HF	+	H <sub>2</sub> O	$\rightleftharpoons$	H <sub>3</sub> O+	+	F <sup>-</sup>
(	i)	Explain why w	ater be	have	es as a	base	in both	of tl	hese reactions.
									[2]
(i	i)	•	In the	othe	f the h er equ	ydrog ilibriui	en chloi	ride	exists as molecules, the rest has the hydrogen fluoride exists as
		What does this	s tell yo	u ab	out the	e strei	ngth of e	each	acid?
									[2]
(ii	i)	How would the	pH of	thes	e two	solutio	ons diffe	r?	
									[1]
									[Total: 8]

8 Lactic acid can be made from corn starch.

lactic acid

It polymerises to form the polymer, polylactic acid (PLA) which is biodegradable.

a)	Suggest <b>two</b> advantages that PLA has compared with a polymer made from petroleur	n.
		[2]

**(b)** The structure of PLA is given below.

(i) What type of compound contains the group that is circled?

		[1]
(ii)	Complete the following sentence.	
	Lactic acid molecules can form this group because they contain both an	
	group and an group.	[2]
iii)	Is the formation of PLA, an addition or condensation polymerisation? Give reason for your choice.	e a

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(C)	When	lactic	acid is	s heated,	acrylic	acid is	tormed.
ν-/				,	o. o. j o		

For
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Use

H H     H—C—C—COOH     H OH	H COOH
lactic acid	acrylic acid

activité acta
Complete the word equation for the action of heat on lactic acid.
lactic acid $\rightarrow$ +
Describe a test that would distinguish between lactic acid and acrylic acid.
test
result for lactic acid
result for acrylic acid [3]
Describe a test, other than using an indicator, which would show that both chemicals contain an acid group.
test
result

[Total: 13]

[2]

9

		ies of chemicals, expressed in moles, can be used to find the formula of a und, to establish an equation and to determine reacting masses.
(a)		compound contains 72% magnesium and 28% nitrogen. What is its empirical mula?
		[2]
(b)		compound contains only aluminium and carbon. 0.03 moles of this compound reacted n excess water to form 0.12 moles of A $l$ (OH) $_3$ and 0.09 moles of CH $_4$ .
	Wri	ite a balanced equation for this reaction.
		[2]
(c)	0.0	7 moles of silicon reacts with 25 g of bromine.
		$Si + 2Br_2 \longrightarrow SiBr_4$
	(i)	Which one is the limiting reagent? Explain your choice.
		[3]
	(ii)	How many moles of SiBr₄ are formed?
		[1]
		[Total: 8]

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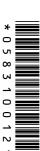
DATA SHEET
The Periodic Table of the Elements

	0	4 <b>H</b> elium	2	20	Ne	Neon 10	40	Ā	Argon 18	84	궃	Krypton 36	131	Xe	Xenon 54		Ru	Radon 86				175	3	Lutetium 71		۲	103
	II/			19	ш	Fluorine 9	35.5	CI	Chlorine 17	80	ģ	Bromine 35		Ι	lodine 53		¥	Astatine 85				173				8	Nobelium 102
	IN			16	0	Oxygen 8	32	S	Sulfur 16	62	Se	Selenium 34	128	Тe	Tellurium 52			Polonium 84				169	Ę			Md	Ε
	>			4	z	Nitrogen 7			Phosphorus 15		As	Arsenic 33		Sb	Antimony 51		ä	Bismuth 83				167	ш	Erbium 68		Fm	
	<u>&gt;1</u>			12	ပ	Carbon 6		Si	Silicon 14		Ge	Germanium 32	119	Sn	Tin 50	207	Pb	Lead 82				165	운	Holmium 67		Es	n Einsteinium 99
	≡			7	М	Boron 5	27	Ν	Aluminium 13	20	Ga	Gallium 31	115	I	Indium 49	204	11	Thallium 81				162		Ę		ర	
			'								Zn	Zinc 30	112	ဦ	Cadmium 48	201	Нg	Mercury 80				159	Q L	Terbium 65			_
										64	ე ე	Copper 29	108	Ag		197	Αn	Gold 79				157		Gadolinium 64			Curium 96
Group										69	Z	Nickel 28	106	Pd	Palladium 46	195	₹	Platinum 78				152	En	Europium 63		Am	Americium 95
Gro										59	ပိ	Cobalt 27	103		Rhodium 45	192		Iridium 77				150	Sm	Samarium 62		Pu	
		1 <b>T</b> Hydrogen	1							99	Fe	Iron 26	101		Ruthenium 44	190	Os	Osmium 76					Pm	Promethium 61		Q N	Neptunium 93
											Mn	Manganese 25		ည	Technetium 43	186	Re	Rhenium 75				144	Š	Neodymium 60	238	>	Uranium 92
										52	ပ်	Chromium 24	96	Mo	Molybdenum 42	184		Tungsten 74				141	Ŗ	Praseodymium 59		Ра	Protactinium 91
										51	>	Vanadium 23		S S	Niobium 41	181	⊐	Tantalum 73				140	ပီ	Cerium 58	232	드	Thorium 90
										48	F	Titanium 22	91	Zr	Zirconium 40	178	Ξ	Hafnium 72							nic mass	lod	nic) number
										45	လွ	Scandium 21	88	>	Yttrium 39	139	Гa	Lanthanum 57 *	227	Ac Activiting	1 68	ceries	orion or	20	a = relative atomic mass	X = atomic symbol	b = proton (atomic) number
	=			6	Be	Beryllium 4	24	Mg	Magnesium 12	40	Ça	Calcium 20	88	Š	Strontium 38	137	Ba	Barium 56	226	<b>8</b>	88	*58-71   anthanoid series	90 / 1 Editing Sch		a	×	ت
	_			7	=	Lithium 3	23	Na	Sodium 11	39	¥	Potassium 19	85	Rb	Rubidium 37	133	Cs	Caesium 55	ı	Francing	87	*58-71	100-103	00-00-		Key	٩

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

CANDIDATE NAME	
CENTRE NUMBER	CANDIDATE NUMBER
CHEMISTRY	0620/32
Paper 3 (Extended)	May/June 2009
	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 questions.

For Exam	iner's Use
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of 15 printed pages and 1 blank page.



For Examiner's Use

<b>/:</b> \	
(i)	Draw a labelled diagram to describe how you could show that there is more than one coloured pigment in the green solution.
	[3]
(ii)	Given a pure sample of chlorophyll, how could you show that the green solution from the grass contained chlorophyll?
	[2]
Exp	plain the role of chlorophyll in green plants.
	[3]
	[Total: 8]
	Exp

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2 The results of experiments on electrolysis using inert electrodes are given in the table.

For Examiner's Use

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
	lithium formed	chlorine formed	used up
dilute aqueous sodium chloride			
aqueous copper(II) sulfate			
	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

3 The following is a list of the electron distributions of atoms of unknown elements.

For Examiner's Use

element	electron distribution
Α	2,6
В	2,8,4
С	2,8,8,2
D	2,8,18,8
E	2,8,18,8,1
F	2,8,18,18,7

		F	2,8,18,18,7	
(a) C	hoos	e an element from	n the list for each of the follow	ing descriptions.
(i)	It is a	a noble gas.		
(ii)	It is a	a soft metal with a	low density.	
(iii)	It ca	n form a covalent	compound with element A.	
(iv)	It ha	s a giant covalent	structure similar to diamond.	
(v)	It is a	a diatomic gas wit	h molecules of the type $X_2$ .	[5]
(b) E	i) Dr	aw a diagram tha	orm an ionic compound.  It shows the formula of this control of the valency electrons aro	ompound, the charges on the ions
	Us	se <b>o</b> to represent a	an electron from an atom of <b>C</b> an electron from an atom of <b>A</b>	
(ii	i) Pr	edict <b>two</b> properti	es of this compound.	[3]
				[2]

[Total: 10]

4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked \*, their common oxidation states are given.

For Examiner's Use

* barium	Ва
* lanthanum	La (+3)
magnesium	
zinc	
* chromium	Cr (+2), (+3), (+6)
iron	
copper	
* palladium	(+2)

Choose metal(s) from the above list to answer the following questions.

(i)	Which <b>two</b> metals would not react with dilute hydrochloric acid?	
		[2]
(ii)	Which <b>two</b> unfamiliar metals (*) would react with cold water?	
		[2]
(iii)	What is the oxidation state of barium?	
		[1]
(iv)	Name an unfamiliar metal (*) whose oxide cannot be reduced by carbon.	
		[1]
(v)	Why should you be able to predict that metals such as iron and chromium ha	ave
( )	more than one oxidation state?	
		[1]
	[Total	71
	[Total	7]

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[1]

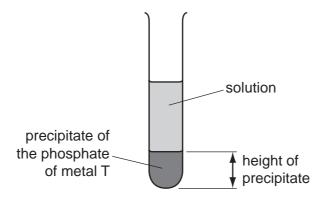
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(iv) Why is the solid heated?

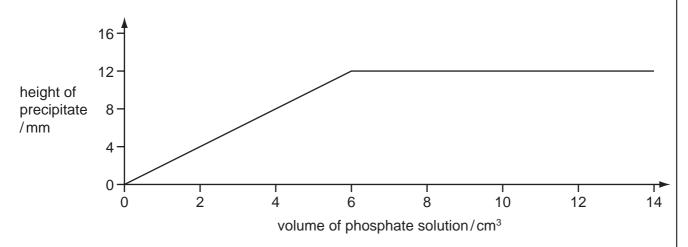
(b) The formulae of insoluble compounds can be found by precipitation reactions.

For Examiner's Use

To  $18.0~\text{cm}^3$  of an aqueous solution of the nitrate of metal T was added  $2.0~\text{cm}^3$  of aqueous sodium phosphate,  $Na_3PO_4$ . The concentration of both solutions was  $1.00~\text{mol/dm}^3$ . When the precipitate had settled, its height was measured.



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal T? Give your reasoning.

••••
[3]

[Total: 8]

6 Ammonia is manufactured by the Haber process.  $3H_2(g) \rightleftharpoons 2NH_3(g)$  the forward reaction is exothermic (a) (i) Name the raw materials from which nitrogen and hydrogen are obtained. nitrogen from [1] hydrogen from [1] ..... (ii) Name the catalyst used in this process. [1] ..... (iii) What is the most important use of ammonia? (b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with pressure. % ammonia at equilibrium 0 pressure (i) Explain the term equilibrium.

.....

For Examiner's Use

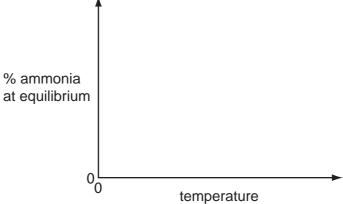
[1]

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(ii) How does the percentage of ammonia vary with pressure?

(c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with temperature.

For Examiner's Use



[1]

(ii)	Explain why the graph has the shape shown.	
		[2]

[Total: 10]

7 Hydrogen reacts with the halogens to form hydrogen halides.

For Examiner's Use

(a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ/mol
H—H	+436
F–F	+158
H–F	+562

Use the above data to show that the following reaction is exothermic.

H–H + F–F →	2H—F	
	,	[3]

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<b>(b)</b> Th	ey rea	act with	water	to fo	rm	acidic	solutio	ons.		
			ŀ	HC/	+	H <sub>2</sub> O	$\rightleftharpoons$	$H_3O^+$	+	CI <sup>-</sup>
				HF	+	H <sub>2</sub> O	$\rightleftharpoons$	$H_3O^{\dagger}$	+	F <sup>-</sup>
(i)	Exp	lain wh	y wate	er bel	าลง	es as a	base	in both	of t	hese reactions.
										[2
(ii)	forn	•	s. In	the	othe	er equ	ilibriur			exists as molecules, the rest has the hydrogen fluoride exists as
	Wha	at does	this te	ell you	u ab	out the	e strer	ngth of	each	n acid?
										[2
(iii)	Hov	v would	the pl	H of t	thes	e two	solutio	ons diffe	er?	
										[1
										[Total: 8]

8 Lactic acid can be made from corn starch.

сн—соон

lactic acid

It polymerises to form the polymer, polylactic acid (PLA) which is biodegradable.

(a)	Suggest <b>two</b> advantages that PLA has compared with a polymer made from petroleum.
	[2]

**(b)** The structure of PLA is given below.

(i) What type of compound contains the group that is circled?

		[1]
(ii)	Complete the following sentence.	
	Lactic acid molecules can form this group because they contain both an	
	group and an group.	[2]
iii)	Is the formation of PLA, an addition or condensation polymerisation? Give reason for your choice.	e a
		 [2]

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(C)	When	lactic	acid is	s heated,	acrylic	acid is	tormed.
ν-/				,	o. o. j o		

For
Examiner's
Use

H H     H—C—C—COOH     H OH	н соон
lactic acid	acrylic acid

(i)	Complete the word equation for the action of heat on lactic acid.
	lactic acid $\rightarrow$ + [1]
(ii)	Describe a test that would distinguish between lactic acid and acrylic acid.
	test
	result for lactic acid
	result for acrylic acid [3]
(iii)	Describe a test, other than using an indicator, which would show that both chemicals contain an acid group.
	test
	result

[Total: 13]

[2]

		ind, to establish an equation and to determine reacting masses.
(a)		compound contains 72% magnesium and 28% nitrogen. What is its empirical nula?
		[2]
(b)		ompound contains only aluminium and carbon. $0.03\text{moles}$ of this compound reacted excess water to form $0.12\text{moles}$ of $A\mathit{l}(OH)_3$ and $0.09\text{moles}$ of $CH_4$ .
	Wri	te a balanced equation for this reaction.
	•••••	[2]
(c)	0.0	8 moles of silicon reacts with 7.2 g of fluorine.
		$Si + 2F_2 \longrightarrow SiF_4$
	(i)	Which one is the limiting reagent? Explain your choice.
		[3]
	(ii)	How many moles of SiF₄ are formed?
		[1]
		[Total: 8]

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DATA SHEET
The Periodic Table of the Elements

Group	0	4 <b>He</b> lium	20 Neon 10 Neon 40 Ar Argon	84 <b>Kry</b> pton 36	131 Xenon Xenon	Radon 86		175 <b>Lu</b> Lutetium	Lawrencium
	=>		19 Fluorine 9 35.5 <b>C1</b> Chlorine	80 <b>Br</b> Bromine 35	127 <b>I</b> lodine 53	At Astatine 85		173 <b>Yb</b> Ytterbium 70	Nobelium
	5		16 Oxygen 8 32 <b>S</b> Sulfur	Selenium	128 <b>Te</b> Tellurium	Po Polonium 84		169 <b>Tm</b> Thulium 69	Md Mendelevium
	>		14 Nitrogen 7 31 97 Phosphorus 15	AS As Arsenic	Sb Antimony 51	209 <b>Bi</b> Bismuth		167 <b>Er</b> Erbium 68	Fm Fermium
	2		Carbon 6 28 Silicon 14	73 <b>Ge</b> Germanium	Sn Tin 50	207 <b>Pb</b> Lead		165 <b>Ho</b> Holmium 67	
	≡		11 B Boron 5 27 A A A I	70 <b>Ga</b> Gallium 31	115 <b>In</b> Indium 49	204 <b>T t</b> Thallium		162 <b>Dy</b> Dysprosium 66	
				65 <b>Zn</b> Zinc	Cadmium Cad			159 <b>Tb</b> Terbium 65	<b>BK</b> Berkelium
				64 Copper 29	108 <b>Ag</b> Silver	197 <b>Au</b> Gold		157 <b>Gd</b> Gadolinium 64	Curium
				59 Nickel	106 Pd Palladium 46	195 <b>Pt</b> Platinum 78		152 <b>Eu</b> Europium 63	
				59 <b>Cobalt</b> 27	103 <b>Rh</b> Rhodium 45	192 <b>Ir</b> Iridium		150 <b>Sm</b> Samarium 62	
		Hydrogen		56 <b>Fe</b> Iron	Ruthenium	190 <b>Os</b> Osmium 76		Pm Promethium 61	Neptunium
				Mn Manganese 25	Tc Technetium 43	186 <b>Re</b> Rhenium 75		144 <b>Nd</b> Neodymium 60	238 <b>C</b> Uranium
				Chromium 24	96 Molybdenum 42	184 <b>W</b> Tungsten 74		Pr Praseodymium 59	Pa Protactinium
				51 V Vanadium 23	93 <b>Nb</b> Niobium 41	181 <b>Ta</b> Tantalum 73		140 <b>Ce</b> Cerium 58	232 <b>Th</b>
				48 <b>Ti</b> Titanium 22	2 <b>Z</b> Zirconium 40	178 <b>Hf</b> Hafnium			nic mass bol nic) number
				45 <b>Sc</b> Scandium 21	89 <b>×</b> Yttrium	139 <b>La</b> Lanthanum 57 *	227 <b>Ac</b> Actinium 89	series eries	<ul> <li>a = relative atomic mass</li> <li>X = atomic symbol</li> <li>b = proton (atomic) number</li> </ul>
	=		Be Beryllium 4 24 Magnesium 12	40 <b>Cal</b> cium 20	Strontium	137 <b>Ba</b> Barium 56	226 <b>Ra</b> Radium	*58-71 Lanthanoid series	в <b>Х</b> а
	_		7	39 K	Rubidium	Caesium	Francium 87	*58-71 L:	Key

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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