### **Location Entry Codes**

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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** Mark Scheme **Principal Examiner's** Report Introduction Introduction Introduction First variant Question Paper First variant Mark Scheme First variant Principal Examiner's Report Second variant Question Second variant Mark Second variant Principal Paper Scheme 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

	swer on the Question Paper.		1 hour 15 minute	S
Paper 3 (Exten	ded)		May/June 200	9
CHEMISTRY			0620/3	1
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.

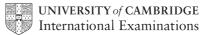
A copy of the Periodic Table is printed on page 16.

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

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



1			rass is crushed and mixed with the solvent, propanone. The colour pigments are d 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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For Examiner's Use 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
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) Choo	ose an element fron	n the list for each of the followi	ng 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 Control an electron from an atom of F.	
(ii) l	Predict <b>two</b> propert	ies of this compound.	[3]
u			
11			ro1
•			[2]

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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

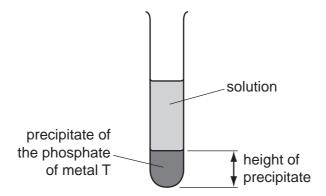
(ii)	Why is the volume of sodium fluoride solution double that of the calcium chlor solution?	ide
		F.43
		[1]
(iii)	Why is the mixture washed with distilled water?	
		[1]
(iv)	Why is the solid heated?	
		[1]

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

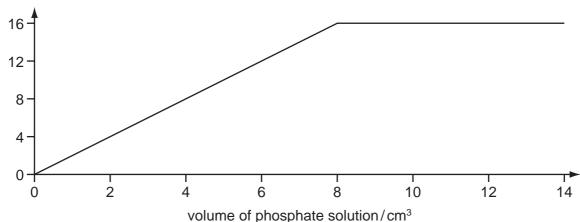
For Examiner's Use

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

.....

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

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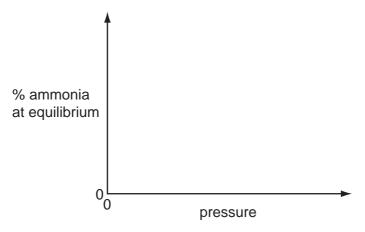
[1]

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(i) Explain the term equilibrium.

(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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[Total: 8]

(b)	The	ey react with wa	ater to fo	orm	acidic	solutio	ons.			
			HC/	+	H <sub>2</sub> O	$\rightleftharpoons$	H <sub>3</sub> O+	+	Cl <sup>-</sup>	
			HF	+	H <sub>2</sub> O	$\rightleftharpoons$	H <sub>3</sub> O+	+	F <sup>-</sup>	
	(i)	Explain why w	ater be	hav	es as a	a base	in both	of t	hese reactions.	
										[2
	(ii)	•	In the	oth	er equ	ilibriu			exists as molecules, the rest h the hydrogen fluoride exists	
		What does thi	s tell yo	u al	out the	e strei	ngth of e	each	n acid?	
										••••
										[2]
	(iii)	How would the	e pH of	thes	se two	solutio	ons diffe	er?		
										[1]

8 Lactic acid can be made from corn starch.

Examiner's Use

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	m.
		••••
		••••
		••••
		[2]

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

$$-O-CH - C-O - CH - CH$$

(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.	a :

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

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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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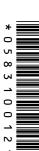
DATA SHEET
The Periodic Table of the Elements

	0	4 <b>He</b> Helium	20 Neon 10 Ar Argon	84 <b>K</b> rypton 36	131 <b>Xe</b> Xenon	Rn Radon 86		175 <b>Lu</b> Lutetium 71	<b>Lr</b> Lawrencium 103
	II/		19 Fluorine 9 35.5 <b>C 1</b>			At Astatine 85		173 <b>Yb</b> Ytterbium 70	Nobelium
	N		16 Oxygen 8 32 Suffur 16	79 <b>Se</b> Selenium 34	Te Tellurium	1		169 <b>Tm</b> Thulium	Md Mendelevium 101
	>		Nitrogen 7 31 <b>Ph</b> Phosphorus 15	AS Arsenic	122 <b>Sb</b> Antimony 51	1		167 <b>Er</b> Erbium 68	Fm Fermium
	N		Carbon 6 Carbon 8 Silicon 14	73 <b>Ge</b> Germanium 32	<b>Sn</b> Tin 50	207 <b>Pb</b> Lead		165 <b>Ho</b> Holmium 67	
			11 B Boron 5 27 A1 Aluminium	70 <b>Ga</b> Gallium 31	115 <b>In</b> Indium	204 <b>T t</b> Thallium		162 <b>Dy</b> Dysprosium 66	
				65 <b>Zn</b> Zinc 30	112 <b>Cd</b> Cadmium 48			159 <b>Tb</b> Terbium 65	<b>BK</b> Berkelium 97
				64 Copper	108 <b>Ag</b> Silver 47	197 <b>Au</b> Gold		157 <b>Gd</b> Gadolinium 64	
Group				59 Nickel 28	106 <b>Pd</b> Palladium 46	195 <b>Pt</b> Platinum 78		152 <b>Eu</b> Europium 63	
Gre				59 <b>Co</b> Cobalt	Rh Rhodium 45	192 <b>Ir</b> Irdium		Samarium 62	
		Hydrogen		56 <b>Fe</b> Iron	Ruthenium	190 <b>Os</b> Osmium 76		Pm Promethium 61	Neptunium 93
				Mn Manganese 25	Tc Technetium 43	186 <b>Re</b> Rhenium 75		Neodymium 60	238 <b>U</b> Uranium
				Cr Chromium 24	96 Mo Molybdenum 42	184 <b>W</b> Tungsten 74		Pr Praseodymium 59	Pa Protactinium 91
				51 V Vanadium 23	Niobium N41	181 <b>Ta</b> Tantalum		140 <b>Ce</b> Cerium	232 <b>Th</b>
				48 <b>T</b> Titanium	91 <b>Zr</b> Zirconium 40	178 <b>#</b> Hafnium			nic mass bol nic) number
				Scandium 21	89 <b>×</b>	139 <b>La</b> Lanthanum 57 *	227 <b>AC</b> Actinium 89	d series series	<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>Ca</b> Calcium	Strontium	137 <b>Ba</b> Barium 56	226 <b>Rad</b> Radium	*58-71 Lanthanoid series 190-103 Actinoid series	в <b>Х</b>
	_		23 Codum 11	39 <b>K</b> Potassium	Rb Rubidium 37	133 <b>Cs</b> Caesium 55	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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# UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	
CHEMISTRY			0620/32
Paper 3 (Extend	led)		May/June 2009
			1 hour 15 minutes
Candidates ans	wer on the Question Paper.		
No Additional M	aterials 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.

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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]

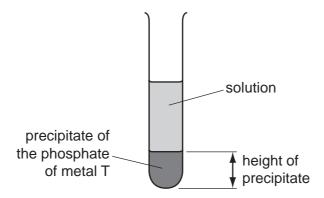
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(iv) Why is the solid heated?

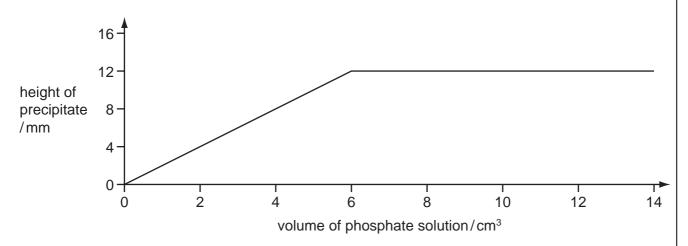
(b) The formulae of insoluble compounds can be found by precipitation reactions.

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

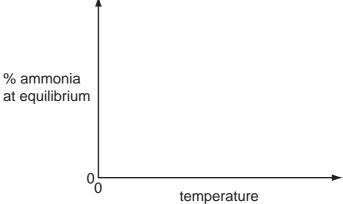
[1]

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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 -	<del>&gt;</del> 2H—F	
 		••
 		••
 		••
	[3	31

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<b>(b)</b> Th	ney react with w	ater to fo	rm	acidic	solutio	ons.			
		HC <i>l</i>	+	H <sub>2</sub> O	$\rightleftharpoons$	$H_3O^+$	+	Cl <sup>-</sup>	
		HF	+	H <sub>2</sub> O	$\rightleftharpoons$	$H_3O^{\dagger}$	+	F <sup>-</sup>	
(i)	Explain why	water bel	nave	es as a	base	in both	of t	these reactions.	
			••••						
								[:	2]
(ii)	•	In the	othe	er equ	ilibriu			exists as molecules, the rest hat the hydrogen fluoride exists a	
	What does th	nis tell you	u at	out the	e strer	ngth of e	each	n acid?	
	,								
								[:	2]
(iii)	How would th	ne pH of	thes	se two	solutio	ons diffe	er?		
			••••					[	1]
								[Total: 8	31

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 petroleul	m.
		[2]

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

$$-O-CH - C-O - CH_3 \\ -C-O - CH - CH_3 \\$$

(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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For Examiner's Use

(C)	When	lactic	acid is	heated,	acrylic	acid is	tormed.
\ <sup>-</sup> /				,			

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 7.2g 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

	0	He Heium	Neon 10 Neon 40 Ar Argan 18	84 Krypton 36	131 <b>Xe</b> Xenon	Rn Radon		175 <b>Lu</b> Lutetium 71	Lr Lawrencium 103
	II/		19 Fluorine 9 35.5 <b>C.1</b> Chlorine	80 <b>Br</b> Bromine	127 <b>I</b> lodine	At Astatine 85		173 <b>Yb</b> Ytterbium 70	Nobelium 102
	VI		16 Oxygen 8 32 32 Sulfur 16	79 <b>Se</b> Selenium 34	128 <b>Te</b> Tellurium	1		169 <b>Tm</b> Thulium 69	Md Mendelevium 101
	^		Nirrogen 7 31 31 Phosphorus 15	AS Arsenic	Sb Antimony 51			167 <b>Er</b> Erbium 68	Fm Fermium
	IV		Carbon 6 Carbon 8 Silicon 14	73 <b>Ge</b> Germanium	119 <b>Sn</b> Tin	207 <b>Pb</b> Lead		165 <b>Ho</b> Holmium 67	<b>ES</b> Einsteinium 99
	ш		11 B Boron 5 27 A Uminium 13	70 <b>Ga</b> Gallium 31	115 <b>In</b> Indium	204 <b>T 1</b> T T		162 <b>Dy</b> Dysprosium 66	<b>Cf</b> Californium 98
				65 <b>Zn</b> Zinc 30	112 <b>Cd</b> Cadmium 48	201 <b>Hg</b> Mercury 80		159 <b>Tb</b> Terbium 65	<b>BK</b> Berkelium 97
				64 <b>Cu</b> Copper 29	108 <b>Ag</b> Silver 47	197 <b>Au</b> Gold		157 <b>Gd</b> Gadolinium 64	Curium 96
Group				59 Nickel	106 <b>Pd</b> Palladium 46	195 <b>Pt</b> Platinum 78		152 <b>Eu</b> Europium 63	Americium 95
Ģ				59 <b>Cobalt</b>	103 <b>Rh</b> Rhodium 45	192 <b>Ir</b> Iridium		150 Sm Samarium 62	<b>Pu</b> Plutonium
		1 Hydrogen		56 <b>Fe</b> Iron	Ruthenium	190 <b>OS</b> Osmium 76		<b>Pm</b> Promethium 61	Np Neptunium 93
				Mn Manganese	Tc Technetium 43	186 <b>Re</b> Rhenium 75		144 <b>Nd</b> Neodymium 60	238 <b>U</b> Uranium 92
				52 <b>Cr</b> Chromium 24	96 Mo Molybdenum 42	184 <b>W</b> Tungsten 74		141 <b>Pr</b> Praseodymium 59	<b>Pa</b> Protactinium 91
				51 Vanadium 23	Niobium 41	181 <b>Ta</b> Tantalum		140 <b>Ce</b> Cerium	232 <b>Th</b> Thorium
				48 <b>Ti</b> Titanium	2r Zrzonium 40	178 <b>H</b> Hafnium 72			nic mass Ibol nic) number
		ı		Scandium 21	89 <b>×</b> Yttrium 39	La Lanthanum 57 *	Actinium Actinium 189	series series	a = relative atomic mass  X = atomic symbol b = proton (atomic) number
	=		Beryllium 4 24 Magnesium 12	40 <b>Ca</b> Calcium 20	Strontium	137 <b>Ba</b> Barium 56	226 <b>Ra</b> Radium	*58-71 Lanthanoid series	© × ö × v
	_		Lithium 3 Lithium 3 23 Na Sodium 11	39 <b>K</b> Potassium 19	85 <b>Rb</b> Rubidium 37	133 Cs Caesium 55	<b>Fr</b> Francium 87	*58-71 L	Key L

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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