

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

Who can I contact for further information on these changes?

Please direct any questions about this to CIE's Customer Services team at:

international@cie.org.uk

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

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

October/November 2008

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 questions.

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

This document consists of **12** printed pages.



1 Complete the following table.

gas	test for gas
ammonia	
	bleaches damp litmus paper
hydrogen	
	relights a glowing splint
	turns limewater milky

[Total: 5]

For
Examiner's
Use

2 There are three types of giant structure – ionic, metallic and macromolecular.

(a) Sodium nitride is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from a sodium atom.
Use o to represent an electron from a nitrogen atom.

[3]

(b) (i) Describe metallic bonding.

.....
..... [3]

(ii) Use the above ideas to explain why
metals are good conductors of electricity,

..... [1]

metals are malleable.

..... [2]

(c) Silicon(IV) oxide has a macromolecular structure.

(i) **Describe** the structure of silicon(IV) oxide (a diagram is not acceptable).

.....
.....
..... [3]

(ii) Diamond has a similar structure and consequently similar properties.
Give **two** physical properties common to both diamond and silicon(IV) oxide.

.....
..... [2]

[Total: 14]

3 Steel is an alloy made from impure iron.

(a) Both iron and steel rust. The formula for rust is $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.
It is hydrated iron(III) oxide.

(i) Name the **two** substances that must be present for rusting to occur.

..... [2]

(ii) Painting and coating with grease are two methods of preventing iron or steel from rusting. Give **two** other methods.

.....
..... [2]

(b) (i) Name a reagent that can reduce iron(III) oxide to iron.

..... [1]

(ii) Write a symbol equation for the reduction of iron(III) oxide, Fe_2O_3 , to iron.

..... [2]

(c) (i) Calculate the mass of one mole of $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.

..... [1]

(ii) Use your answer to (i) to calculate the percentage of iron in rust.

.....
..... [2]

(d) Iron from the blast furnace is impure. Two of the impurities are carbon and silicon. These are removed by blowing oxygen through the molten iron and adding calcium oxide.

(i) Explain how the addition of oxygen removes carbon.

.....
..... [1]

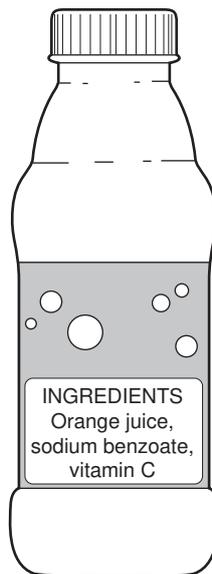
(ii) Explain how the addition of oxygen and calcium oxide removes silicon.

.....
..... [2]

[Total: 13]

- 4 Across the world, food safety agencies are investigating the presence of minute traces of the toxic hydrocarbon, benzene, in soft drinks. It is formed by the reduction of sodium benzoate by vitamin C.

For
Examiner's
Use



- (a) Sodium benzoate is a salt, it has the formula C_6H_5COONa . It can be made by the neutralisation of benzoic acid by sodium hydroxide.

(i) Deduce the formula of benzoic acid.

..... [1]

(ii) Write a word equation for the reaction between benzoic acid and sodium hydroxide.

..... [1]

(iii) Name **two** other compounds that would react with benzoic acid to form sodium benzoate.

..... [2]

- (b) Benzene contains 92.3% of carbon and its relative molecular mass is 78.

(i) What is the percentage of hydrogen in benzene?

..... [1]

(ii) Calculate the ratio of moles of C atoms: moles of H atoms in benzene.

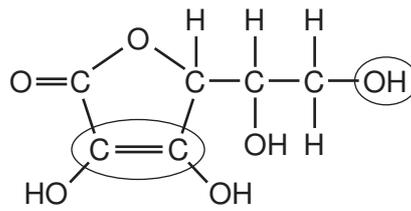
.....
..... [2]

(iii) Calculate its empirical formula and **then** its molecular formula.

The empirical formula of benzene is

The molecular formula of benzene is [2]

(c) The structural formula of Vitamin C is drawn below.



For
Examiner's
Use

(i) What is its molecular formula?

..... [1]

(ii) Name the two functional groups which are circled.

..... [2]

[Total: 12]

5 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

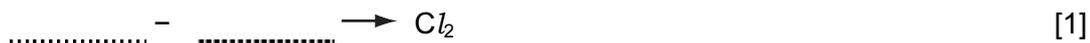
For
Examiner's
Use

(a) The ions present are $\text{Na}^+(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$ and $\text{OH}^-(\text{aq})$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).



(ii) Complete the ionic equation for the reaction at the positive electrode (anode).



(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]

(b) (i) Why does the water supply industry use chlorine?

..... [1]

(ii) Name an important chemical that is made from hydrogen.

..... [1]

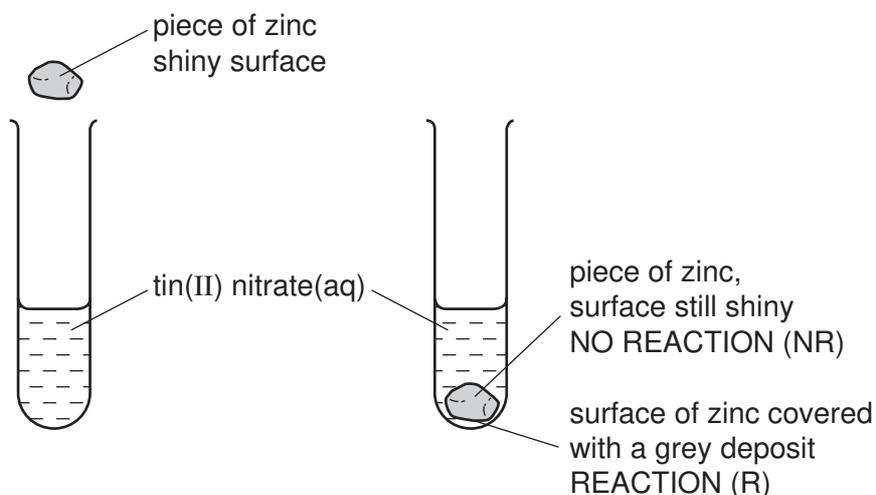
(iii) How is sodium hydroxide used to make soap?

..... [2]

[Total: 7]

6 The reactivity series lists metals in order of reactivity.

- (a) To find out which is the more reactive metal, zinc or tin, the following experiment could be carried out.



This experiment could be carried out with other metals and the results recorded in a table. Then the order of reactivity can be deduced.

- (i) The order was found to be:
- | | |
|-----------|----------------|
| manganese | most reactive |
| zinc | |
| tin | |
| silver | least reactive |

Complete the table of results from which this order was determined.

aqueous solution	tin Sn	manganese Mn	silver Ag	zinc Zn
tin(II) nitrate		R	NR	R
manganese(II) nitrate				
silver(I) nitrate				
zinc nitrate				

[3]

- (ii) Write the ionic equation for the reaction between tin atoms and silver(I) ions.

.....

[2]

- (iii) The following is a redox reaction.



Indicate on the equation the change which is oxidation.
Give a reason for your choice.

..... [2]

- (iv) Explain why experiments of this type cannot be used to find the position of aluminium in the reactivity series.

.....
..... [2]

- (b) Potassium and calcium are very reactive metals at the top of the series. Because their ions have different charges, K^+ and Ca^{2+} , their compounds behave differently when heated.

- (i) Explain why the ions have different charges.

.....
..... [2]

- (ii) Their hydroxides are heated.
If the compound decomposes, complete the word equation.
If it does not decompose, write "no reaction".

Potassium hydroxide \longrightarrow

Calcium hydroxide \longrightarrow [2]

- (iii) Complete the equations for the decomposition of their nitrates.

$2\text{KNO}_3 \longrightarrow$ +

$2\text{Ca}(\text{NO}_3)_2 \longrightarrow$ + + [4]

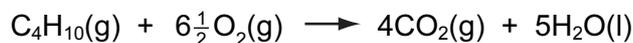
[Total: 17]

- 7 The alkanes are generally unreactive. Their reactions include combustion, substitution and cracking.

For
Examiner's
Use

(a) The complete combustion of an alkane gives carbon dioxide and water.

- (i) 10 cm³ of butane is mixed with 100 cm³ of oxygen, which is an excess. The mixture is ignited. What is the volume of unreacted oxygen left and what is the volume of carbon dioxide formed?



Volume of oxygen left = cm³

Volume of carbon dioxide formed = cm³ [2]

- (ii) Why is the incomplete combustion of any alkane dangerous, particularly in an enclosed space?

.....
..... [2]

(b) The equation for a substitution reaction of butane is given below.



- (i) Name the organic product.

..... [1]

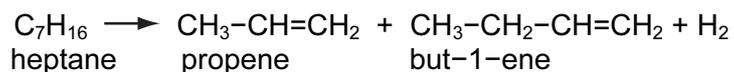
- (ii) This reaction does not need increased temperature or pressure. What is the essential reaction condition?

..... [1]

- (iii) Write a different equation for a substitution reaction between butane and chlorine.

..... [1]

- (c) Alkenes are more reactive and industrially more useful than alkanes. They are made by cracking alkanes.



- (i) Draw the structural formula of the polymer poly(propene).

[2]

- (ii) Give the structural formula and name of the alcohol formed when but-1-ene reacts with steam.

name

[1]

structural formula

[1]

- (iii) Deduce the structural formula of the product formed when propene reacts with hydrogen chloride.

[1]

[Total: 12]

DATA SHEET
The Periodic Table of the Elements

		Group																																			
		I	II	III	IV	V	VI	VII	VIII	IX	X	0																									
		1 H Hydrogen 1																																			
		4 He Helium 2																																			
7	9	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20																		
Li Lithium	Be Beryllium	B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon	Na Sodium	Mg Magnesium	Al Aluminium	Si Silicon	P Phosphorus	S Sulphur	Cl Chlorine	Ar Argon	K Potassium	Ca Calcium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese	Fe Iron	Co Cobalt	Ni Nickel	Cu Copper	Zn Zinc	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine	Kr Krypton				
19	20	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
Rb Rubidium	Sr Strontium	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium	Ru Ruthenium	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine	Xe Xenon	Cs Caesium	Ba Barium	La Lanthanum	Ce Cerium	Pr Praseodymium	Nd Neodymium	Pm Promethium	Sm Samarium	Eu Europium	Gd Gadolinium	Tb Terbium	Dy Dysprosium	Ho Holmium	Er Erbium	Tm Thulium	Yb Ytterbium	Lu Lutetium			
87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124
Fr Francium	Ra Radium	Ac Actinium	Rf Rutherfordium	Hf Hafnium	Ta Tantalum	W Tungsten	Os Osmium	Ir Iridium	Pt Platinum	Au Gold	Hg Mercury	Tl Thallium	Pb Lead	Bi Bismuth	Po Polonium	At Astatine	Rn Radon	U Uranium	Np Neptunium	Pu Plutonium	Am Americium	Cm Curium	Bk Berkelium	Cf Californium	Es Einsteinium	Fm Fermium	Md Mendelevium	No Nobelium	Lr Lawrencium								

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

a	X	a = relative atomic mass
b	X	X = atomic symbol
b	X	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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Second Variant Question Paper



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
NUMBER

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CHEMISTRY

0620/32

Paper 3 (Extended)

October/November 2008

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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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	
Total	

This document consists of **12** printed pages.



1 Complete the following table.

*For
Examiner's
Use*

gas	test for gas
	turns damp red litmus paper blue
	bleaches damp litmus paper
hydrogen	
oxygen	
carbon dioxide	

[Total: 5]

2 There are three types of giant structure – ionic, metallic and macromolecular.

(a) Sodium sulphide is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from a sodium atom.
Use o to represent an electron from a sulphur atom.

[3]

(b) (i) Describe metallic bonding.

.....
..... [3]

(ii) Use the above ideas to explain why
metals are good conductors of electricity,

..... [1]

metals are malleable.

..... [2]

(c) Silicon(IV) oxide has a macromolecular structure.

(i) **Describe** the structure of silicon(IV) oxide (a diagram is not acceptable).

.....
.....
..... [3]

(ii) Diamond has a similar structure and consequently similar properties.
Give **two** physical properties common to both diamond and silicon(IV) oxide.

.....
..... [2]

[Total: 14]

3 Steel is an alloy made from impure iron.

(a) Both iron and steel rust. The formula for rust is $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.
It is hydrated iron(III) oxide.

(i) Name the **two** substances that must be present for rusting to occur.

..... and [2]

(ii) Painting and coating with grease are two methods of preventing iron or steel from rusting. Give **two** other methods.

.....
..... [2]

(b) (i) Name a reagent that can reduce iron(III) oxide to iron.

..... [1]

(ii) Write a symbol equation for the reduction of iron(III) oxide, Fe_2O_3 , to iron.

..... [2]

(c) (i) Calculate the mass of one mole of $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.

..... [1]

(ii) Use your answer to (i) to calculate the percentage of water in rust.

.....
..... [2]

(d) Iron from the blast furnace is impure. Two of the impurities are carbon and silicon. These are removed by blowing oxygen through the molten iron and adding calcium oxide.

(i) Explain how the addition of oxygen removes carbon.

.....
..... [1]

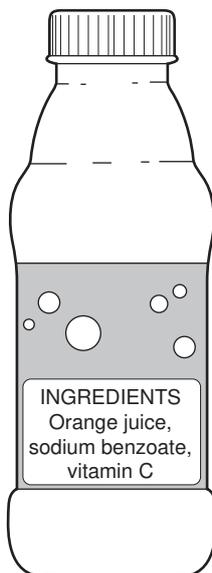
(ii) Explain how the addition of oxygen and calcium oxide removes silicon.

.....
..... [2]

[Total: 13]

- 4 Across the world, food safety agencies are investigating the presence of minute traces of the toxic hydrocarbon, benzene, in soft drinks. It is formed by the reduction of sodium benzoate by vitamin C.

For
Examiner's
Use



- (a) Sodium benzoate is a salt, it has the formula C_6H_5COONa . It can be made by the neutralisation of benzoic acid by sodium hydroxide.

- (i) Deduce the formula of benzoic acid.

..... [1]

- (ii) Write a word equation for the reaction between benzoic acid and sodium hydroxide.

..... [1]

- (iii) Name **two** other compounds that would react with benzoic acid to form sodium benzoate.

..... [2]

(b) Benzene contains 92.3% of carbon and its relative molecular mass is 78.

(i) What is the percentage of hydrogen in benzene?

..... [1]

(ii) Calculate the ratio of moles of C atoms: moles of H atoms in benzene.

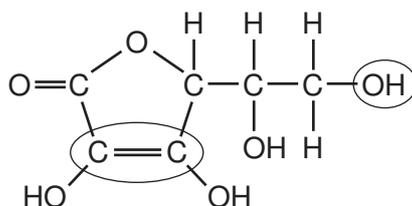
.....
..... [2]

(iii) Calculate its empirical formula and **then** its molecular formula.

The empirical formula of benzene is

The molecular formula of benzene is [2]

(c) The structural formula of Vitamin C is drawn below.



(i) What is its molecular formula?

..... [1]

(ii) Name the two functional groups which are circled.

..... [2]

[Total: 12]

5 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals; hydrogen, chlorine and sodium hydroxide.

For
Examiner's
Use

(a) The ions present are $\text{Na}^+(\text{aq})$, $\text{H}^+(\text{aq})$, $\text{Cl}^-(\text{aq})$ and $\text{OH}^-(\text{aq})$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).



(ii) Complete the ionic equation for the reaction at the positive electrode (anode).



(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]

(b) (i) Why does the water supply industry use chlorine?

..... [1]

(ii) Name an important chemical that is made from hydrogen.

..... [1]

(iii) Sodium hydroxide reacts with fats to make soap and glycerine
What type of compound are fats?

..... [1]

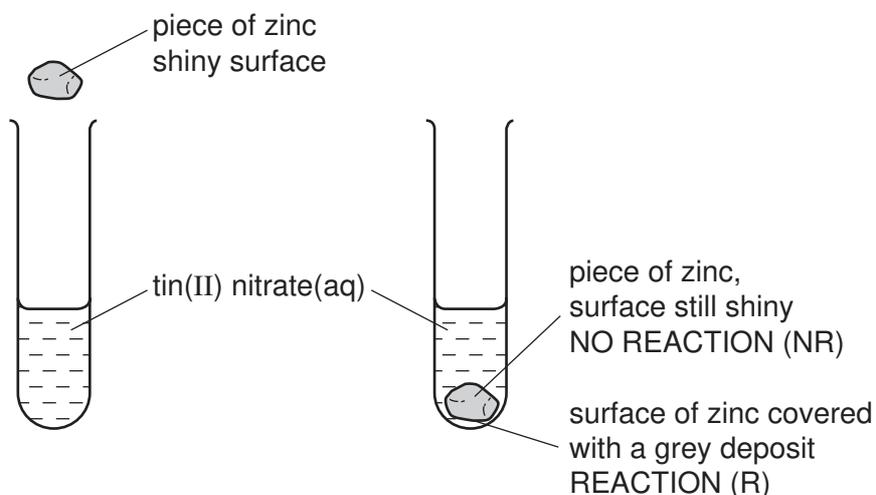
What type of the reaction is this?

..... [1]

[Total : 7]

6 The reactivity series lists metals in order of reactivity.

- (a) To find out which is the more reactive metal, zinc or tin, the following experiment could be carried out.



This experiment could be carried out with other metals and the results recorded in a table. Then the order of reactivity can be deduced.

- (i) The order was found to be:
- | | |
|-----------|----------------|
| manganese | most reactive |
| zinc | |
| tin | |
| silver | least reactive |

Complete the table of results from which this order was determined.

aqueous solution	tin Sn	manganese Mn	silver Ag	zinc Zn
tin(II) nitrate		R	NR	R
manganese(II) nitrate				
silver(I) nitrate				
zinc nitrate				

[3]

- (ii) Write the equation for the reaction between zinc and silver(I) nitrate.

.....

[2]

- (iii) The following is a redox reaction.



Indicate on the equation which reagent is the oxidant or oxidizing agent.
Give a reason for your choice.

..... [2]

- (iv) Explain why experiments of this type cannot be used to find the position of aluminium in the reactivity series.

.....
..... [2]

- (b) Potassium and calcium are very reactive metals at the top of the series. Because their ions have different charges, K^+ and Ca^{2+} , their compounds behave differently when heated.

- (i) Explain why the ions have different charges.

.....
..... [2]

- (ii) Their hydroxides are heated.
If the compound decomposes, complete the word equation.
If it does not decompose, write "no reaction".

Potassium hydroxide \longrightarrow

Calcium hydroxide \longrightarrow [2]

- (iii) Complete the equations for the decomposition of their nitrates.

$2\text{KNO}_3 \longrightarrow$ +

$2\text{Ca}(\text{NO}_3)_2 \longrightarrow$ + + [4]

[Total: 17]

- 7 The alkanes are generally unreactive. Their reactions include combustion, substitution and cracking.

For
Examiner's
Use

(a) The complete combustion of an alkane gives carbon dioxide and water.

- (i) 20 cm³ of butane is mixed with 150 cm³ of oxygen, which is an excess. The mixture is ignited. What is the volume of unreacted oxygen left and what is the volume of carbon dioxide formed?



Volume of oxygen left = cm³

Volume of carbon dioxide formed = cm³ [2]

- (ii) Why is the incomplete combustion of any alkane dangerous, particularly in an enclosed space?

.....
..... [2]

(b) The equation for a substitution reaction of butane is given below.



- (i) Name the organic product.

..... [1]

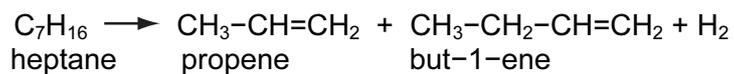
- (ii) This reaction does not need increased temperature or pressure. What is the essential reaction condition?

..... [1]

- (iii) Write a different equation for a substitution reaction between butane and chlorine.

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- (c) Alkenes are more reactive and industrially more useful than alkanes. They are made by cracking alkanes.



- (i) Draw the structural formula of the polymer poly(propene).

[2]

- (ii) Give the structural formula and name of the alcohol formed when propene reacts with steam.

name

[1]

structural formula

[1]

- (iii) Deduce the structural formula of the product formed when but-1-ene reacts with hydrogen chloride.

[1]

[Total: 12]

For
Examiner's
Use

DATA SHEET
The Periodic Table of the Elements

		Group																																																																																																																																																																														
I	II	III	IV	V	VI	VII	0																																																																																																																																																																									
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 Si Silicon 14	15 P Phosphorus 15	16 S Sulphur 16	17 Cl Chlorine 17	18 Ar Argon 18	19 F Fluorine 9	20 Ne Neon 10	21 Na Sodium 11	22 Mg Magnesium 12	23 Al Aluminium 13	24 Si Silicon 14	25 P Phosphorus 15	26 S Sulphur 16	27 Cl Chlorine 17	28 Ar Argon 18	29 K Potassium 19	30 Ca Calcium 20	31 Sc Scandium 21	32 Ti Titanium 22	33 V Vanadium 23	34 Cr Chromium 24	35 Mn Manganese 25	36 Fe Iron 26	37 Co Cobalt 27	38 Ni Nickel 28	39 Cu Copper 29	40 Zn Zinc 30	41 Ga Gallium 31	42 Ge Germanium 32	43 As Arsenic 33	44 Se Selenium 34	45 Br Bromine 35	46 Kr Krypton 36	47 Rb Rubidium 37	48 Sr Strontium 38	49 Y Yttrium 39	50 Zr Zirconium 40	51 Nb Niobium 41	52 Mo Molybdenum 42	53 Tc Technetium 43	54 Ru Ruthenium 44	55 Rh Rhodium 45	56 Pd Palladium 46	57 Ag Silver 47	58 Cd Cadmium 48	59 In Indium 49	60 Sn Tin 50	61 Sb Antimony 51	62 Te Tellurium 52	63 I Iodine 53	64 Xe Xenon 54	65 Cs Caesium 55	66 Ba Barium 56	67 La Lanthanum 57	68 Hf Hafnium 72	69 Ta Tantalum 73	70 W Tungsten 74	71 Re Rhenium 75	72 Os Osmium 76	73 Ir Iridium 77	74 Pt Platinum 78	75 Au Gold 79	76 Hg Mercury 80	77 Tl Thallium 81	78 Pb Lead 82	79 Bi Bismuth 83	80 Po Polonium 84	81 At Astatine 85	82 Rn Radon 86	83 Fr Francium 87	84 Ra Radium 88	85 Ac Actinium 89	86 Th Thorium 90	87 Pa Protactinium 91	88 U Uranium 92	89 Np Neptunium 93	90 Pu Plutonium 94	91 Am Americium 95	92 Cm Curium 96	93 Bk Berkelium 97	94 Cf Californium 98	95 Es Einsteinium 99	96 Fm Fermium 100	97 Md Mendelevium 101	98 No Nobelium 102	99 Lr Lawrencium 103	100 Ac Actinium 89	101 Th Thorium 90	102 Pa Protactinium 91	103 U Uranium 92	104 Np Neptunium 93	105 Pu Plutonium 94	106 Am Americium 95	107 Cm Curium 96	108 Bk Berkelium 97	109 Cf Californium 98	110 Es Einsteinium 99	111 Fm Fermium 100	112 Md Mendelevium 101	113 No Nobelium 102	114 Lr Lawrencium 103	115 Ce Cerium 58	116 Pr Praseodymium 59	117 Nd Neodymium 60	118 Pm Promethium 61	119 Sm Samarium 62	120 Eu Europium 63	121 Gd Gadolinium 64	122 Tb Terbium 65	123 Dy Dysprosium 66	124 Ho Holmium 67	125 Er Erbium 68	126 Tm Thulium 69	127 Yb Ytterbium 70	128 Lu Lutetium 71	129 Ce Cerium 58	130 Pr Praseodymium 59	131 Nd Neodymium 60	132 Pm Promethium 61	133 Sm Samarium 62	134 Eu Europium 63	135 Gd Gadolinium 64	136 Tb Terbium 65	137 Dy Dysprosium 66	138 Ho Holmium 67	139 Er Erbium 68	140 Tm Thulium 69	141 Yb Ytterbium 70	142 Lu Lutetium 71	143 Ce Cerium 58	144 Pr Praseodymium 59	145 Nd Neodymium 60	146 Pm Promethium 61	147 Sm Samarium 62	148 Eu Europium 63	149 Gd Gadolinium 64	150 Tb Terbium 65	151 Dy Dysprosium 66	152 Ho Holmium 67	153 Er Erbium 68	154 Tm Thulium 69	155 Yb Ytterbium 70	156 Lu Lutetium 71	157 Ce Cerium 58	158 Pr Praseodymium 59	159 Nd Neodymium 60	160 Pm Promethium 61	161 Sm Samarium 62	162 Eu Europium 63	163 Gd Gadolinium 64	164 Tb Terbium 65	165 Dy Dysprosium 66	166 Ho Holmium 67	167 Er Erbium 68	168 Tm Thulium 69	169 Yb Ytterbium 70	170 Lu Lutetium 71	171 Ce Cerium 58	172 Pr Praseodymium 59	173 Nd Neodymium 60	174 Pm Promethium 61	175 Sm Samarium 62	176 Eu Europium 63	177 Gd Gadolinium 64	178 Tb Terbium 65	179 Dy Dysprosium 66	180 Ho Holmium 67	181 Er Erbium 68	182 Tm Thulium 69	183 Yb Ytterbium 70	184 Lu Lutetium 71

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

a	X	a = relative atomic mass
b	X	X = atomic symbol
Key	b	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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