National
Qualifications
2016

2016 Chemistry

Higher

Finalised Marking Instructions

General Marking Principles for Higher Chemistry

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must always be assigned in line with these General Marking Principles and the Detailed Marking Instructions for this assessment.

(b) Marking should always be positive, ie marks should be awarded for what is correct and not deducted for errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader.

(d) There are no half marks awarded.

(e) Where a candidate makes an error at an early stage in a multi stage calculation, credit should normally be given for correct follow on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. The same principle should be applied in questions which require several stages of non-mathematical reasoning. The exception to this rule is where the marking instructions for a numerical question assign separate "concept marks" and an "arithmetic mark". In such situations, the marking instructions will give clear guidance on the assignment or partial marks.

(f) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units) on its own.

(g) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of developed bullet points.

(h) Marks should not be deducted for inaccurate or unconventional spelling or vocabulary as long as the meaning of the word(s) is conveyed. **For example**, responses that include 'distilling' for 'distillation', or 'it gets hotter' for 'the temperature rises', should be accepted.

(i) If a correct answer is followed by a wrong answer, it should be treated as a cancelling error and no marks should be given. **For example**, in response to the question, 'State the colour seen when blue Fehling's solution is warmed with an aldehyde', the answer 'red green' gains no marks.
However, if a correct answer is followed by additional information which does not conflict with that, the additional information should be ignored, whether correct or not. **For example**, in response to a question concerned with melting point, 'State why the tube should not be made of copper', the response 'Copper has a low melting point and is coloured grey' would **not** be treated as having a cancelling error. **I**f a candidate lists a number of possible answers it should not be for the marker to choose the correct answer from the list.

(j) Full marks are usually awarded for the correct answer to a calculation without working and the partial marks shown in the detailed marking instructions are for use when working is given but the final answer is incorrect. An exception is when candidates are asked to 'Find, by calculation', when full marks cannot be awarded for the correct answer without working.

(k) Ignore the omission of one H atom from a full structural formula provided the bond is shown.

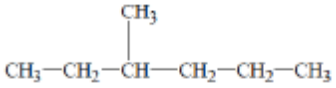
(l) A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the detailed marking instructions.**

(m) When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

(n) If an answer comes directly from the text of the question, no marks should be given. **For example**, in response to the question, ' A student found that 0·05 mol of propane, C_3H_8 burned to give 82·4 kJ of energy. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$. Name the kind of enthalpy change that the student measured', no marks should be given for "burning" since the word "burned" appears in the text.

(o) A guiding principle in marking is to give credit for correct elements of a response rather than to look for reasons not to give marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon

- Although the punctuation is not correct '3, methyl-hexane' should gain the full mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	*pH*
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

Describe the relationship between the number of chlorine atoms in the molecule and the strengths of the acids.

- Although not completely correct, an answer such as 'the more Cl_2, the stronger the acid' should gain the full mark.

(p) Unless the question is clearly about a non-chemistry issue, eg costs in an industrial chemical process, a non-chemical answer gains no marks.
For example, in response to the question, 'Why does the (catalytic) converter have a honeycomb structure?', 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

(q) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify, name, give** or **state**, they need only name or present in brief form;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **explain**, they must relate cause and effect and/or make relationships between things clear;

- **compare**, they must demonstrate knowledge and understanding of the similarities and/or differences between things;
- **complete**, they must finish a chemical equation or fill in a table with information
- **determine** or **calculate**, they must determine a number from given facts, figures or information;
- **draw**, they must draw a diagram or structural formula, eg "Draw a diagram to show the part of a poly(propene) molecule formed from two propene molecules"
- **estimate**, they must determine an approximate value for something;
- **predict**, they must suggest what may happen based on available information;
- **evaluate**, they must make a judgement based on criteria;
- **suggest**, they must apply their knowledge and understanding of [subject] to a new situation. A number of responses are acceptable; marks will be awarded for any suggestions that are supported by knowledge and understanding of [subject];
- **use your knowledge of [chemistry or aspect of chemistry] to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). They will be rewarded for the breadth and/or depth of their conceptual understanding.
- **Write**, they must complete a chemical or word equation, eg "Write the word equation for the complete combustion of ethanol."

Marking Instructions for each question

Section 1

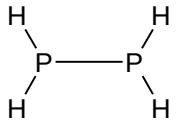
Question	Answer	Max Mark
1.	D	**1**
2.	A	**1**
3.	A	**1**
4.	B	**1**
5.	B	**1**
6.	A	**1**
7.	C	**1**
8.	D	**1**
9.	C	**1**
10.	B	**1**
11.	B	**1**
12.	C	**1**
13.	C	**1**
14.	B	**1**
15.	C	**1**
16.	A	**1**
17.	C	**1**
18.	D	**1**
19.	D	**1**
20.	A	**1**

Section 2

Question			Answer	Max Mark	Additional Guidance
1.	(a)		The number of **successful** collisions will increase/There will be a greater chance of successful collisions **(1 mark)** **OR** More reactant particles will have energy equal to or greater than the activation energy. **(1 mark)**	**1**	Also acceptable More particles have sufficient/enough energy to react.
	(b)	(i)	1 mark for drawing suitable experiment that will work **and** for indicating how **volume** will be measured eg collecting in a gas syringe or downward displacement of water from a measuring cylinder or similar.	**1**	Accept a recognisable/labelled gas syringe, as long as graduations are shown. Graduations must be shown if a measuring cylinder is used. Mark not awarded if delivery tube passes through the side of a measuring cylinder.
		(ii)	3·7 (volume strength).	**1**	Ignore any units. 3·7 must clearly be final answer.
	(c)		8 (s).	**1**	Accept 7·7 (1/0·13) to 8·3 (1/0·12) or correct answer to 2 decimal places. No units required but no mark is awarded if wrong unit is given. (wrong units would only be penalised once in any paper).

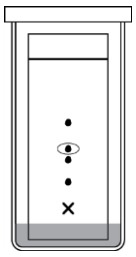
Question			Answer	Max Mark	Additional Guidance
2.	(a)	(i)	(The electron shells are pulled closer because) nuclear charge increases/the number of protons in the nucleus increases.	**1**	Mention must be made of nuclear charge or number of protons in candidate's answer giving the idea of pull by the nucleus. Increased nuclear pull is not accepted.
		(ii)	Two points are required Understanding that the atom loses an electron (when the ion is formed), **(1 mark)** **AND** the Sodium ion will only have two electron shells whereas the sodium atom has three electron shells **OR** the sodium ion will have fewer electron shells (than the sodium atom). **(1 mark)**	**2**	A diagram of the atom and ion or stating the electron arrangement of both would be sufficient to gain 1 mark but the second mark can only be awarded if this diagram or electron arrangement is accompanied with an explanatory statement.
	(b)	(i)	As you go down the group the outer electron is more shielded from the nuclear pull **OR** less strongly attracted by the nucleus.	**1**	
		(ii)	2nd ionisation energy involves removal from an electron shell which is inner/full (whole)/(more) stable/closer to the nucleus **OR** second electron is removed from an electron shell which is inner/full (whole)/(more) stable/closer to the nucleus. **(1 mark)** The electron is less shielded from, or, more strongly attracted to the nucleus. **(1 mark)**	**2**	Stating that more energy is required to remove the second electron would be seen as restating the information from the stem.

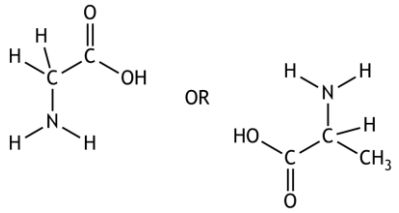
Question			Answer	Max Mark	Additional Guidance
2.	(c)	(i)	Any value in range 720–770 ($kJ\ mol^{-1}$).	**1**	Data value 760 $kJ\ mol^{-1}$ No units required but no mark is awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
		(ii)	As the ionic radii (of the positive and/or the negative ion) increase, the lattice enthalpy decreases.	**1**	A general statement stating the greater the difference in ionic radii the greater the lattice enthalpy must be related to either chlorides or fluorides. The mark cannot be awarded for a statement such as, "As the lattice enthalpy decreases the ionic radii increases" which implies that ionic radius is a dependent variable.

Question			Answer	Max Mark	Additional Guidance
3.	(a)		Covalent molecular.	**1**	
	(b)		n =m/gfm =2900/58 =50 **(1 mark)** V = n × Vm = 50 × 24 = 1200 (litres) **(1 mark)** Or by Proportion 58 g ⟶ 24 l **(1 mark)** 2·9 kg ⟶ 24 × 2900/58ℓ = 1200 (ℓ) **(1 mark)**	**2**	Follow through applies in this question. No units required but only one mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper) Accept L for ℓ.
	(c)			**1**	

Question			Answer	Max Mark	Additional Guidance
4.			This is an open ended question **1 mark:** The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding, at an appropriate level, of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding, at an appropriate level, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	3	Zero marks should be awarded if: The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

Question			Answer	Max Mark	Additional Guidance
5.	(a)		Glycerol or glycerine or propan(e)-1,2,3-triol.	**1**	
	(b)	(i)	Polyunsaturated.	**1**	
		(ii)	Octanoic acid.	**1**	
	(c)	(i)	Bromine solution is added to both until the bromine is no longer decolourised. (or reddish-brown colour remains) **(1 mark)** More bromine would be required for the more unsaturated/olive oil **OR** Less bromine would be required for the more saturated/coconut oil. **(1 mark)**	**2**	
		(ii)	Hexane is a non-polar (solvent)/ water is a polar (solvent).	**1**	Answers in terms of "Like dissolves like" are only acceptable if explanation in terms of polarity is given. Oil and water don't mix would not be awarded a mark.
		(iii)	Coconut oil molecules can pack more closely together **OR** Coconut oil has linear fatty acid chains/olive oil chains have bends/kinks (due to the double bonds) **(1 mark)** There are stronger/more **intermolecular** forces between the molecules in coconut oil **OR** The London dispersion forces (van der Waals' forces) between the molecules in coconut oil are stronger than in olive oils. **(1 mark)**	**2**	

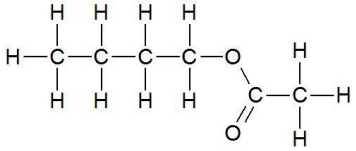
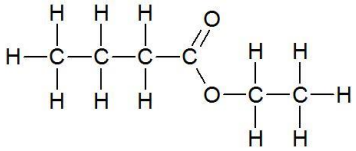
Question			Answer	Max Mark	Additional Guidance
6.	(a)		Hexapeptide.	**1**	
	(b)		isoleucine-leucine-glycine-valine-serine **OR** serine-valine-glycine-leucine-isoleucine.	**1**	
	(c)		Essential.	**1**	
	(d)	(i)	The peptide molecule: must have contained an amino acid that is repeated in the sequence **OR** contained only four different amino acids (accept four different peptides). **OR** The peptide contains two amino acids: with the same R_f value **OR** that moved the same distance.	**1**	
		(ii)		**1**	

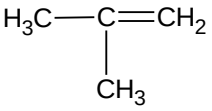
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>6.</td><td>(e)</td><td>(i)</td><td>  OR </td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>30 g – units required (2 marks)
Partial marks:
Correctly calculated mass of mushrooms without units, (1 mark)
Appropriate units (1 mark)
<table><tr><th>Mass (1)</th><th>Units (1)</th></tr><tr><td>0·03</td><td>kg</td></tr><tr><td>30</td><td>g</td></tr><tr><td>30000</td><td>mg</td></tr></table></td><td>2</td><td>If an incorrect mass is calculated but the units used are appropriate to the calculation then 1 mark would be awarded.

If the candidate has ended the calculation at the lethal dosage then the mark for units can be awarded if the unit is appropriate to the value calculated.

If the candidate’s working is unclear in terms of what is being worked out then the mark for units cannot be awarded.</td></tr>
</table>

Question			Answer	Max Mark	Additional Guidance
7.	(a)		Any reason from list UV light is damaging/harmful to skin. UV light causes sunburn. UV light can break bonds/molecules in skin. UV light damages collagen. UV light can cause skin cancer. UV light ages skin. UV light causes photo ageing. UV light creates free radicals/initiates free-radical chain reactions. Sunblocks contain free-radical scavengers.	**1**	
	(b)	(i)	Species (Atoms/molecules etc) with unpaired electrons.	**1**	
		(ii)	Initiation.	**1**	
		(iii)	Carboxylic acid **OR** carboxyl group.	**1**	
		(iv)	The hydroxyl/functional group is attached to a carbon that is attached to two other carbons **OR** The hydroxyl/functional group is attached to a carbon which has only one hydrogen attached.	**1**	The answer required is an answer based on structure not an answer based on a chemical property. ie, an answer stating it can be oxidised to give a ketone would not be awarded the mark.

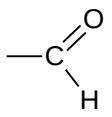
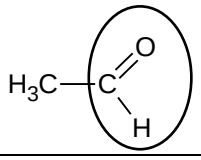
Question			Answer	Max Mark	Additional Guidance
7.	(c)	(i)	A correct structural formula for butyl ethanoate.	1	 ✓  X
		(ii)	To condense any vapours or reactants/products which evaporate **OR** To act as a condenser.	1	Must be indication that gases are being turned to liquid.
		(iii)	60·7/61 % **(2 marks)** **1 mark** Calculates theoretical mass = 4·78g **OR** correctly calculates no of moles reactant (0·054) and product (0·033) **1 mark** Calculating % yield using the actual and theoretical masses, or using the actual number of moles of products and actual number of moles of reactant.	2	Follow through applies.
		(iv)	Condensation **OR** Esterification.	1	

Question			Answer	Max Mark	Additional Guidance
8.	(a)	(i)	<table><tr><th></th><th>Temperature (High/Low)</th><th>Pressure (High/Low)</th></tr><tr><td>Step 1</td><td>High</td><td>Low</td></tr><tr><td>Step 2</td><td>Low</td><td>High</td></tr></table>	**2**	Temperature and pressure are dealt with separately as two single marks.
	(b)	(i)	Correct structure for 2-methylpropene.	**1**	 The name 2-methylpropene would be accepted on it's own. (on the basis that the candidate would have to process through the structure to obtain the name).
		(ii)	The proportion of the total mass of all starting materials successfully converted into the desired product is 100% **OR** All the atoms in the reactants are converted into the product you want./Mass of **product** is equal to mass of reactants **OR** No by-products/no waste products/ only one product is formed.	**1**	

Question			Answer	Max Mark	Additional Guidance
8	(c)		56 or + 56 **(2)** Bond breaking 412 + 412 + 412 + 360 + 463 = 2059 Bond forming 743 + 412 + 412 + 436 = 2003 2059 − 2003 = 56 ($kJ\,mol^{-1}$) A single mark is available if either of the following operations is correctly executed **Either** The five relevant values for the bond enthalpies of the C-H, H-H, C-O, O-H and C=O bonds (or multiples thereof) are retrieved from the data book 412,360,463,743,436 (ignore signs) **OR** If only four values are retrieved, the candidate recognises that bond breaking is endothermic and bond formation is exothermic and correctly manipulates the bond enthalpy values they have used to give their answer.	**2**	−56 would qualify for 1 mark. No units required but only one mark can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in any paper). kJ is acceptable in place of $kJ\,mol^{-1}$. If less than four bond enthalpy values are retrieved then no mark can be awarded.

Question			Answer	Max Mark	Additional Guidance
9.	(a)	(i)	4·93 (kJ) (no units required) **1 mark** for extrapolating the graph and finding the corrected temperature difference ΔT = 11·8 (^oC) **1 mark** for use of the relationship $E_h = cm\Delta T$ to calculate the E_h = 4·93 (kJ) Maximum of **1 mark** for using ΔT = 11·2 which gives E_h = 4·68 (kJ)	**2**	▫T 11·6 - 12·0 acceptable 11·6 ⟶ 4·85 11·7 ⟶ 4·89 11·8 ⟶ 4·93 11·9 ⟶ 4·97 12·0 ⟶ 5·02 ▫T follow through applies No units required but only one mark can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in any paper).
		(ii)	To prevent (minimise) heat loss to the surroundings **OR** polystyrene cup is a poor conductor of heat/insulator.	**1**	
		(iii)	52·5 (kJ or $kJmol^{-1}$)	**1**	accept −52·5 (kJ or kJ mol^{-1}). No units required. No mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
	(b)		−414 kJ mol^{-1} (no units required) Partial marks Treat as two concepts either would be acceptable for **1 mark** Evidence of understanding of reversal of first equation in order to achieve the target equation. Reversal of both equations would be taken as cancelling **OR** evidence of understanding of multiplying first equation by 2 in order to achieve the target equation.	**2**	No units required but only one mark can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in any paper).

Question			Answer	Max Mark	Additional Guidance
10.			This is an open ended question **1 mark:** The student has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood. **2 marks:** The student has demonstrated a reasonable understanding, at an appropriate level, of the chemistry involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding, at an appropriate level, of the chemistry involved. The student shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	Zero marks should be awarded if: The student has demonstrated no understanding of the chemistry involved. There is no evidence that the student has recognised the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the student merely restates the chemistry given in the question.

Question			Answer		Max Mark	Additional Guidance
11.	(a)	(i)	A drawing that shows a flask with a long narrow neck and a single gradation mark which goes completely across, or is labelled, on the narrow neck.		**1**	
		(ii)	Accurate method for volume measurement eg uses pipette **(1 mark)** Describes weighing by difference or using a tared balance. **(1 mark)**		**2**	Burette would be accepted. Syringe not accepted for measuring volume accurately.
		(iii)	All points plotted correctly within tolerance of ½ a box **(1 mark)** Best fit line **(1 mark)**		**2**	
		(iv)	(A)	The dissolved gas/bubbles will affect the density/mass/ volume of solution.	**1**	"The gas would affect the results" would not be enough to be awarded the mark.
			(B)	3·43%.	**1**	If a rounded answer is given there must be evidence of the equation being used.
		(v)	34·98 (g)/35·0 (g).		**1**	No units required. No mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
	(b)	(i)	Correctly drawn aldehyde group 		**1**	Functional group must show open bond. Aldehyde structures only acceptable if functional group is highlighted. 
		(ii)	$C_6H_{12}O_6 + H_2O \rightarrow C_6H_{12}O_7 + 2H + 2e$		**1**	
		(iii)	Blue to orange/(brick)red/brown/ yellow/green.		**1**	Blue-green is not acceptable as the original colour.

Question			Answer	Max Mark	Additional Guidance
11.	(b)	(iv)	0·0099 (mol l^{-1}) **(3 marks)** Partial marks can be awarded using a scheme of two 'concept' marks, and one 'arithmetic' mark. **1 mark** for knowledge of the relationship between moles, concentration and volume. This could be shown by any <u>one</u> of the following steps: • Calculation of number of moles of Cu^{2+} eg 0·025 × 0·0198 = 0·000495 • Calculation of conc of reducing sugars eg 0·0002475 ÷ 0·025 • Insertion of correct pairings of values of conc and volume in titration formula eg $\frac{0\cdot025\times19\cdot8}{n_1}=\frac{C_{RS}\times25\cdot0}{n_2}$ **1 mark** for knowledge of relationship between Cu^{2+} and reducing sugars. This could be shown by any <u>one</u> of the following steps: • Calculation of moles of reducing sugars from moles Cu^{2+} eg 0·000495 ÷ 2 = 0·0002475 • Insertion of correct stoichiometric values in titration formula e.g. $\frac{0\cdot025\times19\cdot8}{2}=\frac{C_{RS}\times25\cdot0}{1}$ **1 mark** is awarded for correct arithmetic throughout the calculation. This mark can only be awarded if both concept marks have been awarded.	**3**	No units required but only two marks can be awarded for correct answer if wrong unit is given. (wrong units would only be penalised once in any paper). 2 concept marks 1 mark for stoichiometric relationship being applied. 1 mark for correctly using n = c × v Candidates require to correctly apply relationship if used twice in their working. In terms of the mark for the stoichiometric relationship, the 1 should be associated with the unknown concentration of the sugar and the 2 with the with concentration of the Fehling's.

Question			Answer	Max Mark	Additional Guidance
12.	(a)	(i)	hydrogen bonding.	**1**	
		(ii)	(More) branching lowers the boiling point **(1 mark)** The shorter the alcohol, the lower the boiling point/The longer the carboxylic acid the lower the b.p. **OR** The nearer the ester link is to the right hand end (of the molecule) the higher the boiling point. **(1 mark)**	**2**	An answer relating to chain length must be specific to either the alcohol or carboxylic acid portion of the ester. Accept this positional trend if the candidate correctly identifies it by reference to the oxygen atom in the chain or the C=O but not if candidate refers to a carbonyl group.
		(iii)	Any temperature between 99 and 124 (°C) (data value 116°C)	**1**	No units required. No mark can be awarded if wrong unit is given. (wrong units would only be penalised once in any paper).
	(b)	(i)	Peaks labelled in order 2,3,1,4 $\longrightarrow$	**1**	
		(ii)	5.	**1**	

[END OF MARKING INSTRUCTIONS]