National
Qualifications

X813/76/12

Chemistry
Paper 1 — Multiple choice

Marking Instructions

Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.

Marking instructions for each question

Question	Response	Mark
1.	A	**1**
2.	D	**1**
3.	B	**1**
4.	A	**1**
5.	C	**1**
6.	C	**1**
7.	D	**1**
8.	B	**1**
9.	B	**1**
10.	C	**1**
11.	C	**1**
12.	B	**1**
13.	C	**1**
14.	B	**1**
15.	D	**1**
16.	A	**1**
17.	D	**1**
18.	B	**1**
19.	C	**1**
20.	D	**1**
21.	A	**1**
22.	B	**1**
23.	C	**1**
24.	A	**1**
25.	A	**1**

[END OF MARKING INSTRUCTIONS]

National
Qualifications

X813/76/01

Chemistry
Paper 2

Marking Instructions

Please note that these marking instructions have not been standardised based on candidate responses. You may therefore need to agree within your centre how to consistently mark an item if a candidate response is not covered by the marking instructions.

General marking principles for Higher Chemistry

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

(a) Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

(b) If a 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.

(c) Do not award half marks.

(d) Where a candidate makes an error at an early stage in a multi-stage calculation, award marks for correct follow-on working in subsequent stages, unless the error significantly reduces the complexity of the remaining stages. Apply the same principle for questions that 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.

(e) Unless a numerical question specifically requires evidence of working to be shown, award full marks for a correct final response (including units) on its own.

(f) Candidates may fully access larger mark allocations whether their responses are in continuous prose, linked statements, or a series of developed bullet points.

(g) Do not deduct marks 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', are acceptable.

(h) In many questions, the unit in which the answer is to be expressed is given. In these questions, the candidate does not need to state a unit in their answer; but if they do, the unit must be correct. The full mark allocation cannot be awarded if an incorrect unit is shown. In these questions, incorrect units would only be penalised once in any paper.

(i) If a correct response is followed by a wrong response, award no marks. **For example** in response to the question, 'State the colour seen when blue Fehling's solution is warmed with an aldehyde', do not award marks for the response 'red green'. However, if a correct response is followed by additional information which does not conflict with that, ignore the additional information, 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** gain marks.

(j) Award full marks for the correct response to a calculation without working. Award partial marks, as shown in the detailed marking instructions, when working is given but the final response is incorrect. An exception is when candidates are asked to 'Find, by calculation' - do not award full marks for the correct response without working.

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

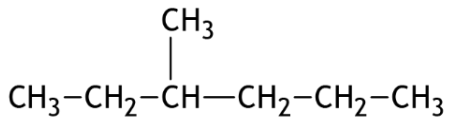
(l) Award marks for a symbol or correct formula in place of a name **unless stated otherwise in the detailed marking instructions.**

(m) When formulae of ionic compounds are given as responses, candidates only need 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, do not award marks.

(n) If an answer comes directly from the text of the question, do not award marks. **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. $C_3H_8(g) + 5O_2(g) = 3CO_2(g) + 4H_2O(\ell)$. Name the kind of enthalpy change that the student measured', do not award marks 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

- Award the full mark for '3, methyl-hexane', although the punctuation is not correct.

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.

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.

- Award the full mark for a response such as 'the more Cl_2, the stronger the acid', although not completely correct.

(p) Unless the question is clearly about a non-chemistry issue, for example costs in an industrial chemical process, do not award marks for a non-chemical response.
For example, in response to the question, 'Why does the (catalytic) converter have a honeycomb structure?', do not award a mark for 'To make it work'. This response may be correct but it is not a chemical response.

(q) Only award marks for a valid response to the question asked. Where candidates are asked to:

- **identify, name, give** or **state**, they must 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, for example '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 chemistry to a new situation. A number of responses are acceptable: award marks for any suggestions that are supported by knowledge and understanding of chemistry.
- **use their 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). Candidates gain marks for the breadth and/or depth of their conceptual understanding.
- **write**, they must complete a chemical or word equation, for example 'Write the word equation for the complete combustion of ethanol.'

Marking instructions for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)	(i)	Increases (across period)	**1**	
		(ii)	They don't form (covalent) bonds	**1**	Accept: They (noble gases) are unreactive. They are noble gases is not acceptable.
		(iii)	Screening increases so less attraction (of nucleus/protons for the bonding/outer/shared electrons**)** **OR** Covalent radius/atomic size/number of shells increases so less attraction (of nucleus/protons for the bonding/outer/shared electrons**)**	**1**	Shielding is acceptable in place of screening. 'Screening/shielding effect' by itself is not acceptable. Information in brackets is not required but if included, the direction of attraction must be correct.
	(b)	(i)	2·8 ± 0·05	**1**	
		(ii)	Cross at (2·1, 1·8) on graph **2 marks** **Partial mark** For calculation of both average electronegativity (2·1) and difference (1·8) **(1 mark)** **OR** For correctly plotting the point for the values candidate has calculated **(1 mark)**	**2**	A point other than (2·1, 1·8) plotted with no calculated values is worth 0 marks.
		(iii) A	$(Li^+)_2S^{2-}$ **Both** charges must be shown. Brackets are required for Li^+.	**1**	
		B	Carbon fluorine Sulfur fluorine Boron oxygen	**1**	Accept correct symbols. If candidate states name of a compound then it must be correct. Accept germanium and oxygen.
	(c)		Polar (covalent)	**1**	

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>2.</td><td>(a)</td><td>(i)</td><td>Graphite</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>Form of carbon</th><th>Strongest attraction broken</th></tr><tr><td>Diamond</td><td>covalent (network) bond(s) (1 mark)</td></tr><tr><td>fullerene</td><td>London dispersion forces (1 mark)</td></tr></table></td><td>2</td><td>Mention of molecular would cancel the mark for covalent bonds for diamond.

Accept LDFs for London dispersion forces.

Treat each mark separately.</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>12</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>45·81/45·8/46(%) (2 marks)

A partial mark can be awarded for any one of the following:

Correct use of atom economy relationship without correct use of stoichiometry (working must be shown). (1 mark)

OR

Correct working with no correct final answer. (1 mark)</td><td>2</td><td>No units required. Only 1 mark can be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).</td></tr>
</table>

Question			Expected response	Max mark	Additional guidance
2.	(c)		+250 kJ mol^{-1} **(2 marks)** Partial marks Treat as two concepts. **Either** would be acceptable for **1 mark.** Evidence of understanding of reversal of first and second enthalpy values must be seen ie +283 and +286 (or positive multiples of either/both). The third enthalpy value (regardless of value) must be negative, or this partial mark cannot be awarded. **OR** Evidence of understanding of multiplying the second enthalpy value by 3 (shown as 3 x +/-286 or +/- 858) Multiplication of any other enthalpy value by any factor is taken as cancelling of this partial mark.	**2**	If correct answer is shown, award 2 marks. **Only 1 concept mark can be awarded if the final answer is incorrect.** If answer given is -250, maximum of 1 mark can be awarded. No units required. Only 1 mark can be awarded for the 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} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted).

Question			Expected response	Max mark	Additional guidance
3.			**Award 1 mark** where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. **Award 2 marks** where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. **Award 3 marks** where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide 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. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 0** marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	**3**	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, 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			Expected response	Max mark	Additional guidance
4.	(a)		Bond enthalpy is high (945)/has the highest bond enthalpy value (in the data booklet)	**1**	(Bond(s)) take(s) a lot of energy to break/are very strong would not be accepted on its own but would not be cancelling.
	(b)		Diagram shows a workable method for removing carbon dioxide – must include label for KOH (solution) **(1 mark)** Diagram shows a workable method for passing gas over heated copper – must include label for heated copper **(1 mark)**	**2**	Treat each mark separately.

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>4.</td><td>(c)</td><td>(i)</td><td>2 marks for correct calculations AND 1 mark for a statement which follows on from the calculation stating that nitrogen is in excess or that lithium is the limiting reactant.

Partial marks

By calculating number of moles:

1 mark for the correct calculation of number of moles of Li and N_2.

1 mark for correct application of the mole ratio. This can be shown by dividing a calculated number of moles of Li by 6 or multiplying a number of moles of N_2 by 6.

1 mark awarded for a correct statement following on from the candidate's calculations.

OR

By proportion:

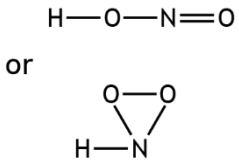
1 mark for 41·4 g $\rightarrow$ 24 litres

1 mark for follow through from incorrect multiples of 6·9g or 24 l

1 mark awarded for a correct statement following on from the candidate's calculations.</td><td>3</td><td>Correct calculation of moles of lithium = 0·07/0·072/0·0725 moles
and
nitrogen = 0·04/0·038/0·0375 moles

The values in the tables shown provide guidance as to whether 1 mark or 2 marks for calculations should be awarded.

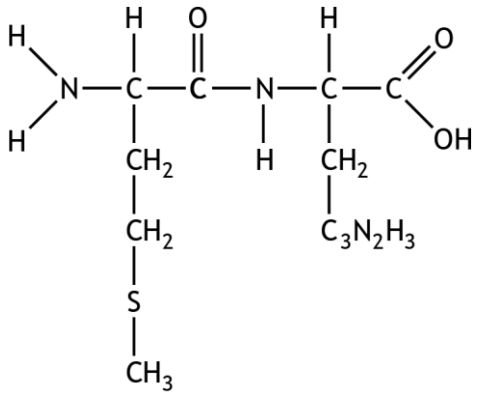
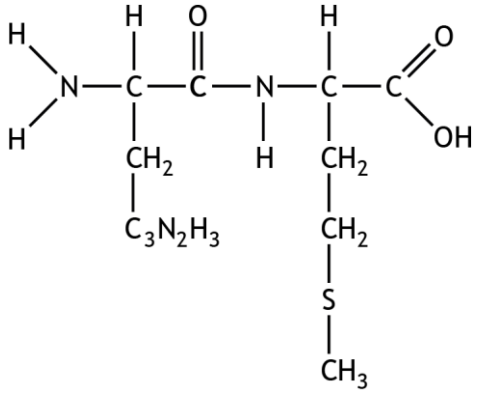
2 marks can be awarded for any one of the following paired values in the table obtained by applying the mole ratio
<table><tr><td>have</td><td>need</td></tr><tr><td>0·5 g Li</td><td>0·29 l N_2</td></tr><tr><td>0·9 l N_2</td><td>1·55 g Li</td></tr><tr><td>0·9 l N_2</td><td>0·29 l N_2</td></tr><tr><td>0·5 g Li</td><td>1·55 g Li</td></tr><tr><td>0·0725 mol Li</td><td>0·225 mol Li</td></tr><tr><td>0·0375 mol N_2</td><td>0·012 mol N_2</td></tr></table>
1 mark can be awarded for any one of the following paired values in the table obtained without applying mole ratio
<table><tr><td>have</td><td>need</td></tr><tr><td>0·5 g Li</td><td>1·74 l N_2</td></tr><tr><td>0·9 l N_2</td><td>0·26 g Li</td></tr><tr><td>0·9 l N_2</td><td>1·74 l N_2</td></tr><tr><td>0·5 g Li</td><td>0·26 g Li</td></tr></table>
This mark can only be awarded if the candidate shows appropriate calculations to justify the statement.</td></tr>
</table>

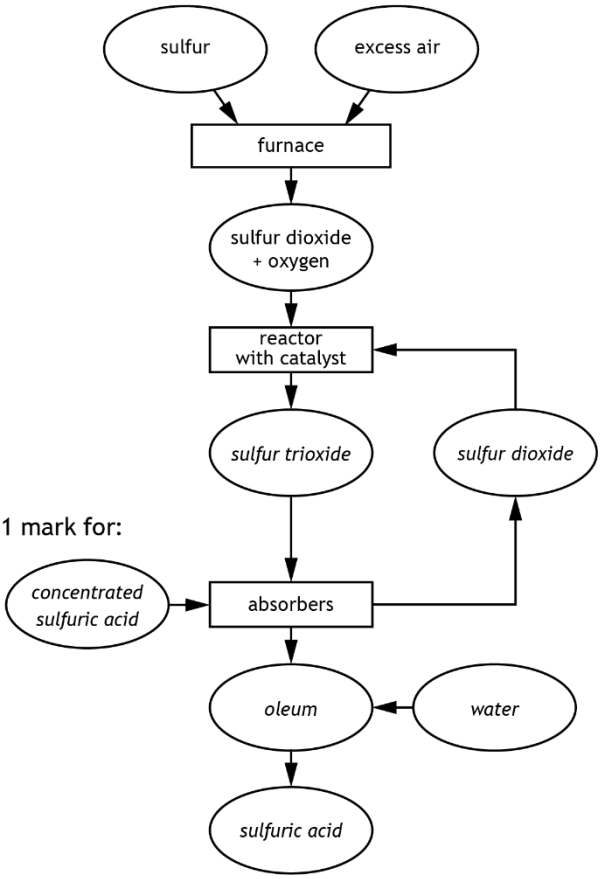
Question			Expected response	Max mark	Additional guidance
4.	(c)	(ii)	$Cu^{+}(aq) + e^{-} \rightarrow Cu(s)$	**1**	State symbols not required but if given must be correct. Accept electron without a negative sign.
		(iii)	(ionic) lattice/network	**1**	Covalent network is not acceptable
	(d)	(i)	atoms/molecules with an unpaired electron	**1**	
		(ii)	676 (kJ mol^{-1}) -676 would be worth **1 mark** Partial marking, **1 mark** can be awarded for candidate correctly retrieves both of the relevant bond enthalpy data (945, 498) and attempts to use this with 91 **OR** calculation carried out correctly with one error in retrieval of bond enthalpy	**2**	No units are required but award only 1 mark for correct answer if incorrect unit is given. (Wrong units would only be penalised once in any paper). kJ is acceptable in place of kJ mol^{-1} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted)
		(iii) A	termination	**1**	
		B	 or 	**1**	

Question			Expected response	Max mark	Additional guidance
4.	(e)	(i)	Decreasing temperature favours the exothermic reaction/increasing temperature favours endothermic reactions **(1 mark)** Increases the yield of ammonia **(1mark)**	**2**	
		(ii) A	$C_3H_5N_3O_9 \rightarrow$ $3CO_2 + 2½H_2O + 1½N_2 + ¼ O_2$ **OR** correct multiples	**1**	
		B	The shock/bump provides the activation energy/E_A **OR** the shock/bump provides **sufficient/enough** energy to start the reaction **OR** the reaction has a low activation energy/E_A	**1**	If candidate uses "it" in response, this can be taken as "the shock/bump".

Question			Expected response	Max mark	Additional guidance
5.	(a)		**1 mark** for any correct feature and explanation as shown: • Contains oxygen to ensure complete combustion • Sample is surrounded by water so all energy transferred/reduce heat loss to surroundings • Sealed container prevents/ reduces heat loss to the surroundings • Stirring to ensure accurate temperature (measurement)	**1**	
	(b)	(i)	-34 078 (kJ mol^{-1}) Partial marks **1 mark** for a demonstration of the correct use of the relationship $E_h = cm\Delta T$ as shown by (4·18 × (an order of magnitude of 0·775) × 11·9) (ignore units for this partial mark) **1 mark** for evidence of the knowledge that enthalpy of combustion relates to 1 mole, evidenced by the scaling up of a calculated value of energy released. **1 mark** for correct arithmetic. This mark should be awarded if the candidate has obtained the 2 partial marks above but has applied correct early rounding within the calculation resulting in an answer that differs from –34 078).	**3**	Maximum of 2 marks can be awarded if negative enthalpy sign is not shown in final answer. Units not required. Only 2 marks can be awarded for the 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} (KJ or Kj or KJ mol^{-1} or Kj mol^{-1} accepted).
		(ii)	0·71/0.713/0.7125	**1**	
	(c)	(i)	23·3	**1**	Ignore any units
		(ii)	Glycerol has 3 hydroxyl groups.	**1**	Accept glycerol is propan(e)-1,2,3-triol/an alcohol with 3 hydroxyl (-OH) groups

Question			Expected response	Max mark	Additional guidance
6.	(a)		<table><tr><th>Mass **(1 mark)**</th><th>Unit **(1 mark)**</th></tr><tr><td>0·00113</td><td>kg</td></tr><tr><td>1·13</td><td>g</td></tr><tr><td>1130</td><td>mg</td></tr></table> Any correct line in the table (2 marks) Correctly calculated mass of iodine without units **(1)** Appropriate units **(1)**	**2**	As no unit is specified, the correct answer can be expressed with any appropriate unit (as shown in table). Any correct rounding accepted e.g. 1·1278/1·128/1·13 g Partial mark for appropriate units can only be awarded when the order of magnitude of an incorrectly calculated mass matches the unit. If the candidate's working is unclear then the mark for units cannot be awarded.
	(b)	(i)	Measuring the mass of container + seaweed/sample and subtracting the mass of the container	**1**	Taring the balance with container and then adding the seaweed/ sample is accepted "use of Tare function" on its own is not accepted.
		(ii)	I^-/iodide (ions)	**1**	
		(iii)	A solution of accurately/exactly/ precisely known concentration	**1**	
		(iv) A	0·00013 (moles)	**1**	Units not required, but if present, must be correct. Wrong units are only penalised once per paper.
		B	0·03299g/0·033 g/0·03 (g)	**1**	To award this mark, the candidates answer to part **B must** be correct for their use of their answer to part **A** (i.e. answer to part A x 253·8). Units not required, but if present, must be correct. Wrong units are only penalised once per paper.

Question			Expected response	Max mark	Additional guidance
6.	(c)	(i)	Amino acid that must be acquired/obtained from the diet.	**1**	Amino acid that cannot be made by the body is accepted.
		(ii)	Correctly drawn structure for dipeptide.  **OR** 	**1**	Shortened structural formula accepted. All atoms and bonds must be present as shown. However, **in the side chains only**, bonds drawn from C (or S) to H (or N) would not be penalised.

Question			Expected response	Max mark	Additional guidance
7.	(a)		1 mark for:  1 mark for:	**2**	1 mark for correct top half (4 responses) and 1 mark for correct bottom half (4 responses). Accept correct chemical formula in place of names. Accept "air" for "excess air".

<table>
<tr><th colspan="3">Question</th><th>Expected response</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>7.</td><td>(b)</td><td></td><td>Require heat to be removed (to prevent the temperature from rising).</td><td>1</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>1 mark for description of LDFs as forces of attraction between temporary dipoles (and induced dipoles)

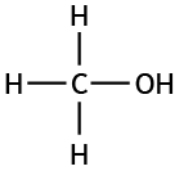
1 mark for an explanation of the cause of temporary dipoles in terms of uneven distribution of electrons/ electron wobble/movement of electrons in the molecule</td><td>2</td><td>Attraction involving permanent dipoles cancels this mark</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>1 mark
Sulfur/S has more electrons than oxygen/O

1 mark
These forces are stronger due to sulfur structure being S_8 whereas oxygen is O_2</td><td>2</td><td>The structure of S_8 and O_2 must be evidenced in answer (molecular formula, structural formula) for the second mark to be awarded.

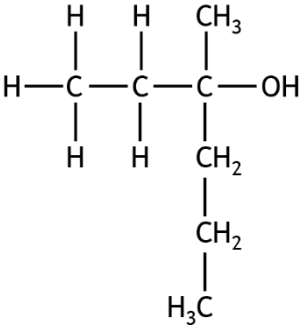
Correctly calculated number of electrons (16, 128) would also be evidence of structure.</td></tr>
<tr><td></td><td>(d)</td><td></td><td><table><tr><th>Effect of catalyst on enthalpy change</th><th>Effect of catalyst on activation energy</th></tr><tr><td>Increase
stay the same
decrease</td><td>increase
stay the same
decrease</td></tr></table></td><td>1</td><td></td></tr>
<tr><td></td><td>(e)</td><td>(i)</td><td>Do not form scum.</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Both parts of molecule must be described.

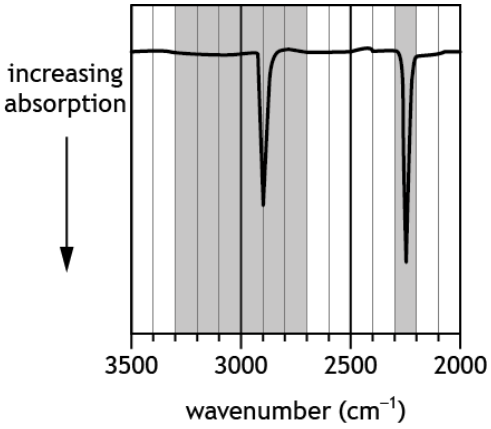
<table><tr><th>Head</th><th>Tail</th></tr><tr><td>Hydrophilic</td><td>Hydrophobic</td></tr><tr><td>Polar</td><td>Non-polar</td></tr><tr><td>Ionic</td><td>Non-polar</td></tr><tr><td>Water soluble</td><td>Fat soluble</td></tr></table>
Any term to describe the head from the table can be used with any term from the table to describe the tail.</td><td>1</td><td>If answer mentions head and/or tail, then it must be correct ie head is hydrophilic.</td></tr>
</table>

Question			Expected response	Max mark	Additional guidance
8.	(a)	(i)	pentyl ethanoate	**1**	
		(ii)	condensation/esterification	**1**	
	(b)	(i)	Carbon dioxide is (relatively) insoluble/has very low solubility	**1**	
		(ii)	0·029 (g) **2 marks** Partial marks Correctly calculated number of moles of carbon dioxide divided by 3 to give number of moles of citric acid e.g. moles of citric acid = 0·00076 **(1 mark)** Calculated number of moles of citric acid x 192 divided by 5 **(1 mark)** **OR** by proportion 192 g → 72 l (1 mark) 0·147 *g* → 0·055 l 0·147/5 = 0·029 (g) **(1 mark)** Allow follow through from incorrect multiple of 24 l	**2**	Units not required, but if present, must be correct. Wrong units are only penalised once per paper. Allow follow through from incorrect application of mole ratio or correct mole ratio applied to incorrectly calculated number of moles of CO_2
	(c)	(i) A	orange to green/blue-green/ blue	**1**	
		B	Tollens' reagent **OR** Fehling's solution	**1**	Benedict's/ Schiff's reagent would be accepted.
		(ii)	2	**1**	
		(iii)	1 pence/ £0·01 (2 marks) Partial marks 1 mark can be awarded for: cost per mg of vanillin = £0·00105 **OR** cost per g of vanillin = £1·05 **OR** cost of 0·184 g of vanillin = £0·1932 **OR** mass of vanillin needed = 0·0092 g	**2**	Candidates final answer must be in a correct monetary number.

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	1·575/1·58/1·6(g)	**1**	Units not required. 0 marks should be awarded for the correct answer if wrong unit is given. (Wrong units would only be penalised once in any paper).
		(ii)	Protein(s)	**1**	
		(iii)	pipette and burette	**1**	Volumetric flask would not be taken as cancelling.
	(b)		essential oils	**1**	
	(c)	(i)	2-methylbuta-1,3-diene	**1**	
		(ii)	ketone	**1**	accept terpenoids
	(d)	(i)	methanol	**1**	A correct structure would also be accepted 
		(ii)	79·24/79·2/79 (%) (2 marks) Partial marking for **1 mark** Theoretical yield = 31·17 (g) **OR** Allow follow through from incorrect calculation of theoretical yield.	**2**	Units not required, but if present, must be correct. Wrong units are only penalised once per paper. Rounding of a calculated theoretical yield to 31 g gives 77·68/79·7/80 (%) which would be accepted.
		(iii)	6·5 (cm^3) Partial marking for **1 mark** For correct calculation of toxic dose = 9·1 g **OR** For calculation of the volume of oil of wintergreen containing 0·14 g of methyl salicylate = 0·1 cm^3	**2**	Units not required. Only 1 mark can be awarded for the correct answer if wrong unit is given. Wrong units would only be penalised once in any paper. Allow follow from incorrect first step of candidate's calculation.

Question			Expected response	Max mark	Additional guidance
10.			**Award 1 mark** where the candidate has demonstrated, at an appropriate level, a limited understanding of the chemistry involved. They have made some statement(s) which are relevant to the situation, showing that they have understood at least a little of the chemistry within the problem. **Award 2 marks** where the candidate has demonstrated, at an appropriate level, a reasonable understanding of the chemistry involved. They make some statement(s) which are relevant to the situation, showing that they have understood the problem. **Award 3 marks** where the candidate has demonstrated, at an appropriate level, a good understanding of the chemistry involved. They show a good comprehension of the chemistry of the situation and provide 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. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 0** marks where the candidate has not demonstrated, at an appropriate level, an understanding of the chemistry involved. There is no evidence that they have recognised the area of chemistry involved, or they have not given any statement of a relevant chemistry principle. Award this mark also if the candidate merely restates the chemistry given in the question.	**3**	Zero marks should be awarded if: The student has demonstrated, at an appropriate level, 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			Expected response	Max mark	Additional guidance
11.	(a)	(i)	Reactants/solvent is flammable/ catches fire with a flame	**1**	accept products
		(ii)	condenser	**1**	
	(b)	(i)	addition	**1**	
		(ii)	2-methylbutan-2-ol	**1**	
		(iii)	A correct structural formula for 3-methylhexan-3-ol e.g. a full structural formula or a shortened structural formula	**1**	A mixture of full and shortened structural formula is accepted, e.g. 

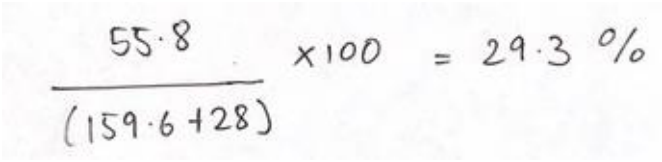
Question			Expected response	Max mark	Additional guidance
12.	(a)		Poly(phenylethene)	**1**	
	(b)		C=O circled	**1**	accept 'C=O stretch'
	(c)		2 single absorptions (peaks) required 1 for C-H within the range 2700-3300 cm^{-1} and 1 for C≡N within the range 2260-2215 cm^{-1}  	**1**	Ignore the intensity of the absorptions. Ignore the width of the absorptions so long as the peak maximum is defined and within the given range.

[END OF MARKING INSTRUCTIONS]

Exemplification of Marking Instructions

Exemplification of Question 2 b

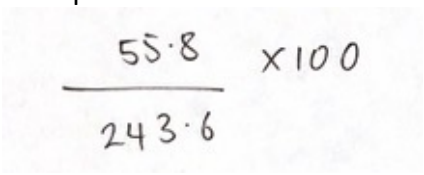
Example 1



1 mark

1 mark for correct use of atom economy relationship

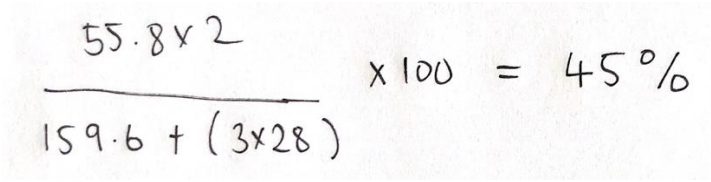
Example 2



1 mark

1 mark for correct working shown with no final answer

Example 3

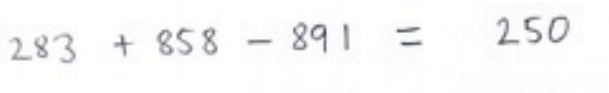


1 mark

1 mark for correct working with wrong final answer

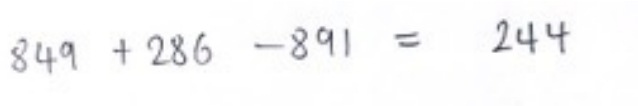
Exemplification of Question 2 c

Example 1



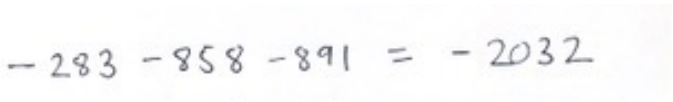
2 marks

Example 2



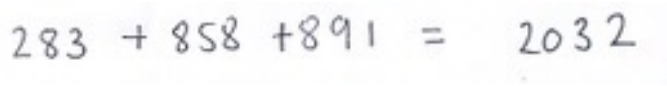
1 mark
1 mark for evidence of reversing first and second equation

Example 3



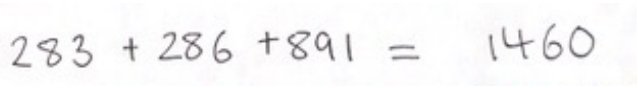
1 mark
1 mark for evidence of multiplying second equation by 3

Example 4



1 mark
1 mark for evidence of multiplying second equation by 3

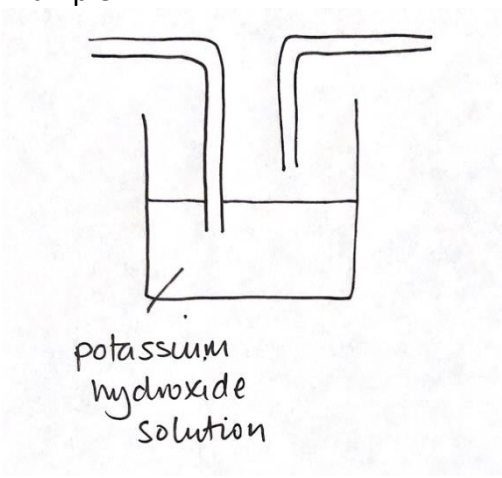
Example 5



0 marks
Reversal of first and second equation cancelled by reversal of third equation

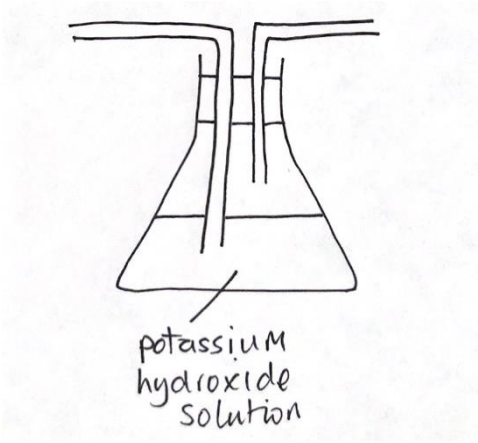
Exemplification of Question 4 b

Example 1



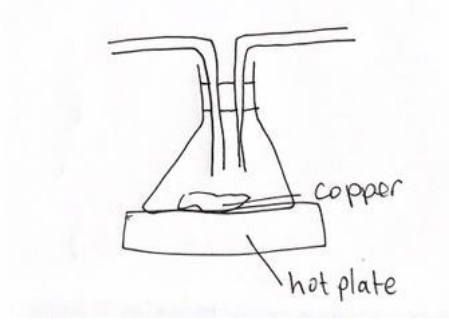
0 marks
no top on container, not workable for gas collection

Example 2



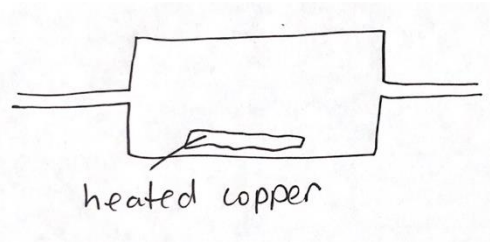
1 mark

Example 3



1 mark

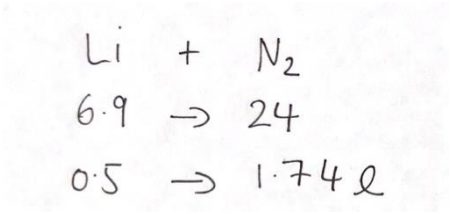
Example 4



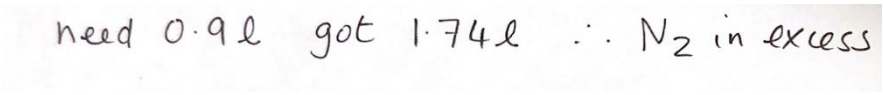
1 mark

Exemplification of Question 4 c i

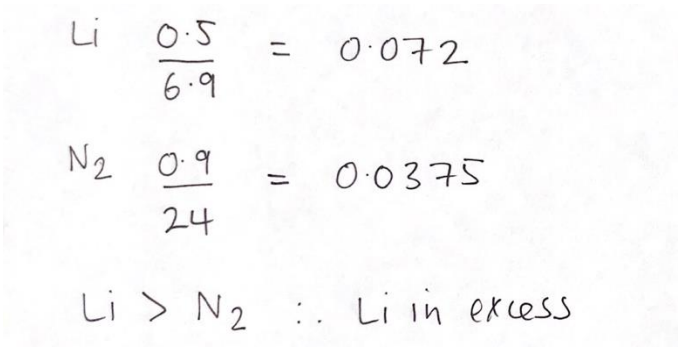
Example 1



0 marks
Statement incorrect

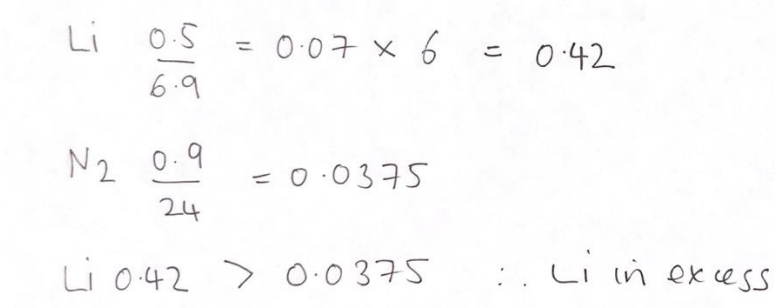


Example 2



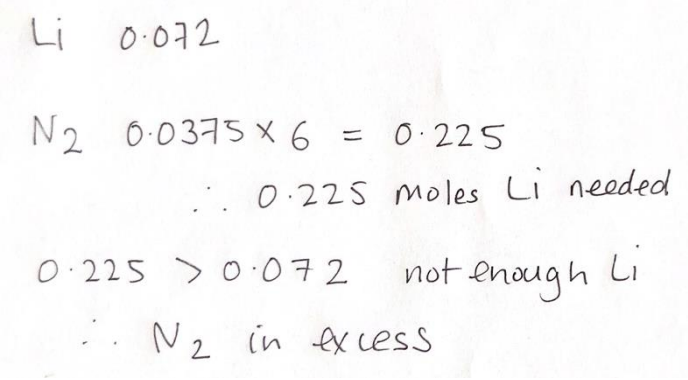
1 mark
1 mark for correct calculation of number of moles of Li and N_2

Example 3



1 mark
1 mark for correct calculation of number of moles of Li and N_2

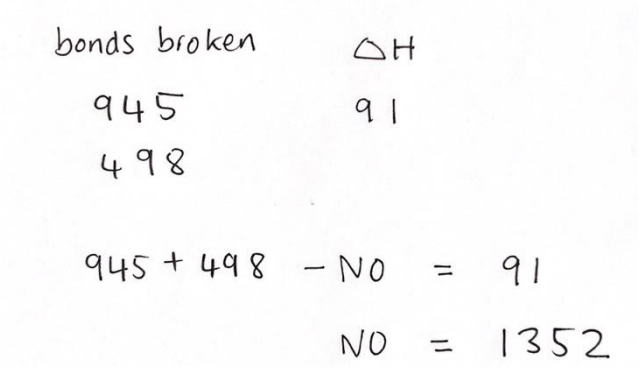
Example 4



3 marks
1 mark for correct calculation of number of moles of Li and N_2
1 mark for correct use of mole ratio
1 mark for correct statement of excess

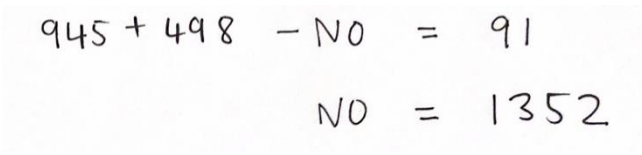
Exemplification of Question 4 d ii

Example 1



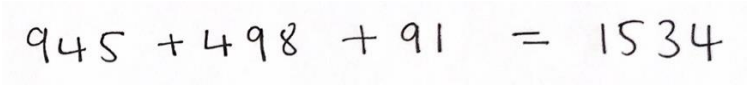
1 mark
1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 2



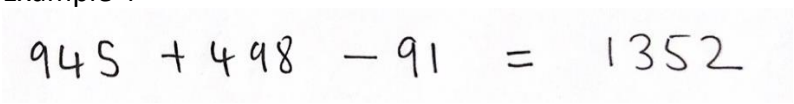
1 mark
1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 3



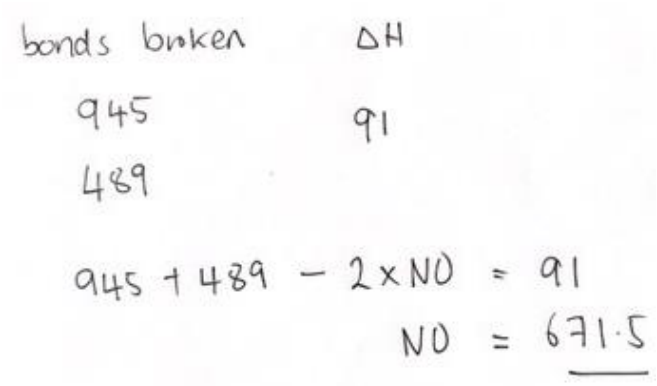
1 mark
1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

Example 4



1 mark
1 mark for correct retrieval of bond enthalpy data and use of this with the reaction enthalpy change

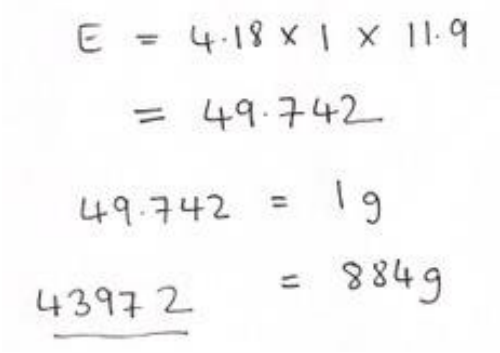
Example 5



1 mark
1 mark for correct calculation with 1 error in the bond enthalpies retrieved (489 for 498))

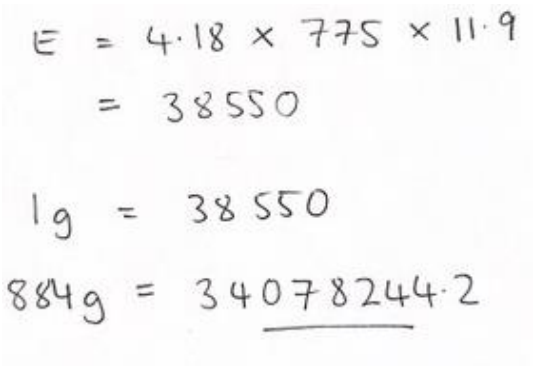
Exemplification of Question 5 b ii

Example 1



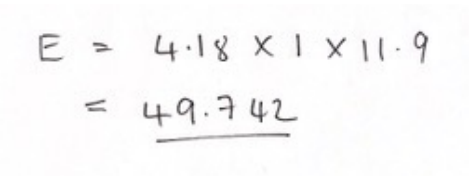
1 mark
1 mark for evidence of knowledge that enthalpy of combustion relates to 1 mole

Example 2



2 marks
1 mark for demonstration of correct use of $E_h = cm\Delta T$
1 mark for evidence of knowledge that enthalpy of combustion relates to 1 mole

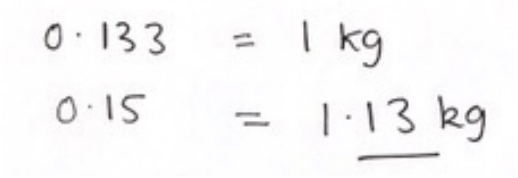
Example 3



0 marks

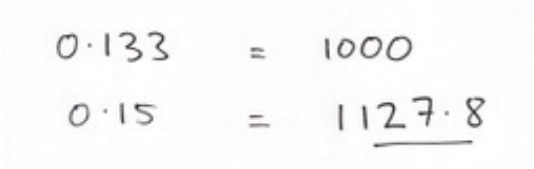
Exemplification of Question 6 a

Example 1



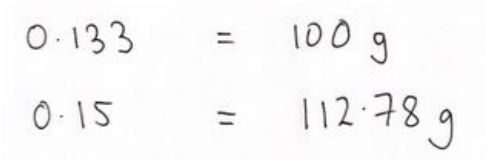
1 mark
1 mark for correct calculated mass of iodine

Example 2



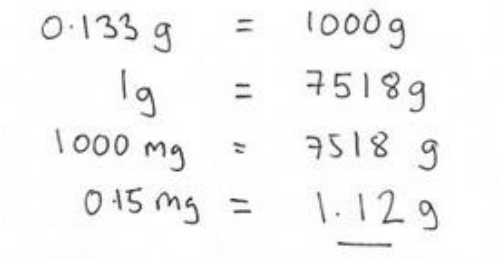
1 mark
1 mark for correct calculated mass of iodine

Example 3



1 mark
1 mark for correct calculated mass of iodine

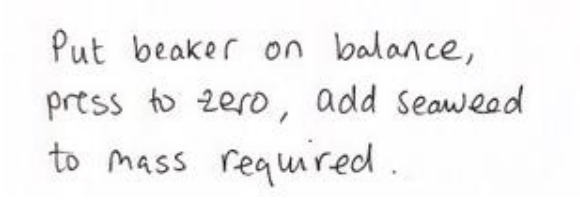
Example 4



1 mark
1 mark for correct unit for incorrectly rounded calculated mass

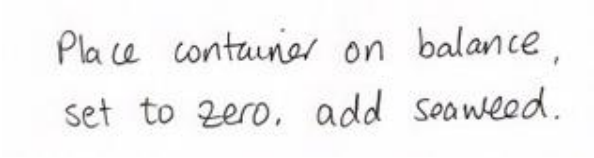
Exemplification of Question 6 b i

Example 1



1 mark

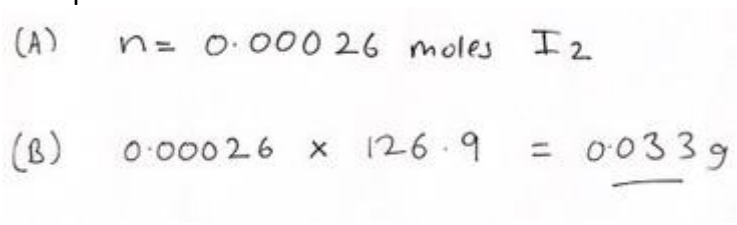
Example 2



1 mark

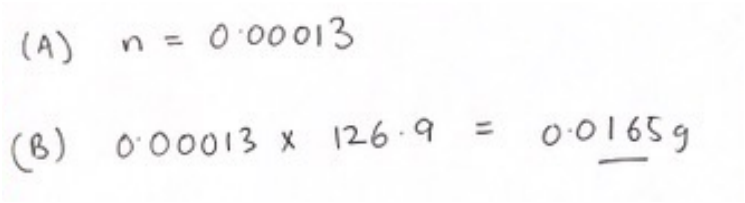
Exemplification of Question 6 b iv

Example 1



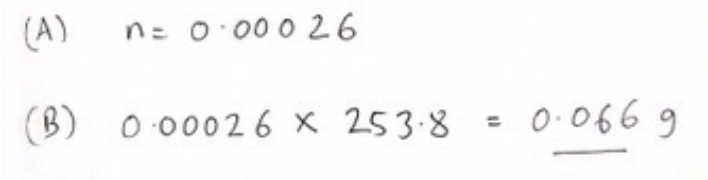
Part A **0 marks**
Part B **0 marks** Incorrect answer for candidates answer to Part A as incorrect GFM for iodine used

Example 2



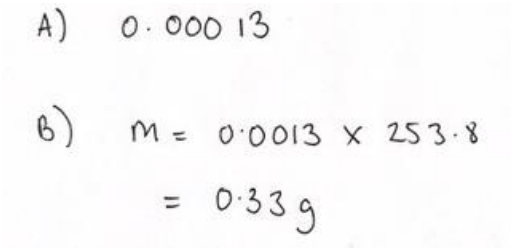
Part A **1 mark**
Part B **0 marks** Incorrect GFM for iodine used

Example 3



Part A **0 marks**
Part B **1 mark** for follow through from Part A

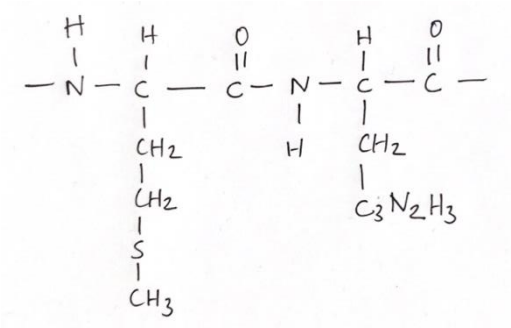
Example 4



Part A **1 mark**
Part B **0 marks** Incorrect number of moles used

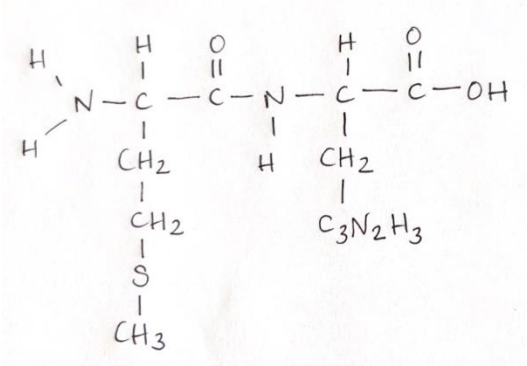
<u>Exemplification of Question 6 c</u>

Example 1



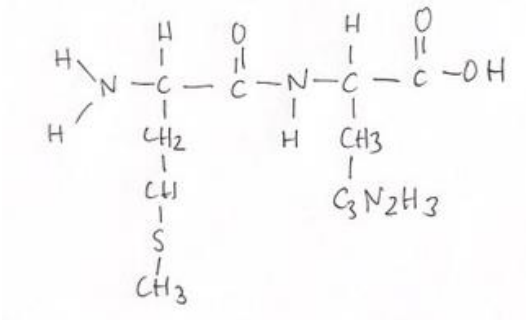
0 marks
End bonds not acceptable for dipeptide

Example 2



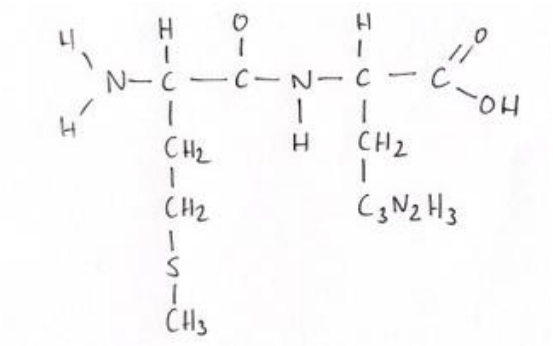
1 marks
Incorrect connection of bonds in side chains not penalised

Example 3



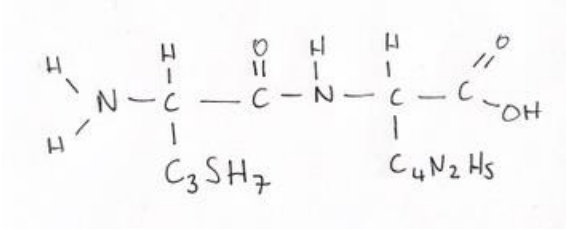
0 marks
Number of Hs in side chains incorrect

Example 4



0 marks
Missing bond in the C=O in amide link

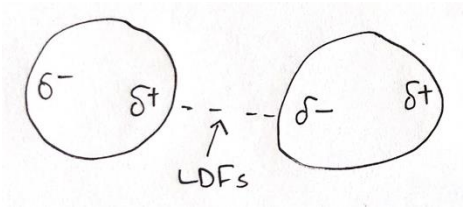
Example 5



1 mark

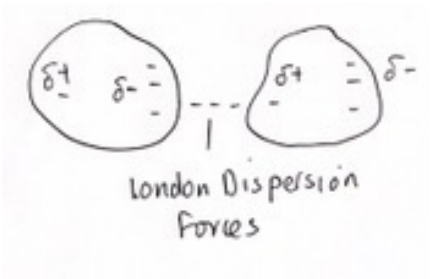
Exemplification of Question 7 c i

Example 1



1 mark

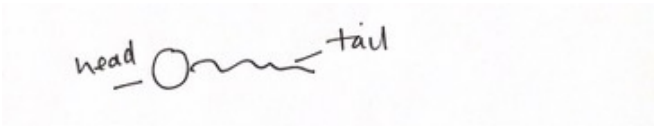
Example 2



1 mark

Exemplification of Question 7 e ii

Example 1



0 marks

Example 2

The head is polar and the tail is fat soluble.

1 mark

Example 3

The tail dissolves in water and the head dissolves in oil.

0 marks

Example 4

One part is hydrophobic and one part is ionic.

1 mark

Exemplification of Question 8 b ii

Example 1

CO_2 $\frac{55}{24}$ = 2.29 moles

1 → 3

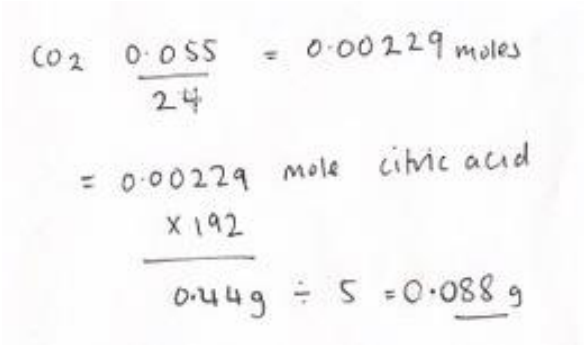
0.76 ← 2.29

mass = 0.76 × 192 = 146.67 g

÷ 5 = 29.3 g

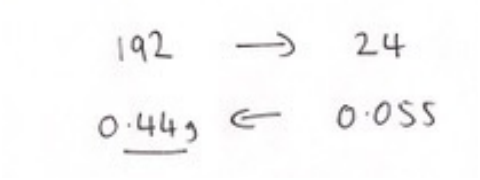
1 mark
1 mark for calculated number of moles x 192 divided by 5

Example 2



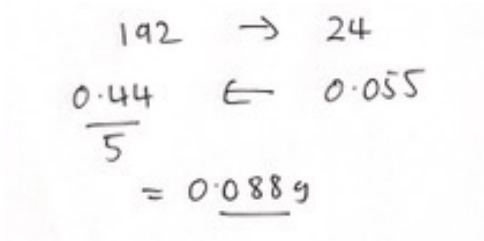
1 mark
1 mark for calculated number of moles x 192 divided by 5

Example 3



0 marks

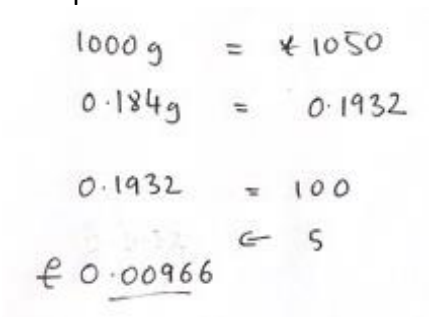
Example 4



1 mark
1 mark for calculation without applying mole ratio

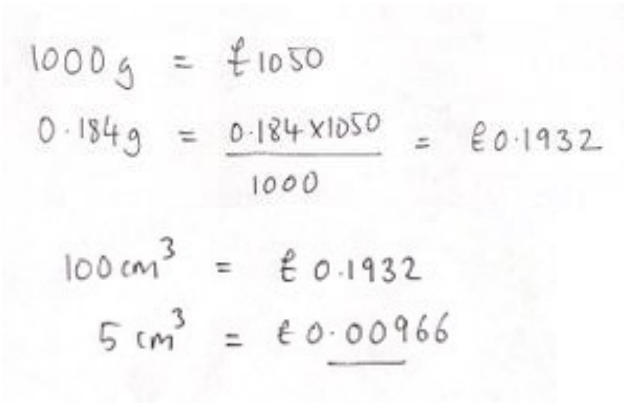
<u>Exemplification of Question 8 c iii</u>

Example 1



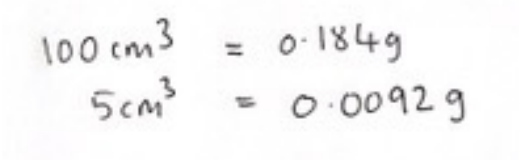
1 mark
1 mark for calculation with answer not rounded for a monetary unit

Example 2



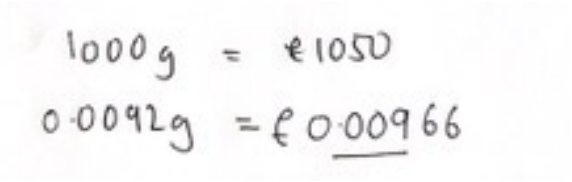
1 mark
1 mark awarded for calculation of £0.1932 as step in calculation with incorrect final answer

Example 3



1 mark

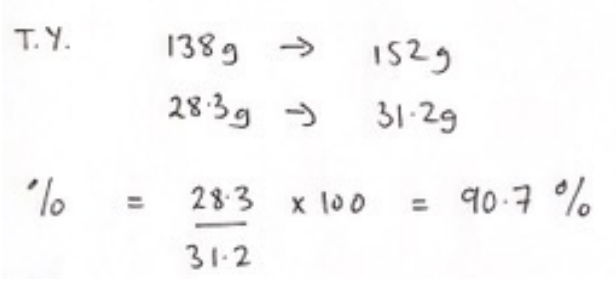
Example 4



1 mark
1 mark awarded for calculation with answer not rounded for a monetary unit

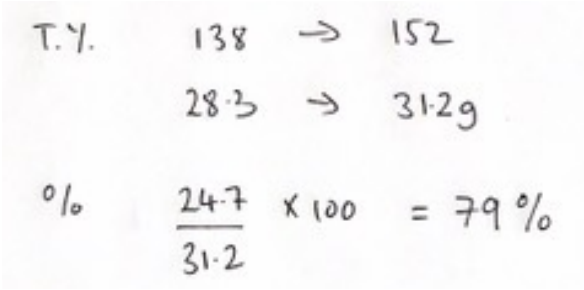
Exemplification of Question 9 d ii

Example 1



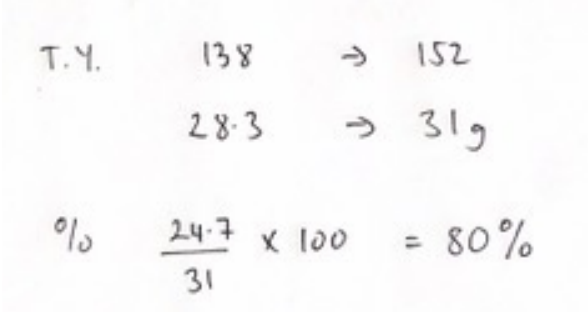
1 mark
1 mark for correct theoretical yield

Example 2



2 marks

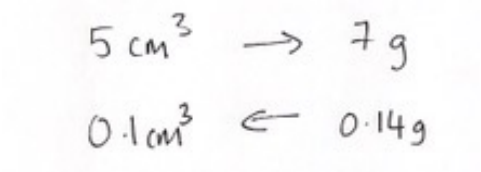
Example 3



2 marks
Correct early rounding of theoretical yield to 31 gives 79.67/79.7/80 %

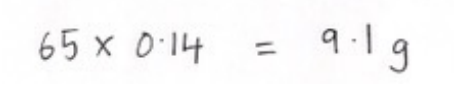
Exemplification of Question 9 d iii

Example 1



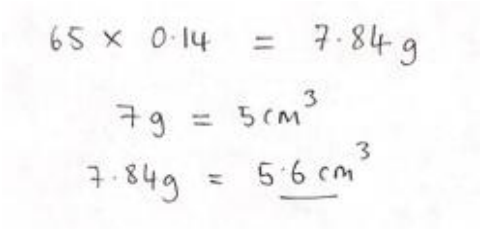
1 mark

Example 2



1 mark

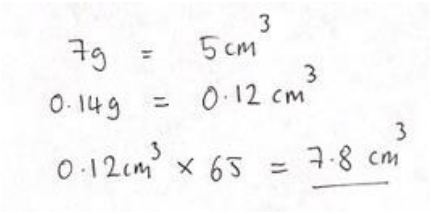
Example 3



1 mark

1 mark for follow through from incorrect first step of calculation

Example 4



1 mark

1 mark for follow through from incorrect first step of calculation

2021 Higher Chemistry Question Paper breakdown

This document provides the structure of the 2021 questions in Paper 1 and Paper 2 by Key Area; Knowledge/Skill; intended grade A marks.

Paper 1

Question	Key Area of Course	Question Type	Grade A
1	General practical techniques	Planning or designing experiments	
2	Periodicity	Applying knowledge to new situations, interpreting, solving problems	
3	Intermolecular forces	Applying knowledge to new situations, interpreting, solving problems	
4	Oxidising and reducing agents	Knowledge and understanding - making statements	1
5	Intermolecular forces	Applying knowledge to new situations, interpreting, solving problems	
6	Periodicity	Applying knowledge to new situations, interpreting, solving problems	
7	Systematic carbon chemistry	Applying knowledge to new situations, interpreting, solving problems	
8	Carboxylic acids	Applying knowledge to new situations, interpreting, solving problems	
9	Oxidation of food	Applying knowledge to new situations, interpreting, solving problems	
10	Oxidation of food	Applying knowledge to new situations, interpreting, solving problems	
11	Carboxylic acids	Applying knowledge to new situations, interpreting, solving problems	
12	Proteins	Knowledge and understanding - making statements	
13	Periodicity	Applying knowledge to new situations, interpreting, solving problems	
14	Oxidation of food	Applying knowledge to new situations, interpreting, solving problems	
15	Skin care	Knowledge and understanding - making statements	
16	Collision theory	Applying knowledge to new situations, interpreting, solving problems	
17	Collision theory	Processing information (using calculations and units)	
18	Reaction pathways	Applying knowledge to new situations, interpreting, solving problems	1
19	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	
20	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	1
21	Equilibria	Drawing conclusions and giving explanations	1
22	Volumetric analysis	Applying knowledge to new situations, interpreting, solving problems	1
23	Chromatography	Drawing conclusions and giving explanations	
24	General practical techniques	Making predictions and generalisations	
25	Equilibria	Applying knowledge to new situations, interpreting, solving problems	1

Paper 2

Question	Area of Course	Question Type	Grade A
1(a)(i)	Periodicity	Knowledge and understanding - making statements	
1(a)(ii)	Periodicity	Applying knowledge to new situations, interpreting, solving problems	
1(a)(iii)	Periodicity	Knowledge and understanding - descriptions and explanations	
1(b)(i)	Non-specific	Selecting information	
1(b)(ii)	Types of chemical bond	Applying knowledge to new situations, interpreting, solving problems	
1(b)(iii)(A)	Types of chemical bond	Processing information (incl. calculations)	
1 b (iii)(B)	Non-specific	Processing information (incl. calculations)	
1(c)	Types of chemical bond	Applying knowledge to new situations, interpreting, solving problems	
2(a)(i)	Periodicity	Knowledge and understanding - making statements	
2(a)(ii)	Types of chemical bond; Intermolecular forces	Knowledge and understanding - making statements	
2(a)(iii)	Systematic carbon chemistry	Processing information (incl. calculations)	
2(b)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	
2(c)	Chemical energy	Applying knowledge to new situations, interpreting, solving problems	
3	Collision theory	Knowledge and understanding - descriptions and explanations	2
4(a)	Chemical energy	Knowledge and understanding - descriptions and explanations	
4(b)	General practical techniques	Planning or designing experiments	1
4(c)(i)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	1
4(c)(ii)	Oxidising and reducing agents	Applying knowledge to new situations, interpreting, solving problems	
4(c)(iii)	Types of chemical bonds	Knowledge and understanding - making statements	
4(d)(i)	Skin care	Knowledge and understanding - making statements	
4(d)(ii)	Chemical energy	Applying knowledge to new situations, interpreting, solving problems	1
4(d)(iii)(A)	Skin care	Knowledge and understanding - making statements	
4(d)(iii)(B)	Non-specific	Processing information (incl. calculations)	1

4(e)(i)	Equilibria	Knowledge and understanding - descriptions and explanations	
4(e)(ii)(A)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	1
4(e)(ii)(B)	Reaction pathways	Applying knowledge to new situations, interpreting, solving problems	1
5(a)	General practical techniques	Suggesting improvements to experimental procedures	
5(b)(i)	Chemical energy	Applying knowledge to new situations, interpreting, solving problems	1
5(b)(ii)	Getting the most from reactants	Processing information (incl. calculations)	
5(c)(i)	Esters, fats and oils	Making predictions and generalisations	
5(c)(ii)	Esters, fats and oils	Knowledge and understanding - descriptions and explanations	
6(a)	Non-specific	Processing information (incl. calculations)	
6(b)(i)	General practical techniques	Planning or designing experiments	
6(b)(ii)	Oxidising and reducing agents	Applying knowledge to new situations, interpreting, solving problems	
6(b)(iii)	General practical techniques	Knowledge and understanding - making statements	
6(b)(iv)(A)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	
6(b)(iv)(B)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	
6(c)(i)	Proteins	Knowledge and understanding - making statements	
6(c)(ii)	Proteins	Applying knowledge to new situations, interpreting, solving problems	1
7(a)	Getting the most from reactants	Selecting information	
7(b)	Chemical energy	Knowledge and understanding - descriptions and explanations	1
7(c)(i)	Intermolecular forces	Knowledge and understanding - descriptions and explanations	1
7(c)(ii)	Periodicity, Intermolecular forces	Knowledge and understanding - descriptions and explanations	1
7(d)	Reaction pathways	Knowledge and understanding - making statements	
7(e)(i)	Soaps, detergents and emulsions	Knowledge and understanding - descriptions and explanations	
7(e)(ii)	Soaps, detergents and emulsions	Knowledge and understanding - descriptions and explanations	
8(a)(i)	Esters, fats and oils	Applying knowledge to new situations, interpreting, solving problems	
8(a)(ii)	Esters, fats and oils	Knowledge and understanding - making statements	
8(b)(i)	General practical techniques	Applying knowledge to new situations, interpreting, solving problems	
8(b)(ii)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	1

8(c)(i)(A)	Oxidation of food	Knowledge and understanding - making statements	
8(c)(i)(B)	Oxidation of food	Applying knowledge to new situations, interpreting, solving problems	
8(c)(ii)	Fragrances	Applying knowledge to new situations, interpreting, solving problems	
8(c)(iii)	Non-specific	Processing information (incl. calculations)	
9(a)(i)	Non-specific	Knowledge and understanding - making statements	
9(a)(ii)	Proteins	Knowledge and understanding - making statements	
9(a)(iii)	Common chemical apparatus	Planning or designing experiments	
9(b)	Fragrances	Knowledge and understanding - making statements	
9(c)(i)	Fragrances	Knowledge and understanding - making statements	1
9(c)(ii)	Oxidation of food	Applying knowledge to new situations, interpreting, solving problems	
9(d)(i)	Esters, fats and oils	Applying knowledge to new situations, interpreting, solving problems	
9(d)(ii)	Getting the most from reactants	Applying knowledge to new situations, interpreting, solving problems	
9(d)(iii)	Non-specific	Processing information (incl. calculations)	
10	Intermolecular forces; Esters, fats and oils; Proteins	Knowledge and understanding - descriptions and explanations; Applying knowledge to new situations, interpreting, solving problems	2
11(a)(i)	General practical techniques	Applying knowledge to new situations, interpreting, solving problems	
11(a)(ii)	Common chemical apparatus	Knowledge and understanding - making statements	1
11(b)(i)	Systematic carbon chemistry	Applying knowledge to new situations, interpreting, solving problems	
11(b)(ii)	Alcohols	Applying knowledge to new situations, interpreting, solving problems	
11(b)(iii)	Oxidation of food	Processing information (incl. calculations)	1
12(a)	Non-specific	Making predictions and generalisations	
12(b)	Systematic carbon chemistry	Processing information (incl. calculations)	
12(c)	Systematic carbon chemistry	Presenting information appropriately in a variety of forms	1