Pearson

Mark Scheme (Results)

November 2021

Pearson Edexcel GCSE
In Chemistry (1CH0) Paper 2H

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response
- Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.

Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.

When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

Assessment Objective		**Command Word**	
Strand	**Element**	**Describe**	**Explain**
AO1*		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

*there will be situations where an AO1 question will include elements of recall of knowledge directly from the specification (up to a maximum of 15%). These will be identified by an asterisk in the mark scheme.

Paper 2H Higher Tier

Question number	Answer	Additional guidance	Mark
1(a)	smallest - sodium atom ethene molecule starch molecule largest - nanoparticle (2)	Any 3 particles in correct order (1)	**(2)** **AO1**

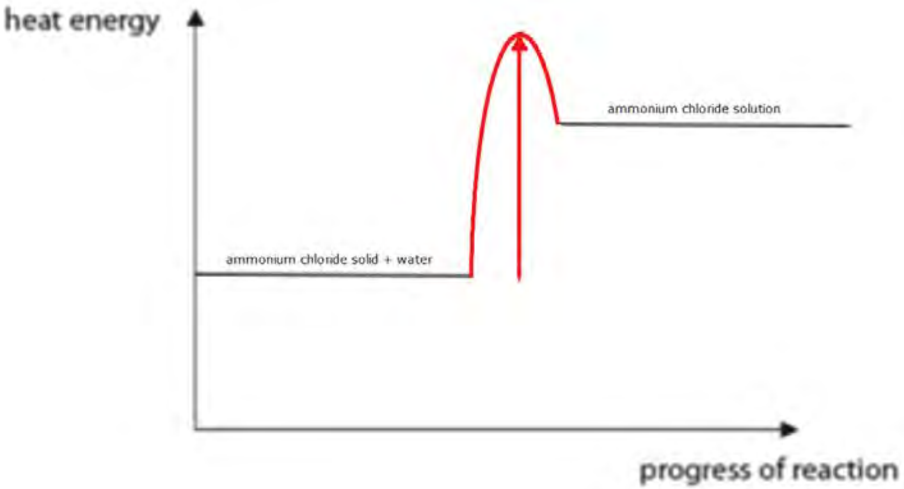
Question number	Answer	Additional guidance	Mark
1(b)	An explanation linking two from • do not know the risks fully / long term risk not yet known (1) • because they have not been used for a long time / are new technology / no long term research (1) • might pass into the body / through cell membranes / enter the skin / enter the bloodstream (1) • could {change / catalyse} reactions in body (1)	allow 'cause a change'	**(2)** **AO1**

Question number	Answer		Mark
1(c)	An explanation linking two from • catalyst particles have much larger surface area (when made from nanoparticles) (1) • leads to increased reaction rate (1)		**(2)** **AO1**

Total for Question 1 = 6 marks

Question number	Answer	Additional guidance	Mark
2(a)	46.25 / 46 with or without working scores 2 marks $\frac{200}{1000}$ (1)= 0.200 (dm^3) $\frac{9.25}{0.200}$ (1) = 46.25 / 46 OR $\frac{9.25}{200}$ = (0.04625) (1) 0.04625 x 1000 = 46.25 (1)	answer to 2 or more sig fig	**(2) AO2**

Question number	Answer	Additional guidance	Mark
2(b)(i)	an explanation linking two of: • {ammonium chloride solution/product} has more energy than {ammonium chloride solid and water/reactant} / ora (1) • heat (energy) has increased / energy change is positive (1) • (therefore) heat energy has been {absorbed/taken in} (1)	ignore arguments about bond making / bond breaking	**(2) AO3**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	 (2)	curve from reactants to products with peak higher than product energy (1) arrow labelled activation energy on correct curve (1)	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
2(c)	An explanation linking • ammonium chloride solution conducts electricity and solid ammonium chloride does not conduct electricity (1) • ammonium chloride contains **ions** (1) • in solution **ions** can move / in solid **ions** cannot move (1)	Answer must refer to both solid and solution for full marks	**(3)** **AO3**

Total for Question 2 = 9 marks

Question number	Answer	Mark
3(a)	**fractional** distillation / fractionation (1)	(1) AO1

Question number	Answer	Mark
3(b)	**C** they have the same general formula **A**, **B** and **D** not correct as compounds in homologous series have different chemical, empirical and molecular formulae.	(1) AO1

Question number	Answer	Additional guidance	Mark
3(c)	$N_2 + 2O_2 \rightarrow 2NO_2$ (2) or NO_2 (1)	other incorrect balancing max 1	(2) AO2

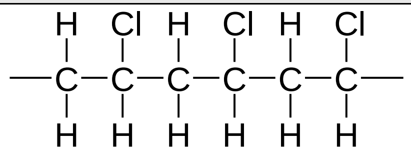
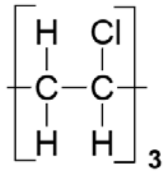
Question number	Answer	Additional guidance	Mark
3(d)	An explanation linking • {carbon dioxide / water} produced (1) • (the gases) absorb heat radiated from earth (1) • re-radiate heat back into the atmosphere (1)	 allow formula allow traps the heat	(3)

Total for Question 3 = 7 marks

Question number	Answer	Additional guidance	Mark
4(a)(i)	Any one from • need to sort polymers into different types • polymers often need to be separated from other polymers • takes time to sort by hand • containers may need to be washed before recycling • difficult to break down into their monomers • some not recyclable • requires a lot of energy		**(1) AO1**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	A description to include • polymers persist in landfill / landfill site fills up too quickly • polymers degrade very slowly or • combustion produces gases • which may be toxic	accept polymers persist in the environment / harmful to wildlife not biodegradable / hard to decompose	**(2) AO1**

Question number	Answer	Additional guidance	Mark
4(b)(i)	circle around C=C	or circle around C-Cl	**(1) AO1**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	 (3)	chain containing 6 C atoms (1) single bonds between C atoms (1) rest of structure complete (1) allow alternative arrangements allow max 2 for 	**(3)** **AO2**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	addition (polymer)		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
4(b)(iv)	relative formula mass C_2H_3Cl = 62.5 (1) 2850 x 62.5 (1) (=178125) 178000 (to 3 sig figs) (1)	without working 178000 (3) 178125 /178127 (2) allow TE on incorrect relative formula mass answer to 3 sig fig from calculation (1) (stand alone mark)	**(3)** **AO2**

Total for Question 4 = 11 marks

Question number	Answer	Mark
5(a)	**C** 63 °C Is the only answer. **A** would be a gas at room temperature **B** would be a liquid at room temperature **D** alkali metals have low melting points – this is too high	**(1)** **AO1**

Question number	Answer	Mark
5(b)	An explanation linking • number of electrons on outer shell gives the group number / 1 electron on outer shell so group 1 (1) • number of electron shells gives the period number / 4 electron shells so period 4 (1)	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
5(c)(i)	A description to include • use of **glowing** splint (1) • (glowing splint) relights (1)	2nd mark dependent on correct test	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
5(c)(ii)	potassium ion: 2.8.8 (1) oxide ion: 2.8 (1)	Allow other separators between the numbers including spaces	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
5(d)	A plan to include • heating tube where zinc is (1) • pass {gas / air} over (heated) zinc (1) • until no further change in volume (1) • measuring volume of gas after experiment / calculate difference in volume (1)		**(4)** **AO3**

Total for Question 5 = 11 marks

Question number	Answer	Mark
6(a)	**B** $CaCO_3$ is the only correct answer **A**, **C** and **D** are incorrect formulae	(1) AO1

Question number	Answer	Mark
6(b)	diagram of • delivery tube with bung in flask connected to (1) • gas syringe / gas syringe labelled (1) or • delivery tube with bung in flask leading into water trough (below upturned measuring cylinder) (1) • upturned measuring cylinder containing water / measuring cylinder labelled (1) allow • connected delivery tube from flask to upturned test tube in water trough (1)	(2) AO1

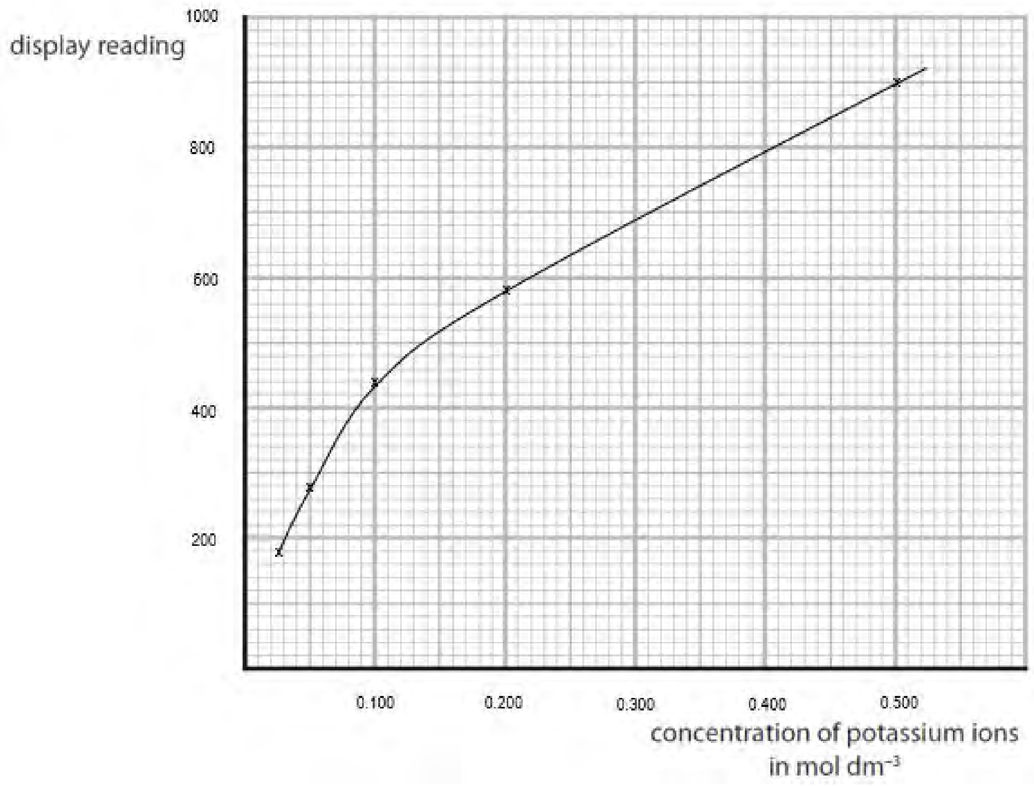
Question number	Answer	Additional guidance	Mark
6(c)(i)	conical flask in water bath [could be shown on diagram]	Reject heat with a Bunsen burner warm water alone is not enough.	(1) AO3

Question number	Answer	Mark
6(c)(ii)	Using tangent drawn on graph eg $\frac{\text{vertical difference}}{\text{horizontal difference}}$ $\frac{(100 - 52)}{180}$ (1) (1) (= 0.267) ($cm^3\ s^{-1}$) calculation will depend on final graph 2 marks for rate being within a range eg 0.250 – 0.290 1 mark for rate being in range 0.230 – 0.249 or 0.291 – 0.310	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
6(c)(iii)	particle size / concentration of acid / volume of acid / mass of calcium carbonate	allow marble chips for calcium carbonate allow amount of calcium carbonate ignore size of container	**(1)** **AO1**

Question number	Answer	Mark
6(c)(iv)	An explanation linking • fewer successful collisions (between acid and calcium carbonate particles) / fewer collisions with activation energy (1) and any two from • (because) decreasing temperature (of the acid) particles have lower energy (1) • (because) the particles move slower (1) • (so) rate of reaction decreases (1)	**(3)** **AO1**

Total for Question 6 = 10 marks

Question number	Answer	Additional guidance	Mark
7(a)(i)		suitable scale on axes using more than half axis in both directions (1) correctly plotted points (1) best fit curve (1)	**(3)** **AO2**

Question number	Answer	Mark
7(a)(ii)	reading of concentration from graph (1) (about 0.070 - 0.080 mol dm^{-3})	**(1)** **AO3**

Question number	Answer	Additional guidance	Mark
7(b)	$Ag^{+} + Cl^{-} \rightarrow AgCl$ (2)	$Ag^{+} + Cl^{-} \rightarrow$ (1) $\rightarrow AgCl$ (1) allow (1) max for equation with no ionic charges	**(2)** **AO2**

Question number	Indicative content	Mark
7(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. • ions present – NH_4^{+}, Fe^{2+}, SO_4^{2-} • dissolve solid in (distilled / deionised) water • add drops of sodium hydroxide solution • green / grey-green / dirty green • precipitate shows Fe^{2+} ion • precipitate is iron(II) hydroxide • $Fe^{2+} + 2OH^{-} \rightarrow Fe(OH)_2$ • warm mixture of salt solution and sodium hydroxide solution • hold damp (red litmus / universal / pH indicator) paper **above** mixture • indicator paper turns (blue / purple) • test shows ammonia gas formed • ammonia gas comes from NH_4^{+} ions present • $NH_4^{+} + OH^{-} \rightarrow NH_3 + H_2O$ • to second portion of salt solution add drops of dilute hydrochloric acid • add drops of barium chloride solution (or lead nitrate solution) • white • precipitate forms • precipitate is barium sulfate (or lead sulfate) • Ba^{2+}(or Pb^{2+}) + $SO_4^{2-} \rightarrow$ Ba(or Pb)SO_4	**(6)** **AO1** **AO2**

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> • names an ion present in the compound or • attempts test to identify an ion	<u>Possible candidate responses</u> • Ion present in compound NH_4^+ / Fe^{2+} / SO_4^{2-} • Adds compound to water (to make a solution) • Adds sodium hydroxide solution to solution of compound • Adds barium chloride solution to solution of compound
Level 2	3–4	<u>Additional guidance</u> • names at least two ions present And • describes at least one test to identify one of those ions – with positive result	<u>Possible candidate responses</u> • Adds sodium hydroxide solution to solution of compound - green ppt shows Fe^{2+} ion present or • adds dilute hydrochloric acid and barium chloride solution to solution of compound - white ppt shows SO_4^{2-} ion present or • adds sodium hydroxide solution to solution of compound and warms gently - pungent gas given which turns damp universal indicator purple shows presence of NH_4^+
Level 3	5–6	<u>Additional guidance</u> • Identifies all 3 ions And • Describes at least two tests for those ions – with positive results And • Suitable equations for at least two tests of ions	<u>Possible candidate responses</u> • adds sodium hydroxide solution to solution of compound - green ppt shows Fe^{2+} ion present • $Fe^{2+} + 2\,OH^- \rightarrow Fe(OH)_2$ • adds dilute hydrochloric acid and barium chloride solution to solution of compound - white ppt shows SO_4^{2-} ion present • $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ • adds sodium hydroxide solution to solution of compound and warms gently - pungent gas given which turns damp universal indicator purple shows presence of NH_4^+ ions in compound • $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Total for Question 7 = 12 marks

Question number	Answer	Mark
8(a)	**D** iodine: dark-grey solid bromine: red-brown liquid Is the only correct answer **A**, **B** and **C** all contain at least one incorrect piece of information	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
8(b)	Formula mass $POCl_3$ = (31+16+3x35.5) (1) (= 153.5) % Cl = $\frac{3\text{x}35.5}{153.5}$ x 100 (1) (= 69.4%)	allow answers to 2 or more sig figs allow ecf on formula mass allow % Cl = $\frac{35.5}{82.5}$ x 100 = 43% (1)	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
8(c)	mass of chlorine = 19.05 – 8.40 (1) (= 10.65 g) **EITHER** moles iron = $\frac{8.40}{56}$ (= 0.15) and moles chlorine = $\frac{10.65}{35.5 \times 2}$ (= 0.15) (1) ratio 1:1 so equation **A** represents reaction (1) **OR** moles iron = $\frac{8.40}{56}$ (=0.15) and moles chlorine atoms = $\frac{10.65}{35.5}$ (=0.30) (1) Ratio 1:2 for formula of product $FeCl_2$ so equation **A** (1) **OR** formula mass $FeCl_2$ = 56 + 2x35.5 (=127) (1) moles Fe = $\frac{8.4}{56}$ (=0.15) and moles $FeCl_2$ = $\frac{19.05}{127}$ (=0.15) (1) ratio 1:1 so equation **A** represents reaction (1)	allow not finding mass of chlorine initially: moles iron = $\frac{8.40}{56}$ (=0.15) and moles chlorine atoms = $\frac{19.05}{35.5}$ (=0.537) (1) simplest ratio: $\frac{0.15}{0.15}$: $\frac{0.537}{0.15}$ or 1 : 3.58 allow: mass of chlorine = 19.05 – 8.40 (1) (= 10.65 g) for reaction A, mass of chlorine needed $\frac{2 \times 35.5}{56} \times 8.4$ = 10.65 (g) (1) mass of chlorine needed = mass of chlorine reacted,so equation **A** represents reaction (1) accept calculations based on expected mass of $FeCl_2$ or mass of $FeCl_3$ to show which reaction is taking place	**(3)** **AO3**

Question number	Indicative content	Mark
8(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. • group 1 metals form positive ions • outer electron lost • further down the group outer electron more easily lost • due to electron shell further from nucleus OR greater electron shielding • so lower nuclear attraction • group 1 metal becomes more reactive • order of reactivity Li < K < Rb • group 7 elements form negative ions • gains electron to complete outer shell • further down the group electron is less easily gained • due to outer electron shell further from nucleus OR greater electron shielding • so lower nuclear attraction • group 7 element becomes less reactive • order of reactivity F > Br > I • most reactive pair likely to be potassium + fluorine with suitable justification (K low in group 1 and F is at the top of group 7) • allow rubidium +iodine with justification (Rb lower in group 1 than K and so more reactive)	**(6)** **AO1** **AO2**

Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> States some simple facts about group 1 OR group 7 elements OR Correctly identifies most violent reaction(s) with simple reasoning	<u>Possible candidate responses</u> • Group 1 elements lose 1 electron from outer shell. • Group 7 elements are more reactive up the group. • The most violent reaction could be potassium with fluorine as fluorine is the most reactive group 7 element (2)
Level 2	3–4	<u>Additional guidance</u> Correctly identifies most violent reaction(s) with a simple justification OR A simple explanation of the reactivity of group 1 AND group 7 elements. OR A detailed explanation of the reactivity of group 1 OR group 7 elements.	<u>Possible candidate responses</u> • The most violent reaction could be rubidium with iodine as rubidium is the most reactive of the group 1 elements given. Rubidium is so reactive because it loses its outer electron easily. • Group 1 elements are more reactive down the group as the distance between the nucleus and the outer electron is further, so the force of attraction between them is weaker and the electron is more easily lost. • Fluorine is the most reactive halogen because its outer electron shell is closer to the nucleus. Group 1 elements are more reactive down the group as their outer shell gets further from the nucleus.
Level 3	5–6	<u>Additional guidance</u> Correctly identifies the most violent reaction with a detailed justification. OR A detailed explanation of the reactivity of group 1 AND group 7 elements.	<u>Possible candidate responses</u> • The most violent reaction is potassium and fluorine as fluorine is the most reactive element in group 7. Potassium loses its outer electron easily as there is a weak nuclear attraction, and fluorine gains this electron easily as it has a strong nuclear attraction. • Group 1 elements become more reactive down the group. They lose 1 electron to form cations and the larger the distance between the nucleus and the outer shell, the more easily the electron is lost. Group 7 elements gain 1 electron to form anions and the smaller elements gain this electron more easily. This is because the force between the nucleus and the outer shell is stronger.

Level	**Mark**	**Descriptor**
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Total for Question 8 = 12 marks

Question number	Answer	Mark
9(a)(i)	An explanation linking • insufficient oxygen (1) • to oxidise all carbon to carbon dioxide (1)	**(2)** **AO1**

Question number	Answer	Mark
9(a)(ii)	An explanation linking • carbon monoxide reacts with {haemoglobin (in blood) / blood / red blood cells} (1) • stops oxygen being carried by {haemoglobin / blood / red blood cells} / so less oxygen reaches brain (1)	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
9(b)	C_2H_4	Allow H_4C_2	**(1)** **AO2**

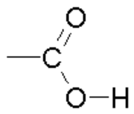
Question number	Answer	Additional guidance	Mark
9(c)	bonds broken = C=C + O-H = 612 + 464 (1) (= 1076 (kJ mol^{-1})) bonds formed = C-C + C-O + C-H = 347 + 358 + 413 (1) (= 1118 (kJ mol^{-1})) energy change of reaction = 1076 – 1118 (1) = - (1) (42 (kJ mol^{-1}))	answer of - 42 (kJ mol^{-1}) scores 4 marks answer of (+) 42 (kJ mol^{-1}) scores 3 marks bonds broken = C=C + C-C + 6 C-H + 2 O-H = 612 + 347 + 6x413 + 2x464 (1) (= 4365 (kJ mol^{-1})) bonds formed = 2C-C + 7C-H + C-O + O-H = 2x347 + 7x413 + 358 + 464 (1) (= 4407 (kJ mol^{-1})) Energy change = 4365 – 4407 (1) = - (1) (42 (kJ mol^{-1}))	**(4)** **AO2**

Question number	Answer	Mark
9(d)	An explanation to include • water vapour forms during combustion (1) • (water vapour) condenses on cold surface (1)	**(2)** **AO2**

Total for Question 9 = 11 marks

Question number	Answer	Mark
10(a)(i)	**B** propanol is dehydrated is the only answer Reaction **B** involves loss of water, **A**, **C** and **D** do not involve loss of water	**(1)** **AO1**

Question number	Answer	Mark
10(a)(ii)	An explanation linking • bromine water is yellow (1) • with compound **X**, yellow colour remains / no change of colour (1) • with compound **Y**, bromine water turns colourless (1) or • bromine water and compound **X** – no change in colour of bromine water (1) • bromine water and compound **Y** – bromine water changes from yellow (1) to colourless (1)	**(3)** **AO2**

Question number	Answer	Mark
10(a)(iii)	**C**  is the only answer. **A**, **B** and **D** are not correct	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
10(a)(iv)	Any suitable reaction and result such as • add a piece of magnesium ribbon (1) • bubbles of gas form (1) • add a (metal) carbonate (1) • bubbles of gas form (1) • add a metal oxide and warm (1) • metal oxide reacts to form a solution (1) • measure pH (1) • pH less than 7 (1) • add an alkali (1) • a neutral solution produced (1)	ignore add any metal but allow MP2 ignore using other indicators	(2) AO3

Question number	Answer	Mark
10(b)	moles of sucrose = $\frac{\underline{\text{moles of ethanol}}}{4}$ (1) (= $\frac{26.9}{4 \times 46}$ = 0.146) mass of sucrose = $\frac{\underline{\text{moles of ethanol}}}{4}$ x 342 (1) (= $\frac{26.9 \times 342}{4 \times 46}$ = 49.999 g) allow 50 g for 2 marks	(2) AO2

Question number	Answer	Mark
10(c)	moles sucrose = $\frac{10.0}{342}$ (1) (=0.029) number of atoms = $\underline{10.0}$ x 45 x 6.02 x 10^{23} (1)	(2) AO2

	342 (= 7.92×10^{23})	

Total for Question 10 = 11 marks