Mark Scheme
(Results)

November 2021

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

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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.

1CH0/1H 2106 Paper 1 Higher Tier

Question number	Answer	Additional guidance	Mark
1(a)	• heat remaining solid/ heat it for longer / heat it again (1) • and determine mass (1) • repeat until mass after heating stays the same (1)	allow heat to a constant mass (3) allow remove sample (1) add acid (1) no fizz (1)	**(3)** **AO3**

Question number	Answer	Additional guidance	Mark
1(b)	$\frac{1.63}{1.86}$ (1) (= 0.876) 0.876 x 100 (1) (= 87.6 (%))	award full marks for correct final answer without working allow 2 or more sig figs MP2 depends on MP1	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
1(c)	blue flame: hot(test) / very hot (1) lid: to stop {zinc oxide/ product} escaping (1)		**(2)** **AO2**

(Total for question 1 = 7 marks)

Question number	Answer	Additional guidance	Mark
2(a)	Any two from (in modern model) • atoms are formed of sub-atomic particles (1) • atoms have a nucleus (1) • atoms contain protons (1) • atoms contain neutrons (1) • atoms contain (shells of) **electrons** (1) • atoms of same element can have different numbers of neutrons / isotopes exist (1)	allow (for Dalton's model) atoms are indivisible ignore statements that are simply the negative of those in the question reject each comparison with 'plum pudding model'	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
2(b)	molecular formula: C_2H_4 (1) empirical formula: CH_2 (1)	allow H_4C_2 allow H_2C allow use of small letter / superscripts / non-subscripts	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
2(c)(i)	$Cl_2(g) + H_2O(l) \rightleftharpoons HCl(aq) + HClO(aq)$ (3)	all three formulae (only) on correct sides of equation with no incorrect balancing (2) two formulae correct regardless of any other error (1) all three state symbols (1) Do not allow incorrect symbols or non subscripts eg CL^2	**(3)** **AO2**

Question number	Answer	Additional guidance	Mark
2(c)(ii)	H^+	if any other ions included 0 marks	**(1) AO1**

Question number	Answer	Additional guidance	Mark
2(c)(iii)	neutralisation	allow exothermic reject endothermic	**(1) AO1**

(Total for question 2 = 9 marks)

Question number	Answer	Mark
3(a)	**C** the impurities are harmless **C** is the only correct answer. **A**, **B** and **D** are incorrect as the properties are not relevant	**(1)** **AO2**

Question number	Answer	Mark
3(b)(i)	**C** the impurities in the waste water settle to the bottom of their container **C** is the only correct answer. **A**, **B** and **D** are incorrect because no sediment is formed	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	to remove {insoluble substances / solids}	allow named solid substances eg sand ignore materials removed by initial screening eg twigs, debris etc ignore to produce clean/pure water reject remove bacteria	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	to kill {bacteria / microorganisms}	ignore to cleanse, purify, clean, make safe allow to remove bacteria / germs	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
3(c)	An answer including • best amount of **A** is 150 (mg) (1) • 150 mg **A** removes more than 100 (mg) **B** (1) • so it is better to use salt **A** than salt **B** (1) OR • because (at peak activity) **B** removes a higher percentage per gram than **A** (1) • so less salt would be needed / more efficient (1) • so it is better to use salt **B** than salt **A** (1) OR • 150 mg of A removes 48% impurities • 100 mg of B removes 44% impurities • so salt **A** is better (than salt **B)** as more impurities are removed (1) OR • 100 mg of A removes 40% impurities • 100 mg of B removes 44% impurities • so salt B is better (than salt A**)** as more impurities are removed for same mass of salt (1)	ignore incorrect units of mass allow so salt B is more effective in smaller quantities	**(3)** **AO3**

Question number	Answer	Additional guidance	Mark
3(d)	Al^{3+} + PO_4^{3-} → $AlPO_4$ (2) Al^{3+} (1) $AlPO_4$ (1)	allow any neutral aluminium phosphate formula based on their aluminium ion. allow $Al^{3+}PO_4^{3-}$	**(2)** **AO2**

(Total for question 3 = 9 marks)

Question number	Answer	Additional guidance	Mark
4(a)	An explanation linking • (in pure aluminium all the atoms are the same (size) whereas) in alloy atoms are different sizes (1) • (in aluminium) {layers/ rows/ sheets} of atoms easily slide over each other (1) • (in alloy) {layers/ rows/ sheets} of atoms cannot easily slide over each other (1)	reject the use of 'molecules' once only allow ion/ particle in place of atom throughout	**(3)** **AO1**

Question number	Answer	Additional guidance	Mark
4(b)	$\frac{2.00}{100} \times 695.0$ (1) (= 13.9) 695.0 – 13.9 (1) (= 681.1 (g)) OR $\frac{98.00}{100}$ (1) x 695.0 (1) (= 681.1 (g))	award full marks for correct final answer without working allow 2 or more sig.fig.	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
4(c)(i)	A description to include • the strength increases (1) AND any one from • as percentage of magnesium (by mass in the alloy) increases (1) • linearly (1) • from 0.1 % to 3.5 % magnesium (1)	MP2 is dependent on MP1	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
4(c)(ii)	(from graph) percentage by mass of magnesium = 3.0 % (1) percentage aluminium in alloy = 100 − 3 (1) (= 97 (%))	 credit MP1 if written on graph ecf	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
4(d)	• improve the appearance (1) • increase resistance to corrosion (1)	allow • to improve electrical conductivity (1) • cheaper than using solid gold (1)	**(2)** **AO1**

(Total for question 4 = 11 marks)

Question number	Answer	Mark
5(a)	**D** potassium and bromine **D** is the only correct answer. **A** is incorrect since neither hydrogen nor oxygen are products of this electrolysis. **B** is incorrect because only bromine is a product and hydrogen is not a product of this electrolysis. **C** is incorrect since only potassium is a product and oxygen is not a product of this electrolysis.	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
5(b)	An explanation linking • zinc chloride soluble **and** zinc carbonate insoluble (1) • so ions free to move only in zinc chloride solution / comparison with zinc carbonate (1)		**(2)** **AO1**

Question number	Answer	Mark
5(c)(i)	hydrogen / H_2	**(1)** **AO3**

Question number	Answer	Additional guidance	Mark
5(c)(ii)	An explanation linking • hydrogen ions attracted to cathode/ negatively charged electrode (1) • (two) hydrogen ions {gain (two) electrons / are reduced / form hydrogen molecules} / correct half equation ($2H^+ + 2e^{(-)} \rightarrow H_2$) (1)	allow positively charged ions attracted to cathode ignore references to sodium ions	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
5(d)(i)	Diagram to show • electrodes in solution (1) • wires and power supply connected to give a complete circuit (1)	max 1 mark if no labelling Ignore any charges on the diagram	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
5(d)(ii)	• anode: smaller because copper atoms form ions (and go into solution) / oxidation of Cu atoms (1) • cathode: larger because copper atoms are formed (from ions in the solution) / reduction of Cu^{2+} (1) • solution: the same number of ions enter and leave solution (1)		**(3)** **AO1**

(Total for question 5 = 11 marks)

Question number	Answer	Additional guidance	Mark
6(a)(i)	the acid is in excess	allow exact quantity of acid used to react with the carbonate	**(1)** **AO3**

Question number	Answer	Mark
6(a)(ii)	**D** 1/10 000 is the only correct answer. **A**, **B** and **C** are factually incorrect	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
6(b)	A description to include • heat solution (to evaporate water and concentrate the salt solution) (1) • leave to cool (1)	evaporating all water loses MP1 allow leave {in warm place/on window sill} (for water to evaporate slowly) (1) for several days (1)	**(2)** **AO1**

Question number	Answer	Mark
6(c)	**B** turns blue is the only correct answer. **A**, **C** and **D** are incorrect because the position of equilibrium will shift to the left-hand side	**(1)** **AO2**

Question number	Answer	Additional guidance	Mark
6(d)	M_r H_2O = 18.0 (1) then moles of H_2O = 4.5 / 18.0 (= 0.25) (1) moles $CuSO_4.5H_2O$ = 1/5 x 0.25 (= 0.05) (1) mass $CuSO_4.5H_2O$ = 0.05 x 249.5 (= 12.475 g) (1) OR 5 H_2O : 1 $CuSO_4.5H_2O$ (1) 5 x 18 : 249.5 (1) mass $CuSO_4.5H_2O$ = 249.5 / 90 x 4.5 (= 12.475 g) (1)	12.475 / 12.48 (g) with or without working scores 4 Allow TE throughout Answer must be to 2 or more sig figs	**(4)** **AO2**

(Total for question 6 = 9 marks)

Question number	Answer	Additional guidance	Mark
7(a)	A description to include • place separate pieces of **each** metal into solutions of **each** of salt (in spotting tray/ container) (1) • observe changes in appearance/ colour of {metal/ solution} (1) • the more reactive metal shows the greater number of reactions (1)	two reactions of different metals in different metal sulfate solutions plus conclusion about reactivity (2) Allow 1 mark for one correctly described reaction between a metal and a different metal sulfate solution	**(3) AO2**

Question number	Answer	Additional guidance	Mark
7(b)	An explanation linking any two from • aluminium is more reactive than carbon (so electrolysis required) (1) • carbon cannot remove the oxygen / there is no reaction between carbon and aluminium oxide / carbon cannot displace aluminium (1) • electrolysis can be used to **reduce aluminium ions** (1)	allow electrolysis is a more powerful method of reduction (1)	**(2) AO1**

Question number	Answer	Additional guidance	Mark
7(c)	(simple) distillation	allow fractional distillation	**(1) AO2**

Question number	Answer	Additional guidance	Mark
7(d)(i)	M_r $TiCl_4$ = 48.0 + (4 x 35.5) (1) (= 190) moles of $TiCl_4$ = 45 000/ 190 = 236.8 (1)	ecf allow two or more sig figs	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
7(d)(ii)	(minimum) moles of Mg needed = 236.8 x 2 = 473.6 (1) 500 moles of Mg added > minimum 473.6 moles required	allow ecf from 7d(i) for moles of $TiCl_4$	**(1)** **AO2**

Question number	Answer	Additional guidance	Mark
7(e)	A description to include either • add dilute hydrochloric acid (to solid mixture sample to react with the magnesium to form magnesium chloride solution) (1) • filter the mixture (to remove titanium) / filter off the titanium (1) or • filter the mixture (to remove titanium) / filter off the titanium (1) • wash the titanium (1)		**(2)** **AO3**

(Total for question 7 = 11 marks)

Question number	Answer	Additional guidance	Mark
8(a)	voltage constant OR chemical cells <u>contain</u> harmful/ toxic substances (which need careful disposal after use)	allow produces a voltage as long as hydrogen/ oxygen/ reactants are supplied fuel cells have longer lifetime does not discharge when left unused	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
8(b)	$O_2 + 4H^+ + 4e^{(-)} \rightarrow 2H_2O$ (2) $e^{(-)}$ (on left) (1) balancing (1)	allow equation with e^+ to score MP2 if this is only error allow equation missing electrons but with no extraneous substances to score MP2 if correctly balanced	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
8(c)	moles of oxygen = 48/ 32 (1) (= 1.5 mol) volume of oxygen = 1.5 x 24.0 dm^3 (= 36 dm^3) (1)	award full marks for correct final answer without working allow ecf on incorrect number of moles	**(2)** **AO2**

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. (effect of using a catalyst) • increases rate of attainment of equilibrium • increasing rate of both forward and back reaction • lowers activation energy • provides an alternative reaction pathway • no effect on equilibrium yield (effects of using a temperature of 220°C rather than lower temperatures) • equilibrium attained in a shorter period of time / faster rate of attainment of equilibrium • because particles move faster/ have higher (kinetic) energy • increased collision frequency and more energetic collisions • equilibrium yield of hydrogen increases with higher temperatures • because heat energy is taken in the forward reaction (endothermic) • increasing the temperature shifts equilibrium further to the right-hand side	**(6)** **AO1**

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> Identifies at least ONE way that use of a catalyst OR temperature affects equilibrium. OR A simple explanation of one way that catalyst or temperature affects equilibrium.	<u>Possible candidate responses</u> • Increasing temperature increases rate of attainment. • Increasing temperature shifts equilibrium to the right. • Using a catalyst has no effect on the equilibrium yield / position of equilibrium • Using a catalyst increases rate of attainment. • Increasing temperature increases the rate of attainment and produces more hydrogen (2) • Using a catalyst lowers activation energy so equilibrium is reached faster (2)
Level 2	3–4	<u>Additional guidance</u> A simple explanation of at least TWO ways that the use of a catalyst OR temperature affects equilibrium. OR A detailed explanation of ONE way that equilibrium is affected	<u>Possible candidate responses</u> • Increasing temperature favours the endothermic reaction so more hydrogen is produced. • A catalyst has no effect on the equilibrium yield but provides an alternative reaction pathway, so the rate of attainment of equilibrium increases. • Increasing temperature means that particles have more kinetic energy, so there are more frequent, successful collisions and the rate of attainment of equilibrium increases.
Level 3	5–6	<u>Additional guidance</u> A detailed explanation of at least TWO ways that the use of a catalyst AND temperature affects equilibrium	<u>Possible candidate responses</u> • Increasing the temperature favours the endothermic reaction and so a higher temperature will produce more hydrogen. A catalyst has no effect on the equilibrium yield as it increases the rate of both the forward and reverse reaction. • Increasing temperature gives the particles more kinetic energy and increases the frequency of collisions, so the rate of attainment of equilibrium increases. Using a catalyst lowers the activation energy, so more particles have the minimum energy required for a successful collision

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
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) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

(Total for question 8 = 11 marks)

Question number	Answer	Mark
9(a)	number of protons = 52 (1) number of neutrons = 125 - number of protons (1) (= 73)	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
9(b)(i)	(isotopes of same element) have the same number of protons	allow same number of electrons reject same number of neutrons	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
9(b)(ii)	total mass of 100 atoms = (28 x 92) + (29 x 5) + (30 x 3) (1) (= 2811) relative atomic mass = $\frac{2811}{100}$ (= 28.11) (1)	correct final answer without working (2) final answer must contain at least one decimal place	**(2)** **AO2**

Question number	Indicative content	Mark
*9(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. Substance **A** • giant ionic structure • (high melting point) strong electrostatic attractions between ions • due to a lot of energy required to overcome strong forces • (electrical conductivity) in solid ions strongly attracted in lattice ions cannot move, so poor conductor when solid • when molten ions free to move, so good conductor when molten Substance **B** • metallic structure • (high melting point) strong attraction between metal ions and delocalised electrons • due to a lot of energy required to overcome strong forces between particles in solid • (electrical conductivity) in solid delocalised electrons • free to move throughout metallic lattice, so good conductor when solid • delocalised electrons and ions free to move when molten, so good conductor when molten Substance **C** • covalent simple molecular • (low melting point) weak intermolecular forces/ attractions between molecules • little energy needed to separate molecules, so low melting point • (electrical conductivity) in solid and when molten no delocalised electrons or ions to carry charge, so poor conductor	**(6)** **AO1** / **AO3**

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> Identifies correct structure types OR explains a property of one substance	<u>Possible candidate responses</u> • A – giant ionic, B – metallic, C – simple molecular • High mp (for A or B) due to strong bonds (between atoms / ions) • Low mp for C due to weak intermolecular forces • A conducts when molten – ions can move • B conducts when solid / molten – electrons can move • C does not conduct – no free ions or electrons can't move
Level 2	3–4	<u>Additional guidance</u> Identifies correct structure type for one substance AND explains at least one property of that substance OR explains at least two properties	<u>Possible candidate responses</u> • A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move • B – metallic AND high mp due to strong bonds between { atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move • C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move
Level 3	5–6	<u>Additional guidance</u> Identifies correct structure types and explains properties for least two substances	<u>Possible candidate responses</u> • A – giant ionic AND high mp due to strong bonds between ions AND poor conductor when solid – ions not free to move; good conductor when molten – ions free to move AND / OR • B – metallic AND high mp due to strong bonds between { atoms / metal ions and delocalised electrons} AND good conductor when solid and molten – electrons free to move AND / OR • C – simple molecular AND low mp due to weak intermolecular forces AND poor conductor when solid and molten – no ions and electrons not free to move

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Deconstructs scientific information but understanding and connections are flawed. An unbalanced or incomplete argument that provides limited synthesis of understanding. (AO3)
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) • Deconstructs scientific information and provides some logical connections between scientific concepts. An imbalanced argument that synthesises mostly relevant understanding, but not entirely coherently (AO3)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Deconstructs scientific information and provide logical connections between scientific concepts throughout. A balanced, well-developed argument that synthesises relevant understanding coherently. (AO3)

(Total for question 9 = 11 marks)

Question number	Answer	Additional guidance	Mark
10(a)(i)	Suggestions to include any three from • make the potassium hydroxide solution using a volumetric flask (1) • use distilled / deionised water (to make up solution) (1) • make solution of total volume 250 cm^3 (rather than adding 250 cm^3 water to the solid) (1) • use of pipette to measure out the potassium hydroxide solution (1) • repeat until titres within ±0.2(0) cm^3 of each other / concordant titres **and** use to calculate the mean titre (1)	allow add solution from burette dropwise only near end point (1) allow conduct rough titration first (1)	**(3)** **AO3**

Question number	Answer	Mark
10(a)(ii)	**C** pink colourless is the only correct answer **A** and **B** have colours for methyl orange. **D** has the colours reversed.	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
10(b)	moles of sulfuric acid = $0.140 \times \frac{12.15}{1000}$ (1) (= 0.001701 mol) ratio 2 : 1 KOH to H_2SO_4 (1) moles of KOH = 2 x 0.001701 (1) (= 0.003402 mol) concentration of KOH = $0.003402 \times \frac{1000}{25.00}$ (1) (= 0.136 mol dm^{-3})	award full marks for correct final answer without working allow ecf from moles of sulfuric acid allow ecf from moles of KOH	**(4)** **AO2**

Question number	Answer	Additional guidance	Mark
10(c)	0.175 x 56.0 = 9.80 g dm^{-3} (1) mass in 250 cm^3 sample = 0.25 x 9.80 = 2.45 g (1) %pure KOH = 2.45 / 2.56 x 100 = 95.7 (%) (1)	award full marks for correct final answer without working	**(3)** **AO2**

(Total for question 10 = 11 marks)

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