GCSE
CHEMISTRY
8462/1H

Paper 1 Higher Tier

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

216G8462/1H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, ‘allow’ is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do not accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student’s answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

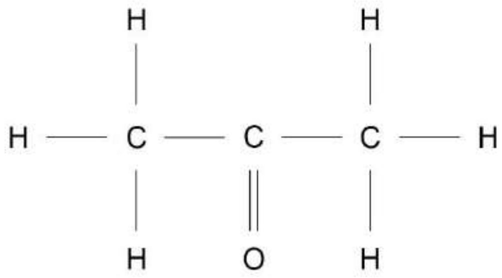
You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	spherical	allow ball-shaped ignore round / circular	1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	any **one** from: • drug delivery (round the body) • hydrogen storage • anti-oxidants • reduction of bacterial growth • catalysts • (cylindrical fullerenes for) strengthening materials • (spherical fullerenes for) lubricants		1	AO1 4.2.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3			1	AO2 4.2.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	C_3H_6O	allow CH_3COCH_3 allow elements in any order	1	AO2 4.2.1.4

Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the intermolecular forces are weak		1	AO1 4.2.2.1 4.2.2.4

Question	Answers	Mark	AO/ Spec. Ref
01.6	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.2.2.6 4.2.3.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • bonds are covalent • giant / macromolecular structure • three (covalent) bonds per carbon atom **or** only three electrons per carbon atom used in (covalent) bonds • so one electron per carbon atom (is delocalised) • these delocalised electrons • can move through the structure • carrying (electrical) charge • so graphite conducts electricity • layered structure • of (interlocking) hexagonal rings • with weak (intermolecular) forces between layers **or** no (covalent) bonds between layers • so the layers can slide over each other • so graphite is soft and slippery		

Total			**11**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(atoms with the) same number of protons	allow atoms with the same atomic number allow atoms of the same element ignore the same number of electrons	1	AO1 4.1.1.4 4.1.1.5
	(but with) different numbers of neutrons	ignore (but with) different mass numbers do **not** accept (but with) different relative atomic mass	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	$(A_r =) \frac{(69 \times 60) + (71 \times 40)}{100}$		1	AO2 4.1.1.6
	= 69.8		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(number of electrons) = 31		1	AO2 4.1.1.4 4.1.1.5
	(number of neutrons) = 38		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	Ga^{3+}		1	AO3 4.2.1.2

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	(gallium) fitted in a gap (Mendeleev had left)		1	AO2 4.1.2.2
	(gallium's) properties were predicted correctly (by Mendeleev)	allow (gallium's) properties matched the rest of the group	1	

Total			**9**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(3 × M_r H_2O = 3 × (2 + 16) =) 54 (A_r **R** = 150 – 54 =) 96 **alternative approach**: (M_r **R**O_3 = 150 – 6 =) 144 (1) (A_r **R** = 144 – (3 × 16) =) 96 (1)	 ignore units ignore units	1 1	AO2 4.3.1.1 4.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(**R** =) molybdenum / Mo	allow ecf from question **03.1**	1	AO3 4.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(total M_r of reactants) = 163 (% atom economy =) $\frac{119}{163}$ (×100) = 73 (%)	 allow correct use of an incorrectly calculated value of total M_r allow 73.00613 (%) correctly rounded to at least 2 significant figures	1 1 1	AO2 4.3.1.2 4.3.3.2

Question 3 continued

Question	Answers	Mark	AO/ Spec. Ref
03.4	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3-4	AO3 4.4.1.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • carbon and iron are the cheapest reactants • hydrogen is the most expensive reactant • separating solid products is expensive • separating solid products is time consuming • in method 1, tungsten needs to be separated from tungsten carbide • in method 1, some tungsten is lost as tungsten carbide • in method 1, the carbon dioxide produced will escape • in method 2, the water vapour produced will escape • in method 2, no separation of solids is needed • in method 3, tungsten needs to be separated from iron oxide		

Total			**10**

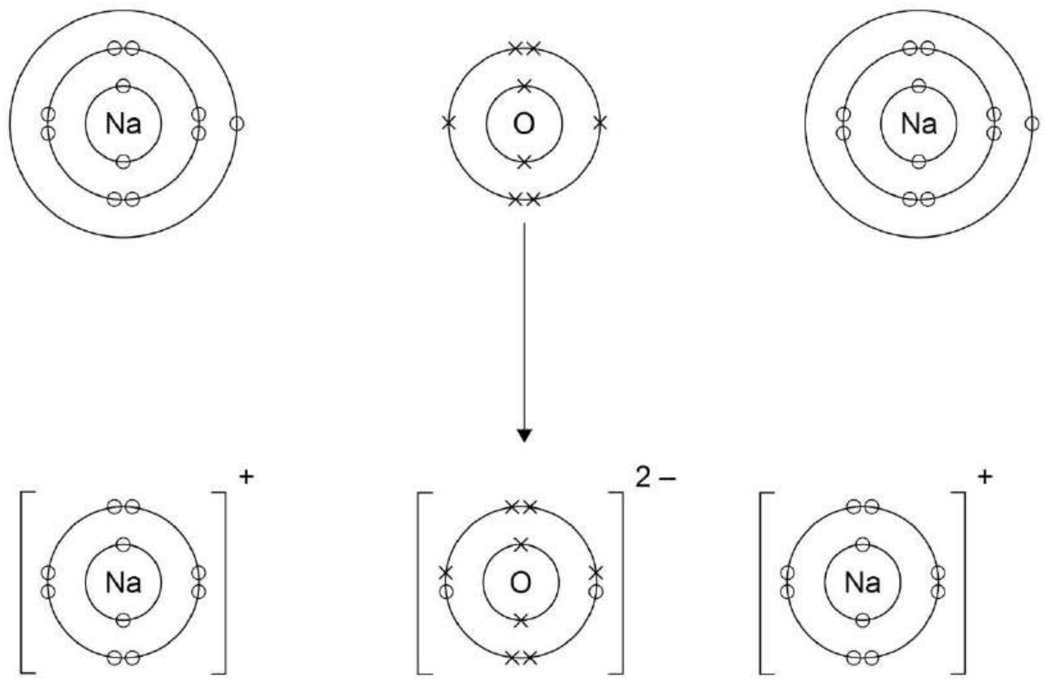
Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	any **two** from: • (potassium) floats • (potassium) melts • (potassium) moves around • potassium becomes smaller • (lilac) flame • effervescence	 allow potassium disappears allow fizzing	2	AO1 4.1.2.5 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	$2K + 2H_2O \rightarrow 2KOH + H_2$	allow multiples allow **1** mark for KOH **and** H_2	2	AO1 AO2 4.1.1.1 4.1.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	reactivity increases (going down the group)		1	AO1 4.1.2.5 4.4.1.2
	(because) the outer electron / shell is further from the nucleus	allow (because) there are more shells allow (because) the atoms get larger	1	
	(so) there is less attraction between the nucleus and the outer electron / shell	allow (so) there is more shielding from the nucleus do **not** accept incorrect attractions	1	
	(so) the atom loses an electron more easily		1	

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(dot and cross diagram to show) sodium atom **and** oxygen atom	allow use of outer shells only	1	AO2 4.2.1.1 4.2.1.2
	two sodium atoms to one oxygen atom	allow two sodium ions to one oxide ion	1	
	(to produce) sodium ion with a + charge		1	
	(to produce) oxide ion with a 2– charge		1	
	 scores **4** marks			

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(oxygen) gains electrons		1	AO1 4.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	giant structure	allow (giant ionic) lattice	1	AO1 4.2.1.3 4.2.2.1 4.2.2.3
	(with) strong (electrostatic) forces of attraction between (oppositely charged) ions		1	
	(so) large amounts of energy are needed to break the bonds / forces	allow (so) large amounts of energy are needed to separate the ions	1	

Total			**16**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	potassium chloride	allow KCl	1	AO1 4.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	$H^+ + OH^- \rightarrow H_2O$	ignore state symbols	1	AO1 4.1.1.1 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	copper carbonate and copper oxide only		1	AO1 4.4.1.2 4.4.2.2 4.4.2.3 RPA1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(Step 2) to speed up the reaction		1	AO1 4.4.2.3 RPA1
	(Step 5) to make sure all the (hydrochloric) acid reacts		1	
	(Step 6) to remove the excess magnesium oxide	ignore to remove impurities	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	using a (boiling) water bath **or** using an electric heater		1	AO1 4.4.2.3 RPA1

Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(moles Fe = $\frac{14}{56}$ =) 0.25 (mol)		1	AO2 4.3.2.1 4.3.2.2 4.3.5
	(moles Cl_2 = $\frac{3}{2}$ × 0.25 =) 0.375 (mol)	allow correct use of an incorrectly calculated number of moles of Fe	1	
	(volume Cl_2 = 24 × 0.375) = 9.0 (dm^3)	allow correct use of an incorrectly calculated number of moles of Cl_2	1	

Total			**10**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	C		1	AO3 4.2.2.7 4.2.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(in an alloy) the atoms are of different sizes		1	AO1 4.2.2.7
	(so) the layers (of atoms in an alloy) are distorted		1	
	(so in an alloy) the layers slide over each other less easily (than in a pure metal)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	measure temperature change	allow measure the temperature before **and** after the reaction	1	AO1
	when each metal is added to silver nitrate solution		1	AO1
	same concentration / volume of solution **or** same mass / moles of metal	allow same initial temperature (of silver nitrate solution)	1	AO2
	the greater the temperature change the more reactive		1	AO3
				4.4.1.2 4.5.1.1 RPA4

Total			**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		allow voltage for electricity allow potential difference for electricity allow (electrical) current for electricity		AO1 4.4.3.1 4.5.2.1
	electrolysis uses electricity to produce a chemical reaction	allow electrolysis uses electricity to decompose a compound / electrolyte	1	
	(but) cells use a chemical reaction to produce electricity		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$2\,Br^{-} \rightarrow Br_2 + 2\,e^{-}$	allow multiples allow **1** mark for Br_2 **and** e^{-}	2	AO2 4.1.1.1 4.4.3.1 4.4.3.2 4.4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3				AO2 4.4.1.2 4.4.3.4 RPA3

Salt solution	Product at positive electrode	Product at negative electrode	Mark
(copper nitrate)	oxygen (1)	(copper)	1
(potassium iodide)	iodine (1)	hydrogen (1)	2

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	filter the mixture wash and dry the copper / residue weigh the copper collected add to the increase in mass of the electrode		1 1 1 1	AO3 4.1.1.2 4.4.3.4 RPA3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	(for given current) straight line through the origin	allow (for given current) when time doubles, mass doubles	1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(for given time) when current doubles, mass doubles with supporting data		1	AO3 4.4.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7	copper ions are discharged (from the solution)	allow the solution becomes less concentrated allow copper ions are removed (from the solution) allow copper ions are used up (from the solution)	1	AO3 4.4.3.1

Question 7 continued

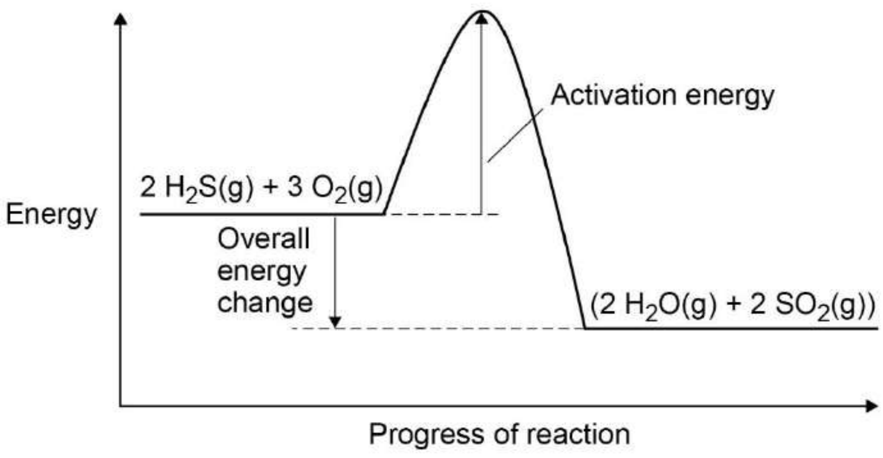
Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	(number of moles = $\frac{0.24}{63.5}$ =) 3.78×10^{-3} **or** 0.00378		1	AO2 4.3.2.1
	(number of atoms =) $0.00378 \times 6.02 \times 10^{23}$	allow correct use of an incorrectly calculated number of moles	1	
	$= 2.28 \times 10^{21}$	allow a correct evaluation to 3 significant figures of an incorrect expression which involves only a mass from the graph, the A_r of copper and the Avogadro constant	1	

Total			**17**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	water vapour	allow steam allow gaseous water	1	AO1 4.1.1.1 4.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	75 (cm^3)		1	AO2 4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	product level below reactants	ignore labelling of products	1	AO1 4.5.1.2
	activation energy drawn and labelled		1	
	overall energy change drawn and labelled	if endothermic profile drawn allow corresponding overall energy change	1	
	 scores **3** marks			

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(bonds broken = 4(364) + 3(498) =) 2950		1	AO2 4.5.1.3
	(bonds formed = 2950 + 1034 =) 3984	allow correct use of incorrectly calculated values of bonds broken	1	
	4**X** + 4(464) = 3984	allow correct use of incorrectly calculated values of bonds formed	1	
	4**X** = **(**3984 **–** 1856 =) 2128		1	
	X = 532 (kJ/mol)		1	
	alternative approach: (bonds broken = 4(364) + 3(498) =) 2950 (1)			
	(bonds formed = 4(464) + 4**X** =) 1856 + 4**X** (1)			
	(1856 + 4**X**) **–** 2950 = 1034 (1)	allow correct use of incorrectly calculated values of bonds broken and/or bonds formed		
	4**X** = (1034 + 2950 **–** 1856 =) 2128 (1)			
	X = 532 (kJ/mol) (1)			

Total			**10**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	a dilute solution of a strong acid		1	AO2 4.3.2.5 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	1.0 mol/dm^3 hydrogen chloride solution		1	AO2 4.4.2.4 4.4.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **two** from: • swirl (the solution) • white tile (under the flask) • add (ethanedioic) acid dropwise (near the endpoint) • repeat **and** calculate mean		2	AO3 4.4.2.5 RPA2

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(concentration = 90 × 0.0480 =) 4.32 (g/dm^3) (mass = $4.32 \times \frac{250}{1000}$) = 1.08 (g) **alternative approach**: (moles = $0.0480 \times \frac{250}{1000}$ =) 0.012 (mol) (1) (mass = 0.012 × 90) = 1.08 (g) (1)	 allow correct use of an incorrectly calculated value of concentration in g/dm^3 allow correct use of an incorrectly calculated value of number of moles	1 1	AO2 4.3.2.1 4.3.2.5 4.3.4

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(moles $H_2C_2O_4 = \frac{15.0}{1000} \times 0.0480$) = 0.00072 (mol)		1	AO2 4.3.4 4.4.2.5 RPA2
	(moles NaOH = moles $H_2C_2O_4 \times 2$ =) 0.00144 (mol)	allow correct use of an incorrectly calculated value of number of moles of $H_2C_2O_4$	1	
	(concentration= $\frac{0.00144}{25.0} \times 1000$) = 0.0576 (mol/dm^3)	allow 0.058 (mol/dm^3) allow correct use of an incorrectly calculated value of number of moles of NaOH	1	
	alternative approach: $\frac{\text{volume} \times \text{conc (acid)}}{\text{volume} \times \text{conc (NaOH)}} = \frac{1}{2}$ (1)	allow inverse		
	(conc NaOH =) $2 \times \frac{15.0 \times 0.0480}{25.0}$ (1)	allow correct use of incorrect mole ratio		
	= 0.0576 (mol/dm^3) (1)			

Total			**9**	