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AQA

GCSE
CHEMISTRY
8462/1H

Paper 1 Higher Tier

Mark scheme

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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.

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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, level of demand 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.

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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

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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 <u>not</u> 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.

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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.

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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	poly(ethene) water		1 1	AO2 4.2.1.4 4.2.2.4 4.2.2.5

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Question 1 continued

Question	Answers	Mark	AO/ Spec. Ref
01.2	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 4.2.1.2 4.2.1.3 4.2.1.4
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content • (both) carbon dioxide and silicon dioxide are made up of atoms • (but) magnesium oxide is made up of ions • (both) silicon dioxide and magnesium oxide are giant structures • (but) carbon dioxide is small molecules • with weak intermolecular forces • all three compounds have strong bonds • (both) carbon dioxide and silicon dioxide are formed from two non-metals • (so) bonds formed are covalent • (so) electron (pairs) are shared (between atoms) • (but) magnesium oxide is formed from a metal and a non-metal • (so) bonds in magnesium oxide are ionic • (so) electrons are transferred • from magnesium to oxygen • two electrons are transferred • bonds in silicon dioxide are single bonds • (where) each silicon forms four bonds • (and) each oxygen forms two bonds • (but) in carbon dioxide the bonds are double bonds • (where) carbon forms two double bonds • (and) oxygen forms one double bond ignore properties e.g. melting point, electrical conductivity		

Total			**8**

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Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	they form ions with different charges		1	AO1 4.1.3.1 4.1.3.2
	they have high melting points		1	
02.2	the (grey) crystals are silver		1	AO3 4.4.1.2
	the copper ions (produced) are blue	allow the copper nitrate / compound (produced) is blue	1	
	(because) copper displaces silver		1	

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Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.3	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 AO3 4.4.1.2 4.5.1.1 RPA 4
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content **Key steps** • add the metals to (dilute) hydrochloric acid • measure temperature change **or** compare rate of bubbling **or** compare colour of resulting solution for copper: • no reaction • shown by no temperature change **or** shown by no bubbles for magnesium and iron: • magnesium increases in temperature more than iron **or** magnesium bubbles faster than iron **or** magnesium forms a colourless solution and iron forms a coloured solution **Control variables** • same concentration / volume of hydrochloric acid • same mass / moles of metal • same particle size of metal • same temperature (of acid if comparing rate of bubbling)		

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Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$\frac{(203 \times 30) + (205 \times 70)}{100}$ **or** $\frac{6090 + 14\,350}{100}$		1	AO2 4.1.1.6
	= 204.4	ignore units	1	
Total			**11**	

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Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(total) mass before = 156.76 (g) **and** (total) mass after = 156.76 (g) **or** increase in mass of beaker **A** and contents = 29.96 (g) **and** decrease in mass of beaker **B** and contents = 29.96 (g)	allow 78.26 + 78.50 = 156.76 **and** 108.22 + 48.54 = 156.76 allow 108.22 – 78.26 = 29.96 **and** 48.54 – 78.50 = – 29.96	1	AO2
	(so) the mass of products equals the mass of the reactants **or** (so) there is no change in mass during the reaction	allow (so) no atoms were lost or made during the reaction	1	AO1 4.3.1.1
03.2	filter / filtration	allow a description of filtration	1	AO2 4.1.1.2
03.3	sodium nitrate (solution) **or** silver nitrate (solution) **or** sodium iodide (solution)	allow correct formulae allow sodium / nitrate / silver / iodide ions	1	AO2 4.1.1.2
03.4	to remove / evaporate the water	allow to dry (the solid)	1	AO3 4.1.1.2

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Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	(total M_r = 170 + 150) = 320	allow (235 + 85) = 320	1	AO2 4.3.3.2
	(% atom economy =) $\frac{235}{320} \times 100$	allow correct use of incorrectly calculated total M_r	1	
	= 73.4375 (%)		1	
	= 73.4 (%)	allow an answer correctly calculated to 3 significant figures from an incorrect percentage calculation which uses the values in the question	1	
03.6	any **one** from: • for sustainable development • for economic reasons • to produce a high(er) percentage of useful product	allow to reduce waste	1	AO1 4.3.3.2
Total			**10**	

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Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	CrO_4^{2-} / chromate ions moved to the positive electrode (because) opposite charges attract	allow anode for positive electrode allow yellow (coloured) ions moved to the positive electrode allow (because) negative ions are attracted to the positive electrode	1 1	AO2 AO1 4.4.3.1 RPA 3
04.2	water	ignore copper chromate solution	1	AO1 4.4.3.4 RPA 3
04.3	copper ions gain two electrons (to) form copper (atoms)	allow Cu^{2+} for copper ions allow **1** mark for copper ions gain electrons **or** allow **1** mark for copper ions are reduced do **not** accept copper ions are oxidised allow Cu for copper (atoms) the equation: $Cu^{2+} + 2e^{-} \rightarrow Cu$ scores **3** marks	2 1	AO2 AO3 4.4.3.1 4.4.3.4 RPA 3
04.4	(negative electrode) hydrogen (positive electrode) iodine	allow H_2 allow I_2	1 1	AO2 4.4.3.4 RPA 3
Total			**8**	

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Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **three** from: (nuclear model) • mostly empty space • the positive charge is (all) in the nucleus • the mass is concentrated in the nucleus • the electrons and the nucleus are separate	allow the plum pudding model has no empty space allow the plum pudding model is solid allow in the plum pudding model the atom is a ball of positive charge (with embedded electrons) do **not** accept reference to protons allow in the plum pudding model the mass is spread out do **not** accept reference to neutrons allow in the plum pudding model the electrons are embedded allow in the nuclear model the electrons are in orbits	3	AO1 4.1.1.3
05.2	 electrons orbit the nucleus electrons are at specific distances from the nucleus	do **not** accept reference to protons / neutrons allow electrons are in energy levels around the nucleus **or** allow electrons are in shells around the nucleus	 1 1	AO1 4.1.1.3
05.3	atomic number is the number of protons (and) protons were not discovered until later	 ignore electrons / neutrons were not discovered until later	1 1	AO3 4.1.1.3 4.1.1.4 4.1.2.2

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Question 5 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	so their properties matched the rest of the group	allow converse	1	AO1 4.1.2.2
Total			**8**	

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Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the (minimum) energy needed for particles to react **or** the (minimum) energy needed for a reaction to occur	allow the (minimum) energy needed to start a reaction	1	AO1 4.5.1.2
06.2	(M_r of Fe_2O_3 =) 160		1	AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4
	(moles $Fe_2O_3 = \frac{3000}{160}$ =) 18.75 (mol)	allow correct use of incorrectly calculated M_r	1	
	(moles Al $= \frac{1000}{27}$ =) 37.0 (mol)	allow 37.037037 (mol) correctly rounded to at least 2 significant figures if both MP2 and MP3 are not awarded allow **1** mark for 0.01875 mol Fe_2O_3 **and** 0.037 mol Al	1	
	(aluminium is limiting because) 37.0 mol is less than the (2 x 18.75 =) 37.5 mol (aluminium needed) **or** iron oxide is in excess because 18.75 mol is more than the ($\frac{37.0}{2}$ =) 18.5 mol (iron oxide needed)	allow correct use of incorrect number of moles from steps 2 and/or 3	1	

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Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 1:** **(finding required mass of aluminium by moles method)** (M_r of Fe_2O_3 =) 160 (1) (moles Fe_2O_3 = $\frac{3000}{160}$ =) 18.75 (mol) (1) (moles Al needed =18.75 × 2 =) 37.5 (mol) **and** (mass Al needed = 37.5 × 27 =) 1012.5 (g) **or** 1.0125 kg (1) (so) 1.00 kg of aluminium is not enough (1) **approach 2:** **(finding required mass of aluminium by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (3.00 kg Fe_2O_3 needs) $\frac{3.00}{160}$ × 2 × 27 (kg Al) (1) (=) 1.0125 (kg) (1) (so) 1.00 kg of aluminium is not enough (1)	allow correct use of incorrectly calculated M_r allow correct use of incorrectly calculated moles of iron oxide allow correct use of incorrectly calculated moles of aluminium needed dependent on calculated mass of aluminium needed being greater than 1.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of aluminium needed being greater than 1.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

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Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2 ctd	**alternative approaches:** **approach 3:** **(finding required mass of iron oxide by moles method)** M_r of Fe_2O_3 =) 160 (1) (moles Al $= \frac{1000}{27}$ =) 37.0 (mol) (1) (moles Fe_2O_3 needed) $= \frac{37.0}{2}$) = 18.5 (mol) **and** (mass Fe_2O_3 needed = 18.5 × 160 =) 2960 (g) **or** 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1) **approach 4:** **(finding required mass of iron oxide by proportion method)** (M_r of Fe_2O_3 =) 160 (1) (1.00 kg Al needs) $\frac{1.00}{2 \times 27} \times 160$ (kg Fe_2O_3) (1) (=) 2.96 (kg) (1) (so) 3.00 kg of iron oxide is an excess (1)	 allow 37.037037 (mol) correctly rounded to at least 2 significant figures allow correct use of incorrectly calculated moles of aluminium allow correct use of incorrectly calculated moles of iron oxide needed allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg) allow correct use of incorrectly calculated M_r dependent on calculated mass of iron oxide needed being less than 3.00 (kg)		AO2 4.3.1.2 4.3.2.1 4.3.2.2 4.3.2.4

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Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$	allow multiples allow **1** mark for Mg^{2+} + Zn with missing or incorrect state symbols	2	AO2 4.1.1.1 4.2.2.2 4.4.1.4
06.4	magnesium (atoms) are oxidised because they lose electrons (and) zinc (ions) are reduced because they gain electrons	if no other marks awarded allow **1** mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons	1 1	AO2 4.4.1.4
Total			**9**	

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Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	the activation energy should be from the reactants (line to the peak)	ignore description of where the activation energy is on the diagram	1	AO3 4.5.1.2
	the products (line) should be below the reactants (line) **or** the products should have less energy than the reactants	allow the product (line) is above the reactants (line) allow the products have more energy than the reactants allow the profile shows an endothermic reaction ignore the arrow for the overall energy change should point downwards	1	
07.2	any **two** from: (hydrogen fuel cells)	allow converse arguments for a rechargeable cell	2	AO1 4.5.2.2
	• no toxic chemicals to dispose of at the end of the cell's life			
	• take less time to refuel (than to recharge rechargeable cells)			
	• travel further before refuelling (than before recharging rechargeable cells)	allow has a greater range		
	• no loss of efficiency (over time)	allow does not lose capacity / range in cold weather		

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Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	any **one** from: • $H_2 \rightarrow 2H^+ + 2e^-$ • $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ • $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ • $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	allow multiples allow $H_2 - 2e^- \rightarrow 2H^+$ allow $H_2 + 2OH^- - 2e^- \rightarrow 2H_2O$	1	AO1 4.5.2.2
07.4	any **two** from: • hydrogen is not shown as H_2 / molecules • particles are shown as spheres • particles are shown as solid • does not show the (weak) forces (between particles) • does not show the movement / speed (of particles) • is only two-dimensional		2	AO1 4.2.2.1
07.5	any **one** from: • under (higher) pressure • cool • absorb / adsorb in a solid	allow increase concentration allow condense allow store as a liquid / solid allow develop more efficient engines	1	AO3 4.2.2.1 4.5.2.2

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Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	(58 MJ =) 58 000 kJ **or** (290 kJ =) 0.290 MJ	allow (58 MJ =) 58 000 000 J **and** (290 kJ =) 290 000 J	1	AO2 4.3.2.1 4.3.5 4.5.2.2
	(moles = $\frac{58000}{290}$ **or** $\frac{58}{0.290}$ =) 200	allow correct use of an incorrectly converted or unconverted value of energy	1	
	(volume =) 200 × 24	allow correct use of an incorrectly calculated number of moles of hydrogen	1	
	= 4800 (dm^3)		1	
	alternative approach: (58 MJ =) 58 000 kJ (1) (energy released per dm^3 = $\frac{290}{24}$ =) 12.08333 (kJ/dm^3) (1)			
	(volume =) $\frac{58000}{12.08333}$ (1) = 4800 (dm^3) (1)	allow correct use of an incorrectly converted or unconverted value of energy allow correct use of an incorrectly calculated energy released per dm^3		

Total			Mark
			12

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Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	liquid gas		1	AO2 4.2.2.1
08.2	(boiling point) increases (down the table / group)		1	AO1 4.1.2.6 4.2.2.1 4.2.2.4
	(because) the relative formula / molecular mass increases **or** (because) the size of the molecule increases		1	
	(so) the intermolecular forces increase (in strength)	allow (so) the forces between molecules increase (in strength)	1	
	(so) more energy is needed to overcome the intermolecular forces	allow (so) more energy is needed to separate the molecules do **not** accept a reference to breaking bonds unless specifically between molecules	1	
08.3	boiling point is a bulk property	allow boiling point is related to intermolecular forces (so more than one molecule is involved)	1	AO1 4.2.2.1
08.4	the gas / halogen is toxic	allow the gas / halogen is poisonous / harmful allow to prevent inhalation of the gas / halogen ignore deadly / lethal	1	AO3 4.1.2.6

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Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5		allow energy level for shell throughout		AO1 4.1.2.6
	(going down the group) the outer electrons / shell become further from the nucleus	allow the atoms become larger allow the number of shells increases ignore the number of outer shells increases	1	
	(so) the nucleus has less attraction for the outer electrons / shell	allow (so) the nucleus has less attraction for the incoming electron allow (so) increased shielding between the nucleus and the outer electrons / shell allow (so) increased shielding between the nucleus and the incoming electron	1	
	(so) an electron is gained less easily		1	

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Question 8 continued

08.6	4.48 (g iron) **and** 8.52 (g chlorine)		1	AO2 4.1.1.1 4.1.2.6 4.3.2.3
	(moles Fe = $\frac{4.48}{56}$ =) 0.08	allow correct calculation using incorrectly calculated mass of iron	1	
	(moles Cl = $\frac{8.52}{35.5}$ =) 0.24	allow correct calculation using incorrectly calculated mass of chlorine allow (moles Cl_2 = $\frac{8.52}{71}$ =) 0.12	1	
	(Fe : Cl = 0.08 : 0.24 =) 1 : 3	allow correct calculation using incorrectly calculated moles of iron and / or chlorine	1	
	$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$	allow multiples / fractions allow a correctly balanced equation including Fe and Cl_2 from an incorrect ratio of Fe : Cl allow **1** mark for Fe **and** Cl_2 (reactants) **and** $FeCl_3$ (product) **or** allow **1** mark for Fe **and** Cl_2 (reactants) **and** a formula for iron chloride correctly derived from an incorrect ratio of Fe : Cl (product)	2	

Total			**16**

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Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	didn't stir (the solution enough)	allow measured the temperature before the temperature stopped falling allow measured the temperature too soon	1	AO3 4.5.1.1 RPA 4
09.2	the temperature decreases (initially) because energy is taken in (by the reaction from the solution)	allow temperature decreases (initially) because the reaction is endothermic	1	AO2 AO3 4.5.1.1 RPA 4
	when 1.5 g (of citric acid) is added the sodium hydrogencarbonate has all reacted **or** from 1.5 g the citric acid is in excess **or** when 1.5 g (of citric acid) is added the reaction is complete	allow when the temperature reaches 11.6 °C the sodium hydrogencarbonate has all reacted allow after the temperature reaches 11.6 °C the citric acid is in excess allow when the temperature reaches 11.6 °C the reaction is complete	1	
	(so) the temperature increases as energy is transferred from the room to the solution	allow (so) the temperature increases as energy is transferred from the excess citric acid to the solution	1	

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Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	less steep line starting at 16.8 °C **and** reaching 1.00 g (of citric acid)	ignore any part of the line drawn beyond 1.00 g	1	AO3 4.2.2.8 4.5.1.1 RPA 4
	(as) metal is a better conductor	allow (as) polystyrene is a better insulator	1	
	(so) more energy is absorbed (from the surroundings)	allow (so) more heat is absorbed (from the surroundings)	1	
09.4	(M_r citric acid =) 192		1	AO2 4.3.2.5 4.3.4
	(moles = $\frac{250}{1000}$ × 0.0500) = 0.0125		1	
	(mass = 0.0125 × 192 =) 2.4 (g)	allow correct use of an incorrectly calculated M_r allow correct use of an incorrectly calculated number of moles	1	
	alternative approach:			
	(M_r citric acid =) 192 (1)			
	(concentration = 0.0500 × 192) = 9.6 (g/dm^3) (1)	allow correct use of an incorrectly calculated M_r		
	(mass = $\frac{250}{1000}$ × 9.6 =) 2.4 (g) (1)	allow correct use of an incorrectly calculated concentration in g/dm^3		

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Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	add the citric acid (to the flask) until there is a (permanent) colour change	ignore colours of indicator	1	AO1 4.4.2.5 RPA 2
	measure / record the volume (of citric acid) added	allow take the final (and initial) burette reading	1	
	any **one** from: • swirl • use a white tile • add the citric acid dropwise (near the end-point) • repeat **and** calculate a mean	allow add the citric acid slowly (near the end-point)	1	
09.6	any **two** from: • can add (the citric acid) in small increments • can measure variable volumes • more accurate than a measuring cylinder	allow can add (the citric acid) drop by drop allow can add (the citric acid) slowly allow has a scale (for variable volumes)	2	AO1 4.4.2.5 RPA 2

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Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.7	(moles citric acid = $\frac{13.3}{1000} \times 0.0500$) = 0.000665		1	AO2 4.3.4 4.4.2.5 RPA 2
	(moles NaOH = 3 × 0.000665) = 0.001995	allow correct use of an incorrectly calculated number of moles of citric acid	1	
	(conc = $\frac{1000}{25} \times 0.001995$) = 0.0798 (mol/dm^3)	allow 0.08 or 0.080 (mol/dm^3) allow correct use of an incorrectly calculated number of moles of NaOH	1	
	alternative approach:			
	$\frac{25.0 \times \text{conc NaOH}}{13.3 \times 0.0500} = \frac{3}{1}$ (1)	allow $\frac{13.3 \times 0.0500}{25.0 \times \text{conc NaOH}} = \frac{1}{3}$		
	(conc NaOH =) $3 \times \frac{13.3 \times 0.0500}{25.0}$ (1)			
	= 0.0798 (mol/dm^3) (1)	allow 0.08 or 0.080 (mol/dm^3)		

Total			18

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