GCSE
CHEMISTRY
8462/2H

Paper 2 Higher Tier

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

2 1 6 G 8 4 6 2 / 2 H / M S

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 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 <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.

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	use of oil has decreased by 0.8% **or** use of oil has decreased from 1.3% to 0.5%		1	AO2 4.10.1.1
	use of solar energy has increased by 3.4% **or** use of solar energy has increased from 0% to 3.4%	allow any value below 0.05% for 2007	1	
	any **one** from: • use of oil increased from 2007 to 2009 • no change in oil use between 2013 and 2015 • no change in solar energy use between 2007 and 2009 • use of solar energy increased most between 2013 and 2015 • between 2007 and 2011 more oil was used **and** between 2013 and 2017 more solar energy was used	allow use of oil was highest in 2009	1	
		if no other mark is awarded, allow **1** mark for oil decreased **and** solar energy increased		

Question 1 continued

Question	Answers	Mark	AO / Spec. Ref
01.2	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content • carbon dioxide produced • (which is) a greenhouse gas • (therefore) surface temperature increases • (therefore) global warming • (so) climate change • (so) polar ice caps melt • (so) increasing sea levels • (so) flooding • (so) extreme weather events • (so) reduction in biodiversity • (so) famine **/** drought • sulfur dioxide produced • (which causes) acid rain • (so) damage to buildings / statues • (so) damage to trees • (so) damage to aquatic animals • (so) respiratory problems in humans • carbon **/** soot produced • (which are) particulates • (which cause) global dimming • (so) respiratory problems in humans • carbon monoxide produced • (which is) toxic		4.9.2.2 4.9.2.3 4.9.3.1 4.9.3.2

Question 1 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	solar is (a) renewable (source of energy)	allow oil is (a) finite (source of energy)	1	AO3 4.10.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	any **two** from: • sunshine is unreliable • increased demand for energy • lack of space	ignore references to cost	2	AO3 4.9.2.4 4.10.1.1

Total			**12**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	all five points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for three or four points plotted correctly	2	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	98 (°C)	allow a value in the range 92 to 104 (°C)	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	the boiling point is lower than 0 (°C)	allow the graph cannot show negative temperatures	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	gas	allow (g)	1	AO2 4.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	C_9H_{20}		1	AO2 4.7.1.1

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	(nonane) has a higher boiling point	allow converse for the other alkanes	1	AO2 4.7.1.2
	(so nonane) condenses where the column has a higher temperature	allow (so nonane) collects where the column has a higher temperature	1	

Total			**8**

Question 3

Question	Answers	Mark	AO/ Spec. Ref
03.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.8.1.3 RPA6
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The design/plan 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 **Method** • draw (pencil) start line on (chromatography) paper • place spot of food colouring on start line • use of suitable solvent • place solvent in beaker / container • place (chromatography) paper in beaker / container • so (chromatography) paper is in solvent • but solvent is below start line • use a lid • wait for solvent to travel up the (chromatography) paper (until near top) • mark solvent front • dry the (chromatography) paper **Measurements** • measure distance between start line and centre of spot • measure distance between start line and solvent front • use of measurements to determine R_f value		

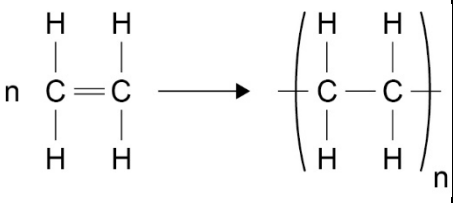
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	different solvent used		1	AO3 4.8.1.3 RPA6

Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	paper		1	AO1 4.8.1.3 RPA6

Total			**8**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1		if equation incorrect allow **1** mark for 5 single bonds **or** allow **1** mark for n	2	AO1 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2		allow converse statements about thermosetting polymers		
	(poly(ethene)) melts	allow thermosoftening polymers melt	1	AO1
	(so) can be reshaped (into new products)		1	AO3 4.10.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	use different (reaction) conditions	allow use different temperatures / pressures	1	AO1 4.10.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		allow converse statements about LDPE		AO3 4.10.3.3
	(in HDPE) polymer chains / molecules are closer together	allow (HDPE has) unbranched polymer chains / molecules	1	
	(so) more atoms per unit volume	allow (so) more molecules per unit volume	1	

Question 4 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	circle around HO– **or** –OH on monomer **A**		1	AO2 4.7.2.3 4.7.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	H_2O **and** HCl	must be in this order	1	AO3 4.7.3.2

Total			9

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	ammonium phosphate potassium nitrate		1 1	AO2 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(nitric acid) calcium nitrate (phosphoric acid) (calcium) triple superphosphate **or** calcium dihydrogenphosphate		1 1	AO1 4.10.4.2

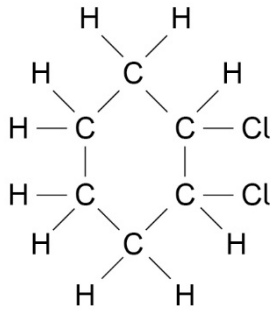
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3		allow converse for laboratory process ignore references to cost / energy		AO3 4.10.4.2
	(industrial process) (is) large(er) scale	 ignore large mass produced	 1	
	(is) quicker		1	
	(is a) continuous process	allow does not need to be repeated	1	
	reasoned judgement		1	

Total			8

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(test) (add) bromine (water) (result) (changes from) brown / orange to colourless	 ignore clear	 1 1	AO1 4.7.1.4 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	C_nH_{2n-2}		1	AO2 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3		allow **1** mark for the structure of 1, 1-dichlorocyclohexane **or** 1, 3-dichlorocyclohexane **or** 1, 4-dichlorocyclohexane	2	AO2 4.7.2.2

Question 6 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(M_r ($C_6H_{10}Cl_2$) =) 153		1	AO2 4.3.1.2
	(% chlorine=) $\frac{71}{153}$ × 100	allow correct use of an incorrectly calculated value of M_r	1	
	= 46.4 (%)	allow 46.405228758 (%) correctly rounded to at least 2 significant figures	1	

Total			**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	flame test lilac (flame)	allow description of flame test	1 1	AO1 4.8.3.1 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	flame emission spectroscopy		1	AO1 4.8.3.6 4.8.3.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	white precipitate	ignore precipitate dissolves	1	AO1 4.8.3.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(add) excess sodium hydroxide (solution) precipitate dissolves	allow (add) more sodium hydroxide (solution)	1 1	AO3 AO1 4.8.3.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	add barium chloride (solution) add (dilute) hydrochloric acid white precipitate	allow add barium nitrate (solution) allow add (dilute) nitric acid dependent on MP1 being awarded	1 1 1	AO1 4.8.3.5 RPA7

Total			9

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(lead is) toxic / poisonous	allow (lead is) harmful ignore (lead is) dangerous / deadly / lethal	1	AO3 4.10.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	the proportions (of metals) are different		1	AO3 4.10.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	any **three** from: • recycling conserves copper ores • recycling uses less energy • recycling reduces waste • mining / quarrying cause environmental impacts	ignore references to cost allow copper ores are finite allow recycling reduces use of landfill allow description of environmental impact caused by mining / quarrying	3	AO1 AO2 AO3 4.10.1.1 4.10.1.4 4.10.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	grow plants (on land containing copper ores) plants are burnt (to produce ash) ash dissolved in acid (to produce a solution of a copper compound) electrolysis of solution (containing a copper compound) **or** displacement (of copper) from solution (containing a copper compound)	allow named plant allow addition of scrap iron to the solution (of a copper compound)	1 1 1 1	AO1 4.10.1.4

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	any **two** from: • high grade ores still available • land not available • phytomining takes a long time • new technology	allow demand not high enough	2	AO3 4.10.1.4

Total			**11**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(delivery) tube is in (sulfuric) acid		1	AO3 4.6.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	reaction has stopped (because a) reactant is used up	allow no more gas produced allow named reactants	1 1	AO2 4.6.1.1 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	any **one** from: • the line (for 0.05 mol/dm^3 sulfuric acid) is less steep • (0.05 mol/dm^3 sulfuric acid) produces less gas in a fixed time • the reaction (using 0.05 mol/dm^3 sulfuric acid) takes longer to finish	allow converse statements about 0.10 mol/dm^3 sulfuric acid ignore produces less gas do **not** accept produces less gas in total	1	AO1 4.6.1.1 RPA5

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	tangent drawn at 80 s on 0.05 mol/dm^3 curve		1	AO2 4.6.1.1 RPA5
	(from tangent) value for *x*-step **and** value for *y*-step	allow a tolerance of ± ½ a small square	1	
	(rate =) $\frac{\text{value for } y\text{-step}}{\text{value for } x\text{-step}}$	allow correct use of incorrectly determined values from tangent for *x*-step and/or *y*-step	1	
	calculation of rate	allow an answer correctly calculated to 2 significant figures	1	
	answer to 2 significant figures	from an incorrect calculation of rate	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	Cu^{2+}		1	AO2 4.1.3.2 4.6.1.4

Total			**10**

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(steam / catalytic) cracking	allow thermal decomposition	1	AO1 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	high temperature steam / catalyst	allow a temperature in the range 300 – 900 °C	1 1	AO1 4.7.1.4

Question 10 continued

Question	Answers	Mark	AO/ Spec. Ref
10.3	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2 4.6.1.3 4.6.2.4 4.6.2.6 4.6.2.7 4.7.2.2
	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 **Rate** • higher temperature gives higher rate • because more frequent collisions • higher pressure gives higher rate • because more frequent collisions • a catalyst can be used to give a higher rate • because the activation energy is reduced **Yield** • higher temperature gives lower yield • because the reaction is exothermic • higher pressure gives higher yield • because there are more molecules on left hand side **Other factors** • higher temperatures use more energy so costs increase • higher pressures use more energy so costs increase • higher pressures require stronger reaction vessels so costs increase **Compromise** • chosen temperature is a compromise between rate and yield • chosen temperature is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between yield and cost (of energy used)		

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	fermentation	allow ferment(ing)	1	AO1 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	warm anaerobic (conditions)	allow a value in the range 25 °C to 45 °C allow without oxygen / air	1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(conversion) 200 km = 200,000 m (moles =) $\frac{200000 \times 1.95 \text{ (mol)}}{1300}$ = 300 (mol)	 allow correct use of incorrect / no conversion for distance 	 1 1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.7	$C_4H_9OH + 6\,O_2 \rightarrow 4\,CO_2 + 5\,H_2O$	allow $C_4H_{10}O$ for C_4H_9OH allow multiples allow **1** mark for $C_4H_9OH + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers ignore state symbols	2	AO2 4.1.1.1 4.3.1.1 4.7.2.3

Total			**17**