AQA

GCSE
COMBINED SCIENCE: SYNERGY
8465/3H

Higher Tier   Paper 3 Physical Sciences

Mark scheme

June 2023

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 their 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 (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

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**.
Alternative words in the mark scheme are shown by a solidus 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 errors / 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** magnetic materials.

[2 marks]

Student	Response	Marks awarded
1	iron, steel, tin	1
2	cobalt, nickel, nail*	2

3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, 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. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks are **not** awarded for a correct final answer from incorrect working.

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

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **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.

3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

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, if necessary, 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. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

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	lithium	allow Li	1	AO2 4.5.1.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.2	loss of an electron		1	AO2 4.5.1.2 4.6.2.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.3	(an) alloy		1	AO1 4.6.2.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.4	percentage of copper = 59 (%)		1	AO2 4.6.2.7
	(mass =) $\dfrac{59}{100} \times 20$	allow correct use of incorrectly determined percentage of copper	1	
	= 11.8 (g)		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.5	the alloy / mixture contains different size atoms		1	AO1 4.6.2.6 4.6.2.7
	(so) the (crystal) structure is distorted	allow (so) the regular pattern is distorted	1	
	(so in the alloy / mixture) the layers / atoms cannot slide over each other easily	allow (so) in (pure) copper the layers / atoms can slide over each other easily	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.6	any **two** from: • (copper has a) giant structure • (copper has) strong (metallic) bonds • large amount of energy needed to break bonds	allow (copper has a giant) lattice structure do **not** accept reference to intermolecular forces	2	AO1 4.6.2.6 4.6.2.7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.7	(copper has) delocalised electrons	allow (copper has) electrons which are free to move through the metal / structure	1	AO1 4.6.2.6 4.6.2.7

Total Question 1	12

Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.1	$E_k = \dfrac{1}{2}\,mv^2$		1	AO1 4.7.1.9

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.2	$v = 24$ (m/s)		1	AO2 4.7.1.9
		subsequent marks can only be awarded if value for v is in the range 22 to 28		
	$900\,000 = 0.5 \times m \times 24^2$	allow a correct substitution of an incorrect value of v	1	
	$m = \dfrac{900\,000}{0.5 \times 24^2}$	allow a correct rearrangement using an incorrect value of v	1	
	$m = 3125$ (kg)	allow $m = 3100$ (kg) allow an answer consistent with an incorrect value of v	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.3	kinetic energy is transferred to gravitational potential energy		1	AO1 4.7.1.9 4.6.1.5 4.8.2.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.4	water decreases the friction that causes braking	allow water lubricates the brakes	1	AO1 4.7.1.10
	(which) increases the (braking) distance		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.5	(the material) is a good (thermal) conductor		1	AO1 4.8.2.6
	(because) it has a high rate of energy transfer		1	

Total Question 2	**10**

Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1	water	allow H_2O	1	AO1 4.7.3.1
	carbon dioxide	allow CO_2	1	4.7.3.2 RPA17

Question	Answers	Mark	AO/ Spec. Ref.
03.2	**Level 3**: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.7.3.2 RPA17
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	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
	
	• **add copper carbonate to (hydrochloric) acid**
	• in suitable container
	• stir
	
	• **continue adding copper carbonate until in excess**
	• when solid remains
	  or
	  when effervescence stops
	
	• **filter (the reaction mixture)**
	• to remove excess copper carbonate
	• using filter paper and funnel
	• pour solution into evaporating dish
	
	• **heat the solution**
	• using electric heater
	  or
	  using a Bunsen burner and a water bath
	• to crystallisation point
	
	• **leave solution to crystallise**
	• dry crystals with filter paper		

Total Question 3	8

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	the potential difference changes direction		1	AO1 4.7.2.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.2	230 (V)		1	AO1 4.7.2.5 4.7.2.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.3	50 (Hz)		1	AO1 4.7.2.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.4	to stop the appliance becoming live		1	AO1 4.7.2.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.5	when S_1 is open no power output		1	AO1 4.7.2.3 4.7.2.4 4.7.2.7
	when (only) S_1 is closed the hair straighteners are at low power		1	
	when both S_1 **and** S_2 are closed the hair straighteners are at high power		1	
		if no other marks awarded allow 1 mark for: S_1 closed switches on A and B (only) **and** S_1 and S_2 need to be closed to switch on A, B, C and D		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.6	E = 14 400 (J)		1	AO2 4.7.2.7
	14 400 = 12 × t **or** $12 = \dfrac{14\ 400}{t}$	allow a correct substitution of an incorrectly / not converted value of energy	1	
	$t = \dfrac{14\ 400}{12}$	allow a correct rearrangement using an incorrectly / not converted value of energy	1	
	t = 1200 (s)	allow an answer consistent with an incorrectly / not converted value of energy	1	

Total Question 4	**11**

Question 5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1 **E**		allow any combination of dots, circles, crosses, e$^{(-)}$ for electrons	1	AO1 4.6.2.1 4.6.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.2	any **two** from: • dot and cross diagram is 2D **or** actual (methane) molecule is 3D • relative sizes of atoms not to scale • only shows the outer shell (of electrons) • moving electrons shown stationary	allow does not show the shape of the molecule allow does not show nuclei / protons / neutrons	2	AO2 4.6.2.4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.3	crude oil is heated to vaporise (the hydrocarbons) temperature (of column) decreases from bottom to top (so) the fractions / hydrocarbons condense at different heights (in the column) (because) the hydrocarbons have different boiling points	 allow the column gets cooler going up	1 1 1 1	AO1 4.8.1.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.4	kerosene has smaller molecules (than fuel oil)	allow converse	1	AO2 4.8.1.3
	(so) kerosene is less viscous (than fuel oil) **and** kerosene is more flammable (than fuel oil)		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.5	(alkane) has the (general) formula C_nH_{2n+2}		1	AO2 4.5.2.1 4.8.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.6	(simplest whole number mole ratio C:H =) $\dfrac{84}{12} : \dfrac{14}{1}$		1	AO2 4.5.2.3 4.5.2.4 4.6.2.4
	= 7 **:** 14		1	
	= 1 **:** 2	allow correct use of incorrectly determined ratio of moles	1	
	(empirical formula =) CH_2		1	
	$\dfrac{28}{12 + (2\times1)} = 2$	allow correct use of incorrectly determined empirical formula	1	
	(formula =) C_2H_4		1	

Total Question 5	16

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1	(mass =) 7.24 x 0.25 = 1.81 (g)		1 1	AO2 4.5.2.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.2	$Al_2(SO_4)_3$		1	AO2 4.7.3.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.3	only partially ionised in aqueous solution		1	AO1 4.7.3.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.4	any **one** from: • ethanoic (acid) • citric (acid) • carbonic (acid)		1	AO1 4.7.3.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.5	increases by a factor of 10		1	AO1 4.7.3.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.6	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$	if no / incorrect balancing, allow **1** mark for $NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$	2	AO2 4.5.2.1 4.7.3.2

Total Question 6	8	

Question 7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.1	distance travelled includes bends in the road so is greater than displacement		1	AO1 4.7.1.1
	(whereas) the displacement of the car is the straight line distance travelled by the car (from the start to the finish)		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.2	(Newton's 1st law states that) if the resultant force is zero, an object will carry on moving with the same velocity		1	AO1 4.7.1.5
	the seatbelt provides a backwards force (on the passenger)		1	
	slowing / stopping the passenger and preventing a collision with the dashboard	allow windscreen or steering wheel for dashboard	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.3		allow converse for dummy **B**		AO3
	the time taken (for dummy **A**) to stop is greater		1	AO1
	(but) the change in velocity is the same		1	AO1
	(so) the deceleration of dummy **A** is less	dependent on scoring MP1 **or** MP2	1	4.7.1.6 4.7.1.4

Total Question 7	8	

Question 8

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.1	(percentage yield =) 61 (%)	allow a value in the range 60 to 64 (%)	1	AO3 4.7.4.8 4.7.4.10

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.2	(percentage) yield decreases as temperature increases	allow converse argument	1	AO2 4.7.4.8 4.7.4.10
	(because) the (forward) reaction is exothermic		1	
	(so) equilibrium position shifts to the left / reactants		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.3	so that none of the gases can escape	allow the system must be closed	1	AO1 4.7.4.9

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.4	(a substance that) changes the rate of a (chemical) reaction but is not used up (during the reaction)		1	AO1 4.7.4.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.5	(effect) (the catalyst) does not affect the percentage yield (of ethanol at equilibrium)		1	AO3 4.7.4.6 4.7.4.8 4.7.4.9
	(reason) (because) the rate of the forward and reverse reactions are increased by the same amount	allow (because the catalyst) decreases the activation energy of the forward and reverse reactions by the same amount	1	

Total Question 8	**8**

Question 9

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.1	(number of copper atoms =) $0.0400 \times 6.02 \times 10^{23}$		1	AO2 4.5.2.4 4.7.5.3
	$= 2.408 \times 10^{22}$		1	
	$= 2.41 \times 10^{22}$	allow an answer correctly calculated to 3 significant figures from an incorrect calculation which uses the values in the question	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.2	$2\,Cl^- \quad \rightarrow \quad Cl_2 + 2\,e^-$	if no / incorrect balancing, allow **1** mark for $Cl^- \rightarrow Cl_2 + e^-$	2	AO2 4.7.5.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
09.3		allow hydrogen ions for H^+ throughout		AO2 4.7.5.3
	water (molecules) break down		1	
	(to) produce H^+ (ions and OH^- ions)		1	
	(which) gain electrons at the negative electrode	allow (which) are reduced at the negative electrode	1	
	to form hydrogen molecules		1	

Total Question 9	9	

Question 10

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.1	(when the switch is closed) there is a current in the wire		1	AO1 4.6.3.5
	(which) creates a magnetic field around the wire	dependent on scoring MP1	1	
	the magnetic field around the wire interacts with the magnetic field around the permanent magnet		1	
	(which) causes a force on the wire	dependent on scoring MP2 or MP3	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
10.2	$0.14 = I \times 0.040$		1	AO2 4.6.3.5 4.7.2.2
	$I = \dfrac{0.14}{0.040}$		1	
	$I = 3.5$ (A)		1	
		the equation $V=IR$ must have been used to score subsequent marks		
	$B = 0.022$ (T)		1	
	$F = 0.022 \times 3.5 \times 0.050$	allow a correct substitution of an incorrectly / not converted value of B	1	
	$F = 0.00385$ (N)	allow an answer consistent with an incorrectly / not converted value of B allow 0.0039 (N)	1	

Total Question 10	10