GCSE
COMBINED SCIENCE: SYNERGY
8465/4H

Higher Tier Paper 4 Physical Sciences

Mark scheme

June 2023

Version: 1.0 Final

2 3 6 G 8 4 6 5 / 4 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.

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 <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.

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	water	allow H_2O	1	AO1 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	(test) (bubble through) limewater (result) (limewater turns) cloudy / milky	MP2 is dependent on MP1 being awarded allow calcium hydroxide solution for limewater allow white precipitate formed	 1 1	AO1 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	measure mass (of fuel and burner /container) before **and** after heating calculate the difference (to measure the mass of fuel burnt)		1 1	AO3 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	any **one** from: • volume of water • time the water is heated for • distance between the flame and the conical flask	allow use 100 cm^3 of water allow heat the water for 5 minutes allow initial temperature of the water	1	AO2 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	(because) **C** used the least fuel to produce the greatest temperature increase	 allow **2** marks for calculations showing that 50/1.23 is greater than 45/1.65 **and** 40/1.72	1 1	AO3 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	any **one** from: • more energy is transferred to the water • draughts are reduced	allow less energy is transferred to the surroundings	1	AO3 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	the temperature increase would be more uniform	allow so the water is all at the same temperature allow so the water is heated evenly allow the temperature increase would be more accurate	1	AO3 4.8.1.3

Total Question 1	**10**

Question 2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**Level 3**: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO3 4.7.2.2
	Level 2: The method 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 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: • use a clamp stand to fix the torch in position • measure the distance between the solar cell and the torch • measure distance with a metre rule • record the corresponding potential difference • vary the height of the torch above the solar cell • use a range of heights between 0 cm and 40 cm • use an interval of 5 cm • ensure there are no other light sources in the lab • ensure the torch is directly above the solar cell • take repeat readings and remove anomalies • take repeat readings and calculate a mean		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	1.8 to 3.7 (V)	allow answers in the range 1.8 to 1.9 for 1.8	1	AO3 4.7.2.2 RPA15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$V = I R$		1	AO1 4.7.2.2 RPA15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	I = 0.09 (A)		1	AO2 4.7.2.2 RPA15
	2.7 = 0.09 × R	allow a correct substitution of a value of current of 0.9 (A) or 0.21 (A)	1	
	$R = \frac{2.7}{0.09}$	allow a correct rearrangement of an equation with a value of current of 0.9 (A) or 0.21 (A)	1	
	R = 30 (Ω)	allow an answer consistent with a value of current of 0.9 (A) or 0.21 (A)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5				AO3 4.7.2.2 RPA15
	between 0 and 1.8 V the resistance is (very) high	allow values in the range 1.8 to 1.9 for 1.8	1	
	above 1.8 V the resistance decreases		1	
		if no other marks awarded allow for **1** mark only for 'the resistance decreases as potential difference increases'		

..0

Total Question 2	**14**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	power output		1	AO3 4.8.2.4
	(power output) is higher	allow more electricity generated (each second) allow more energy is transferred (each second)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2		MP2 is dependent on MP1 being awarded		AO3 4.8.2.4
	power output increases with frequency	allow positive correlation	1	
	the relationship is non-linear	allow a description of the non-linear relationship	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	$Q = I\,t$		1	AO1 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$216\,000 = 5.0 \times t$		1	AO2
	$t = \frac{216\,000}{5.0}$		1	AO2
	$t = 43\,200$		1	AO2
	seconds / s	allow 720 minutes allow 12 hours	1	AO1 4.7.2.1

Total Question 3	**9**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	phytomining		1	AO1 4.8.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	bioleaching		1	AO1 4.8.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	copper ores are (becoming) scarce	ignore references to cost / energy	1	AO1 4.8.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	any **one** from: • (traditional) mining not required • digging / moving / disposing of large amounts of rock not required	ignore references to cost / energy allow consequences of less mining allow can decontaminate land	1	AO1 4.8.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(mixture) has a lower melting point (than aluminium oxide) (so) less energy is required (to melt the mixture)	allow cryolite lowers the melting point (of the mixture) ignore boiling point do **not** accept cryolite is a catalyst	1 1	AO1 4.8.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	the electrodes are made of carbon / graphite (so) the electrodes react with oxygen (and) carbon dioxide is produced (as a gas)	 allow (so) the electrodes are used up allow (so) the electrodes are burnt away	1 1 1	AO1 4.7.5.2 4.8.2.2

Total Question 4	**9**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	5.0 = 0.80 × Δ*v* $\Delta v = \frac{5.0}{0.80}$ Δ*v* = 6.25 (m/s) final velocity = 1.25 (m/s)	 alternative method: initial momentum = 0.80 x 7.5 (1) = 6.00 (kg m/s) (1) final velocity = $\frac{6.00 - 5.00}{0.80}$ (1) final velocity = 1.25 m/s (1)	1 1 1 1	AO2 4.7.1.8

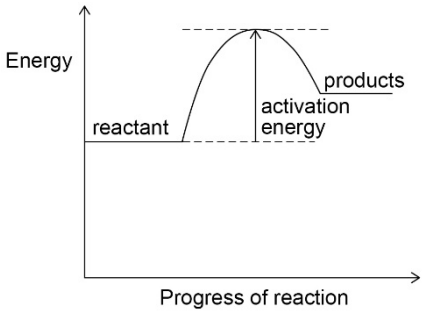
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	the forces are equal in magnitude / size but (the forces) act in opposite directions	 if no other marks awarded allow **1** mark for the forces are equal and opposite	1 1	AO1 4.7.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	s = 0.012 (m)		1	AO2 4.6.1.3
	6.0 = F × 0.012	allow a correct substitution of an incorrectly / not converted distance	1	
	$F = \frac{6.0}{0.012}$	allow a correct rearrangement of an equation with an incorrectly / not converted distance	1	
	F = 500 (N)	allow an answer consistent with an incorrectly / not converted distance	1	

Total Question 5	**10**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(energy needed to break bonds =) 2**Y**		1	AO2 4.7.4.5
	(energy released in forming bonds = 436 + 193 =) 629		1	
	(overall energy change = energy needed to break bonds – energy released in forming bonds)		1	
	103 = 2**Y** - 629	allow 2**Y** = 629 + 103 allow 2**Y** = 732 allow correct use of incorrectly determined value of energy released in forming bonds		
	Y = $\frac{629 + 103}{2}$	allow correct use of incorrectly determined value of energy needed to break bonds	1	
	= 366 (kJ/mol)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(*y*-axis) energy **and** (*x*-axis) progress of reaction	ignore arrow heads	1	AO1 4.7.4.4 4.7.4.5
	endothermic profile with product energy above reactant energy		1	
	reactant labelled **and** products labelled	allow hydrogen bromide for reactant allow hydrogen and bromine for products allow (2) HBr for reactant allow H_2 and Br_2 for products	1	
	activation energy labelled from reactant energy to top of curve		1	
		an answer of  scores **4** marks		

Total Question 6	**9**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(when the force / weight is removed) the spring returns to its original length	allow size or shape for length	1	AO1 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	20 (cm)	allow answer in the range 20 to 21 (cm)	1	AO3 4.6.1.6 RPA13

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		MP2, 3 and 4 are dependent on MP1 being awarded		AO2 4.6.1.6 RPA13
	e = 20 (cm) **and** F = 8 (N)	allow other corresponding pair of values from linear section of graph	1	
	e = 0.20 (m)	allow conversion of their value of e to metres	1	
	$k = \frac{8}{0.20}$	allow correct substitution using their values of F and e allow a correct substitution from an incorrectly / not converted value of e	1	
	k = 40 (N/m)	allow an answer consistent with an incorrectly / not converted value of e	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	vertical arrow upwards with arrowhead pointing up 3 cm long arrow	MP2 is dependent on MP1 being awarded	1 1	AO2 4.6.1.6 4.6.1.2 RPA13

Total Question 7	**8**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	concentration of (hydrochloric) acid		1	AO1 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	tangent drawn at 60 s		1	AO2 4.7.4.1
	(from tangent) value for *x*-step **and** value for *y*-step	allow a tolerance of ± ½ a small square allow evidence of use of two points on tangent either on the graph or in the text	1	4.7.4.3 RPA19
	(rate =) $\frac{\text{value for } y\text{-step}}{\text{value for } x\text{-step}}$	allow correct use of incorrectly determined value(s) from tangent for *x*-step and / or *y*-step from a drawn tangent	1	
	correctly calculated rate		1	
	correctly rounded to 2 significant figures	allow a correctly calculated answer to 2 significant figures from an incorrect calculation which uses values determined from the graph	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	gradient of line (of best fit) decreases (over time)	allow less carbon dioxide is collected per unit time	1	AO3 4.7.4.1 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	concentration of (hydrochloric) acid decreases (in the reaction mixture) (so) there are fewer (hydrochloric) acid particles per unit volume (so) the frequency of collisions decreases **OR** (total) surface area of calcium carbonate decreases (in the reaction mixture) (1) (so) there are fewer (calcium carbonate) particles on the surface (1) (so) the frequency of collisions decreases (1)		1 1 1	AO3 AO1 AO1 4.7.4.3 RPA19

Total Question 8	**10**

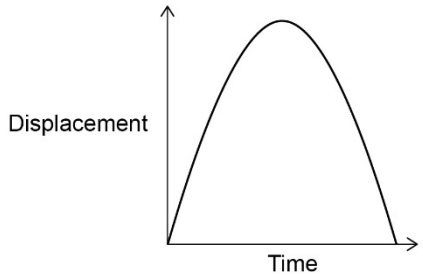
Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	$h = \frac{(7.0 \times 0.70)}{2}$ h = 2.45 (m)	allow method to determine area under the graph by counting squares	1 1	AO2 4.7.1.2 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	area under the graph line represents distance travelled (area) is the same for both positive and negative velocities	allow for **1** mark only: initial velocity is 7.0 m/s and final velocity is -7.0 m/s **or** initial speed is the same as the final speed **or** time to travel upwards (0.70 s) is the same as the time to travel downwards	1 1	AO3 4.7.1.2 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	the gradient represents the acceleration (and) the acceleration due to gravity is constant / 9.8 m/s^2		1 1	AO3 4.7.1.2 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	any **two** from: • line would reach 0.0 m/s before 0.70 s • area under line would be smaller • line would have a steeper gradient • line would be curved (rather than straight)	allow the velocity would become negative before 0.70 s	2	AO3 4.7.1.2 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5			1	AO3 4.7.1.2

Total Question 9	**9**

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	the distance travelled during the driver's reaction time		1	AO1 4.7.1.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	the driver being tired using a mobile phone while driving		1 1	AO1 4.7.1.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	braking distance is shorter for 2020 / modern car at all speeds (because) the 2020 / modern car had more effective brakes	 dependent on scoring MP1 allow (because) the tyres on the 2020 / modern car had better grip	1 1 1	AO3 4.7.1.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	braking distance = 34 (m)		1	AO3
	$0^2 - 27^2 = 2 \times a \times 34$	allow correct use of misread value of braking distance to score subsequent marks	1	AO2
	$a = \frac{(-)\ 729}{68}$		1	AO2
	a = (-)10.7… (m/s^2)		1	AO2
		the equation $v^2 - u^2 = 2as$ must have been used to score subsequent marks		AO2
				AO2
		subsequent marks can be awarded using their calculated acceleration		4.7.1.4 4.7.1.6
	$F = 850 \times 10.7$		1	4.6.1.3 4.7.1.9
	F = 9112.5 (N)	allow a correct answer rounded to 2 or more significant figures.	1	
	OR			
	$E_k = ½\ 850 \times 27^2$ (1)			
	E_k = 309 825 (J) (1)			
	braking distance = 34 (m) (1)			
		the equation $E_k = ½\ m \times v^2$ must have been used to score subsequent marks		
		subsequent marks can be awarded using their calculated E_k		
	309 825 = $F \times 34$ (1)			
	$F = \frac{309\ 825}{34}$ (1)			
	F = 9112.5 (N) (1)	allow a correct answer rounded to 2 or more significant figures.		

Total Question 10	**12**