GCSE
COMBINED SCIENCE: SYNERGY
8465/4H

Higher Tier Paper 4 Physical Sciences

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226G8465/4H/MS

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

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

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

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make 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	distance travelled under the braking force	allow distance travelled while decelerating do **not** accept references to time	1	AO1 4.7.1.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	weight = mass × gravitational field strength **or** $W = m \times g$		1	AO1 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$14\ 700 = m \times 9.8$ $m = \frac{14\ 700}{9.8}$ $m = 1500$ (kg)		1 1 1	AO2 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$\Delta t = 0.35 \times 0.50$ $\Delta t = 0.175$ (s) reaction time = 0.675 (s) **or** reaction time = 1.35 × 0.50 (2) reaction time = 0.675 (s) (1)		1 1 1	AO2 4.7.1.10

Question	Answers	Mark	AO / Spec. Ref.
01.5	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 4.7.1.10
	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 • all activities using a mobile phone increase reaction time • using a mobile phone increases your reaction time more than driving at the legal alcohol limit • driving at legal alcohol limit increases reaction time (by 12%) to 0.56 (s) • hands-free phone call increases reaction time by 26% (to 0.63 s) • hand-held phone call increases reaction time by 41% (to 0.705 s) • typing text message increases reaction time by 35% (to 0.675 s) • using a hands-free kit doesn't greatly change the reaction time compared with hand-held • using a mobile phone is more dangerous than drinking alcohol (at the legal limit) while driving		

Total Question 1		**12**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	36 (cm^3)		1	AO2 4.7.3.1 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	the reaction starts before the stopper is fitted (so) hydrogen / gas escapes	allow difficult to fit stopper and start timer at same time	1 1	AO3 4.7.3.1 4.7.4.3 RPA19

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	80 (s)	allow a value in the range 78 to 82 (s)	1	AO3 4.7.3.1 4.7.4.3 RPA19

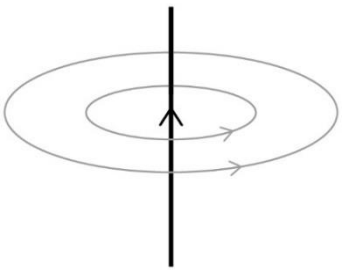
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	initially the line of best fit would have a higher gradient		1	AO3 4.7.3.1 4.7.4.1 4.7.4.3 RPA19

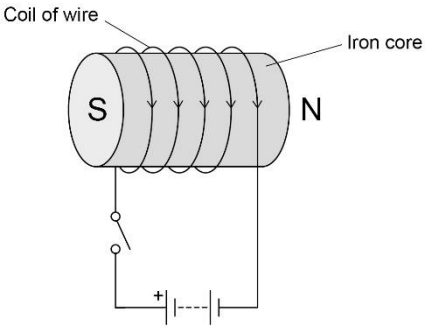
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	(test) burning splint (result) (burns rapidly with) a pop sound	 MP2 is dependent on MP1	 1 1	AO1 4.7.3.1 4.7.5.4

Total Question 2		**7**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	move the magnetic compass close to the magnet the needle of the compass will point towards the south pole of the magnet		1 1	AO1 4.6.3.1 4.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2		at least 2 concentric rings with correct arrows	1	AO1 4.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		**N** and **S** labels need to be next to the vertical surfaces of the poles both labels needed	1	AO2 4.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	resultant force = mass × acceleration **or** $F = m \times a$		1	AO1 4.7.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$4.8 \times 10^{-3} = 4.0 \times 10^{-4} \times a$ $a = \frac{4.8 \times 10^{-3}}{4.0 \times 10^{-4}}$ $a = 12$ (m/s^2)		1 1 1	AO2 4.7.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(as distance decreases the magnetic) force (on paper clip) increases (so) the paper clip's <u>acceleration</u> increases		1 1	AO1 4.6.3.2 4.7.1.6

Total Question 3		10

Question 4

Question	Answers	Mark	AO / Spec. Ref.
04	**Level 3**: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3 4.8.1.2 4.8.2.8 4.8.2.9
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content **raw materials** • paper bags are made from renewable plant materials so do not use up finite resources • wood involves land use for forestry so less available for food production • plastic bags are made from crude oil which is a finite resource **manufacturing** • both require energy which may be derived from finite fuels (so they run out more quickly) • paper bag requires (4.1 times) more energy to produce than the plastic bag • paper bag involves (3.5 times) more water usage (so increases the potential for water pollution) • paper bags are (1.6 times) heavier to transport (so have higher energy requirement) **usage** • plastic bag can be reused (more often than a paper bag) **disposal** • paper bag will decompose so will not remain in landfill • both can be recycled to avoid landfill • both can cause litter • plastic bags can be eaten by organisms eg whales		

Total Question 4		**6**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	potential difference (across **R**) decreased current (in **R**) decreased		1 1	AO1 4.7.2.2 RPA15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	resistance is constant (because) the gradient is constant **or** (because) the graph is a straight line passing through the origin	dependent on MP1	1 1	AO3 4.7.2.2 RPA15

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	the temperature (of the resistor) had increased (so) the resistance (of the resistor) has increased (so the current is lower)		1 1	AO3 4.7.2.2 RPA15

Question	Answers	Mark	AO / Spec. Ref.
05.4	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 4.7.2.3 RPA16
	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 • connect one additional resistor in parallel with resistor **R** • measure the current with the ammeter • measure the p.d. with the voltmeter • calculate resistance using $R=\frac{V}{I}$ • repeat with increasing number of resistors		

Total Question 5		**10**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the equilibrium position shifts towards the side with the smaller number of molecules		1	AO2 4.7.4.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	the relative amount of ammonia decreases		1	AO2 4.7.4.10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	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.
06.4	(the relative amounts are) unchanged (because) the forward and reverse reactions occur at equal rates		1 1	AO2 4.7.4.9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	all the ammonia reacted (because) excess hydrogen chloride was added		1 1	AO1 4.5.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	(moles of NH_4Cl = moles of NH_3 = $\frac{6.8}{17}$ =) 0.4		1	AO2 4.5.2.3 4.5.2.4 4.5.2.5
	(M_r of NH_4Cl = 14 + 4 + 35.5 =) 53.5		1	
	(mass of NH_4Cl =) 0.4 × 53.5	allow correct use of incorrectly calculated value(s) of M_r of NH_4Cl and/or moles of NH_3	1	
	= 21.4 (g)		1	
	alternative approach: (M_r of NH_4Cl = 14 + 4 + 35.5 =) 53.5 (1)			
	17 (g of NH_3) gives 53.5 (g of NH_4Cl) (1)	allow correct use of incorrectly calculated value(s) of M_r of NH_3 and / or M_r of NH_4Cl		
	(6.8 g of NH_3 gives) $\frac{6.8}{17}$ × 53.5 (g of NH_4Cl) (1)			
	= 21.4 (g) (1)			

Total Question 6		**11**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$230 \times 2.40 = 48.0 \times I$ $I = \frac{230 \times 2.40}{48.0}$ $I = 11.5$ (A)		1 1 1	AO2 4.7.2.9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$288 = 2.40 \times t$ **or** $t = \frac{288}{2.40}$ $t = 120$ (s) $t = 2$ (minutes)	 allow correct conversion of incorrectly calculated time using data from the question	1 1 1	AO2 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	earth potential is zero (volts) (so) there is a potential difference between the circuit and earth / electrician causing charge to flow through electrician	allow electrician is at zero volts allow electrician is earthed allow current for charge	1 1 1	AO1 4.7.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	50 Hz causes pain at lower currents than both dc or 10 000 Hz ac		1	AO3 4.7.2.6
	pattern continues as effects increase in severity		1	
	dc and 10 000 Hz both have similar currents at all pain levels		1	

Total Question 7		**12**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	magnesium loses electrons (to form magnesium ions) so is oxidised hydrogen ions gain electrons (to form hydrogen) so are reduced	 if no other mark awarded allow **1** mark for magnesium loses electrons **and** hydrogen ions gain electrons	1 1	AO2 4.5.1.2 4.7.3.1 4.7.5.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	the pH increases by 1		1	AO1 4.7.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	allow **1** mark for $H^+ + OH^- \rightarrow H_2O$	2	AO1 AO2 4.5.2.1 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	any **two** from: • fizzing • flame • (potassium) floats • (potassium) melts • (potassium) moves (on the surface)	ignore a gas is produced ignore colour of flame allow potassium disappears	2	AO1 4.5.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	potassium hydroxide is produced (so in aqueous solution) hydroxide ions are present (and the solution) is alkaline		1 1 1	AO2 AO2 AO1 4.5.1.4 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.6	**Z** **Z** is partially ionised so is a weak acid **Z** has more particles / ions (than **W** in the same volume) so is more concentrated	 (if **W** is chosen) allow **W** is partially ionised so is a weak acid (if **X** is chosen) allow **X** has the most particles / ions (in the same volume) so is more concentrated	1 1 1	AO3 4.7.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.7	any **two** from: • particles are shown as 2D • water molecules are not shown • relative sizes of the particles are not to scale	allow particles are not shown as 3D ignore references to forces / movement	2	AO3 4.6.2.2 4.7.3.5

Total Question 8		**15**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	$m = 0.025$ (kg)		1	AO2 4.6.1.5
	$0.147 = 0.025 \times 9.8 \times h$	allow a correct substitution using an incorrectly / not converted value of m	1	
	$h = \frac{0.147}{0.025 \times 9.8}$	allow a correct rearrangement using an incorrectly / not converted value of m	1	
	$h = 0.60$ (m)	allow a correct calculation using an incorrectly / not converted value of m	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	two pairs of values of a and m showing that $a \times m$ = constant	eg $1.0 \times 0.1 = 0.10$, etc	1	AO3 4.7.1.6 RPA14
	third pair of values of a and m showing that $a \times m$ = constant		1	
	(so) $a \times m$ = constant (showing the student was correct)		1	
		if no other marks awarded a maximum of 2 marks can be awarded as follows **1** mark for a statement relating the change in mass (of glider) to the change in acceleration **1** mark for use of data from graph to confirm the statement		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	lubricate the axle of the trolley	allow wheels for axle allow put trolley on incline to compensate for friction ignore lubricate the bench	1	AO3 4.8.2.6 RPA14

Total Question 9		**8**

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	force ∝ extension **or** force is (directly) proportional to extension (up to the limit of proportionality)	allow $F = ke$	1	AO1 4.6.1.6 RPA13

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	$e = 0.20$ (m)		1	AO2 4.6.1.7
	$k = \frac{1.16}{0.5 \times 0.20^2}$	allow a correct rearrangement using an incorrectly / not converted value of e	1	
	$k = 58$ (N/m)	allow a correct calculation using an incorrectly / not converted value of e	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	both stones have the same kinetic energy (because they have the same elastic potential energy) **or** energy of both stones is ½ mv^2 (because they have the same elastic potential energy)		1	AO2
	A: $E_k = ½\ mv^2$ **and** **B:** $E_k = ½\ (4m)\ v^2$	**A:** $v = \sqrt{\frac{E_k}{0.5\ m}}$ **and** **B:** $v = \sqrt{\frac{E_k}{2\ m}}$	1	AO3
	(so) speed of **B** is half the speed of **A**		1	AO3 4.6.1.7 4.7.1.9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	student should have taken more readings between 0 and 5 (N) **or** student should have taken more readings between 0 and 1 (N) **or** student should have taken more readings between 4 and 5 (N)	allow specific examples eg an interval of 0.50 (N)	1	AO3 4.6.1.6 RPA13
	which would make the line of best fit easier to determine		1	

Total Question 10		9