GCSE
COMBINED SCIENCE: SYNERGY
8465/3H

Higher Tier Paper 3 Physical Sciences

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226G8465/3H/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	layers of atoms slide over each other		1	AO1 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	delocalised electrons	allow free electrons	1	AO1 4.6.2.6
	(which) carry (electrical) charge	ignore current / electricity for charge	1	4.6.2.7
	(as the electrons move) through the metal / structure	ignore throughout for through	1	

<table>
<tr><th>Question</th><th>Answers</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td rowspan="4">01.3</td><td>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.</td><td>4–6</td><td rowspan="4">AO1
4.6.2.1
4.6.2.2
4.6.2.3
4.6.2.4
4.6.2.5
4.8.1.1</td></tr>
<tr><td>Level 1: Relevant features are identified and differences noted.</td><td>1–3</td></tr>
<tr><td>No relevant content</td><td>0</td></tr>
<tr><td>Indicative content

similarities:

• giant structure
• regular structure
• strong bonds

differences:

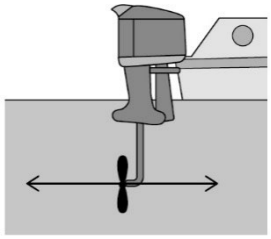
<table>
<tr><th>diamond:</th><th>sodium chloride:</th></tr>
<tr><td>• only consists of carbon atoms</td><td>• consists of sodium ions and chloride ions</td></tr>
<tr><td>• element (carbon)</td><td>• compound made of two elements (sodium and chlorine)</td></tr>
<tr><td>• non-metal</td><td>• contains a metal and a non-metal</td></tr>
<tr><td>• covalent bonding</td><td>• ionic bonding</td></tr>
<tr><td>• shared pairs of electrons</td><td>• electrostatic forces of attraction</td></tr>
<tr><td>• between (carbon) atoms</td><td>• between oppositely charged ions (sodium and chloride)</td></tr>
<tr><td>• each carbon atom is bonded to four other atoms</td><td>• each ion is surrounded by six other ions</td></tr>
<tr><td></td><td>• forces act in all directions</td></tr>
</table>
</td><td></td><td></td></tr>
</table>

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(M_r =) (12 × 2) + (4 × 1) = 28		 1 1	AO2 4.5.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	poly(ethene) has larger molecules (so poly(ethene)) has stronger intermolecular forces (so) more energy is needed to overcome the intermolecular forces	allow converse	1 1 1	AO2 4.6.2.5

Total Question 1		**15**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1		force arrow pointing horizontally to the right starting/finishing on the propellor force arrow pointing horizontally to the right and same length as force of propeller on water arrow	1 1	AO2 4.6.1.1 4.7.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	<table><tr><td>Quantity</td><td>Scalar</td><td>Vector</td></tr><tr><td>Speed</td><td>✓</td><td></td></tr><tr><td>Velocity</td><td></td><td>✓</td></tr><tr><td>Mass</td><td>✓</td><td></td></tr><tr><td>Weight</td><td></td><td>✓</td></tr></table>	4 correct answers for **2** marks 2 or 3 correct answers for **1** mark	2	AO1 4.6.1.1 4.6.1.4 4.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$v = \frac{s}{t}$		1	AO1 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$6000 = 12 \times t$ $t = \frac{6000}{12}$ $t = 500$ (s)		1 1 1	AO2 4.7.1.2

Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.7.1 4.7.1.5 4.7.1.6 4.7.1.7
	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: • forward force decreases (to zero) • (because) propeller stops turning **or** (because) the engine has been turned off • water resistance decreases • (because) water resistance depends on speed • weight of boat remains constant • (because) weight depends on mass which is constant • upthrust force is constant • (because) same volume of water is displaced Extra descriptions • upthrust force remains equal to the weight of the boat • vertical resultant force does not change • initially resultant (horizontal) force acts to the left • horizontal resultant force decreases to zero		

Total Question 2		**14**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	carbon dioxide escapes (from the conical flask)	allow a gas escapes (from the conical flask)	1	AO3 4.5.2.2 4.7.4.1 4.7.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	$0.0012 = \frac{0.36}{\text{time taken}}$		1	AO2 4.7.4.1 4.7.4.2
	(time taken =) $\frac{0.36}{0.0012}$		1	
	= 300 (s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	powder has a greater surface area (to volume ratio than lumps)		1	AO1 4.7.4.2
	(so) more calcium carbonate is in contact with the (hydrochloric) acid		1	
	(so) the frequency of collisions is greater	(so) greater probability of collisions	1	

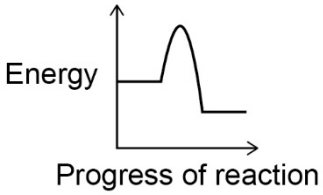
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(surface area of one face = 0.8 × 0.8 =) 0.64		1	AO2 4.7.4.2
	(surface area of cube =) 6 × 0.64	allow correct use of an incorrectly calculated surface area of one face	1	
	= 3.84 (cm^2)		1	

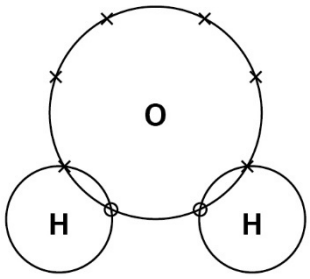
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	the lump has an irregular shape		1	AO3 4.7.4.2

Total Question 3		**11**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(energy released =) 4 × 464 = 1856 (kJ/mol)		1 1	AO2 4.7.4.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2			1	AO1 4.7.4.4 4.7.4.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	one bonding pair of electrons in each overlap four non-bonding electrons on oxygen	allow any combination of dots, circles, crosses, $e^{(-)}$ for electrons do **not** accept non-bonding electrons on hydrogen an answer of  scores **2** marks	1 1	AO1 4.6.2.1 4.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	hydrogen atoms have one electron (in the outer shell)	allow energy level for shell	1	AO1 4.6.2.1 4.6.2.4
	(so) two (hydrogen) atoms share a pair of electrons	allow (so) two (hydrogen) atoms form a covalent bond	1	
	(so) the (hydrogen) atoms have stable arrangements of electrons **or** (so) the (hydrogen) atoms have full outer shells		1	

Total Question 4		**8**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	number of squares = 12	allow 11−13 squares	1	AO2 4.7.1.2
	each square = 2.5 (m)		1	
	distance = 12 × 2.5 = 30 (m)	allow an answer consistent with the number of squares used	1	
		allow for **3** marks a correct calculation of the total distance using 2 or more separate areas if no other mark awarded allow **1** mark for the correct calculation of 1 area		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	efficiency = 0.80		1	AO2 4.8.2.7
	$0.80 = \frac{220}{\text{total power input}}$	allow use of efficiency = 80%	1	
	$\text{total power input} = \frac{220}{0.80}$	allow use of efficiency = 80%	1	
	total power input = 275 (W)	allow an answer of 2.75 if used efficiency = 80%	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(after the collision) the student continues to move forward (with the same velocity) until the seatbelt exerts a force in the opposite direction (which) causes the student to decelerate (and stop)		1 1 1	AO1 4.7.1.5 4.7.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	600 (ms) = 0.600 (s) $2.0 = \frac{\Delta v}{0.600}$ $\Delta v = 2.0 \times 0.600$ $v = 1.2$ (m/s)	 allow a correct substitution of an incorrectly / not converted value of *t* allow a correct rearrangement using an incorrectly / not converted value of *t* allow a correct calculation using an incorrectly / not converted value of *t*	1 1 1 1	AO2 4.7.1.4 4.7.1.6

Total Question 5		14

Question 6

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	iron oxide loses oxygen so is reduced carbon gains oxygen so is oxidised	ignore references to loss or gain of electrons if no other mark awarded allow **1** mark for iron oxide loses oxygen **and** carbon gains oxygen	1 1	AO2 4.8.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	any **one** from: • the metal is more reactive than carbon • the metal reacts with carbon	allow carbon is less reactive than the metal	1	AO1 4.8.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	cryolite lowers the melting point (of the mixture) (so) less energy is needed	ignore references to cost allow (so) less electricity is needed	1 1	AO1 4.8.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	$Al^{3+} + 3e^- \rightarrow Al$	allow multiples allow **1** mark for $Al^{3+} + e^- \rightarrow Al$ with no / incorrect balancing numbers	2	AO2 4.5.2.1 4.7.5.2 4.7.5.5

Total Question 6		**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(concentration =) $\frac{48.4}{0.40}$		1	AO2
	= 121		1	AO2
	g/dm^3		1	AO1 4.5.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(number of molecules =) 3.00 × 6.02 × 10^{23}		1	AO2 4.5.2.4
	= 1.806 × 10^{24}		1	
	= 1.81 × 10^{24}	allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses the values in the question	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$2(A_r$ of **M**$) + (3 \times 16) = 152$		1	AO2
	$(A_r$ of **M**$) = \frac{104}{2}$		1	AO2
	$= 52$		1	AO2
	M is chromium	allow an answer consistent with an incorrectly calculated A_r of **M**	1	AO3 4.5.2.1 4.5.2.3

Total Question 7		**10**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	reactivity decreases (going down the group)	allow energy level for shell throughout	1	AO1 4.5.1.5
	(because) the outer electrons / shell become further from the nucleus	allow (because) the atoms become larger allow (because) the number of shells increases	1	
	(so) the nucleus has less (electrostatic) attraction for the outer electrons / shell	allow (so) the nucleus has less (electrostatic) attraction for the incoming electron allow (so) there is more shielding between the nucleus and the outer electrons / shell	1	
	(so) an electron is gained less easily		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	the electronic structure is 2,8,8,2	allow calcium has two electrons in the outer shell	1	AO1 4.5.1.2 4.6.2.2
	(so) calcium reacts by losing (two) electrons to form a positive ion	allow (so) calcium reacts by losing (two) electrons to achieve a full outer shell	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$2\,Rb + 2\,H_2O \rightarrow 2\,RbOH + H_2$	allow multiples allow **1** mark for RbOH allow **1** mark for H_2	3	AO2 AO3 4.5.1.1 4.5.1.4 4.5.2.1 4.5.2.2

Total Question 8		**9**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	resistance of variable resistor is changed		1	AO1 4.7.2.2
	(which) changes the current in the motor	do **not** accept electricity for current	1	
	(so) greater current increases motor speed **or** smaller current decreases motor speed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	alternating current constantly reverses direction		1	AO1 4.7.2.5 4.7.2.2
	(but) diode only allows current in one direction	do **not** accept electricity for current	1	4.7.2.4
	(because) the diode has a very high resistance in the reverse direction		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	$P = 5.0^2 \times 0.18$		1	AO2 4.7.2.8
	$P = 4.5$ (W)		1	4.7.2.1 4.7.2.7
	$t = 7200$ (s)		1	
	$E = 4.5 \times 7200$	allow a correct substitution of an incorrectly / not converted value of t	1	
	$E = 32\,400$ (J)	allow a correct calculation using an incorrectly / not converted value of t	1	
	OR			
	$t = 7200$ s (1)			
	$Q = 5.0 \times 7200$ (1)	allow a correct substitution of an incorrectly / not converted value of t		
	$Q = 36\,000$ (C) (1)	allow a correct calculation using an incorrectly / not converted value of t		
	$V = (5.0 \times 0.18 =) 0.9$ (1)	allow a correct calculation using an incorrectly / not converted value of t		
	$E = (36\,000 \times 0.9 =) 32\,400$ (J) (1)			
	OR			
	$V = (5.0 \times 0.18 =) 0.9$ (1)			
	$P = (5.0 \times 0.9 =) 4.5$ (W) (1)	allow a correct substitution of an incorrectly / not converted value of t		
	$t = 7200$ (s) (1)			
	$E = 4.5 \times 7200$ (1)	allow a correct calculation using an incorrectly / not converted value of t		
	$E = 32\,400$ (J) (1)			

Total Question 9		**11**