GCSE
COMBINED SCIENCE: SYNERGY
8465/3H

Higher Tier Paper 3 Physical Sciences

Mark scheme

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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.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

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 should be awarded for a correct numerical answer, without any working shown.
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	protein	allow complex 3D structure allow polymer ignore biological catalyst ignore named enzymes	1	AO1 4.7.4.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	the mass of the catalyst stays the same		1	AO1 4.7.4.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	(**X**) active site		1	AO1 4.7.4.7
	(**Y**) substrate	allow reactant	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	lock and key		1	AO1 4.7.4.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5		allow enzyme for amylase		
	so the temperature is the same (for all the solutions)	allow temperature is a control variable	1	AO1 4.7.4.7 RPA20
	(because) amylase is affected by (change in) temperature	allow (because) high temperatures denature the amylase allow (because 35°C is) the optimum temperature for amylase do **not** accept killing the amylase	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	(test) add iodine reagent (result) turns blue-black	 ignore iodine unqualified allow iodine solution allow turns black allow turns dark purple allow turns dark blue	 1 1	AO1 4.7.4.7 RPA20

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	pH 7.0 to pH 7.5		1	AO3 4.7.4.7 RPA20

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	any **one** from: • decrease the sampling time • have smaller intervals of pH • test more pH values between 7.0 and 7.5	 allow repeat **and** calculate a mean	1	AO3 4.7.4.7 RPA20

Total Question 1	**11**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	$a = \frac{6}{20}$	allow a substitution using a correct pair of corresponding values from the first 20 seconds of the graph	1	AO2 4.7.1.4
	$a = 0.3$ (m/s^2)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	$s = 6 \times 25$		1	AO2 4.7.1.4
	$s = 150$ (m)		1	

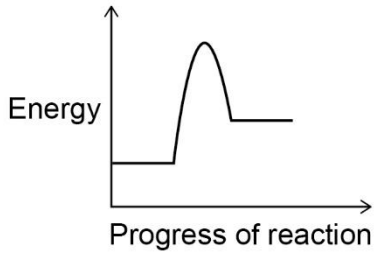
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	the deceleration was greater than the acceleration		1	AO2 4.7.1.4
	the gradient was steeper	dependent on MP1 allow less time to decelerate	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	$16^2(-0^2) = 2 \times a \times 80$	allow $256 = 160 \times a$	1	AO2 4.7.1.4
	$a = \frac{16^2}{2 \times 80}$	allow $a = \frac{256}{160}$	1	
	$a = 1.6$ (m/s^2)		1	

Total Question 2	**9**

Question 3

Question	Answers	Mark	AO / Spec. Ref.
03.1	**Level 3**: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5−6	AO1 4.7.3.3 RPA18
	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: • **measure volume of (sodium hydrogen carbonate) solution** • using a measuring cylinder • **pour (sodium hydrogen carbonate) solution into a suitable container eg polystyrene cup** • stand the polystyrene cup in a beaker • measure the initial temperature (of the sodium hydrogen carbonate solution) • using a thermometer • **add a known mass of citric acid to the (sodium hydrogen carbonate) solution** • measured with a balance • stir • **measure the lowest temperature reached** • using a thermometer • **repeat with different masses of citric acid** **or** **add successive masses of citric acid to the same mixture** • repeat the whole investigation • use the same volume of (sodium hydrogen carbonate) solution • use the same concentration of (sodium hydrogen carbonate) solution • use the same initial temperature		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2			1	AO1 4.7.4.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	powder has greater surface area (so) frequency of collisions is increased	allow powder has a higher surface area to volume ratio	1 1	AO1 4.7.4.2

Total Question 3	**9**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	any **one** from: • to allow comparisons to be made • to allow the total impact to be calculated (in one LCA)		1	AO2 4.8.2.8

Question	Answers	Mark	AO / Spec. Ref.
04.2	**Level 2**: A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3
	Level 1: Some logically linked reasons are given. There may also be a simple judgement.	1–2	AO2
	No relevant content	0	
	Indicative content **materials** • shirt **A** has a much higher impact • shirt **A**'s impact is 0.71 (equivalent units) greater • shirt **A**'s impact is 1.82 times greater • shirt **B** has 55% of the impact of shirt **A** • for both shirts, materials have less impact than energy • for both shirts, materials have more impact than bleach **energy** • shirt **B** has a slightly higher impact • shirt **B**'s impact is 0.09 (equivalent units) greater • shirt **B**'s impact is 1.04 times greater • shirt **A** has 96% of the impact of shirt **B** • for both shirts, energy has the greatest overall impact **bleach** • for both shirts, impact is the same • for both shirts, bleach has the least overall impact **total impact** • shirt **A** = 4.05 (equivalent units) • shirt **B** = 3.43 (equivalent units) • shirt **A**'s overall impact is 0.62 (equivalent units) greater **reasoned overall judgement**		4.8.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	any **one** from: • to avoid bias • to avoid misuse of the information (in the LCA) • to detect false claims • to confirm the validity (of the claims)	allow to check for accuracy	1	AO1 4.8.2.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(bacteria) bioleaching (plants) phytomining		1 1	AO1 4.8.2.3

Total Question 4	**8**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(step-up transformers) increase the potential difference		1	AO1 4.7.2.9
	(so) the current decreases		1	
	(so) energy/power loss from the power cables decreases	allow (so) there is less heating in the power cables	1	
	(which) increases the efficiency (of the National Grid)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(step-down transformers) decrease the potential difference		1	AO1 4.7.2.9
	(so) it is safer (for consumers)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	V_P = 345 000 (V)		1	AO2 4.7.2.9
	230 × I_S= 345 000 × 0.060	allow a correct substitution using an incorrectly / not converted value of V_P	1	
	$I_S = \frac{345\,000 \times 0.060}{230}$	allow a correct rearrangement using an incorrectly / not converted value of V_P	1	
	I_S = 90 (A)	allow an answer consistent with an incorrectly / not converted value V_P	1	

Question	Answers	Mark	AO / Spec. Ref.
05.4	**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.	3–4	AO1 4.8.2.4
	Level 1: Relevant features are identified and differences noted.	1–2	
	No relevant content	0	
	Indicative content: **nuclear power stations** • nuclear fuel requires mining • which causes disruption to habitats • produce radioactive waste • that will be radioactive for a long time • that needs to be buried • nuclear disasters can happen • which can have a major environmental impact **coal power stations** • coal requires mining • which causes disruption to habitats • release carbon dioxide • which is a greenhouse gas • which contributes to global warming • release sulfur dioxide • which causes acid rain • release soot / particulates • which cause global dimming • which cause respiratory problems		

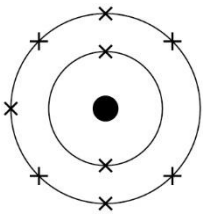
Total Question 5	14

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	noble gases		1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(Group 0 elements are) unreactive (because the atoms have) a stable arrangement of electrons	 allow (because the atoms have) a full outer shell allow (because the atoms have) a full outer energy level	1 1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	as the relative atomic mass increases, the boiling point (of the elements in Group 0) increases		1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4		allow any combination of x, ●, o, $e^{(-)}$ for electrons	1	AO2 4.5.1.1 4.5.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the elements in Group 7 react with non-metals to form covalent compounds		1	AO1 4.5.1.5 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	any **two** from: • effervescence / bubbles / fizzing • (lithium) floats • (lithium) moves around • (lithium) becomes smaller	ignore gas is produced ignore (lithium) melts	2	AO1 4.5.1.4 4.7.5.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7		allow energy level for shell throughout allow converse		AO1 4.5.1.4 4.7.5.1
	(lithium's) outer shell / electron is closer to the nucleus	allow the (lithium) atom is smaller allow (lithium) has fewer shells	1	
	(so) there is more (electrostatic) attraction between the nucleus and the outer electron (in lithium)	allow (so) there is less shielding between the outer electron and the nucleus (in lithium)	1	
	(so) the outer electron (in lithium) is less easily lost	allow (so) more energy is needed to remove the outer electron (in lithium)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.8	$2Li + 2H_2O \rightarrow 2LiOH + H_2$	allow multiples allow **1** mark for LiOH allow **1** mark for H_2	3	AO2 4.5.1.4 4.5.2.1 4.5.2.2

Total Question 6	**14**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	magnesium (atom) loses (two) electrons		1	AO2 4.6.2.1 4.6.2.2
	oxygen (atom) gains (two) electrons		1	
	reference to two electrons (involved in bonding)		1	
	(to form) a magnesium ion **and** an oxide ion **or** (to form) a Mg^{2+} (ion) **and** an O^{2-} (ion)	allow (to form) ions with full outer shells allow (to form) ions with full outer energy levels	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(scale for *y*-axis) 0.20 (at 2cm), 0.40, 0.60, 0.80, (1.00)	allow 0.2 (at 2cm), 0.4, 0.6, 0.8, (1.0) ignore intermediate values	1	AO2 4.6.2.2
	all points correctly plotted	allow a tolerance of ± ½ a small square allow **1** mark for four or five points correctly plotted	2	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	there is only one set of results (for each mass of magnesium)		1	AO3 4.6.2.2

Total Question 7	**8**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(the bodysuit) increases impact time	ignore reference to slowing down (impact) time	1	AO1 4.7.1.6 4.7.1.4
	(which) decreases the deceleration		1	
	(and) decreases the force (on the person)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	momentum of **A** = 70 × 2.0	allow momentum of **A** = 140	1	AO2 4.7.1.8
	140 = (-) 40 × v		1	
	$v = (-)\frac{140}{40}$		1	
	v = −3.5 (m/s)	allow a maximum of 4 marks for an answer of v = (+)3.5 (m/s)	2	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$E_p = 80 \times 9.8 \times 6.4$		1	AO2 4.7.1.9 4.6.1.5
	$E_p = 5017.6$ (J)		1	
		the equation $E_p = mgh$ must have been used to score subsequent marks		
	$5017.6 = 0.5 \times 80 \times v^2$	allow a correct substitution using their calculated value for energy	1	
	$v = \sqrt{\frac{5017.6}{0.5 \times 80}}$	allow a correct rearrangement using their calculated value for energy allow $v^2 = \frac{5017.6}{0.5 \times 80}$	1	
	$v = 11.2$ (m/s)	allow 11 (m/s) allow an answer consistent with their calculated value for energy	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	work is done by friction **or** work is done by air resistance		1	AO1 4.7.1.9 4.6.1.5 4.8.2.5
	(so) some energy is dissipated / wasted	allow (so) energy transfer is less than 100% allow (so) not all E_p is converted into E_k	1	

Total Question 8	**15**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	alkanes		1	AO1 4.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	C_nH_{2n+2}		1	AO1 4.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3		allow C_6H_{14} for hexane allow C_5H_{12} for pentane allow forces between molecules for intermolecular forces allow converse		
	hexane is a larger molecule (than pentane)		1	AO2
	(so in hexane) the intermolecular forces are stronger		1	AO1
	(so in hexane) more energy is required to overcome the intermolecular forces		1	AO1 4.6.2.5 4.8.1.2 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	$C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$	allow **1** mark for C_2H_4	2	AO1 AO2 4.5.2.1 4.5.2.2 4.8.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5		allow C-H for **Y**		AO2 4.7.4.5 4.8.1.3
	(bonds broken =) 4**Y** + 996	allow 498 + 498 for 996	1	
	(bonds formed = (4 × 464) + (2 × 803) =) 3462		1	
	(energy released = bonds formed − bonds broken =) 814 = 3462 − 4**Y** − 996	allow 4**Y** + 996 = 3462 - 814 allow correct use of incorrectly determined value(s) of bonds broken and/or bonds formed	1	
	4**Y** = 1652		1	
	Y = 413 (kJ/mol)	allow correct use of an incorrectly determined value for 4**Y**	1	

Total Question 9	**12**