GCSE
COMBINED SCIENCE: SYNERGY
8465/4H

Higher Tier Paper 4 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 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	as force increases, extension increases		1	AO3 4.6.1.6 RPA13
	in a linear relationship	allow in a straight line allow **2** marks for force and extension are (directly) proportional	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	spring **C**		1	AO3 4.6.1.6 RPA13
	smallest extension for the same force **or** lowest gradient	MP2 dependent on MP1 allow correct calculations of all three spring constants	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$75.6 = 0.5 \times k \times 0.60^2$		1	AO2
	$k = \dfrac{75.6}{0.5 \times 0.60^2}$		1	AO2
	$k = 420$		1	AO2
	N/m		1	AO1 4.6.1.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	work done is equal to elastic potential energy stored		1	AO1 4.6.1.6

Total Question 1	**9**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	other pH values are also green	allow pH 6 / 8 is also green	1	AO3 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	pH probe	allow pH meter / sensor	1	AO3 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	neutralisation	allow exothermic	1	AO1 4.7.3.2 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(M_r =) 1 + 14 + (16 × 3) = 63		1 1	AO2 4.5.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	OH^-		1	AO1 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	(conversion 5 cm^3 =) 0.005 dm^3		1	AO2 4.5.2.6
	(mass =) 5.6 × 0.005	allow correct use of incorrect / no conversion of volume	1	
	= 0.028 (g)		1	
	alternative approach:			
	(conversion 5.6 g/dm^3 =) 0.0056 g/cm^3 (1)			
	(mass =) 0.0056 × 5 (1)	allow correct use of incorrect / no conversion of concentration		
	= 0.028 (g) (1)			

Total Question 2	**9**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	power input to 1 m^2 = $\frac{468\ 000}{720}$		1	AO2 4.8.2.4
	power input to 1 m^2 = 650 (W)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	efficiency = $\frac{\text{useful power output}}{\text{total power input}}$		1	AO1 4.8.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	0.20 = $\frac{\text{useful power output}}{250\ 000}$		1	AO2 4.8.2.7
	useful power output = 0.20 × 250 000		1	
	useful power output = 50 000 (W)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	0:00 to 06:00 **and** 16:00 to 0:00		1	AO3 4.8.2.4
	time = 14 (hours)		1	

Question	Answers	Mark	AO / Spec. Ref.
03.5	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 4.8.2.4 4.7.2.9
	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 • solar panels do not generate electricity at night • battery provides power at night • power from solar panels can recharge the battery when power demand is less than power output • power demand is greater than power output between 16:00 and 06:00 • (so) battery provides power between 16:00 and 06:00 • power demand is less than power output between 06:00 and 16:00 • (so) power from solar panels can recharge the battery between 06:00 and 16:00 To get into Level 2, answers must show use of data from the graph.		

Total Question 3	**12**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	to reduce loss of gas	allow to reduce loss of hydrogen do **not** accept to stop loss of gas / hydrogen	1	AO3 4.7.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	any **one** from: • volume of (hydrochloric) acid • mass of magnesium • concentration (of hydrochloric acid) • temperature (of hydrochloric acid)		1	AO3 4.7.4.1 4.7.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	to ensure the investigation is valid		1	AO3 4.7.4.1 4.7.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	all points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for four / five points plotted correctly (ignore 0,0)	2	AO2
	line of best fit		1	AO3 4.7.4.1 4.7.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the rate of reaction increases		1	AO1 4.7.4.1 4.7.4.2
	(because) powder has a greater surface area (to volume ratio than ribbon)	allow (because) powder has smaller pieces (than ribbon)	1	
	(so) the frequency of collisions increases		1	

Total Question 4	**9**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	elastic potential energy of spring decreases (to zero)	allow elastic potential energy (of the spring) is transferred to kinetic energy (of the aeroplane) for MP1 and MP2	1	AO1 4.6.1.6 4.7.1.9 4.8.2.5
	while the kinetic energy of aeroplane increases		1	
	some energy is dissipated		1	
		ignore references to gravitational potential energy		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	s = 0.40 (m)	all subsequent marks may score using a not / incorrectly converted value of s	1	AO2 4.6.1.3
	3.0 = F × 0.40		1	
	$F = \frac{3.0}{0.40}$		1	
	F = 7.5 (N)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	any **three** from: • (initially) as (launch) angle increases the (horizontal) distance increases • (horizontal) distance is greatest when (launch) angle is 37° • at angles greater than 37° as (launch) angle increases, the (horizontal) distance decreases • at 90° the horizontal distance is zero **or** at 0° the (horizontal) distance is 2.3 m	 allow a value between 34° and 40° allow a value between 37° and 40°	3	AO3 4.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(increasing the extension of the spring) increases the elastic potential energy stored **or** causes a greater (mean) force **or** increases the launch speed **or** increases the acceleration (so) the (horizontal) distance travelled increases	 MP2 dependent on scoring MP1	1 1	AO1 4.6.1.7 4.7.1.9

Total Question 5	**12**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	high temperature (with) a catalyst **or** (with) steam		1 1	AO1 4.8.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	cracking breaks down larger (alkane) molecules into smaller (alkane) molecules (and) there is a high(er) demand for small(er) molecules (as fuels)		1 1	AO1 4.8.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	any **one** from: • to make polymers • as starting materials for the production of (many other) chemicals	 allow as chemical feedstock	1	AO1 4.8.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(bonds broken = (4 × 413) + 612 + 243 =) 2507 (kJ/mol)		1	AO2 4.7.4.5
	(bonds made = (4 × 413) + 347 + (2 × 346) =) 2691 (kJ/mol)		1	
	(energy change = 2507−2691 =) (−)184 (kJ/mol)	allow correct use of an incorrectly determined value for bonds broken and / or bonds made	1	
	alternative approach:			
	(bonds broken = 612 + 243 =) 855 (kJ/mol) (1)			
	(bonds made = 347 + (2 × 346) =) 1039 (kJ/mol) (1)			
	(energy change = 855 − 1039 =) (−)184 (kJ/mol) (1)	allow correct use of an incorrectly determined value for bonds broken and / or bonds made		

Total Question 6	**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$E_k = \frac{1}{2} mv^2$		1	AO1 4.7.1.9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$0.0441 = 0.5 \times 0.180 \times v^2$		1	AO2 4.7.1.9
	$v = \sqrt{\frac{0.0441}{0.5 \times 0.180}}$ **or** $v^2 = \frac{0.0441}{0.5 \times 0.180}$		1	
	$v = 0.70$ (m/s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(total) momentum before the collision = (total) momentum after the collision		1	AO1 4.7.1.8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	**before collision:**			
	$p_W = 0.18 \times 1.50$		1	AO2 4.7.1.8
	$p_W = 0.27$		1	
	after collision:			
	(white ball) $p_W = 0.18 \times 0.30$	allow $p_W = 0.054$	1	
		subsequent marks may only be awarded if the equation $p = m\,v$ has been used allow their value(s) of p_W calculated using data from the question		
	(black ball) $p_B = 0.27 - 0.054$	allow $p_B = 0.216$	1	
	$0.216 = 0.16 \times v_B$		1	
	$v_B = 1.35$ (m/s)		1	

Total Question 7	11

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	length of card time for card to pass light gate		1 1	AO3 4.7.1.6 RPA14

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	range = 1.05 – 0.95 **or** range = 0.10 (m/s^2) uncertainty = ± 0.05 (m/s^2)	allow mean = 1.00	1 1	AO3 4.7.1.6 RPA14

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	the product of mass and acceleration is a constant two calculations of $m \times a = 0.75$ confirmed by a third calculation of $m \times a = 0.75$	allow $m = \frac{k}{a}$ **or** $m \times a = k$ if no other mark scored a statement that doubling the mass halves the acceleration, supported by two calculations scores **2** marks	1 1 1	AO3 4.7.1.6 RPA14

Total Question 8	**7**

Question 9

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	−1 (°C)	allow a value in the range −10 to 10 (°C)	1	AO3 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3		allow converse explanation for the trend going up the table		
	(going down the table) boiling points increase		1	AO3
	(because) the molecules increase in size		1	AO3
	(so the) intermolecular forces increase	allow (so the) forces between the molecules increase	1	AO1
	(so) more energy is needed to overcome the intermolecular forces	allow (so) more energy is needed to separate the molecules	1	AO1 4.6.2.5 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$	allow multiples allow **1** mark for $C_3H_8 + O_2$ allow **1** mark for $CO_2 + H_2O$	3	AO2 4.5.2.1 4.5.2.2 4.8.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	crude oil is heated to vaporise (the hydrocarbons)		1	AO1 4.8.1.3
	the column has a temperature gradient	allow the column gets cooler going up	1	
	(so) the fractions / hydrocarbons condense at different levels / temperatures (in the column)		1	
	(because of their) different boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	heavy fuel oil is the most viscous and has the highest boiling point		1	AO1 4.8.1.3

Total Question 9	**14**

Question 10

Question	Answers	Mark	AO / Spec. Ref.
10.1	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO3 4.7.2.2
	Level 1: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	1–2	
	No relevant content	0	
	Indicative content • measure potential difference and current • use the voltmeter to measure potential difference • use the ammeter to measure current • method to vary current eg vary variable resistor, variable power pack or vary the number of cells • take several readings of potential difference and current • calculate resistance of the lamp using $V = IR$ • plot a graph of resistance against current • draw a line of best fit through the plotted points		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	$12.0 = I \times 30$		1	AO2 4.7.2.2 4.7.2.7
	$I = \frac{12}{30}$		1	
	$I = 0.40$ (A)	subsequent marks may be awarded if I has been incorrectly calculated using $V = IR$ and numbers from the question	1	
	$P = 0.40 \times 12.0$ **or** $P = 0.40^2 \times 30$		1	
	$P = 4.8$ (W)		1	

Total Question 10	**9**