GCSE
COMBINED SCIENCE: TRILOGY
8464/P/2H

Physics Paper 2H

Mark scheme

June 2023

Version: 1.0 Final

2 3 6 G 8 4 6 4 / P / 2 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	**A** radio waves **B** microwaves **C** X-rays	allow **1** mark if 2 correct	2	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	**Similarity** any **one** from: • same speed (in a vacuum) • both transfer energy • both transverse **Difference** any **one** from: • gamma has a higher frequency • gamma has a shorter wavelength • gamma is more ionising • gamma is more penetrating	allow both can travel through a vacuum allow both are ionising allow both can harm living tissue allow both can be used for medical treatment / imaging allow gamma has more energy	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	refraction		1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	wave speed = frequency × wavelength **or** $v = f\lambda$		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$3.0 \times 10^{8} = f \times 5.0 \times 10^{-7}$ $f = \dfrac{3.0 \times 10^{8}}{5.0 \times 10^{-7}}$ $f = 6 \times 10^{14}$ (Hz)	 allow a correct rearrangement using incorrect powers of 10 allow a correct calculation of f using incorrect powers of 10 allow 6.0×10^{14} (Hz)	1 1 1	AO2 6.6.1.2

Total Question 1	9

Question 2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**Level 3:** The plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.5.4.2.2
	Level 2: The plan 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 plan 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 **method of varying force** • clamp a pulley onto the edge of the desk • attach a string to the trolley and place the string over the pulley • attach a mass holder to the string **or** • vary the height of the runway • use wooden blocks **measurements** • place a slotted mass on the mass holder • use $W = mg$ to calculate the force • mark the starting and finishing points of the trolley on the runway • measure the distance between the two marks with a metre rule • time how long it takes to travel between the two marks with a stopclock / timer • use $v = \frac{s}{t}$ and $a = \frac{\Delta v}{t}$ **or** • use light gate(s) to determine time and / or speed • computer calculates acceleration • repeat for different numbers of slotted masses allow a description of a method using a ticker timer		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	second law		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$\frac{3.6}{1.2} = 3$ 1.6 × 3 = 4.8 (m/s^2) **OR** (use of $F = ma$) $m = \frac{1.2}{1.6} = 0.75$ (1) $a = \frac{3.6}{0.75} = 4.8$ (m/s^2) (1)		1 1	AO3 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	resultant force = mass × acceleration **or** $F = ma$		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	0.42 = m × 1.2 $m = \frac{0.42}{1.2}$ m = 0.35 kg		1 1 1	AO2 6.5.4.2.2

Total Question 2	**13**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	distance across all 8 wavelengths = 113 (mm)	allow a range from 108 (mm) to 118 (mm)	1	AO2 6.6.1.2 RPA20
	their distance × 5.0		1	
	wavelength = 70 (mm)	allow a range from 68 mm to 72 mm	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	97 × 5 = (96 + 99 + 97 + **X** + 97)	allow **X** = (97 × 5) – (96 + 99 + 97 + 97)	1	AO2 6.6.1.2 RPA20
	X = 96		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the spread of values about the mean is very small		1	AO3 6.6.1.2 RPA20

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	the oscillations / vibrations in longitudinal waves are parallel to the direction of energy transfer	allow direction of wave travel for direction of energy transfer	1	AO1 6.6.1.1
	(whereas) the oscillations / vibrations in transverse waves are perpendicular to the direction of energy transfer		1	
		if no other mark awarded allow 1 mark for oscillations / vibrations in longitudinal waves are parallel **and** oscillations / vibrations in transverse waves are perpendicular		

Total Question 3	**8**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	inertia		1	AO1 6.5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2			1	AO2 6.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	increase the current so that the (resultant) force increases	allow use a stronger magnet	1 1	AO1 6.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	bring the (same end of the) iron bar close to each pole / end of the permanent magnet any repulsion shows the iron bar is a permanent magnet **or** if one end of the iron bar is attracted to both poles it is not a permanent magnet	allow bring each end of the iron bar to the same pole of the magnet	1 1	AO3 6.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the compass (needle always) points in the same direction because it aligns itself with the Earth's magnetic field	allow the compass (needle always) points north dependent on MP1	1 1	AO1 6.7.1.2

Total Question 4	**8**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	$W \propto e$		1	AO1 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	750 = k × 0.060		1	AO2 6.5.3
	$k = \frac{750}{0.060}$	allow a correct rearrangement using an incorrectly / not converted value of *e*	1	
	k = 12 500 N/m	allow a correct calculation using incorrectly / not converted value of *e*	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(an object that is inelastically deformed) will not go back to its original length	allow shape for length	1	AO1 6.5.3
	when the force is removed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	$1800 = ½ \times 225 \times e^2$		1	AO2 6.5.3
	$e = \sqrt{\frac{2\times1800}{225}}$	allow $e^2 = \frac{2\times1800}{225}$	1	
	e = 4 (m)	allow *e* = 4.0 (m)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	$e = \frac{750}{225}$		1	AO3 6.5.3
	e = 3.3… (m)		1	
	the extension will be too great so not suitable for use in the chair	allow a conclusion consistent with their calculated extension	1	
	OR			
	F = 225 x 0.3 (1)			
	F = 67.5 (N) (1)			
	the weight of a person will be too great so (spring is) not suitable for use in the chair (1)			
		allow the chair would rest on the ground		
		allow the spring will not stretch beyond its elastic limit		

Total Question 5	**12**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$v^2 - 3.1^2 = 2 \times 9.8 \times 6.3$		1	AO2 6.5.4.1.5
	$v = \sqrt{(3.1^2 + (2 \times 9.8 \times 6.3))}$	allow $v^2 = 3.1^2 + (2 \times 9.8 \times 6.3)$	1	
	$v = 11.5\ldots$		1	
	$v = 12$ (m/s)	this mark can only be awarded if the correct equation is used and a value of v is calculated	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(magnitude) increases (uniformly)		1	AO2
	direction remains constant		1	AO3 6.5.1.1 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3		allow resistive / frictional force for drag throughout		AO3 6.5.4.1.5
	drag is greater than weight	allow upward force is greater than downward force	1	
	(so) there is a resultant force acting in the opposite direction to the velocity (causing deceleration)		1	
	as velocity decreases the drag decreases		1	
	(until) drag is equal to weight (so velocity is constant)	allow until the resultant force is zero ignore upthrust	1	

Total Question 6	**10**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$a = \frac{26 - 0}{5.25 - 2.0}$	allow any pair of correct points substituted allow ± half a small square for reading of time	1	AO2 6.5.4.1.5
	$a = 8$	allow 8.0 allow a correct calculation using their acceptable values from the graph ignore any minus sign	1	
	m/s^2		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2		allow ecf for acceleration and initial velocity from question **07.1**		
	thinking distance			
	$s = 26 \times 0.75$	to award MP1 and MP2 a time of 0.75 must have been used	1	AO3
	$s = 19.5$ (m)		1	AO2
	braking distance			
	$s = \frac{(5.25 - 2.0) \times 26}{2}$ **or** $s = \frac{26^2 - 0^2}{2 \times 8.0}$	allow a range of 5.2 to 5.3 for final time	1	AO3
	$s = 42.25$ (m)		1	AO2
		marks for thinking distance and braking distance may be awarded independently		
	stopping distance			
	$s = 19.5 + 42.25 = 61.75$ (m)	for this mark to be awarded both the thinking distance and braking distance must have been calculated using correct equations allow an answer correctly rounded to 2 or 3 sig figs	1	AO2 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	the brakes can overheat		1	AO1 6.5.4.3.4
	(so) the brakes will not work properly	dependent on MP1	1	
	OR			
	can lead to loss of control (1)	allow the car may skid		
	(because) the tyres lose traction / grip (1)	dependent on MP1		
	OR			
	the greater the deceleration the greater the force (1)			
	(and) large forces can cause injury (1)	dependent on MP1		
		ignore accidents and crashes throughout		

Total Question 7	**10**