GCSE
PHYSICS
8463/2H

Paper 2 Higher Tier

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

216g8463/2H/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

Copyright information

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Copyright © 2021 AQA and its licensors. All rights reserved.

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 his or her judgement
- the Assessment Objectives, level of demand 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.

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**. Different terms in the mark scheme are shown by a /; 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 error/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 planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols/formulae

If a student writes a chemical symbol/formula instead of a required chemical name, 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. Full marks can, however, be given for a correct numerical answer, without any working shown.

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

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **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.

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 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.

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	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.		3–4	AO1 4.5.6.3.3 4.5.6.3.4 4.1.1.2
	Level 1: Point 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 Factors • poor condition of tyres • poor road surface • wet or icy road • poor/worn brakes Explanation • because of decreased friction Factors • increased mass of car/passengers Explanation • increases kinetic energy of car • more work needs to be done to stop car • increases momentum of the car Factor • road slopes downhill Explanation • (a component of) gravity opposes the braking force • resultant (braking) force is reduced allow answers in terms of reducing braking distance throughout A single factor with no related explanation is insufficient to score a mark			

01.2	resultant force = mass × acceleration		1	AO1 4.5.6.2.2

01.3	7200 = 1600 × *a* $a = \frac{7200}{1600}$ *a* = 4.5 (m/s^2)	ignore negatives throughout	1 1 1	AO2 4.5.6.2.2

01.4	15 (m) 38 (m) = 53 (m)	two correct values identified allow the correct addition of a misread braking distance and /or a misread thinking distance taken from the graph	1 1	AO3 4.5.6.3.1

01.5	$p = \frac{F}{A}$		1	AO1 4.5.5.1.1

01.6	120 000 = $\frac{60}{A}$ $A = \frac{60}{120\,000}$ *A* = 0.0005 *A* = 5 (.0) × 10^{-4} m^2	 allow an answer given to 2 sig figs from an incorrect calculation using the given data	1 1 1 1 1	AO2 AO2 AO2 AO2 AO1 4.5.5.1.1

Total			**16**

Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref
02.1	will return to its original shape/length		1	AO2 4.5.3
	when the force is removed	allow (when) the child gets off the second mark is dependent on scoring the first mark	1	

02.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.5.3
	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 • set up a clamp stand with a clamp • hang the spring from the clamp • use a second clamp and boss to fix a (half) metre rule alongside the spring • record the ruler reading that is level with the bottom of the spring • hang a 1 N / a known weight from the bottom of the spring • record the new position of the bottom of the spring • calculate the extension of the spring • measure the extension of the spring • add further weights to the spring so the force increases 1 N at a time up to 5 N • for each new force record the position of the bottom of the spring and calculate / measure the extension Indicative content continues on the next page…		

	<u>Risk Assessment</u> Hazard: Clamp (stand, boss and masses) might fall off desk Risk: injury to feet Precaution: Use clamp to fix apparatus to the bench **or** Ensure that the slotted masses hang over the base/foot of the stand **or** Ensure that the boss is screwed tightly into the stand and clamp **or** Put (heavy) masses on the base/foot of the stand **or** Stand up so that you can move out of the way Hazard: Spring could break / come loose Risk: damage eye Precaution: Wear safety goggles If a risk assessment / hazard is not given, the answer can still reach level 3, but not full marks. Full marks may be awarded for alternative feasible methods.		

02.3	force = spring constant × extension		1	AO1 4.5.3

02.4	5.00 0.125 $k = \frac{5.00}{0.125}$ k = 40 (N/m)	allow any correct pair of values from the graph allow a misread value(s) from the graph allow a correct calculation using their incorrect value(s)	1 1 1	AO2 4.5.3

02.5	the line is straight and passes through the origin	allow the line does not curve allow a constant gradient	1 1	AO3 4.5.3

02.6	e = 0.20 m $E_e = 0.5 \times 13 \times 0.20^2$ E_e = 0.26 (J)	 allow an incorrectly / not converted value of e use of two incorrectly/not converted values scores a maximum of 1 mark	1 1 1	AO2 4.5.3

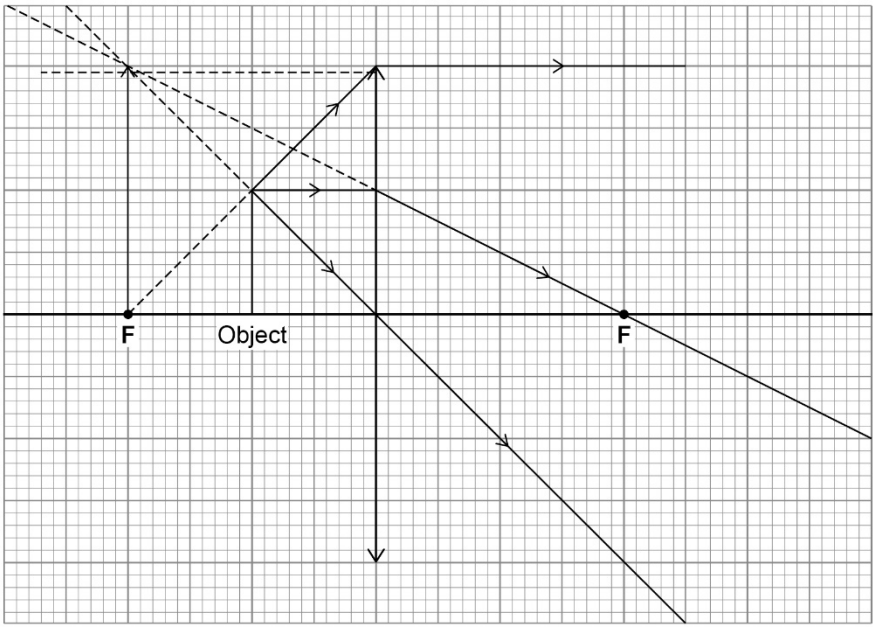
Total			**17**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	gravitational force inwards and forces as a result of fusion reactions outwards are in equilibrium / balanced	allow fusion energy for fusion reactions outwards allow radiation pressure for fusion reactions outwards dependant on scoring 1st mark point allow for **1** mark forces are in equilibrium	1 1	AO1 4.8.1.1
03.2	(the star will) expand to become a red giant (the star will) collapse to become a white dwarf (the star will) cool to become a black dwarf	the answers must be in the correct sequence to score all **3** marks allowed outer layers ejected for collapsed if no other marks score, allow red giant, white dwarf, black dwarf in the correct order for **1** mark	1 1 1	AO1 4.8.1.2
03.3	**A** it is (moving away from Earth) the slowest or it is the closest (to the Earth)	 reason only scores if A is chosen	1 1	AO3 4.8.2
Total			**7**	

Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref
04.1	**both** answers correct virtual diminished	answers may be in either order allow a description of diminished (eg smaller / reduced)	1	AO3 4.6.2.5
04.2	any **two** correct lines drawn from the top of the object, passing through the lens and traced backwards image drawn in the correct position and with the correct orientation	allow construction lines that are not dashed allow 1 mark for **two** correct lines drawn from the top of the object, passing through the lens BUT not traced backwards mark only scores if first two marks score	2 1	AO2 4.6.2.5



04.3	(increasing the object distance) decreases the image distance more rapidly at small (object) distances / more gradually at larger (object) distances	do **not** accept inversely proportional	1	AO3 4.6.2.5

04.4	$\frac{(2.2 - 1.4)}{2}$ uncertainty = (±) 0.4 (cm)	 allow $\frac{1.9 + 1.7 + 2.2 + 1.4}{4} = 1.8$ (1) (2.2 – 1.8 =) (±) 0.4 (cm) (1)	1 1	AO3 4.6.2.5

04.5	only red is transmitted by the filter red is absorbed by the (blue) object (so) no light is reflected by the (blue) object		1 1 1	AO1 4.6.2.6

Total			**10**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	any **one** from: • (sun) tan • energy efficient lamps	allow • (invisible) security coding • detecting forged bank notes • kill microbes • attract insects • sterilise (surgical) equipment • cause the body to produce vitamin D • increasing the growth rate of plants • water purification	1	AO1 4.6.2.4
05.2	3×10^{-7} m		1	AO1 4.6.2.1
05.3	3.0×10^{8} = frequency × 3×10^{-7} frequency = $\frac{3.0 \times 10^{8}}{3 \times 10^{-7}}$ frequency = 1×10^{15} (Hz)	allow ecf from question **05.2**	1 1 1	AO2 4.6.1.2
05.4	**Wave** / **Name** Wave E – Infrared Wave F – Visible light Wave G – X-rays all three lines correct for **1** mark		1	AO3 4.6.2.1

05.5	in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer	allow direction of wave travel for direction of energy transfer	1 1	AO1 4.6.1.1

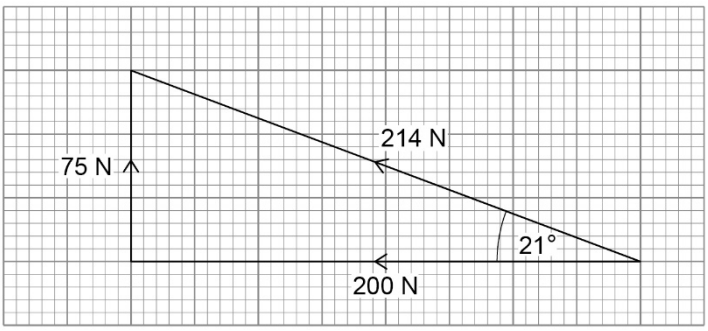
Total			**8**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	to reduce the effect of random errors	allow gives a more accurate mean ignore reference to anomalous results ignore measurements are more accurate	1	AO1 4.6.1.2
06.2	$\frac{(8.4+7.8+8.1)}{3}$ = 8.1 (s)		1	AO2 4.6.1.2
	$\frac{8.1}{10}$ = 0.81 (s)		1	
	frequency = $\frac{1}{0.81}$	allow a correct substitution of an incorrectly calculated value for time	1	
	frequency = 1.2345…	this mark may be awarded if the time is incorrectly calculated	1	
	frequency = 1.2 (Hz)	allow a calculated value correctly rounded to 2 sig figs	1	
06.3	measure the distance travelled by a wave using a metre rule	allow measure the length of the (ripple) tank using a metre rule	1	AO1 4.6.1.2
	measure the time taken (for the wave to travel the measured distance) with a timer / stopwatch		1	
	divide the distance by the time	dependant on scoring the first two mark points	1	
Total			**9**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	friction		1	AO1 4.5.1.2
07.2	(area of rectangle =) 108 (m) (area of triangle =) 54 (m) (total area / distance =) 162 (m)	 allow a correctly calculated total area / distance from an incorrectly calculated area of rectangle and / or triangle	1 1 1	AO2 4.5.6.1.5
07.3	(the force on the pedal) causes a moment about the pedal axle which causes a force on the chain (which causes a moment about the rear axle)	 allow gear B for chain	1 1	AO1 4.5.4
07.4	2.4^2 (– 0^2) = 2 × a × 18 a = $\frac{2.4 \times 2.4}{36}$ a = 0.16 (m/s^2) <u>alternative method</u> t = 18 / 1.2 t = 15 (s) (1) a = 2.4 / 15 (1) a = 0.16 (m/s^2) (1)	 this mark may be awarded if the time is incorrectly calculated allow a correctly calculated acceleration from an incorrectly calculated time	1 1 1	AO2 4.5.6.1.5

07.5	horizontal (200N) **and** vertical (75N) forces drawn to the same scale		1	AO2 4.5.1.4
	resultant force drawn in the correct direction	shown by an arrow head from bottom right to top left	1	
	resultant force with a value in the range 212 to 218 (N)	allow a calculated value of 213.6 **or** 214 (N)	1	
	direction in the range 20–22 (degrees from the horizontal)	allow 68–70 (degrees from the vertical) allow a bearing in the range 290–292 to gain full marks a vector diagram must have been drawn	1	
				

Total			**13**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	motor (effect)		1	AO1 4.7.2.4
08.2	current creates a magnetic field (around the coil) (which) interacts with the permanent magnet field producing a (resultant) force causing the coil/cone to move (when the) direction of the current reverses, the direction of the (resultant) force reverses (producing a sound wave)	 allow coil/cone for force allow backwards for reverses	1 1 1 1	AO1 4.7.2.4
08.3	the student changed two variables at the same time (so) it is not possible to know the effect of each variable	allow only one variable should be changed at a time	1 1	AO3 4.6.1.2
Total			**7**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	hold thumb first finger and second finger (of left hand) at right angles to each other	allow first two fingers/index and middle for first and second finger throughout	1	AO1
	second finger represents the current pointing out of the paper		1	AO1
	first finger represents the field pointing downwards		1	AO3
	thumb points in the direction of the force / thrust / acceleration		1	AO3
	(therefore) the rod moves left to right	allow correct description (eg away from the magnet) dependent on scoring marking point 3 or 4	1	AO3 4.7.2.2
09.2	decrease the resistance of the variable resistor	allow increase the current/pd	1	AO3 4.7.2.2
	use a stronger magnet	allow use a magnet with a greater flux density	1	

09.3	F = 0.30 × 1.7 × 0.050 F = 0.0255 (N) m = 0.004(0 kg) 0.0255 = 0.0040 × a a = 0.0255 / 0.0040 **or** a = 6.375 *Δv* = 6.375 × 0.15 = 0.95625 (m/s) <u>alternative method</u> *F* = 0.30 × 1.7 × 0.050 (1) *F* = 0.0255 (N) (1) m = 0.004(0 kg) (1) 0.0255 = $\frac{0.0040 \times \Delta v}{0.15}$ (1) *Δv* = $\frac{0.0255 \times 0.15}{0.0040}$ (1) *Δv* = 0.95625 (m/s) (1)	 this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated allow a correct calculation using an incorrectly / not converted *m* and / or an incorrectly calculated *F* allow 0.96 **or** 0.956 (m/s) this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated this mark may be awarded if *m* is incorrectly / not converted and / or *F* is incorrectly calculated allow a correct calculation using an incorrectly / not converted *m* and / or an incorrectly calculated *F* allow 0.96 **or** 0.956 (m/s)	1 1 1 1 1 1	AO2 4.5.6.2.2 4.5.6.1.5 4.7.2.2

Total			**13**