GCSE
Physics

8463/2H – PAPER 2 – HIGHER TIER

Mark scheme

8463

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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 Assessment Writer.

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.

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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 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 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 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	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	uniform acceleration	allow constant / steady acceleration allow velocity / speed increasing at a constant rate ignore reference to direction acceleration scores **1** mark **or** velocity / speed is increasing scores **1** mark do **not** accept acceleration increases	2	AO1 4.5.6.1.5
01.2	up(wards)		1	AO1 4.5.6.1.5
01.3	a group of objects that interact		1	AO1 4.1.1.1
01.4	velocity just after bounce is less than just before bounce **or** the height at the top of the bounce is less than the height from which it was dropped	allow velocity is less / decreases allow speed for velocity velocity decreases to zero – on its own scores zero	1	AO3 4.5.6.1.5
	so the ball has lost energy		1	AO1 4.1.1.2
	correct reference to (loss of) ke or (reduced) gpe		1	AO1 4.1.2.1
	total energy of ball and Earth / ground is constant	allow 'a system' for ball and Earth allow energy is conserved	1	AO1 4.1.2.1
Total			**8**	

Question	Answers	Mark	AO/ Spec. Ref
02.1	**Level 3:** The method would lead to the production of a valid outcome. All 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 ruler alongside the spring record the metre ruler reading that is level with the bottom of the spring hang a 2 N 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 2 N at a time up to 10 N for each new force record the position of the bottom of the spring and calculate / measure the extension **possible source of inaccuracy** not fixing the ruler in position but simply holding the ruler next to the spring not clamping the ruler vertical misjudging the position of the bottom of the spring parallax error allow any other sensible suggestion that could reasonably lead to inaccuracy in the data allow a description that would increase accuracy repeating the measurements is insufficient		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	to identify any anomalous results **or** to reduce the effect of random error	allow calculate an average for the spring constant allow (more) accurate to obtain an average is insufficient to be able to draw a graph is insufficient	1	AO3 4.5.3
02.3	both points plotted correctly correct line of best fit drawn	 to pass through (0,0) and (10,20)	1 1	AO2 4.5.3
02.4	force = spring constant × extension	allow F = ke	1	AO1 4.5.3
02.5	 extension = 0.2 10 = k × 0.2 $k = \frac{10}{0.2}$ k = 50	an answer of 50 scores **4** marks allow 0.035 / 0.08 / 0.125 / 0.16 force value must match extension this mark may be awarded if e is in cm allow correct transformation of their chosen values this mark may be awarded if e is in cm an answer 0.5 scores **3** marks	 1 1 1 1	 AO2 AO2 AO2 AO2 4.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	the line is straight and passes through the origin	allow the line does not curve this mark is dependent on scoring the first mark allow a correct description of direct proportionality for **2** marks ignore the line shows they are directly proportional	1 1	AO3 4.5.3
Total			**16**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	P-waves are longitudinal and S-waves are transverse		1	AO1 4.6.1.5
03.2	0.4		1	AO2 4.6.1.2
03.3	wave speed = frequency × wavelength	allow v = f λ	1	AO1 4.6.1.2
03.4	7200 = 0.4 × wavelength wavelength = $\frac{7200}{0.4}$ wavelength = 18 000 (m)	an answer 18 000 scores **3** marks allow up to full marks for ecf using their answer to question **03.2** a method shown as 7200 × 2.5 = 18 000 scores **0** marks	 1 1 1	AO2 4.6.1.2
03.5	because S-waves cannot travel through a liquid and S-waves do not travel through the (outer) core	 allow some (seismic) waves cannot travel through a liquid and do not go through the core for **1** mark	1 1	AO1 4.6.1.5
03.6	magnetic field around the coil changes **or** the magnetic field (lines) cut by the coil	allow the generator effect	1	4.7.3.1 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	because the magnet changes direction		1	4.7.3.1 AO2
03.8	stationary		1	4.7.3.1 AO2
03.9	any **two** from: • stronger magnetic field • more turns on the coil • turns pushed closer together • spring with a lower spring constant	 allow stronger magnet allow heavier magnet bigger magnet is insufficient bigger coil is insufficient do **not** accept more coils of wire allow less stiff spring allow weaker spring do **not** accept add an iron core	2	4.7.3.1 AO2
Total			**13**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	all heights drawn the same as tube 1	judge by eye	1	AO2 4.5.5.1.2
04.2	increasing depth increases the height / mass / volume (of the water column) above the swimmer	allow more water above (the swimmer) more water is insufficient	1	AO1 4.5.5.1.2
	increasing the weight / force (of water) acting on the swimmer		1	
04.3		an answer of 12 112.8 scores **3** marks		
	increase in depth = 1.2 (m)		1	AO2 4.5.5.1.2
	(Δ) p = 1.2 $\times$ 1030 $\times$ 9.8	allow either 0.50 **or** 1.70 for 1.2	1	AO2 4.5.5.1.2
	(Δ) p = 12112.8	allow a correctly rounded answer allow a correct calculation using either 0.50 **or** 1.70	1	AO2 4.5.5.1.2
	pascals **or** Pa	do **not** accept pa allow N/m^2	1	AO1 4.5.5.1.2
Total			**7**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	random	human error is insufficient	1	AO3 4.6.1.3
05.2	accept any practical suggestion that could cause a range of values eg misjudging the centre of the ray eg not replacing mirror / ray box in the same position	 measuring the angle incorrectly is insufficient moving the mirror / ray box is insufficient	1	AO2 4.6.1.3
05.3	 range = 10 **or** mean of 51 calculated 5(º)	an answer of 5(º) scores **2** marks	 1 1	AO3 4.6.1.3
05.4	within experimental accuracy the angle of incidence and the angle of reflection are the same **or** the angle of reflection is usually different to the angle of incidence relevant use of data eg at 20º / 30º / 40º there is at least one measurement of angle of reflection that is exactly the same **or** at 50º there are big differences	allow the angle of incidence is nearly the same as the angle of reflection allow only a few of the values are the same / similar allow the idea of a range of values allow 50º includes anomalous results an answer in terms of calculated mean(s) may score both marks eg mean calculated for one or more angle of reflection (1) conclusion correctly stating angle i = / ≠ angle r (1)	1 1	AO3 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	results could be collected for angles (of incidence) not yet measured	allow a stated angle of incidence eg 10º or 60º changing the mirror is insufficient ignore repeat the measurements	1	AO3 4.6.1.3
05.6	replace the mirror with an irregular reflecting surface	allow use an irregular reflecting surface replace mirror with paper is insufficient do **not** accept use a glass block	1	AO3 4.6.1.3
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	arrow of equal size pointing vertically upwards	judged by eye ignore horizontal arrows if equal and opposite horizontal arrows of unequal length negates this mark	1	AO2 4.5.1.4
	labelled 'upthrust'	ignore buoyancy ignore 25 kN	1	AO1 4.5.5.1.2
06.2		an answer of 2600 scores **4** marks		
	weight = 25 kN	allow 24 to 25 kN inclusive	1	AO3
	25 000 = mass x 9.8 **or** $m = \frac{25\,000}{9.8}$	allow their W correctly converted and substituted	1	AO2
	m = 2551 kg	allow correctly calculated value using their converted W allow a value correctly calculated with W in kN	1	AO2
	m = 2600 kg	allow a calculated answer correctly rounded to 2 significant figures	1	AO2 4.5.1.1 4.5.1.3
06.3	Newton's 3rd law (of motion)		1	AO1 4.5.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	vertical force (50 N) drawn **and** horizontal force (150 N) drawn to the same scale		1	AO2 4.5.1.4
	resultant tension force in the correct direction	shown by an arrowhead	1	
	value of the tension force in the range 156 N–160 N	allow a calculated value of 158	1	
	value of direction in the range 18^{o}–20^{o} (from the horizontal)	allow 70^{o} to 72^{o} (from the vertical) allow a bearing in the range 288 to 290	1	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	any **one** from: • too few turns / coils on the secondary • p.d. across the primary was reduced	allow number of turns / coils on the primary was increased ignore human error	1	AO3 4.7.3.4
07.2	the p.d. (across the secondary) goes above 2V	allow p.d. across secondary is higher than p.d. across primary after 20 turns	1	AO3 4.7.3.4
07.3	it increases (until the nails reach a constant temperature)		1	AO1 4.6.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer of 1.2 (A) scores **5** marks		AO2 4.7.3.4
	$\frac{640}{4} = \frac{V_p}{1.75}$		1	
	$V_p = \frac{640 \times 1.75}{4}$		1	
	$V_p = 280$ (V)		1	
	$280 \times I_p = 336$	allow their calculated $V_p \times I_p = 336$	1	
	$I_p = 1.2$ (A)	allow an answer that is consistent with their calculated value of V_p	1	
	or			
	$336 = I_s \times 1.75$ (1)			
	$I_s = \frac{336}{1.75}$ (1)			
	$I_s = 192$ (A) (1)			
	$I_p = 192 \times \frac{4}{640}$ (1)	allow I_p = their calculated $I_s \times \frac{4}{640}$		
	$I_p = 1.2$ (A) (1)	allow an answer that is consistent with their calculated value of I_s		
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(force of) gravity causes the satellite to accelerate (towards the Earth)	allow satellite is (constantly) accelerating	1	AO1 4.8.1.3
	the acceleration causes a change in direction	acceleration causes a change in speed negates this mark point	1	
	velocity changes because direction changes		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2		an answer of 15 scores **5** marks		AO2 4.8.1.3 4.5.6.1.2
	length of orbit taken from graph = 42 100 (km)		1	
	42 100 = 7.73 × time **or** time = $\frac{42\,100}{7.73}$	allow their distance = 7.73 × time	1	
	time (1 orbit) = 5446(s)	allow a value consistent with their distance	1	
	number of orbits = $(\frac{24 \times 3600}{5446})$ = 15.86	allow $(\frac{24}{1.51}) = 15.86$ allow a value consistent with their distance	1	
	number of orbits = 15	allow a value consistent with their distance an answer of 16 scores **4** marks	1	
	or length of orbit taken from graph = 42 100 (km) (1) 7.73 = $\frac{\text{distance}}{24 \times 3600}$ (1) distance = 667 872 (km) (1)			
	number of orbits =($\frac{667\,872}{42\,100}$) = 15.86 (1)	allow a value consistent with their two distances		
	number of orbits = 15 (1)	allow a value consistent with their two distances up to full marks can be awarded for a method calculating velocity in km/h and time in hours		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	the predicted data is very close to the actual data		1	AO3 4.8.1.3
08.4	supported the prediction (made by Bode) so provides evidence that the equation is true / correct / works / accurate	allow predicted and actual values are very close allow proves for provides evidence	1 1	AO3 4.8.1.3
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	an idea used to explain observations and data		1	AO1 key ideas
09.2	different models may be appropriate in different situations	allow one particular model may not be able to explain all observations	1	AO1 key ideas
09.3	new (experimental) evidence / data		1	AO1 key ideas
	evidence cannot be explained using an existing model **or** predictions made using old model are shown to be incorrect	allow old model based on data now shown to be incorrect	1	
	new model explains new evidence **or** predictions made with new model are shown to be correct		1	
	a suitable example given eg nuclear model of the atom replacing the plum pudding model	allow tectonic plates replacing static land masses	1	
	big bang theory replacing other theories for the creation of the universe	allow heliocentric model of solar system replacing geocentric model		
09.4	velocity / speed is slower in shallow water		1	AO2 4.6.2.2
	so edge of wave (front) entering shallow water slows down		1	
	but the part of the wave (front) in deeper water continues at a higher speed (leading to a change in direction of the wave fronts)	allow one part of the wave (front) changes speed before other parts allow an answer in terms of wave (front) travelling from shallow to deep water	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	every point on the wave (front) enters / hits the shallow water at the same time		1	AO2 4.6.2.2
	and so every point slows down at the same time	allow changes speed for slows down allow an answer in terms of wave (front) travelling from shallow to deep water	1	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	at least three circles drawn clockwise arrows on circles	 allow **1** mark for one or two circles with clockwise arrows	1 1	AO1 4.7.2.1
10.2	4×10^{-6}		1	AO1 4.7.2.1
10.3	the sides of the coil (parallel to the magnet) experience a force (in opposite directions) the forces cause moments that act in the same (clockwise / anticlockwise) direction **or** the moments cause the coil to rotate (clockwise / anticlockwise) (each half-revolution) the two halves of the (rotating) commutator swap from one (carbon) brush to the other (each half-revolution) the commutator reverses the current (in the coil) **or** keeping the forces in the same direction (keeping the coil rotating)	allow the current creates a magnetic field ignore Fleming's Left Hand Rule allow the magnetic fields interact to create a pair of forces (acting in opposite directions) **or** allow the magnetic fields interact causing the coil to rotate allow keeps the current in the same direction relative to the (permanent) magnetic field	1 1 1 1	AO1 4.7.2.3
Total			**7**	