GCSE
PHYSICS
8463/2H

Paper 2 Higher Tier

Mark scheme

June 2024

Version: 1.0 Final

2 4 6 G 8 4 6 3 / 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.

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

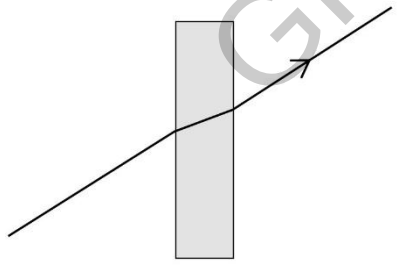
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	1 (°)		1	AO3 4.6.1.3 RPA9

Question	Answers	Mark	AO / Spec. Ref.
01.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.6.1.3 RPA9
	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 Some indicative content could be indicated within a labelled diagram • place a glass block on a piece of paper • draw around the glass block • use the ray box to shine a ray of light through the glass block • mark the ray of light entering the glass block • mark the ray of light emerging from the glass block • join the points to show the path of the complete ray through the block • and draw a normal line at 90 degrees to the surface • use a protractor to measure the angle of incidence • use a protractor to measure the angle of refraction • use a ray box to shine a ray of light at a range of different angles (of incidence) • increase the angle of incidence in 10 degree intervals • from an angle of incidence of 10 degrees to an angle of incidence of 60 degrees Methods involving mirrors **and** reflection score zero		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	points plotted correctly curve drawn passing through points	allow tolerance of ± half a small square allow a line starting at the origin	1 1	AO2 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	the line curves	allow the line is not straight allow line does not pass through the origin if consistent with their answer to question **01.3**	1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	normal drawn ray reflected so $i = r$	 judge by eye	1 1	AO2 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6			1	AO1 4.6.2.2

Total Question 1	13

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	0 (N)		1	AO2 4.5.6.2.1
	the child isn't accelerating (vertically)	MP2 dependent on MP1	1	
	or			
	upwards forces are equal to the downwards forces	allow forces are balanced		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	work done = force × distance		1	AO1 4.5.2
	or			
	$W = F \times s$			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$35 = F \times 2.8$		1	AO2 4.5.2
	$F = \frac{35}{2.8}$		1	
	$F = 12.5$ (N)	allow 13 (N)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	the resistive force has decreased	allow friction (between the wheels and the floor) has decreased	1	AO3 4.5.1.4 4.5.6.2.1 4.5.6.2.2
	so the resultant force increases		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	moment = force × distance **or** $M = F \times d$		1	AO1 4.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	7.5 cm = 0.075 m		1	AO2 4.5.4
	$M = 2.0 \times 0.075$	allow a correct substitution of an incorrectly / not converted value of d	1	
	$M = 0.15$ (Nm)	allow an answer consistent with an incorrectly / not converted value of d	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	gear B rotates in the opposite direction (to gear A) **or** gear B rotates clockwise **or** gear B rotates faster than gear A		1	AO2 4.5.4
	(because) gear A exerts a force on gear B **or** (because) gear A causes a moment about the pivot of gear B		1	

Total Question 2	14

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	planets dwarf planets moons **or** natural satellites	 allow asteroids / meteors / meteoroids / meteorites allow comets	1 1 1	AO1 4.8.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	Betelgeuse		1	AO3 4.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	1.1×10^{17} m		1	AO2 4.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	both show red-shift so both are moving away from us **or** the wavelength of the (absorption) lines has increased so both are moving away from us A shows a greater red-shift (than B) so A is travelling faster (than B)		1 1 1	AO3 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$s = 3.6 \times 10^{17}$ (m)		1	AO2 4.5.6.1.2
	$3.6 \times 10^{17} = 3.0 \times 10^{8} \times t$	allow a correct substitution of an incorrectly / not converted value for *s*	1	
	$\frac{3.6 \times 10^{17}}{3.0 \times 10^{8}} = t$	allow a correct re-arrangement using an incorrectly / not converted value for *s*	1	
	$t = 1.2 \times 10^{9}$ (s) **or** $t = 1\,200\,000\,000$ (s)	allow a correct calculation using an incorrectly / not converted value for *s*	1	

Question	Answers	Mark	AO / Spec. Ref.
03.6	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3–4	AO1 4.8.1.2
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–2	
	No relevant content	0	
	Indicative content • fusion occurs at high temperatures • fusion produces new elements • hydrogen nuclei fuse to form helium nuclei • hydrogen (in the core) begins to run out • helium nuclei fuse to make heavier elements • up to iron • some massive stars become supernovae • creating elements heavier than iron		

Total Question 3	**16**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	the height of the (column of) water above the submarine increases	allow volume / mass for height	1	AO1 4.5.5.1.2
	which increases the force / weight (of the water) acting on the submarine so pressure increases	allow $p = \rho g h$ and ρ and g remain constant so pressure increases	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	p = 110 000 000 Pa		1	AO2 4.5.5.1.2
	110 000 000 = 1026 × 9.8 × Δh	allow a correct substitution of an incorrectly / not converted value for p	1	
	$\Delta h = \frac{110\,000\,000}{1026 \times 9.8}$	allow a correct re-arrangement using an incorrectly / not converted value for p	1	
	Δh = 10 940 (m)	allow a correct calculation from using an incorrectly / not converted value for p allow 11 000 (m) if correct working shown	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	P-waves are longitudinal and S-waves are transverse		1	AO1 4.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	D only P-waves can travel through liquids	 allow only P-waves can travel through the outer core allow S waves cannot travel through liquids allow S waves cannot travel through the outer core MP2 dependent on MP1	1 1	AO3 4.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	$4500 = 3.6 \times \lambda$ $\lambda = \frac{4500}{3.6}$ $\lambda = 1250$ (m)	allow a correct substitution of an incorrectly / not converted value for *v* allow a correct re-arrangement using an incorrectly / not converted value for *v* allow 1300 (m) only allow an answer consistent with a correctly converted value for *v*	1 1 1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	the distance is (directly) proportional to the time between the two waves arriving (at the seismometer)	allow they are (directly) proportional allow a greater distance means a greater time for **1** mark allow there is a positive correlation for **1** mark	2	AO3 4.5.6.1.2

Total Question 4	**14**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	tension		1	AO2 4.5.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(combined) mass of trolley and mass hanger	allow mass / weight of trolley / hanger	1	AO1 4.5.6.2.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3		allow speed for velocity throughout		AO3 4.5.6.1.5 4.5.6.1.2
	divide distance travelled by time taken to give (average / mean) velocity		1	4.5.6.2.2 RPA7
	double mean velocity (to give maximum velocity)		1	
	divide change in velocity by time taken (to give acceleration)	allow divide maximum velocity by time (to give acceleration) allow use of $v^2 = u^2 + 2as$ allow correct use of $s = ut + \frac{1}{2}at^2$	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(range =) 0.06 (m/s^2) **or** (mean =) 1.36 (m/s^2)		1	AO3 4.5.6.2.2 RPA7
	uncertainty = ±0.03 (m/s^2)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	a component of the weight of the trolley acts parallel to runway (so) resultant force increases so acceleration increases	 allow work is done (by raising the trolley) so the trolley gains gravitational potential energy (1) gravitational potential energy is transferred to kinetic energy increasing the final velocity and the acceleration (1)	1 1	AO3 4.5.6.2.2

Total Question 5	**9**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **three** from: • they travel at the same speed (in a vacuum / air) • they can travel through a vacuum • they are transverse (waves) • they are electromagnetic (waves)	allow they travel at the speed of light allow they do not need a medium (to travel) ignore they can be reflected / refracted / absorbed / transmitted / diffracted.	3	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	any **one** from: • (medical) imaging • (medical) treatments	allow correctly named method eg PET scan, tracer, gamma camera do not accept ultrasound, CT scan, X-rays, MRI scan allow correctly named treatment eg radiotherapy, brachiotherapy, gamma knife do not accept chemotherapy allow sterilising medical equipment	1	AO1 4.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gamma rays are (weakly) ionising but radio waves are <u>not</u> (ionising) (so gamma rays) can cause mutations in genes / DNA **or** (so gamma rays) can increase the risk of cancers	 allow can cause cancer allow damages / kills cells	1 1	AO1 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	(radio waves are produced by) oscillations in electrical circuits (of the scanner)	allow (radio waves are produced by) alternating current allow (radio waves are produced by) oscillating electrons (in an aerial)	1	AO1 4.6.2.3
	the radio waves have the same frequency as the oscillations	MP2 dependent on MP1	1	

Total Question 6	**8**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$(\frac{1}{2} \times 56 \times 220) = 6160$ $(56 \times 380) = 21280$ $(6160 + 21280) = 27\,440$ (m)	 allow a correctly calculated total distance from an incorrectly calculated area of the rectangle and / or the triangle	1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the gradient is less after 720 s so the deceleration is smaller so the braking force is smaller	allow the gradient is less after (velocity decreases to) 20 m/s	1 1 1	AO3 4.5.6.1.5 4.5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	correct section of line identified attempt to calculate a gradient using values from the correct section of the graph eg gradient = $\frac{(-)36}{120}$ correct calculation using their correct values eg $a = (-)0.3$ (m/s^2)	judge by values used allow use of correct values obtained from the section of the graph after 720 s allow a correct calculation using correct values obtained from the section of the graph after 720 s if no other marks scored, an answer that rounds to 0.16 (m/s^2) scores 1 mark	1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	$(-)270\,000 = 240\,000 \times a$		1	AO2 4.5.6.1.5
	$a = \frac{(-)270\,000}{240\,000}$		1	
	$a = (-)\ 1.125\ (m/s^2)$	the equation $F = ma$ must have been used to score subsequent marks	1	
	$0 = 60^2 + (2 \times (-1.125) \times s)$	allow a correct substitution using their value of deceleration	1	
	$s = \frac{3600}{2.25}$	allow a correct re-arrangement using their value of deceleration	1	
	$s = 1600\ (m)$	allow a correct calculation using their value of deceleration	1	
	OR			
	$E_k = \frac{1}{2} \times 240\,000 \times 60^2$ (1)			
	$= 432\,000\,000$ (1)			
	ΔE_k = work done (1)			
		the equation $E_k = \frac{1}{2} mv^2$ must have been used to score subsequent marks		
	$432\,000\,000 = 270\,000 \times s$ (1)	allow a correct substitution using their value of E_k		
	$s = \frac{432\,000\,000}{270\,000}$ (1)	allow a correct re-arrangement using their value of E_k		
	$s = 1600\ (m)$ (1)	allow a correct calculation using their value of E_k		

07.4 cont.	**OR** p = 240 000 × 60 (= 14 400 000) (1) 270 000 = $\frac{14\ 400\ 000}{t}$ (1) t = 53.333…(s) (1) mean speed = $\frac{60}{2}$ = 30 (1) s = 30 × 53.333… (1) s = 1600 (m) (1)	 allow t = 53 (s) the equation $F = \frac{\text{change in momentum}}{\text{time taken}}$ must have been used to score subsequent marks allow a correct substitution using their value of t allow a correct calculation using their value of t		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	stopping distance includes both braking distance and thinking distance alcohol increases driver's reaction time which will increase the thinking distance so stopping distance increases		1 1 1	AO1 4.5.6.3.1 4.5.6.3.2

Total Question 7	**18**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	generator (effect)	allow electromagnetic induction	1	AO1 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	wire cuts through the magnetic field (between the magnets) a potential difference was <u>induced</u> (across the wire) as it was part of <u>complete circuit</u> (there was a current in the circuit)		1 1 1	AO1 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	the needle will deflect to –0.4 mA		1	AO3 4.7.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(the pressure variations in) the sound (waves) cause the diaphragm to vibrate the diaphragm causes the coil / wire to vibrate (the coil repeatedly changes direction) <u>inducing</u> an alternating current (in the circuit)	allow air particles collide with diaphragm causing it to vibrate diaphragm moves is insufficient do not accept moves the diaphragm up and down do not accept moves the coil / wire up and down if MP1 and MP2 do not score, allow sound (waves) cause the coil / wire to vibrate for **1** mark	1 1 1	AO1 4.7.3.3

Total Question 8	**8**