GCSE
PHYSICS
8463/2H

Paper 2 Higher Tier

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 should be awarded for a correct numerical answer, without any working shown.
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	Mark	AO / Spec. Ref.
01.1	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account	4–6	AO1 4.6.1.1 4.6.2.1
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear	1–3	
	No relevant content	0	
	Indicative content **Differences** • sound waves are mechanical whereas visible light waves are electromagnetic waves • sound waves require a medium to travel through whereas visible light waves can travel through a vacuum • sound waves are longitudinal whereas visible light waves are transverse • sound waves travel slower (in air) than visible light waves • sound waves travel faster in solids than in air whereas visible light waves travel slower in solids than in air • sound waves have longer wavelengths than visible light • sound waves have a lower frequency than visible light waves **Similarities** • both types of waves can be reflected • both types of waves can be refracted • both types of waves can be diffracted • both types of wave transfer energy		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	speed = $\frac{\text{distance}}{\text{time}}$		1	AO1 4.5.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$330 = \frac{13\,200}{t}$ **or** $13\,200 = 330 \times t$ $t = \frac{13\,200}{330}$ 40 (s)		1 1 1	AO2 4.5.6.1.2

Total Question 1	**10**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	force (applied to spring) **or** weight (of the masses)	allow mass (hung from spring)	1	AO1 4.5.3 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	stand could tip over **and** hurt/hit the student **or** masses could fall off **and** hurt/hit the student		1	AO1 4.5.3 RPA6
	clamp base of stand to desk	allow rotate base/clamp allow place some masses on the base of the clamp stand allow student should stand up allow limit the mass hung on spring allow limit the mass hung on spring	1	
	OR spring could snap **and** hurt the student (1)			
	wear goggles (1)	allow limit the mass hung on spring		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	any **two** from: • ensure the ruler is vertical • clamp the ruler (close to the spring) • attach a pointer to bottom of the spring • use a ruler with a better resolution	allow move ruler so it is in line with spring	2	AO3 4.5.3 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	the spring length is not proportional to the force **or** the unstretched/initial length of the spring is not zero	 allow student has plotted/measured spring length instead of extension	1	AO3 4.5.3 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	the spring is inelastically deformed (so) the extension is no longer proportional to the force	 allow the spring has reached/passed its limit of proportionality allow no longer obeys Hooke's law	1 1	AO3 4.5.3 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	force = spring constant × extension		1	AO1 4.5.3 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	$4.0 = k \times 0.064$ $\frac{4.0}{0.064} = k$ $k = 62.5$ (N/m)	 allow 63 (N/m)	1 1 1	AO2 4.5.3 RPA6

Total Question 2	**12**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	range = 0.61 – 0.49 **or** range = 0.12	allow mean = 0.55	1	AO2 4.5.6.1.5
	uncertainty = ± 0.06 (s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	random error		1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the ball may have been dropped from different heights **or** the initial speed of the ball may have been different **or** there may have been a different delay between the student pressing the start button and releasing the ball	allow the stopwatch did not always stop (immediately) when the ball hit the floor	1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	corresponding values of height and time squared read from graph	eg 3.5 (m) and 0.70 (s^2)	1	AO2 4.5.6.1.5
	gradient = 5.0		1	
	acceleration = 10.0 (m/s^2)	MP3 can be awarded for a correct calculation of acceleration using their gradient provided it is change in height ÷ change in time^2	1	

Total Question 3	**7**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	convex	allow converging	1	AO1 4.6.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(the parallel) rays converging rays meeting/crossing at the principal focus		1 1	AO2 4.6.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	0.60 μm = 0.6 × 10^{-6} m $3.0 \times 10^{8} = f \times 0.6 \times 10^{-6}$ $f = \frac{3.0 \times 10^{8}}{0.6 \times 10^{-6}}$ $f = 5.0 \times 10^{14}$ (Hz)	allow 0.60 μm = 0.000 000 6 m all subsequent marks may be awarded if wavelength is incorrectly / not converted	1 1 1 1	AO2 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	wavelength		1	AO1 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	distant galaxies are moving away from our galaxy		1	AO1 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	the distance to this galaxy is greater than any previously observed galaxies		1	AO3 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	a gravitational / centripetal / resultant force acts on the satellite		1	AO1 4.8.1.3
	(so) the satellite accelerates (towards the centre of the orbit)	do **not** accept acceleration causes a change in speed	1	
	(so) the direction changes (which changes the velocity)		1	

Total Question 4	**13**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	single arrow starting from dot, pointing vertically upwards and shorter than weight arrow		1	AO2
	labelled air resistance	allow drag	1	AO1 4.5.1.4 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	2.5 minutes = 150 s	all subsequent marks may be awarded if time is incorrectly / not converted	1	AO2 4.5.6.1.5
	$0.64 = \frac{v-0}{150}$		1	
	$v = 0.64 \times 150$		1	
	$v = 96$ (m/s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(as the skydiver's velocity / speed increased) the air resistance increased	allow drag for air resistance throughout	1	AO1 4.5.6.1.5
	until the air resistance was equal to the weight of the sky diver (and in the opposite direction)		1	
	(so) the resultant force was zero		1	
	(so) the acceleration was zero (so the velocity was constant)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	greater weight of air above the skydiver as distance fallen increases and pressure = *F/A* (so pressure increases) **OR** the density of the air surrounding the skydiver increases as the skydiver falls (1) more frequent collisions of air particles with skydiver (so pressure increases) (1)	allow the mass / number of air molecules above the skydiver increases	1 1	AO1 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	triangle / parallelogram drawn with vertical line longer than horizontal line resultant force arrow in correct direction magnitude of resultant force in range 300 N to 320 N angle to vertical of resultant force in range 38 °– 42 °		1 1 1 1	AO2 AO2 AO3 AO3 4.5.1.4

Total Question 5	**16**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	car **X** has a smaller maximum acceleration (than car **Y)**		1	AO3 4.5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	increases the time taken (for the driver to come to a stop) (so) the rate of change of momentum decreases **or** the deceleration / acceleration of the driver is less (so) the force (on the driver) is reduced	allow for MP1 **and** MP2 the change of momentum is the same but over a greater time	1 1 1	AO1 4.5.6.2.2 4.5.7.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$0 - 18^2 = 2 \times a \times 24$		1	AO2 4.5.2
	$a = -\frac{324}{48}$		1	4.1.1.2 4.5.6.2.2 4.5.6.1.5
	$a = -6.75$	the equation $v^2 - u^2 = 2as$ must have been used to score subsequent marks	1	4.5.7.3
	$F = 1400 \times (-) 6.75$		1	
	9450 (N)		1	
	OR			
	$E_k = \frac{1}{2} \times 1400 \times 18^2$ (1)			
	$=226\ 800$ (1)	the equation $E_k = \frac{1}{2} m v^2$ must have been used to score subsequent marks		
	$226\ 800 = F \times 24$ (1)			
	$F = \frac{226\ 800}{24}$ (1)			
	9450 (N) (1)			
	OR			
	average velocity = (18 + 0) / 2 (1)			
	$24 = 9 \times t$ (1)			
	$t = \frac{24}{9}$ (1)	subsequent marks may be awarded if t has been calculated using initial velocity rather than average velocity		
	$F = \frac{1400 \times 18}{\frac{24}{9}}$ (1)			
	9450 (N) (1)			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	work is done by friction (in the brakes) (some of the kinetic) energy (of the vehicle) is transferred as thermal energy (in the brakes)	ignore friction alone	1 1	AO1 4.5.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the brakes will overheat the driver will lose control of the car		1 1	AO1 4.5.6.3.4

Total Question 6	**13**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	B		1	AO3 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$F = 0.30 \times 2.0 \times 0.070$		1	AO2 4.7.2.2
	$F = 0.042$ (N)	the equation $F = BIl$ must have been used to score subsequent marks	1	
	$0.042 = 0.005 \times a$	subsequent marks may be awarded if an incorrectly / not converted mass is used	1	
	$a = \frac{0.042}{0.005}$		1	
	$a = 8.4$ (m/s^2)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		do **not** accept answers describing a generator		AO1 4.7.2.3
	(the interaction of) the magnetic fields produce forces on the sides of the coil (AB and CD)		1	
	AB and CD move in opposite directions		1	
	(each half-revolution) the ends of the coil swap from one contact to the other	*allow 'split ring commutator' for ends of the coil'*	1	
	(so) current in each side of the coil is reversed, so the forces on each side of the coil are reversed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	there is no current in the wire		1	AO1
	(so) there is no (magnetic) force acting (therefore there is no moment)	MP2 is dependent on MP1	1	AO3 4.5.1.4 4.7.2.3

Total Question 7	**12**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	at right angles (to surfaces) **or** normal (to surfaces)		1	AO1 4.5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	$774 = \frac{1.50}{A}$		1	AO2 4.5.5.1.1
	$A = \frac{1.50}{774}$		1	
	$A = 0.0019379\ldots$		1	
	0.00194 (m^2)	allow an answer calculated using all the data in the question given to three significant figures	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	pressure increases with depth	allow the vinegar has a greater density than the oil	1	AO3 4.5.5.1.2
	(so) the pressure on the bottom of the garlic (from the vinegar) is greater than the pressure on the top of the garlic (from the oil)		1	
	(therefore) the upwards force on the bottom is greater than the downwards force on the top		1	
	the resultant of these two forces is the upthrust	this mark is dependent on MP2 **or** MP3	1	

Total Question 8	**9**

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	iron is easily magnetised (and demagnetised)	ignore magnetic unqualified allow it is magnetically soft do **not** accept iron is a conductor	1	AO1 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	$V_s = 400\,000$ V $\frac{V_p}{400\,000} = \frac{345}{6000}$ $V_p = 0.0575 \times 400\,000$ 23 000 (V)	subsequent marks may be awarded if an incorrectly / not converted *V*s is used	1 1 1 1	AO2 4.7.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(the ac in the primary) causes a changing magnetic field in the core the secondary coil cuts through the (changing) magnetic field inducing a pd (across the ends of the secondary coil) **or** so a pd is induced (across the ends of the secondary coil)		1 1 1	AO1 4.7.3.4

Total Question 9	**8**