GCSE
PHYSICS
8463/2H

Paper 2 Higher Tier

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

2 2 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.

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	any **two** from: • capacity of the battery • speed • mass / weight • uphill / downhill • stopping at traffic lights • condition of the road • (air) temperature • (incorrect) tyre pressure • streamlining of the car	 allow energy/charge stored in battery allow efficiency of battery ignore size of battery allow terrain ignore 'the road' only ignore 'weather' only allow efficiency of engine allow anything that would use charge from the battery **or** anything that will reduce the energy stored	2	AO3 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	acceleration = change in velocity/time (taken) **or** $a = \frac{\Delta v}{t}$	allow any correct rearrangement allow $a = \frac{v - u}{t}$ do **not** accept $a = \frac{v}{t}$	1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$20 = \frac{28}{t}$ $t = \frac{28}{20}$ 1.4 (s)		1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	v^2 (- 0^2) = 2 × 10 × 605 v^2 = 12 100 v = 110 (m/s)		1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	work done = force × distance **or** $W = Fs$	allow any correct rearrangement	1	AO1 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	*s* = 7500 (m)		1	AO2 4.5.2
	W = 4000 × 7500	allow correct substitution using incorrectly / not converted value of s	1	
	W = 30 000 000 (J)	allow correct calculation using incorrectly / not converted value of s	1	

Total Question 1		**13**

Question 2

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 4.6.1.3
	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 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 80 degrees Methods involving mirrors and reflection score zero		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	angle of incidence in degrees / ° on *x*-axis **and** angle of refraction in degrees / ° on *y*-axis		1	AO2 4.6.1.3
	all points plotted correctly	allow **1** mark if 3 or 4 points plotted correctly allow tolerance of half a small square	2	
	curved line of best fit	allow line of best fit from their incorrectly plotted points	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	normal drawn at 90° at the point where the incident ray strikes the mirror		1	AO2 4.6.1.3
	straight line drawn with a ruler **and** angle of incidence = angle of reflection	ignore any arrows	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(the protractor drawn on the paper means you) do not have to move the mirror (to measure the angles)	allow do not have to mark the position of the rays of light allow protractor does not need to be repositioned	1	AO3 4.6.1.3
	(so) more likely to record the correct angle of incidence and / or reflection	allow reducing random error allow more accurate	1	
	ray in method A does not diverge	allow ray in method A is thin(ner)	1	
	(making it) easier to judge the centre (position) of the ray	allow more accurate if not already awarded allow converse answers in terms of method B being worse than method A	1	

Total Question 2		**16**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: • wet / icy road conditions • poor condition of brakes • poor condition of tyres • increased mass of car • negative gradient of the road	ignore weather allow weight for mass allow going downhill	2	AO1 4.5.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	distance = speed × time (so) longer reaction time = longer distance		1 1	AO1 4.5.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	mean reaction time increases after drinking alcohol the change in reaction time is not the same for all people after drinking alcohol		1 1	AO3 4.5.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	distance = 1500 (m)		1	AO2 4.5.6.1.2
	1500 = 20 × *t*	allow a correct substitution using an incorrectly / not converted value of distance	1	
	$t = \frac{1500}{20}$	allow a correct rearrangement using an incorrectly / not converted value of distance	1	
	75 (s)	allow a correctly calculated value using an incorrectly / not converted value of distance	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	velocity is a vector and speed is a scalar	allow velocity includes direction (speed does not)	1	AO3 4.5.6.1.2
	road is not straight	allow driver may change lanes	1	
	therefore direction changes so the velocity changes		1	

Total Question 3		**13**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	there is a resultant force acting	allow weight/gravity is greater than air resistance allow (initially) weight/gravity is the only force acting	1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	as the velocity of the hailstone increases air resistance increases until air resistance becomes equal to the weight of the hailstone so the <u>resultant force</u> is (equal to) zero	allow speed for velocity	1 1 1	AO1 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	as mass increases the weight of a hailstone increases		1	AO3 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	kinetic energy depends on both mass and velocity	allow $E_k = ½ mv^2$	1	AO1
	as mass increases so does terminal / maximum velocity	a statement is required	1	AO1
	kinetic energy ∝ m and kinetic energy ∝ v^2 so as mass doubles kinetic energy more than doubles	this mark can be scored by relevant calculations	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	1 N m		1	AO3 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	mass = 0.0185 (kg)	allow 0.018 to 0.019 inclusive	1	AO2 4.5.7.3
	$F = \frac{0.0185 \times 25}{0.060}$	allow a correct substitution using an incorrectly / not converted value of *m*	1	
	F = 7.708 (N)	allow 7.7 (N) allow correct calculation using an incorrectly / not converted value of *m* **if no other marks are awarded** a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then correctly converted giving an answer between 6.50 and 6.54 scores 2 marks a misreading of the scale giving a value between 15.6 and 15.7 inclusive that is then not converted giving an answer between 6500 and 6542 scores 1 mark	1	

Total Question 4		**12**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	the point from which weight may be considered to act **or** the point where the mass appears to be concentrated	allow the point through which the line of action of the weight acts allow the point at which the mass is concentrated	1	AO1 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	mass of 5 tomatoes = 0.425 (kg) mass of 1 tomato = 0.085 (kg) W = (0.085 × 9.8) = 0.833 (N)	 allow an incorrect and / or not converted reading correctly divided by 5 allow a correct calculation using their value of mass	1 1 1	AO2 4.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	6.0 = k × 0.015 $k = \frac{6.0}{0.015}$ k = 400 (N/m)	 allow correct rearrangement using an incorrectly calculated value of e allow a correct calculation using an incorrectly calculated value of e	1 1 1	AO2 4.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	deforms elastically (so) will return to its original length / shape (after force is removed) **OR** compression is directly proportional to the force (applied) (1) (so) gives a linear scale (1)	 allow easy to calibrate	1 1	AO3 4.5.3

Total Question 5		**9**

Question 6

Question	Answers	Mark	AO / Spec. Ref.
06.1	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO1 4.8.1.1 4.8.1.2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content **all stars:** • form in a cloud of gas and dust (nebula) by gravity – mostly hydrogen • forms a protostar • fusion begins • fusion of small nuclei into larger nuclei (hydrogen into helium) • main sequence star – stable period where gravitational forces (inwards) balance forces (outwards) due to fusion processes **comparisons:** • stars about the same size as the Sun expand to become a red giant, stars much bigger than the Sun expand to become a red super giant • stars about the same size as the Sun contract (and temperature increases) to become a white dwarf, stars much bigger than the Sun explode in a supernova • stars about the same size as the Sun (cool to) become a black dwarf, stars much bigger than the Sun become either a neutron star or black hole		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	the (observed) increase in wavelength (of light from galaxies) as galaxies move away from us	ignore light waves are stretched	1 1	AO1 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	the furthest galaxies are moving away (from the Milky Way) the fastest (which suggests that) at some time all galaxies / matter started at the same point		1 1	AO3 4.8.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	there are new observations / evidence that does not fit into current theory / model	allow specific examples of new observations / theories such as dark matter or dark energy	1	AO1 4.8.2

Total Question 6		**11**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	**A** primary coil **and** **B** secondary coil		1	AO1 4.7.3.4
	C iron core		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$\frac{230}{V_s} = \frac{200}{1200}$		1	AO2 4.7.3.4
	$V_s = \frac{1200 \times 230}{200}$		1	
	$V_s = 1380$ (V)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(the alternating current causes) a changing magnetic field around the primary (coil)		1	AO2 4.7.3.4
	creates magnetic field that changes direction in the core	allow creates a changing magnetic field in the core	1	
	this induces an alternating potential difference across the secondary (coil causing an alternating current)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	down		1	AO2 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	$B = 60 \times 10^{-6}$ (T)		1	AO2 4.7.2.2
	$0.045 = 60 \times 10^{-6} \times 50 \times l$	allow correct substitution of incorrectly / not converted value of B	1	
	$l = \dfrac{0.045}{60 \times 10^{-6} \times 50}$	allow correct rearrangement using an incorrectly / not converted value of B	1	
	$l = 15$ (m)	allow a correct calculation using an incorrectly / not converted value of B	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	the wire / force is at right angles to the magnetic field	allow the current is constant allow the cable is straight allow the field is uniform allow the force is constant	1	AO3 4.7.2.2

Total Question 7		**14**

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	upthrust acts (upwards on the brick) normal contact force acts upwards (on the brick) weight is equal to upthrust plus normal contact force	 allow resultant force is equal to zero only if all three forces are given	1 1 1	AO1 4.5.1.2 4.5.5.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	$A = 0.25 \times 0.10 = 0.025$ (m^2)		1	AO2 4.5.5.1.1 4.5.5.1.2
	$P = \frac{637}{0.025}$	allow correct substitution of incorrectly calculated value of A	1	
	$P = 25\,480$ (Pa)	allow correct calculation using an incorrectly calculated value of A to gain further marks, $P = F/A$ or an incorrect rearrangement of $P = F/A$ must have been used with the given data	1	
	$25\,480 = \underline{2.5} \times \rho \times 9.8$	allow correct substitution of incorrectly calculated value of P	1	
	$\rho = \frac{25\,480}{9.8 \times 2.5}$	allow correct rearrangement using an incorrectly calculated value of P allow use of $h = 2.6$ (m)	1	
	$\rho = 1040$ (kg/m^3)	allow correct calculation using an incorrectly calculated value of P allow use of $h = 2.6$ (m)	1	
	Alternative method			
	$A = 0.25 \times 0.10 = 0.025$ (m^2)		1	
	volume of water column (V) $= 0.025 \times 2.5$	allow use of an incorrectly calculated value of A	1	
	$V = 0.0625$ (m^3)	allow use of an incorrectly calculated value of A	1	
	$m \left(= \frac{637}{9.8}\right) = 65$ (kg)		1	
	$\rho = \frac{65}{0.0625}$	allow use of an incorrectly calculated value of V	1	
	$\rho = 1040$ (kg/m^3)	allow use of an incorrectly calculated value of V	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	$F = 618 \times \frac{49.9}{2.5}$	allow calculation of density = 1008.979 (kg/m^3)	1	AO3 4.5.5.1.1 4.5.5.1.2
	F = 12 335.28		1	
	F = 12 300 (N)		1	
		allow correct rounding of an incorrectly calculated value of F		
		allow max of **2** marks if 50 m is used		

Total Question 8		**12**