OXFORD AQA

INTERNATIONAL QUALIFICATIONS

INTERNATIONAL AS

PHYSICS

PH02

Unit 2 Electricity, waves and particles

Mark scheme

June 2025

Version: 0.1 Pre-Standardisation

256XPH02/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 www.oxfordaqa.com

Level of response marking instructions

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 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. 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 and not look to pick holes in 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 and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 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.

An answer which contains nothing of relevance to the question must be awarded no mark

Question	Answers	Additional comments/Guidelines	Mark	AO
01.1	The minimum frequency of light that results in electrons being emitted (from the metal surface) ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	$E_{k(max)} = eV_{STOP}$ **OR** $E = hf$ used at any point ✓ Use of photoelectric effect equation to find ϕ ✓ 5.1×10^{14} (Hz) ✓		3	AO1

Total			**4**

Question	Answers	Additional comments/Guidelines	Mark	AO
02	Uses $d = \frac{10^{-3}}{280}$ or equivalent ✓ Uses $d\sin\theta = n\lambda$ with $\theta = 90$ **OR** $n\lambda = d$ to find n ✓ Doubles their n and adds 1 ✓	expect 3.6×10^{-6}; condone POT error n must be integer for MP3 (full marks for correct final answer $= 11$ bright spots)	3	AO1

Total			**3**

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Reference to wave equation **AND** frequency stays the same ✓	Or reverse argument	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	$\left(\frac{\sin 59}{\sin 31} = \right) 1.4$ ✓	Reject if any units are given	1	AO2

Total			**2**

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	2.5 (s) ✓ Idea that there are two maxima/minima of energy/height in one period ✓		2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Use of $T = 2\pi\sqrt{\frac{l}{g}}$ ✓ 1.6 (m) ✓	 ecf from **04.1** for both marks	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	Any **one** from: ✓ • the motion is damped (by air resistance/friction) • the motion is driven (by the child kicking her legs) • the angle of oscillation is not small • the child is not a point mass / mass of chain is significant • the chain does not stay taut.		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.4	Sinusoidal shape with correct period ✓ Decreasing peaks ✓ Minima touching x-axis at 0, 1.25, 2.5; maxima at approximately 0.63, 1.88 ✓		3	AO2

Total			**8**

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	(Plane) polarisation is when the direction of oscillation is restricted to a certain plane (perpendicular to the direction of propagation of the wave) ✓ The idea that there are no oscillations perpendicular to the direction of propagation in longitudinal waves **OR** only transverse waves have oscillations perpendicular to the direction of propagation ✓		2	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	When signals are polarised, the antenna/receiver must be aligned with the plane of the signal ✓ Idea that mobile phones can be moved around and held in different orientations **OR** that the signal quality would fluctuate (as the user moves) ✓		2	AO2

Total			**4**

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Read-off = $1.6(0)$ (V) ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	Gradient determined using points far apart ✓ Gradient negative, resistance positive ✓ 0.19 (Ω) ✓	Expect to see eg $\frac{1.6}{8.6}$	3	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	Lamp with **B** is brighter because: lower internal resistance of **B** means less lost volts ✓ (so) higher terminal pd ✓ **OR** Lamp with **B** is brighter because: lower total resistance ✓ (so) greater current ✓		2	AO2

Total			**6**

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Sketch shows the light totally internally reflecting multiple times in the water jet ✓	Lines must be straight, judged by eye Condone roughness of drawing	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	Line travels straight to water−air boundary, then refracts downwards at boundary then travels straight to screen ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	The angle of incidence of the light decreases and becomes less than the critical angle ✓ so the light refracts out of the water / no longer totally internally reflects ✓ Idea that the light speeds up so it bends away from the normal when it leaves the water ✓		3	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	Any **one** from: ✓ • put a warning sign on the door • idea of not using lasers at eye level • do not point lasers at the audience **OR** do direct lasers at a screen • keep lasers stored safely (locked etc) • use lasers with an 'on' button that must be held down • use non-reflective screen.	Condone laser eye protection goggles Do not accept simply 'goggles' unless it is clear they are specifically for laser protection	1	AO4
Total			**6**	

Question	Answers	Additional comments/Guidelines	Mark	AO
08.1	Any **two** from: ✓✓ • energy is transferred along a progressive wave, but stored in a stationary wave • the phase of the oscillations varies continuously along a progressive wave, but is constant between two adjacent nodes/antinodes in a stationary wave • stationary waves have nodes and antinodes, while progressive waves do not **OR** the peaks and troughs (or compressions, rarefactions) move in a progressive wave but don't in a stationary wave • a progressive wave has the same amplitude at all points whereas the amplitude varies along a stationary wave.		2	AO1

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr>
<td>08.2</td>
<td>The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2-mark (L1), 3 or 4-mark (L2) and 5 or 6-mark (L3) answer.
<table>
<tr><th>Mark</th><th>Criteria</th></tr>
<tr><td>6</td><td>All three areas covered with at least two aspects covered in some detail. There should be at least one statement from the conclusions. Can be awarded even if there is an error and/or parts of one aspect missing.</td></tr>
<tr><td>5</td><td>A fair attempt to analyse all three areas, with two areas discussed successfully and one are partially.</td></tr>
<tr><td>4</td><td>Two areas successfully discussed, or one Discussed and two others covered partially. Whilst there will be several gaps, there should only be an occasional error.</td></tr>
<tr><td>3</td><td>One area discussed and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.</td></tr>
<tr><td>2</td><td>Only one area discussed or makes a partial attempt at two areas.</td></tr>
<tr><td>1</td><td>None of the three areas covered without significant error.</td></tr>
<tr><td>0</td><td>No relevant comments</td></tr>
</table>
</td>
<td>
• the measurements to be taken, including details of the measuring instruments used
measure hanging mass with mass balance
measure L with ruler or tape measure
vary hanging mass OR L
measure f for first harmonic (or second) using the signal generator
• techniques to reduce the uncertainty in the experiment
at least 6 values of hanging mass OR L used
repeat and average / remove anomalies
• how μ is determined using a graphical method
valid combination of x and y variables
algebraic manipulation of $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$ into the form $y = mx + c$
express μ in terms of the gradient
Accept answers in terms of the 2nd harmonic
</td>
<td>6</td>
<td>2 × AO1
4 × AO4</td>
</tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
08.3	Idea that the second harmonic has a node in the centre and it is easier to observe a node than an antinode ✓		1	AO4

Total			**9**

Question	Answers	Additional comments/Guidelines	Mark	AO
09.1	The atoms de-excite and emit photons ✓ corresponding to the energy of each transition ✓ Idea that only specific wavelengths are emitted, showing that only specific transitions are possible ✓		3	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
09.2	Any **three** from: ✓✓✓ • use of $E = \frac{hc}{\lambda}$ • converts from eV to J correctly or vice versa at any time • determines $1.9\ \text{eV}$ using the wavelength • shows $-1.51 - -3.39\ \text{eV} = 1.9\ \text{eV}$ Concludes level 3 to level 2 ✓		4	3 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
09.3	6		1	AO3

Total			**8**

Question	Answers	Additional comments/Guidelines	Mark	AO
10.1	Micrometer (screw gauge) / digital Vernier caliper ✓		1	AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
10.2	Zero before use **OR** Take readings and subtract reading when micrometer fully closed ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
10.3	To reduce random errors / to identify and eliminate anomalies **OR** Idea of determining whether wire has circular cross-section / uniform thickness ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.4	Any **two** from: ✓✓ • calculates mean d (expect $0.17\ \text{mm}$) • uses $\frac{\frac{1}{2}\text{range}}{\text{their } \overline{d}}$ $(\times 100)$ to find % uncertainty in d • $2\times$ their % uncertainty in d to find uncertainty in A 12% ✓	Only first bullet point and final answer require anomaly to be removed	3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.5	% uncertainty in length 1.2% ✓ Adds their answer to their value in **10.4** ✓		2	AO3

Total			**8**

Question	Answers	Additional comments/Guidelines	Mark	AO
11.1	Read-off from **Figure 15** for 37 °C (7.5 to 8 kΩ) ✓ Use of potential divider equation or other valid method ✓ Answer that rounds to 2100−2200 Ω ✓		3	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
11.2	When resistance of **R** is increased, it has a larger share of the voltage (for any particular temperature) **OR** the current in the circuit decreases ✓ The voltage of the thermistor is decreased (for the same temperature) ✓ The threshold voltage is reached at a lower temperature ✓		3	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
11.3	Idea that the light can turn on at some other threshold temperature so the chosen temperature for the bath water can be adjusted to be warmer or cooler ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
11.4	Very high resistance so it does not affect the voltages in the other components of the circuit (ie the potential divider shown in **Figure 14**) ✓		1	AO3

Total			**8**

Question	Key	Answer	AO
12	D	60 Ω	AO3
13	D	1.3 W	AO1
14	A	$\frac{V}{R}$ | 0 | V	AO1
15	D	6 Ω	AO2
16	A	$0.87I$ $0.87P$	AO1
17	B	$1.2f$	AO1
18	D	24 cm	AO1
19	B	0.64 m	AO1
20	C	y	AO1
21	A	decreases increases	AO2
22	C	$\frac{L}{v}\left(\frac{1}{\cos\theta}-1\right)$	AO2
23	C	acrylic Teflon	AO1
24	B	ultraviolet photons visible photons	AO2
25	B	increases increases	AO2