OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A-LEVEL

PHYSICS

PH05

Unit 5 Physics in practice

Mark scheme

January 2025

Version: 1.0 Final

2 5 1 X P H 0 5 / 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 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 marks.

Question	Answers	Additional comments/Guidelines	Mark	AO
01.1	Uses $F = \Delta mg$ to give 0.0285 (N) ✓ downwards ✓	Accept a 2 sf answer	2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	Uses $F = BIL$ to give 0.11 (T) **ecf from 01.1** ✓ **2 sf only** ✓	Look for $\frac{\text{candidate's } \mathbf{01.1}}{0.257}$	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	absolute uncertainty in $\Delta m = 0.01$ g ✓ absolute uncertainty in $l = 1$ mm ✓	Accept 0.02 g for MP1	2	1 × AO1 1 × AO2

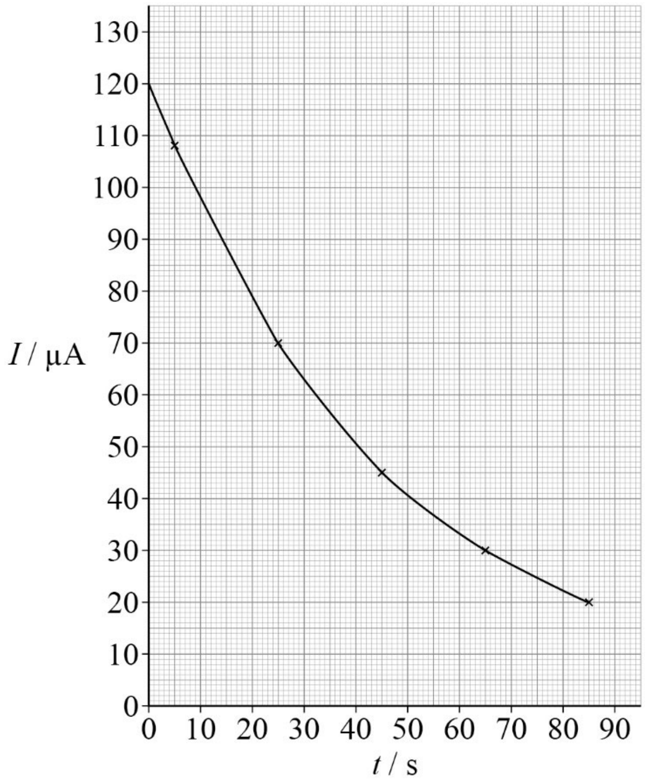
Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	Reads off max emf = 3.4 V **OR** determines period of rotation as $T = 80$ ms ✓$_{1a}$ Use of emf = $BAN\omega$ with their ω or $\omega = \frac{2\pi}{T}$ ✓$_{2a}$ $B = 0.11$ (T) ✓$_{3a}$ **OR** 31 to 35 squares OR 2.5×10^{-3} (Vs) / square ✓$_{1b}$ Divides by $2AN$ ✓$_{2b}$ 0.11 to 0.12 (T) ✓$_{3b}$	$\omega = 78.5\ \text{rad s}^{-1}$ 2 sf max Correct working must be seen for MP3	3	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.5	$B = 0.113$ (T) ✓ Uncertainty in $B = 0.005$ (T) ✓	Condone 1 mark for both 0.109 (T) and 0.015 (T) (ignoring anomaly)	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.6	Calculates percentage uncertainty for method 3 as 4% ✓ States that the uncertainty for method 2 is greater than 10% (since one component of the determination has uncertainty of 10%)… **AND** compares method 3 uncertainty with method 1 (2%) and method 2 ($>10\%$) **AND** to conclude that method 1 has smallest $\%$ uncertainty ✓	Allow ecf from 1.5 Condone any SF for mp1. No marks if no attempt at mp1. Allow ecf for mp2.	2	AO4

Total			**13**

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	Suitable choice of scales ✓ Plotting accuracy minus 1 for each error ✓✓ Best-fit curve drawn well ✓	Expect to see 5 / cm on both axes. Need regular interval $\leq 4\ \text{cm}$ Award 2 marks for MP2 only when small, neat crosses or circled dots are seen. For dots, max 1 for mp2. (5,108), (25,70), (45,46), (65,30), (85,20) Expect to see curve through all points and intercepting at approximately 120 on the current axis.	4	AO3

		I / μA 130 120 110 100 90 80 70 60 50 40 30 20 10 0 0 10 20 30 40 50 60 70 80 90 t / s		

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	Shows how to rearrange the decay equation to give $\ln I = \ln I_0 - \frac{t}{RC}$ ✓1 Recognises that the gradient should be found ✓2 States that $C = -\frac{1}{R \times \text{gradient}}$ ✓3	Allow m for gradient. Condone slope for gradient. Do not allow other undefined symbols for the gradient in ✓2, but condone in ✓3.	3	1 × AO3 2 × AO4
Total			**7**	

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr>
<td>03.1</td>
<td>
The mark scheme gives some guidance as to what statements are expected in a 1- or 2-mark (L1), 3- or 4-mark (L2) or 5- or 6-mark (L3) answer. Guidance provided on page 3 of the “Mark Scheme Instructions” document should be used to assist marking this question.
<table>
<tr><th>Mark</th><th>Criteria</th></tr>
<tr><td>6</td><td>All three areas covered in some detail.
6 marks can be awarded even if there is an error and/or parts of one aspect missing.</td></tr>
<tr><td>5</td><td>All three areas covered, at least two in detail.
Whilst there will be gaps, there should only be an occasional error.</td></tr>
<tr><td>4</td><td>Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be 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 analysis.</td></tr>
</table>
</td>
<td>
Making the necessary measurements

Measures the height gained by the load using a metre ruler or data logger with position sensor
Measures the time taken for the load to rise the measured distance using a stopwatch or datalogger
Measures the current using an ammeter
Measures the voltage using a voltmeter
(allow use of joulemeter in place of voltmeter and ammeter)
(allow using a datalogger and position sensor to measure speed instead of height and time)
(allow use of datalogger and light gate(s) with an appropriate distance measurement)
(Repeat for different masses)

Performing the investigation accurately

Way of ensuring ruler is vertical
h as large as possible
h not measured from floor
Use of fiducial marker for timing
Use of a non-parallax method
Repeats and averages V, I, t
Repeats and removes anomalies V, I, t
4Controls the voltage to keep it constant at different loads
Use of datalogger with appropriate sensor(s) (removes variation in human reaction time).
Use of video and slow motion

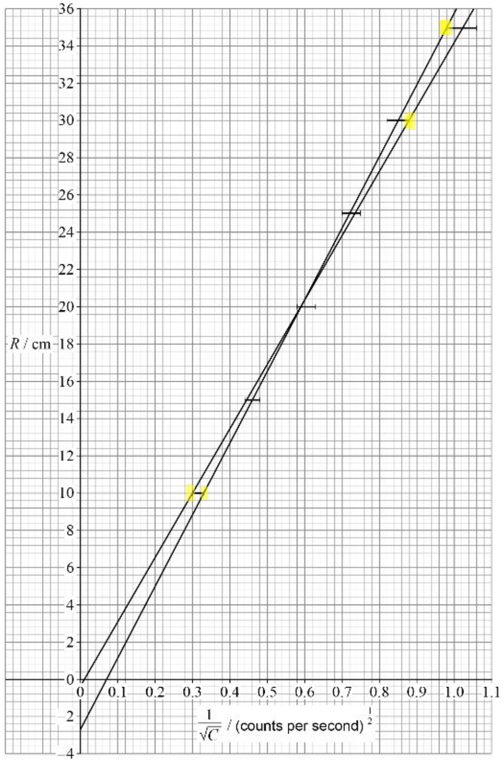
Determining η and processing results
</td>
<td>6</td>
<td>AO4</td>
</tr>
</table>

		• Calculates the useful power output $P_{out} = \frac{mg\Delta h}{t}$ OR mgv if speed is measured or calculated. • Calculates input power $P_{in} = VI$ • Accept energy equations in place of power equations • Calculates efficiency $\eta = \frac{P_{out}}{P_{in}}$ ($\eta = \frac{mg\Delta h}{IVt}$ fully addresses this area) Do not allow kinetic energy in efficiency calculation.		

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	Idea of using smaller increments of mass… ✓ …with more determinations around the maximum of the graph (to identify the precise point of max efficiency) ✓	Ignore increase frequency of readings.	2	AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
03.3	greater current (needed as torque is greater) producing a greater heating/I^2R effect ✓	It must be clear that the energy loss increases not just an increase in the energy of the motor, power supply or input energy. Do not allow answers which use $\eta = \frac{mg\Delta h}{IVt}$ that state or require t to be constant.	1	AO2

Total			**9**

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	Clear attempt to use the error bars to produce lines with maximum and minimum gradients ✓ Minimum gradient line passes through left-hand end of 1st error bar and right-hand end of 5th error bar Maximum gradient line passes through right-hand end of 1st error bar and left-hand end of 6th error bar The lines should produce intercepts on R axis between -0.0 and -0.8 for the minimum gradient and between -2.3 and -2.8 for the maximum gradient ✓	For mp1 lines must cross between first and last error bars. Condone lines which do not intercept the y −axis for both marking points. 	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Uses the two intercepts on the R axis ✓ Finds the mean of the two values ✓ States the absolute uncertainty as the difference between the mean and either of the two values / half of the candidate's range ✓	Values must be calculated **OR** from a line which intercepts the y –axis for mp1. Expect to see a mean of approximately 1.5 (cm) Expect to see an uncertainty of 1.2 (cm) Unsupported values can gain 1 mark only for correct mean and half range for their values. Condone 1SF	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	Idea that the data fit with the equation ✓ Rearranges equation to show that it is consistent with the inverse-square law ✓	Look for a comparison with $y = mx + c$ **OR** a comment that it's a straight line that is not through the origin **OR** graphs shows linear relationship Expect to see $C = \frac{k^2}{(R+r)^2}$	2	1 × AO1 1 × AO3

Total			**7**

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	Use of $R = \frac{\rho l}{A}$ ✓ One correct use of $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ 0.030 (Ω) from correct working ✓	Expect $R = 0.181\ \Omega$ for 1 wire **OR** $R = 0.0302\ \Omega$ for total aluminium	3	1 × AO1 1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	Use of $P = \frac{V^2}{R}$ to give 0.19 (W) ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Use of $P = \frac{mc\Delta\theta}{\Delta t}$ or $Q = mc\Delta\theta$ ✓ 6.6×10^{-5} ($\mathrm{K\ s^{-1}}$) **ecf from 05.2** ✓	Allow use of wrong m **OR** c but not both for mp1. $m = 5.62$ (kg) $c = 502$ ($\mathrm{J\ kg^{-1}\ K^{-1}}$) Allow 6.7×10^{-5}	2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	The idea that the power in the aluminium is (much) greater than in the steel because resistance of aluminium is less than resistance of steel ✓ Recognises that pd across the aluminium is the same as pd across the steel ✓ Idea that ratio $\frac{\text{power in aluminium}}{\text{power in steel}}$ is very large (148 or 25 for 1 wire) compared with ratio $\frac{\text{thermal capacity of aluminium}}{\text{thermal capacity of steel}}$ (3.8) ✓ OR Attempts to compare rate of temperature increase in materials algebraically: Finds the ratio of powers using $P = \frac{V^2}{R}$ or $P = mc\frac{\Delta\theta}{\Delta t}$ for each material ✓ Combines expressions to give $\frac{\text{rate of temp rise in Al}}{\text{rate of temp rise in steel}} = \frac{R_s m_s c_s}{R_{Al} m_{Al} c_{Al}}$ or the equivalent ✓ Evaluates the ratio to give 39 or 40 ✓	Accept explanation using specific heat capacity and mass in MP3 Must have some use of data to get all three marks **Alternative** Use of $P = \frac{V^2}{R}$ and $P = \frac{mc\Delta\theta}{\Delta t}$ for aluminium ✓ To get $\frac{\Delta\theta}{\Delta t} = 2.6 \times 10^{-3}$ ($\mathrm{K\,s^{-1}}$) ✓ Comparison of 2.6×10^{-3} or 4.3×10^{-4} with value for steel from **05.3** ✓ 39 must be supported by some relevant working for mp3. Condone comparison of values of Rmc	3	1 × AO1 1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.5	Rate of heating is equivalent to rate of heat transfer (to the surroundings) ✓	Allow references to power.	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.6	Idea that the strands are fixed together so they must all extend by the same amount (and the original lengths are all the same) ✓	Do **not** allow same tension.	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.7	Uses $E = \frac{FL}{A\Delta L}$ for both metals ✓ Uses area of aluminium $= 6 \times$ area of steel to give 0.5 ✓	Allow use of $E = \frac{F}{A \times \text{strain}}$	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.8	Tension in aluminium = 77 (single strand) or 462 (total) (N) OR tension in steel = 231 (N) ✓ Correct substitution into $E = \frac{FL}{A\Delta L}$ in any form ✓ 7.1×10^{-3} (m) ✓	Steel $E = 2.1 \times 10^{11}$ Aluminium $E = 7.0 \times 10^{10}$ Area for 1 strand = 1.05×10^{-5} $L = 68$ Correct for either steel or aluminium Allow ecf for $T = \frac{693}{2} = 346.5$ in an otherwise correct substitution for steel for mp2 only.	3	2 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.9	Use of $T \cos 7$ **OR** $d \cos 7$ ✓ Use of $693 \times 8.4 \cos 7°$ to give 5780 (N m) ✓		2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.10	Any appropriate condition plus the appropriate change with rationale	e.g. High wind leads to increase in moment due to additional component of T Hot weather causes cable to stretch, reducing moment since angle increases Condone cold weather causes cable to contract, increasing tension and increasing moment. Condone idea that hot weather causes cable to stretch which leads to increase in tension linked to $E = \frac{FL}{A\Delta \mathrm{L}}$ which increases the moment. Snow or ice build-up will increase the moment as tension would be greater	1	AO2

Total			**19**

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Constant frequency / wavelength ✓ Constant phase relationship / difference ✓	Do **not** allow in phase.	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	Idea that they originate from the same point (at the same time) / ray ✓	Allow A for point Condone source for point.	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	Idea that a path difference of a whole number of wavelengths would produce positive reinforcement… ✓ …but the phase change results in the two rays being in antiphase so a dark fringe occurs ✓	mp2 depends on mp1. Alternatives Path difference of 48.5λ or 47.5λ **OR** Phase difference of 97π or 95π✓ So a dark fringe occurs ✓ Condone Path difference of 24.5λ or 23.5λ **OR** Phase difference of 49π or 47π **AND** So a dark fringe occurs ✓ Condone Phase difference of 48.5λ or 47.5λ **OR** Path difference of 97π or 95π **AND** So a dark fringe occurs ✓ Allow π phase difference leads to a dark fringe if justified with a path difference.✓ Do not allow other quoted numbers for phase or path difference.	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.4	$24\lambda = t$ OR $\frac{t}{x} = \frac{H-h}{d}$ ✓ Both equations seen and correctly manipulated ✓	Allow $\frac{x}{t} = \frac{d}{H-h}$ If a symbol other than t is used it must be defined. Allow mp1 only if 24λ is shown in a similar triangle equation with no justification.	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.5	Uses $c = f\lambda$ ✓ $h = 0.149954\ \mathrm{m}$ ✓	Expect to see $6.48900 \times 10^{-7}\ \mathrm{m}$	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.6	Wavelength decreases ✓ Idea that number of fringes that fit in space increases (now greater than 24): **and one** of ✓ • since t is now greater than 48 × the new wavelength • fringe spacing/width decreases • use of $h = H - \frac{n\lambda d}{x}$ in some form	Do not allow use of $w = \frac{\lambda D}{s}$ for mp2.	2	AO2

Total			11

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	3611 m **cao** ✓	Condone 1SF	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	Any **2** from: ✓✓ • Uses depth × area to find volume • Use of $m = \rho V$ with their volume • Use of $Q = mL$ with their mass 7.2×10^{21} (J) ✓	Expect: volume $= 0.06 \times 3.6 \times 10^{14} = 2.16 \times 10^{13}$ mass $= 2.16 \times 10^{16}$ Ignore PoT in mp1 and mp2	3	2 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	Any **one** from: ✓ • Works out percentage or fractional change in volume • Multiplies by $\frac{0.100}{0.0020}$ 0.6 (K) ✓	Look for $\frac{0.12}{1000}(\times 100)$ Condone 1SF **Alternative:** $1.00002^n = \frac{1000.12}{1000}$ ✓ $\frac{\left(\ln\frac{1000.12}{1000}\right)}{\ln 1.00002} = 0.6$ (K) ✓ Condone for 1 max $1.002^n = \frac{1000.12}{1000}$	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	Any **one** from: ✓ Warm water is less dense so it floats to the surface Radiation is attenuated **/** can't penetrate Water is a poor thermal conductor (so lower layers not heated much by conduction)		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Estimates temperature at $15\ ^{\circ}\mathrm{C} \pm 15\ \mathrm{K}$ and converts to K ✓ Uses the equation to get an accurate answer for their estimate with correct unit ✓	273 – 303 K look for a value of around $2.9 \times 10^{-3}\ \mathrm{K\ m}$ Allow 1SF Do not allow $\mathrm{K\ M}$, $\mathrm{k\ m}$ or $\mathrm{k\ M}$ Do not allow $^{\circ}\mathrm{C}$ for K	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.6	Uses $E = hf$ to find photon energy ✓ Uses $E = \frac{3}{2}kT$ to find the molecular kinetic energy ✓ Makes an appropriate comparison, eg that photon energy is 410% of initial internal energy ✓	look for 2.0×10^{-20} (J) look for 4.8×10^{-21} (J) Do not allow 1SF for energies. Allow 1SF for ratio.	3	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.7	Idea that re-radiation (happens in all directions and) some will be directed back towards the surface of the Earth ✓ Idea that photons directed towards Space are likely to be absorbed by other carbon dioxide or other greenhouse gas molecules ✓	Allow reflection from clouds (towards the Earth).	2	AO2

Total			**14**