OXFORD
INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL A-LEVEL

PHYSICS

PH05

Unit 5 Physics in practice

Mark scheme

June 2023

Version: 1.0 Final

236XPH05/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 oxfordaqaexams.org.uk

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	Idea that the resolution of the micrometer is better than the calipers ✓ ...using a micrometer leads to a smaller (percentage) uncertainty in the measurement (of diameter) ✓	Accept reference to precision or resolution For MP2 accept reference to difficulty of ensuring vernier jaws are across the diameter	2	1 AO2 1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	An attempt to explain why 0.01 is chosen ✓ Correct manipulation with powers of ten dealt with convincingly ✓	E.g. for MP1: Absolute uncertainty in 3 sig fig value is $\pm\ 0.01$ Expect to see $\frac{0.01}{9.81} \times 100\%$	2	1 AO1 1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	Correct substitution or manipulation ✓ 3.89 ✓ $\mathrm{N\ s\ m^{-2}}$ OR $\mathrm{kg\ s^{-1}\ m^{-1}}$ ✓	Allow MP1 even with power of ten errors Answer to at least 3sf. Calculator value is 3.8903452 Allow variations consistent with unit eg 3900 with $\mathrm{mN\ s\ m^{-2}}$	3	2 AO1 1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	Adds absolute uncertainties of density and finds percentage uncertainty for the difference in densities ✓ Doubles their percentage uncertainty in r ✓ Adds their percentage uncertainties and 4% to give 5% or 5.4% ✓	Expect to see 0.76 % Expect to see 2 × 0.28 %	3	1 AO1 2 AO2
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	Takes logs of $V = V_0 e^{\frac{-t}{RC}}$ successfully ✓ Compares the correct log equation with $y = mx + c$ to show that $m = -\frac{1}{RC}$ ✓		2	2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	Calculates one gradient correctly or calculates one value of 1/gradient correctly ✓ Attempts to find both gradients and takes their average ✓ 34 s ✓	Max gradient $= 0.030$ (s^{-1}) Min gradient $= 0.029$ (s^{-1}) Corresponding values of 1/gradient are 33 s and 35 s Candidates who draw a single line in between those plotted can access MP1 and MP3 but not MP2	3	3 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.3	(Candidate compares max and min gradient from **02.2** with mean value to give) an uncertainty in the range 0.7 s to 1.0 s ✓		1	1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.4	Any random error ✓	Accept reasonable alternative eg parallax (but parallax cannot be rewarded in both **02.4** and **02.5**)	1	1 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
02.5	zero error on voltmeter or contact resistance or resistance of voltmeter ✓	Accept reasonable alternative eg parallax (but parallax cannot be rewarded in both **02.4** and **02.5**) Accept 'voltmeter incorrectly calibrated' but not 'voltmeter not calibrated'.	1	1 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
02.6	ANY 2 ✓✓ • Camera/'phone may be arranged to prevent parallax error • Idea that freeze frame capacity allows the observer to take simultaneous readings ✓ • Greater number of readings possible (within the time range) (should reduce range of possible gradients)	Allow idea that analogue meters respond quickly compared with fixed sampling time for electronic meters	2	2 AO4
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Idea that friction is an external force (and momentum is only conserved in the absence of external forces) ✓		1	AO4

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidance</th><th>Mark</th><th>AO</th></tr>
<tr>
<td>03.2</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. Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.
<table>
<tr><th>Mark</th><th>Criteria</th></tr>
<tr><td>6</td><td>All three areas (as outlined alongside) covered with at least two aspects 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>A fair attempt to analyse all three areas, with two areas discussed successfully and one area partially.</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 successfully 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 successfully, or makes a partial attempt at two areas.</td></tr>
<tr><td>1</td><td>One of the three areas covered partially. There are likely to be many errors or omissions.</td></tr>
<tr><td>0</td><td>No relevant analysis.</td></tr>
</table>
</td>
<td>
Area 1: Description of apparatus and how to minimise friction

Angled runway/air track with explanation of how friction compensated
Trolley/equivalent with wheels or glider
Light gates with dataloggers/timers/computer with sensors OR other means of determining speed/time

Area 2: Account of the method

Finds mass of both gliders using mass balance
Measure length of card/glider or distance between pairs of light gates or uses doppler device
Record time card/glider interrupts 1st light gate OR record initial velocity of glider
Record time card/glider interrupts 2nd light gate OR record final velocity of gliders

Area 3: How measurements used.

Determine or use velocity of single and combined gliders
Calculate initial momentum of single glider
Calculate final momentum of combined gliders
Compare both momenta and draw a conclusion OR equate final and initial momenta OR an attempt at a graphical method which may not be complete

</td>
<td>6</td>
<td>4 × AO2
2 × AO3</td>
</tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
03.3	Momentum before collision = $2.60\ \text{kg m s}^{-1}$ and momentum after collision = $2.56\ \text{kg m s}^{-1}$ ✓ Uses uncertainties appropriately and states that the principle is supported ✓	E.g. for appropriate use of uncertainties in MP2 Shows that there is overlap in the ranges (2.58 to 2.62 cf 2.53 to 2.59) OR Determines percentage uncertainty in speed measurements and compares with percentage difference in momenta. Expect to see $0.7 + 1.2 > 100 \times (2.6\text{-}2.56) \div 2.56$	2	1 AO3 1 AO4
Total			**9**	

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr><td>04.1</td><td>All values correct to 2 sf but accept 1 sf for the first two rows ✓
Condone 3sf</td><td>
<table>
<tr><th>l / m</th><th>y / mm</th><th>$\sqrt[3]{y}$ / $\text{mm}^{\frac{1}{3}}$</th></tr>
<tr><td>0.200</td><td>1</td><td>1.0</td></tr>
<tr><td>0.300</td><td>6</td><td>1.8</td></tr>
<tr><td>0.400</td><td>14</td><td>2.4</td></tr>
<tr><td>0.500</td><td>30</td><td>3.1</td></tr>
<tr><td>0.600</td><td>50</td><td>3.7</td></tr>
</table>
</td><td>1</td><td>1 AO3</td></tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Acceptable scales chosen ✓ Axes properly labelled ✓ First point plotted correctly on a sensible scale✓ Fifth point plotted correctly on a sensible scale✓ Good best-fit straight line with a positive intercept on the l axis ✓	At least half of space used. No awkward scales Candidates who draw axes the wrong way round lose MP2 For a graph of y against $\sqrt[3]{y}$ only MP1 accessible	5	5 AO3

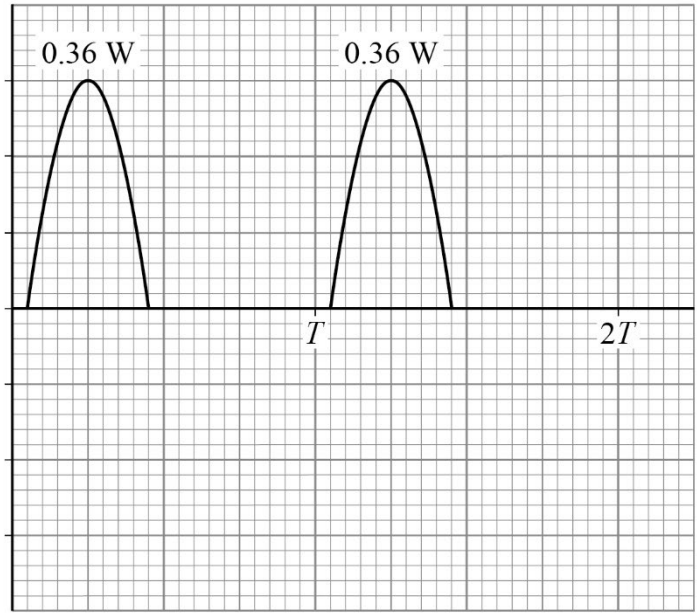
Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	Does not go through the origin so l not proportional to $\sqrt[3]{y}$ (therefore y is not proportional to l^3) ✓		1	1 AO3
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	Substitutes their T into $f = \frac{1}{T}$ OR extracts period correctly ✓ 11.4 (Hz) to 3sf ✓	Expect to see 0.088 s Accept between 0.087 s and 0.089 s to give 11.2 (Hz) to 11.5 (Hz)	2	2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	Evidence of $I = \frac{P}{4\pi r^2}$ ✓ 23.6 W ✓	P should appear in an equation in some form.	2	1 AO2 1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Uses electrical power $= \frac{23(.6)}{0.057}$ OR $R = \frac{220^2}{\text{their } P}$ ✓ 117 (Ω) ✓	Do not alllow incorrect method e.g. using 220×0.057 Use of $P = 24$ W gives an answer of 115 (Ω) Accept 110 (Ω) or 120 (Ω) from correct working.	2	1 AO1 1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	Idea that (for the first $22\ \text{ms}$) the temperature of the filament is increasing (when there is a current) ✓ ... and takes more time ($50\ \text{ms}$) to cool after current stops ✓		2	1 AO1 1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.5	Peak at $0.36\ (\text{W})$ ✓ Misses every other half cycle ✓ Clearly starts after $t = 0$ and ends before $T / 2$ ✓	power / W  Accept any shape of 'hump'	3	3 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.6	Idea that the filament lamp takes time to heat up/cool down/reach maximum intensity (and therefore flashes would overlap). ✓	Accept reverse arguments Accept idea that filament lamp may have higher failure rate Accept idea that the filament lamp will not reach zero intensity	1	1 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
05.7	Takes data correctly from **Figure 12** ✓ Uses their value of s in $s = \frac{1}{2}gt^2$ ✓ Uses the third, fourth or fifth image and divides by 3, 4 or 5 appropriately to give the periodic time of the flash ✓ uses it to obtain an answer that rounds to 16 (Hz) ✓	0.02 m, 0.08 m, 0.17 m, 0.31 m and 0.49 m Expect to see t = 0.04 s, 0.13 s, 0.19 s, 0.25 s, 0.32 s MP4 is dependant on MP3	4	1 AO2 3 AO3
Total			**16**	

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Use of $Q = ml$ AND use of $Q = mc\Delta\theta$ ✓ Complete substitution OR at least two correct components ✓ Use of $E = Pt$ ✓ 38 (minutes) ✓	Allow POT errors in MP1, MP2 and MP3 $5.4 \times 10^7 \times t = (9.3 \times 10^4 \times 1440 \times 510) + (9.3 \times 10^4 \times 980 \times 340) + (9.3 \times 10^4 \times 2.4 \times 10^5) = 6.83 \times 10^{10} + 3.1 \times 10^{10} + 2.23 \times 10^{10}$ t (seconds) = 2250 s Accept answer between 37 and 38 (minutes)	4	1 AO1 3 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	Use of $P = VI$ ✓ Use of $\frac{I_s}{I_p} = \frac{N_p}{N_s}$ OR $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ ✓ $1.8(4) \times 10^4$ A ✓	Expect to see $I_p = 818.18$ (A) Expect to see $I_s = 5.52 \times 10^4$ (A) OR $V_s = 978$ (V) In MP2 accept use of peak current or peak voltage	3	1 AO1 2 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	The idea that (more) charge carriers are being created ✓ Charge carriers collide with atoms and cause ionisation OR Charge carriers are accelerated (by the electric field) ✓	Allow "ions" for "charge carriers"	2	1 AO1 1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.4	MAX 2 from✓✓ • Linear velocity to the right of large rollers is $1.48\ \text{m s}^{-1}$ • use of $\frac{22.0}{17.8} \times 4.2$ or 5.19 seen • uses $v = r\omega$ 23.7 or $24\ \text{rad s}^{-1}$ ✓		3	1 AO1 2 AO2
Total			**12**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Uses $\varepsilon = \frac{\Delta L}{L}$ or $\frac{0.13}{0.647}$ seen **and** $\sigma = E\varepsilon$ ✓ Additional tension = 1.74 (N) ✓ Total tension = their additional tension + 56.4 ✓ Use of $f = \frac{1}{2l}\sqrt{\frac{Their\,T}{\mu}}$ ✓ (increase of) 5.0 to 5.2 Hz ✓	Alternative MP1 Use of $E = \frac{FL}{eA}$ Expect to see 58.1 (N) Condone original length for l 2 or more sf	5	1 AO1 3 AO2 1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	Correctly identifies decrease in length with increase in frequency OR Correctly identifies decrease in tension with decrease in frequency ✓ Correctly identifies both ,with conclusion based on $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ ✓	Expect conclusion to include idea that the frequency will decrease because a small decrease in length is associated with a large decrease in tension	2	1 AO2 1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	Flux (from permanent magnet) linking with the coil changes (in accordance with Faraday's law) ✓	Condone idea that the magnetic field lines are cutting the coil. Treat references to the string as neutral.	1	1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	(The string is moving away) and the effect of the induced emf will tend to oppose that motion (in accordance with Lenz's law). ✓ Magnetic field will be strengthened ✓	Do not accept induced emf opposes the motion Condone 'greater/bigger magnetic field'	2	2 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Use of $R = \frac{\rho l}{A}$ and $V = IR$ ✓ Use of $E = N\frac{\Delta\phi}{\Delta t}$ or $E = NA\frac{\Delta B}{\Delta t}$ ✓ 5.2×10^{-6} (Wb s^{-1}) ✓	Expect to see $R = 2.09$ x 10^3 Ω and $V = 0.038$ V Condone lack of N	3	2 AO2 1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.6	Sound wave produces a (periodic) driving force (on the string). ✓ The driving (force's) frequency is equal to the (string's) vibrational/natural frequency ✓ (The amplitude of the vibration increases as) the string is in resonance/resonating ✓	Reject MP3 if there is a suggestion that the speaker or sound wave is in resonance. Condone 'resonance occurs'.	3	1 AO1 2 AO2
Total			**16**	