OXFORD
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INTERNATIONAL A-LEVEL

PHYSICS

PH05

Unit 5 Physics in practice

Mark scheme

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226XPH05/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	Marking guidance	Mark	Comments
01.1	497 ✓	1	

Question	Marking guidance	Mark	Comments
01.2	12.5 or 13 ✓	1	

Question	Marking guidance	Mark	Comments
01.3	253 ✓ ecf from 01.1 and 01.2 14.5 or 15 ✓	2	Condone 3sf for the uncertainty

Question	Marking guidance	Mark	Comments
01.4	6.20×10^{-3} or 6.20 ✓ ecf from 01.1, 01.2 and 01.3 J or mJ ✓	2	Condone POT error in MP1 Accept 2 or 3 sf only Unit must match the numeric value Condone base unit kgm^2s^{-2} Accept 6200 μJ

Question	Marking guidance	Mark	Comments
01.5	Clear attempt to add percentage uncertainties ✓ 10 ✓ ecf from **01.3**	2	No sf penalty
Total		**8**	

Question	Marking guidance	Mark	Comments
02.1	2 lines consistent with error bars ✓	1	Both lines must go through all error bars Look for: maximum max gradient line to hit bottom of 3rd and top of last error bar and minimum gradient to hit top of first and bottom of 7th error bar.

Question	Marking guidance	Mark	Comments
02.2	Large triangle (drawn) and correct data extraction for at least 1 gradient ✓ Maximum gradient (expect in the range 0.39 to 0.41) ✓ Minimum gradient (expect in the range 0.33 to 0.35) ✓	3	Large triangle means ΔM ≥400 2 or 3 sf only In MP2 and MP3 gradients must be correct for their lines.

Question	Marking guidance	Mark	Comments
02.3	Extraction of data from graph necessary to determine an M_b ✓$_1$ Use of their data with an appropriate method that would give M_b✓$_2$ A value of M_b determined correctly ✓$_3$ Maximum and minimum values of M_b determined correctly and the correct way round ✓$_4$	4	Allow ecf from **02.2** No sf or unit penalty. Allow rounding from gradients from **02.2** Award MP1 even if data incorrectly substituted. Examples for ✓$_1$and ✓$_2$ One intercept on the *m*-axis extracted correctly, with evidence of gradient✓$_1$ Attempt to use M_b = intercept/gradient ✓$_2$ OR Pair of points on one line read correctly✓$_1$ Used with provided equation (to eliminate μ) ✓$_2$ OR One point read correctly, with evidence of gradient✓$_1$ Used with provided equation✓$_2$

Total		**8**

Question	Marking guidance	Mark	Comments
03.1	Answer that rounds to 6.3 V ✓ Clear evidence that the transformer equation was applied more than once with Np =100 ✓	2	2 or 3 sf only

Question	Marking guidance	Mark	Comments
03.2	Use of the transformer efficiency equation ✓ (Using Ip = 8.88 (mA) and Is = 4.19 (mA)) to get answer that rounds to 94% or 0.94 ✓	2	"Use of" includes the substitution of an I_s and I_p from the table. Equation does not need to be seen. Condone answer rounding to 95% or 0.95 (from using Vp=6.26 (V)) Presence or absence of the % sign should be consistent with the answer given. Correct answer can gain both marks.

Question	Marking guidance	Mark	Comments
03.3	MAX 5 from 6✓✓✓✓✓ Extra apparatus: • Method of supply different primary voltages e.g. variable ac power unit or potential divider • idea that (ac) voltmeter or multimeter needed to measure the input voltage Method: • use the same (primary coil and secondary) coil(s) OR use the same load resistor (for all the measurements) • take measurements for at least six different input voltages (over the full range available) Processing • calculate the efficiency for each set of readings • plot a graph of efficiency against input voltage	5	In MP 2 the need for an extra voltmeter needs to be stated clearly rather than inferred from a description of the method. In MP5 calculation of the efficiency can be inferred from an efficiency equation. In MP6 condone axis the other way round.2 Accept "efficiency – Vp graph" .Condone plotting of graph of efficiency against $1/Vp$

Total		**9**

Question	Marking guidance	Mark	Comments
04.1	$V = kp^{-1}$ followed by $\ln V = \ln k - \ln p$ **or** $\ln (pV) = \ln k$ followed by $\ln p + \ln V = \ln k$ ✓ **or** $V = k/p$ $\ln (V) = \ln (k/p)$ followed by $\ln V = \ln k - \ln p$ ✓	1	**Both** steps required The sequence of steps should be clear.

Question	Marking guidance	Mark	Comments
04.2	4.477 4.290 4.127 3.951 3.807 ✓	1	All five correct 2 or 3 dp required

Question	Marking guidance	Mark	Comments
04.3	Sensible scale marked on both axes ✓ All five points accurately plotted ✓✓ Well drawn straight line of best fit ✓	4	Points should take up more than half of each axis. Allow ecf from **04.2** If only 4 points correct only award 1 mark for MP2 and MP3; If only 3 or fewer correct do not award MP2 or MP3 Look for intercept on ordinate of around 4.52 and on the abscissa of around 4.94 The line of best fit should follow the trend of the points with an even scatter of points on either side of the line. Penalise multiple lines and lines that are too thick.

Question	Marking guidance	Mark	Comments
04.4	Gradient of the line of best fit determined in range (-)0.95 to (-)1.02 ✓ Statement that the result (gradient of -1) (within experimental error) supports Boyle's law ✓	2	Evidence of calculation is needed for MP2. Accept alternative consistent statement if their gradient not approximately equal to -1

Question	Marking guidance	Mark	Comments
04.5	Appropriate data taken from graph✓ Correct use of ln or e^x✓ Answer in range 6.1 to 6.3 J ✓	3	Condone POT error in MP1 and MP2 If data is taken from a plotted point it must lie on the line. Withhold MP2 for evidence of use of 10^x, for example. Power of ten and consistent unit correct for MP3 – accept N m Alternative method: calculates a value of pV from Table 3 ✓ calculates at least 3 values of pV from Table 3 and determines the mean ✓ $6.2(2)$ (J) ✓
Total		**11**	

Question	Marking guidance	Mark	Comments
05.1	$E = eV$ used ✓ their $E = \frac{hc}{\lambda}$ **or** their $E = hf$ and $f = \frac{c}{\lambda}$ used ✓ 1.88×10^{-11} (m) or 1.9×10^{-11} (m) ✓	3	Condone efficiency consideration seen in either MP1 or MP2. 'Used' means substitution or rearrangement seen. Correct answer on its own gets MP3 only.

Question	Marking guidance	Mark	Comments
05.2	Use of $P = VI$ ✓ leading to 138(.6) (W) to at least 3 sf ✓	2	Expect to see $P = 66 \times 10^{3} \times 140 \times 10^{-3} \times 0.015$ but condone lack of 0.015 for mp1 MP1 requires at least the subject "P =" Condone use of percentage in MP1.

Question	Marking guidance	Mark	Comments
05.3	Use of $E = mc\Delta\theta$ or $P = mc\Delta\dot{\theta}$ ✓ 240 or 243 (K s^{-1}) ✓	2	Condone POT error in MP1. Award 1 MAX for answers that use the whole beam power (9240 W) rather than 98.5% of the beam power (to get an answer of 246). Do not credit answers that use 140 W. (Calculator value is 242.574627)

Question	Marking guidance	Mark	Comments
05.4	(Answer to **05.3** will increase because) each electron will have more kinetic energy/velocity/speed when it strikes the target OR this will cause the rate of increase in temperature (of the target) to be greater. ✓	1	

Question	Marking guidance	Mark	Comments
05.5	(Answer to **05.3** will increase because) there will be more electrons in the beam (current) ✓	1	Accept more electrons are emitted (into the beam)/reach the target per unit time/second

Question	Marking guidance	Mark	Comments
05.6	3 points from: Interactions between electrons and lattice ions transfers kinetic energy from electrons to ions OR reference to resistive/I^2R heating due to the current in the filament ✓ Filament will transfer energy/heat surroundings by emitting (thermal/visible/IR) radiation ✓ Work done emitting electrons (from the surface) of the filament ✓ Energy transferred from filament (via conduction) through the connecting wires✓	MAX 3	Ignore references to the target. Do not credit answers that do not refer to where or how the energy transfer is taking place. E.g. “electrical energy converted to heat and light” gains no marks. For MP3, accept references to kinetic energy of electrons emitted from the surface ‘surroundings’ is insufficient for MP4

Total		**12**

Question	Marking guidance	Mark	Comments
06.2	It breaks when the extension is $0.4l$ ✓	1	Do not allow a reference to the equation for strain on its own. Condone idea that it extends up to a (maximum) extension of $0.4l$

Question	Marking guidance	Mark	Comments
06.1	Area = $\frac{1}{2}\sigma_b\varepsilon_b$ ✓ Uses $\sigma_b = \frac{F}{A}$ and $\varepsilon_b = \frac{\Delta l}{l}$ (to give Area = $\frac{1}{2}\frac{F}{A}\frac{\Delta l}{l}$) ✓ Volume = Al and work done /energy stored = ½ $F\Delta l$ stated ✓	3	Condone missing subscripts MP2 is for expressing the stress in terms of the force and cross-sectional area and the strain in terms of the extension and original length.

Question	Marking guidance	Mark	Comments
06.3	16 squares ± ½ square OR 1 square ≡ 1×10^7 (J m^{-3}) ✓ 1.55 to 1.65 $\times 10^8$ (J m^{-3}) ✓	2	Alternative if evidence of calculating area from **Figure 8** to determine the area is seen: Award MP1 for value between 1.4×10^8 and 1.8×10^8 Award MP2 for value between 1.55×10^8 and 1.65×10^8

Question	Marking guidance	Mark	Comments
06.4	Uses $\frac{1}{2}mv^2 = mgh$ ✓ 2.97 (m s^{-1}) to at least 3 sf ✓	2	MP1 requires some idea that GPE (lost) = KE (gained) 'Use of' means by substitution or manipulation. Condone use of 9.8 for g, but not 10. (Calculator value using 9.81 is 2.971363323 and using g = 9.8 is 2.96984848)

Question	Marking guidance	Mark	Comments
06.5	Use of idea that energy (absorbed by sample) = GPE lost (= GPE (of hammer) before swing – GPE at top of swing) ✓ Determines $mg\Delta h$ with $\Delta h = l\sin 38$ ✓ 6.79 (J) to at least 2 sf ✓	3	MP1 may be seen in substituted equations. Do not award MP1 if $mgl\sin(38)$ used without support Allow 2 MAX for use of $l\sin(38)$ as height at top of swing (expect to see 4.2(4) (J)) Allow alternative: Evidence of energy (absorbed by sample) = KE (at bottom of swing) – GPE (at top of swing) ✓ Uses $\frac{1}{2}mv^2 - mgh$ with $h = l(1-\sin(38))$ ✓ Answer rounds to 6.8 to 7.0 (J) ✓ If no other mark given, award 1 mark for determination of $0.45\ (1-\sin 38) = 0.173$ (m)

Question	Marking guidance	Mark	Comments
06.6	Evidence of (initial) momentum = 2.5 ×speed at impact (=2.5× 3) OR Evidence of attempt to use impulse = change in momentum ✓ Answer that rounds to 4.6 to 4.7 ($kg\ m\ s^{-1}$) ✓	2	Accept value close to 3 (e.g. 2.97) Alternative: Calculation of velocity after impact using data from **06.5** (expect to see $1.84\ m\ s^{-1}$) OR evidence of attempt to calculate change of momentum ✓ Answer that rounds to 4.6 to 4.7 Ns ✓

Question	Marking guidance	Mark	Comments
06.7	Impulse received by the broken piece of sample is less than impulse received by the hammer ✓ Idea that an external force applied (by the clamp) OR momentum is not conserved (because of external force acting)✓	2	Treat the two marks independently. Ignore any quantification. Ignore references to air resistance.
Total		**15**	

Question	Marking guidance	Mark	Comments
07.1	1.5(0) (s) ✓	1	2 or more sf

Question	Marking guidance	Mark	Comments
07.2	$\omega^2 = {\omega_0}^2 + 2\alpha\theta$ or equivalent seen with $\omega_0 = 0$✓ Use of $(\theta =) \frac{\pi}{2}$ seen ✓ 5.61 to at least 3 sf based on correct working✓	3	Accept $v^2 = u^2 + 2as$ with $u = 0$

Question	Marking guidance	Mark	Comments
07.3	($T = I\alpha$ leading to) 5.17 or 5.16 (Nm) ✓	1	Allow 2sf or more answer Allow ecf from **07.2** Allow 5.15 from use of 5.6 (from **07.2**)

Question	Marking guidance	Mark	Comments
07.4	Determination of E from $E = T\theta$ or max KE✓ Use of $P = \frac{E}{t}$ ✓ 10.8 or 10.9 W together with suitable comparison with 10 000 W ✓	3	

Question	Marking guidance	Mark	Comments
07.5	Evidence of $I = \frac{P}{4\pi r^2}$ ✓ $3.5(4) \times 10^{-6}$ (W m^{-2})✓	2	

Question	Marking guidance	Mark	Comments
07.6	Factor of $\left(\frac{0.40}{1.30}\right)$ OR $\frac{1.9}{6.5}$ seen or used ✓ evidence of $\left(\frac{0.40}{1.30}\right)^2$ seen or used✓ Both factors used to get $0.025(5)$ (kg m^2) ✓	3	For 0.40 and 1.30 accept alternatives e.g. 40 and 130, or 20 and 65 etc. Accept ratios expressed either way up and within a calculation. Accept alternative routes

Question	Marking guidance	Mark	Comments
07.7	Interference will happen because sources have same frequency and/or wavelength ✓ They have a constant phase relationship ✓	2	If no other mark given, award 1 mark for stating that the two sources are coherent. For MP2 do not accept 'in phase'

Question	Marking guidance	Mark	Comments
07.8	Evidence of substitution into $w = \frac{\lambda D}{s}$ ✓ Leading to 179 m fringe separation ✓	2	D and s must be substituted correctly for MP1. Allow POT error in MP1.

Total		**17**