OXFORD
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INTERNATIONAL A-LEVEL
PHYSICS
PH05

Unit 5 Physics in practice

Mark scheme

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2 2 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 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	3.97 (cm) **cao** ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	(Uses half of the range to give) 0.07 (cm) ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	Mean diameter found as 3.99 (cm) ✓ 1.8 (%) or 2 (%) ✓	1 or 2 sf only Allow ecf from MP1 and **1.2**	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	Uses density = $\frac{M}{\frac{4}{3}\pi r^3}$ ✓ 1460 to 1500 (kg m^{-3}) ✓	Allow MP1 in any units and even if diameter is used instead of radius also condone POT error for MP1 2 or 3 sf only	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.5	Percentage uncertainty = $0.2\% + 3 \times$ candidate's **01.3** ✓ Finds absolute uncertainty based on candidate's **01.4** ✓	Expect to see an answer of around $80\ (\text{kg m}^{-3})$ - either 5.6% or 6.2% of candidate's **01.4** Sig figs consistent with **01.4** Condone use of calculated max and min values	2	1 × AO2 1 × AO3
Total			**8**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	<table><tr><th>x / cm</th><th>C / counts s^{-1}</th><th>ln(C / counts s^{-1})</th></tr><tr><td>0.50</td><td>2967</td><td>8.00</td></tr><tr><td>1.00</td><td>1873</td><td>7.54</td></tr><tr><td>1.50</td><td>1183</td><td>**7.08**</td></tr><tr><td>2.00</td><td>746</td><td>**6.61**</td></tr><tr><td>2.50</td><td>471</td><td>**6.15**</td></tr></table> All three correct **cao** ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	All points plotted correctly ✓ Good best fit line ✓	Within ½ grid square Expect to see x or + Only condone dot if **not** obscured by the line Do not condone thick/uneven/multiple lines	2	2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.3	Large ($\Delta x \geq 1.5$) triangle (or equivalent) seen on graph to give gradient in the range of -0.91 to -0.94 (cm^{-1}) ✓ Correct value from BFL and answer in the range 0.080 to 0.083 ✓ $cm^2\ g^{-1}$ ✓	Accept use of triangle formed by the axes and the BFL for MP1 Gradient must be negative for this variant of MP1 Allow value and consistent unit for MP2 and MP3 (e.g $8.0 \times 10^{-3}\ m^2\ kg^{-1}$)	3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.4	Intercept 8.45 ✓ Manipulation to give 4700 (counts s^{-1}) ✓	Allow ecf for their line At least 2 sf	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
02.5	Log value for count rate of $2350 = 7.76$ used on graph ✓ 0.75 cm **ecf** from **02.4** ✓	Allow use of $\ln 2$/ (- gradient from **02.3)** for MP1 2sf only Using 2500 gives 7.82	2	2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.6	$5 \times$ candidate's **02.5** ✓	Expect to see 3.75 (cm) Allow use of $\ln 32$/their gradient	1	1 × AO2
Total			**11**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Primary circuit correct includes an ac power supply, voltmeter and ammeter ✓ Secondary circuit correct includes (variable) resistor, voltmeter and ammeter in secondary circuits ✓	Condone extra resistor in primary circuit	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	ANY 5 from: ✓✓✓✓✓ Uses a range of output power by changing resistance of load Measure current with an ammeter and voltage with a voltmeter in named part of circuit Repeat and average each current and voltage measurement OR use non-parallax position for reading analogue meters Calculate input power (V_pI_p) OR output power (V_sI_s) Calculate other power and calculate efficiency $(= \frac{\text{(useful) output power}}{\text{input power}})$ Plot appropriate graph eg efficiency on ordinate and output power on abscissa and (identify maximum) (from the curve)	Allow symbols provided subscripts clear (e.g. Vp, Vo for primary voltage). Allow other subscripts if supported on diagram. Condone efficiency against output power	5	5 × AO4
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	Uses $v = f\lambda$ AND $l + e = \frac{\lambda}{4}$ ✓ manipulates convincingly ✓	MP2 can be awarded if MP1 not awarded if substitution seen	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Horizontal error bars of length 1 small square one each side of all plotted points ✓		1	1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	2 lines correctly drawn using error bars ✓	**ecf** from **04.2** only for horizontal error bars	1	1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.4	Use of $0.0119 = \frac{4}{v}$ leading to $336\ (\text{m s}^{-1})$ ✓		1	1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.5	Generalised scheme: Makes use of graph(s) to determine required datum/data ✓1 Determines value of an appropriate quantity using equation and datum from MP1✓2 Uses their quantity from MP2 to come to supported judgement.✓3	Examples: 2 intercepts found - correct for candidate's lines✓1 Uses intercept $= \frac{4e}{v}$ together with data from **04.4** to find at least 1 value for e ✓2 Theoretical value of e ($= 1.45$ cm) not within range so theory not supported OR not within range but calculated value of e also depends on the uncertainty in v so theory could possibly be supported. ✓3 OR Best fit line drawn and intercept determined✓1 Equation used with data from **04.4** to determine e✓2 Comparison of their e with 1.4 +/- 0.5 and suitable comment.✓3 OR Best fit line drawn and 1/f point read✓1 Use of equation with their value from **04.4** to obtain a value of l✓2 Use graph to see if that l lies between their max and min lines.✓3	3	1 × AO2 2 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
04.6	more data points related to extending range/more even distributed (within the range) ✓ Valid comment about the measurement of l ✓	Do not accept just 'use larger l' Accept registering of 0 cm mark with surface of water or putting ruler closer to cylinder or using set squares to avoid parallax	2	2 × AO4
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	The person is in equilibrium or has no resultant force ✓ Rope supports its own weight too OR total mass is 116 kg ✓ 116 × 9.81 = 1138 (N) ✓		3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	States that impulse = change in momentum (N s) and 98 × 1.5 seen leading to 147 ✓	Accept use of symbols	1	1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Identifies the impulse as the area under the graph.✓ Identifies triangular section as the required area✓ Extracts data correctly from graph (960 and 1140) 1.63 or 1.67 (s) ✓	Expect to see ½ (t) (1140 − 960) = 147 or 150 for MP2 Candidates who get 0.41 s by finding the whole area under the graph get MP1 and MP2	3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	Use of $T = mg$ ✓ Either $(98 + \frac{18}{2})g$ or uses 1138 (N) and 961 (N) to give answer that rounds to 1050 (to more than 3 sf) ✓		2	2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.5	Uses $\sigma = \frac{F}{A}$ AND $\epsilon = \frac{\Delta L}{L}$ AND $E = \frac{\sigma}{\epsilon}$ OR $E = \frac{FL}{\Delta lA}$ ✓ Extension = 2.8 m ✓ Subtracts : $309 - 295$ – the candidate's extension ✓	Condone POT error in MP2 Correct answer is 11.2 (m)	3	1 × AO1 2 × AO2
Total			**12**	

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	3.1×10^6 (J) ✓		1	1 × AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	2.6×10^5 (C) ✓		1	1 × AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	Output pd of the panel drops (to below 12 V or to zero) ✓ Diode prevents the battery discharging through the panel (since it only conducts in one direction) ✓		2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.4	Uses 12.6 V and 2.65 A ✓ Answer in the range 33.1to 33.7 (W) ✓	Condone in MP1 range from 2.6 to 2.7 for current MP2 includes quality mark - range is narrower than acceptable MP1	2	1 × AO3 1 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
06.5	16.8 (V) ✓ Idea that beyond that value the current decreases more rapidly than voltage increases✓	Allow value in range 16.6 to 17.2 (V) Alternative for MP2: reference to max power occurs when (emf is at) shoulder of the curve	2	2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.6	The idea that the difference between the panel pd for max power (approx. 17 V) and the battery emf is dropped across the diodes. ✓ 8 or 9 diodes (@ 0.60 V each) consistent with candidate's MP1 should be included in the circuit.	Allow ecf from **6.5**	2	1 × AO3 1 × AO4
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Use of $E = ml$ ✓ 63.7 (W) ✓	Accept substitution even with power of ten error Must be to at least 3 sf	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	Use of $\dot{Q} = \frac{kA\Delta\theta}{L}$ ✓ $64 = \frac{111\pi(1.6 \times 10^{-2})^2}{(1.2 \times 10^{-3})}\Delta\theta$ ✓ 0.86 K ✓	Tolerate 1 power of ten error. Accept calculation of area of base that takes into account the thickness of the metal cylinder walls.	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	$\frac{10^{-2}}{355 \times 4}$ or $\frac{64}{2260\ (\times 10^3)}$ seen ✓ ...leading to 7.04×10^{-6} with convincing treatment of powers of ten to at least 2 sf ✓	Accept working done in gramme Using 63.7 W gives 7.05×10^{-6}	2	2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	MAX 3 ✓✓✓ Steam possess momentum as it leaves the nozzle The rate of change of this momentum causes a (reaction) force on the nozzle The idea that line of action of the force does not go through the axis of rotation (and thus produces a torque) The torques from each nozzle are in the same sense and therefore add to produce a resultant torque.	Need more than mention of Newton's Third Law of Motion e.g. mention of reaction too.	3	1 × AO1 1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Data correctly extracted from graph plus conversion to rev s^{-1} ✓ Use of $\alpha = \frac{\Delta\omega}{t}$ and $\omega = 2\pi f$ ✓ 0.93 (rad s^{-2}) ✓	eg (200, 1800) or (225, 2000) Condone 0.93 or 0.94	3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.6	Use of $T = Fr$ ✓ Use of rate of change of momentum = $\frac{\Delta m}{\Delta t} v$ ✓ Within the range of 275 to 283 (m s^{-1}) ✓		3	1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.7	Any two from:✓✓ Find gradient Convert to rad s^{-2} ... ...Between 355 s and 365 s Use $T = I\alpha$ ✓	Do not award mark for gradient if using a positive part of the slope and restrict to MAX 2	3	1 × AO2 1 × AO3 1 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
07.8	Large amplitude oscillations at natural frequency of system ✓ Resonance stops when past the natural frequency. ✓ The idea that (during resonance) energy from the jets is used to cause the vibrations rather than to accelerate the sphere. ✓	 Allow idea that (after 250s) driving frequency is no longer equal to the natural frequency	3	1 × AO2 2 × AO3
Total			**22**	