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INTERNATIONAL A-LEVEL

PHYSICS

PH05

Unit 5 Physics in practice

Mark scheme

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211XPH05/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

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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	Well drawn line ✓	Expect to see line clipping top of third error bar and bottom of the final one, within half a grid square	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	Large triangle drawn with values taken from the line of best fit ✓ 0.112 ± 0.001 ✓		2	AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	0.119 (m kg^{-1}) ecf ✓	Look for mean of candidate's 01.2 and 0.126	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	half of the range of values of max and min gradients divided by their mean gradient✓ divided by 2 and expressed as a percentage✓	Expect to see $\frac{0.126 - 0.112}{0.119}$ Expected answer around 6% (5.9% from m/s data) No sf penalty Alternative for both marks: $\frac{\text{best gradient} - \text{worst gradient}}{\text{best gradient}} \times 100$	2	AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.5	$(1.79 \times 10^{9} / 0.119 =)\ 1.5(0) \times 10^{10}$ ecf from 01.3✓	Allow for rounding	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
01.6	Their answer to 1.5 x their answer to 1.4✓	Accept 1 or 2 sf only	1	AO2
Total			**8**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	1.04 (s) cao ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	(±) 0.03 (s) ✓	1 sf only	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
02.3	Use of multiple oscillations in one timing ✓ Use of a fiducial mark at the centre ✓ Reason why multiple / why fiducial mark at centre ✓	At least 10	3	AO2 AO3 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
02.4	Recognises that the percentage uncertainty in f_N is the same as that in T_N ✓ Percentage uncertainty in $f_N^2 = 2 \times$ percentage uncertainty in f_N = (±) 5.8 (%) ✓	Allow ecf from 02.1 and/or 02.2 No sf penalty	2	AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
02.5	$k = (1/1.04^2 + 1/1.39^2) \div 2.1 \times 10^{-5} = 1.9(4) \times 10^4$ ✓ final answer given to 2 sf ✓ Unit = $T^{-1}\,s^{-2}$ or $Hz^2\,T^{-1}$ ✓	Allow ecf from 02.1 – working does not need to be shown	3	AO2 AO3 AO4
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Substitution of $\frac{2}{5}mr^2$ for I OR use of $\omega = \frac{v}{r}$ ✓ Other substitution and manipulation ✓ gh = (½ + ⅕)$v^2 = 7/10\,v^2$	Look for the use of $\omega = \frac{v}{r}$ Look for correct manipulation including the correct addition of fractions: $\frac{1}{2} + \frac{1}{5} = \frac{7}{10}$	2	AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	Four from:✓✓✓✓ ● Metre rule used to measure h OR plumb-line to check verticality ● Practical method for measuring d described ● At least six different values of h investigated along the full length of the track ● Repeat readings taken and mean values calculated for each $h - d$ pair ● Results presented as a graph of d against h With one mark for: Straight line through the origin if $d \propto h$ ✓	eg tray of damp sand to record impact and metre rule to measure d OR video capture OR self-carbonising paper Accept evidence from sketch graph	5	AO4
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	Both axes correctly labelled with variable and unit and with I on the vertical axis ✓ Sensible scale chosen on both axes ✓ Four points accurately plotted ✓ All seven points accurately plotted ✓ Well drawn curve of best fit ✓	The line of best fit should follow the trend of the points with an even scatter of points on either side of the line.	5	3 × AO3 2 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Value found from the line of best fit in the range 0.275 to 0.285 ✓	Evidence must be seen on the graph	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	Use of $V = 1.47\ \text{V}$ ✓ Answer in the range 15.5 to 16.5 ✓ Unit $= \Omega\,\text{m}^{-1}$ ✓	Accept 2 or 3 sf only Condone $\text{VA}^{-1}\text{m}^{-1}$	3	AO2 AO3 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
04.4	(As x increases) the resistance (of section **AB**) increases **OR** current decreases ✓ So the p.d. dropped across the internal resistance decreases (and terminal p.d. increases) ✓	Reference to internal resistance needed for MP2	2	AO2 AO3
Total			**11**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	Use of $g = \frac{GM}{R^2}$ for either planet✓ Divides the two values of g and manipulates convincingly ✓	Expect to see subscripts on R and M Accept $mg = \frac{GMm}{R^2}$ Do not allow reverse argument	2	AO1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	$17(.4)$ N (kg^{-1}) cao✓	Accept 17.39 or 17.35	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Uses $\frac{GM}{r^2} = r\omega^2$ ✓ Use of $T = \frac{2\pi}{\omega}$ OR divides by 3600×24 $30(.7)$ (day)	r must be correct for MP1	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	Uses $I = \frac{P}{4\pi r^2}$ (to calculate intensity) ✓ One correct value ✓ Both values correct plus statement of comparability ✓ OR Uses $I\alpha \frac{P}{r^2}$ for both K2-18b and Earth ✓ Leading to $I_{\text{k}} = I_{\text{E}} \frac{P_{\text{k}}}{P_{\text{E}}} \frac{{r_E}^2}{{r_k}^2}$ ✓ Intensity for K2-18b is $1.15 \times$ intensity for Earth ✓	Condone inclusion of radius of star or planet provided the orbital radius is also given. $1360\ (\text{W m}^{-2})$ or $1570\ (\text{W m}^{-2})$ Expect to see comparable but accept K2-18b is higher	3	AO2 AO3 AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
05.5	Uses $\theta = \frac{\text{arc length}}{\text{radius}}$ ✓ $\frac{2 \times 6.96 \times 10^8}{1.5 \times 10^{11}}$ seen ✓ $1.17 \times 10^{18}\ (\text{m})$ ✓	Do not award MP2 if factor of 2 not seen unless evidence seen of cancelling the factor of 2	3	AO1 AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.6	Reference to energy levels in atoms or characteristic line spectra ✓ Diffraction (as a means of measuring characteristic lines) ✓	 Condone dispersion/use of prisms Condone example of diffraction experiment e.g. Young's slits	2	AO1 AO2
Total			**14**	

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Evidence of Attempt to find area under curve ✓ 22 to 24 squares OR 1 square equivalent to 1 J ✓ 22 to 24 J ✓		3	1 × AO1 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	(Candidate's 06.1 × 0.40) – 1.9 ✓ Uses work = force × distance ✓ 209 (N) ✓	For E = 22 J: F = 197 N For E = 23 J: F = 209 N For E = 24 J: F = 220 N For E = 25 J: F = 231 N	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	Uses $pV = nRT$ or $\frac{pV}{T}$ = constant ✓ 200 or 197 or 196 (K) ✓		2	AO1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.4	Idea of larger container so greater time between collisions between molecules and wall OR Temperature falls so smaller (rms) speed of molecules ✓ ... therefore smaller rate of change of momentum ✓	If no other mark given, allow 1 mark for suggestion that the (average) KE of the molecules is reduced as the temperature falls	2	AO1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.5	Uses $E = Pt$ to give answer of $0.13(2)$ (s) ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.6	3890 ✓	Condone sf provided that answer is to > 1 sf	1	AO2
Total			**12**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Mentions conservation of angular momentum ✓ Idea that the total angular momentum of the propellers is zero ✓	Full marks can be awarded for a correct discussion of torque	2	AO1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	1.60 multiplied by 9.81 and divided by 4 leading to $3.9(2)$✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	Use of 3.9 or $4(\text{N})$ and graph to get $\text{I} = 8.5$ to 9.5 (A)✓ $P = VI$ used ✓ Multiplies their P by 4 ✓	If no other mark given, award one mark for inclusion of factor of 4. Allow ecf in MP2 and MP3 for their I	3	AO1 AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	Mention of large current taken from battery ✓	If no other mark given, one mark can be awarded for reverse argument of consequences of large value of internal resistance on wasted energy or power output.	2	AO2 AO3

	Links (low) internal resistance to maximum current and battery emf ✓			

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Uses max thrust of 7 (N) (1 motor) or 28 (N) (4 motors) ✓ Uses resultant force = thrust – mg ✓ Uses $s = \frac{1}{2}at^2$ ✓ 7.2 (s) ✓	If energy route attempted, award one mark for correct determination of change in GPE	4	1 × AO1 2 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.6	Reads off 15000 rpm OR 15500 rpm ✓ Divides by 60 and uses $\omega = 2\pi f$ To give 1622 to 1675 rad s^{-1} ✓	condone POT error in mp1 Allow ecf in MP2 but not for POT error	2	AO2 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.7	Uses angular momentum = $I\omega$ ✓ 0.91 rad s^{-1} ✓		2	AO1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.8	Idea that horizontal component of thrust causes horizontal acceleration OR movement to the left ✓ Idea that reduced vertical component of thrust will cause drone to move or accelerate downwards ✓	Accept explanation about angular momentum being changed for 1 mark Accept that horizontal component will make the drone rotate	2	AO3
Total			**18**	