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PHYSICS
PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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236XPH01/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	kg m s^{-2} ✓	units in any order must be all lower case	1	AO1
Total			1	

Question	Answers	Additional comments/Guidelines	Mark	AO
02	use of $\frac{charge}{mass}$ with a correct numerical substitution for **either** mass or charge ✓ 4.8×10^{7} ✓ (C kg^{-1})	$Q = 2 \times 1.60 \times 10^{-19}$ (C) $M = 4 \times 1.67 \times 10^{-27}$ or $4 \times 1.66 \times 10^{-27}$ or $4 \times 1.7 \times 10^{-27}$ (kg) use of 1.7×10^{-27} gives 4.7×10^{7} C kg^{-1}	2	AO1 × 2
Total			2	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	calculates u_{vert} or $4.5 \sin 15$ or $4.5 \cos 75$ seen ✓ partially correct substitution into $s = ut + \frac{1}{2}at^2$ ✓ numerically correct substitution ✓ 28 (m) ✓	MP2: any suitable combination of the equations of motion condone inconsistent signs for MP2 and MP3 correct final answer scores all marks condone -28 (m)	4	AO2 × 4

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	horizontal (components of) velocity are the same for both sandbag and balloon ✓ no horizontal resultant force/acceleration on sandbag ✓	condone horizontal speed for horizontal (component of) velocity throughout	2	AO2 × 2
Total			**6**	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	use of $KE = \frac{1}{2}mv^2$ to determine v OR 27 (m s^{-1}) seen ✓ use of $P = Fv$ with their v to determine F ✓ 1.4×10^5 (N) ✓	accept POT errors for MP1 and MP2 calculator value: $1.3663155499\ldots \times 10^5$ (N); penalise rounding errors in final answer	3	AO2 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	use of $\sin\theta = 1.5/100$ or angle calculated correctly = 0.86°✓ use of acceleration = $g \sin\theta$ (for their θ) OR use of $F = ma$ with a force substituted✓ $(-)0.15$ (m s^{-2}) ✓	accept the angle to the vertical used consistently throughout accept alternative MP1: use of $mgh = F_{net}d$ condone incorrect sign	3	AO2 × 3
Total			**6**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	idea that paper does not absorb gamma (sufficiently to change the count rate) ✓ idea that count rate would be the same (regardless of thickness) ✓	MP1 must be in terms of paper ignore any references to safety	2	AO1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	1.67×10^4 to 1.68×10^4 ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	no, because: *any two:* the activity/count rate decreases (with time) ✓ the old calibration curve would be too high OR if recalibrated, the new curve would be lower ✓ idea that the thickness will be overestimated ✓	do not allow yes it can/could be used for any marks	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	read off for $0.30\ \text{mm} = 12.2 \times 10^3$ (counts s^{-1}) ✓ divide by 4 = 3.1×10^3 (allow 1 sf) ✓	condone POT error for MP1	2	AO3 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.5	same *y*-intercept, lower everywhere else, cuts x-axis anywhere before $0.5\ \text{mm}$ ✓		1	AO3
Total			**8**	

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	the idea that it is the gradient at the steepest point ✓ draw a tangent at the steepest point and determine the gradient (of that tangent) ✓	steepest point could be named i.e. 27s, 25m MP2 is dependent on MP1	2	AO1 AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	correctly reads off displacement at 50 s (= 9 m) ✓1 calculates total distance travelled = 41 m ✓1✓2 use of average speed = total distance/total time to give 41/50 = 0.82 (m s^{-1}) ✓3		3	AO2 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	uses displacement/50 s ✓ ecf from **06.2** towards **B**/to the right owtte ✓	expect 9/50 = 0.18 (m s^{-1}) ignore sign for MP1 condone positive or original direction if velocity and speed have been reversed in **06.2** and **06.3**, give ecf for this part	2	AO3
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	use of $M = \rho V$ AND $V = AL$ ✓ 720 (kg m^{-3}) ✓	condone POT error for MP1	2	AO1 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	$E = \frac{1}{2}kx^2$ AND $E = mgh$ seen and equated, with 0.6 seen anywhere in the equation ✓ both combined correctly ✓	reject answers where 0.6 (or 60%) is not seen, e.g. 0.3 seen with no reasoning	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	use of $h \propto x^2$ OR use of $h = \frac{0.3\,kx^2}{mg}$ (to determine k) ✓ 6.1 (cm) ✓	$k = 72$ N cm^{-1} correct final answer scores full marks	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	the height is double for R ✓ because the (elastic) energy stored is the same and $GPE = mgh$ (and mass has halved) ✓	for MP2 accept a correct equation relating mass to height and explicit comment that the other variables are constant	2	AO2 × 2
Total			8	

Question	Answers	Additional comments/Guidelines	Mark	AO
08.1	read off from section A of graph and divide by g ✓	expect to see 56.1 kg but condone 2 sf	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.2	counts squares in the hump (above the weight line) = 11.5−13 big squares ✓1 determines area of one square = 12.5 kg m s^{-1} ✓2 Alternative: calculation of a rectangle: height tolerance of (900 to 1100) ✓1 width tolerance of (0.12 to 0.16) ✓2 momentum = 140−163 (kg m s^{-1}) (must be at least 2 sf) ✓3	condone MP1 (either alternative) for including below the weight line MP3 is dependent on MP1 and MP2 working required for final mark	3	AO3 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.3	use of $p = mu$ (to give u = 2.5–3.0 m s^{-1}) ✓	ecf from **08.2**	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
08.4	uses $v = u + at$ (or alternative suitable suvat equations) to give time to reach peak height ✓ doubles time to determine total time of flight (expect 0.50 to 0.60 s) ✓	ecf from **08.3** give both MP1 and MP2 for use of $s=ut+1/2\ at^2$ to give the total time directly	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
08.5	finds time of flight from graph = 0.54 to 0.56 s ✓	some working or annotation of the graph required 2 sf only	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.6	idea that determination in **08.5** has a smaller percentage uncertainty (or reverse argument) because estimating the area under the curve (e.g. counting squares) is likely to be inaccurate ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.7	statement of Newton's 2nd law in terms of change of momentum ✓ change of momentum/impulse is the same ✓ increasing (contact) time decreases the (average) force ✓	law must be named and stated	3	AO1 × 3
Total			**12**	

Question	Answers	Additional comments/Guidelines	Mark	AO
09.1	the force required is less at A / the moment created is greater at A (for the same force) AND statement of moment = force × (perpendicular) distance to pivot ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
09.2	they are not a couple because the forces are not equal in magnitude OR the forces are not antiparallel/opposite OR a net force is exerted ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
09.3	(use of $T = Fd$ to give) $3.8(2)$ (Nm) ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
09.4	use of Pythagoras to get magnitude = 2.7 (N) ✓ use of $\tan^{-1}(1.8/2.0)$ or vice versa ✓ to give 42^{o} ✓	alternative for scale diagram method: a correct vector triangle of suitable size seen ✓ magnitude 2.5 to 2.9 N ✓ angle 40 to 45^{o} ✓	3	AO3 × 2 AO2 x 1

Question	Answers	Additional comments/Guidelines	Mark	AO
09.5	arrow from central shaft going down and slightly to the right with the angle labelled ecf from **09.4** ✓	allow ecf for any direction in the bottom quadrant that matches their **09.4**	1	AO3
Total			**7**	

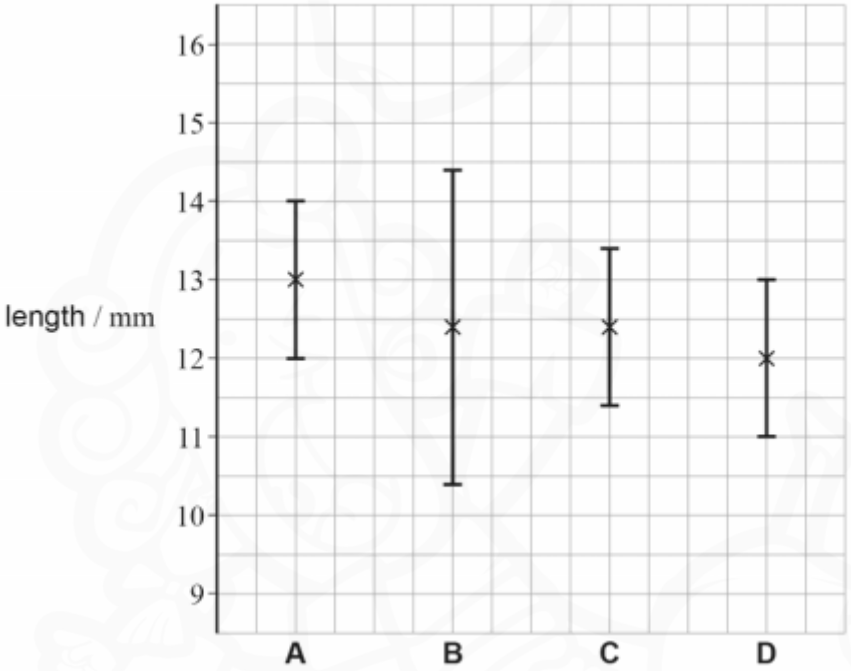
Question	Answers	Additional comments/Guidelines	Mark	AO
10.1	$\Delta L = 9.6$ mm ✓	cao	1	AO1

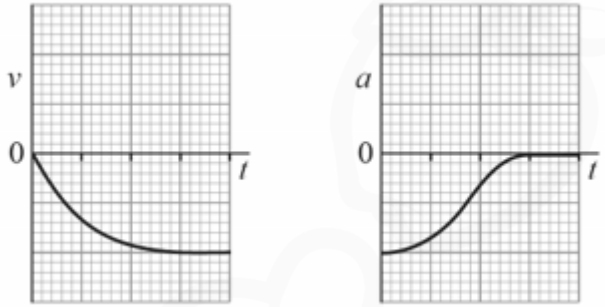
Question	Answers	Additional comments/Guidelines	Mark	AO
10.2	correct plotting of their value ✓		1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.3	best-fit line ✓ determination of gradient from points on line far apart (large triangle)✓ 410 to 425 (kg m^{-1}) ✓	2 or 3 sf	3	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.4	uses $Young\ modulus = \frac{gradient \times g \times length}{cross\text{-}sectional\ area}$ **or** $F = mg$ ✓ value for Young modulus 1.0×10^{11} to 1.1×10^{11} Pa ✓	 2 or 3 sf	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.5	larger extension ✓$_1$ reduces (percentage) uncertainty in extension and therefore in E ✓$_2$ OR smaller cross-sectional area ✓$_1$ increases (percentage) uncertainty in c-s area and therefore in E ✓$_2$	accept greater strain for extension accept greater stress reject just 'area'	2	AO3
Total			**9**	

Question	Key	Answer	AO
11	**D**	N s	AO1
12	**B**		AO4
13	**C**	26 N	AO2
14	**B**	speed distance	AO2

15	**C**		AO3
16	**A**	subtract the diameter of the ball from h	AO4
17	**D**	It undergoes little plastic deformation before breaking.	AO1
18	**B**	the energy stored per unit volume	AO1
19	**A**	$\frac{1}{12}$	AO1
20	**D**	The mass is concentrated in the centre of the atom.	AO1
21	**B**	zero 1.7×10^{-27}	AO1
22	**C**	Momentum	AO1
23	**C**	positron and neutrino	AO2
24	**A**	$3\ \text{min}$	AO3