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INTERNATIONAL QUALIFICATIONS

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PHYSICS

PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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241XPH01/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 www.oxfordaqa.com

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.

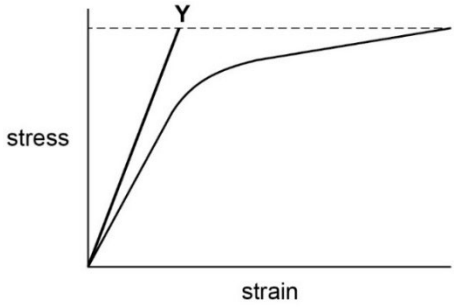
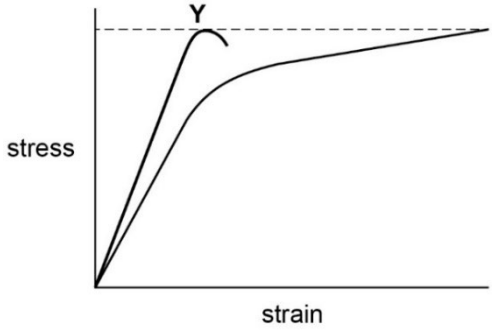
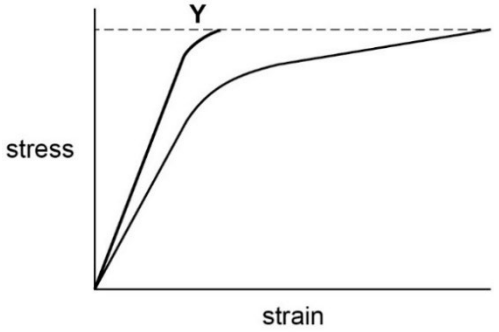
You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

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	$\text{kg m}^{-1}\text{ s}^{-2}$ ✓	units in any order Do not condone K for k	1	AO1
Total			**1**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02	use of efficiency in a correct equation **OR** $5.25\ (\text{W})$ **OR** $10.5\ (\text{W})$ seen ✓ 16% or 0.16 ✓	eg $\text{P} = 7\ \text{W} \times 0.75$ Allow POT errors for MP1 Condone the factor of two incorrectly placed in MP1. Calculator value is 16.1538462	2	AO1 × 2
Total			**2**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03	straight line with steeper gradient and small or no reduction of gradient ✓ same max stress ✓	 for MP1: • Do not condone line that carries on towards P • Line must begin straight but may be curved near the top as shown but curved part must be less than half a grid square:  	2	AO1 × 2
Total			**2**	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	$(2)T\cos 30$ **OR** $(2)T\sin 60$ seen ✓ $15(.3)$ N ✓	For MP1 allow omission of the factor of 2	2	AO1 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	use of $\sigma = \frac{F}{A}$ OR use of $E = \frac{\text{their } \sigma}{\varepsilon}$ OR $\frac{\text{Their } \mathbf{04.1}}{0.75 \times 10^{-6} \times 1.5 \times 10^{-2}}$ ✓ 1.4×10^{9} (Pa) ecf from **04.1** ✓	condone POT error in MP1 answer should be candidate's **04.1** $\times 8.9 \times 10^{7}$	2	AO1 AO2
Total			**4**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05	(Estimation of mass = $0.05\ \text{kg}$ to $0.5\ \text{kg}$) Use of $v^2 = u^2 + 2as$ **OR** $v = \sqrt{2gh}$ ✓ Use of $p = mv$ with their v and their m ✓ Answer that rounds to value between 0.4 and 4 (kg m s^{-1}) 1 or 2 sf ✓	Award MP1 for an unsupported value of v of $8\ \text{m s}^{-1}$ or $10\ \text{m s}^{-1}$ Award both MP1 and MP2 for $mgh = \frac{p^2}{2m}$ from energy approach. Do not award MP3 if incorrect method for MP1 or MP2 seen.	3	AO2 × 3
Total			**3**	

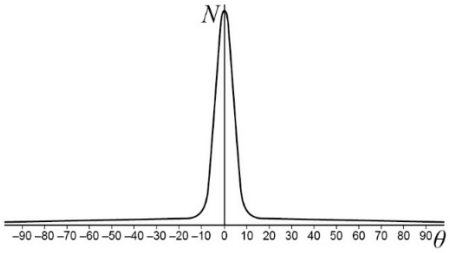
Question	Answers	Additional comments/Guidelines	Mark	AO
06	use of $E = \frac{1}{2}mv^2$ **OR** use of $\Delta E = Fs$ ✓ $\frac{1}{2}m \times 15^2 - \frac{1}{2}m \times 13^2 = \frac{1}{2}mv^2$ **OR** recognition that energy difference is final energy of **Q** ✓ 7.5 (m s^{-1}) ✓ **alternative:** Use of kinematics equations to obtain an expression for a for **P** ✓ (expression for a found and) substituted into $v^2 = u^2 + 2as$ for **Q** ✓ 7.5 (m s^{-1}) ✓	'use of' here means rearrangement and partial substitution Calculator value is 7.483314774 In MP1 look for $a = (-)\frac{13^2}{2s}$ Condone incorrect sign in MP2	3	AO1 × 2 AO2 × 1
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	use of kinematic equation(s) e.g. $s = ut + \frac{1}{2}at^2$ to find expression for t ✓ rearranges $E = ½\ mv^2$ to get horizontal velocity ✓ shows both and multiplies them to get $D = 2\sqrt{\frac{HE}{mg}}$ ✓	If no other mark given, award 1 mark if $E = ½\ mv^2$ AND $H = ½\ gt^2$ AND $D = vt$ seen	3	AO1 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	no air resistance ✓	accept statement that the ball is not rotating condone "air friction" for "air resistance"	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	obtains gradient = 14 ✓ correct rearrangement **OR** substitution into $D = \Delta L\sqrt{\frac{2Hk}{mg}}$ ✓ 36 (N m^{-1}) ✓	Accept a single data point substituted into given equation for MP1 Allow POT error for MP1 and MP2 Accept answer that rounds to 36	3	AO3 × 3
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
08.1	All three points for two marks ✓ ✓ Any two points for one mark ✓ • Central/dense/positively charged nucleus • (containing) 13 protons and 14 neutrons • 13 electrons and idea that they are in shells/in orbitals/surrounding (the nucleus)		2	AO1 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
08.2	curve with a single peak at $\theta = 0$ ✓ curve decreases to a small non-zero value at (and beyond) ± 90 degrees ✓	If no scale given, assume centre is zero degrees. Condone $\pm$ 60° as minimum range. Expect to see  Candidate's value must drop by 90% of maximum within an angle of $\pm$ 10 degrees	2	AO3 × 2
Total			**4**	

Question	Answers	Additional comments/Guidelines	Mark	AO
09.1	2 from: ✓✓ • subtracts 23 before attempting the inverse-square law • divides any count rate by 9 or multiplies by $\frac{10^2}{30^2}$ • adds 23 to their new count rate 66 ✓	Award one mark for any one answer from the list.	3	AO2 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
09.2	Suggestion: ✓ Idea that they do not keep hold of the gamma source / place the source in a holder **OR** hold the source with tongs instead of gloves Reason: ✓ Idea that it is to maximise the distance between user and source / to minimise irradiation	If no other mark given accept for one mark general statement e.g. put a sign on the door. Accept 'fix the source' owtte.	2	AO3 AO4

<table>
<tr><th>Question</th><th>Answers</th><th>Additional comments/Guidelines</th><th>Mark</th><th>AO</th></tr>
<tr><td>09.3</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.

<table>
<tr><th>Mark</th><th>Criteria</th></tr>
<tr><td>6</td><td>All three areas covered satisfactorily.
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>Two areas covered satisfactorily and one partially.</td></tr>
<tr><td>4</td><td>Two areas covered satisfactorily, or one covered satisfactorily 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 covered satisfactorily 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 covered satisfactorily, or makes a partial attempt at two areas.</td></tr>
<tr><td>1</td><td>None of the three areas covered without significant error.</td></tr>
</table></td><td>For each area, a satisfactory answer is more than half of the statements. A partial answer only includes one statement from that area.

Examples of likely statements

Other measurements
• Take a background count
• Subtract background count from count rate (to determine corrected count rate)
• Reason: because background (does not vary with distance so) must be eliminated

Accuracy
• Take repeats of count rate and average
• Take background count for a long period of time
• Reason: because this reduces (percentage) uncertainty in the corrected count rate

Processing
• Plot graph of corrected count rate vs $\frac{1}{r^2}$ or equivalent OR log count rate - log distance.
• Reason: gradient is a straight line OR gradient is -2 for log-log option OR graph in method would not give a straight line</td><td>6</td><td>3 × AO3
3 × AO4</td></tr>
<tr><td>Total</td><td></td><td></td><td>11</td><td></td></tr>
</table>

Question	Answers	Additional comments/Guidelines	Mark	AO
10.1	Momentum argument: water gains/has downward momentum ✓1 rocket gains/has equal and opposite (upward) momentum with reference to Newton's 3rd Law. ✓2	Treat references to force on launch tube as neutral Condone ref to Law of conservation of momentum for Newton's 3rd Law in momentum argument. Force alternative: (compressed gas exerts) downwards force on the water ✓1 an equal and opposite (upward) force is exerted on the (air in the) rocket with ref to Newton's 3rd law ✓2 Energy alternative: Water leaves bottle and compressed gas expands✓1 Compressed gas does work on bottle, bottle gains GPE reference to Law of conservation of energy✓2	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.2	At 1.3 s, the gradient stops being positive/is zero ✓ so there is no longer a (resultant) upward force (from the water)✓	For MP1 allow idea that after 1.3 s the velocity starts to decrease OR at 1.3s the velocity is a maximum.	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.3	Attempt to find area under the graph up to 2.8 s ✓ Area correct in the range of 15–16 squares **OR** 1 square is equivalent to 2.5 m ✓ Correct answer in the range 37–40 (m) ✓	For MP2 if triangles/trapezium used give mark if at least two areas combined.	3	AO3 × 3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.4	Attempts to find a gradient of a tangent of the steepest part of the graph ✓ Answer in range 32 to 35 (m s^{-2}) ✓	 Condone a positive or negative final answer	2	AO3 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.5	Idea that (the resultant force is more than the weight because) both air resistance and weight are acting downwards/in the same direction ✓ Links (greater) acceleration to (greater) force with a reference to $F = ma$ in some form ✓	In MP1 condone idea that the air resistance and weight add together. Alternative: an algebraic form for a eg $a = (mg + R)/m$ ✓ with terms defined ✓	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.6	Extend the line at the same terminal velocity ✓ until the area between above the axis is equal to the area below the axis (and then read off the time) owtte ✓	reject the idea that $5.0\ \text{s}$ is the time of flight	2	AO3
Total			**13**	

Question	Answers	Additional comments/Guidelines	Mark	AO
11.1	The sum of the clockwise moments is equal to the sum of the anticlockwise moments ✓ for an object in equilibrium ✓		2	AO1 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
11.2	Use of $T = F \times d$ for any correct moment ✓ equates moments about handle to give 600 g ✓	e.g. 0.40×0.15g or $0.10 \times m$ g Condone missing 'g' Do not penalise POT error in MP1	2	AO2 × 2

Question	Answers	Additional comments/Guidelines	Mark	AO
11.3	Max 3 from: ✓✓✓ • The maximum mass for the Bismar is greater … • …because the sliding handle can be brought closer to the hook • Calculates either maximum mass (3600 g OR 410 g) • The minimum mass for the Bismar is smaller/zero OR minimum mass for simple is about 110 g • Consistent comparison of resolution or sensitivity… • …with consistent reasoning about spacing of markings. • The mass of the counterweight can be changed for the simple balance	Accept idea that the markings getting closer together on the Bismar makes them harder to read for large mass. Accept reverse argument. Accept differences in values based on not moving counterweight right to the end Condone a practical suggestion such as counterweight could fall off the simple scale	3	AO2 × 3
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
12.1	Percentage uncertainty = $0.3(\%)$ ✓	Condone 0.31	1	AO1

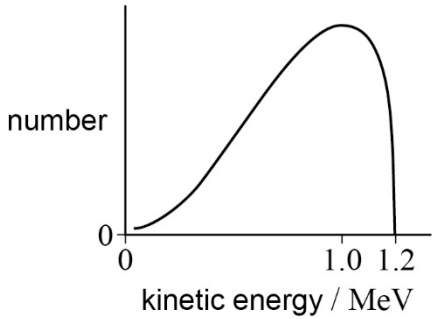
Question	Answers	Additional comments/Guidelines	Mark	AO
12.2	Calculation of the mean value omitting $16.3\ \text{mm}$ ($= 15.6\ \text{mm}$) ✓ Determine the uncertainty uncertainty $= \frac{1}{2}$ (range) $= \pm 0.1$ or ± 0.4 if 16.3 included ✓ Percentage uncertainty in diameter $= \frac{\textit{their uncertainty}}{15.6} \times 100$ $= 0.64(\%)$✓	mean value if 16.3 is included: $15.7\ \text{mm}$ At least 2sf in final answer % uncertainty if 16.3 is included: 2.5%	3	AO1 AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
12.3	use of volume $= \frac{4}{3}\pi r^3$ OR density $= \frac{m}{V}$ ✓ density $= 8090\ \text{kg m}^{-3}$ ✓ ecf from their mean diameter in **12.2** for both marks	= expect to see $1.99 \times 10^{-6}\ (\text{m}^3)$ Allow ecf if 16.3 is included, volume $= 2.03 \times 10^{-6}\ \text{m}^3$ density $= 7930\ \text{kg m}^{-3}$	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
12.4	3 × (value in **12.2**) + (value in **12.1**) evaluated ✓	Expect to see 2, 2.1 or 2.2 Accept 1 sf if process is seen to be correct	1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
12.5	Volume of displaced water too small to be measured accurately ✓ Therefore increases the overall uncertainty ✓	For MP1 accept idea that the scale divisions are too large. Accept answer in terms of change of height of water In MP2 accept idea that the uncertainty in the measurement of the volume will be greater.	2	AO2
Total			**9**	

Question	Key	Answer	AO
13	**A**	41 N	AO2
14	**A**	10 | 31	AO2
15	**A**	extension is overestimated | Young modulus is underestimated	AO4
16	**D**	The drag on the ball increases.	AO2
17	**C**	$1.1\ \text{m s}^{-1}$	AO2
18	**B**	1.2 N s	AO3
19	**C**	63 N	AO2
20	**B**	k | $0.8k$	AO2
21	**B**	Line B	AO3

Question	Key	Answer	AO
22	**D**	neutron and antineutron: 1860	AO2
23	**D**		AO3
24	**B**	$^{20}_{8}\mathrm{O} \rightarrow {}^{20}_{9}\mathrm{F} + \beta^{-} + \bar{\nu}_{e}$	AO1
25	**C**	1300 MBq	AO1
26	**C**	gamma emission	AO1

Total: 14 marks