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AQA EXAMINATIONS

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PHYSICS

PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

January 2021

Version: 1.0 Final

2 1 1 X P H 0 1 / 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	ID details
01	Any **two**: Do not handle source directly / use tongs to handle source ✓ Store source in lead box **or** keep source in lead box when not in use **or** limit exposure time ✓ Do not point source towards people ✓ Display warning notices ✓	Answers must be consistent with sources being used Do not accept any reference to clothing including gloves and goggles. Allow description for 'tongs' Allow misspelling of 'tongs' Do not accept 'keep' without qualification Do not accept keep source away from people/work at a safe distance Accept reference to correct record keeping	2	E
Total			**2**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
02.1	The total energy (of the particle) measured by an observer in the same inertial frame of reference as the particle **or** the energy equivalent to the (rest) mass (of the particle) ✓	Answer requires reference to mass Allow 'energy stored' Do not allow '… **is** the mass' Accept correct reference to $E = mc^2$ with m explained	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
02.2	Multiplies mass of electron in u by 931.5 or divides by u ✓ 0.51 MeV ✓	Accept mass in any unit for MP1 Accept attempt to use $E = mc^2$ for MP1 Expect to see 8.199×10^{-14} J If no other mark give, give 1 mark for conversion of their energy to MeV.	2	E
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
03	<u>Both graphs start at the origin</u> and any **three** from: Graphs have the same initial gradient **and** gradients decrease✓ Both graphs begin to flatten out **and T** flattens out more quickly than **C** ✓ Maximum velocity for **C** is greater than the velocity for **T** ✓ **T** extends for a longer period of time than **C** so that the areas are approximately the same✓	Ignore any part of graph that clearly shows what happens after a ball bounces. Ignore any labels on the axes If graphs not labelled, only MP1 can be awarded	Max 3	E
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
04.1	Mark as a list (Max 2) ✓✓ 2 <u>forces</u> • of equal magnitude • acting in opposite directions • co planer OR not co-linear	Condone alternatives for 'equal' in MP1 e.g. identical Mention of equilibrium loses MP3 Allow 1 mark maximum if it is not clear that there are two forces	2	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
04.2	Idea that the force is not directed through the <u>centre of mass</u>	Condone gravity/weight for mass	1	E
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.1	Beta plus correct $^{0}_{1}\beta$ **or** $^{0}_{+1}\beta$ or positron ✓	Allow $_{+}\beta$ or $^{+}\beta$ or e^{+} or β^{+} Allow B for β do not allow β on its own condone 'anti-electron'	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.2	12 ✓		1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.3	0,0 ✓		1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.4	conservation of energy mentioned ✓ beta particles (from a particular decay) have a range of energies ✓	Ignore references to momentum	2	E
Total			**5**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
06.1	Angle correct $63(.4)^{o}$ or 26.6^{o} or $\tan\theta = 0.5$ or 2✓ Attempts moments equation ✓ Correct moment equation ✓ 66 or 65.8 or 65.7 (N) ✓	For MP1 accept $\sin\theta = 2/\sqrt{5}$ or $1/\sqrt{5}$ or calculation of perpendicular distance to line of action of T (4.3 m) MP2 any T × distance = any W × distance May lack trig function or g and distances need not be correct MP3 condone incorrect angle Expect to see $T\,4.8\sin 63.4 = 12g \times 2.4$ Or $T\,4.8\cos 26.6 = 12g \times 2.4$ Or $4.3T = 12g \times 2.4$	4	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
06.2	T will decrease because The anticlockwise moment/moment of the weight of the boom will decrease (since the centre of mass moves nearer to the mast) ✓ The (perpendicular) distance of T from **Q** increases ✓	There is no mark for this statement – only for the explanation. If no other mark given give 1 for idea that centre of mass moves towards mast, or words to that effect. Condone 'momentum' for 'moment' if it is clear what is meant.	2	E
Total			**6**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
07.1	MAX 3 More significant figures/decimal places (for h) ✓ Consistent significant figures/decimal places for t ✓ More sets of results (within the range) ✓ Repeats (and averages) performed (for each set of results) ✓	Allow more than one mark within an answer space but penalise talk-outs. In MP1 allow 'data' for 'h' but not suggestion of more sf for t.	3	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
07.2	Evidence of gradient being found using a large triangle or the equivalent ✓ Use of $h = \frac{1}{2}gt^2$ or gradient $= \frac{g}{2}$ ✓ Answer value that rounds to 9.4 (m s^{-2}) ✓	Look for more than half of t^2 axis used Allow 9.35 to 9.44	3	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
07.3	Zero error on ruler /measuring h✓	Zero error on its own does not get the mark Must be a valid systematic error. Accept h measured from top of metal ball (instead of bottom)	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
07.4	Method of detecting start of drop ✓ Method of measuring end of drop✓	Either seen gains MP1. Method must include labelled timer e.g. data logger For both marks it must be clear that the time of drop can be obtained – e.g. start and end system connected to same data logger.	2	E
Total			**9**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
08.1	Elastic means returns to original shape/length (when stress is removed) ✓ Not possible to tell whether it is elastic from the graph because stress/force not removed/decreased✓	Accept idea that graph should return to zero/elastic should return to original shape/length for MP1	2	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
08.2	Breaking strain of 4.75 taken from graph **or** extension is strain × original length used. ✓ Adds original length to give an answer that rounds to 10.3 or 10.4 cm ✓	Allow 4.7 to 4.8 Expect to see $(1.8 \times 4.75) + 1.8$ Allow 10.25 to 10.44	2	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
08.3	Area is 17 to 19 squares **or** 1 square is equivalent to 1.25×10^{8} J m^{-3} ✓ Energy per unit volume determined ✓ Volume determined ✓ Energy of between 1.9(2) and 2.1(5) $\times 10^{-3}$ J ✓	If no other mark given, give one mark for attempt to count squares. May be left as an uncalculated expression but expect to see $16 \times 0.5 \times 2.5 \times 10^{8}$ or 2.0×10^{9} (J m^{-3}) May be left as an uncalculated expression but expect to see $\pi(4.0 \times 10^{-6})^2 \times 0.018$ **or** 9.05×10^{-13} (m^3) Allow 2sf 2.2×10^{-3} J	4	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
08.4	Idea that the force/stress/strain/energy Is shared/distributed/transferred between more fibres ✓	Allow 'spread out to each strand' Allow 'dissipate the energy'	1	E
Total			**9**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
09.1	Uses $E_k = \frac{1}{2}mv^2$ with v = 250 m s^{-1} ✓ Uses $E_p = mgh$ with h = 1600 m✓ 1.737×10^5 to at least 3 sf ✓	Expect to see 1.16 x 10^5 J Expect to see 5.81 x 10^4 J Do not accept use of suvat	3	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
09.2	Uses answer to **09.1** to give 306 or 310 (m s^{-1}) ✓	Accept: Unrounded value for 09.1 gives 306(.4) Using 1.7×10^5 from 09.1 gives 303(.1)	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
09.3	Use of Pythagoras' theorem ✓ 265 or 261 or 257 or 256 (m s^{-1}) ✓	Allow marks for suvat approach only if clearly using vertical component of velocity Unrounded value for 09.2 gives 265 Using 303(.1) from 09.2 gives 261 Using 300 from 09.2 gives 257	2	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
09.4	56^{o} to 60^{o} ✓	Allow answer consistent with their values in this range	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
09.5	Use of $v = u + at$ to find (t) ✓ Candidate's time × horizontal component of velocity ✓ 4370 m ✓	Candidates could also use $s = \frac{1}{2}gt^2$ if they have found the maximum height Expect to see 27×167 (=4509) Allow answer consistent with their values between 4300 m and 4600 m	3	E
Total			**10**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
10.1	Use of $v^2 = u^2 + 2as$ ✓ To give a = 5.8 ms^{-2} ✓ Use of $F = ma$ to give 3010 (N) to at least 3 sf ✓ **or** Use of $W = \frac{1}{2}mv^2$ ✓ To give W = 1.90 x 10^5✓ Use of $F = \frac{W}{s}$ to give 3010 (N) to at least 3 sf ✓ **or** Use of $s = \left(\frac{u+v}{2}\right)t$ ✓ To give t = 4.7 s ✓ Use of $F = \frac{\Delta mv}{\Delta t}$ to give 3010 (N) to at least 3 sf ✓	The first mark is for the use of a correct first step equation, The second mark is for evaluating the first step quantity The third mark is for the second step **and** final answer to more than 3 sf. MP2 can be awarded by implication	3	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
10.2	Momentum is conserved/rate of change of momentum is the same on each ✓ Magnitude of (change in) momentum of the jet ski (in a forward direction) is equal to magnitude (change in) momentum of water (in a backwards direction) wtte ✓	For MP2 accept the idea that momentum in one direction has the opposite sign to momentum in the other direction	2	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
10.3	Use of force = rate of change of momentum ✓ Leading to $v = 39\ (m\ s^{-1})$ ✓	Do not penalise sf error in MP1 Allow impulse equation for MP1 Accept 38 from use of $3.0\ kN$	2	E
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.1	449(.2) or 448 ✓		1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.2	Point accurately plotted at (3.70, their 11.1) ✓		1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.3	Well drawn straight line ✓	The line should pass below the end two points and above the middle point.	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.4	Large triangle drawn (or implied with values taken from the line of best fit) ✓ to find the gradient ✓ k in the range 101 to 117 (counts per minute m^2) ✓	Allow 3 sf but not more	3	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.5	Not supported as proportionality requires a straight-line graph through the origin wtte ✓	Allow 'yes, as it is a straight line through the origin' if consistent with their BFL	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.6	Background count rate ✓	Accept background count per minute Allow explanation for 'background' e.g. radiation present before sources put out	1	E

Question	Answers	Additional comments/Guidelines	Mark	ID details
11.7	Value correct for their BFL ✓	Do not accept '0' Allow use of $y-y_0 = m(x-x_0) + c$ using their graph	1	E
Total			**9**	

Question	Key
12	B
13	B
14	A
15	C
16	D
17	D
18	C
19	B
20	A
21	D
22	C
23	B
24	C
25	C