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PHYSICS

PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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20IXPH01/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	Marking guidance	Additional comments/guidelines	Mark
01	Random: incorrect positioning of ruler OR Parallax error OR irregular shaped desk OR misreading ruler wtte ✓ Systematic: Incorrectly calibrated ruler OR zero error (ruler with zero mark not at the end or worn end) ✓	Mark as a list i.e. a misplaced error cancels a correct error. Mark each answer separately	2
02	Max 3 from the following: • Photon interacts with another particle / nucleus ✓ • Photon transfers energy ✓ • Positron (and electron) formed ✓ • (Original) photon was gamma / High energy ✓ • Positron and electron move with equal speeds in opposite directions ✓	Accept neutral boson for photon Accept high-energy photon for gamma photon Can be seen as an equation; condone missing KE	3
03.1	Most alpha particles are undeviated wtte ✓ A few have small deviations ✓ A very small number are backscattered wtte ✓	Answers must give sense of the relative numbers. Accept, most > some > few, condone part for number accept < 90^{o} accept > 90^{o} if no other mark awarded 1 mark can be given for some go through and some are reflected back	3
03.2	Old model had a large positively charged sphere with negative charges embedded wtte ✓ The new model has small positively charged / dense nucleus (surrounded by electrons) ✓	Any mention of proton or neutron prevents award of this mark Treat any mention of electrons as neutral Allow big mass for dense	2

Question	Marking guidance	Additional comments/guidelines	Mark
04.1	Nucleon numbers correct: $99, 0, 0$ ✓ Proton numbers correct: $42, -1, 0$ ✓ (electron) antineutrino ✓	Accept $\bar{\nu}$ but not ν	3
04.2	Reduces energy level OR Reduces the (total) energy of the nucleus ✓	Accept increases binding energy or reduces mass or becomes more stable or goes from excited state to ground state. Accept it will lose energy. Any suggestion of a change in the constituents of a nucleus loses the mark.	1
04.3	Clear attempt visible on graph to find time taken for count rate to halve ✓ Subtracts 30 to find true count and OR redraws graph with corrected count rate ✓ 5.9 to 6.1 h ✓	Can get this mark irrespective of whether or not background is taken into account eg $200 - 30 = 170$; ½ × $170 = 85$; $85 + 30 = 115$; time taken to fall to $115 = 6$ h Calculations based on $N = N_0 e^{-\lambda t}$ or $N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$ for MP1	3

Question	Marking guidance	Additional comments/guidelines	Mark
05.1	Uses $P = Fv\ cos\ 20$ ✓ to give 530 (N) or 532 (N) ✓	Uses $P = Fv$ gets MP1 Expect to see 500N or 470N	2
05.2	Uses efficiency $= \frac{\text{useful output power}}{\text{input power}}$ ✓ 340 (W) or 345 (W) ✓	Allow CE for their value of output power for 1 max. Rounding to 344 gets 1 max.	2
05.3	(rate of) work done against friction constant ✓ Speed in direction of force is now greater OR force increased by addition of component of weight down the ramp OR (additional) work is being done raising the (CoG of the) car / increasing GPE ✓	Accept statement that T will increase	2
05.4	Speed decreases (as it moves along the bed) ✓ Horizontal component of force decreases ✓	Award no marks if answer suggests speed increases or stays the same	2

Question	Marking guidance	Additional comments/guidelines	Mark
06.1	Max 3 from: • Speed is a scalar AND velocity is a vector (quantity) • Speed takes no account of direction OR velocity is speed in a stated direction ✓ • Speed = distance / time AND displacement = velocity / time ✓		2

06.2	Uses $v^2 = u^2 + 2as$ or $\frac{1}{2}mv^2 = mg\Delta h$ ✓ 1.88 (m s^{-1}) ✓	Condone *u* and *v* swapped Answers should be to at least 2sf	2
06.3	Uses $s = \frac{1}{2}gt^2$ ✓ 0.19 seen ✓ Doubles to get $0.38(3)$ (s) to at least 2 sf ✓ OR Uses s = ut + ½ at^2 ✓ Solves for t ✓ to get 0.38s✓	Accept use of $v = u + at$ or $s = \frac{v+u}{2}t$ with value from 06.2 used for u Accept 2nd MP if 0.192 not seen but suitable algebra used eg $t = 2\sqrt{\frac{2s}{g}}$ This is alternative using quadratic and horizontal component:	3
06.4	At the highest part of the jump wtte ✓ only has the (constant) horizontal component with no additional vertical component of velocity wtte ✓	Accept explanation in terms of potential energy and kinetic energy eg idea that PE max so KE min so v min	2
06.5	$\frac{0.32}{0.383}$ to give 0.84 ✓	Answers to at least 2 sf unless 0.4 is used then allow 1 sf answer (0.8)	1
06.6	Uses Pythagoras ✓ Use of tan for the angle ✓ 2.06 or 2.1 (m s^{-1}) ✓ 24^o to vertical OR 66^o to horizontal OR angle defined by diagram ✓ Alternative by scale drawing: Correct rectangle ✓ Scale given ✓ 2.0 to 2.2 (m s^{-1}) ✓ 23^o to 25^o ✓	Expect to see (candidate's 06.2)^2 + (candidate's 06.5)^2 Using show that value gives v = 2.06 and angle = 67.2 to horizontal. Alternative for angle using resultant velocity and sin or cos e.g. Sin (angle) = horizontal component/resultant velocity ✓ to give angle = 22.9º to the vertical ✓	4

Question	Marking guidance	Additional comments/guidelines	Mark
07.1	Use of $E_p = mg\Delta h$ ✓ 6.75 or 6.76 or 6.8 (m) ✓	Substitution or rearrangement Allow 1 max if g=10 used (to give 6.6(25))	2
07.2	Use of $E = \frac{1}{2}k\Delta l^2$ ✓ Leading to 4141 N m^{-1} ✓	To at least 2 sf Units and powers of ten must be consistent	2
07.3	6630 (N) ✓ **cao**	If k = 4000 is used, accept 6400 (N)	1
07.4	Resultant force = candidate's P.3 – mg ✓ Use of $F = ma$ ✓ $73(.0)$ (m s^{-2}) ✓	If k = 4000 is used, accept $70(.2)$ (m s^{-2}) Allow CE in MP3 only if the weight has been taken into account	3
07.5	Smaller acceleration... ✓ Two from: ✓✓ • Not all of the change in gravitational potential energy stored in rope OR less elastic strain energy stored in the rope • Extension of rope smaller • (Resultant) force (on climber) OR tension in rope smaller • Or work done against friction in the pulley MAX 3	If k = 4000 is used, accept $70(.2)$ (m s^{-2})	3

Question	Marking guidance	Additional comments/guidelines	Mark
08.1	$\pm$ 0.03 ✓	Condone missing $\pm$	1
08.2	2.9(4) ✓	Accept 2 or 3 sf	1
08.3	Calculates % uncertainty in T (4.4%) ✓ 0.13 (m s^{-1})✓	Condone use of fractional uncertainty No sf penalty Allow CE for % uncertainty $\left(\frac{ans\ to\ 8.1}{0.68}\right) X(ans\ to\ 8.2) = correctly\ evaluated$ gets both marks	2
08.4	Data point accurately plotted with an error bar of $\pm$ approximately 2.5 small squares ✓ Smooth curve drawn ✓	The line should accurately follow the trend of the points within the error bars, and with an even scatter of points about the line	2
08.5	A plot of v^2 against w ✓ would give a straight line through the origin if the suggestion were true ✓	Accept calculate w/v^2 (or similar) for each data set; if the value is a constant then suggestion is true. For 1 mark only Condone *u* for *v* but do not condone *f* for *w*	2

Question	Marking guidance	Additional comments/guidelines	Mark
09.1	Change in momentum ✓	Accept $F\Delta t$ with terms defined Accept *mv-mu* with terms defined	1
09.2	Use of 60s for Δt ✓ Uses $m = V\rho$ ✓ Uses momentum (acquired by sand) = mv to give $120\ 900$ or $121\ 000$ (N) ✓	Expect to see $372/60$ or 6.2 Expect to see 2500×6.2 Must see statement connecting force to rate of change of momentum for the third mark	3
09.3	Use of $P = Fv$ OR total force $(1.2 \times 10^5 + 4.5 \times 10^5)$ = $5.7(1) \times 10^5$ OR total distance = 6.7×10^5 ✓ Use of $E = Pt$ ✓ 3.8×10^{11} (J) or 3.9×10^{11} (J) ✓	Accept similar analysis based on energy = force × distance moved (in 24 h) 2 marks MAX can be awarded for: • forgetting the additional frictional force to get 8.2×10^{10} J • forgetting the belt force to get 3.0×10^{11}J • subtracting the forces to get 2.2×10^{11}J	3
09.4	(Law of conservation of momentum) states that momentum is only conserved <u>in the absence of external</u> forces ✓ OR External force is applied✓ OR there is a resultant force ✓	Accept the idea that horizontal impulse changes the horizontal component momentum	1

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