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PHYSICS
PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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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 Assessment Writer.

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	Marking guidance	Mark	Comments
01.1	Beta-<u>plus</u> **or** positron (emission) ✓	1	Accept $_{+1}^{0}\beta$ Accept correct decay equation in which beta plus is seen Just beta decay is insufficient
01.2	(electron) neutrino ✓	1	Accept correct symbols Reject anti-neutrino.
01.3	the correct antiparticle to student's 01.2. ✓	1	Accept correct symbols Expect (electron) antineutrino but **not** if **01.2** is incorrect ecf from 01.2

Question	Marking guidance	Mark	Comments
02.1	No resultant moment OR sum of clockwise moments = sum of anticlockwise moments ✓ For a body in equilibrium ✓	2	condone lack of 'sum of' for 1st mark only accept "total" for "sum of" ignore the definition of a moment must be completely correct to get both marks
02.2	Use of principle of moments f1d1 = f2d2 ✓ Moment of weight = 27 × 9.81 × 3.2/2 × cos35 (= 347 Nm) **or** Force = their moment of weight / 3.2 ✓ = 110 (N) OR = 108 (N) ✓	3	 Accept 109 (N)

Question	Marking guidance	Mark	Comments
03.1	Conversion of speed to $\mathrm{m\ s^{-1}}$ ✓ Use of $E_\mathrm{k} = \frac{1}{2}mv^2$ ✓ m = 1100 (kg) ✓	3	Look for (80 $\mathrm{km\ h^{-1}}$ =) 80 × 1000 / 3600 = 22.2 Look for $280 \times 10^3 = 0.5 \times \mathrm{m} \times 22.2^2$ Accept 2 sf or more
03.2	Use of W = Fs ✓ = 7400 (N) ✓	2	condone power 10 error on sub for KE allow SUVAT route eg $v^2 = u^2 + 2as$ and $F = ma$

Question	Marking guidance	Mark	Comments
04.1	15 cos20 or 14.1 seen ✓ = 2.1(1) (m) ✓	2	
04.2	Use of *u*sin20 ✓ (= 5.13 m s^{-1}) Use of $s = ut + \frac{1}{2}at^2$ ✓ = 0.66 (m) ✓	3	= u_V*0.15 − 0.5*9.81*0.15^2
04.3	Use of SUVAT in an attempt to calculate v_v ✓ Use of Pythagoras ✓ = 15 *or* 14.6 (m s^{-1}) ✓	3	$v_V = u_V + at$ = 5.13 − 9.81*0.15 (= 3.65 m s^{-1}) $v = \sqrt{(v_V^2 + v_H^2)}$ $= \sqrt{(3.65^2 + 14.1^2)}$ Correct answer only for 3rd mark

Question	Marking guidance	Mark	Comments
05	Additional apparatus: Ruler (ignore stopwatch) ✓ Measurements: Background measurement taken *or* subtracted ✓ Count rate measured at various distances ✓ Accuracy: counts taken for a long time **or** large range of distances mentioned **or** repeats and averages **or** reference to end correction ✓ Process results: Graph: **either** C vs $1/r^2$ **or** $1/C^{1/2}$ vs r ✓ Straight line (through the origin) ✓	Max 5	Log-log graph ✓ MP6 requires MP5

Question	Marking guidance	Mark	Comments
06.1	Attempt to take the area under the graph between $t = 0$ and $t = 0.57$ s ✓ extracting the correct data from the graph ✓ = $1.6(0)$ m ✓ **or** extracts time from graph $t = 0.57$ s ✓ uses s = $\frac{1}{2}$ gt^2 or gradient of line or $s = \frac{V+U}{2}t$ or $v^2 = 2gs$ ✓ = $1.6(0)$ (m) ✓	3	
06.2	Attempt to take the gradient of the bounce section ✓ = $(5.6 + 3.6)/(0.60 - 0.57)$ ✓ = 310 or 307 (m s^{-2}) ✓	3	Award full marks if just 0.57 s to 0.59 s is taken, or 0.59 to 0.60s. Expect 280 or 360 (m s^{-2}) respectively. Ignore minus signs
06.3	Use of F = ma ✓ Use of W = mg ✓ F = ma + mg = $17.8 + 0.569 = 18(.4)$ ✓	3	ecf from 06.2 Accept $F = \frac{\Delta p}{t}$. Condone POT error for MP1 Do not accept 18 if the mg term has been ignored 280 in **06.2** gives 16.8 here. Accept
06.4	End of new line or curve is at a later time ✓ Curve with decreasing gradient ✓ Max velocity is lower ✓	3	Ignore any attempt to sketch the bounce or subsequent motion Reject curves with a gradient larger than the original

Question	Marking guidance	Mark	Comments
07.1	Uses stiffness = $\frac{\Delta F}{e}$ or uses $k = \frac{9.81}{\text{gradient}}$ ✓ Extracts data correctly from graph✓ Converts from mm to m ✓ k = (9.81*1000/10.7) = 920 N m^{-1} ✓	4	For the second mark, allow power of ten error condone small triangle for gradient
07.2	$E = \frac{kL}{A}$ ✓ 1.31×10^8 **or** 131×10^6 **or** 131 ✓ Pa or MPa or Nm^{-2} or kg m^{-1} s^{-2}✓	3	If 900 N m^{-1} used, E = 128 MPa Number and unit must match for full marks
07.3	Same as they are the same material ✓	1	Accept same wire
07.4	Stiffness halved for **X** ✓ Because extension doubled for same load ✓	2	For the explanation, accept correct algebraic argument *or* use of the analogy of two springs in series. Allow max one for correct qualitative argument
07.5	**Either** wire **X** stores more (double) energy✓ load falls a greater distance, losing more potential energy✓ **or** Wire **X** stores more (double) energy ✓ Because **X** has double extension but same load and energy stored = ½ Fx✓	2	condone a qualitative answer in 07.5 allow any justified version of the energy stored equation

Question	Marking guidance	Mark	Comments
08.1	(The area under the graph is) the change in momentum or impulse (which) is the same ✓ The initial/change in velocity is the same ✓ And the mass is the same ✓	3	
08.2	Same loss in E_k ✓ Work done = force x distance ✓ Idea that A has a small force and a large distance compared with B which has a large force and small distance wtte ✓	3	Accept explanations in terms of equations even if symbols are undefined on this occasion
08.3	A body will remain in a state of rest or uniform motion unless acted on by an (external) force.	1	Accept steady speed in the same direction Do not accept just steady speed
08.4	Dummy **B** carries on moving because it has no seat belt to decelerate it owtte	1	Accept that **B** decelerates when it experiences a force (eg when it hits the windscreen)

Question	Marking guidance	Mark	Comments
09.1	$t_{mean} = 0.79$ ✓ $\Delta t_{mean} = (\pm)\ 0.02$ ✓	2	Exact answers only
09.2	a = $2.40\ m\ s^{-2}$ ✓ Either $\Delta s\%$ or $\Delta t\%$ correctly calculated ✓ Use of $\Delta a\% = \Delta s\% + 2\Delta t\%$ ✓ $\Delta a\% = (\pm)\ 5.3$ ✓	4	Accept 2 or 3 sf. ecf on t_{mean} from 9.1 Look for 0.26% and 2.5% respectively (any sf) Accept 1 or 2 sf only for final answer
09.3	Resultant force on trolley is reduced ✓	1	Accept algebraic statement $mg - F = (M + m)a$
09.4	Tilt the trolley track (slightly) downwards ✓	1	Accept add (small) additional mass to m (to compensate for friction) Accept use a linear air track

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