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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	The object's direction is changing ✓ Acceleration is rate of change of velocity ✓ Velocity is a vector quantity **or** velocity is speed in a given direction **or** mention of an appropriate circumstance (eg circular motion)✓	3	Accept statement that an object is accelerating if it's velocity is changing **or** $a = \frac{\Delta v}{t}$ but not just $a = \frac{v}{t}$ for MP2
02	$\mathrm{kg\ m^2\ s^{-2}}$ ✓ work = force × distance **or** other valid energy equation **or** a joule is a N m or ✓	2	Correct answer with no working scores 2 marks. Accept symbol equation using normal symbols without definition of symbols=
03	Positron correct 1.6×10^{-19} C electron Neutron correct zero **or** 0 antineutron Any 2 correct ✓ All 4 correct ✓	2	Accept $+e$ Accept $\bar{n}$

04	ANY 2 from: Two photons ✓ Gamma (photons) ✓ Two photons must travel in opposite directions.✓ PLUS Gamma energy appropriate to the energy released by the annihilation of that amount of mass ✓ Opposite direction of the movement of the photons conserves momentum ✓	4	Accept two gamma rays must travel in opposite directions Accept whether or not kinetic energy of particles prior to collision is accounted for

05.1	Use of Pythagoras: expect to see $1.1^2 + 0.65^2$✓ $1.28\ (\text{m s}^{-1})$ to at least 3 sf ✓	2	Accept even if there are more than 3 terms in the Pythagoras equation Not $1.27\ \text{m s}^{-1}$

05.2	Magnitude = $0.25\ \text{m s}^{-1}$ Direction = (towards the) west	1	Accept just W or "to the left"

06	Clear attempt to construct a moments equation ✓ Two correct terms seen: (2x700), (2.5x470), ($4F_s$) ✓ 640 or 644 N ✓	3	Minimum requirement is a recognisable force × distance on either side of an equals sign Accept as correct terms 1400 and/or 1175 Expect to see $(2 \times 700) + (2.5 \times 470) = 4\ F_S$

07.1	(electron) antineutrino, **or** $\bar{\nu}$ **or** $\overline{\nu_e}$✓	1	Accept mis-spellings when intention is clear but not confusion of neutrino and neutron. Accept anti electron neutrino

07.2	MAX 2 Only weak interactions with matter **or** very weakly ionising✓ It has no charge ✓ It has a <u>very</u> small (or zero or negligible) mass ✓	2	

07.3	Actinium has one more proton **or** Z is 1 higher for actinium ✓ Actinium has one fewer neutron **or** A is the same for both ✓	2	Accept that the masses are the same

07.4	$88 \times 1.6\times10^{-19}$ seen ✓ Expression for total mass or mass of protons seen ✓ Number of neutrons = 136 **cao** ✓	3	Expect to see A x 1.661×10^{-27} or 88x 1.673×10^{-27} but accept any values of nucleon mass (1.661×10^{-27}, 1.673×10^{-27} or 1.675×10^{-27}) Correct final answer gets all 3 marks

Question	Marking guidance	Mark	Comments
08.1	$v_h = \frac{25.0}{0.260}$ **or** $v_h = 96(.15)$ seen ✓ Use of tan (1) leading to 1.678 to at least 3 sf ✓	2	Use of tan must be seen. Use of sin loses the mark even if the numbers seem to be correct. Accept appropriate combination of cos and sin
08.2	Use of $s = ut + \frac{1}{2}at^2$ ✓ $s = 0.10$ to 0.11 ✓ Between 0.10 m and 0.11 m above the centre of the target ✓	3	Expect to see 0.105 (m) but allow range for different degrees of rounding / use of approximate value for v_h Accept valid approach using different equations of motion Both magnitude and direction must be there for the final mark and the answer must include an appropriate unit

Question	Marking guidance	Mark	Comments
09.1	Reasonable tangent drawn at t = 16 s✓ Correct values from tangent used ✓ Deceleration = 0.35 – 0.41 m s^{-2} ✓	3	Allow intercepts on the t axis of between 22 and 27 Candidates who find the gradient of a triangle around 16 s can access 1 mark max. Tolerate small triangle on a tangent – accept any correct data. Tolerate lack of minus sign
09.2	Attempt to use area ✓ Medium square equivalent to 1.25 m **or** large square equivalent to 5 m **or** 11.4 to 12.6 large squares **or** 45.5 – 50.5 medium squares **or** finds distance represented by initial triangle and rectangle correctly (= 40 m) ✓ d = 57 – 63 m ✓	3	Give equal credit if small squares are used.
09.3	Starts at candidate's answer to **09.2** at time t = 21 (s)✓ **Then any 2 from** Curve with (increasing) negative gradient from t = 21 (s) to t = 25 (s) ✓ Straight line with negative gradient from t = 25 (s) to t = 30 (s) ✓ Additional detail: either: initial curve has negative gradient that gets steeper with time **or** final displacement is candidate's 09.2 – 14 m ✓	MAX 3	If everything correct but with a positive gradient, candidates may access MP2 and/or MP3. Candidates who plot distance from the point at which the turn is made instead of the distance from the start can access MP2 and MP3 ie MAX 2 Marks available only for: - a curve with (increasing) positive gradient from t = 21 (s) to t = 25 (s) - a straight line with positive gradient from t = 25 (s) to t = 30 (s) **or** final displacement is 14 m

Question	Marking guidance	Mark	Comments
10.1	The (magnitude of the) momentum of the block is smaller (than that of the object) ✓ The two momenta are in different directions wtte ✓	2	Not just that the magnitudes are different Accept that "they" are in different directions
10.2	Attempts to use (for the object) $mg - T = ma$ ✓ $T = 3.0(3)$ (N) ✓	2	Expect to see $0.4g - T = 0.4a$ but accept incorrect equation with 3 terms – possible with incorrect sign
10.3	Use of $v^2 = u^2 + 2as$ ✓ $v = 1.42$ to at least 3 sf (m s^{-1}) ✓	2	Credit use of $s = \frac{1}{2}gt^2$ with $v = at$
10.4	$mg \sin 30$ **or** $mg \cos 60$ 1.23 (N) ✓	2	

Question	Marking guidance	Mark	Comments
10.5	Adds frictional force to component of weight parallel to slope: 1.25 + 1.23 (2.48) **or** 1.25 + candidate's **10.4** ✓ Use of $E_{\mathrm{k}} = \frac{1}{2}mv^2$ **and** work = force x distance **or** $F = ma$ **and** $v^2 = u^2 + 2as$ (or other legitimate combination of equations of motion ✓ d = 0.10(2) m ✓	3	For equ^{n} of motion method expect to see a = 9.905 m s^{-2} Use of $v = 1.4$ gives d = 0.099 m for full marks

Question	Marking guidance	Mark	Comments
11.1	Both points accurately plotted ✓ Well drawn straight line of best fit ✓	2	The line should accurately follow the trend of the points with an even scatter of points about the line. An intercept outside the range of 2.2 to 2.5 is not likely to be correct
11.2	It (the straight line) should go through the origin or (0,0) ✓	1	Not just "doesn't go through zero"
11.3	The weight of the tray (has been ignored) ✓	1	Accept zero error (on ruler) but not inaccurate ruler or ruler not vertical – explanation has to be valid for a systematic error not for a random error
11.4	Gradient in the range 18.5 to 20.5 from a large triangle (Δl at least 7 mm) **ecf** for BFL✓ Unit = $\mathrm{N\ mm^{-1}}$ **or** $\mathrm{N\ m^{-1}}$ consistent with the candidate's value ✓	2	Triangle need not be seen on this occasion
11.5	(The graph can be used to find a value for k) k is the gradient of the graph✓ Since the systematic error does not affect the gradient of the graph **or** systematic error only affects the intercept. ✓	2	Accept correct reference to $y = mx + c$

Question	Marking guidance	Mark	Comments
12.1	More penetrative wtte ✓	1	
12.2	More likely to be absorbed and/or kill bacteria ✓	1	Accept more ionising
12.3	Uses $I_1 r_1^2 = I_2 r_2^2$ ✓ 9.0×10^{-2} (W m^{-2}) ✓	2	Accept even with only one value of $I_n r_n^2$ seen
12.4	At 10.6 years, intensity = 1.0×10^{-2} W m^{-2} ✓ At 15.9 years, intensity 5.0×10^{-3} W m^{-2} ✓ Ticks box for 10.6 to 15.9 years **cao** ✓ **or** uses appropriate equation to calculate time taken for intensity to fall to 8.0×10^{-3} W m^{-2} 12.3 y **or** 2.32 half lives (based on 4.0×10^{-2} W m^{-2}) or 18.5 y (based on 9.0×10^{-2} W m^{-2}) Ticks box for 10.6 to 15.9 years **cao** ✓	3	For the 1st and 2nd marking points accept working based on 9.0×10^{-2} W m^{-2} instead of 4.0×10^{-2} W m^{-2}: At 15.9 years, intensity = 1.1×10^{-2} W m^{-2} ✓ At 21.2 years, intensity 5.6×10^{-3} W m^{-2} ✓

12.5	The idea that the high energy electrons would have insufficient penetrative power to reach the bottom of the box (absorbed by box and/or contents) wtte ✓	1	Not just insufficient penetrative power.

Question	**Key**
13	**A**
14	**D**
15	**B**
16	**C**
17	**A**
18	**D**

19	**D**
20	**C**
21	**A**
22	**D**
23	**B**
24	**C**
25	**A**
26	**A**