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PHYSICS

PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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226XPH01/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

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	Radiation not coming from the source being investigated. ✓	1	Condone radiation all around us or from the surroundings or always present. Allow radiation from the environment Do not allow examples of sources of background radiation. Do not accept limiting answers e.g. “radiation in the environment from cosmic rays”; “radiation that is naturally in the environment”

Question	Marking guidance	Mark	Comments
01.2	Named waste/leaked material from nuclear power stations or radioisotopes used in medicine or food processing ✓	1	A named origin on its own is not sufficient, some detail is required.

Total		**2**

Question	Marking guidance	Mark	Comments
2	11 and 5✓ ν ✓	2	Accept v or ν_e but not $\bar{\nu}$ Condone (electron) neutrino but not ev on its own. Condone νe
Total		**2**	

Question	Marking guidance	Mark	Comments
03.1	Positron ✓	1	Condone spelling error if meaning is clear Allow antielectron or e^+ or β^+

Question	Marking guidance	Mark	Comments
03.2	Energy of photon needs to provide at least the rest masses OR at least the rest energy ✓ of the electron and positron / of (both) particles / of particle and antiparticle ✓	2	Allow particles or products MP2 is contingent on MP1 being awarded.

Total		**3**

Question	Marking guidance	Mark	Comments
04.1	A quantity that has magnitude and direction ✓	1	Condone size for magnitude Do not accept 'value' or 'quantity' for magnitude.

Question	Marking guidance	Mark	Comments
04.2	acceleration occurs in A and does not occur in B ✓ (velocity is changing) in A (since) there is a change in direction (and velocity is a vector quantity) ✓ direction (of the velocity) is not changing in B ✓	3	The marking point can be awarded for a response anywhere in **04.2**

Total		**4**

Question	Marking guidance	Mark	Comments
05.1	The point through which a force (on the object) has no turning effect. ✓	1	Accept: the point at which all of the mass can be considered to be concentrated. Condone: the point at which an object balances. Condone a definition of the centre of gravity such as the position where the weight of the object acts.

Question	Marking guidance	Mark	Comments
05.2	Use of either $W = mg$ **or** density = $\frac{\text{mass}}{\text{volume}}$ ✓ $1940\ \text{kg m}^{-3}$ ✓	2	Do not condone use of weight ($343\ \text{N}$) for mass No sf penalty Condone 1944 or 1943 or 1942 or $1900\ \text{kg m}^{-3}$ unless $g = 10$ used.

Question	Marking guidance	Mark	Comments
05.3	Attempt to equate moments✓ One side of moment equation correct. ✓ 85.8 N ✓	3	Condone mass x distance in MP1. Expect to see $343 \times 0.300 \cos 60 = 0.600 \times F$ Condone a final answer of 86 N
Total		**6**	

Question	Marking guidance	Mark	Comments
06.1	Kinetic energy at start of the curved section is 1125 J OR Change in gravitational energy on the curved section is 863.3 J ✓ Adding their KE and GPE✓ 1988.3 J ✓	3	Accept 2 or more sf

Question	Marking guidance	Mark	Comments
06.2	Use of distance = work / force (= 2000 / 250) ✓ Distance = 8.00 m ✓	2	Allow candidate's value from **06.1** instead of 2000 J

Question	Marking guidance	Mark	Comments
06.3	(Kinetic energy of adult at the barrier = 460.8 J) Kinetic energy of adult at start of flat (= 460.8 × 10) = 4608 J ✓ Work done to friction is 4608 – 460.8 = 4147 J ✓ Friction (= 4147 / 12.5) = 332 N ✓ OR 9/4 × KE of child (2000) = 4500 J ✓ 0.1 × 4500 J = 450 J✓ Friction = (4500 – 450) / 12.5 = 324 N✓	3	If no marks are awarded, 1 mark can be awarded for calculating kinetic energy of adult at the barrier = 460.8 J Accept use of candidate's value of KE for child from **06.1**

Question	Marking guidance	Mark	Comments
06.4	The change in momentum/impulse will be the same ✓ The time (over which the person stops) will be greater ✓ The rate of change of momentum will be less ✓ Force is proportional to the rate of change of momentum so the force will be less ✓ OR Work will be the same✓ Force will be applied over a greater distance ✓ Force = work / greater distance ✓ constant work leads to lower force ✓	4	N2 approach: velocity at barrier will be the same✓ The time (over which the person stops) will be greater ✓ so acceleration is less✓ F=ma so force is less.✓ For the alternative scheme, do not credit statement of work = force × distance for third mark
Total		**12**	

Question	Marking guidance	Mark	Comments
07.1	v = (20 sin 15 =) 5.2 (5.18) m s^{-1} ✓	1	

Question	Marking guidance	Mark	Comments
07.2	Correct use of equation of uniform motion $v^2 = u^2 + 2as$ ✓ Correct substitution to give a value of 1.37 m ✓ Adds 1 m to give 2.37 m ✓	3	ecf incorrect value from **07.1** for velocity For MP1 more than half of substitutions must be correct. Condone rounding errors in MP2 Accept 2.38 m

Question	Marking guidance	Mark	Comments
07.3	Correct calculation of time to centre of the motion 0.53 s OR Calculates time to fall from centre to the ground 0.70 (0.695) s ✓ Total time of flight (= 0.52 + 0.69) = 1.22 s ✓ Horizontal distance = (v_ht = 20 cos15 × 1.22 =) 23.5 m ✓	3	If no other marks awarded, allow 1 mark for adding together their two different times of flight.

Question	Marking guidance	Mark	Comments
07.4	½ $9.3 \times 10^3 \times 0.05^2 = 11.625$ J ✓ use of ½ k × $0.05^2 = mgh$ ✓ h = 20.4(3) m ✓	3	If no other mark given, allow 1 mark for calculating the initial force from spring (465 N) Alternative MP2 (KE approach): Use of suvat and KE equation

Question	Marking guidance	Mark	Comments
07.5	In the spring: Not all of the energy stored in the spring is transferred to the ball wtte ✓ In the air: Work is done against air resistance (reducing the final PE of the ball) ✓	2	It must be clear whether answers refer to the spring or movement through the air. Alternative for MP2: Air resistance increases downwards acceleration of ball (reducing height reached).

Total		**12**

Question	Marking guidance	Mark	Comments
08.1	Charge = $79 \times 1.60 \times 10^{-19}$ ($= 1.26 \times 10^{-17}$ C) OR Mass = $197 \times 1.67 \times 10^{-27}$ ($= 3.29 \times 10^{-25}$ kg) ✓ (Specific charge = charge / mass = $1.26 \times 10^{-17} / 3.29 \times 10^{-25}$) $= 3.84 \times 10^{7}$ ✓ C kg^{-1} ✓	3	Award 1 mark for 79/197 If no marks are awarded, award 1 for specific charge = charge / mass Some working needs to be seen in order to award unit mark.

Question	Marking guidance	Mark	Comments
08.2	The count will be much less at position 2 wtte ✓	1	Less on its own is not sufficient

Question	Marking guidance	Mark	Comments
08.3	The nucleus is (very) small (compared to the distance between nuclei) ✓ The nucleus is (very) dense ✓	2	Accept the nucleus is positively charged Condone the nucleus has the same sign of charge as an alpha particle Allow most of the mass is concentrated in the nucleus but treat “nucleus has a high mass” or “lots of space between nucleus and electrons” as neutral.

Question	Marking guidance	Mark	Comments
08.4	Any pathway that shows a reduced anticlockwise angle of scattering and does not cross the original line, or equivalent description in words ✓	1	

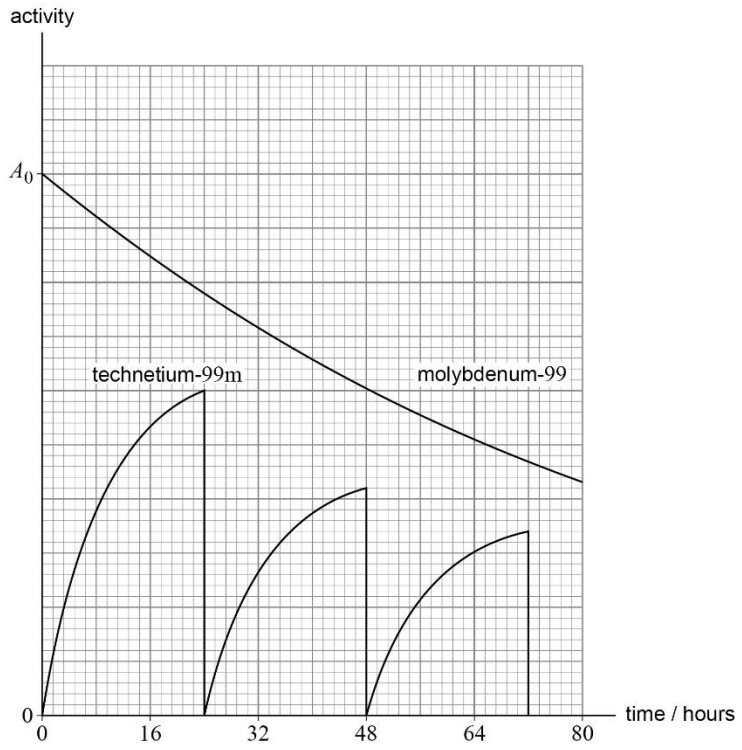
Question	Marking guidance	Mark	Comments
08.5	(Number of protons is less so) less positive charge ✓ Weaker force of (electrostatic) repulsion ✓	2	MP2 cannot be based on incorrect physics.

Total		**9**

Question	Marking guidance	Mark	Comments
09.1	Gamma ✓	1	Allow symbol

Question	Marking guidance	Mark	Comments
09.2	The generator/storage container are shielded with lead ✓ Reduces the amount of radiation that the user is exposed (to a safe level) ✓	2	Accept lead absorbs some of the gamma radiation or wtte for MP2 Accept idea that technetium cannot escape or that it is all contained

Question	Marking guidance	Mark	Comments
09.3	66 hours ✓	1	Accept 65–66 hours

Question	Marking guidance	Mark	Comments
09.4	Peaks at 48 and 72 hours ✓ Extra 2 peaks decreasing in height ✓	2	

Question	Marking guidance	Mark	Comments
09.5	The technetium should be extracted when at/near its maximum activity.✓ This is reached after 24 hours✓	2	Accept reverse argument

Total		**8**

Question	Marking guidance	Mark	Comments
10.1	Well drawn line of best fit which, starting at the origin, is initially linear and then curves smoothly ✓	1	Overall, the line should accurately follow the trend of the points with an even scatter of points about the line Penalise multiple or thick lines

Question	Marking guidance	Mark	Comments
10.2	Clear attempt to measure the gradient at or below 1.4×10^{8} Pa ✓ Answer in the range $(0.9–1.1) \times 10^{11}$ ✓	2	Do not penalise sf in MP1. There must be some evidence that a single point has not been used. Final answer 2 or 3 sf only

Question	Marking guidance	Mark	Comments
10.3	Establish the difference maximum and minimum gradients (consistent with the points) (along the linear part of the graph).✓	1	OWTTE Allow discussion involving 'worst fit' line Allow difference between the worst of max OR min gradient and the best fit line gradient.

Question	Marking guidance	Mark	Comments
10.4	Strain calculated = 4×10^{-3} ✓ Estimate for number of 'cm' squares in the range 106–112 OR Clear attempt to convert squares to $\mathrm{J\,m^{-3}}$ seen ✓ Volume = $1.5 \times 0.397 \times 10^{-6}$ ✓ Answer in the range 0.30–0.35 (J) ✓	4	26–28 if '2 cm' squares counted. Allow ecf for square count if wrong strain value used. Unit required for final answer but no sf penalty Look for 5.1 to 5.8×10^{5} $\mathrm{Jm^{-3}}$ if worked out directly. Condone pot error in MP3 Candidates who use a strain value of 6×10^{-3} can be awarded 3 marks: Expect to see 184 to 191 'cm' squares or 45 to 48 '2 cm' squares to give 9.0 to 9.6×10^{5} $\mathrm{J\,m^{-3}}$ And answer in range 0.53 to 0.58 J
Total		**8**	

Question	Key	Answer
11	**C**	$\text{kg m}^2\text{ s}^{-2}$
12	**B**	kinetic energy displacement
13	**B**	$F = T \times \sin\theta$
14	**B**	larger in P1 than in P2 larger in P1 than in P2
15	**C**	40 m s^{-1}
16	**B**	elastic elastic
17	**D**	5 N s
18	**D**	$20P$
19	**A**	$^{22}_{10}\text{Ne}$ $^{23}_{11}\text{Na}$
20	**D**	$e^- + e^+ \rightarrow \gamma + \gamma$
21	**A**	can be deflected by a strong magnetic field.
22	**C**	60 counts per minute
23	**C**	50 counts per minute

24	**A**