OXFORD

INTERNATIONAL
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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 aqa.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	0.28 (m s^{-1}) ✓	1	Not 1 sf
01.2	1000 (kg m^{-3}) ✓	1	
Total		**2**	

Question	Marking guidance	Mark	Comments
02.1	Distance = $2\pi r$ OR πd seen OR Speed = $\frac{\text{distance}}{\text{time}}$ ✓ Speed = 11 (m s^{-1}) ✓ cao	2	Award both marks for the correct answer
02.2	Velocity = 0 (m s^{-1}) ✓	1	
02.3	Displacement = $2r$ = 84 m ✓ Velocity = 7.0 (m s^{-1}) ✓	2	Award both marks for the correct answer Condone 1 sf in final answer
Total		**5**	

Question	Marking guidance	Mark	Comments
03.1	-1.6×10^{-19} (C) ✓ 1.67×10^{-27} (kg) ✓ $(-)9.58 \times 10^{7}$ (C kg^{-1}) ✓	2	Numbers all correct – 1 mark Accept 1.66×10^{-27} (kg) Numbers all correct and charge given as negative – 2 marks
03.2	A particle and its (corresponding) antiparticle (or particle–antiparticle pair) ✓ Cease to exist/are destroyed OWTTE ✓ Two (gamma) photons are produced ✓ The photons have the same total energy as the mass–energy of the particles **or** momentum is conserved ✓	4	Accept a proton and an antiproton but not a particle and an antiparticle Allow "vanished" and "eliminated"; do not allow "annihilated" Allow "converts their (rest) mass into energy"
Total		**6**	

Question	Marking guidance	Mark	Comments
04.1	$\frac{\text{extension}}{\text{unstretched length}}$	1	Accept $\frac{\text{extension}}{\text{original length}}$ OR $\frac{l}{\Delta l}$ with symbols defined OR extension per unit original length
04.2	Correctly indicated limit of proportionality (where the line stops being straight), either on the curve or on the y-axis labelled L ✓	1	
04.3	First property correct✓ Second property correct ✓ Correct explanation of one property✓	Max 3	Accept references to breaking stress, Young modulus, stiffness, elastic limit, limit of proportionality, yield Explanations must be in appropriate technical language; do not accept “easier to break”
Total		**5**	

Question	Marking guidance	Mark	Comments
05.1	Any mention of neutrino (1 mark) ✓ Electron-neutrino OR ν_e (2 marks) ✓	2	$\bar{\nu_e}$ OR anti-electron neutrino scores max 1
05.2	Two half-lives so the $\mathrm{F}{-}18$ has quartered ✓ $\frac{25\%}{75\%} = 0.33$ ✓	2	Accept 1:3, 33%, $\frac{1}{3}$ Do not credit $\frac{1}{4}$ without working seen
05.3	The activity (of the sample) must be large enough ✓ to be distinguishable from background radiation **OR** so that it is not all absorbed by the body (OWTTE) ✓	2	Condone idea that too much of the $\mathrm{F}{-}18$ will have decayed (in a short time) for MP1
Total		**6**	

Question	Marking guidance	Mark	Comments
06.1	Equal in magnitude **AND** Parallel **or** offset **or** opposite in direction ✓	1	Accept: A system with a resultant torque/moment but no resultant force
06.2	Force = 1.2/0.032 = 37.5 (N) ✓	1	Not 1 sf
06.3	% uncertainty on the diameter: 6(.25)% ✓ candidate % uncertainty for diameter + 10% (=16%) ✓	2	Accept 16.25 in this case
Total		**4**	

Question	Marking guidance	Mark	Comments
07.1	$5.5 \times 10^6 \times 1.6 \times 10^{-19}$ seen OR 8.8×10^{-13} (J) seen ✓ Use of $E_k = \frac{1}{2}mv^2$ ✓ Leading to 1.63×10^7 m s^{-1} ✓	3	"Use of" means correct rearrangement or substitution Value given to at least 3 sf
07.2	Substitution into $m_x v_x = (-)m_\alpha v_\alpha$ $(3.6 \times 10^{-25} \times v_x = 6.6 \times 10^{-27} \times 1.63 \times 10^7)$ **OR** $218v_x = 4v_\alpha$ ✓ $v_x = 3.0 \times 10^5$ m s^{-1} ✓	2	Condone POT error in MP1 1.6×10^7 m s^{-1} gives 2.9×10^5 (m s^{-1})
07.3	Conservation of momentum or energy discussed ✓ Third particle carries some energy or momentum ✓ Each decay (of a given nuclide) has the same energy ✓ Mention of components of momentum (perpendicular to direction of recoil) ✓	Max 3	Accept converse
Total		**8**	

Question	Marking guidance	Mark	Comments
08.1	(Horizontal u =) 48cos 15 seen (= 46.4 m s^{-1}) ✓ (D = $u$cos15 × t = 46.4 × 3.0 =) 139 (m) ✓	2	Accept 138 m if 46 m s^{-1} is used.
08.2	48sin 15 leading to 12.4 m s^{-1}	1	Must be given to at least 3sf
08.3	Use of $s = ut + ½ at^2$ (*e.g.* (12.4×3.0) + 0.5×(–)9.8×3.0^2) ✓ = –6.9 m ✓ height h = (12 – their 6.9) = 5.1 m ✓	3	Allow methods that involve a combination of the other *suvat* equations Accept any clear correct alternative use of the uniform acceleration equations
Total		**6**	

Question	Marking guidance	Mark	Comments
09.1	Work done is force × distance ✓ travelled in the direction of the force ✓	2	Accept $F \times s$ with symbols defined for MP1 Accept $F \times s \times \cos\theta$ with symbols defined for both marks
09.2	use of $(m)gh = \frac{1}{2}(m)v^2$ $(9.81 \times 5.5 = 0.5v^2)$ **OR** use of $mg \sin\theta = ma$ with $v^2 = u^2 + 2as$ where a = acceleration down slope and $s = 17.5$ m ✓ $v = 10.4$ m s^{-1} ✓	2	Do not accept use of $v^2 = u^2 + 2as$ where $g = 9.81$ and $s = 5.5$ m answer to at least 3sf for second mark

09.3	Finds one energy correctly ✓ attempts to find difference in energies✓ uses friction force = work done/distance ✓ 160 OR 162 (N) cao ✓	4	E.g. Predicted kinetic energy = $0.5mv_{predicted}^2$ $= 0.5(75)(10.4^2)$ (= 4056 J) True kinetic energy = $0.5mv_{true}^2$ $0.5(75)(5.8^2)$ (= 1261 J) Friction force = $\frac{(4056-1261)}{17.2}$ Alternative for first mark: $mgh = 75(9.81)(5.5) = 4047$ J Work done = 2795 (J) scores MP1 and MP2
Total		**8**	

Question	Marking guidance	Mark	Comments
10.1	0.8 and 1.9 ✓cao	1	1 dp for both answers
10.2	Both points accurately plotted ✓ Well-drawn line of best fit ✓	2	Points must be plotted within ½ small square of true position. The line of best fit should follow the trend of the points with an even scatter of points on either side of the line. Do not allow thick line or plots.
10.3	Points taken from large gradient triangle ✓ k calculated to be in the range $(1.08–1.17) \times 10^3$ ✓	2	Triangle hypotenuse must be greater than ½ length of candidate line. Gradient readings must be notated on the graph in some way for MP1. Accept 2 or 3 sf only
10.4	Use of $E = k\,L/A$ **OR** $E = \frac{FL}{A\Delta L}$✓ Young modulus = $(1.08 – 1.17) \times 10^{11}$ (Pa) ✓	2	ecf and no sf penalty
Total		**7**	

Question	Marking guidance	Mark	Comments
11.1	reasonable precaution ✓ comments on precaution in terms of irradiation or contamination ✓	2	*Eg:* Use long tongs ✓ To reduce irradiation to the body ✓ **OR** Wear gloves *or* wash hands after use ✓ To reduce chance of contamination ✓ **OR** Minimise the time the source is out of its container ✓ To reduce irradiation to the body ✓
11.2	23 ± 2 counts per minute ✓	1	Expect to see a smooth curve drawn on the graph
11.3	Construction of best-fit line✓ Deduct background OR Halve assigned corrected count rate✓ Answer within range (1.3 ± 0.3) minutes ✓	3	Ecf from 11.2 Time is 78 ± 18 s Award max 2 for candidate who treats the data as already corrected for background, ie ≈1.9 s

11.4	Named suitable counting apparatus✓ Operated with the source not present✓ Method to ensure accuracy of measurement✓	3	Eg Geiger(-Müller) counter/tube/ ratemeter scaler counter E.g reading for long time repeat and average readings

Total		**9**

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