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PHYSICS

PH01

Unit 1 Mechanics, materials and atoms

Mark scheme

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231XPH01/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	Answers	Additional comments/Guidelines	Mark	AO
01.1	The idea that vectors have direction and scalars do not ✓	Reject any suggestion vectors do not have a magnitude.	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	Any correct example of a vector quantity AND any correct example of a scalar quantity ✓		1	AO1
Total			**2**	

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	The energy equivalent of the mass of the particle when it is stationary/ its kinetic energy is zero.	Accept the product of mass and speed of light squared; only accept formula with terms defined.	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	MAX 3 The electron and positron will <u>annihilate</u> ✓ Two gamma photons produced ✓ (Gamma) photons travel in opposite directions ✓ Each with an energy of $0.851\ \text{MeV}$ ✓	For MP4 accept a descriptive statement that the sum of the gamma photon energies is equal to the sum of the rest energies plus the sum of the kinetic energies For MP4 accept energy value in J.	3	2 × AO2 1 × AO3
Total			**4**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Count rate – background count rate ✓	Reject answers that give no idea of rate.	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	Any half value taken and seen on graph ✓ Mean of at least two determinations with answer between 5.6 and 5.7 (h) ✓	For MP1 allow use of activity equation to determine half life.	2	AO3
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	(Experiment must be conducted in vacuum) so that alpha particles reach gold foil OR (In a vaccuum) the alpha particles are not stopped by air ✓	Accept reference to range if correct. Accept alternatives for 'stopped'.	1	AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Mention of scintillation	Allow description of scintillation. 'Photons produced' is insufficient for idea of flashes of light. Treat references to other detectors/materials as neutral.	1	AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	Idea that angle (relative to incident direction) and number of particles detected (at that angle) are measured ✓	Accept number of flashes (per second) at different angles	1	AO4
Total			**3**	

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	Neutron (in the nucleus) decays ✓ …to form a proton and an electron (and an electron antineutrino) ✓	The first mark point is for the idea that a neutron changes Accept beta particle for electron Accept symbols Equation gets both marks. Condone missing/incorrect neutrino.	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	$A = 90; Z = 39$ cao ✓	Both answers must be correct for the mark to be awarded	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	MAX 2 measurements showed a range of (kinetic) energies/ energies up to a maximum ✓ idea that the energy released in each decay should be the same... ✓ ...the (anti) neutrino was hypothesised to account for the "missing" energy ✓	Allow MP3 if energy of neutrino is linked to the law of conservation of energy.	2	1 × AO1 1 × AO2
Total			**5**	

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Use of $F = k\Delta l$ ✓ Use of $F = mg$ ✓ 470 (N m^{-1}) ✓	"Use of" means by manipulation or substitution. Accept answers that round to 470 Missing "x 13" is penalised in MP3	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	Use of $E = \frac{1}{2}F\Delta l$ ✓ 6.5 (J) ✓ ecf for their k from **06.1**	Accept use of $E = \frac{1}{2}k\Delta l^2$	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	Idea that plates will compress spring more ✓ ... so that plates (will not be able to be removed as they) will be below the top of the 'well' ✓		2	AO3
Total			**7**	

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Uses $E_p = mgh$ ✓ 180 (m) ✓	In MP1 allow one transcription error for value of mass or E_p. If more than 2 sf only accept answers that round to 176 (m)	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	Uses $E_k = \frac{1}{2}mv^2$ to attempt to find initial kinetic energy ✓ Uses final KE = their initial KE + work done + GPE ✓ $81(.4)$ (m s^{-1}) ✓	Look for 344 J In MP2 tolerate omission of one of the terms on the right hand side of the equation	3	2 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	Idea that not all of the work done by the falcon goes to increasing its kinetic energy ✓ (wings disturb the air so) some of the work will increase kinetic energy of the air OR Work is done heating the air OR Energy is transferred due to air resistance/drag ✓	Allow idea that work is done against air resistance/drag	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	Idea that before and after an interaction momentum is the same for a closed system/ in the absence of external forces ✓	Condone collision for interaction	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Uses momentum = mv ✓ Recognisable conservation of momentum equation with some substitution Or one initial momentum calculated correctly (27.5 or 2.16) ✓ 23(.2) (m s^{-1}) ✓		3	2 × AO2 1 × AO3
Total			**11**	

Question	Answers	Additional comments/Guidelines	Mark	AO
08.1	**P** = lift **Q** = drag **R** = weight **S** = thrust (owtte) Any 2 correct gets 1 mark ✓ All correct gets 2 marks ✓	Allow alternatives terms Do not accept 'gravity' for R.	2	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.2	MAX 3 speed increases or aircraft accelerates (initially)... ✓ air resistance (Q) increases as speed increases ✓ aircraft acquires a new constant speed when air resistance matches increased value of **S** ✓ aircraft climbs as lift increases (as it depends on the speed of the air over the aerofoil) ✓	In MP2 reference to speed increasing can be seen in MP1.	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
08.3	use of resultant force $= 9870 - 9600\ (= 270)$ (N) ✓ use of $m = \frac{W}{g}$ or 979 (kg) or 980 (kg) ✓ Use of $F = ma$ ✓ 0.276 (m s^{-2}) to at least 3 sf m s^{-2} ✓	Need to see a subject for each of MP1, MP2 and MP3 Calculator value is 0.275906 MP4 requires use of 9.81 m s^{-2} for g	4	1 × AO1 2 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
08.4	Use of $v^2 = u^2 + 2as$ ✓ $16.7\ \text{m s}^{-1}$ to at least 3 sf ✓	Allow combining suvat equations Must see equation for MP1. Accept 16.5 or 16.6 Allow energy approach.	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
08.5	Use of Pythagoras ✓ $72\ (\text{m s}^{-1})$ ✓ Use of $\tan^{-1}(\frac{16.6}{70})$ ✓ 13° ✓	Expect to see $70^2 + 16.6^2$ Accept use of tan to find the angle (2 marks) followed by any appropriate trig to find magnitude of resultant velocity (2 marks) Use of the 'show that' value gives 14°	4	1 × AO2 3 × AO3
Total			**15**	

Question	Answers	Additional comments/Guidelines	Mark	AO
09.1	Uses $W = Fd$ ✓ 720×2.4 leading to 1728 (J) to at least 3 sf ✓	for MP2 must see 2.4 or 2×1.2 written.	2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
09.2	Uses efficiency= $\frac{\text{useful work done}}{\text{total energy input}}$ or useful work done = $140 \times 9.81 \times 1.2$ ✓ 0.95 or 95 % ✓ ecf	97% or 0.97 if candidate uses 1700 (from **09.1**)	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
09.3	Calculate difference between work done on engine and work done by operator. ✓ Uses difference in work done = force x distance to determine weight of pulley. ✓	MP2 is contingent on correct method for MP1 Work done lifting pulley = candidate's **09.1** – 1650 (Weight = $\frac{80}{1.2}$) = 67 (N) ecf from **09.2** Allow for rounding Allow alternatives e.g. approach to say that 140 N = 0.954 × total weight of engine and bottom pulley	2	1 × AO1 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
09.4	Uses $\varepsilon = \frac{\Delta L}{L}$ and $\sigma = \frac{F}{A}$ and Young modulus $= \frac{\sigma}{\varepsilon}$ OR $e = \frac{FL}{EA}$ ✓ 2.3×10^{-2} (m) ✓	Award MP1 and MP2 for candidate who goes directly to $e = \frac{FL}{EA}$	2	1 × AO1 1 × AO2
Total			**8**	

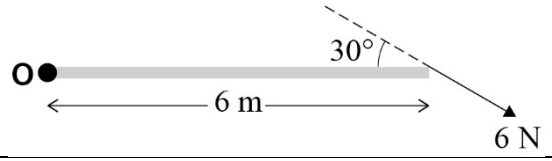
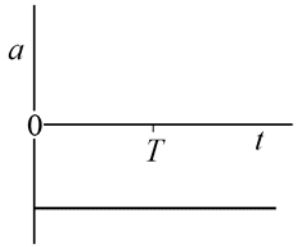
Question	Answers	Additional comments/Guidelines	Mark	AO
10.1	$Mga + wb/2 = Fb$ seen ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
10.2	Good best-fit line ✓	Look for intercept of between 1.0 and 1.2 (N) The line should accurately follow the trend of the points with an even scatter of points either side of the line.	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
10.3	Large triangle drawn (or implied with values taken from the line of best fit) to find the gradient ✓ Gradient in the range 8.0 to 8.3 ✓ Correct calculation leading to M in the range 0.65 to 0.68 (kg) ✓	Alternative for MP1 and MP2 using the equation for the line: MP1 choose points from large distance apart from the line of best fit. MP2 Two simultaneous equations correct	3	1 × AO2 1 × AO3 1 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
10.4	Intercept accurately read from graph in the range of 1.0 to 1.2 (N) OR doubles intercept to find w ✓ Zero error in range -0.2 to -0.6 (N) ✓	Allow consistent of point on the line. Accept 1 dp only	2	1 × AO3 1 × AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
10.5	No effect because gradient is not affected by zero error OR the same error affects every measurement of F ✓		1	AO4
Total			**8**	

Question	Key	Answer	AO
11	**C**	0.1%	AO2
12	**C**	a ball falling vertically at terminal speed	AO1
13	**B**		AO3
14	**C**	moment $\quad$ kg m^2 s^{-2}	AO1
15	**A**		AO3
16	**D**	The gradient of a distance–time graph is equivalent to speed.	AO1
17	**A**	increasing the weight of the ball	AO2
18	**B**	the gravitational force of the Earth on a box and the reaction of the box on the Earth	AO3
19	**A**	140 N s	AO3
20	**D**	$12t$.	AO2
21	**D**	0.37 m	AO2

22	**B**	2	AO1
23	**B**	4.5 h	AO1
24	**D**	gamma Gamma emissions can escape from the patient and be detected outside.	AO1