AQA

AS
PHYSICS
7407/1

Paper 1

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

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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/Guidance	Mark	ID details
01.1	Use of specific charge = charge / mass eg 1.60×10^{-19} / $(1.67(3) \times 10^{-27} + 1.67(5) \times 10^{-27})$ ✓ 4.8×10^{7} (C kg^{-1}) ✓	Any substitution or equation suggesting specific charge = charge/mass gains the first mark. Use of ½ × proton specific charge gains full credit.	2	AO2.1f
01.2	Pion ✓		1	AO1.1a
01.3	(Short-range) attraction up to about 3 fm ✓ (Very short-range) repulsion closer than 0.5 fm ✓ Prevent proton and neutron moving closer or further apart ✓	Allow 1-5 fm. Allow 0.5-1 fm. Allow 1 mark for stating both a value at which attraction occurs and a value at which repulsion occurs. MP3 is for a suggestion that an equilibrium point exists or that nucleus doesn't collapse. Any suggestion of electric forces between proton and neutron loses MP3.	3	AO1.1a AO2.1a

01.4	Correct description of alpha decay **OR** Consequence of alpha decay ✓ Correct description of electron capture **OR** Consequence of electron capture ✓ Correct description of beta decay, with explicit conclusion that this mode is valid ✓	Either MP1 or MP2 lost if answer suggests that decay mode is valid. Accept answers in terms of A and Z, or that use accepted nomenclature eg $^{4}_{2}\mathrm{He}$. Condone absence of antineutrino.	3	AO3.1b

Total			**9**

Question	Answers	Additional Comments/Guidance	Mark	ID details
02.1	Use of $P=VI$ or $P=I^2R$ or $\mathrm{P}=\frac{\mathrm{V}^2}{\mathrm{R}}$ ✓ Use of $\Delta W=P\Delta t$ ✓ **OR** Use of $\Delta Q=I\Delta t$ ✓ Use of $W=VQ$ ✓ 2.1×10^5 (J) ✓	2 marks if time not converted to seconds (3600 J)	3	AO2.1g

02.2	Use of $\rho = \frac{RA}{L}$ ✓ 0.91 (m) + appropriate conclusion ✓	Allow calculation of R, ρ or A assuming 0.85 m length, and conclusion for second mark: R = $3.5\ \Omega$ A = 4.6×10^{-6} m^2 ρ = $2.1 \times 10^{-5}\ \Omega$ m	2	

02.3	$350\ (\Omega)$ ✓ Max 3 from: ✓ ✓ ✓ 15 (mA) read from graph Conversion to A pd across resistor = $7.4 - 2.2 = 5.2$ V Use of $R = \frac{V}{I}$	Full marks for correct answer Allow 14.5 to 15.5 Do not allow gradient calculation for R.	4	AO3.1a AO2.1h

Total			**9**

Question	Answers	Additional Comments/Guidance	Mark	ID details
03.1	Attempt to calculate weight of cage eg $1.2 \times 10^3 \times 9.81$ or 1.18×10^4 seen ✓ Attempt to find vertical component of tension T_V in one rope eg $3.7 \times 10^4 \cos 20$ or 3.5×10^4 seen ✓ Uses F = twice their tension – their weight ✓ 5.8×10^4 (N) ✓	If weight not calculated, allow MP3 for doubling their tension or their resolved component	4	AO2.1b
03.2	Use of $F = ma$ with 6×10^4 N or their 03.1 ✓ 50 (m s^{-2}) ✓	Allow 48 (m s^{-2}).	2	AO2.1f
03.3	Calculation of length of rope eg $35/\cos 20$ or 37.2 seen ✓ Calculation of extension of one rope or calculation of total extension of both ropes eg their length–24 or 13.2 or 26.4 seen ✓ Use of $E = ½ F\Delta L$ e.g. $½ \times 3.7 \times 10^4 \times 13.2 = 2.44 \times 10^5$ (J) ✓ 4.9×10^5 (J) ✓	Allow methods using $F=k\Delta L$ and $E = ½ k\Delta L^2$	4	AO2.1b

Question	Answers	Additional Comments/Guidance	Mark	ID details
03.4	Use of E lost = ΔE_p eg $1.2 \times 10^3 \times 9.81 \times h = 5 \times 10^5$ ✓ $h = 42$ (m) ✓ $42 < 50$ (m), so claim not justified ✓ **OR** Use of $\Delta E_p = mg\Delta h$ with 50 m eg $1.2 \times 10^3 \times 9.81 \times 50$ ✓ $\Delta E_p = 5.9 \times 10^5$ (J) ✓ $5.9 \times 10^5 > 5 \times 10^5$, so claim not justified ✓	No credit for use of suvat in either method and MP3 must come from correct Physics. First method is for calculation of max h and comparison with 50 m. Allow h from their 03.3 if it rounds to 5×10^5 Second method is for calculation of ΔE_p and comparison with E.	3	AO3.1b
03.5	90 km h^{-1} = 25 m s^{-1} ✓ Use of $E_k = ½ mv^2$ eg ½ × 1.2×10^3 × (their v)^2 ✓ 3.8×10^5 (J) ✓	The conversion mark stands alone. ecf for their v	1 2	AO1.1b

03.6	If their $E_k > 5 \times 10^5$, claim is unjustified **OR** If their $E_k < 5 \times 10^5$, claim may be justified depending on gain in E_p or losses due to resistive forces ✓		1	AO3.1b

Total			**17**

Question	Answers	Additional Comments/Guidance	Mark	ID details
04.1	Max 2 from: ✓ ✓ (Because) the refractive index of water is greater than air (and) the angle of incidence is greater than the critical angle <u>total internal reflection</u> (of laser beam) occurs	Allow optical density for refractive index. Allow answer given as a diagram.	2	2 × AO1.1a
04.2	Use of $n = \frac{c}{c_s}$ eg $c_s = \frac{3.00 \times 10^8}{1.33}$ ✓ 2.26×10^8 (m s^{-1}) ✓ 3 sf answer from some relevant working ✓		3	AO1.1b
04.3	49 (°) ✓	Do not allow 1 sf answer.	1	AO1.1b

<table>
<tr><th>Question</th><th>Answers</th><th>Additional Comments/Guidance</th><th>Mark</th><th>ID details</th></tr>
<tr>
<td>04.4</td>
<td>
The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the ‘Mark Scheme Instructions’ document should be used to assist in marking this question
<table>
<tr><th>Mark</th><th>Criteria</th></tr>
<tr><td>6</td><td>Both functions and dispersion problems discussed. No significant error or inconsistency.</td></tr>
<tr><td>5</td><td>Both functions and dispersion problems discussed. There may be some significant error or inconsistency.</td></tr>
<tr><td>4</td><td>Functions or dispersion problems described. No significant error or inconsistency.</td></tr>
<tr><td>3</td><td>Functions or dispersion problems described. There may be some significant error or inconsistency.</td></tr>
<tr><td>2</td><td>Both X and Y named and a function of one given; or
A function of X and Y given, but only one named</td></tr>
<tr><td>1</td><td>X and Y identified by name or function</td></tr>
<tr><td>0</td><td>No relevant analysis</td></tr>
</table>
Level 2 max if dispersion modes confused in descriptions.
</td>
<td>
The following statements are likely to be present.

<u>Names</u>
X is Core
Y is Cladding

<u>Functions</u>
X:
Propagates/Guides the wave/light
By TIR
(with) low attenuation/absorption
Refractive index of core > cladding

Y:
Protects core from damage
Prevents cross talk between touching fibres
Provides ‘clean’ boundary for TIR

<u>Dispersion problems</u>
Both: Cause pulse broadening/limited bandwidth
Material: different wavelengths have different speeds due to different refractive indices within the core – use monochromatic beam
Modal: different paths have different lengths so effective time along fibre differs – use single-mode fibre (narrow core/small Δn between core and cladding)
</td>
<td>6</td>
<td>3 × AO1.1a
3 × AO2.1a</td>
</tr>
</table>

Question	Answers	Additional Comments/Guidance	Mark	ID details
04.5	Max 2 from: ✓ ✓ Light may encounter impurities at different positions/angles Light may encounter different number of impurities Light may encounter different sizes of impurities Angle of incidence may become less than critical angle Bending may cause cracks in the core/cladding Light may be refracted (more/differently)	Allow responses shown on diagram. Allow "different impurities". Don't accept "critical angle changes"	2	AO3
04.6	Transverse – displacement/oscillations/vibrations at right angles/(perpendicular) to direction of energy transfer ✓ Longitudinal – displacement/oscillations/vibrations along/(parallel to) direction of energy transfer ✓	Condone "direction of wave" once. 1 mark for correct reference to difference in polarisation. Treat references to P and S wave as neutral.	2	AO1.1a
Total			**16**	

Question	Answers	Additional Comments/Guidance	Mark	ID details
05.1	0.56 (N) ✓		1	AO2.1h
05.2	Definition of couple as two <u>equal</u> forces acting in opposite directions ✓ Forces (are equal but) don't act in opposite directions, therefore it is not correct ✓	Moment of a couple is independent of the point about which moments are taken ✓ Combined moment of the two forces depends on the point about which moments are taken, therefore not correct. ✓	2	AO2.1c
05.3	Use of total upward force = total downward force eg $0.87 + 0.62 = 1.12 + W$ ✓ 0.32 (N) ✓ Attempt to use Principle of Moments ✓ 0.14 (m) ✓	1 mark for any attempt to equate upward and downward forces. Response may be on diagram. Allow MP4 if (their W) × (their d) = 0.0448	4	AO2.1d
05.4	Readings (on A and B) would be the same/1.44 (N) ✓ (Because) total downwards force/weight is same **OR** All (perpendicular) distances affected by the same factor (cos θ) ✓		2	AO3.1b
Total			**9**	

Question	Answers	Additional Comments/Guidance	Mark	ID details
06.1	Particle with equal (rest) mass/energy ✓ but <u>opposite</u> charge/baryon number/lepton number ✓		2	AO1.1a
06.2	Antiproton ✓ Positron ✓	Do not accept antielectron for positron	2	AO1.1a
06.3	Rest energy of positron (0.510999) <u>and</u> antiproton (938.257) quoted, or 938.768 (MeV) seen ✓ Multiplies by 1.6 ✓ 1.5×10^{-10} (J) ✓	Allow valid use of $E=mc^2$. Allow any power of ten Allow credit for 3.0×10^{-10} (J) for proton–antiproton and electron–positron production	3	AO2.1f
06.4	Max 3 ✓ ✓ ✓ Idea that (atomic) energy levels/states are discrete, or (emitted) photon energy is discrete Idea that a photon is produced by electrons/atoms moving to <u>lower</u> energy levels/states Idea that wavelength/frequency relates to photon energy/ΔE Idea that different wavelengths/frequencies are produced	Allow light/radiation for "photon" May see equation relating ΔE to f or λ	3	AO1.1a
Total			**10**	