AQA

AS
PHYSICS

7407/2 Paper 2

Mark scheme

7407

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Version 1.0: Final

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

Physics - Mark scheme instructions to examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can usually be given for a correct numerical answer without working shown unless the question states 'Show your working'. However, if a correct numerical answer can be evaluated from incorrect physics then working will be required. The mark scheme will indicate both this and the credit (if any) that can be allowed for the incorrect approach.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

A calculation must be followed through to answer in decimal form. An answer in surd form is never acceptable for the final (evaluation) mark in a calculation and will therefore generally be denied one mark.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are likely to be restricted to calculation questions and should be shown by the abbreviation ECF or *conseq* in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited (eg fizix) **unless** there is a possible confusion (eg defraction/refraction) with another technical term.

3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.7 Ignore / Insufficient / Do <u>not</u> allow

'Ignore' or 'insufficient' is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

'Do **not** allow' means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.8 Significant figure penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the **final** answer in a calculation to a specified number of significant figures (sf). This will generally be assessed to be the number of sf of the datum with the least number of sf from which the answer is determined. The mark scheme will give the range of sf that are acceptable but this will normally be the sf of the datum (or this sf -1).
The need for a consideration will be indicated in the question by the use of 'Give your answer to an appropriate number of significant figures'. An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark.

3.9 Unit penalties

An A-level paper may contain up to 2 marks (1 mark for AS) that are contingent on the candidate quoting the correct unit for the answer to a calculation. The need for a unit to be quoted will be indicated in the question by the use of 'State an appropriate SI unit for your answer '. Unit answers will be expected to appear in the most commonly agreed form for the calculation concerned; strings of fundamental (base) units would not. For example, 1 tesla and 1 weber/metre^2 would both be acceptable units for magnetic flux density but 1 kg m^2 s^{-2} A^{-1} would not.

3.10 Level of response marking instructions.

Level of response mark schemes are broken down into three levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are two 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.

Determining 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. i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2.

The exemplar materials used during standardisation will help you to determine the appropriate level. 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

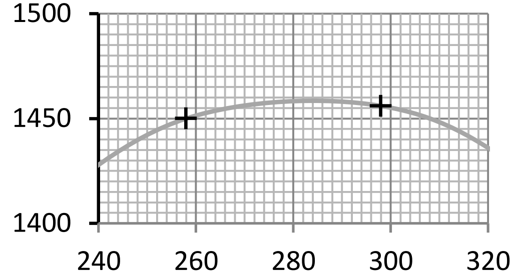
An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answer	Comments/ Guidance	Mark
01.1	extension of wire Q = 2.7 (mm) ✓	ignore any precision given eg ± 0.1 mm if > 2 sf condone if this rounds to 2.7	1
01.2	mass = 5.8 (kg) ✓	allow ce for incorrect 0.1.1 (only look at 01.1 if answer here is incorrect) allow ± 0.1 kg	1
01.3	0.51 (mm) ✓	ignore any precision given eg ± 0.005 mm	1
01.4	method 1: use of $E = \frac{\text{(tensile) stress}}{\text{(tensile) strain}}$ $_1$✓ cross-sectional area from $\frac{\pi \times d^2}{4}$ $_2$✓ (tensile) stress = $\frac{mg}{\text{CSA}}$ $_3$✓ (tensile) strain = $\frac{\Delta l}{l}$ $_4$✓	for $_1$✓ expect to see some substitution of numerical data correct use of diameter for $_2$✓; ignore power of ten error; expect CSA = 2.0(4) × 10^{-7}; allow ce from 01.3 (eg for *d* = 0.37 mm CSA = 1.0(8) × 10^{-7} m^2) penalise use of *g* = 10 N kg^{-1} value of Δl must correspond to Figure 2 value of *m*; answers to 01.1 and 01.2 are acceptable expect *l* = 1.82 m but condone 182 etc; accept mixed units for *l* and Δl	MAX 3

01.4	method 2: evidence of $\frac{\Delta l}{\Delta m}$ from Figure 2 to calculate gradient $_1$✓ $E = \frac{g \times \text{original length}}{\text{CSA} \times \text{gradient}}$ $_2$✓$_3$✓ substitution of l = 1.82 m $_4$✓ cross-sectional area from $\frac{\pi \times d^2}{4}$ $_5$✓	expect gradient between 0.45 to 0.48 mm kg^{-1} missing g loses 3✓ condone 182 etc $_4$✓ correct use of diameter for $_2$✓; ignore power of ten error; expect CSA = 2.0(4) × 10^{-7}; allow ce from 01.3 (eg for d = 0.37 mm CSA = 1.0(8) × 10^{-7} m^2)	MAX 3
	result in range 1.84 ×10^{11} to 1.91 ×10^{11} $_5$✓	condone 1.9 × 10^{11} $_5$✓ mark requires correct working and no power of ten errors: allow ce for error(s) in 01.1, 01.2 and for false/incorrect CSA (eg for d = 0.37 mm allow result in range 3.49 × 10^{11} to 3.63 ×10^{11}, 3.5 ×10^{11} or 3.6 ×10^{11})	1

01.5	(smaller diameter) produces larger extensions $_1$✓ reduces (percentage) uncertainty (in extension and in result for Young Modulus) $_2$✓	outcome and correct consequence for 2 marks, ie $_1$✓ followed by $_2$✓, $_3$✓ followed by $_4$✓ etc dna 'error' for 'uncertainty' no mark for consequence if outcome not sensible, eg 'it gets longer and reduces uncertainty' earns no mark for 'diameter smaller so uncertainty greater' award $_1$✓ (need	MAX 4
	(smaller diameter) increases (percentage) uncertainty in diameter **or** cross sectional area is smaller **or** increases		

	(percentage) uncertainty in cross sectional area $_3$✓ increases (percentage) uncertainty (in result for Young Modulus) $_4$✓	to see further mention of uncertainty to earn $_2$✓)	
	(smaller diameter) increases likelihood of wire reaching limit of proportionality **or** of wire snapping **or** reduces range of readings $_5$✓ increases (percentage) uncertainty (in result for Young Modulus) $_6$✓		

Question	Answer	Comments/ Guidance	Mark
02.1	2 missing points plotted, each to nearest 1 mm (half a grid square); points marked + or × or ⊙; reject thick points, blobs or uncircled dots ✓		1
02.2	continuous smooth best fit line through all 7 points to 1 mm ✓	allow mis-plotted points to be treated as anomalies; multiple lines or points of inflexion lose the mark	1
02.3	candidate's value from Figure 5 ± ½ grid square ✓	if multiple lines are drawn condone value if ± ½ grid square of all lines	
02.4	finding θ_N from Figure 6 is easy since the result is read off where $G = 0$ $_1$✓ **or** finding θ_N from Figure 5 is difficult since θ has a range of values for which ε is a maximum $_2$✓	accept evidence that $G = 0$ used shown on Figure 6; physics error about how Figure 6 used means no credit for any further valid comment about Figure 5 accept 'curve is shallow at peak' for $_2$✓	MAX 1
02.5	method: correctly determines gradient of Figure 6 **or** uses gradient result with any point on line to determine (vertical) intercept $_1$✓	gradient values in the range –0.040 to –0.034 for $_1$✓ (minus sign essential) for $_1$✓ allow the substitution of at least one pair of correct values of G and θ into $G = \beta\theta + \alpha$ to obtain α using	2

	result in range 9.8 to 10.9 ₂✓	simultaneous equations condone 2sf '10' for ₂✓	

02.6	full scale pd = 100 × 1000 = 100000 or 10^5 μV ✓	allow 100 mV or 0.1 V if μV deleted from answer line ✓	1

02.7	idea that resolution of the meter is not satisfactory ₁✓ because the largest pd that will be measured is less than 1500 μV **or** only uses 1.5% of the range **or** pd across meter at full-scale deflection ÷ divisions = $\frac{10^5}{50}$ = 2000 μV per division ₂✓	condone use of 'sensitivity' or 'precision' for 'resolution'; ignore 'meter is not accurate' allow 'hard to tell different readings apart' for ₂✓ allow ce for incorrect 02.6 allow 'unable to measure to nearest <u>micro</u>volt' allow 'resolution of scale should be 1 μV'	2

Question	Answer	Comments/ Guidance	Mark
03.1	use of $V = \frac{4}{3}\pi r^3$ to give $V = \frac{4}{3}\pi(2.5\times10^{-2})^3$ ✓ = 6.5 x 10^{-5} m^3 use of $\rho = \frac{m}{V}$ to give $m = \rho V$ = 8030 x 6.5 x 10^{-5} ✓ = 0.53 kg use of $W = mg$ to give W = 0.53 x 9.81 = 5.2 (N) ✓	the first mark is for making some attempt to calculate the volume; ignore power of ten errors. the second mark is for the correct substitution or for the calculation of mass the third mark is for going on to calculate the weight. allow ce for incorrect volume or mass but 2 errors = 0/3 no sf penalty but g = 10 N kg $^{-1}$ loses mark	3
03.2	distance of line of action of weight to pivot = (0.120 + 0.025) = 0.145 m ✓ moment = force x distance = 5.2 × 0.145 = 0.75 ✓ unit Nm ✓	the first mark is for identifying that the weight of the ball will act through its centre; use of 0.12 m loses this mark the second is for correctly calculating the moment; allow ce for wrong distance; condone force = 5 N (which leads to 0.725) allow suitable unit consistent with calculation, eg N cm reject 'nm' or 'NM' etc	3
03.3	taking moments about the pivot clockwise moment from spring = anticlockwise moment from ball	allow ce from 03.2 the first mark is for the use of the moment equation the second mark is for calculating the force on the spring;	3

	F x 0.080 = 0.75 ✓ F = 9.4 N ✓ use of $F = kx$ to give $x = \frac{F}{k} = \frac{9.4}{100}$ = 0.094 m ✓	condone 9.35 and 9.3 the third mark is for calculating the extension; allow calculation in cm allow ce from the second mark ie use of wrong force; condone 1 sf 0.09 m if (1 sf) 5 N used in 03.2	

03.4	the line / pen (initially) moves up; ignore subsequent motion ✓ (the downwards acceleration of the ball is much less than that of the frame and) the ball does not move (very far in the time taken for the frame to move down) ✓	the first mark is for stating the correct direction of the line / pen; allow 'diagonally up', 'up then down' but reject 'up and down' the second mark is for an explanation which shows some understanding of the relative displacement of the ball and frame; this mark is consequential on the first being correct; condone 'ball has inertia'	2

Question	Answer	Comments/ Guidance	Mark
04.1	top line: 234 4 ✓ bottom line 2 ✓	the first mark is for the nucleon numbers correct the second mark is for the correct proton number of the alpha particle	2
04.2	use of $\frac{\text{electrical power output}}{\text{power generated by decay}}$ = 6% = 0.06 to give: power generated by decay = $\frac{100}{0.06}$ = 1700 W ✓	allow 2000, 1670, 1667 etc	1
04.3	current = $\frac{P}{V} = \frac{100}{32}$ = 3.1 A ✓	allow 3, 3.13 and 3.125; condone 3.12	1
04.4	each component requires $I = \frac{V}{R} = \frac{32}{45}$ = 0.71 A ✓ number of components = $\frac{3.1}{0.71} = 4.4$; thus n = 4 ✓ alternative 1:use of power formula $\frac{V^2}{R} = \frac{32^2}{45}$ = 23 W ✓ number of components $= \frac{100}{23}$ = 4.3; thus n = 4 ✓	condone '4' for both marks; if the answer is not rounded down to the greatest whole number, lose the last mark if P = 1700 used rather than 100 allow ce alternative 2: use of total resistance formula $R_T = \frac{V^2}{P} = \frac{32^2}{100}$ **or** $\frac{P}{I^2} = \frac{100}{3.1^2}$ =10.24 ✓ $\frac{1}{R_T} = \frac{1}{10.24} = \frac{n}{45} \therefore n = \frac{45}{10.24} = 4.4$; thus n = 4 ✓	2

04.5	energy = 1000 kW h =1000 × 1000 × 3600 = 3.6 × 10^9 J ✓ average power = $\frac{3.6\times10^9}{365\times24\times3600}$ = 114 W ✓	allow 1 sf 100 W for solution using Watt-hours $\frac{10^6}{365\times24}$ ✓ = 114 W ✓	2
04.6	(as Sun's intensity is similar) area needed = (similar to that of UK domestic solar power installation =) 10m^2 (to an order of magnitude) ✓	allow ce for average power ie $\frac{1000}{\text{answer to } 04.5}$	1

Keys to Multiple Choice Questions (each correct answer is worth 1 mark)									
5	**6**	**7**	**8**	**-**	**10**	**11**	**12**	**13**	**14**
B	B	B	D	-	D	A	C	A	D
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
C	B	B	C	B	A	A	C	C	C
25	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
B	C	D	B	A	C	A	D	A	D