AQA

A-level
PHYSICS
(7408/2)

Paper 2

Mark scheme

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).

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 $\mathrm{kg\,m^2\,s^{-2}\,A^{-1}}$ 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	Answers	Additional Comments/Guidance	Mark
01.1	$t = \sqrt{\frac{2s}{g}}$ or $4.5 = \frac{1}{2} \times 9.81 \times t^2$ ✓ *t* = 0.96 s✓		2
01.2	Field strength = 186000V m^{-1}✓ Acceleration = *Eq/m* or 186 000 × 1.2 × 10^{-6} ✓ 0.22 m s^{-2} ✓		3
01.3	0.10(3)m (allow ecf from (i))✓		1
01.4	Force on a particle = *mg* and acceleration = *F/m* so always = *g*✓ Time to fall (given distance) depends (only) on the distance and acceleration✓ OR: $g = GM/r^2$ ✓ Time to fall = $\sqrt{2s/g}$ so no *m* in equations to determine time to fall✓		2

01.5	Mass is not constant since particle mass will vary✓ Charge on a particle is not constant✓ Acceleration = Eq/m or (V/d) (q/m) or Vq/dm✓ E or V/d constant but charge and mass are 'random' variables so q/m will vary (or unlikely to be the same)✓		4
02.1	$d = \frac{8.9\times10^{-12}\times2.3\times250\times10^{-4}}{370\times10^{-12}}$✓ 1.4×10^{-3} m (1.4 (1.38) mm)✓	Data substitution – condone incorrect powers of 10 for C and A✓	2
02.2	New capacitance = 161 pF✓ New V = 0.13 nC/161pF = 81 V✓		2
02.3	Energy stored = ½ × 161 × 10^{-12} × 81^2 ✓ 0.53 μJ✓		2
02.4	Energy increases because: In the polar dielectric molecules align in the field with positive charged end toward the negative plate (or WTTE).✓ Work is done on the capacitor separating the positively charged surface of the dielectric from the negatively charged plate (or vice versa).✓		2

03.1	The molecules (continually) move about in random motion✓ Collisions of molecules with each other and with the walls are elastic✓ Time in contact is small compared with time between collisions✓ The molecules move in straight lines between collisions✓ **ANY TWO**	Allow reference to 'particles interact according to Newtonian mechanics'	2
03.2	Ideas of pressure = F/A and F = rate of change of momentum✓ Mean KE/rms speed/mean speed of air molecules increases✓ More collisions with the inside surface of the football each second✓	Allow reference to 'Greater change in momentum for each collision'	3
03.3	Radius = 690 mm/6.28) = 110 mm or T = 290 K ✓ seen volume of air = 5.55×10^{-3} m^3✓ $n \times 29$(g) = 11.4 (g)✓ n = 0.392 mol Use of $pV = nRT$ = $\frac{0.392 \times 8.31 \times 290}{5.55 \times 10^{-3}\ m^3}$ ✓ $p = 1.70 \times 10^5$ Pa ✓ Conclusion: Appropriate comparison of their value for p with the requirement of the rule, ie whether their pressure above 1×10^5 Pa falls within the required band✓	Allow ecf for their n V and T.	6

04.1	$(3.0 \times 10^{-10}/24) \times 6.02 \times 10^{23}$ seen✓ (7.52×10^{10})		1
04.2	Decay constant = $(0.69/14.8\ h^{-1})$ or $1.3 \times 10^{-5}\ s^{-1}$✓ $A = 1.30 \times 10^{-5} \times 7.5 \times 10^{10}$ ✓ 9.75×10^{5} Bq ✓ Allow 2 or 3 sf	Allow use of $A = \lambda N$ with an incorrectly calculated decay constant	3
04.3	Activity 3.5 h later should be $A = 9.8 \times 10^{5}\ e^{-0.0466 \times 3.5}$ ✓ 8.33×10^{5} Bq✓ Volume of liquid = $(8.33 \times 10^{5}/3600) \times 15 = 3470\ cm^{3}$✓		3
04.4	Estimate gives 3700 compared with 3500✓ Flask has more mass than average/liquid is not water✓		2

05.1	Induced current such as to opposes the change producing it✓ **Switch on** current increases the flux through Y✓ Current opposite direction/anticlockwise to create opposing flux✓ **Switch off** flux thorough Y due to X decreases so current travels clockwise to create flux to oppose the decrease✓	one marks for Lenz's law statement two for explaining what happens at switch on **OR** switch off adequately one for completing the argument for switch on and off adequately	4
05.2	Determines correctly in the calculation two of V_{pk}(5.6±1 μV) , A (0.096 m^2) and ω(9.4 rad s^{-1})β✓ Substitutes all three in $v = BAn\omega$ ignoring powers of 10 and calculation errors for A and/or ω provided they have been attempted with working shown✓ B_H = 12.4 nT✓	Allow 2 or 3 sf	3
06.1	Equatorial orbit ✓ Moving west to east ✓ Period 24 hours✓ **ANY TWO**		2
06.2	$T\ (= \frac{2\pi}{\omega} = \frac{2\pi}{2.5(4)\times10^{-4}}) = 2.5\times10^4\ \text{s}$ ✓		1
06.3	$\lambda\ (= \frac{c}{f} = \frac{3.0\times10^8}{1100\times10^6})\ = 0.27\ (3)\text{m}\ )$✓ $\theta\left(= \frac{\lambda}{d} = \frac{0.27(3)}{1.7}\right) = 0.16(1)\ \text{rad}$ = 92 ° ✓ (linear) width = $D\theta$ = 12000 km 0.16(1) rad) = 1.9(3) × 10^3 km ✓		3

06.4	Angle subtended by beam at Earth's centre = beam width/Earth's radius = 1.9(3) × 10^3 / 6400) ✓ 0.30 rad (or 17^o) ✓ Time taken = α/ω = 0.30 / 2.5(4) × 10^{-4} = 1.18 × 10^3 s = 20 mins ✓	Alternative: Speed of point on surface directly below satellite = ωR = 2.5(4) × 10^{-4} × 6400 × 10^3) = 1.63 × 10^3 m s^{-1}✓ Time taken = width / speed = 1.93 × 10^6 m / 1.63 × 10^3 m s^{-1} ✓ = 1.18 × 10^3 s (accept 1.2 × 10^3 s or 20 mins) ✓ or Satellite has to move through angle of 1900/6400 radian = 0.29 rad✓ Fraction of one orbit = 0.30/2 × 3.14✓ Time = 0.048 × 2.5 × 10^4 = 1.19 × 10^3 s✓ Time= $\frac{17}{360}\times$ 2.5 × 10^4 = 1.18 × 10^3 s or Circumference of Earth = 2π × 6370 ✓ = 40023 km Width of beam at surface = 1920 km✓ Time = $\frac{1920}{40023}\times 2.48\times 10^4$ = 1180 s = 19.6 min ✓	3

06.5	Signal would be weaker ✓(as distance it travels is greater) Energy spread over wider area/intensity decreases with increase of distance ✓ Signal received for longer (each orbit) ✓ Beam width increases with satellite height/satellite moves at lower angular speed✓)		4

Keys to Objective Test Questions (each correct answer is worth 1 mark)

7	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
D	C	B	D	D	B	D	D	A	C	D	B	A

20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
B	C	C	B	A	D	C	A	D	B	D	D

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