AS
Physics
7407/1
PAPER 1

Mark scheme

June 2017

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

Answers to questions in the practical sections (7407/2 – Section A and 7408/3A) should display an appropriate number of significant figures. For non-practical sections, 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).

An answer in surd form cannot gain the sf mark. An incorrect calculation **following some working** can gain the sf mark. For a question beginning with the command word 'Show that…', the answer should be quoted to **one more** sf than the sf quoted in the question eg 'Show that X is equal to about 2.1 cm' – answer should be quoted to 3 sf. An answer to 1 sf will not normally be acceptable, unless the answer is an integer eg a number of objects. In non-practical sections, 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'.

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	Neutron	Condone misspelling eg nuetron	1
01.2	<u>Weak</u> (interaction)	Ignore nuclear or references to beta	1
01.3	Bosons	Accept ‘exchange particles’ Do not allow ‘force mediator’	1
01.4	charge number 2/3 -1/3 – 1/3 → 2/3 +-1/3 + 2/3 - 1 + 0✓ baryon number 1/3 + 1/3 + 1/3 → 1/3 + 1/3 + 1/3 + 0 + 0✓	Ignore equation if given, marking should be based on the numbers Allow 1 for both correct in terms of n & p instead of quarks: 0 → +1 + -1 + 0 1 → 1 + 0 + 0	2
01.5	proton	Allow ‘free proton’	1
01.6	Electron + an electron antineutrino + muon neutrino	All 3 needed Condone anti-electron neutrino for electron anti-neutrino No credit given for symbols Allow antiparticle answer: positron, electron neutrino, muon antineutrino	1

Question	Answer	Comments/Guidance	Mark
02.1	An increase in current/voltage leads to an increase in temperature (more heat generated) ✓ This causes an increase in the movement of the lattice/ions/atoms✓ And therefore an increase in the rate of collisions with electrons✓ So the resistance increases as shown by V/I changing/V not proportional to I (on the graph)✓	Ignore of particles in first mark Do not condone 'particles' in second mark Allow more frequent collisions Allow correct reference to gradient of I/V curve unless the answer suggests that this is the resistance or inverse of resistance.	Max 4
02.2	14.3 (Ω)	Allow range 14 to 15 but calculated answer must lie between 14 and 15	1
02.3	Determination of pd across either filament or resistor from graph✓ Determination of pd across the other component, and values added✓ Use of V=IR to give 3.4 (V) Or Clear attempt to determine total resistance and multiply by 0.18✓ (Resistance of lamp at 0.18A = 4.4 Ω)	Pd across resistor can be calculated from resistance value in 2.2 Eg V = 0.18 x 14.3 = 2.6 Allow ecf if either value is wrong allow 2 max Condone small rounding error	3

	Total resistance = 18.7 Ω ecf from 2,2✓ 3.4 V (ecf from 2.2) ✓	Allow for small rounding errors (eg allow range 3.3 to 3.5)	

02.4	Determination of current through either filament or resistor from graph ✓ Determination of current through the other component, and values added✓ (Current through resistor = 0.28 A Current through filament = 0.36 A) R = V/I = 4/ (0.28 + 0.36) = 6.25 (Ω) **Or** Calculation of filament resistance or statement of resistor resistance ✓ Calculation of other resistance and use of parallel formula (allow ecf from part 2.2) ✓ 6.2 -6.3 (Ω) ✓	Allow calculation of resistor current using 4/(answer to 2.2) If either value wrong allow 2 max Condone small rounding errors. Resistance of filament = 11.1 (Ω) Either resistance gets the first mark	3

02.5	Calculation of area, ignoring power of ten errors. Correct resistivity 3.1×10^{-8} ✓ Ω m ✓	A = 8.0×10^{-10} m^2 Allow ecf for A (for example use of d for r gives 3.2×10^{-11} for A and 1.2×10^{-7} for answer) Some working must be shown for award of unit mark.	3

Question	Answer	Comments/ Guidance	Mark
03.1	Calculation of energy = $12 \times 7.2 \times 10^4 = 8.64 \times 10^5$ J Or time = 12000/1.5 = 8000 s ✓ Calculation of other quantity and substitution in power = useful energy/time taken ✓ Power = 110 (108 W)✓ Or Time = 8000 s✓ Current = charge/time = 9 A✓ Power = VI = 108 (W) ✓	Allow ecf for current or time	3
03.2	Attempt to use Power/velocity✓ 73 N ✓ or work done = *F* x 12000 ✓ equates to 110 × 8000 so *F* = 73 N ✓	Allow use of 100W for P Ignore inclusion of KE in calculation If 108 used then answer is 72 N If 100 used then answer is 67 N allow ecf from 3.1	2
03.3	Force parallel to slope = 120 × 9.81 × sin 4.5 = 92 N ✓		1
03.4	Total resistive force = ans to **3.3** + ans to **03.2** (= 165 N) ✓ speed = $\left(\frac{100}{165} =\right)$ 0.61 m s^{-1} ✓	Allow ecf for incorrect F Allow 0.66/0.67 if 108 W or 110 W used	2

03.5	**Increasing the mass** Reduces the range ✓ increases the friction on the bearings/tyres OR More energy/power is used accelerating the user to the final speed OR user and wheelchair have higher KE/ more energy to move ✓ **Increasing the speed** Reduces the range ✓ Air resistance increases with speed ✓	Reward discussion of compression of tyres Treat as independent parts If not explicit about increasing/decreasing lose the first mark in each part Within each part, second mark is dependent on the first Allow opposite answers for decreasing mass/speed	4

Question	Answer	Comments/ Guidance	Mark
04.1	path difference for two waves✓ gives rise to a phase difference✓ Destructive interference occurs ✓	Allow 'waves travel different distances' Condone out of phase if phase and path confused only give 1 for first 2 marks allow explanation of interference	3
04.2	(Path difference =) 0.056 m ✓ Path difference = 2λ or wavelength = 0.028 m ✓e Use of $f=c/\lambda$ so $f =$ 11(10.7) × 10^9 Hz ✓	Allow 2 max for 5.4 x 10^9 Hz or 2..7 x 10^9 Hz Allow ecf	3
04.3	Intensity decreases with distance ✓ One wave travels further than the other ✓ Amplitudes/intensities of the waves at the minimum points are not equal✓	Or "do not cancel out"	max 2
04.4	The signal decreases/becomes zero✓ The waves transmitted are polarised ✓ zero when detector at 90° to the transmitting aerial/direction of polarisation of wave ✓		max 3

Question	Answer	Comments/ Guidance	Mark
05.1	Substitution of data in $Y = \frac{FL}{A\varepsilon}$ ✓ 3.1×10^{-3} (m) ✓	2 marks can be awarded if 4mm used to show T>500 N provided an explanation is provided, otherwise award zero.	2
05.2	(500 = Tcos 65) T = 1200 N ✓		1
05.3	Wind produces a wave/disturbance that travels along the wire ✓ Wave is reflected at each end / waves travel in opposite directions✓ (Incident and reflected) waves interfere/superpose ✓ Only certain frequencies since fixed ends have to be nodes. ✓		4
05.4	Mass per m of the wire = 0.14(2) kg ✓		1
05.5	Use of $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ (=2.47) to find fundamental (or $f = \frac{3}{2l}\sqrt{\frac{T}{\mu}}$) Third harmonic = 7.4 (Hz) ✓	The second mark is for multiplying the fundamental frequency by 3 – allow ecf	2
05.6	Diagram showing three approximately equally spaced loops	Condone single line	1

05.7	Copper may be stretch beyond elastic limit/may deform plastically ✓ Permanent deformation/Does not return to original length✓	Allow 'will remain longer than original' or 'will be permanently deformed'	2

Question	Answer	Comments/ Guidance	Mark
06	3rd box (Electrons produce dark rings in diffraction experiments) ✓		1
07.1	$\lambda = 656$ nm ✓ Use of $E = hc/\lambda$ ✓ = 3.0×10^{-19} (J) $E/\ 1.6 \times 10^{-19}$ = 1.9 (1.88) (allow 1sf if correct)	Power of 10 error allow 2 Allow ecf for wrong <u>choice</u> of wavelength Treat as skill mark – allow conversion for any value of E	3
07.2	They are (just) free ✓	Allow released from atom	1
07.3	This is the ground state ✓ or This is the lowest level an electron can occupy	Allow lowest energy state Condone level for state Allow description of ground state	1

07.4	To become free/to remove an electron (reach zero energy) energy has to be supplied ✓ or Energy decreases from 0 as electrons move to lower energy levels/relate to energy needed to move from that state to 0	Or Electrons release energy as they move lower Or Zero is the maximum energy	1

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<td>07.5</td>
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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><td>Mark</td><td>Criteria</td></tr>
<tr><td>6</td><td>All three aspects analysed. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.</td></tr>
<tr><td>5</td><td>A fair attempt to analyse all 3 aspects. If there are a couple of errors or missing parts then 5 marks should be awarded.</td></tr>
<tr><td>4</td><td>Two aspects successfully discussed, or one discussed and two others covered partially. Whilst there will be gaps, there should only be an occasional error.</td></tr>
<tr><td>3</td><td>Two aspects discussed, or one discussed and two others covered partially. There are likely to be several errors and omissions in the discussion.</td></tr>
<tr><td>2</td><td>Only one aspect discussed successfully, or makes a partial attempt at 2 or all 3.</td></tr>
<tr><td>1</td><td>None of the three aspects covered without significant error.</td></tr>
<tr><td>0</td><td>No relevant analysis.</td></tr>
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The following statements are likely to be present.

A Reason for high potential difference

pd accelerates electrons/produces high speed/high energy electrons in the tube L1

electrons have to have sufficient energy to excite the atoms/raise electrons into higher levels L3

B Relation between spectrum and energy level diagram

Visible spectrum results from excited electrons moving into the lower level at -3.4 eV .L3

Each transition results in a photon of light.L2

Energy of photon is the difference in the energies of the two levels L2

Frequency of light in the spectrum given by $\Delta E = hf$ L1

C Relevant calculation clearly communicated

Gives an example: eg the lowest frequency is due to a transition from the -1.5 eV level to the -3.4 level. L1

Uses an energy difference to deduce one of the wavelengths: eg energy difference in J = 3×10^{-19} L2

$\lambda = hc/E = 660$ nm L2
</td>
<td>6</td>
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