AQA

AS
Physics

7407/1 - Paper 1

Mark scheme

June 2018

Version/Stage: 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.

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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 Wb m^{-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	Answers	Additional Comments/Guidelines	Mark
01.1	THREE FROM: the strong interaction✓ has short range OR mention range (less than 5 fm)✓ attraction up to 5 fm✓ repulsive (any distance below 1fm)✓ is zero/negligible beyond 5 fm✓ only affects <u>hadrons/</u> <u>baryons and mesons</u>✓ mediated by gluons/pions✓	If **wrong** interaction identified then zero marks If refer to strong interaction correctly then ignore any subsequent reference to other interactions	1 1 1 (3 MAX)
01.2	in alpha decay number of nucleons/protons and neutrons is unchanged OR baryons in parent nucleus equals the total number of baryons in daughter nucleus and the alpha particle✓ in beta decay a neutron changes into a proton (and both have same baryon number)✓ beta (-) particle and antineutrino have zero baryon number/beta(+) and neutrino have zero baryon number✓	If only refer to baryon number/nucleon number of alpha particle then do not award first mark Can be shown by equations e.g. ${}^{A}_{Z}\mathrm{X} \rightarrow {}^{A-4}_{Z-2}\mathrm{Y} + {}^{4}_{2}\alpha$ Second marking point can also be shown in equation	1 1 1
01.3	quark structure π^- = $\bar{u}$ d and p = uud quark structure kaon = d$\bar{s}$✓ hence as strong interaction quark structure Λ^0 = uds✓	if two of the quark structures correct then 1 mark any correct answer (uds) full marks	1 1
01.4	strangeness is not conserved/lost✓		1
01.5	TWO FROM: results of experiments must be independently checked/validated/peer reviewed before they are accepted/can be confirmed✓ particle accelerators are very expensive and collaboration helps to spread the cost of building them✓ many skills and disciplines are required (which one team are unlikely to have)✓		1 1 (2 MAX)

	lots of data to process (so more teams needed)✓		
Total			**11**

Question	Answers	Additional Comments/Guidelines	Mark
02.1	*(use of gain in E_k = loss in E_p)* $1/2mv^2 = mgh$ $1/2v^2 = 9.81 \times 8.0$✓ $(v = \sqrt{(2 \times 9.81 \times 8.0)}) = 13$ (12.5) (m s^{-1}) ✓	Bald correct answer scores 1 mark If use $v^2 = u^2 + 2as$ then zero Unless resolved g along slope If use 10 for g (-1) Gets second mark if answer rounds to 13	1 1
02.2	THREE FROM: acceleration of truck in Fig.1 is constant✓ In Fig.2 acceleration is greater/greatest at start/top✓ acceleration decreases✓ reference to zero acceleration/uniform velocity between C and D✓ because the component of weight/acceleration parallel to the slope changes✓		1 1 1 (3 MAX)
02.3	the loss of (gravitational) potential energy is the same hence gain in kinetic energy is the same✓		1
02.4	THREE FROM: rain has no (initial) <u>horizontal</u> momentum ✓ <u>vertical</u> momentum of rainwater decreases ✓ there is no external (horizontal) impulse/force on the truck (and water system) ✓ mass (of truck) increases but speed/velocity decreases✓ <u>horizontal</u> momentum of water increases (but horizontal momentum of	If say: 'vertical momentum/velocity of rain drops/water changes to horizontal (momentum/velocity)' score 2 marks	1 1 1 (3 MAX)

	truck decreases by same amount) ✓		
	(so) no change in (horizontal) momentum of truck and collected water/total momentum ✓	Cannot score last mark if stated that speed/velocity of truck does not change	

Total			**9**

<table>
<tr><th>Question</th><th>Answers</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td>03.1</td><td>
<table>
<tr><th>Transition</th><th>Ultraviolet</th><th>Visible</th><th>Infrared</th></tr>
<tr><td>A</td><td></td><td></td><td>✓</td></tr>
<tr><td>B</td><td></td><td>✓</td><td></td></tr>
<tr><td>C</td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>all correct 1 mark</td><td>1</td></tr>
<tr><td>03.2</td><td>EITHER
energy needed for electron to move to higher level/orbital✓
OR
for a transition/excitation/change of levels an exact amount of energy is needed✓

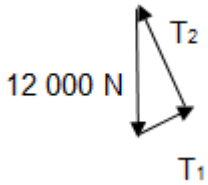
all the photon’s energy absorbed(in 1 to 1 interaction) ✓
electron can transfer part of its energy (to cause a transition/excitation)/ continues moving/ lower kinetic energy/ lower speed✓</td><td>Any implication of photoelectric effect max 1
Accept one energy level to another</td><td>1
1
1</td></tr>
<tr><td>03.3</td><td>(use of $\phi = hf_0$)
$\phi = 6.63 \times 10^{-34} \times 5.1 \times 10^{14}$ ✓(= 3.38×10^{-19})
$\phi = 3.38 \times 10^{-19}/1.6 \times 10^{-19} = 2.1(1)$ (eV)✓
OR
$\phi = 6.63 \times 10^{-34} \times 5.1 \times 10^{14}$ ✓(= 3.38×10^{-19})
energy in J $10.2 \times 1.6 \times 10^{-19} = 1.63 \times 10^{-18}$✓
OR
energy levels in J = $10.2 \times 1.6 \times 10^{-19} = 1.63 \times 10^{-18}$✓
photons frequencies giving this energy= 2.46×10^{15}✓

2 → 1 / C possible✓</td><td>If see 2.1 get these first two marks

last mark dependent on previous 2</td><td>1
1

1</td></tr>
<tr><td>03.4</td><td>(use of $hf = \phi + E_k$)</td><td>photoelectric equation must be used</td><td></td></tr>
</table>

	$12.1 \times 1.6 \times 10^{-19} = 2.1 \times 1.6 \times 10^{-19} + E_k$✓	ecf for third mark their calculated kinetic energy	1
	$E_k = 1.6 \times 10^{-18}$(J) ✓ $v = \sqrt{(2 \times 1.6 \times 10^{-18}/9.11 \times 10^{-31})}$ ✓(= 1.9×10^{6} m s^{-1})	having used photoelectric equation even if not converted eV to J or frequency to J correct answer gets(1.9×10^{6} m s^{-1}) full marks	1 1 1
Total			**10**

Question	Answers	Additional Comments/Guidelines	Mark
04.1	resultant/overall/sum of force = 0 OR forces up equal forces down AND forces left equal forces right✓ (sum of) anticlockwise moments (about any point) = (sum of) clockwise moments/zero resultant moment/torque✓		1 1
04.2	EITHER the point through which (the line of action of) a force has no turning effect/causes no rotation/ no torque✓ OR where the mass of the body can be considered to be concentrated OR where the weight can be considered to act✓	NOT where mass can be considered to act Ignore reference to force of gravity	1
04.3	so there is not a resultant moment/turningeffect / turning forceOR moments do not balance OR (beam) does not rotate/oscilate/swing ✓ about A/ because A is pivot ✓	Allow moments balanced for no resultant moment	1 1
04.4	 T_1 = 12 000 cos 53✓ T_1 = 7200 (7221) (N)✓ T_2 = 12 000 sin53✓ T_2 = 9600 (9583) (N)✓ OR	If T_1 and T2 are the wrong way round get 3 out of 4 If scale drawing 2 max +/- 300(N) If values out by a factor of 10 then -1 (i.e. confusion over g)	1 1 1 1

	$T_1 \cos 53 + T_2 \cos 37 = 12\,000$✓ $T_1 \sin 53 = T_2 \sin 37$✓ $T_2 = T_1 \sin 53/\sin 37$ hence $T_1 \cos 53 + T1 \sin 53 \cos 37/\sin 37 = 12\,000$ $T_1 = 7200$ (7221) (N)✓ $T_2 = 7221 \sin 53/\sin 37 = 9600$ (9583) (N)✓		

Question	Answers	Additional Comments/Guidelines	Mark
04.5	(use of $\Delta l = Fl/AE$) $A = \pi \times (0.75 \times 10^{-2})^2$✓ ($= 1.767 \times 10^{-4}$) $\Delta l = 12\,000 \times 12/(1.767 \times 10^{-4} \times 200 \times 10^9)$✓ $\Delta l = 4.1 \times 10^{-3}$ (m)✓	No attempt to calculate area scores zero wrong area (e.g. d^2 or $2\pi r$ or $2\pi rl$) maximum 1 mark unless diameter used for radius in πr^2 then maximum 2 mark accept 4.0×10^{-3} If 4×10^{-3} then -1 as 1 sig. fig.	1 1 1
Total			**12**

Question	Answers	Additional Comments/Guidelines	Mark
05.1	(use of $\rho = M/V$) M = $4.0 \times 10^{-6} \times 920 = 3.68 \times 10^{-3}$ (kg)✓ weight = $3.68 \times 10^{-3} \times 9.81 = 3.6 \times 10^{-2}$ (N)✓	ecf for second mark 1 sig.fig. -1 mark	1 1
05.2	V = $3.68 \times 10^{-3}/1000 = 3.7\ (3.68) \times 10^{-6}$ m^3✓	ecf 5.1 from mass calculation	1
05.3	THREE FROM: any mass divided by 7800✓ $V \times 7800 + (4.0 \times 10^{-6} - V) \times 920 = 3.9 \times 10^{-3}$ ✓ 6880 $V = 3.9 \times 10^{-3} - 3.68 \times 10^{-3}$ ✓ $V = 3.2 \times 10^{-8}$ m^3✓	Ignore mass value if awarding first mark	1 1 1 (MAX 3)
Total			**6**

Question	Answers	Additional Comments/Guidelines	Mark
06.1	resistance of lamp B and D = $3.5^2/4.1$ = 3.0 (2.98)(Ω)✓ resistance of lamp A and C = $6.0^2/6.0$ = 6.0 (Ω)✓ pd across lamp B and lamp D = 3/9 × 9.0 = 3.0 (V) OR pd across lamp A and C = 6.0 (V)✓ hence A and C normal brightness✓	can justify in terms of current i.e. current needed by A and C is 1 A provided resistance values calculated must have some correct working for conclusion mark	1 1 1 1
06.2	the pd across new lamp = 0 / E does not light✓ no current in E✓ other lamps are not affected✓ because the current in the lamps/pd across lamps does not change ✓	2nd and 3rd marks conditional on 1st mark	1 1 1 (MAX 3)
06.3	in first circuit current in battery = 9.0/4.5 = 2.0 A ✓ in second circuit current in battery = 9.0/7 = 1.2857 A✓ hence current in battery decreases✓	allow ecf from 06.1 original current = 2A can come from 06.1 and score here if say circuit resistance increases so current decreases and no other marks awarded score 1 mark	1 1 1

Question	Answers	Additional Comments/Guidelines	Mark
07.1	TWO FROM: central white fringe✓ (fringes either side) showing range of colours/spectrum✓ with red furthest and blue/violet closest to centre✓	 Allow rainbow for spectrum Reject different colour fringes If colours mentioned for last mark must be in right order i.e. red last	 1 1 (MAX 2)
07.2	FOUR FROM: central fringe is a mixture of red and green light/two wavelengths ✓ EITHER (1 marks) (separate) red and green fringes are seen (on either side) ✓ OR (for 2 marks) spacing of green fringes is less than spacing of red fringe / green fringes closer to middle than red✓✓ OR (for 3 marks) spacing of red fringes is 20% (or 1.2 times)greater than green fringes✓✓✓ 6^{th} green fringe overlaps with 5^{th} red fringe ✓	allow orange/yellow for central fringe if *w* used must be identified as fringe spacing for third alternative	 1 1 1 1 (MAX 4)

07.3

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.

Mark	Criteria	QoWC
6	Explains how (%) uncertainties combine to determine uncertainty in wavelength OR identify % uncertainty *s* as being the largest	The student presents relevant information coherently, employing structure, style and sp&g to render meaning clear. The text is legible.
5	Explain how wavelength is determined using $\lambda=\frac{ws}{D}$	
4	Explains how second change affects fringe spacing AND Comments on how change in fringe spacing affects (%)uncertainty / change in *s* OR *D* affects (%)uncertainty	The student presents relevant information and in a way which assists communication of meaning. The text is legible. Sp&g are sufficiently accurate not to obscure meaning.

The following statements may be present for decreasing slit separation *s*:

Fringe separation increases
Uncertainty in measuring fringe separation will decrease
and as this is needed to measure wavelength, uncertainty in wavelength
measurement will decrease

The following statements may be present for smaller *D*:

Uncertainty in measuring D would increase
Fringe separation would also decrease
so uncertainty in measuring fringe separation would increase
Both are required to find wavelength so uncertainty in finding wavelength would increase

FOR Middle Band **one** of these considered:

Decrease *s*
Larger fringe separation so smaller (%) uncertainty (in *w*)
Smaller *s* so higher (%) uncertainty in *s*
Decrease *D*
Smaller fringe separation so larger (%) uncertainty (in *w*)
Smaller *D* so higher (%) uncertainty in *D*

6

	3	Explains how second change affects fringe spacing OR Comments on how change in fringe spacing affects (%)uncertainty / change in *s* OR *D* affects (%)uncertainty			
	2	States how one of the changes affects fringe separation (decrease *s* increases fringe separation / decrease *D* decrease fringe separation	The student presents some relevant information in a simple form. The text is usually legible. Sp&g allow meaning to be derived although errors are sometimes obstructive.	If explain reverse change correctly (*s* increase *D* increase) no penalty	
	1	States that one of the changes alters fringe separation			
	0	No correct change identified	The student's presentation, spelling and grammar seriously obstruct understanding.		
Total					**12**