A-LEVEL
PHYSICS
7408/1

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 Examiner.

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	ID details
01.1	Award each mark independently Lepton number not conserved therefore not possible✓ Lepton numbers for particles correct ✓ Eg 0 = 1 –1 –1 (for lepton number) OR 0 = 0 -1 +0 (for muon lepton number)	Any incorrect quantum number equation (for Q, B or S) loses MP2. Alternative for MP2 reference to missing muon neutrino in order to balance/conserve (muon) lepton number.	2	2× AO1a
01.2	up anti-up AND down anti-down✓	Either order Credit symbols But do not condone any use of capital letter	1	AO1a
01.3	Identification of quarks in either neutral kaon correct, ie kaon $d\bar{s}$ OR anti-kaon $\bar{d}s$ ✓ Identification of quarks in other kaon correct, with statement that they are not the same. ✓	Alternative: Kaon has strangeness +1✓ Anti-kaon has strangeness –1 and is therefore not the same.✓ **Allow max 1 if** • quark configurations wrong way round. • value of strangeness is wrong way round • statement that strangeness is different without reference to value. • strangeness and quarks given but one of them is incorrect.	2	AO1a AO1b

Question	Answers	Additional comments/Guidelines	Mark	ID details
01.4	Award each mark independently Links hadrons to strong nuclear force (snf) OR identifies snf as forcing holding nucleus together✓ Reason why it cannot be the kaon✓ Reason why it cannot be the muon✓ pion is the particle as it (has mass in range and) is a hadron (and therefore experiences snf) ✓	For MP2: kaon rest energy is not between those of electron and half that of nucleon. (values quoted from data booklet) OR (only) pion and muon have correct rest energy with no mention of kaon. For MP3: muon is a lepton (and does not experience snf) An incorrect statement amount a particle negates the mark for that particle. Rest energies/MeV: kaon 493.821 or 497.762 pion 139.576 or 134.972 muon 105.659 nucleon 938.257 or 939.551	4	AO3.1b

Total			9

Question	Answers	Additional comments/Guidelines	Mark	ID details
02.1	Frequency related to energy (of photon) /$E = hf$✓ There is a minimum energy (of a photon) required to remove photoelectron; (minimum energy relates to minimum frequency). ✓	MP1 is for linking photon energy to frequency MP2 is for explaining what is meant by the work function. If no other mark awarded, one mark can be given for relevant mention of work function. Do not credit mention of threshold frequency unless explained If no mention of a photon, 1 max. Ignore references to energy levels.	2	AO1a AO1a
02.2	Evidence of use of maximum current ÷ charge on electron✓ 1.9×10^{14} (electrons per second) ✓	Expect to see $30 \times 10^{-6} \div 1.6 \times 10^{-19}$ Condone e for $1.6 \text{x} 10^{-19}$ in MP1 Allow POT error for current in MP1 Correct answer only for MP2	2	AO3.1a AO2.1f
02.3	Number of photoelectrons released (per second) depends on intensity of em radiation/number of (incident) photons (per second) (not pd.) ✓ Constant current reached when <u>all</u> photoelectrons released (each second) reach anode (due to anode pd).✓	MP1 is for relating the intensity to either the no. of incident photons or released photoelectrons per second MP2 is for linking constant current to all photoelectrons being detected. Condone ‘go round the circuit’ for ‘reach anode’.	2	AO1b

02.4	MP1 is for range of KE✓ MP2 for what happens when V is negative in terms of kinetic energy or potential energy or work done on/by electron✓ MP3 is for link to fewer photoelectrons having necessary KE. ✓	Example statements: MP1: photoelectrons are released with a range of KE. MP2: (When V negative) photoelectrons lose KE/gain (E)PE crossing to anode. MP3: (As V is increasingly negative) fewer of the photoelectrons (released per second) have sufficient (initial) KE to cross to anode (so current decreases).	3	AO1b

02.5	<u>Award each mark independently</u> Stopping potential related to <u>maximum</u> kinetic energy of photoelectrons/ $KE_{max} = eV_s$✓ (Max) KE = energy of photon – work function/ ϕ. OR (max) KE increases as (work function is lower and) radiation same✓ (max) KE increases, so stopping potential increases. ✓	If no mention of <u>maximum</u> KE do not award MP1. Alternative Reference to Einstein equation in the form: $hf = \phi + eV_s$ ✓ rearranged to $V_s = \frac{hf-\phi}{e}$✓ So lower work function,(with hf and e constant,) gives higher Vs. ✓	3	AO3.1a

Total			**12**

Question	Answers	Additional comments/Guidelines	Mark	ID details
03.1	Understanding that for coherence sources must have same frequency/wavelength AND constant phase difference. ✓ And that this achieved by both speakers being connected to same signal (generator). ✓		2	AO1a AO1b
03.2	The sound waves from the two speakers superpose (at a point) ✓ At A (and B) the two waves are in phase/ have zero phase difference (and a maximum is produced)✓ Moving away from A introduces a path difference/phase difference/waves are out of phase (and amplitude decreases) ✓ (Moving on towards B the waves move back in phase)	Do **not** accept 'interfere' or 'superimpose' for 'superpose' Accept for MP1 waves adding together/combine at a point (e.g. point A) for 'superpose'. Do not accept diagram. Award MP3 for formation of minimum/destructive interference due to (odd number of) half wavelength path difference/ π/ 180^{o} phase difference/ antiphase.	3	2 × AO2.1g 1 × AO2.1c
03.3	Clear evidence of use of Pythagoras ✓ Correct calculation of either length PB or QB ✓ PB = $(2.25^2 + (0.95 - 0.3/2)^2)^{½} = 2.39$ m QB = $(2.25^2 + (0.95 + 0.3/2)^2)^{½} = 2.50$ m (Path difference =) QB – PB either numerically or algebraically✓ (= 0.11 (0.12) m)	If ws/D used to give 0.13 (m) reward with 1 mark	3	AO2.1h

Question	Answers	Additional comments/Guidelines	Mark	ID details
03.4	(Path difference = one wavelength) Use of speed = frequency × wavelength to give Speed = 2960 × 0.12 = 360 m s^{-1}✓	Working or equation must be seen. Condone use of 0.10 m or 0.11 m or 0.127m or 0.13 m 0.10 gives 300 (296) m s^{-1} 0.11 gives 330 (325.6) m s^{-1} 0.127 gives 376 m s^{-1} 0.13 gives 380 (385) m s^{-1}	1	AO2.1h
03.5	Wavelength (gradually) increases. ✓ So that path difference at C gets closer to one wavelength✓ (Amplitude of) sound will get larger/louder as waves move in phase (then smaller/quieter).✓	Alternative for MP2: Separation of maxima (along line AB) increases✓ Alternatives for MP3: Maximum moves (from B) towards C so amplitude of sound gets larger/louder (then quieter). OR Maximum moves further along path/beyond C so amplitude of sound gets quieter✓	3	AO3.1a
Total			**12**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
04.1	Evidence of distance travelled = area under graph = 1755 + 1440 + 1620 = 4815✓ Average speed = total distance/time taken = 4815/240 = 20.1 m s^{-1}✓ (at least 3sf) Which is less than (speed) limit, (and therefore the answer is No). ✓ Alternative for MP2 and MP3 Calculation of distance travelled at speed limit = 5280 m✓ Which is greater than distance travelled (so no). ✓	Full marks can be credited for use of suvat. Allow ecf for distance in MP2 Only award MP3 for incorrect speed if attempt made to calculate distance correctly e.g. area under graph OR a.e. in distance or speed Alternative for MP1 and MP2: Total area = 80.25 m s^{-1} min✓ Time = 4 min Average = 20.1 m s^{-1}✓	3	AO3.1a AO2.1f AO3.1a
04.2	Using reaction time of 2.0 s ✓ Use of distance = speed × time = 62 m. 62 m (would be appropriate). ✓	Award MP2 if 1.6 s (to give 50 m) or 1.8 s (to give 56 m) or 1.7 s (to give 53 m) or average of two distances used Allow 60 m.	1 1	AO3.1a AO1a

04.3	Use of F = ma to calculate acceleration. a = 6800/1200✓ = 5.7 m s^{-2} evidence of use of suvat to calculate s or t, ✓ to give t = 5.5 s ✓ s = 85 m. ✓	If no other mark given, allow 1 mark for mv = 1200 x 31 (= 37200) Alternative for MP1 and MP2 $t = \frac{mv - mu}{F}$ Allow ce for a. Allow ce for either incorrect s or t.	4	AO2.1b

Question	Answers	Additional comments/Guidelines	Mark	ID details
04.4	(It is assumed that) the car in front would take the same time/travel the same distance as the car behind when braking/ only difference is reaction time of the driver of car behind.✓ Or Car in front cannot stop instantaneously (so car behind will have time/distance to bring car to rest).or words to that effect	Alternative: suggestion that total stopping distance is too large (drivers would ignore it/inefficient use of motorway)	1	AO3

Question	Answers	Additional comments/Guidelines	Mark	ID details
04.5	Correct use of cos (5) ✓ E.g. $mg = N \cos(5)$ Correct use of sin (5) ✓ E.g. $N \sin(5)$ (= mv^2/r) So mv^2/r seen✓ And $v = (rg \tan(5))^{½}$ Gives $v = (200 \times 9.81 \times \tan(5))^{½} = 13$ So speed limit = 13 m s^{-1}✓	May see cos (85) for sin (5) Alternative for MP1 and MP2: Evidence of $mg \tan(5)$ fourth mark is for answer and suggesting this as the speed limit. Max 3 if mg = N used	4	AO3.1a
Total			**14**	

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.1	Use of power equation Or combination of power equation and $V = IR$ To get $R = 96$ (Ω).✓	Must see some working Do not allow reverse arguments	1	AO2.1h
05.2	Either calculation of current through one lamp And multiply by 3 OR calculate total resistance ✓ (and use $V = IR$) To give 0.38 A. ✓ (at least 2sf)	Condone use of any other method eg use of power = 4.5 W and power equation. Allow ecf for their R from 5.1 used or their I Use of 100 Ω gives 0.36 A (0.4A)	2	AO2.1h
05.3	Evidence of equation to calculate area . ✓ 2.8×10^{-8} m^2✓ Use of resistivity equation to get 49 Ω.✓	Allow POT error in MP1 Evidence for MP2 may be in final answer Accept 48 Ω	3	AO2.1h AO1.1a AO2.1h

Question	Answers	Additional comments/Guidelines	Mark	ID details
05.4	Total resistance = 46 + 46 + 100/3 = 125 Ω. ✓ Calculation of circuit current = 12/125 = 0.096 A. ✓ operating current of lamp (=1.5/12 = 0.13)/current for all 3 lamps to be fully on = 0.38 A. ✓ Yes demo works as lamps will be dimmer/ off (with constantan). ✓	Allow ecf for incorrect resistance If no other marks awarded, one mark each can be given for (max 2) • for resistance increases with length. • Too much p.d. dropped across constantan • Resistivity of constantan is greater than resistivity of copper For MP3 allow quoted comparison to previously calculated current in 5.2 For MP4 allow ecf if answer is yes and is consistent with their calculation	4	AO3.1b
05.5	**Advantage** Zero resistance/resistivity. ✓ Reduce heat/energy transfer / power loss in cables✓ **Difficulty** Difficult to maintain low temperature (over long distances) ✓ Must be kept at/below the critical temperature. ✓	Ignore references to critical field. Allow very low resistance	Max 3	AO1.1a 2 × AO3.1a

Total			**13**

Question	Key
06	C
07	A
08	B
09	B
10	C
11	C
12	D
13	A
14	D
15	A
16	A
17	C
18	D
19	B
20	C
21	B
22	A
23	A
24	B
25	C
26	D
27	D
28	A
29	C
30	B