A-LEVEL
Physics
7408/1

PAPER 1

Mark scheme

June 2017

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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 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 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	Answers	Additional Comments/Guidelines	Mark
01.1	$^{40}_{19}\mathrm{K} + {}^{0}_{-1}e \rightarrow {}^{40}_{18}\mathrm{Ar} + \nu_{(e)}$ ✓✓	first mark for 40 and 18 second mark for electron neutrino if negative superscript on neutrino mark not awarded	1 1
01.2	is the weak interaction/weak nuclear force✓ because involves leptons and hadrons/ because quark character/flavour/identity/type changed✓	 allow change in quark composition allow second mark if applied to stated interaction e.g. up quark changes to down quark	1 1
01.3	(use of *E=hf*) energy in J = $1.46\times10^{6}\times1.6\times10^{-19}$ ✓ (= 2.336×10^{-13}) $f = (\frac{E}{h} =) = \frac{2.336\times10^{-13}}{6.63\times10^{-34}}$ AND $\lambda = \frac{3\times10^{8}}{f}$ ***OR*** $\lambda = \left(\frac{hc}{E} =\right)\frac{3\times10^{8}\times6.63\times10^{-34}}{2.336\times10^{-13}}$ seen directly✓ 8.51×10^{-13} m ✓	1 for the attempt at the conversion to J allowing POT 1 for attempt to sub in hf and c/λ (or hc/λ) allow energy substituted in MeV or eV for second mark 1 for the correct answer (not awarded if eV used or MeV or if POT error) Accept 8.52×10^{-13}	1 1 1
01.4	identifies the decay as beta emission ✓ *so will expect to see:* electron released (from nucleus) correct details of how electron detected antineutrino released no photon released } 2 from 4	If state incorrect interaction e.g. beta plus decay the wrong Physics and no consequential error(CE) and therefore zero. If no interaction stated then can score next 2 marks. e.g. cloud chamber or absorption If give correct equation for beta decay award mark for	3

		electron and antineutrino	
Total			**10**

Question	Answers	Additional Comments/Guidelines	Mark
02.1	EITHER calculate value for constant using two calculations✓ calculate value for constant using three calculations <u>and</u> make a comment that they have same value✓ OR calculate ratio between masses and √T for one pair of values✓ calculate ratio between masses and √T for two pair of values <u>and</u> make comment about same value✓ OR work out constant and use to predict one other frequency or mass✓ work out constant and use to predict two other frequencies or mass✓	need to see table to look for any working e.g. 0.5/0.8 = √110/√140 no comment needed with this alternative	2
02.2	$\mu = \rho A = 1150 \times \pi(5.0 \times 10^{-4}/2)^2$ $\mu = 2.258 \times 10^{-4}$ (kg m^{-1})✓ use of consistent *m* and *f* Substituted in $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ including g but condone powers of 10 error✓ 0.67 m✓	Award second mark if *T* and *f* substituted correctly (ignore μ) If used diameter for radius incorrectly then lose first mark but can get third mark (answer 0.335 m)	3
02.3	appreciation of reducing diameter when string is stretched.✓		2

	lower mass per unit length so (constant of proportionality and hence) frequency is higher (than would be predicted)✓		

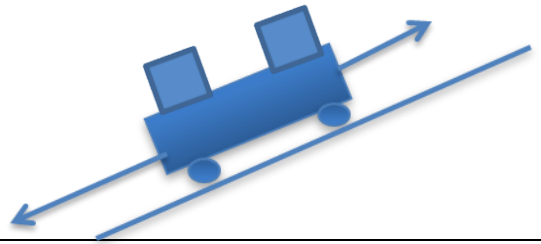
Total			**7**

Question	Answers	Additional Comments/Guidelines	Mark
03.1	$i = \sin^{-1}(1/1.6) = 39°$ ✓		1
03.2	sin 58 = n/1.6✓ $n = 1.4\ (1.36)$✓		1 1
03.3	blue light undergoes TIR✓ red light refracted✓ reason i.e. critical angle for red light is more OR critical angle for blue light is less✓ OR if refractive indices change by same factor✓ critical angle stays constant✓ so path followed by red and blue light is the same✓ OR don't know if refractive indices change by same factor✓ so can't predict the effect on critical angle✓ so can't predict paths of red and blue light✓	Allow correct description of refraction. Ignore statements about towards/away from normal For second two alternatives third mark (i.e. about paths of red and blue) dependent on first mark (i.e. factor of refractive index change)	1 1 1
Total			**6**

Question	Answers	Additional Comments/Guidelines	Mark
04.1	emf is the intercept on the pd/y axis✓ gradient of the graph is –r /internal resistance is <u>minus</u> the gradient of the graph/modulus of gradient is r/absolute value of gradient is r/magnitude of gradient is r✓		1 1
04.2	figure 5 circuit supplies $50\ \text{mA}$ ✓ figure 6 circuit has emf of $1.4\ \text{V}$ ✓ and internal resistance of $12\ \Omega$ ✓ hence current of $78\ \text{mA}$ which is $>75\ \text{mA}$ ✓ OR calculate required pd is 0.45 V (0.075 × 6.0)✓ show pd for cell in fig. 5 is 0.1 V ✓ show pd across parallel cells in fig. 6 is 0.4 V✓ show total pd in fig 6 is 0.5 V which is greater than 0.45 V✓ OR calculate emf needed for 75 mA in fig 5 (1.05)✓ calculate emf needed in fig 6 (1.35)✓ comment on emf needed in fig. 5 is larger than cell provides✓ comment on emf in fig. 6 being close to what is required✓	Can use different routes independently for fig 5 and fig 6 If candidates calculated current is not 50 mA or 75 mA allow CE for correct conclusion relating to 75 mA Must explain which circuit <u>is</u> suitable. If their calculation shows neither circuit suitable must explain why <u>both</u> circuits not suitable from graph for current for current of 75 mA from graph for current of ½ of 75 mA i.er. 37.5 mA i.e. 0.1 V from single cell and 0.4 V from parallel cells	4
04.3	useful power dissipated = $(75 \times 10^{-3})^2 \times 6$✓ (= $0.03375\ (\text{W})$) input power (at the cells) = $0.03375/.04 = (\text{W})$✓ solar power =$0.8437 /(32 \times 10^{-4})$=260 (263.7 or 264) W m^{-2}✓	Condone use of 78 mA gives answer of 285 W If use resistance of 18 Ω then lose first mark but CE to give answer of 791 W CE from power calculation but not from % calculation if incorrect % calculation at any stage only qualify for useful power mark	1 1 1

Total			**9**

Question	Answers	Additional Comments/Guidelines	Mark
05.1	force is at right angles/horizontal to wall (and so no component along the wall)✓		1
05.2	arrow drawn upwards from point of contact with ground✓ between ladder and vertical which when extended would pass through 'on ladder' part of label✓	Must be vertical or pointing to right for first mark	1 1
05.3	(*use of sum of clockwise moments = sum of anticlockwise moments*) EITHER $F \times 8.0\sin 60$ OR $390 \times 4.0 \cos 60$ ✓ $F = 390 \times 4.0 \cos 60 / 8.0 \sin 60 = 110\ (113)$ N✓	Either moment correct gets first mark (does not have to be evaluated)	1 1
05.4	**ANY 3** (vertical reaction) force from ground increases✓ direction of arrow of resultant force from ground changes (as ladder is ascended)✓ friction force/horizontal component of G between ladder and ground would increase✓ the (reaction) force from the wall increases✓ weight (of system)/load on ladder increases✓ as person climbs they exert a force along the ladder✓		MAX 3
Total			**8**

Question	Answers	Additional Comments/Guidelines	Mark
06.1	arrow parallel to slope labelled (M+2m)gsin35 and label parallel to slope labelled tension OR T✓ 	Ignore arrows not parallel to ground e.g. weight Ignore friction W not acceptable for (M +2m)g	1
06.2	T – Mgsin35 = Ma AND (M+2m)gsin35 – T = (M+2m)a ✓ add two equations (M + 2m)gsin35 – Mg sin35 = Ma + (M +2m)a ✓ HENCE (a= mgsin35/(M+m)) OR (M +2m)gsin35 – Mgsin35✓ (= (2M+2m)a) a = 2mgsin35 /(2M +2m) ✓ HENCE (a= mgsin35/(M+m))		1 1
06.3	SECOND MARK CONDITIONAL ON FIRST mass/impulse/acceleration (of trollies) is the same✓	SECOND MARK CONDITIONAL ON FIRST both have same <u>speed / magnitude of velocity</u> but different	1

	momenta (trolley A and B) the same	masses✓ (hence)momentum of A is greater/momenta in opposite directions✓	1

06.4	acceleration = $\frac{1}{4} \times \frac{30 \times 9.81 \times \sin 35^{\circ}}{(30+95)} = 0.338$ ✓ (use of $v^2 = 2as$) $v = \sqrt{(2 \times 0.338 \times 9.0)} = 2.47$ ✓ $t = \frac{2.47}{0.338} = 7.3$ s ✓ OR (use of $s = 1/2at^2$) $9 = ½ \times 0.338 \times t^2$ ✓ $t = 7.3$ s✓	CE from acceleration calculation If used g for acceleration then no marks awarded	1 1 1

06.5	number of journeys = $(1800/(12 + 7.3) = 93$ or 94✓ number of blocks = $2 \times 93 = 186$ or $2 \times 94 = 188$✓	Allow CE from 06.4 Allow between 93 to 94 Allow CE from incorrect number of journeys Allow 186 to 188	1 1

Total			**10**

Question	Answers	Additional Comments/Guidelines	Mark
07.1	*(use of* $v = 2\pi f\sqrt{a^2 - x^2}$*)* v_{max}=2π×2.0×2.5×10^{-2} v_{max}= 0.314 m s^{-1}✓ (use of E_k = ½mv^2) 54 × 10^{-3}= ½m × $(0.314)^2$ *m*= 1.1 (kg) ✓ $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$	Can	1 1

	$2.0 \times 2\pi = \sqrt{(k/1.1)}$ ✓ ($k = (4\pi)^2 \times 1.1$) k = 173 (172.8) ✓(N m^{-1}) OR $5.4 \times 10^{-3} = ½\ k\ (2.5 \times 10^{-2})^2$✓ k= 173 (172.8) N m^{-1}✓ OR $54 \times 10^{-3} = ½\ F \times 2.5 \times 10^{-2}$ F = 4.32 $4.32 = k \times 2.5 \times 10^{-2}$ k = 173 (N m^{-1})	If use either these method can then find mass from frequency formula or from kinetic energy Accept 170 and172.8 to 174	1 1

07.2	(use of $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$) same mass so $f \propto \sqrt{k}$ thus frequency = $2.0 \times \sqrt{3}$✓ frequency = 3.5 (3.46) (Hz) ✓	Allow CE from 07.1 for k or m	1 1

07.3	Two from: (resonance) peak/maximum amplitude is at a higher frequency✓ due to higher spring constant✓ (resonant) peak would be broader ✓ due to damping✓ amplitude would be lower (at all frequencies)✓ due to energy losses from the system✓	First mark in each case for effect Second mark for reason 2 marks max for effects 2 marks max for reason Cannot award from sketch graph unless explained First mark in each pair stand alone Second mark conditional on first in each pair	 1 1 1 1

Total			**10**

	Keys to Objective Test Questions (each correct answer is worth 1 mark)												
Q	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
A	B	A	C	D	C	B	C	C	C	A	A	B	C
Q	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	
A	D	B	B	B	C	B	B	C	B	D	D	D	