A-level
Physics

7408/3BB-Paper 3 Section B – Medical Physics
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.

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 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	Coherent bundle – fixed arrangement of fibres at each end ✓ Used to transmit image (from inside the body to the viewer)✓ Non-coherent bundle – random arrangement of fibres ✓ Used to transmit light into the body / to illuminate (area under investigation) ✓	Name of bundle plus either point for first mark If no marks awarded, give 1 mark if both bundles have been named.	4
01.2	Core at 1.6; cladding 1.55 ie half way between their core and 1.5 ✓ series of clear horizontal steps with air at 1.0 ✓	Although they are told to do a calculation, give the mark on the diagram for 1.55 even if no calc shown If no marks awarded for drawing, then give 1 mark for correct calculation.	2
Total			**6**

Question	Answers	Additional Comments/Guidelines	Mark
02.1	$d / 21 \times 10^{-3} = 12 \times 10^{-3} / 61$ ✓ $d = 4.1 \times 10^{-6}$ m ✓ $4.1 / 1.5 = 2.75$ ✓ Eye can resolve the images as they are more than 2 cell diameters apart / a distance greater than 3 x 10^{-6} m apart / separated by at least 1 unstimulated cell. ✓	Marks 3 and 4 are ECF	4
02.2	three curves labelled blue, green, red from left to right ✓ roughly at correct height green, red above 2/3 green, and blue less than 1/3 green ✓ blue 375 to 500, green 425 to 675, red 475 to 725 ; all + or –30 ✓		3
Total			**7**

Question	Answers	Additional Comments/Guidelines	Mark
03	Points to consider: For the basic principles of the CT scan • Patient lies in centre of ring • X-ray tube is mounted on one side of the ring with array of detectors mounted on the other side of the ring opposite the X-ray tube. • Narrow beam of X-rays in a short pulse sent through the head and the signals from the array of detectors are fed into a computer. • The X-ray tube and detectors are rotated about the patient's head and pulses of X-rays are sent through the patient's head from different directions. • The signals from the detectors are then added together and a 2D image of that slice of the head is produced by the computer. For advantages of CT for head injuries • Better defined image of tissue boundaries inside skull • Possible to identify bleeding inside skull For simple X-rays • Cheaper and easier for patient • Allows simple fractures to be identified • Less harmful as patient dose is less than that of CT scan	6 marks will clearly explain the basic principles of the CT scan. They will explain using this scan to assess head injuries. They will give good reasons for the use of basic X-rays in certain situations. 5 marks will clearly explain some of the basic principles of the CT scan. They will give some explanation for using this scan to assess head injuries. They will give good reasons for the use of basic X-rays in certain situations. 4 marks will explain some of the basic principles of the CT scan. They will give some explanation for using this scan to assess head injuries. They will give some explanation for the use of basic X-rays in certain situations. 3 marks will address at least two of the bullet points 2 marks will address at least one of the bullet points 1 mark will have any sensible comment 0 marks has no relevant Physics.	6
Total			**6**

Question	Answers	Additional Comments/Guidelines	Mark
04.1	Mention of ear's sensitivity starting low, increasing to maximum and then falling again resulting in convex nature of their curve which is wrong as does not fall after 5 kHz / should fall at higher frequencies and not plateau ✓ Mention of $1\ \text{kHz}$ being the reference frequency for both scales / mention of 3 kHz being the frequency of maximum sensitivity of the ear ✓ both scales should have same reading at 1 kHz which they don't / it is wrong that the curves cross at about $750\ \text{Hz}$✓ dBA curve should have maximum value at 3 kHz which it doesn't / wrong as max sensitivity of dBA scale is shown at $4\ \text{kHz}$ ✓		4

04.2	Initial use of 110 dB in correct equation – $110 = 10 \log (I / I_0)$ leading to correct calculation of intensity = 0.10 ($W\ m^{-2}$) ✓ Use of equation the calculated intensity = $7.8 / 4\pi r^2$ ✓ Leads to distance = 2.5 m ✓ Thus 2 m is slightly too close to the drill as it is less than 2.5ml ✓	The 4 marks are basically 1. The correct manipulation of the equation relating intensity and power 2. The correct answer from this 3. The correct use of the decibel equation 4. A suitable statement relating numbers These marks can come in any order depending on how they attack the problem. They may do 3 before 1 and 2, as in my original mark scheme, but many are doing 1 and 2 before 3. If 1 is wrong then this is EOP and thus 2 cannot be awarded, but 3 and 4 are ECF and are still available. Be aware that by using the initial power and distance quoted in the question, the final answer for the intensity level is 112 dB. Some candidates may then say that to 2sf, this is 110 dB which is that quoted as the safe level. This argument must be given the credit which it deserves. Remember that ECF is available from 2 to 3, or from 3 to 1 and 2. The final mark is for a sensible comment based on their final answer with some numeric comparison.	4

Total			**8**

Question	Answers	Additional Comments/Guidelines	Mark
05.1	There will be many answers possible and examiners must use their professional judgement. These answers may include: • Using scan before treatment to locate the precise position / size of the tumour • Using X-rays of the correct energy for the depth/size of the tumour • Using a computer to position X-ray relative to patient / target the tumour • Minimising time of use • Irradiating tumour from different directions • Less damage caused to healthy cells ✓ ✓ ✓ for three relevant answers		3
05.2	The thickness of material needed to reduce the intensity of the X-ray beam by half ✓		1
05.3	$\mu = \ln 2$ / half thickness ✓ $\mu = 165$ ✓ $\mu_m = \mu / \rho = 1.5 \times 10^{-2}$ ✓ unit $m^2\ kg^{-1}$ ✓	Unit mark is independent of the numerical answer or indeed a lack of any numerical working. 3rd mark is ecf	4
Total			**8**