



**General Certificate of Education (A-level) Applied
June 2012**

Applied Science

SC08

**(Specification
8771/8773/8776/8777/8779)**

Unit 8: Medical Physics

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner 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 examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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| Question | Part & sub-part | Marking guidance | AO | Total Mark | Comment |
|----------|-----------------|---|-------------------|------------|--|
| 1 | (a) | To avoid interference From other electrical signals/electrical signals produced due to movement | AO1 AO1 | 2 | Accept 'trace changed' Allow 'movement increases brain activity' for max 1 if no other mark awarded. |
| 1 | (b) | To improve conductivity/contact/ act as coupling agent <u>Electrical</u> contact/conductivity | AO1 AO1 | 2 | Ignore reference to air/reflections for 1 st mark. Reference to reflection negates second mark. |
| 1 | (c) | Suitable issue: e.g. volunteers must be aware of purpose of research Reason explained: e.g. so they can be sure that they want to take part – not against their principles | AO2 AO2 | 2 | Synoptic – allow pregnancy & medical issues only if rationale clearly explained and relevant. |
| 1 | (d) | (i) alpha | AO1 | 1 | |
| 1 | (d) | (ii) During mental activity | AO1 | 1 | Allow 'awake' 'conscious' |
| 1 | (d) | (iii) During (deep) sleep | AO1 | 1 | List principle – daydreaming, coma, relaxing negate. |
| 2 | (a) | (i) <u>Time taken</u> for activity to <u>halve</u> (or wtte) | AO1 | 1 | Do not allow for an individual atom to halve. |
| 2 | (a) | (ii) Allow any figure between 2.5 and 3.5 (hours) inclusive | AO2 | 1 | This is from using the table not the graph. |
| 2 | (b) | (i) Even, large scales All points plotted correctly Line of best fit drawn - curve | AO2 AO2 AO2 | 3 | 2 nd & 3rd marks cannot be awarded if scales are uneven. |

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| 2 | (b) | (ii) | As read from line of best fit | AO2 | 1 | Cannot be awarded is scales are uneven or line is straight. |
| 2 | (c) | | 24 (days) One compensation mark each for: <ul style="list-style-type: none"> • Correct equation stated • Correct substitution To a maximum of 2 compensation marks 1/24 (approx 0.042) (days) gains 2 marks | AO2 AO2 AO2 | 3 | Correct answer alone gets 3 marks (unless working shown indicates a completely incorrect method) |
| 2 | (d) | | B (no mark) Any 2: <ul style="list-style-type: none"> • Half-life longer • remains at a higher level of activity/ effective for longer • Implant would need to be changed less frequently | AO2 AO2 | 2 | 'stays in the body longer' and 'lasts longer' are insufficient. |
| 3 | (a) | (i) | Any 2 of: <ul style="list-style-type: none"> • Readings can be stored (for comparison later) • Autoreadings are taken / nurse doesn't have to be present • Little co-operation needed from child (or wtte) • Easier to <u>read</u> / less human error in <u>reading</u> | AO2 AO2 | 2 | Either order (NB remember a nurse can take readings every 30 mins manually) |
| 3 | (a) | (ii) | Any 2 of: <ul style="list-style-type: none"> • Not used internally/will not read core temperature/ affected by surroundings • Not very precise • Battery will need changing | AO2 AO2 | 2 | Either order 'needs a battery' is insufficient |
| 3 | (a) | (iii) | Yes (no mark) Human body is only alive within this range of temperatures Accept answers which say that it is unsuitable because it would be better to be able to measure slightly above or below the temperatures at which the person would be alive, | AO1 | 1 | The key point is awareness that at temperatures above or below this range the patient would be dead. Both ends of the scale needed. Allow answers where candidates think death occurs at 25°C or reference to hypothermia and hyperthermia. |

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| 3 | (a) | (iv) | Resistance/ resistivity/conductance/conductivity involved Resistance/resistivity/conductance/conductivity varies with temperature Current/ voltage varies with temperature OR as T increases, R decreases OR the greater the change in T, the greater the change in R. (or wtte) Calibrated | AO1 AO1 AO1 AO1 | 4 | |
| 3 | (b) | | Related to losing heat through perspiration/evaporation Evaporation faster (so cools faster) / air flow helps evaporation | AO2 AO2 | 2 | Appropriate arguments related to convection could be credited. synoptic |
| 3 | (c) | | Any 2 of: <ul style="list-style-type: none"> • Blood flow diverted away from core/brain • Core/brain requires blood to keep person alive • Core should be warmed (first) / not warming core | AO2 AO2 | 2 | synoptic |
| 4 | (a) | | Radioisotope - Radioactive material (or wtte) Medical tracer – substance inserted in the body which has its path traced/followed | AO1 AO1 | 2 | Must be in the body and traced/detected. |
| 4 | (b) | (i) | Long enough for the trace to be carried out Loses activity quickly enough for patient not to be radioactive/affected by radiation for too long | AO2 AO2 | 2 | 'long enough to act as tracer' insufficient 'doesn't stay in body long' insufficient |
| 4 | (b) | (ii) | Half-life very short Activity would drop too quickly | AO2 AO2 | 2 | Any reference to half- life being used up or dropping negates both marks. |
| 4 | (b) | (iii) | 24 hours – gains both marks One mark compensation for either: Recognising 4 half-lives Use of iterative method | AO2 AO2 | 2 | |
| 4 | (c) | (i) | Has to be detected outside the body/ (accept) by gamma camera (Only) gamma radiation penetrates the body / high penetration | AO2 AO2 | 2 | Do not accept 'leave the body' – neutral response. |

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|---------------|-----|---------------------------------|--|------------|----------|---|--------------|---|---------------------------------|---------------|---|-----------------|------------|----------|--|
| 4 | (c) | (ii) | Any 2 of: <ul style="list-style-type: none"> Alpha and beta act at site / damage cells nearby Alpha and beta are very ionising | AO2 AO2 | 2 | Do not accept 'remain in the body' – neutral response | | | | | | | | | |
| 4 | (c) | (iii) | If toxic then could <u>poison</u> patient (Some) radioactive decay makes the radioisotope change into another substance (or wtte) | AO2 AO2 | 2 | | | | | | | | | | |
| 4 | (d) | (i) | Accumulates in a specific organ (allow attracted to/ most absorbed by/ only absorbed by a specific organ) | AO1 | 1 | Do not allow 'works with/ targets/ absorbed by/ travels to a specific organ' – neutral responses. | | | | | | | | | |
| 4 | (d) | (ii) | May accumulate in the wrong organ / can only be used with one organ / can build up in the organ and cause damage. | AO2 | 1 | | | | | | | | | | |
| 4 | (e) | | <table style="border: none; width: 100%;"> <tr> <td style="width: 30%;">Cobalt-60</td> <td style="width: 10%; text-align: center;">/</td> <td style="width: 60%;">Treating thyroid cancer</td> </tr> <tr> <td>Iodine – 131</td> <td style="text-align: center;">\</td> <td>Implants to treat breast cancer</td> </tr> <tr> <td>Iridium – 192</td> <td style="text-align: center;">/</td> <td>General therapy</td> </tr> </table> 1 or 2 correct = 1 mark, all 3 correct = 2 marks | Cobalt-60 | / | Treating thyroid cancer | Iodine – 131 | \ | Implants to treat breast cancer | Iridium – 192 | / | General therapy | AO1 AO1 | 2 | |
| Cobalt-60 | / | Treating thyroid cancer | | | | | | | | | | | | | |
| Iodine – 131 | \ | Implants to treat breast cancer | | | | | | | | | | | | | |
| Iridium – 192 | / | General therapy | | | | | | | | | | | | | |

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|---|-----|---|-------|--|-------|---|
| 5 | (a) | The marking scheme for this part of the question includes an assessment of the Quality of Written Communication (QWC). There are no discrete marks for the assessment of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level below. | | | 5xAO3 | 5 |
| | | Level | Marks | Descriptor an answer will be expected to meet most of the criteria in the level descriptor | | |
| | | 3 | 4-5 | -answer is full and detailed and is supported by an appropriate range of relevant points such as those given below -argument is well structured with minimal repetition or irrelevant points -accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar | | |
| | | 2 | 2-3 | -answer has some omissions but is generally supported by some of the relevant points below -the argument shows some attempt at structure the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms spelling, punctuation and grammar | | |
| | | 1 | 0-1 | -answer is largely incomplete, it may contain some valid points which are not clearly linked to an argument structure -unstructured answer -errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency | | |

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| | | | <p><i>A typical answer would include:</i></p> <p><i>I would collect sources of α, β and γ radiation. I would use a geiger-muller tube and counter to measure their activity, in turn, over a set length of time (e.g. one minute). I would then place each one of these, in turn, behind a sample of the glass. I would then place my detector on the opposite side of the glass and measure the activity of each source over the same time period. If the sample meets the specifications then none of the α or β radiation would pass through the glass. The count for the γ would be less than half of what it was when the glass wasn't present. I would need to account for background radiation.</i></p> | | | |
| 5 | (b) | (i) | Repeat the experiment (under the same conditions) | AO3 | 1 | Mentioning averaging negates this mark. Ignore 'fair test' but use list rule if other incorrect suggestions made. |
| 5 | (b) | (ii) | Account for background radiation Allow repeat and average/look for anomalies/compare with other readings | AO3 | 1 | |
| 5 | (c) | | Any two of: <ul style="list-style-type: none"> • Ensure sources were back in <u>safe</u> containers when not in use • Use sources for least amount of time/ smallest dose • Not pointing sources at anyone • Handling sources with tongs /<u>lead lined</u> gloves Allow <ul style="list-style-type: none"> • Standing behind a (lead) screen/Wearing a lead lined apron/ keeping well away/ warning signs | AO3 | 2 | Do not allow: (neutral responses) <ul style="list-style-type: none"> • working in a lead lined room • wearing lead lined clothing • wearing a film badge • hazard symbols • protective eyewear/clothing |
| 6 | (a) | (i) | Sound/longitudinal/compression waves Frequency above human hearing range/ 20kHz/ over 20kHz | AO1 AO1 | 2 | |

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|---|-----|------|--|-------------------|---|--|
| 6 | (a) | (ii) | <p>5.5×10^{-5} (m) correct answer gains full marks</p> <p>Allow 1 compensation mark for any one of the following:</p> <ul style="list-style-type: none"> • 5.5 with incorrect power of 10 • Correct equation • Correct substitution | AO2 AO2 | 2 | |
| 6 | (b) | | <p>0.01 (allow 0.0107/ 0.011/ 0.0108/ 0.01079)</p> <p>Also allow each of the above with a –sign.</p> <p>Correct answer gains full marks</p> <p>Allow one compensation mark for each of the following.</p> <ul style="list-style-type: none"> • Correct equation • Correct substitution | AO2 AO2 AO2 | 3 | |
| 6 | (c) | (i) | <p>To prevent reflections</p> <p>Reflection/transmission at the (surface of) the skin / due to density differences</p> <p>Allow 'to reduce friction between the probe and the skin' OR 'to remove air' for max 1 mark only if other points above not made.</p> | AO1 AO1 | 2 | Any indication of electrical connection negates these marks. |
| 6 | (c) | (ii) | Similar /the same | AO1 | 1 | List rule |

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| 7 | (a) | (i) | <p>The marking scheme for this part of the question includes an assessment of the Quality of Written Communication (QWC). There are no discrete marks for the assessment of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level below.</p> | | | 5xAO2 | 5 | |
| | | | Level | Marks | Descriptor an answer will be expected to meet most of the criteria in the level descriptor | | | |
| | | | 3 | 4-5 | <ul style="list-style-type: none"> -answer is full and detailed and is supported by an appropriate range of relevant points such as those given below -argument is well structured with minimal repetition or irrelevant points -accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling, punctuation and grammar | | | |
| | | | 2 | 2-3 | <ul style="list-style-type: none"> -answer has some omissions but is generally supported by some of the relevant points below -the argument shows some attempt at structure the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms spelling, punctuation and grammar | | | |
| 1 | 0-1 | <ul style="list-style-type: none"> -answer is largely incomplete, it may contain some valid points which are not clearly linked to an argument structure -unstructured answer -errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency | | | | | | |

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|---|-----|------|---|------------|---|------------------------|
| | | | <p><i>A typical answer would include: Some advantages of capsule endoscopy include not having to be sedated before the investigation takes place and the fact that it is much less uncomfortable than traditional endoscopy. The patient only has to swallow the capsule. Having a wide angled view also means that the doctor will be able to see a large area of the oesophagus as the capsule travels down it. With traditional endoscopy there may be areas that you cannot see clearly. Disadvantages include the fact that you can't control the speed of the capsule as it moves through the digestive system. There may be an area that you want to see in more detail that it passes through quite quickly. However, as it takes so many images per seconds this is not likely to be a major problem. There are advantages and disadvantages to the new system being wireless. The main disadvantage is that the wireless system may fail in which case you have lost all the images that have been taken. Being able to store the images to view later is very useful though. Overall, this seems to be an useful system which is worth developing.</i></p> | | | |
| 7 | (b) | (i) | High density / dense enough / dense / higher density than tissues | AO1 | 1 | |
| 7 | (b) | (ii) | <ul style="list-style-type: none"> • Low difference in density between stomach and other surrounding tissues • Density too low to absorb X-rays / depends on density difference | AO2 AO2 | 2 | |
| 7 | (c) | | X-rays are high frequency/high energy/ ionising radiation X-rays are known to cause <u>cell</u> damage (whereas there is no evidence that endoscopy does) / (allow) link between ionisation and cell damage | AO1 AO1 | 2 | Ignore 'more ionising' |