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General Certificate of Education
June 2010

APPLIED SCIENCE SC08

Unit 8 Medical Physics

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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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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Question 1

(a)(i)	Heart valve – MRI Hypothermia – thermometer High blood pressure – sphygmomanometer Coma – EEG Lung function – spirometer (synoptic)	(1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1)	**5**
(b)	Above 37.2˚	(1) (AO1)	**1**
(c)(i)	Movement causes electrical impulses Electrical impulses interfere with the trace	(1) (AO1) (1) (AO1)	**2**
(c)(ii)	C	(1) (AO1)	**1**
(d)(i)	Systolic diastolic	(1) (AO1) (1) (AO1)	**2**
(d)(ii)	measures are taken when the heart is contracting and when it is relaxing blood pressure is different at these times – higher when contracting. (synoptic)	(1) (AO1) (1) (AO1)	**2**

Total Mark: 13

Question 2

(a)(i)	One mark each for: large even scales all points correctly plotted appropriate line of best fit. (straight)	 (1) (AO2) (1) (AO2) (1) (AO2)	**3**
(a)(ii)	They are (directly)proportional or WTTE 'Inversely proportional gains no marks'	(1) (AO2)	**1**
(b)(i)	45.58˚ (allow 45˚ to 46˚) One compensation mark for correct equation, correct substitution, correct use of sines – to a maximum of 2 marks)	(3) (AO2)	**3**
(b)(ii)	Endoscopes use total internal reflection Light reflects if it hits the boundary at an angle greater than the critical angle/explanation of what the critical angle is Low critical angle means light entering at a larger range of angles will be reflected (accept more light reflected)	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(c)(i)	Any example of an endoscope being used for diagnosis (e.g. investigating a stomach ulcer)	(1) (AO1)	**1**
(c)(ii)	Matching description of how endoscope is inserted (e.g. via an incision, swallowed etc or the type of light used i.e. normal or laser) Matching explanation of why an endoscope is an appropriate diagnostic technique for the example chosen OR what it does that makes it helpful	(1) (AO1) (1) (AO2)	**2**

Total Mark: 13

Question 3

<table>
<tr>
<td>(a)</td>
<td>
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.
<table>
<tr><th>Level</th><th>Marks</th><th>Descriptor
an answer will be expected to meet most of the criteria in the level descriptor</th></tr>
<tr><td>3</td><td>4-5</td><td>-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</td></tr>
<tr><td>2</td><td>2-3</td><td>-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</td></tr>
<tr><td>1</td><td>0-1</td><td>-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</td></tr>
<tr><td></td><td></td><td>An example of the type of answer that may be produced would be:
The researcher would need to have the following equipment available:
• Radioisotope to be tested
• Radiation detector
• Stop watch or clock
• Ruler
To carry out the experiment the researcher would place the source at a given distance from the detector and record the count detected over a given period of time, e.g. 1 minute). They would then repeat this at suitable time intervals until they had taken a minimum of 5 different readings. Ideally, they would need to make sure that the total time taken for the experiment was longer than the half-life of the radioisotope.</td></tr>
</table>
</td>
<td>(5) (AO3)</td>
<td>5</td>
</tr>
</table>

(a) cont			The researcher would then plot a graph of count rate against time. They could then use this graph to find out how long it took for the count rate to halve. This would be the half-life of the radioisotope. For accuracy they should use their graph to find at least two different values of half-life and average these.	
(b)	15 – 60 minutes would be suitable. Longer intervals could be credited if the explanation justified it. (absolutely no more than 4 hours) Readings would have changed sufficiently between measurements – wouldn't have to take a huge number of readings to cover a half life. (do not allow if time less than 5 minutes) Readings taken frequently enough for the half life to be detectable.(do not allow if time more than 4 hours)			(1) (AO3) (1) (AO3) (1) (AO3)	**3**
(c)	Any sensible suggestion e.g. Background radiation Alpha radiation emitted & detector too far away to detect Explanation of how to account for the error e.g. Measure background radiation in advance and subtract from readings Test type of radiation in advance & ensure detector is in the correct place.			(1) (AO3) (1) (AO3) (1) (AO3) (1) (AO3) max 3	**3**
(d)	Any **two** sensible precautions e.g.: Return radioisotope to container when not in use Handle with tongs Do not point towards anyone Sensible protective clothing			(1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1)	**2**

Total Mark: 13

Question 4

(a)(i)	Any **two** advantages with matching explanation e.g. Less frequent visit to hospital Because patient can be monitored remotely Fewer risks to patient No exposure to X-rays	 (1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1)	**4**
(a)(ii)	Any **two** disadvantages with matching explanation e.g. Less opportunity to discuss concerns with doctor Because fewer face to face meetings More chance of infection Because surgery is required to implant the sensor Poor/unreliable transmission of information Requires effective wireless network	 (1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1) (1) (AO1) max 4	**4**
(b)	Any three points e.g. Bones would be shown clearly – good point Very expensive method of imaging – bad point (High doses of) X-rays involved – bad point Due to cost/time unrealistic to be able to use this method to monitor regularly – bad point For full marks both good and bad points would need to have been considered.	 (1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2) max 3	**3**

Total Mark: 12

Question 5

(a)	20 000 Hz	(1) (AO1)	**1**
(b)	Any four points – must include both similarities and differences to gain full marks e.g. Similarities Rotate around the body/Take pictures from many different angles Computer used to generate composite image Can be viewed as 3D Differences MRI scans use magnetism, CAT scans use X-rays CAT scans more dangerous than MRI scans Metal in or on patients can affect MRI scans but not CAT scans.	 (1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2) (1) (AO2) max 4	**4**

Total Mark: 5

Question 6

<table>
<tr><td>(a)</td><td>1.65MHz or 1650000 Hz
One compensation mark for correct equation or correct substitution (max 1)
Max 2 marks if unit missing or incorrect or not matching numerical value (e.g. Hz rather than kHz)</td><td>(3) (AO2)</td><td>3</td></tr>
<tr><td>(b)</td><td>0.44 (accept 0.36 – 0.49)
One compensation mark for correct equation or correct substitution.(max 2)</td><td>(3) (AO2)</td><td>3</td></tr>
<tr><td>(c)</td><td>Prevents unwanted reflections / maximises transmission
Value of α would be close to 0 / differences in acoustic impedance would cause reflection</td><td>(1) (AO2)

(1) (AO2)</td><td>2</td></tr>
<tr><td>(d)</td><td>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.
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<tr><td></td><td></td><td>An example of the type of answer that may be produced would be:

X-rays are high frequency electromagnetic waves which carry a lot of energy.
Their high energy means X-rays are very dangerous. X-rays are known to cause cancer and also to damage developing foetuses.
X-rays also penetrate soft tissue easily and so it is difficult to get a high quality image of a developing foetus.</td></tr>
</table></td><td>(1) (AO1)
(1) (AO1)

(1) (AO2)
(1) (AO2)
(1) (AO2)</td><td>5</td></tr>
</table>

(d) cont				**5**

		Ultrasound has no known damaging side effects. It can also produce high quality images of soft tissue. Because ultrasound is less dangerous than X-rays and also produces higher quality images of soft tissue, it is a far better method of imaging a developing foetus than X-rays would be.

Note – for all parts of 7(a):
The first marking point is for selecting the correct radioisotope
The second marking point is for selecting a radioisotope which emits **only** the correct type of radiation /identifying that a beta emitter must be chosen (no gamma).
The third marking point is for selecting an isotope with an appropriate half life / indicating a long half life is required (at least one month)

Total Mark: 13

Question 7

(a)(i)	D Beta radiation acts at site (allow if no radioisotope chosen or if C is chosen) Half-life is long enough to affect the cancer over a long period (allow if no radioisotope is chosen or if B or H is chosen)	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(a)(ii)	G Gamma radiation can be detected outside the body (allow if no radioisotope is chosen or if H is chosen) Half-life long enough to do the trace but patient will not remain radioactive for too long (allow if no radioisotope is chosen or if A is chosen)	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(a)(iii)	H Gamma radiation able to penetrate into the body (allow if no radioisotope is chosen or if G is chosen) Half-life long enough to ensure level of radiation administered is consistent. (allow if no radioisotope is chosen or if B or D is chosen)	(1) (AO2) (1) (AO2) (1) (AO2)	**3**
(b)(i)	Organ affinity describes how certain radioisotopes are attracted to (and accumulate) in certain organs Organ affinity may mean that a radioisotope does not go to the part of the body you want to treat / may accumulate elsewhere and cause problems there OR choosing the correct isotope ensures it goes where required /maximises chance of it working OR a suitable example to illustrate organ affinity	(1) (AO1) (1) (AO2)	**2**

(b)(ii)	Acceptable additional factor chosen e.g. Toxicity , radioactive daughter product, cost, availability, ease of manufacture Clear explanation of importance e.g. A radioisotope that is toxic could poison the patient.	(1) (AO1) (1) (AO2)	**2**

Total Mark: 13