Version 0211

General Certificate of Education (A-level)
January 2011

Applied Science SC08

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

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 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 candidates' 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 candidates' 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.

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.

Further copies of this Mark Scheme are available from: aqa.org.uk

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Question	Part	Sub-part	Marking guidance	AO	Mark	Comment
1	(a)		Any two from: • Less scarring • Less bleeding • No friction • Smoother cut • Less chance of infection	AO1 AO1	2	
1	(b)		Any two from: • Warning signs • Not looking into the beam • No reflective surfaces • Careful aim • Appropriate eye protection • No sources of ignition nearby	AO1 AO1	2	
1	(c)	(i)	• Light reflects from inner surfaces of the optical fibre • Reflection is accurate (by eye)	AO2 AO2	2	
1	(c)	(ii)	Removing a tattoo	AO2	1	
1	(d)		5×10^{13} (correct answer gets 3 marks) Allow one compensation mark for any of the following up to a maximum of 2 marks: • Correct equation • Correct re-arrangement • Correct substitution '5' with wrong power of 10 gains 2 marks	AO2 AO2 AO2	4	

			Hz (allow s^{-1})	AO1		
2	(a)	(i)	Below 32°C (allow 32°C) (do not allow any other specific temperatures)	AO1	1	
2	(a)	(ii)	Any three from: • Shake thermometer / ensure liquid is below constriction. • Insert thermometer in mouth / ear / under arm • Leave for a few minutes • Remove from mouth and read scale • Rotate thermometer so scale / thread is magnified	AO2 AO2 AO2	3	
2	(a)	(iii)	Any two from: • Clumsiness or lack of coordination • Slurred speech or mumbling • Confusion or difficulty thinking • Drowsiness or very low energy • Loss of consciousness • Weak pulse • Slow pulse (allow irregular pulse) • Shallow breathing • Pallor / vasoconstriction / lack of blood to extremities • Allow shivering	AO1 AO1	2	
2	(b)		• Silver is a good reflector • of heat radiation / infra red • from the body / back to the body / stops it escaping the body	AO2 AO2 AO2	3	
2	(c)		• B (bradycardia)	AO2	2	

			• Trace is slower than normal (allow slow)	AO2		
3	(a)	(i)	X is delta Y is theta	AO1 AO1	2	
3	(a)	(ii)	Alpha – when the mind is relaxed Beta – during mental activity X – during deep sleep Y – in children and in adults under stress 3 or 4 correct = 3 marks, 2 correct = 2 marks, 1 correct = 1 mark	AO1 x3	3	
3	(b)	(i)	Magnetic Resonance (imaging)	AO1	1	
3	(b)	(ii)	Any three from: • (Uses) nuclear magnetic resonance/NMR • (Strong) magnetic field applied • Detects hydrogen / water • Hydrogen nuclei / water molecules interact with a magnetic field • Radio waves applied • Applied radio waves cause nuclei to 'flip' in the magnetic field • Nuclei return to normal orientation • Different delay times / reorientation times • Signals emitted converted into an image / by a computer	AO2 AO2 AO2	3	
3	(b)	(iii)	• Less dangerous • Because non ionising radiation used / radio waves are less dangerous than X-rays / no hazards known unlike X-rays • Better contrast images of soft tissue • MRI scans work well with tissue that contains	AO2 AO2 AO2 AO2	4	

			water / X-rays not attenuated effectively by soft tissue / tissues not dense enough for X-rays to be effective			
3	(b)	(iv)	• Expense – <u>much</u> more expensive than X-rays • Therefore can use on fewer patients (or wtte) / hospitals may not have one OR • Some patients find them stressful/claustrophobic • In an enclosed tube OR • Take much longer than X-rays • Therefore fewer patients can be treated / more stressful / difficult to lie still	AO2 AO2	2	
4	(a)		• Only gamma penetrates the body / high(est) penetration • Needs to be detected externally / by gamma camera • Least ionising Accept converse points	AO2 AO2 AO2	3	
4	(b)		Any two paired answers from: • Physical half life of a few hours • So long enough to carry out a trace OR • Gamma rays emitted are of appropriate energy to be detected by a gamma camera • therefore easily detected OR • can be incorporated into a wide range of pharmaceuticals • therefore has a wide range of uses	AO1 x2 AO2 x2	4	

			OR • It is relatively cheap • Therefore more patients can be investigated OR • It can be made easily on site • Therefore it will be available when needed / storage not required OR • No particular organ affinity • Therefore can be used to trace in any part of the body OR • Low toxicity • Therefore will not poison the patient Other sensible reasons accepted			

5	(a)	(i)	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.			AO3 x5	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			
						An example of the type of answer that may be produced would be: I would need to have the following equipment available: • Ray lamp & comb • protractor • Ruler & pencil • Rectangular glass block • Plain white paper To carry out the experiment I would place the block in the middle of the paper. Then I'd send a narrow ray of light into the side of the glass block			

					and mark its path into and out of the block on the paper. I'd then use the ruler to mark in the incident and refracted rays, draw normals and measure the angles of incidence and refraction. I would use the angles of incidence and refraction to calculate the refractive index of the glass using the equation n = sin i / sin r.			

5	(a)	(ii)	Any two from: • Very narrow beam • High intensity beam / darkened room • Large angles of incidence • Several readings / take averages • Sharp pencils / mark centre of rays	AO3 AO3	2	

5	(a)	(iii)	Repeat (in identical circumstances) (Accept compare with other results)	AO3	1	

5	(b)		45.58^0 (accept any figure between 45^0 and 46^0 inclusive) Allow one compensation mark for any of the following up to a maximum of 2 marks: • Correct equation • Correct substitution • Correct use of sines	AO2 x3	3	

5	(c)		Any four from: • High refractive index means a small critical angle • Small critical angle means more incident rays will be reflected	AO2 x 4	4	

			• Rays must hit at an angle greater than the critical angle to reflect • Uses total internal reflection • More rays reflecting means more intense light / less light escapes • Low critical angle means more light will reflect when the fibre is bent sharply			
6	(a)		Sphygmomanometer	AO1	1	
6	(b)	(i)	Systolic / systole / heart contracting	AO1	1	
6	(b)	(ii)	Diastolic / diastole / heart relaxing	AO1	1	
6	(c)		• Advantage • Matching explanation e.g. • a more accurate measurement is obtained • because there is a probe inserted directly into the blood stream **NB do not accept continuous monitoring or automatic alarm as these are possible with non invasive methods** • Disadvantage • Matching explanation e.g. • More difficult to set up • Because you need to ensure the probe is inserted into blood vessel correctly Or • Risk of infection • Because inserted into a blood vessel	AO1 AO2 AO1 AO2	4	

<table>
<tr>
<td>7</td>
<td>(a)</td>
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-unstructured answer
-errors in the use of technical terms, spelling, punctuation and grammar or</td></tr>
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</td>
<td>AO2 x5</td>
<td>5</td>
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					lack of fluency			
					An example of the type of answer that may be produced would be: The new method does not use ionising radiation so it is probably safer than a traditional mammogram which uses X-rays. However, a chemical needs to be injected into the breast for the new method to work and this might react with the body and cause medical problems that researchers are not yet aware of. Although most malignant tumours will contain the salt that binds with the injected chemical, others may contain different salts and these could be missed if the new method were used. Though traditional mammograms cannot detect cancer in young women it seems likely that this new method could because it does not depend on the density of the tissue. As the new method has not been tested extensively yet it is not possible to know how effective and safe it will be.			

7	(b)		• Heat radiation emitted from the body is detected • Cancerous tissue produces an unusual amount of heat • Cancerous tissue will show up a different colour/ different intensity on the image formed / different thermal signature / different temperatures appear as different intensities OR	AO1 AO2 AO2	3	

			different colours			

8	(a)		1.25g (correct answer with unit gains 2 marks) One compensation mark for any ONE of: • Recognition of 3 half lives • Use of iterative method • 1.25 with no/wrong unit.	AO2 x2	2	

8	(b)	(i)	4 days (correct answer with unit gains 3 marks) One compensation mark for each of the following – maximum 2 compensation marks. • Correct equation • Correct substitution • 4 as an answer with no/wrong unit • 0.25 as an answer with or without an unit / no unit	AO2 x 3	3	

8	(b)	(ii)	Some of the radioactive material is removed from the body naturally / through excretion etc	AO1	1	