



**General Certificate of Education (A-level) Applied  
January 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.

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](http://aqa.org.uk)

Copyright © 2011 AQA and its licensors. All rights reserved.

**Copyright**

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the school/college.

Set and published by the Assessment and Qualifications Alliance.

Question	Part	Sub Part	Marking Guidance	AO	Mark	Comment
1	(a)		Bradycardia - ECG Coma - EEG High blood pressure – sphygmomanometer Soft tissue injury – MRI scanner	1 AO1 1 AO1 1 AO1	3	All 4 correct =3 marks 2 or 3 correct = 2 marks 1 correct = 1 mark
1	(b)	(i)	Any suitable precaution e.g.  Stand behind a lead screen/leave the room (Allow film badge/lead apron)	1 AO1	1	
1	(b)	(ii)	Explanation matches precaution e.g.  X-rays cannot penetrate lead./lead prevents exposure to X-rays	1 AO2	1	
1	(c)	(i)	Any sensible precaution e.g.: Wearing eye protection Ensuring there are no reflective surfaces. (Allow warning signs) (Ignore reference to goggles unless clearly indicated that these are specific goggles designed to protect against laser light)	1 AO1	1	
1	(c)	(ii)	Explanation that matches chosen precaution e.g.: Stops laser light entering the eyes (as this can cause blindness) Prevents laser beam reflecting (and hitting areas of the patient where it is not needed).	1 AO2	1	
<b>Total Marks: 7</b>						
2	(a)	(i)	Heat causes liquid to expand As it expands it moves up the (inner) tube/thermometer Amount of expansion/ how far it travels up the tube depends on temperature/calibration	1 AO1 1 AO1 1 AO1	3	

2	(a)	(ii)	conduction	1 AO1	1	
2	(b)	(i)	No ( no mark) Temperature is below normal / normal temperature is 37°C (accept 36°C is normal) Hypothermia is diagnosed when the body temperature is below 32°C (accept hypothermia occurs at 31°C)	1 AO1 1 AO1	2	NB – first point is for recognising temperature is below normal so can be awarded even if student says “yes”.
2	(b)	(ii)	Heat (from the body) is reflected Back to the patient / (heat from the body) doesn't escape to the surroundings Radiation / infra-red is the mechanism used	1 AO2 1 AO2 1 AO2	3	
2	(c)	(i)	Any 2 points : <ul style="list-style-type: none"> <li>• Too slow to respond</li> <li>• Cannot take continuous readings/cannot read automatically/ cannot attach to a computer /have to keep taking readings manually</li> <li>• Difficult to read/possible human error in reading</li> </ul>	1 AO2 1 AO2	2	
2	(c)	(ii)	Sensible method suggested e.g.: Thermistor/electronic thermometer Sensible justification for method chosen e.g. More sensitive/ quicker reaction etc Reason why this is important .e.g.: (More sensitive) so it is easier to see slight changes in temperature. 'Invasive' alone will not gain 1st mark but marks can then be gained for improved accuracy(1) as closer to the core temperature(1)	1 AO2 1 AO2 1 AO2	3	
<b>Total Marks: 14</b>						
3	(a)	(i)	The time it takes for the activity of a radioactive source to halve (or wtte)	1 AO1	1	Do not accept 'the time for a radioactive atom to halve' (ignore).

3	(a)	(ii)	0.5 g gets 2 marks Allow one compensation mark for any one of: <ul style="list-style-type: none"> <li>• Correct use of iterative method</li> <li>• Recognition of 3 half lives</li> <li>• 0.5 with no unit or incorrect unit.</li> </ul>	1 AO2 1 AO2	2	
3	(a)	(iii)	Any two of the following: <ul style="list-style-type: none"> <li>• Half-life is very short</li> <li>• Activity would decrease (too quickly)</li> <li>• Would become inactive before it was ready to be used</li> <li>• Would need secure/safe/expensive storage if kept on site</li> </ul> (Allow Safer not to store/ would emit hazardous radioactivity)	1 AO2 1 AO2	2	
3	(b)		<ul style="list-style-type: none"> <li>• (Tracers emit) gamma radiation</li> <li>• (Gamma) radiation can penetrate out of the body /most penetrating (Allow patient is radioactive)</li> <li>• Developing foetus most susceptible to damage</li> <li>• Activity would have decreased significantly within 24 hours</li> </ul>	1 AO2 1 AO2 1 AO2 1 AO2	4	
3	(c)	(i)	Large, even , suitable scales All points correctly plotted Appropriate line of best fit drawn	1 AO2 1 AO2 1 AO2	3	
3	(c)	(ii)	Correct half –life from graph Evidence of taking >1 value of half life (& averaging)	1 AO2 1 AO2	2	Allow even if incorrect line of best fit drawn as long as it is correct (exponential) shape 2 <sup>nd</sup> mark can be awarded irrespective of shape of line of best fit drawn.

3	(d)	(i)	2.4 days gets both marks  1 mark compensation for any one of the following: <ul style="list-style-type: none"> <li>• Correct equation stated</li> <li>• Correct substitution</li> <li>• 2.4 with no unit or incorrect unit.</li> </ul>	1 AO2	2	
3	(d)	(ii)	The isotope is excreted from the body/both physical and biological processes occur at the same time. (Allow metabolised but ignore absorbed)	1 AO1	1	

**Total Marks: 17**

4	(a)	(i)	<p>The marking scheme for this part of the question includes an assessment for the Quality of Written Communication (QWC) .There are no discrete marks for the assessment of quality of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level below:</p>	5xAO3	5													
			<table border="1"> <thead> <tr> <th>Level</th> <th>Marks</th> <th>Descriptor</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>4-5</td> <td> <p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul> </td> </tr> <tr> <td>2</td> <td>2-3</td> <td> <p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul> </td> </tr> <tr> <td>1</td> <td>1-2</td> <td> <p>Answer is largely incomplete. It may contain 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</p> </td> </tr> </tbody> </table>				Level	Marks	Descriptor	3	4-5	<p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul>	2	2-3	<p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul>	1	1-2	<p>Answer is largely incomplete. It may contain 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</p>
			Level				Marks	Descriptor										
			3				4-5	<p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul>										
2	2-3	<p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul>																
1	1-2	<p>Answer is largely incomplete. It may contain 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</p>																

			<p><i>A typical answer would include:</i></p> <p>A clear indication of the equipment used                  An explanation of what was done and the results that would be noted.                  An explanation of what the results would tell you.</p> <p>e.g:                  I would place the radioisotope a few cms away from a geiger counter and note the activity that was registered. I would then gradually move the radioisotope further away from the detector and note whether the count rate decreased. I would note the distance where the count rate had dropped to close to background levels. If this distance was less than about 10cms, I would know that the radioisotope emitted alpha radiation only. If there was still noticeable activity beyond this distance I would know that either beta or gamma radiation was present. I could also double check this by placing different materials between the source and the detector. If a thin sheet of paper stopped the radiation then I would know that only alpha radiation was emitted.</p>	<p>1 AO3</p> <p>1 AO3</p>		<p>Accept reasonable alternatives but not carrying out the experiment in a lead lined room – must relate to normal laboratory procedures.</p>
4	(a)	(ii)	<ul style="list-style-type: none"> <li>Background radiation (Accept reasonable alternatives e.g. source too far from detector, source has very short half-life)</li> <li>Measure it beforehand / deduct value from recorded results</li> </ul>	<p>1 AO3</p> <p>1 AO3</p>	2	<p>Accept reasonable alternatives but not carrying out the experiment in a lead lined room – must relate to normal laboratory procedures.</p>
4	(b)		<ul style="list-style-type: none"> <li>Correct comment relating to penetration</li> <li>Correct comment relating to acting at site</li> <li>Correct comment relating to ionisation</li> <li>Correct comment relating ionisation to ability to kill/damage cancer cells.</li> </ul> <p>To gain full marks answers must refer to both alpha/beta and gamma.</p>	<p>1 AO2</p> <p>1 AO2</p> <p>1 AO2</p> <p>1 AO2</p>	4	

**Total Marks: 11**



5	(a)		1.52 gets the full 3 marks (accept 1.5 – 1.7) Allow one compensation mark for each of the following, up to a maximum of 2: <ul style="list-style-type: none"> <li>• Correct equation</li> <li>• Correct substitution</li> <li>• Correct use of sines</li> </ul>	1 AO2  1 AO2 1 AO2	3	NB 1.39 can be obtained from an incorrect method.
5	(b)	(i)	Refracted ray in correct quadrant And bends away from the normal	1 AO2 1 AO2	2	Refracted ray must be straight by eye.
5	(b)	(ii)	Ray refracts along the boundary between the glass and air (refracted angle = 90°) And is to the right of the normal	1 AO2 1 AO2	2	Refracted ray must be straight by eye.(allow partial reflection)
5	(b)	(iii)	Refracted ray totally internally reflects And incident and reflected angles equal (by eye)	1 AO2 1 AO2	2	Refracted ray must be straight by eye.(allow partial refraction)
5	(c)	(i)	To stop light refracting out of the fibre/to ensure TIR	1 AO1	1	
5	(c)	(ii)	(Slightly) lower	1 AO1	1	

5	(d)	<p>The marking scheme for this part of the question includes an assessment for the Quality of Written Communication (QWC) .There are no discrete marks for the assessment of quality of written communication but QWC will be one of the criteria used to assign the answer to an appropriate level below:</p>	<table border="1"> <thead> <tr> <th>Level</th> <th>Marks</th> <th>Descriptor</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>4-5</td> <td> <p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul> </td> </tr> <tr> <td>2</td> <td>2-3</td> <td> <p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul> </td> </tr> <tr> <td>1</td> <td>1-2</td> <td> <p>Answer is largely incomplete. It may contain 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</p> </td> </tr> </tbody> </table>	Level	Marks	Descriptor	3	4-5	<p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul>	2	2-3	<p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul>	1	1-2	<p>Answer is largely incomplete. It may contain 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</p>	5xAO2	5	
			Level	Marks	Descriptor													
			3	4-5	<p>Answer is full and detailed and is supported by an appropriate range of relevant points such as those given below:</p> <ul style="list-style-type: none"> <li>- argument is well structured with minimum repetition or irrelevant points</li> <li>- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar</li> </ul>													
			2	2-3	<p>Answer has some omissions but is generally supported by some of the relevant points below:</p> <ul style="list-style-type: none"> <li>- the argument shows some attempt at structure</li> <li>- the ideas are expressed with reasonable clarity but with a few errors in the use of technical terms, spelling, punctuation and grammar</li> </ul>													
1	1-2	<p>Answer is largely incomplete. It may contain 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</p>																

**Total Marks: 16**

			<p><i>A typical answer would include:</i></p> <p>Reference to total internal reflection being used                  Explanation of how the angle of incidence must relate to the critical angle for TIR to occur                  Explanation of how refractive index relates to critical angle                  Reference to how the size of the critical angle relates to the proportion of incident rays totally internally reflected.                  Practical implications.</p> <p>e.g.:                  Endoscopes rely on light travelling through optical fibres by means of total internal reflection.</p> <p>A material with a high refractive index will have a small critical angle. The critical angle is the smallest angle of incidence for which total internal reflection will occur. The smaller the critical angle, the greater the proportion of incident rays that will be totally internally reflected. This means that more light will be transmitted along the endoscope, and less will refract out of the fibres, if the glass used has a small critical angle and a high refractive index.</p>			
6	(a)		High frequency / short wavelength / high energy waves Electromagnetic waves/part of electromagnetic spectrum	1 AO1 1 AO1	2	
6	(b)	(i)	Sound/ longitudinal/compression <u>waves</u> Frequency $\geq 20$ kHz/ frequency above human hearing range	1 AO1 1 AO1	2	
6	(b)	(ii)	$8 \times 10^{-3}$ m gets 3 marks Allow one mark compensation for each of: (max 2) <ul style="list-style-type: none"> <li>• Correct equation</li> <li>• Correct substitution</li> </ul> Correct answer without correct unit gains 2 marks	1 AO2 1 AO2 1 AO1	3	Accepts answers correctly stated in cm, mm etc.

6	(c)	<p>Ultrasound uses reflection X-rays use transmission/absorption</p>	<p>1 AO1 1 AO1</p>	2	<p>Alternatively accept for 1 mark: One uses reflection and the other uses absorption/transmission</p>
6	(d)	<p>One mark per reason and one per corresponding explanation. e.g: Reason – soft tissue is being investigated Explanation – insufficient contrast produced/density too low Reason – X-rays are known to be dangerous/could make tumour worse Explanation – they ionise cells/ high energy</p>	<p>1 AO2 1 AO2  1 AO2 1 AO2</p>	4	<p>One reason should relate to the <b>quality</b> of the image. The other reason should relate to <b>safety</b>. This does not ask for a comparison with ultrasound so comments such as “ultrasound is safer are irrelevant.”</p>
6	(e)	<p>Any two of the following:</p> <ul style="list-style-type: none"> <li>• Iodine accumulates in the thyroid</li> <li>• Different substances accumulate in different organs</li> <li>• Correct reference to the term “organ affinity”</li> </ul>	<p>1 AO1 1 AO1</p>	2	

**Total Marks: 15**