



**General Certificate of Education (A-level) Applied
June 2013**

Applied Science

SC08

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

Unit 8: Medical Physics

Final

Mark Scheme

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Question	Part	Sub part	Marking guidance	AO	Mark	Comment
1	(a)	(i)	36.5- 37.2	AO1	1	
1	(a)	(ii)	Hyperthermia c.a.o.	AO1	1	
1	(a)	(iii)	Any 2: <ul style="list-style-type: none"> Heat transfer from/through the skin (to surroundings) The skin is at a higher temperature than the surroundings/ temperature difference needed for heat to pass through skin/ heat lost through conduction/ heat lost through radiation Skin temperature affected by surroundings/body temperature depends on metabolic processes 	AO1 AO1	1 1	
1	(b)	(i)	<ul style="list-style-type: none"> Heat causes the liquid to expand Liquid <u>expands</u> up the inner tube /heat conducted to liquid The greater the temperature, the greater the expansion 	AO1 AO1 AO1	1 1 1	Point 3: Allow liquid stops expanding when it reaches the correct temperature or wtte
1	(b)	(ii)	<ul style="list-style-type: none"> Liquid travels further for each degree rise in temperature Increases precision 	AO2 AO2	1 1	Allow More space for each degree if explained. Accuracy if context makes it clear only.
1	(c)	(i)	Resistance (allow resistivity/conductivity/conductance)	AO1	1	Allow 'resistor' bod

1	(c)	(ii)	<ul style="list-style-type: none"> Change in resistance causes change of current/voltage The greater the change in temperature the greater the change in resistance/ current/voltage OR Meter calibrated to show <u>temperature</u> for different values of <u>resistance/current/voltage</u>	AO2	1	Point 2: Allow the higher the temperature the higher/lower the resistance or wtte.
				AO2	1	

1	(c)	(iii)	How much the resistance changes for each degree change in temperature Accept no. of digits in display or sensitivity of probe	AO1	1	Allow the number of decimal places the scale is <u>rounded</u> to.
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Total: 13 Marks

2	(a)	Any 2 advantages (for each:1 mark for advantage and further two available for explaining advantage stated) e.g:	<ul style="list-style-type: none"> <u>Less</u> dangerous/ side effects less likely Radioactivity is known to damage cells/tissue OR cause cancer Because it is ionising/high energy <u>Less</u> likely to damage surrounding cells As positioned at point where treatment is needed But external radiation passes through other tissue to reach treatment area. Treatment is faster Tumour cells killed instantly External radiotherapy can take months to have an effect. 	AO2	1	
				AO2	1	
				AO2	1	
				AO2	1	
				AO2	1	
				AO2	1	

2	(b)	(i)	<ul style="list-style-type: none"> Alpha & beta act at site (accept low penetration if context makes it clear that this relates to acting at site) Gamma penetrates out of body Alpha & beta are (most) ionising High ionisation causes more damage to cancer cells / gamma not (very) ionising/ gamma has more chance of damaging healthy tissues/ gamma will have little effect on cancer cells. <p>Accept converse throughout.</p>	AO2 AO2 AO2 AO2	1 1 1 1	Points relate to: penetration, acting at site, ionisation power, damage due to ionisation.
2	(b)	(ii)	<p>Any 2 relevant points explained e.g:</p> <ul style="list-style-type: none"> More effective targeting As positioned at the site Patient can carry on with normal life Does not have to keep returning for treatment 	AO2 AO2	1 1	
2	(b)	(iii)	<p>Any 2 relevant points explained e.g:</p> <ul style="list-style-type: none"> Implant becomes less effective as time goes on Because it decays Invasive So more chance of infection/scarring/bleeding 	AO2 AO2	1 1	
2	(c)		One for the light source and one for the 'tools'	AO1	1	

Total: 15 Marks

3	(a)	(i)	$v=f\lambda$	AO1	1	Must be an equation – not just a ‘triangle’
3	(a)	(ii)	2×10^5 gains 2 marks One compensation mark for correct substitution $f = 330 / 1.65 \times 10^{-3}$	AO2 AO2	1 1	
3	(b)		0.45 – 0.46 gains all 3 marks Up to 2 compensation marks, one each for: Correct equation $\alpha = \{(Z_1 - Z_2) / (Z_1 + Z_2)\}^2$ Correct substitution Answer of 0.67 (i.e. forgot to square) gains 2 marks as long as equation is stated correctly.	AO2 AO2 AO2	1 1 1	
3	(c)	(i)	<ul style="list-style-type: none"> To reduce the difference in acoustic impedance/to avoid interference To avoid reflections at the surface of the skin/to increase transmission through the skin/ improve <u>acoustic</u> contact. 	AO1 AO1	1 1	‘impedances are the same’ is insufficient but ‘impedances become the same’ is just sufficient. Contact and conductivity both insufficient. ‘conductivity of <u>sound</u> waves’ allowed bod. Indication of electrical contact negates both marks.

3	(c)	(ii)	The same / similar	AO1	1	
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Total: 9 Marks

4	(a)		<ul style="list-style-type: none"> • Ultrasound images are produced by (differential) reflection • X-ray images are produced by (differential) transmission. Allow absorption	AO1 AO1	1 1	Allow 'one is reflection the other is transmission/absorption' for 1 mark max
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4	(b)		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.			5xAO 2	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						

4	(b)	1	0-1	<p>-answer is largely incomplete, it may contain some valid points which are not clearly linked to an argument structure</p> <p>-unstructured answer</p> <p>-errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency</p>			
				<p>A typical answer would include:</p> <p><i>Ultrasound would be a better choice to check whether the injury was to a muscle. This is because X-rays would not produce a good image of muscle as its density is too low. This means there would not be enough difference in density to produce a good contrast image. The density of the muscle would not be enough to absorb a significant amount of the X-rays. Ultrasound images would be clearer because they rely on reflection at boundaries with different acoustic impedances. There would be enough difference in acoustic impedance to produce a clear image. X-rays would, however, produce greater contrast images of bones and therefore would be more effective at showing bone injury. The other issue is that X-rays are known to be dangerous because their ionising radiation damages cells. Ultrasound is not known to have any dangers and is therefore the safer option.</i></p>			

Total: 7 Marks

5	(a)	(i)	The time taken for half the radioactive nuclei present to decay	AO1	1	Or write Allow decompose but not disintegrate
5	(b)	(i)	<ul style="list-style-type: none"> Sensible sized, even scales All points correctly plotted Sensible line of best fit (exponential curve) 	AO2 AO2 AO2	1 1 1	Point 2 – must be drawn with axes the right way round.
5	(b)	(ii)	<ul style="list-style-type: none"> 2.2 days Evidence of taking more than one measurement and averaging 	AO2 AO2	1 1	Marks are independent. Time as read correctly from graph as long as reasonable lbf. 2.1-2.3 gains first mark.
5	(c)	(i)	12.5 (g) gains 2 marks One compensation mark for evidence of iterative approach	AO2 AO2	1 1	
5	(c)	(ii)	4 hours gains all 3 marks One compensation mark for up to 2 of: Correct equation Correct substitution 3/12 gains 2 marks	AO2 AO2 AO2	1 1 1	Full marks can be awarded for an answer that is not exactly 4 if the candidate has worked using decimals.

5	(d)	(i)	<p>Yes (no mark)</p> <ul style="list-style-type: none"> • Long enough for the trace to take place • (Patient) will not remain radioactive for too long/ activity will decay quickly 	AO2 AO2	1 1	<p>Accept 'no' if justified well. Point 2 'long enough to be a tracer' is insufficient Point 3 accept 'will not be long enough to cause serious damage' but not anything as vague as 'not long enough to damage the body'. Note this is about how long the isotope remains active not about how quickly it is excreted by the body. Therefore 'leaves the body' is irrelevant.</p>
5	(d)	(ii)	<ul style="list-style-type: none"> • Gamma • Needs to have high penetration • Must be detected outside the body/ by gamma camera 	AO2 AO2 AO2	1 1 1	<p>Incorrect reference to half-life negates one mark. All marks independent.</p>
5	(d)	(iii)	<p>the radioisotope accumulates in a specific organ</p>	AO1	1	<p>Allow 'is attracted to' or 'is absorbed the most' but not 'targets' 'has preference for' or 'is absorbed by'.</p>
5	(e)	(i)	<ul style="list-style-type: none"> • Stochastic – random process / probability depends on dose / severity does not depend on dose. • Somatic – not hereditary 	AO1 AO1	1 1	<p>Any answer that combines both points e.g. ' a random process that is not hereditary' is wrong as the two definitions are quite independent.</p>

5	(e)	(ii)	<p>Any two of:</p> <ul style="list-style-type: none"> • The energy/ activity/ intensity/ penetration of the radiation • The type of radiation/ ionisation • The length of exposure time/frequency of irradiation/ amount of previous exposure to radiation • The type of cells/tissue exposed/ part of body exposed (accept age of subject if relevant and explained) 	AO1 AO1	1 1	'the dose' can be accepted for either point 1 or point 3.
5	(e)	(iii)	<ul style="list-style-type: none"> • Any relevant precaution (ignore wearing a film badge, lead lined clothing or working in a lead lined room) e.g. handle with tongs place in lead lined box when not in use • Matching explanation of why the precaution protects the experimenter. e.g. ensures no contact with skin prevents exposure to unnecessary radiation 	AO3 AO3	1 1	Note, this is about protecting self not others.

Total: 23 Marks

6	(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>		
			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

6	(a)	(i)	<p><i>A typical answer would include:</i> <i>Equipment needed:</i> <i>Raylamp & comb, Powerpack, White paper, Sharp pencil, Protractor, rule,</i> <i>Glass block</i></p> <p><i>Place the glass block onto the paper and draw around the outside.</i> <i>Send a thin ray of light into one side of the block.</i> <i>Mark its path into and out of the block using the sharp pencil.</i> <i>Remove the block.</i> <i>Use a ruler & pencil to draw straight lines showing the path of the light into the block, through the block and out of the block.</i> <i>Now draw in a normal at 90° to the block where the ray entered. Measure the angles of incidence and refraction.</i> <i>Calculate the refractive index using</i> $n = \frac{\sin i}{\sin r}$</p>	5xAO 3	5	
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6	(a)	(ii)	<p>Any two of the following four paired marks:</p> <ul style="list-style-type: none"> • Use a sharp pencil / use a thin ray of light • To ensure you mark the centre of the rays (allow to ensure precision if explained). • Use large angles • To reduce the <u>percentage</u> error in measuring • Repeat • To check for anomalies / to find an average/ to ensure results are similar/ to ensure reliability. • Carry out in a dark room • So rays can be seen clearly (do not allow to stop other sources of light interfering) 	<p>AO3 AO3 AO3 AO3</p>	<p>1 1 1 1</p>	
6	(b)		<ul style="list-style-type: none"> • Low refractive index means high critical angle • High critical angle/ low refractive index means TIR is less likely to occur • Because light must hit the boundary at an angle greater than the critical angle to reflect • (As TIR is less likely to occur) less light will be transmitted by reflection <p>Accept converse for all points.</p>	<p>AO2 AO2 AO2 AO2</p>	<p>1 1 1 1</p>	

Total: 13 Marks