Version 1.0

General Certificate of Education (A-level) Applied
January 2013

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.

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<table>
<tr><th>Question</th><th>Part</th><th>Sub-part</th><th>Marking guidance</th><th>AO</th><th>Mark</th><th>Comment</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td>
<table>
<tr><th>description</th><th>Name of part</th><th>Correct label.</th></tr>
<tr><td>Allows electrons to move freely without colliding with air particles.</td><td>Vacuum /evacuated tube</td><td>B</td></tr>
<tr><td>Produces X-rays</td><td>anode</td><td>C</td></tr>
<tr><td>Produces electrons</td><td>cathode</td><td>F</td></tr>
<tr><td>Prevents X-rays escaping (accept radiation)</td><td>Lead casing</td><td>A</td></tr>
</table>
</td><td>AO1
AO1
AO1
AO1
AO1
AO1</td><td>6</td><td></td></tr>
<tr><td>1</td><td>(b)</td><td>(i)</td><td>• The anode is in a vacuum
• Particles are needed for conduction & convection to occur</td><td>AO2
AO2</td><td>2</td><td>Second point is synoptic. Allow ‘air particles’ or ‘materials’ but not ‘air’.</td></tr>
<tr><td>1</td><td>(b)</td><td>(ii)</td><td>• Black (c.a.o.)</td><td>AO1</td><td>1</td><td>synoptic</td></tr>
<tr><td>2</td><td>(a)</td><td>(i)</td><td>A</td><td>AO1</td><td>1</td><td></td></tr>
<tr><td>2</td><td>(a)</td><td>(ii)</td><td>C</td><td>AO1</td><td>1</td><td></td></tr>
<tr><td>2</td><td>(b)</td><td>(i)</td><td>123/80 (mm Hg) c.a.o.</td><td>AO1</td><td>1</td><td>Ignore units</td></tr>
</table>

<table>
<tr>
<td>2</td>
<td>(b)</td>
<td>(ii)</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>
</table>
</td>
<td>5xAO1</td>
<td>5</td>
<td></td>
</tr>
</table>

				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	
						A typical answer would include: *The nurse wraps the sphygmomanometer cuff around the patient's upper arm, level with their heart. The nurse inflates the cuff, whilst using the stethoscope to listen for blood flow. When the blood flow has stopped, the nurse stops inflating the cuff. The nurse then starts to deflate the cuff, still listening for blood flow. When he first hears the blood flowing again, the nurse notes the pressure reading on the sphygmomanometer scale. This gives the value of systolic pressure. He deflates the cuff further and notes the pressure reading when he can no longer hear the blood flow. This is the diastolic reading.*	

2	(c)	(i)	Any acceptable reason with corresponding explanation. For example: • Less chance of infection/scarring/bleeding • Because there is no incision OR • Less stress for patient • Less chance of false reading due to stress	AO2 AO2	2	
2	(c)	(ii)	• Probe is in contact with the blood itself / not measuring through other tissue. Accept answers related to less human error when reading if justified e.g. through reference to analogue scale. 'Near blood' or 'in the body' are insufficient.	AO2	1	
2	(d)	(i)	• 60-80 (bpm) c.a.o.	AO1	1	Synoptic Ignore unit unless it refers to an incorrect time period, e.g. bps – in which case it will negate.
2	(d)	(ii)	• <u>Finger(s)</u> on inside of wrist/ other acceptable area e.g. brachial/carotid artery (accept use of appropriate machine including where machine is placed) • count number of beats in a set time	AO1 AO1	2	Synoptic
3	(a)		Any 2 of: • absorption depends on density of tissue • cancerous tissue has different density from non-cancerous tissue • absorption is different for cancerous and non-cancerous tissue	AO2 AO2	2	

3	(b)	(i)	• detection of heat • emitted by the body	AO1 AO1	2	

3	(b)	(ii)	• cancerous & non-cancerous tissues emit different amounts of heat • Show up different brightness/colours on thermogram OR colour/brightness on thermogram depends on how hot the emitting tissue is.	AO2 AO2	2	

3	(c)	(i)	• (Thermography is) non invasive • X-rays are ionising • X-rays/ ionising radiation can damage/mutate cells/tissue/ can cause cancer	AO2 AO2 AO2	3	

3	(c)	(ii)	• Clearer image/ better contrast • Therefore less subjective OR • More familiar • Therefore easier to interpret accurately (or wtte) Allow other reasonable responses if justified. Do not allow ‘cheaper’ or ‘more common’.	AO2 AO2	2	

3	(d)		Any two acceptable reasons with matching explanations. For example: • (Too) dangerous • Higher/very high levels of radiation used OR • (Far) more expensive • Money could be spent elsewhere OR • Less available • Would have to wait too long for appointment OR • Take too long • Many patients could be X-rayed in the same time.	AO2 AO2 AO2 AO2	4	

4	(a)	(i)	• 1650 Correct answer gains 2 marks irrespective of working. I compensation mark for correct equation OR correct substitution.(max 1) • hz OR s^{-1}	AO2 AO2 AO2	3	

4	(a)	(ii)	• As it is below 20 000 Hz (accept because frequency is too low)	AO2	1	Ultrasound is 20000hz is insufficient. Appropriate reference to human hearing range acceptable.

4	(b)	(i)	• High refractive index means low critical angle • More rays will hit the boundary above the critical angle • Rays only reflect if they hit the boundary at an angle greater than the critical angle • More rays will be reflected/ more chance of reflection/ more total internal reflection/more light will travel along the fibre/ optical fibres use total internal reflection/ less light lost.	AO2 AO2 AO2 AO2	4	

4	(b)	(ii)	• 50.28^0 (accept 49 – 51) Correct answer gains full 3 marks irrespective of working. 1 compensation mark for correct equation OR correct substitution OR correct use of sines (max 2)	AO2 AO2 AO2	3	Sin c = 1/n = 1/1.3 = 0.77; $c=\sin^{-1} 0.77 = 50.28^0$

4	(b)	(iii)	• It will travel out of the side of the fibre/pass through the glass/be refracted • Because it meets the boundary at an angle lower than the critical angle. (allow ecf from (ii) for both points)	AO1 AO1	2	If neither mark awarded then allow credit for calculating angle of refraction: correct equation gains 1 mark, correct answer gains both marks. Refracting in the wrong direction negates first mark.

4	(c)		Any 4 relevant points. For full marks advantages of both methods need to be considered.(accept converse i.e. disadvantages of alternative method) e.g. advantages of ultrasound: no need for incision / <u>less</u> invasive no <u>known</u> dangers of using ultrasound possibly no need for anaesthetic advantages of laser treatment: surgeon can view through endoscope whilst carrying out surgery More likely to destroy stones completely.	AO2 AO2 AO2 AO2	4	

5	(a)		Any two sensible suggestions, e.g.: • Patient is less likely to be anxious/ can be done at home • May be able to monitor other aspects of sleep e.g. heart rate, blood pressure • No wires so could sleep more normally • Portable/can be done at home	AO2 AO2	2	

5	(b)		Any sensible suggestion e.g.: • <u>More likely</u> to get poor connections • Interference more likely • Only being trialled <u>so reliability/effectiveness not known</u> • Won't measure brain waves as <u>directly</u>	AO2	1	

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<td>5</td>
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				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	
						A typical answer would include: *You would need a radiation detector, for example a Geiger-Muller tube, and counter. You would also need a metre rule.* *You would set up the source a few centimetres from the detector and measure how much radiation was detected in a given time, for example, one minute. You would then increase the distance, and again measure how much radiation is detected in the same time interval. You would continue to do this until no radiation, other than background radiation was detected. You would need to make sure you increased the distances by small amounts. Record your results and plot a graph of radiation detected against the distance from the source.*	

6	(a)	(ii)	Any two of: • Warning signs • Return source to <u>effective</u> storage whenever not needed • Handle with tongs • Do not point at anyone • Short exposure time • Small amount / low activity radioisotope Allow other precautions that would be possible <u>in a standard school laboratory.</u> Do not allow: wear goggles, wear gloves, carry out in a lead lined room, wear lead lined clothing, wear a lead apron/ wear a film badge.	AO3 AO3	2	

6	(a)	(iii)	• Background radiation/ other sources • Source placed too far away from detector / source too weak / anomalies not dealt with /random nature of radioactivity produces anomalies for low counts/ short half-life/ measurement time too short.	AO3 AO3	2	

6	(a)	(iv)	• Repeat (do not accept 'repeat and average' but 'remove anomalies and average' is just acceptable)	AO3	1	

6	(b)	(i)	Any 3 of: • Beta radiation is ionising.(good for implant, bad for tracer) • Ionising radiation damages cells/tissue it passes through .(good for implant, bad for tracer) • Beta radiation can kill cancer cells locally./acts at site • Beta has medium/ low penetration .(good for implant, bad for tracer) • Beta cannot be detected outside the body .(good for implant, bad for tracer) Note: To gain full marks there must be reference to: o why beta is suitable as an implant o why beta is unsuitable as a tracer o ionisation o penetration	AO2 AO2 AO2	3	

6	(b)	(ii)	• Accept any half-life of one month or more. Any 2 of: • Long enough to treat the cancer • Implant would not need to be replaced too frequently • Implant would remain at a steady (accept 'high') activity for a long period. Do not credit any of these points if half-life selected is less than one week.	AO2 AO2 AO2	3	Allow 'several weeks' (point 1)

6	(c)	(i)	• 0.75 (g) (correct answer alone gains both marks) 1 mark compensation for EITHER recognition of 4 half lives OR correct use of iterative method.	AO2 AO2	2	

6	(c)	(ii)	• Remains active long enough <u>to carry out the trace</u> • Loses activity quickly enough so <u>patient</u> does not stay radioactive for long/ is not likely to be harmed	AO2 AO2	2	

6	(c)	(iii)	Any 2 of: • No organ affinity • Can be attached to a range of pharmaceuticals • Not toxic / chemically dangerous • Daughter product not toxic • Can be easily made (when required) / easily available • (Comparatively) cheap.	AO1 AO1	2	