AQA

A-LEVEL
Applied Science
SC08 Medical Physics
Mark scheme

8770
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Version: V1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer 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 associates 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 associate understands and applies it in the same correct way. As preparation for standardisation each associate 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, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

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

1a	To get a quick response / to maximise conduction / to maximise energy transfer	AO1	Accept: to conduct easily / to improve conduction	1
1b	Narrow bore inner tube	AO1	Accept large spaces between marks OR triangular cross section OR has a magnifier	1
1c	diagnose brain disorders / research sleep / monitor the effects of anaesthetics / provide evidence of brain death	AO1	Verb required 'Monitor/measure brain activity' is insufficient Other reasonable specific answers accepted e.g. look at brain death	1
1d	Electrical impulses	AO1	Allow electrical activity	1
1e	Breathing	AO1	Synoptic question Allow any relevant specific use, e.g. vital capacity, lung function. Also allow 'the lungs'.	1

2a	125/80	AO1	c.a.o	1
2b	Heart muscles/heart/ventricle (left) is contracting	AO1	Accept valves close/blood forced into the ventricles/ ventricles are contracting	1
2c (i)	• Blood pressure is a measure of how hard blood is being forced through the body. • Pulse rate is a measure of how many times the heart beats in a given time.	AO1	Accept w.t.t.e Note 'pressure of the blood' is insufficient.	2
2c (ii)	• Blood pressure taken level with the heart / so values will be the same/close to that of the heart. • Have to be able to detect the pulse easily / artery near the surface / artery not 'hidden' by too much tissue.	AO1	Accept 'in line with the heart' 'Close to the heart (position) is insufficient'.	2
2d (i)	Advantage : • more accurate Explanation: • because directly in the bloodstream	AO2	Mark both aspects as one as advantage might be written as the explanation and vice versa. Accept 'accuracy'	2
2d (ii)	Disadvantage: • more chance of infection/bleeding/scarring Explanation: • because an incision has to be made	AO2	'Because it is in the bloodstream' accepted for 2nd marking point only if the first point has been awarded. 'Invasive' is insufficient (it's in the stem) Accept 'may give incorrect reading because of patient's anxiety (1) anxiety of invasive procedure may increase blood pressure (1)'. Mark both aspects as one as disadvantage might be written as the explanation and vice versa.	2

3a	Both X-rays and gamma rays are high frequency electromagnetic waves. Both are highly penetrating and very energetic. If we look at how each type of wave is produced and detected, however, we can see that they are quite different. X-rays are produced by X-ray machines. In an X-ray machine, electrons are fired at a metal anode and the energy they transfer is released in the form of X-rays. The amount and the energy of the X-rays produced can be controlled by the machine operator. Gamma rays are released naturally from radioisotopes. Their release is random, decreasing as the radioisotope decays, and cannot be controlled. Both X-rays and gamma rays are detected by photographic film, but X-rays cannot be detected by other radioactivity detectors, such as Geiger-Muller tubes and gamma cameras. **examples of the points made in the response** • X-rays are emitted from X-ray machines and stars • Gamma rays are emitted from radioisotopes and stars • The emission of gamma rays from a radioisotope is random. As a radioisotope gets older it will emit gamma rays at a lower rate (related to half-life) • Gamma rays are a form of radioactivity, X-rays are not • Both gamma rays and X-rays are high frequency	AO2	To gain full marks **both** similarities and differences have to be mentioned and it must be clear that the candidate understands that X-rays are not a type of radioactivity. Candidates may use tables to organise their information without penalty.	5

	waves and part of the electromagnetic spectrum • Gamma rays have higher frequency and carry more energy than X-rays • Both have high penetration, but gamma rays are generally more penetrating than X-rays • X-rays are detected by photographic film but cannot be detected by detectors of radioactivity such as Geiger-Muller tubes and gamma cameras • Gamma rays can be detected by photographic film, Geiger-Muller tubes and gamma cameras • Both are dangerous, causing stochastic and non-stochastic effects			

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.
Level 1 (0—1 marks)
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
Level 2 (2—3 marks)
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
Level 3 (4—5 marks)
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 minimum repetition or irrelevant points - accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar

3b	**label**	**name**	**function**	AO1	One mark for each correct line 'Creates a vacuum' is insufficient for line 4.	4
	C	anode	*emits X-rays*			
	A	lead casing	prevents <u>X-rays</u> escaping			
	D	*cathode*	emits <u>electrons</u>			
	B	*evacuated tube*	allows electrons to move freely			

3c	• Barium meal has a high density / is more dense than soft tissue • Barium meal/high density material will absorb X-rays/increases attenuation • X-rays would not have been absorbed by the stomach/low density tissue/ X-rays have to be absorbed for an image to be formed / greater difference in density created / boundaries of tissue more clearly seen.	AO2	Mp.1 accept 'increases density'	3

3d(i)	(Much) higher dose of X-rays/ionising radiation used (to create image)	AO2	Accept: 'CAT scans use a lot of X-rays/ionising radiation' 'Uses more ionising radiation / they are more ionising' is insufficient as it is unclear if there is more radiation or whether the type of radiation used is more ionising.	1

3d(ii)	• Many images taken/images taken from different angles • These images are amalgamated (by a computer to generate an image)	AO1	'Converted' is not a sufficiently clear synonym for amalgamated. Accept 'put together / combined'	2

4a	• Cladding prevents light escaping out of the sides of the fibre (through refraction) • Cladding has a (slightly) lower refractive index than the glass in the core slightly less optically dense than the core • Reflections are at larger angles (than without cladding) / rays must hit at an angle greater than c to reflect / larger critical angle than without cladding. • Less energy is lost / more light is reflected along the fibre/ there are fewer reflections	AO1 x 2 AO2 x 2		4
4b	c = 38.7° (accept 38.68° or 39° − rounding acceptable) One compensation mark for: • correct equation • correct substitution or re-arrangement • correct use of sines up to a maximum of 2	AO2	Correct answer gains all 3 marks irrespective of working shown sin $c = 1/n$ *for 1 mark* $c = \sin^{-1} 1/n$ or sin c = 1/1.6 for 2 marks $= \sin^{-1} 1/1.6$ for 2 marks $= \sin^{-1} 0.625$ for 2 marks = 38.7° Note answer of 0.625 gains 2 marks irrespective of working	3
4c(i)	Blocked artery	AO1		1
4c(ii)	Advantage: • direct observation Explanation: • not reliant on interpreting image of reflected sound /	AO2	Accept other relevant advantages and disadvantages as long as relevant to the comparison asked for (e.g. 'may be possible to take a sample' is an advantage of	4

	easier to identify Disadvantage: • (more) chance of infection/discomfort/need for sedation Explanation: • inserted into the body		endoscopy). In each case, mark both aspects as one as advantage/disadvantage might be written as the explanation and vice versa. Advantages: neither 'direct contact' or 'clearer image ' is sufficient. Disadvantages: 'invasive' alone is insufficient but allow 'more invasive'. '	
4d	• Large difference in acoustic impedance between soft tissue and air (in the lungs) • The greater the difference in acoustic impedance, the higher the proportion of ultrasound reflected • Most of the ultrasound reflected as it first hits the air inside the lungs	AO2	If no other marks awarded, allow one mark for knowing that lungs contain a lot of air and that this is the cause of the problem Allow 'reflection depends on the difference in acoustic impedance' for MP 2.	3
4e	• Tissue made to vibrate / causes tissues to get warmer	AO2		1
4f	Different densities / speed depends on density	AO2	Accept different acoustic impedances/ different molecular structures / depends on acoustic impedance	1

5a(i)	The student will need an iodine-131 source, a suitable detector and an accurate means of measuring thickness – also several very thin sheets of the material to be tested. He will fix the detector as close as possible to the source and record the number of emissions in a given time (say one minute). The student will then put a thin sheet of the test material between the source and the detector, trying to ensure there are no air gaps. He will measure the count rate for the same period of time as before and record the result. The student will then add a second thin sheet of the material and repeat the procedure. He will continue to do this, increasing the thickness by the same amount each time, until the count rate is significantly less than half of the original. The student will repeat the whole procedure twice. **examples of the points made in the response** Equipment used should include: • source • ruler • radiation detector • different thicknesses of the material to be tested Equipment needs to be set up with no air gap between the source and the material or between the material and the detector	AO3	Recording only the thickness that halves the count rate is unlikely to be sufficient to obtain accurate results Candidates have not been asked to explain what they will do with the measurements they take.	5

	Thickness of material tested must be varied Count rates initially and for each thickness used have to be measured and recorded			

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Unstructured answer
Errors in the use of technical terms, spelling, punctuation and grammar or lack of fluency

Level 2 (2—3 marks)

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

Level 3 (4—5 marks)

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 minimum repetition or irrelevant points
- accurate and clear expression of ideas with only minor errors in the use of technical terms, spelling and punctuation and grammar

5a(ii)	Because it is <u>unlikely that the exact half thickness of material will be used</u>; (so drawing a graph is the only likely means of getting an accurate result)	AO3		1
5b(i)	Use thinner pieces of material	AO3	Accept 'use aluminium instead of lead / change materials used/ move source closer to the detector' or w.t.t.e.	1
5b(ii)	Beta has lower penetration (than gamma)	AO3	Accept ''beta is stopped by aluminium' if candidate has stated changing lead for aluminium as the change is (b)(i)	1
5c	You would need a greater thickness of the new material to have the same effect	AO2	'Different thickness' is insufficient. Accept 'larger amount'.	1

5d(i)	Thyroid	AO1		1
5d(ii)	Iodine has organ affinity (to the thyroid).	AO1	Accept 'absorbed by', 'accumulates in' or 'is attracted to' 'Targets' is insufficient	1
5d(iii)	Property: • emits gamma radiation Reason (any one of): • tracers have to be detected outside the body • must be able to penetrate the body	AO2	'Penetrates skin' or 'leaves the body' or 'passes through the body' are insufficient for reason Accept 'Can be detected by a gamma camera' for the reason Accept answers related to fairly low half-life (approx. 8 days) if sensible	2

6a	Any one of: • must act at site • minimises chance of damage to surrounding tissue • avoids radioactivity penetrating out of the body (to radiate others they are in contact with) • ensures maximum ionisation • alpha and beta are strongly ionising	AO1	Apply the 'list rule' if more than one reason given Accept 'low penetration' for MP 1 Any response suggesting that half-life of alpha and beta is more appropriate than that of gamma means 0 will be awarded	1
6b	16 (hours) (gains both marks) One mark compensation for either: • recognition of 3 half-lives • correct iterative method used	AO2	Correct answer gains 2 marks For correct iterative method, count rate must halve but times must have equal intervals each time.	2
6c	12 days (gains 3 marks) One mark compensation for: • correct equation *and* • correct substitution	AO2	Correct answer gains 3 marks irrespective of working 1/12, due to omitting to invert added fractions, gains 2 marks	3
6d	Less friction with tissue than scalpel produces/cauterises as it cuts	AO2	Answers relating to less chance of infection may be accepted if clearly explained (e.g. related to heat generated). 'Smaller/more precise cuts' is insufficient	1
6e	• Lasers are high energy light beams • Can cause eye damage/burns	AO2		2
6f	4×10^{14} One mark compensation for either: • correct numerical answer with incorrect power of 10 • correct equation	AO2	Accept any figure between 4 and 4.3 Correct answer gains 2 marks irrespective of working	2

7a(i)	• Detection/ imaging of heat/ infra-red (radiation) • Emitted from the body/object (under investigation)	AO1	'Temperature' is insufficient for heat.	2
7a(ii)	Nothing enters (or is removed from) the body/completely non-invasive	AO2		1
7a(iii)	Any three from: • temperature (foot) lower than normal • less heat emitted (than normal) • image shows different temperatures/ different levels of heat. • Image/different temperatures/different levels of heat would show (as) different colours • comparison of colour produced with colour produced for a healthy foot	AO2	Accept 'comparison of foot temperature with normal temperature' for MP1	3
7b(i)	Radio waves	AO1		1
7b(ii)	Better contrast image/less interpretation needed/less chance of being affected by surroundings	AO2	'More accurate/more precise/clearer' are insufficient. Accept 3D image. Do not accept answers that imply MRI scans emit ionising radiation e.g.'CAT scans are more ionising'	1
7c	(X-rays cause) <u>ionisation</u>	AO2	Accept converse.	1