Production & Use of X-Rays Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Торіс	Quantum Physics
Sub Topic	Production & Use of X-Rays
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed:	80 minutes
Score:	/66
Percentage:	/100

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A*	Α	В	С	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	(a) e.g. bea ab sc.	m is divergent/obeys inverse square law sorption (in block) attering (of beam in block)		
	rei (<i>any t</i> w	vo sensible suggestions, 1 each)	B2	[2]
	(b) (i) I	$I = I_0 \exp(-\mu x)$	C1	
	10/	$I = \exp(0.27 \times 2.4)$ = 1.9	A1	[2]
	(ii) I ₀ /	$I = \exp(0.27 \times 1.3) \times \exp(3.0 \times 1.1)$ = 1.42 × 27.1	C1	
		= 38.5	A1	[2]
	(c) either or	much greater absorption in bone than in soft tissue I_{o}/I much greater for bone than soft tissue	B1	[1]

2	(a) shar cor	pness: ease with which edges of structures can be seen itrast: <u>difference</u> in degree of blackening between structures	B1 B1	[2]
	(b) (i)	$I = I_0 e^{-\mu x}$ $I/I_0 = exp(-0.20 \times 8)$	C1	
		= 0.20	A1	[2]
	(ii)	$I/I_0 = \exp(-\mu_1 \times x_1) \times \exp(-\mu_2 \times x_2) \text{ (could be three terms)}$ $I/I_0 = \exp(-0.20 \times 4) \times \exp(-12 \times 4)$ $I/I_0 = 6.4 \times 10^{-22} \text{ or } I/I_0 \approx 0$	C1 C1 A1	[3]
	(c) (i)	sharpness unknown/no	B1	[1]
	(ii)	contrast good/yes (ecf from (b))	B1	[1]

3	(a (i)	edges can be (clearly) distinguished	B1	[1]
	(ii) e.g.	size of X-ray source / anode / target / aperture scattering of X-ray beam pixel size		
	(<i>any</i> furthe	<i>two, 1 each</i>) er detail e.g. use of lead grid	B2 B1	[3]
	(b) X-ray ima CT scan: repeated CT scan i	age involves a <u>single</u> exposure exposure of a <u>slice</u> from many different angles for different slices involves a (much) <u>greater exposure</u>	B1 M1 A1 B1	[4]
4 (a	a) (i) I/I ₀	$= \exp(-1.5 \times 2.9)$ = 0.013	C1 A1	[2]
	(ii) <i>I / I</i> .	$T_0 = \exp(-4.6 \times 0.95)$ = 0.013	A1	[1]
	(b) attenuation	on (coefficients) in muscle and in fat are similar	B1	
	attenuatio contrast o	on (coefficients) in bone and muscle / fat are different depends on difference in attenuation	B1 B1	[3]

 5 (a) X-ray taken of slice / plane / section repeated at different angles images / data is processed combined / added to give (2-D) image of slice repeated for successive slices to build up a 3-D image image can be viewed from different angles / rotated 		B1 B1 B1 B1 B1 B1 max 6	[6]
(k	b) (i) 16	A1	[1

 (b) (i) 16
 A1

 (ii) evidence of deducting 16 then dividing by 3
 C1

 to give
 A1

. 0	
3	2
6	5

6	(a)	(i)	e.m. radiation / photons is produced whenever a charged particle is accelerated wavelength depens on magnitude of acceleration electrons have a distribution of accelerations	M1 A1 A1	[0]
				A0	[၁]
		(ii)	<i>either</i> when electron loses all its energy in one collision <i>or</i> when energy of electron produces a single photon	B1	[1]
	(b)) (parallel beam (in matter)	B1	
			$I = I_0 \exp(-\mu x)$ I, I_0 , (μ) and x explained	M1 A1	[3]
		(ii)	either low-energy photons absorbed (much) more readily		
			or low-energy photons (far) less penetrating	B1 B1	
			low energy photons could cause tissue damage	B1	[3]
				[Total:	10]

[2]

7	(a) C	T image: (thin) slice (through structure) any further detail e.g. built up from many 'slices' / 3-D image X-ray image: 'shadow' image (of whole structure) / 2-D image		B1 B1 B1	[3]
	(b) 2 t t	X-ray image <u>of slice</u> taken from many different angles these images are combined (and processed) repeated for many different slices to build up a 3-D image 3-D image can be rotat computer required to store and process huge quantity of data (<i>any five, 1 each to max 5</i>)	 (1) (1) (1) (1) (1) (1) 	В5	[5]
8	(a	X-ray beam directed through body onto detector (plate) different tissues absorb/attenuate beam by different amounts giving 'shadow' image of structures any other detail e.g. comment re sharpness or contrast		B1 B1 B1 B1	[4]
	(b)	X-ray image is flat OR 2-dimensional (1) CT scan takes many images of a slice at different angles (1) these build up an image of a slice through the body (1) series of images of slices is made (1) so that 3D image can be built up (1) image can then be rotated (1) 1 mark for each point, max 5		В5	[5]

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