Ultrasound

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Waves
Sub Topic	Ultrasound
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** product of density (of medium) and speed (of ultrasound) in the medium — M1 A1 [2]

(b) **(i)** $7.0 \times 10^6 = 1.7 \times 10^3 \times$ speed — C1
speed = $4.12 \times 10^3\,\text{m s}^{-1}$
wavelength = $(4.12 \times 10^3)/(9.0 \times 10^5)\,\text{m}$ — C1
= 4.6 mm *(2 s.f. minimum)* — A1 [3]

(ii) for air/tissue boundary, $I_R/I \approx 1$ — M
for air/tissue boundary, (almost) complete reflection/no transmission — A1
for gel/tissue boundary, $I_R/I = 0.1^2/3.1^2$
$= 1.04 \times 10^{-3}$ *(accept 1 s.f.)* — M1
gel enables (almost) complete transmission (into the tissue) — A1 [4]

2 **(a)** product of density and speed — M1
density of medium, speed of wave in medium — A1 [2]
(*not "speed of light", 0/2*)

(b) $\alpha = (6.4 - 1.7)^2/(6.4 + 1.7)^2$ — C1
= 0.34 — A1 [2]

(ii) $I/I_0 = e^{-\mu x}$ — C1
= exp $(-23 \times 3.4 \times 10^{-2})$ — C
= 0.46 — A1 [3]

(iii) $I_R/I = (0.46)^2 \times 0.34$ — C1
= 0.072 — A1 [2]

3 **(a)** pulse (of ultrasound) B1
produced by quartz / piezo-electric crystal (1)
reflected from boundaries (between media) B1
reflected pulse detected B1
by the ultrasound transmitter (1)
signal processed and displayed B1
intensity of reflected pulse gives information about the boundary (1)
time delay gives information about depth (1)
(*four B marks plus any two from the four, max. 6*) B2 [6]

(b) shorter wavelength B1
smaller structures resolved / detected (*not more sharpness)* B1 [2]

(c) ($I = I_0 e^{-\mu x}$ C1
ratio = $\exp(-23 \times 6.4 \times 10^{-2})$ C
= 0.23 A1 [3]

(ii) later signal has passed through greater thickness of medium M1
so has greater attenuation / greater absorption / smaller intensity A1 [2]

4 **(a)** product of density and speed of sound / wave M1
(density of medium and) speed of sound / wave in medium A1 [2]

(b) if $(Z_1 - Z_2)$ is small, mostly transmission M1
if $(Z_1 - Z_2)$ is large, mostly reflection M1
(if 'mostly' not stated allow 1/2 marks for these first two marks)
either reflection / transmission also depends on $(Z_1 + Z_2)$
or intensity reflection coefficient = $(Z_1 - Z_2)^2 / (Z_1 + Z_2)^2$ A1 [3]

(c) e.g. smaller structures can be distinguished B1
because better resolution at shorter wavelength / higher frequency B1 [2]

5	quartz/piezo-electric crystal			B1	
	p.d. across crystal causes	*either*	centres of (+) and (–) charge to move		
		or	crystal to change shape	B1	
	alternating p.d. (in ultrasound frequency range) causes crystal to vibrate			B1	
	crystal cut to produce resonance			B1	
	when crystal made to vibrate by ultrasound wave			M1	
	alternating p.d. produced across the crystal			A1	[6]