Ultrasound

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Waves
Sub Topic	Ultrasound
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **51 minutes**

Score: **/42**

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 sound (in the medium)   B1   [1]

   (b) α would be nearly equal to 1   M1
   either reflected intensity would be nearly equal to incident intensity
   or coefficient for transmitted intensity = $(1 - \alpha)$ M1
   transmitted intensity would be small   A1   [3]

   (c) ($\alpha = (1.7 - 1.3)^2 / (1.7 + 1.3)^2$ C1
   = 0.018   A1   [2]

   (ii) attenuation in fat = $\exp(-48 \times 2x \times 10^{-2})$ C1
   $0.012 = 0.018 \exp(-48 \times 2x \times 10^{-2})$ C1
   $x = 0.42\,cm$ A1   [3]

2 **(a) (i)** density × <u>speed of wave</u> (in the medium)   B1   [1]

   (ii) $\rho = (7.0 \times 10^6) / 4100$
   = $1700\,kg\,m^{-3}$ A1   [1]

   (b) (i) $I = I_T + I_R$ B1   [1]

   (ii) 1. $\alpha = (0.1 \times 10^6)^2 / (3.1 \times 10^6)^2$ C1
   = 0.001   A1   [2]

   2. $\alpha \approx 1$ A1   [1]

   (c) *either*   very little transmission at an air-skin boundary   M1
   (almost) complete transmission at a gel-skin boundary   M1
   when wave travels in or out of the body   A1   [3]
   or   no gel, majority reflection   (M1)
   with gel, little reflection   (M1)
   when wave travels in or out of the body   (A1)

3 *either* quartz *or* piezo-electric crystal   B1
   opposite faces /two sides coated (with silver) to act as electrodes   B1
   either molecular structure indicated
   or   centres of (+) and (−) charge not coincident   B1
   potential difference across crystal causes crystal to change shape   B1
   alternating voltage (in US frequency range) applied across crystal   B1
   causes crystal to oscillate / vibrate   B1
   (crystal cut) so that it vibrates at resonant frequency   B1   [6]
   (max 6)

4 **(a)** <u>pulse</u> of ultrasound   (1)
        reflected at boundaries / boundary   (1)
        received / detected (at surface) by transducer   (1)
        signal processed and displayed   (1)
        time between transmission and receipt of pulse gives
        (information about) depth of boundary   (1)
        reflected intensity gives information as to nature of boundary   (1)
        (any four points, 1 each, max 4)   B4   [4]

   (b) (i) coefficient $= (Z_2 - Z_1)^2 / (Z_2 + Z_1)^2$
                             $= (6.3 - 1.7)^2 / (6.3 + 1.7)^2$ C1
                             $= 0.33$ *(unit quoted, then −1)*   A1   [2]

      (ii) fraction $= \exp(-\mu x)$ C1
                             $= \exp(-23 \times 4.1 \times 10^{-2})$
                             $= 0.39$ A1   [2]

      (iii) intensity $= 0.33 \times 0.39^2 \times I$ C1
                             $= 0.050\, I$ A1   [2]
              *(do not allow e.c.f. from **(i)** and **(ii)** if these answers are greater than 1)*

5 **(a)** product of density (of medium) and speed of <u>sound</u> (in medium) ....B1   [1]

   (b) difference in acoustic impedance M1
         determines fraction of incident intensity
         that is reflected/amount of reflection ....A1   [2]

   (c) <u>pulse</u> of ultrasound (directed into body) B1
         reflected at boundary (between tissues) B1
         (reflected pulse is) detected and processed B1
         time for return of echo gives (information on) depth B1
         amount of reflection gives information on tissue structures ....B1   [5]