

Name of the Student: _____

Max. Marks : 23 Marks

Time : 23 Minutes

Mark Schemes

Q1.

(a) $d / 21 \times 10^{-3} = 12 \times 10^{-3} / 61$ ✓

$d = 4.1 \times 10^{-6} \text{ m}$ ✓

$4.1 / 1.5 = 2.75$ ✓

Eye can resolve the images as they are more than 2 cell diameters apart / a distance greater than $3 \times 10^{-6} \text{ m}$ apart / separated by at least 1 unstimulated cell ✓

Marks 3 and 4 are ECF.

4

(b) Three curves labelled blue, green, red from left to right ✓

Roughly at correct height green, red above 2/3 green, and blue less than 1/3 green ✓

Blue 375 to 500, green 425 to 675, red 475 to 725 ; all + or -30 ✓

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[7]

Q2.

(a) There will be many answers possible and examiners must use their professional judgement. These answers may include:

- Using scan before treatment to locate the precise position / size of the tumour
- Using X-rays of the correct energy for the depth/size of the tumour
- Using a computer to position X-ray relative to patient / target the tumour
- Minimising time of use
- Irradiating tumour from different directions
- Less damage caused to healthy cells

✓ ✓ ✓ for three relevant answers

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(b) The thickness of material needed to reduce the intensity of the X-ray beam by half ✓

1

(c) $\mu = \ln 2 / \text{half thickness}$ ✓

$\mu = 165$ ✓

$\mu_m = \mu / \rho = 1.5 \times 10^{-2}$ ✓ unit $\text{m}^2 \text{ kg}^{-1}$ ✓

Unit mark is independent of the numerical answer or indeed a lack of

Q3.

- (a) Mention of ear's sensitivity starting low, increasing to maximum and then falling again resulting in convex nature of their curve which is wrong as does not fall after 5 kHz / should fall at higher frequencies and not plateau ✓

Mention of 1 kHz being the reference frequency for both scales / mention of 3 kHz being the frequency of maximum sensitivity of the ear ✓

both scales should have same reading at 1 kHz which they don't / it is wrong that the curves cross at about 750 Hz ✓

dBA curve should have maximum value at 3 kHz which it doesn't / wrong as max sensitivity of dBA scale is shown at 4 kHz ✓

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- (b) Initial use of 110 dB in correct equation –

$$110 = 10 \log (I / I_0)$$

leading to correct calculation of intensity = $0.10 \text{ (W m}^{-2}\text{)}$ ✓

Use of equation the calculated intensity = $7.8 / 4\pi r^2$ ✓

Leads to distance = 2.5 m ✓

Thus 2 m is slightly too close to the drill as it is less than 2.5m ✓

The 4 marks are basically

1. The correct manipulation of the equation relating intensity and power.

2. The correct answer from this.

3. The correct use of the decibel equation.

4. A suitable statement relating numbers.

These marks can come in any order depending on how they attack the problem. They may do 3 before 1 and 2, as in my original mark scheme, but many are doing 1 and 2 before 3.

If 1 is wrong then this is EOP and thus 2 cannot be awarded, but 3 and 4 are ECF and are still available.

Be aware that by using the initial power and distance quoted in the question, the final answer for the intensity level is 112 dB. Some candidates may then say that to 2sf, this is 110 dB which is that quoted as the safe level. This argument must be given the credit which it deserves.

Remember that ECF is available from 2 to 3, or from 3 to 1 and 2.

The final mark is for a sensible comment based on their final answer with some numeric comparison.

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