Mark schemes

Q1.

(a) Max 3 from ✓✓✓

Use of $I = I_0 10^{\frac{IL}{10}}$ to find intensity ✓a

Intensity reduction factor of 0.40 ✓b

Multiply the **intensity** by 0.40 or 0.60 ✓c

Use of $IL = 10\log\left(\frac{I}{I_0}\right)$ to find intensity level ✓d

✓a $I\left(=I_0 10^{\frac{IL}{10}}\right) = 10^{-12} 10^{\frac{110}{10}} (= 0.10\ \mathrm{W\,m^{-2}})$

✓b *condone reduction of intensity level*

✓c *I = 0.10 × 0.40 (= 0.040 W m^{-2})*

✓d $IL = \left(10\log\left(\frac{I}{I_0}\right) = 10\log\left(\frac{0.040}{10^{-12}}\right)\right) = 106\,(\mathrm{dB})$

✓d *substitution for I must be an intensity, not an intensity level*

1 mark for answer of 108 (dB) with no supporting working

Alternative method

Max 3 from ✓✓✓

Reduction factor of 0.40 seen ✓a

Use of their reducing factor in ΔIL equation ✓b eg

$\Delta IL = 10\log\left(\frac{I_2}{I_1}\right) = 10\log(0.40)$

Value of ΔIL consistent with their reduction factor eg ΔIL = (-) 3.98 ✓c

Subtraction of their ΔIL from 110 eg new IL = 110 - 3.98 ✓d

106 (dB) ✓

106 (dB) ✓

(b) Idea of reduction in sensitivity at all frequencies ✓1

Most loss occurs at 4 kHz ✓2

✓1 for idea of reduction in sensitivity accept: hearing loss/ perceives sounds to be quieter/ drop in perceived loudness/ higher intensity required for same loudness

✓2 accept a range of ±1 kHz provided that 4 kHz lies in the range

✓2 Do not award for any suggestion that this is due to the loud noise being at 4 kHz

If no other mark given award 1 mark for suggestion that person will suffer from tinnitus

2

[6]

Q2.

(a) Power (of sound) per unit area

OR

Energy (of source) per unit area per second ✓

allow 'per m^2' for 'per unit area'

1

(b) *I* + 3

1

(c) Division of areas seen OR correct use of factor of 20 ($20 \times 5.9 \times 10^{-6}$) ✓

Use of incorrect relationship between pressure, force and area receives zero marks.

Expect to see

$$\frac{20 \times 5.9 \times 10^{-6}}{7.2 \times 10^{-5}}$$

1.6 ✓

Condone 1.6: 1 for MP2

2

[4]

Q3.

(a) Frequency axis labelled from 100, 1000, 10 000, including the location of 3000 Hz, if marked ✓

Graph line showing a U shape ✓

Lowest point of graph at 3000 Hz ✓

Allow 1000, 10 000 and 100 000 if line ≤ 20 000

3rd mark depends on a valid scale or clear marking of 3000 Hz at the lowest point.

3

(b) (different) frequencies are played (through earphones) and compared to a 1kHz reference signal ✓

Volume is changed until it sounds the same loudness as the reference signal ✓

2

(c) Correct substitution or correct rearrangement ✓

$$I\left(=I_0 10^{\frac{\text{intensity level}}{10}}\right) = 1 \times 10^{-12} \times 10^{\frac{30}{10}} = 1.0 \times 10^{-9} \text{ ✓ (W m}^{-2}\text{)}$$

e.g. $30 = 10\log \frac{I}{10^{-12}}$

2

[7]