Answers to Coursebook questions – Chapter I1

1 The sound intensity level intensity at a distance of 5 m from the source is $70 = 10\log\frac{I}{1.0\times10^{-12}}$ and so the intensity is $I = 1.0\times10^{-5}\ \text{W m}^{-2}$. This is related to power through $I = \frac{P}{4\pi d^2} \Rightarrow P = I4\pi d^2$ and so $P = 4\pi\times25\times1.0\times10^{-5} = 0.0031 \approx 3\ \text{mW}$.

2 The intensity of sound from one child is $75 = 10\log\frac{I}{1.0\times10^{-12}} \Rightarrow I = 3.16\times10^{-5}\ \text{W m}^{-2}$ and so the intensity from three children is

$75 = 10\log\frac{I}{1.0\times10^{-12}} \Rightarrow I = 3\times3.16\times10^{-5} = 9.48\times10^{-5}\ \text{W m}^{-2}$.

The sound intensity level is then $10\log\frac{9.48\times10^{-5}}{1.0\times10^{-12}} = 79.8 \approx 80\ \text{dB}$.

Note: You can do this faster by saying $10\log\frac{3I}{I_0} = 10\log3 + 10\log\frac{I}{I_0} = 4.77 + 75 \approx 80\ \text{dB}$.

3 If the distance is halved, the intensity will increase by a factor of $2^2 = 4$. Hence the new sound intensity level will be $10\log\frac{4I}{I_0} = 10\log4 + 10\log\frac{I}{I_0} = 6.02 + 68 \approx 74\ \text{dB}$.

4 $IL_1 = 10\log\frac{I_1}{I_0}$ and $IL_2 = 10\log\frac{I_2}{I_0}$. Therefore, $IL_1 - IL_2 = 10\log\frac{I_1}{I_0} - 10\log\frac{I_2}{I_0} = 10\log\frac{I_1}{I_2}$.

Hence $15 = 10\log\frac{I_1}{I_2} \Rightarrow \frac{I_1}{I_2} = 10^{1.5} \approx 32$.

5 Using the result of **Q4**, $10 = 10\log\frac{I_1}{I_2} \Rightarrow \frac{I_1}{I_2} = 10^{1.0} \approx 10$ and so 10 radios are required.

6 The loss in dB is 70 dB and so to get to 0 dB the intensity must be increased to $70 = 10\log\frac{I}{1.0\times10^{-12}} \Rightarrow I = 1.0\times10^{-5}\ \text{W m}^{-2}$.

7 The threshold of the hearing curve represents, at each frequency, the least intensity of sound that can be heard. The most sensitive frequency for this patient is 3 kHz. At 200 Hz the sound intensity level is about 22 dB, and so $22 = 10\log\frac{I}{1.0\times10^{-12}} \Rightarrow I = 1.58\times10^{-10} \approx 1.6\times10^{-10}\ \text{W m}^{-2}$.

8 The reason is that the sensation of hearing is not proportional to the intensity of sound but rather the logarithm of the sound intensity.

9 The gap between air and bone conduction data is very small and so the problem is most likely a cochlea problem in the inner ear.