MEDICAL PHYSICS

2-2 Sound measurements

1. Eardrum area = 3.0 mm^2 = 3.0 x 10^{-6} m^2

Rate of sound energy transfer = 6.6 x 10^{-8} Js^{-1} = power of sound in W

I_0 = 1.0 x 10^{-12} Wm^{-2}

(a) Intensity = $\frac{\text{Power}}{\text{Area}} = \frac{6.6 \times 10^{-8}}{3.0 \times 10^{-6}}$ = 2.2 x 10^{-2} Wm^{-2}

(b) Intensity in decibels = $10\log\left(\frac{I}{I_0}\right) = 10\log\left(\frac{2.2 \times 10^{-2}}{1.0 \times 10^{-12}}\right)$ = 103 dB to 3 sf or 100 dB to 2 sf

2. dB = $10\log\left(\frac{I}{I_0}\right)$ so $\log\left(\frac{I}{I_0}\right) = \frac{dB}{10} = \frac{123}{10}$ = 12.3

Hence $\frac{I}{I_0}$ = $10^{12.3}$

As I_0 = 1.0 x 10^{-12}

I = 1.0 x 10^{-12} x $10^{12.3}$ = 1.995… = 2.0 Wm^{-2} to 2 sf

3. 1st reading 60 dB

2nd reading 65 dB

(a) If the intensity of the sound was increased by the same amount again the reading would rise another 5 dB (same factor, therefore same rise).

The meter would then read 70 dB.

(b) dB = $10\log\left(\frac{I}{I_0}\right)$ so 65 = $10\log\left(\frac{I}{1.0 \times 10^{-12}}\right)$

$\log\left(\frac{I}{1.0 \times 10^{-12}}\right)$ = 6.5

I = 1.0 x 10^{-12} x $10^{6.5}$ = 3.16… x 10^{-6} = 3.2 x 10^{-6} Wm^{-2} to 2 sf

4. 102 dB lorry

(a) dB = $10\log\left(\frac{I}{I_0}\right)$ so 102 = $10\log\left(\frac{I}{1.0 \times 10^{-12}}\right)$

$\log\left(\frac{I}{1.0 \times 10^{-12}}\right)$ = 10.2

I = 1.0 x 10^{-12} x $10^{10.2}$ = 1.58… x 10^{-2} = 1.6 x 10^{-2} Wm^{-2} to 2 sf

(b) Both lorries have the same intensity value

So total intensity = (1.6 x 10^{-2} +{ 1.6 x 10^{-2}} = 3.2 x 10^{-2} Wm^{-2}

Intensity in dB = $10\log\left(\frac{3.2 \times 10^{-2}}{1.0 \times 10^{-12}}\right)$ = 105 dB