

**M1.(a)** (i) The dB scale  
*Allow decibel scale Not DB* 1  
 Equal response across all frequencies  
*Allow unaffected by / independent of frequency* 1

(ii) The dBA scale  
*Allow adjusted / adapted decibel scale Not DBA* 1  
 Response depends upon **frequency** as **ear's response** does 1

(b) (i) Point R has equal values on both scales (as 1kHz) is the frequency used to define threshold value  
*Allow reference frequency for dBA scale* 1

(ii) Point S is at (3kHz as this is) the frequency at which the ear is most sensitive  
*Allow most sensitive as at peak of curve* 1

(c)  $I = 1.0 \times 10^{-12} \times 10^{9.5}$   
*First mark for any correct initial equation* 1  
 $I = 3.2 \times 10^{-3} \text{ (W m}^{-2}\text{)}$   
*Only penalise 1 sig fig* 1

[8]

**M2.(a)** Frequency does not change ✓ 1

Amplitude is reduced ✓ 1

(b) Ossicles lever system produces increase in force ✓ 1

Area of oval window much less than area of ear drum ✓ 1

Pressure =  $F / A$  so large increase in pressure ✓ 1

(c)  $I = 1.0 \times 10^{-12} \text{ W m}^{-2}$  ✓  $\times 10^{3.2}$  ✓ 1

$I = 1.6 \times 10^{-4} \text{ W m}^{-2}$  ✓ 1

(d)  $P = 1.6 \times 10^{-4} \times 4 \times \pi \times 2.02$  ✓ 1

$P = 8.0 \times 10^{-3} \text{ W}$  ✓ 1

[10]

**M3.(a)** Minimum intensity heard by normal / average ear ✓  
At frequency of 1kHz ✓ 2

(b) Response of ear is logarithmic ✓  
Allows very large range of intensities to be on sensible scale ✓ 2

- (c) (i) Ageing; loss increases as  $f$  increases ✓  
*Allow higher frequencies are lost*

1

- (ii) Noise; loss increases up to 4 kHz ✓  
then decreases after this frequency ✓  
*Allow loss increases and then decreases for 1 mark*  
*Allow greatest loss at 4kHz for 2 marks*

2

[7]