

M1. (a) (i) longitudinal/pressure waves in the ear canal **(1)**
 forces eardrum into mechanical vibrations **(1)**
 (mechanical) vibrations (passed through middle ear) by a lever system/series of bones/named bones to the oval window **(1)**
 sets up pressure waves in fluid in cochlea **(1)** max 3

(ii) force increased by the action of the lever system/series of bones/named bones; value $F \times 1.5$ **(1)**
 area of oval window \ll area of the eardrum ; value $A/20$ **(1)**
 effect of pinna in increasing intensity in ear canal **(1)** max 2

(b) $46 = 10 \times \log (I/(1.0 \times 10^{-12}))$ **(1)**
 $I = 4.0 \times 10^{-8}$ **(1)**
 $W m^{-2}$ **(1)** 3

(c) dBA scale is frequency dependent to match the response of the ear **(1)**
 ear more sensitive (than I_0) for a range of frequencies between 1 and about 2.6 kHz **(1)** 2

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M2. (a) A ear drum or tympanic membrane **(1)**
 transfers vibration of sound waves into mechanical oscillations
 B ossicles **(1)**
 system of levers to multiply the force **(1)**

[or system of levers to link outer and inner ear]

- C cochlea (1)
converts pressure wave in fluid into electrical signal (1)

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(b) (use of *intensity level* = $10 \log \frac{I}{I_0}$ gives) $42 = 10 \log \frac{I}{1.0 \times 10^{-12}}$ (1)
 $I = 1.6 \times 10^{-8} \text{ W m}^{-2}$ (1)

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- M3.A** ear drum [or tympanic membrane] (1)
transfers sound waves from the outer ear to the
ossicles of the middle ear (1)

- B ossicles [or bones of the middle ear] (1)
system of levers with a mechanical advantage (of 1.5) [or amplification]
[or which links two membranes (ear drum and oval window)
or transmits sound vibrations from outer to inner ear] (1)

- C windows: oval and round (1)
allow sound vibrations to enter the fluid of the inner ear
[or allows sound vibrations to be transmitted around the cochlea
or contain the inner ear's fluid while allowing the fluid to move] (1)

- D cochlea (1)
convert (pressure) waves [or vibrations] in the fluid into electrical signals
[or stimulates (auditory) nerves to send signals to the brain] (1)

[8]