Mark scheme for Support Worksheet – Option I, Worksheet 1

1 The cochlea. [1]

2 The eardrum begins to vibrate. [1]

3 The ossicles are on the other side of the eardrum and with the eardrum vibrating the ossicles act as a lever system amplifying the sound; before feeding it into the inner ear. [2]

4 The force acting on the eardrum and the oval window is the same; the difference in area results in a larger pressure on the oval window enabling the ear to hear faint sounds. [2]

5 From about 20 Hz to 20 kHz. [1]

6 The lower limit gets larger; and especially the higher limit gets lower. [2]

7 The sensation of loudness is proportional to the logarithm of the intensity of sound. [1]

8 The sound intensity level is related to the intensity of sound through

$$SIL = 10\log_{10}\frac{I}{10^{-12}}$$ [1]

9 $SIL = 10\log_{10}\frac{I}{10^{-12}} = 10\log_{10}\frac{2.6\times10^{-9}}{10^{-12}}$; $SIL = 34$ dB [2]

10 $92 = 10\log_{10}\frac{I}{10^{-12}}$; and so $I = 10^{-12}\times10^{9.2} = 1.58$ mW m^{-2} [2]

11 **a** From the minimum of the curve we find about 3000 Hz. [1]

b The wavelength is $\lambda = \frac{340}{3000} = 0.113$ m ; the fundamental wavelength in the canal is $4L$; and so $4L = 0.113 \Rightarrow L = \frac{0.113}{4} = 0.028 \approx 3$ cm [3]

c The intensity of 2.6×10^{-9} W m^{-2} corresponds to a sound intensity level of $SIL = 10\log_{10}\frac{I}{10^{-12}} = 10\log_{10}\frac{2.8\times10^{-10}}{10^{-12}} \approx 25$ dB ; from the graph this corresponds to a range of approximately 70 Hz to 18 kHz. [2]

12 The distance after which the transmitted intensity is reduced to half the original intensity. [1]

13 The probability per unit length that a particular photon will be absorbed. [1]

14 $\mu = \frac{\ln 2}{x_{1/2}} = \frac{\ln 2}{2.17} = 0.3194$ cm^{-1}; so $I = I_0 e^{-\mu x} = I_0 e^{-0.3194\times2.30}$; $I = I_0 \times 0.480$ [3]

15 By having as point-like a source of X-rays as possible; by preventing scattered X-rays from making marks on the film by placing metal strips in between the patient and the film along the direction of the incident X-rays. [2]

16 The patient must swallow a barium meal; which absorbs X-rays much more strongly than the surrounding tissue. [2]

17 X-rays are directed from all directions at a thin slice of the body; the intensity of the X-rays is measured after they exit the body; each slice is divided into 'pixels' and the amount of X-rays absorbed in each pixel is calculated; the procedure is repeated for other slices of the body in order to get a 3-dimensional image. [4]

18 To calculate the absorption of the X-rays in each pixel; as well as the reconstruction of a 3-dimensional image from data on individual slices of the body requires enormous computing time. [2]

19 Sound of frequency above the 20 kHz limit of hearing of humans. [1]

20 An alternating voltage is applied to a crystal; the crystal vibrates and emits ultrasound. [2]

21 The product of the density of the medium and the speed of sound in that medium. [1]