1. (a) A point source of sound has a power of 17 W.

Calculate, in dB, the intensity level at a distance of 12 m from the source.

intensity level = _____ dB

(3)

(b) The frequency of a sound is increased from 3.0 kHz to 8.0 kHz with no change in intensity.

One change in the sound perceived by a person with normal hearing is an increase in pitch.

Explain **one** other change to the sound perceived by the person as the frequency is increased from 3.0 kHz.

_____

_____

_____

_____

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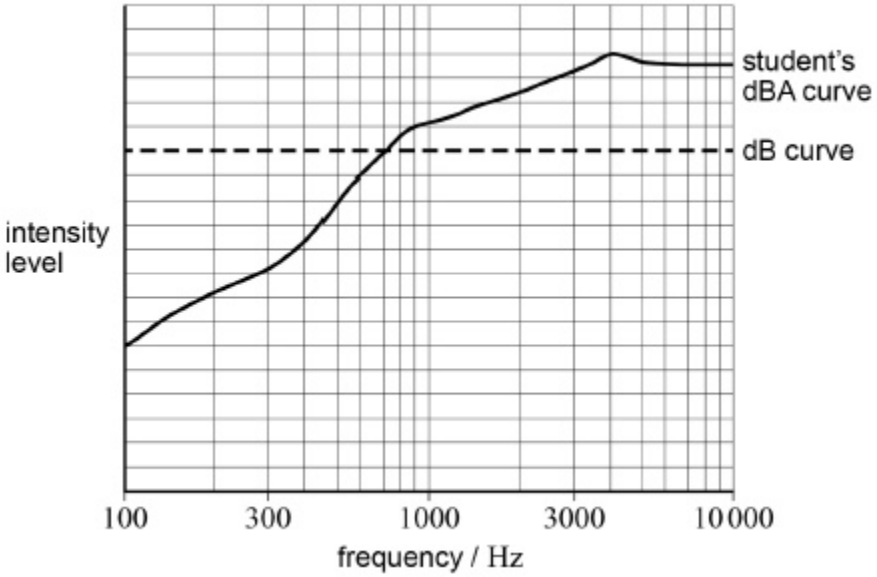
_____

(2)

(Total 5 marks)

2. (a) A source of constant output power is used to generate a sound which is measured using a sound meter.

The dashed line in the graph shows the intensity level curve over a range of frequencies with the meter set to the dB setting.



A student sketches a curve, over the same frequency range, which he thinks would be obtained when the meter is changed to the dBA setting. The curve drawn by the student is shown as the solid line in the graph.

Discuss whether the dBA curve drawn is correct.

(4)

(b) Mesh barriers are set up to keep pedestrians at a safe distance from a noisy drill.
The maximum noise level which pedestrians should be subjected to is 110 dB
The drill emits sound with a power of 7.8 W and acts as a point source.
The mesh barriers are set up a distance of 2.0 m from the drill.

Discuss whether this will keep pedestrians at a safe distance from the sound source.

(4)

(Total 8 marks)

3. Three customers, **P**, **Q** and **R**, are sitting in a café listening to music from a loudspeaker.
Customer **P** is 11 m from the loudspeaker. At the position of customer **P**, the sound intensity is 3.4×10^{-8} W m^{-2}.

(a) Customer **P** moves to a distance of 7.0 m from the loudspeaker.

Calculate the sound intensity at the new position of customer **P**.
Assume that the loudspeaker is a point source.

sound intensity = _____ W m^{-2}

(2)

(b) The sound intensity level is 65 dB at the position of customer **Q** and 42 dB at the position of customer **R**.

Calculate the ratio $\frac{\text{sound intensity at the position of } \mathbf{Q}}{\text{sound intensity at the position of } \mathbf{R}}$

ratio = _____

(2)

(c) Customer **Q** perceives the loudness of the sound differently to customer **R**.

Discuss whether the use of intensity level or intensity is more appropriate to compare the perceived loudness.

_____

_____

_____

_____

(2)

(d) Customers **P**, **Q** and **R** move to the same distance from the loudspeaker.

Customer **P** is 80 years old and has hearing loss due to her age.

Customer **Q** is 35 years old and has hearing loss due to working in an extremely noisy environment.

Customer **R** is 35 years old and has no hearing loss.

The hearing defects of **P** and **Q** affect their perception of the music being played.

Describe how their perceptions are different from that of **R**.

(3)

(Total 9 marks)

4. A sound wave produces a maximum increase in pressure on an ear of 2.5×10^{-3} N m^{-2}.

This causes a maximum increase in pressure in the fluid of the inner ear of 5.0×10^{-2} N m^{-2}.

(a) Explain how the ossicles contribute to this increase in pressure in the fluid of the inner ear.

(2)

(b) The ear's tympanic membrane can be assumed to be a circle of diameter 1.0 cm.

Calculate the area, in m^2, of the oval window.

area = _____ m^2

(3)

(Total 5 marks)