**Instructions and Tips**

- Assume the speed of sound in air ($c_{air}$) is = 340 $m \cdot s^{-1}$, and the speed of sound in water ($c_{water}$) is = $4 \cdot c_{air}$.
- A calculator is not necessary to answer these questions.

1. An increase in sound power by a factor of 2 corresponds to how many decibels (dB)?

   **$dB = 10 \cdot \log_{10} (W_x / W_{ref})$**

   **$dB = 10 \cdot \log_{10} (2 / 1)$**

   **$dB = 10 \cdot (0.301)$**

   **$dB = 3.01$ (or just 3 dB)**

2. What is the intensity level re: $10^{-12}$ W/m$^2$ of a sound whose absolute intensity is $10^{-6}$ W/m$^2$?

   **$dB = 10 \cdot \log_{10} (I_x / I_{ref})$**

   **$dB = 10 \cdot \log_{10} (10^{-6} / 10^{-12})$**

   **$dB = 10 \cdot \log_{10} (10^{6})$**

   **$dB = 60$**

3. What is the intensity level re: $10^{-12}$ W/m$^2$ of a sound whose absolute intensity is $2 \times 10^{-6}$ W/m$^2$?

   **$dB = 10 \cdot \log_{10} (I_x / I_{ref})$**

   **$dB = 10 \cdot \log_{10} (2 \times 10^{-6} / 10^{-12})$**

   **$dB = 10 \cdot \log_{10} (2 \times 10^{6})$**

   **$dB = 10 \cdot [\log_{10} (2) + \log_{10} (10^{6})]$**

   **$dB = 63$**

4. 20 dB corresponds to what intensity ratio?

   **$dB = 10 \cdot \log_{10} (I_x / I_{ref})$**

   **$20 = 10 \cdot \log_{10} (I_x / I_{ref})$**

   **$2 = \log_{10} (I_x / I_{ref})$**

   **$100 = (I_x / I_{ref})$**

5. An increase in sound pressure by 3 dB corresponds to an increase in sound power by ______ decibels?

   **An increase in sound pressure by 3 dB corresponds to an increase in sound power by 3 dB.**

6. An increase in sound pressure by a factor of 2 corresponds to how many decibels?

   **$dB = 20 \cdot \log_{10} (P_x / P_{ref})$**

   **$dB = 20 \cdot \log_{10} (2 / 1)$**

   **$dB = 20 \cdot \log_{10} (0.301)$**

   **$dB = 6.02$ (or just 6 dB)**

7. An increase in sound pressure by a factor of 10 corresponds to how many decibels?

**$dB = 20 \cdot \log_{10} (P_x / P_{ref})$**

**$dB = 20 \cdot \log_{10} (10 / 1)$**

**$dB = 20 \cdot (1)$**

**$dB = 20$**

8. A sound with an absolute pressure of $4 \times 10^5$ μPa corresponds to how many decibels re: $2 \times 10^2$ μPa?

**$dB = 20 \cdot \log_{10} (P_x / P_{ref})$**

**$dB = 20 \cdot \log_{10} (4 \times 10^5 / 2 \times 10^2)$**

**$dB = 20 \cdot \log_{10} (2 \times 10^3)$**

**$dB = 20 \cdot [\log_{10} (2) + \log_{10} (10^3)]$**

**$dB = 66$**

9. 26 dB corresponds to what pressure ratio?

**$dB = 20 \cdot \log_{10} (P_x / P_{ref})$**

**$26 = 20 \cdot \log_{10} (P_x / P_{ref})$**

**$1.3 = \log_{10} (P_x / P_{ref})$**

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**$1.0 = \log_{10} (10)$ and**

**$0.3 = \log_{10} (2)$ . Therefore:**

**$1.3 = [\log_{10} (10) + \log_{10} (2)]$**

**$1.3 = \log_{10} (10 \cdot 2)$**

**$1.3 = \log_{10} (20)$**

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**$\therefore 20 = (P_x / P_{ref})$**

10. What are the fundamental ($f_0$) and first two resonant harmonic frequencies of a 25 cm tube that is open only at <u>one end</u>?

**$f_0 = ¼ \cdot c / L$ , $\therefore$ $f_3 = 3 \cdot c / 4 \cdot L$ and $f_5 = 5 \cdot c / 4 \cdot L$ , and**

**$L = ¼ \cdot \lambda$ (i.e. tube length is ¼ meter per cycles; $\lambda$ = meters per cycle of waveform)**

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**$f_0 = 340\ m \cdot s^{-1} / [4 \cdot (¼\ m \cdot cycles^{-1})]$**

**$f_0 = 340\ m \cdot s^{-1} / 1\ m \cdot cycles^{-1}$**

**$f_0 = 340\ cycles \cdot s^{-1}$ or Hz (1 Hz = 1 cycle per second)**

**$\therefore f_3 = 3 \cdot (340\ Hz) = 1020\ Hz$**

**$\therefore f_5 = 5 \cdot (340\ Hz) = 1700\ Hz$**

11. A friend is talking to you from poolside while you are swimming. After you finish your workout, you explain to her that it is almost impossible for you to hear airborne sounds from underwater because of the huge impedance mismatch at the air-water surface interface. If 99.9% of airborne sound energy reflects off the surface of the water, what is the transmission loss in dB?

    **99.9% sound energy reflects ∴ 0.1% sound energy is absorbed & transmitted through water**

    **0.1% is an absorption coefficient of 0.001**

    **dB** $= 10 \cdot \log_{10} (0.001)$

    **dB** $= 10 \cdot (-3)$

    **dB** $= -30$