

# **Audiology Workbook**

*Third Edition*

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*Third Edition*

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# Preface

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This third edition of *Audiology Workbook* is composed of an abundance of questions and activities designed as a means for undergraduate and beginning graduate students to reinforce their knowledge of concepts and procedures traditionally covered in introductory hearing science and clinical audiology courses. Our intent was to develop a workbook that required focused work and thought in areas that are typically difficult to understand without a lot of practice, in areas that include acoustics, anatomy, physiology, interpreting and describing audiograms, masking, immittance, screening for hearing loss, otoacoustic emissions, and auditory brainstem testing. In addition, there are exercises designed to reinforce knowledge of auditory disorders, and a chapter entirely devoted to case studies in order to help students learn how to integrate basic diagnostic test results and relate them to a variety of hearing disorders. New to this edition is a separate chapter on vestibular anatomy, physiology, disorders, and assessments for those who wish to learn more about this area of audiology.

The activities and questions are comprehensive and challenging and are designed so they may be answered with relatively short answers; the questions may also be appropriate as items for group discussion. As with the previous editions, there is a complete set of answers at the back of the workbook to guide the student in the learning process. This workbook serves as a useful companion to any introductory textbook in audiology, along with some additional literature and input from the instructor. We hope that students who use this workbook will learn to apply and think about what they have covered in class or read in their textbook and will end up with a solid foundation and appreciation of audiology.

## Features and Additions to This Edition

This third edition of *Audiology Workbook* has been extensively revised from the previous edition. This edition represents a collaboration with a new co-author, Larry Small, whose longtime teaching experience and expertise in audiology and hearing science provided an opportunity to make the workbook even more useful to students new to audiology. In addition, users of past editions of the workbook were surveyed and their feedback was important in helping us revise this edition. The workbook is an appropriate supplement to any introductory audiology textbook and/or class lectures and focuses on exercises and questions that are appropriate for any traditional audiology undergraduate or beginning Au.D. course in hearing science and audiology principles and procedures. This edition updates, expands, and reorganizes material from previous editions but retains the features that worked well, including detailed answers for all of the exercises. We have added more exercises in traditionally difficult areas such as properties of sound, anatomy/physiology, audiogram interpretation/description, and masking. In addition, there are now separate chapters on immittance, OAEs and ABRs, as well as a chapter on the vestibular system and its assessment. The popular case studies have been revised into a more consistent format with answers written similar to how they might be done in a

clinical audiology report. We are excited about all the improvements in this edition that will help beginning students gain a better understanding, through crafted exercises and probing questions, about audiology concepts.



# Acknowledgment

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*We wish to acknowledge and thank  
Dr. Lesli Guthrie  
for her contributions to earlier editions of this workbook.*



*To all current and future students who take the challenge to work through this workbook—for you will come to know and appreciate audiology.*

*To my wife Paula, and to all of my colleagues for their continued support during the revision of this workbook.*

—Steven Kramer

*To dB.*

—Larry H. Small



# 1

## Properties of Sound and Speech Acoustics

**1.1** What is the speed of sound in air, in meters/second (m/s), and how does it compare to the speed of light? Is the speed of sound in air faster or slower than the speed of sound in water, and why?

**1.2** Given the following frequencies, calculate the period in seconds (s) and in milliseconds (ms).

A. 20 Hz

B. 60 Hz

C. 250 Hz

D. 500 Hz

E. 1000 Hz

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F. 2000 Hz

G. 2500 Hz

H. 4000 Hz

I. 8000 Hz

J. 20,000 Hz

**1.3** Given the following periods in seconds (s), calculate the frequency (Hz).

A. 0.0000625 s

B. 0.0001 s

C. 0.000125 s

D. 0.00025 s

E. 0.0005 s

F. 0.001 s

G. 0.002 s

H. 0.004 s

I. 0.008 s

J. 0.04 s

**1.4** Given the following periods in milliseconds (ms), convert the period to seconds (s) and calculate the frequency (Hz).

A. 0.125 ms

B. 0.250 ms

C. 0.400 ms

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D. 0.500 ms

E. 1.000 ms

F. 2.000 ms

G. 4.000 ms

H. 25.000 ms

I. 500.000 ms

J. 1000.000 ms

**1.5** Calculate the log (base 10) for each of the following:

A.  $\log 10^5$

B.  $\log 10^{14}$



C.  $\log 10^7$

D.  $\log 10^{10}$

E.  $\log 10^4$

F.  $\log 10$

G.  $\log 1$

H.  $\log 2$

I.  $\log 4$

J.  $\log 100$

K.  $\log 10,000$

L.  $\log 1,000,000$

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**1.6** How are sound pressure and sound intensity related to each other?

**1.7** As *sound intensity* increases by a factor of 4, *sound pressure* increases by what factor?

**1.8** Write the general formulas for decibels of intensity and decibels of pressure.

**1.9** Write the formula for dB intensity level (dB IL).

**1.10** Write the formula for dB sound pressure level (dB SPL).

**1.11** Calculate the dB intensity level (dB IL) for the following sounds.

A.  $10^{-7} \text{ w/m}^2$

B.  $10^{-4} \text{ w/m}^2$

C.  $0.000001 \text{ w/m}^2$

D.  $10^{-3} \text{ w/m}^2$

E.  $10^{-9} \text{ w/m}^2$

F.  $0.000000000001 \text{ w/m}^2$

**1.12** Given the following descriptions, calculate how the dB IL of tone 1 compares with tone 2.

A. Tone 1 is twice the intensity of tone 2.

B. Tone 1 is one-half the intensity of tone 2.

C. Tone 1 is three times more intense than tone 2.

D. Tone 1 is four times more intense than tone 2.

E. Tone 1 is  $10^2$  times more intense than tone 2.

F. Tone 1 is 1,000,000 times more intense than tone 2.

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**1.13** Calculate the dB sound pressure level (dB SPL) for the following measured sounds.

A. 20,000  $\mu\text{Pa}$

B. 200  $\mu\text{Pa}$

C.  $10^3$   $\mu\text{Pa}$

D. 400,000  $\mu\text{Pa}$

E. 8000  $\mu\text{Pa}$

F.  $2 \times 10^8$   $\mu\text{Pa}$

**1.14** Given the following descriptions, calculate how the dB SPL of tone 1 compares with tone 2.

A. Tone 1 has twice the pressure of tone 2.

B. Tone 1 has three times the pressure of tone 2.

- C. Tone 1 has one-third the pressure of tone 2.
- D. Tone 1 has  $10^2$  times more pressure than tone 2.
- E. Tone 1 has  $10^3$  times more pressure than tone 2.
- F. Tone 1 has 10,000 times more pressure than tone 2.

**1.15** Given the following descriptions, calculate either dB IL or dB SPL as appropriate.

- A. Your cousin was enrolled in voice therapy for a problem with breathy voice. Following voice therapy, her average sound pressure for speech increased from  $2.5 \times 10^2$   $\mu\text{Pa}$  to  $4.5 \times 10^3$   $\mu\text{Pa}$ . What was the increase in your cousin's vocal output in dB?
- B. In English, the phoneme with the greatest intensity, /ɔ/, is 680 times greater in intensity than the least intense phoneme, the consonant /θ/. What is the difference in dB between these two phonemes?
- C. Your grandfather purchased a new hearing aid. Unamplified, your grandmother's voice is, on average, approximately  $10^0$  dyne/cm<sup>2</sup>. With the hearing aid, your grandfather hears her voice at an average level of  $10^{-2}$  dyne/cm<sup>2</sup>. In dB, how much does his new hearing aid amplify your grandmother's voice?

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- D. You purchased a new pair of noise-canceling headphones to wear on your plane ride to Hawaii last month. The intensity of the background noise on the plane (prior to wearing the headphones) was  $4 \times 10^{-2}$  watt/m<sup>2</sup>. While wearing the headphones, the intensity of the noise was reduced to  $2 \times 10^{-3}$  watt/m<sup>2</sup>. How much noise reduction (in dB) did the headphones provide?

**1.16** You have three radios playing—each of them has an output of 68 dB SPL.

- A. What is the combined dB SPL of all three radios?
- B. You turn off one of the radios. What is the combined dB SPL of the remaining two radios?

**1.17** You have two electric fans blowing—one has an output of 70 dB SPL and the other has an output of 75 dB SPL.

- A. What is the combined dB SPL of the two fans?
- B. Now you turn on a third fan with an output of 90 dB SPL. What is the combined dB SPL of all three fans?

**1.18** Give three common methods used to describe the overall amplitude of a pure tone.