Instructors' Manual and Test Bank

For

Introduction to Audiology
13th Edition

Frederick N. Martin
Professor Emeritus
Communication Sciences and Disorders
The University of Texas at Austin

John Greer Clark
Professor
Communication Sciences and Disorders
University of Cincinnati

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto
Delhi Mexico City Sao Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

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Preface

This book was originally designed as a primary text for a single-term instructional course in audiology. A variety of pedagogical features were incorporated within the first edition of the text to facilitate student mastery of new concepts in the study of hearing diagnostics and treatment. Each edition has seen an increase in coverage of this evolving field of study and the expanding scope of practice of its practitioners. And as coverage has expanded, so have the pedagogical aides provided within the text to support student learning. These include:

- Learning objectives at the beginning of each chapter to direct students' attention to the material to be introduced.
- Bold facing of all new terms that are fully defined in the glossary at the end of the book.
- A comprehensive glossary that serves as a full dictionary of audiologic terms.
- A large number of illustrative figures with instructional captions throughout the text.
- Summary tables at the end of each chapter.

- An expansion of the instructive "Evolving Case Studies" that are followed from chapter to chapter.
- Twenty demonstrative videos that can be accessed by clicking the video box on the margins of select pages in the e-text.
- A list of frequently-asked questions for each chapter derived from students' actual queries in class and during office hours.
- Brief examinations following each major section within chapters for self-assessment of learning with immediate feedback on selected answers
- Interactive activities at the conclusion of most chapters that include diagram labeling and matching exercises.

This instructors' manual and accompanying PowerPoint slides have been created to further facilitate student learning by making the task of teaching audiology courses easier. The provision of examination questions and other materials can serve to free course instructors from some of the more mundane tasks, allowing them to devote their time to other aspects of their teaching.

Instructors are encouraged to use all or any part of the materials in this instructors' manual to assist in offering audiology courses. Each chapter in this manual opens with a restatement of the chapter's learning outcomes. These learning outcomes are numbered as they are in the text with numbers corresponding to the major heading within the chapter in which the learning outcome is addressed. Learning outcomes are followed by a listing of vocabulary items to which students will be introduced within the corresponding book chapter. Extrapolation of these vocabulary lists from the text facilitates instructors' development of study sheets or vocabulary quizzes pertinent to select chapters. For more in-depth assessment of student learning, essay questions, short answer questions and multiple choice questions are provided. A large sampling of case studies is provided for class discussion. Each includes a background history, expected audiometric findings, the diagnosis of the case based on the findings, the probable etiology, discussion of case management and reasons for the decisions drawn. Any portion of any material in this manual may be used in its entirety, edited, substituted, or augmented with other materials.

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Chapter 1

The Profession of Audiology

Compared to other professions in the health arena, audiology is a relative newcomer, emerging from the combined efforts of otology and speech pathology during World War II. Following the war, this new area of study and practice grew rapidly within the civilian sector because of the high prevalence of hearing loss in the general population and the devastating effects on individuals and families when hearing loss remains untreated. To support the needs of those served fully, especially the pediatric population, audiologists often maintain close working relationships with speech-language pathologists and educators of people with hearing impairment. A mutual respect for what each profession brings to auditory (re)habilitation leads to the highest level of remediation for those served.

Today the profession of audiology supports a variety of specialty areas and is transitioning toward a professional doctorate as the entry-level degree. Given projected population demographics, students choosing to enter this profession will find themselves well placed for professional growth and security.

Learning Objectives

The purpose of this opening chapter is to introduce the profession of audiology, from its origins through its course of development to its present position in the hearing-healthcare delivery system. At the completion of this chapter, the reader should be able to

1.1 Describe the evolution of audiology as a profession.
1.1 Discuss the differences between licensure and certification and why an audiologist might choose to become certified.
1.1 Describe the reasons that speech-language pathologists may interact closely with audiologists as they provide services within their chosen professions.
1.2 Discuss the impact of hearing impairment on individuals and society.
1.2 List specialty areas within audiology and the employment settings within which audiologists may find themselves.

Vocabulary Items

Aural rehabilitation	Otology
Prevalence	Speech-language pathology

Chapter 1 Test Items

Essay Question

1. Discuss the economic burden hearing loss presents to society.

Short Answer Questions

1. Audiology developed from the professions of _____ and _____.

2. A founder of audiology, often called the "father of audiology," is _____.

3. Two professional documents that govern the practice of audiology are _____ and _____.

4. The entry-level degree for the profession of audiology is the_____.

5. The credential required for the practice of audiology in the United States is _____.

6. The two organizations most closely associated with audiology are _____ and _____.

7. List three areas that are impacted by hearing loss in adults besides hearing sensitivity.

8. The work of audiologists in areas of noise is sometimes called _____.

Multiple Choice Questions

1. Audiology developed from the professions of
    a. Education, and psychiatry
    b. Social work and speech pathology
    c. Otology and speech pathology
    d. Speech pathology and education

2. A founder of audiology, often called the "father of audiology," is
    a. Raymond Carhart
    b. David Goldstein
    c. Jack Katz
    d. Jerry Northern

3. Two professional documents that govern the practice of audiology are
    a. Organizational chart and business plan
    b. Scope of practice and code of ethics
    c. Statement of professional purpose and rules and regulations document

4. The entry-level degree for the profession of audiology is the
    a. Master's degree
    b. Ed.D.
    c. Ph.D.
    d. Au.D.

5. The credential required for the practice of audiology in the United States is
    a. State license
    b. ASHA CCC-A
    c. Department of Education registration

6. The two organizations most closely associated with audiology are
    a. Academy of Rehabilitative Audiology and American Academy of Audiology
    b. Academy of Doctors of Audiology and the American Speech-Language-Hearing Association
    c. International Hearing Society and American Auditory Society
    d. American Academy of Audiology and American Speech-Language-Hearing Association

7. Audiology had its beginnings during World War II within
    a. Community-based speech and hearing centers serving the hearing needs of returning veterans
    b. Military-based aural rehabilitation centers
    c. France following the Battle of Verdun and quickly migrated to the United States military hospitals where it blossomed over the next 25 years
    d. Hospital speech pathology departments

8. A speech-language pathologist's scope of practice
    a. Is clearly delineated from that of audiology with no overlap
    b. Allows for the speech pathologist to provide therapeutic aspects of aural rehabilitation and basic checks of hearing aid performance
    c. Is limited beyond work with speech, language and voice disorders to the provision of therapeutic aspects of aural rehabilitation

9. A life time economic burden of hearing loss computed on an average life expectancy of seventy-one years, the economic burden of hearing loss can exceed
    a. $ 250,000
    b. $ 500,000
    c. $ 750,000
    d. $1,000,000

10. The majority of audiologists find employment within
    a. Hospitals
    b. Community speech and hearing centers
    c. Private practice
    d. Physicians' offices

Chapter 1 Test Item Answer Key

Essay Item

1. The student's answer should include the high costs for treatment of transitory ear infections as well as the rehabilitation and educational costs for those with permanent hearing loss. In addition, the later costs of lost income potential for adults with hearing loss should be included in the answer. The astute student may also recognize that there is a national impact from reduced taxes when a person with hearing loss is either not gainfully employed or is working in a position beneath the earning potential that might have been present if he or she had normal hearing.

Short Answer Items

1. otology, speech-language pathology
2. Dr. Raymond Carhart
3. scope of practice, code of ethics
4. Doctor of Audiology (Au.D.)
5. state license
6. American Academy of Audiology, American Speech-Language-Hearing Association
7. general health, psychosocial well-being, generated income
8. industrial audiology

Multiple Choice Items

1. c
2. a
3. b
4. d
5. a
6. d
7. b
8. b
9. d
10. c

Chapter 2

Sound and Its Measurement

Sound may be regarded objectively if we consider its waves in terms of their frequency, intensity, phase, and spectrum. Sounds may also be studied subjectively, in terms of pitch, loudness, or the interactions of signals producing masking or localization. In discussing sound energy it is always important to specify precisely the various aspects and appropriate measurement references, such as hertz, decibels (IL, SPL, HL, or SL), mels, sones, or phons.

LEARNING OBJECTIVES

Understanding this chapter requires no special knowledge of mathematics or physics, although a background in either or both of these disciplines is surely helpful. From this chapter, readers should be able to

2.1 Describe sound waves and their common attributes, and express the way these characteristics are measured.

2.1 Discuss the basic interrelationships among the measurements of sound and demonstrate the ability to perform simple calculations (although at this point it is more important to grasp the physical concepts of sound than to gain skill in working equations).

2.2 Understand the different references for the decibel and when they are used.

2.3 State the difference between physical acoustics and psychoacoustics.

2.4 Discuss the reasons for audiometer calibration and what this may entail in general terms.

Vocabulary Items

American National Standards Institute	Amplitude
Aperiodic	Artificial ear
Artificial mastoid	Beats
Bel	Brownian motion
Cancellation	Complex wave
Components	Compression

Cosine wave	Damping
Decibel	Dyne
Elasticity	Erg
Force	Forced vibration
Formant	Fourier analysis
Free vibration	Frequency
Fundamental frequency	Harmonics
Hearing level	Hertz
Intensity	Intensity level
International Organization for Standardization	Inverse square law
Joule	Kinetic energy
Localization	Logarithm
Longitudinal waves	Loudness
Loudness level	Mass
Mass reactance	Microbar
Newton	Octave
Ohm	Oscillation
Overtones	Period
Phase	Phon
Pitch	Potential
Power	Pressure
Quality	Rarefaction
Ratio	Reactance
Resonance	Resonant frequency
Sensation level	Sinewaves
Sinusoidal	Sound level meter
Sound pressure level	Spectrum
Stiffness	Stiffness reactance
Threshold	Transverse wave
Velocity	Vibration
Watts	Wavelength
Waves	Work

Chapter 2 Test Items

Essay Questions

1. Describe what is meant by Sound Pressure Level, Hearing Level and Sensation Level and how these are used.

2. How would you calibrate an audiometer for air conduction and bone conduction, both with and without electroacoustic equipment?

Short Answer Questions

1. Sound travels through air in the form of ____.

2. Three types of waves discussed in this book are ____, ____, and ____.

3. Waves are described as a series of ____ and ____.

4 Two types of vibration described above are ____ and ____

5. The two major effects on frequency are ____ and ____.

6. The velocity of sound is its ____.

7. The formula for wavelength is ____.

8. The number of beats per second is determined by the difference between two ____.

9. The lowest frequency of vibration in a complex sound is called the ____.

10. Formant frequencies of the human voice are determined by the ____.

11. Two sine waves may be contrasted by their differences in ____, ____, and ____.

12. Decibels cannot be simply added or subtracted because they are ____.

13. The decibel reference on audiometers is ____.

14. Any discussion of decibels must include their ____.

15. The psychological correlate of frequency is ____.

16. The ability to localize sound requires that the individual have ____.

17. The threshold shift of one sound that is caused by the introduction of a second sound is called ____.

18. Audiometer earphones are used to test hearing by ____.

19. An oscillator is placed on the forehead or mastoid to test hearing by ____.

20. The decibel reference used in sound-level meters is ____.

Multiple Choice Questions

1. The zero dB reference level for most sound level meters is
   a. 20 dynes per cm squared
   b. 20 micropascals
   c. 0 dB
   d. 40 watts

2. One parameter not looked at in electroacoustic calibration of audiometers is
   a. frequency
   b. intensity
   c. duration of tonal presentation
   d. attenuator linearity

3. The alternating regions of low pressure and high pressure produced by an object's vibration are called, respectively:
   a. constructive, destructive
   b. rarefactions, condensations
   c. condensations, compressions
   d. troughs, valleys

4. When a sound source produces energy at more than one frequency, the result is a _____ sound.
   a. sinusoidal
   b. simple
   c. loud
   d. complex

5. The reference value for sound power is:
   a. 10^{-16} watt/cm^2
   b. 10^{-4} watts/cm^2
   c. 20μPa
   d. 10^{-12} dynes/cm^2

6. A complex sound is found to have the following frequency components: 100 Hz, 200 Hz, 300 Hz, 400 Hz, and 500 Hz. Its fundamental frequency is:
   a. 50 Hz
   b. 100 Hz
   c. 300 Hz
   d. 500 Hz

7. Complete cancellation of a sound may occur when a _____ encounters a _____
   a. rarefaction, rarefaction
   b. condensation, condensation
   c. rarefaction, condensation
   d. deflection, reflection

8. An object has one frequency at which it will vibrate at its greatest amplitude. This frequency is known as the _____
   a. peak amplitude
   b resonant frequency
   c. octave frequency
   d. harmonic frequency

9. Frequency and intensity are _____ measurements of sound.
   a. physical
   b. perceptual
   c. intuitive
   d. reflective

10. Pitch and Loudness are _____ measurements of sound.
    a. physical

b. reflective
c. intuitive
d. perceptual

11. The amount of time it takes a waveform to complete one cycle is called its _____
    a. wavelength
    b. phase
    c. period
    d. duration

12. The _____ of a sine wave is determined by the number of cycles completed in one second.
    a. phase
    b. frequency
    c. duration
    d. wavelength

13. An increase of _____ dB corresponds to a doubling of sound pressure.
    a. 2
    b. 4
    c. 6
    d. 12

14. At its resonant frequency, a mass vibrates
    a. With the least amount of applied energy
    b. With the greatest amount of applied energy
    c. At its least possible amplitude
    d. As a free vibration

15. The velocity of sound in air is said to be
    a. 20 mph
    b. 1130 ft/sec
    c. 5286 ft/sec
    d. 14.7 mph

16. The period of a sound can be calculated as
    a. Period = 1/frequency
    b. Period = frequency/1
    c. Period = $1/\pi$
    d. Period = frequency/20μPa

17. Masking may take place when
    a. The masker precedes the signal

b. The signal precedes the masker
c. The masker and signal coexist in time
d. All of the above

18. If the fifth harmonic of a sound is 500 HZ, the fundamental frequency is
a. Indeterminable from the above information
b. Determined by wavelength
c. 100 Hz
d. 250 Hz

19. The unit of measurement in equal loudness contorus is
a. mel
b. sone
c. decibel
d. phon

20. The period of a 100 Hz tone is
a. 1/1000 sec
b. 1/100 sec
c. 1/10 sec
d. 1 sec

Chapter 2 Test Item Answer Key

Essay Items

1. In addition to defining SPL, HL and SL, the student's answer should show an understanding how these relate for audiometric testing.

2. A complete response should include discussion of the different purposes between an artificial ear and artificial mastoid and the need for intensity level calibration as well as frequency and attenuator linearity calibration. The response should include mention of the different couplers for supra-aural earphones and insert receivers as well as acknowledgement that the SPL to reach audiometric zero differs for these two transducers and what this means clinically. Finally, recognition of the difference between electroacoustic calibration and biologic calibration and the need for both should be demonstrated in the answer.

Short Answer Items

1. waves
2. transverse, longitudinal, sine
3. compressions, rarefactions
4. forced, free
5. mass, stiffness
6. speed
7. w=v/f
8. frequencies
9. fundamental frequency
10. vocal tract
11. frequency, intensity, phase
12. logarithmic
13. Hearing Level (HL)
14. references
15. pitch
16. similar hearing sensitivity in both ears
17. masking
18. air conduction
19. bone conduction
20. sound-pressure level

Multiple Choice Items

1. b
2. c
3. b
4. d
5. a
6. b
7. c
8. b
9. a
10. d
11. c
12. b
13. c
14. a
15. b
16. a
17. d
18. c
19. d
20. b

Chapter 3

The Human Ear, Hearing Loss and Pure-Tone Hearing Tests

The mechanisms of hearing may roughly be broken down into conductive and sensory/neural portions. Tests by air conduction measure sensitivity through the entire hearing pathway. Tests by bone conduction sample the sensitivity of the structures from the inner ear and beyond, up to the brain.

Early hearing testing was completed with the use of tuning fork tests. Two such tests, still popular today among otologists are the Rinne tuning-fork test which compares patients' own hearing by bone conduction to their hearing by air conduction in order to sample for conductive versus sensory/neural loss and the Weber test which checks for lateralization of a bone-conducted tone presented to the midline of the skull to determine if a loss in only one ear is conductive or sensory/neural.

For modern pure-tone hearing tests to be performed satisfactorily, control is needed over such factors as background noise levels, equipment calibration, patient understanding, and clinician expertise. The audiologist must be able to judge when responses are accurate, and to predict when a sound may have contralateralized to the ear not being tested. When cross hearing occurs, proper masking procedures covered in Chapter 5 must be instituted to overcome this interference. Although at times the performance of pure-tone hearing tests is carried out as an art, it should, in most cases, be approached with a scientific attitude, using rigid controls.

LEARNING OBJECTIVES

The purpose of this chapter is to present a simplified explanation of the mechanism of human hearing and to describe tuning-fork tests that provide information about hearing disorders. Because of the structure of this chapter, some of the statements have been simplified. These basic concepts are expanded in later chapters in this book. Upon completion of this chapter, the reader should be able to

3.1 Describe the general anatomy and physiology of the hearing mechanism and its pathways of sound.

3.1 Define the different types of hearing loss patients may exhibit.

3.2 Describe hearing testing and the means of reducing ambient noise levels for successful testing.

3.2 Describe the roles of the patient and the examiner in successful testing.

3.3 Describe the different purposes of air- and bone-conduction audiometry.

3.3 Outline the procedures for completing air- and bone-conduction tests.

3.4 Interpret various pure-tone tests

Vocabulary Items

Air-bone gap	Air conduction
Attenuation	Audiogram
Audiometer	Audiometric Weber test
Békésy audiometry	Calibration
Clinical decision analysis	Conductive hearing loss
Computerized audiometry	Distortional bone conduction
Eardrum membrane	Efficiency
False negative response	Inertial bone conduction
Inner ear	Lateralization
Malingering	Masking
Mastoid process	Middle ear
Mixed hearing loss	Nonorganic hearing loss
Osseotympanic bone conduction	Outer ear
Pinna	Predictive value
Psychogenic hearing loss	Pure-tone average
Rinne test	Sensitivity
Sensory/neural hearing loss	Specificity
Stenger principle	Tactile response
Tuning fork	Variable pure-tone average
Warble tone	Weber test

Chapter 3 Test Items

Essay *Questions*

1. Describe the pre-requisites that ensure proper pure-tone testing.

2. Compare the sound pathway for air conduction signals to that of bone-conduction signals and how threshold measures attained through these two pathways differentiate type of hearing loss.

Short Answer Questions

1. The three main parts of the ear are _____, _____ and _____.

2. The three main types of hearing loss _____, _____ and _____.

3. The Rinne test is designed to compare the patient's hearing by _____ to his/her hearing by _____.

4. The Weber test is one of _____.

5. A patient who signals that a tone was heard when in fact it was not is giving a _____.

6. Ear canal collapse during audiometry can be avoided with the use of _____.

7. Traditionally, pure-tone thresholds are obtained by increasing the intensity of the signal in _____ dB steps and decreasing it in _____ dB steps.

8. When properly constructed, the audiogram should show the distance of one octave (across) to be the same as _____ dB down.

9. The three ways by which we hear through bone conduction are ____, ____, and _____.

10. The conductive component of a hearing loss can be determined by the _____.

11. In mixed hearing losses the sensory/neural component is shown by the _____.

12. Severe sensory/neural hearing losses may be misdiagnosed as mixed losses when the bone-conduction responses are _____.

Multiple Choice Questions

1. A bone conduction oscillator placed on the right mastoid could result in the tone being heard in
   a. the right ear only
   b. the left ear only
   c. both ears
   d. any of the above

2. You are testing a five year old patient whose responses are inconsistent for bone conduction with masking. The left ear AC thresholds are within normal limits. The right ear AC PTA is 35 dB HL. You suspect a sensory/neural hearing loss in the right ear. To help confirm this suspicion you perform an audiometric Weber test with the BC vibrator placed on the forehead. If your suspicions are correct, you will find the tone
   a. lateralizes to the right ear
   b. lateralizes to the left ear
   c. is reported to be heard at the midline
   d. a and c

3. Abnormal bone conduction with even greater hearing loss by air conduction signifies
   a. normal hearing
   b. conductive hearing loss
   c. sensory/neural hearing loss
   d. mixed hearing loss

4. An audiogram indicating a sensory/neural hearing loss will show:
   a. impaired bone conduction and no air-bone gap
   b. normal air conduction and an air-bone gap
   c. impaired bone conduction and an air-bone gap
   d. normal bone conduction and an air-bone gap

5. An audiogram showing impaired bone conduction and an air-bone gap indicates
   a. normal hearing
   b. a mixed hearing loss
   c. a sensory/neural hearing loss
   d. a conductive hearing loss

6. An audiogram indicating a mixed type hearing loss will show
   a. normal bone conduction and an air-bone gap
   b. impaired air conduction and no air-bone gap
   c. impaired bone conduction and an air-bone gap
   d. impaired bone conduction and no air-bone gap

7. The dimensions of an audiogram should be:

a. 1 octave by 20 dB
b. 1 octave by 10 dB
c. 2 octaves by 10 dB
d. none of the above

8. The bone-conduction pathway is
    a. Outer ear, inner ear, auditory nerve middle ear
    b. Outer ear, middle ear
    c. Outer ear, middle ear, inner ear, auditory nerve
    d. Inner ear, auditory nerve

9. When reporting the results of tuning fork tests one must always specify the
    a. Frequency of the fork
    b. Amplitude of the fork
    c. Pressure of the fork against the head
    d. Weight of the fork

10. The air conduction pathway includes
    a. The outer ear, middle ear, inner ear and acoustic nerve
    b. The inner ear and acoustic nerve
    c. The outer ear and middle ear
    d. The ear canal, tympanic membrane and middle ear ossicles

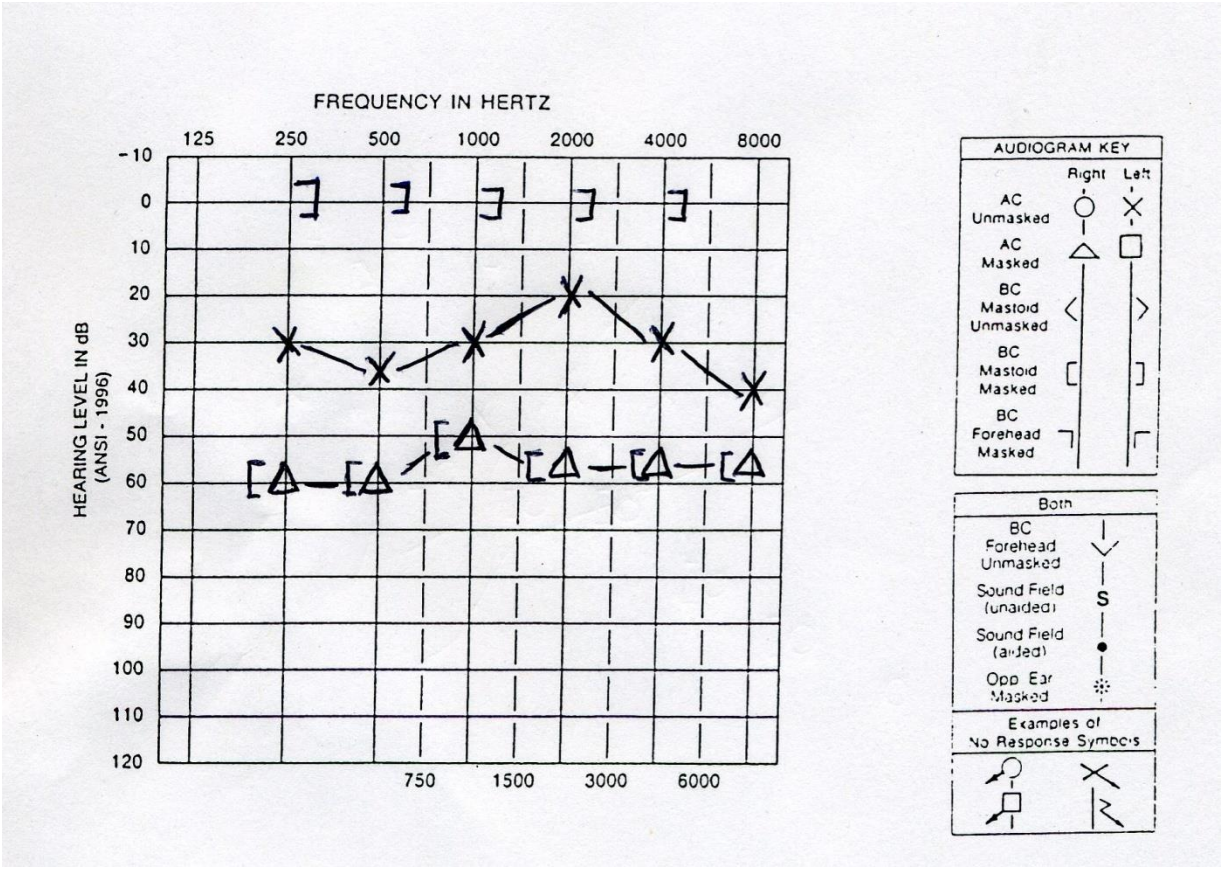
11. Conductive hearing loss originates from disorders in the
    a. Middle ear and inner ear
    b. Auditory nerve and cochlea
    c. Outer ear and cochlea
    d. Outer ear and middle ear

12. In the presence of a unilateral conductive hearing loss, the Weber test will result in
    a. A midline sensation
    b. Lateralization of the tone to the better ear
    c. Lateralization of the tone to the poorer ear

13. The proper sequence of testing when completing a pure-tone audiogram is
    a. Begin at 1000 Hz, proceed to 2000, 4000, 8000 and then test 250 and 500
    b. Begin at 1000 Hz. Proceed to 2000, 3000, 4000, 6000, 8000, recheck 1000 then test 500 and 250 before changing to the other ear and beginning at 250
    c. Begin at 250 and proceed upward testing all octave and interoctave frequencies
    d. Begin at 1000 Hz. Proceed to 2000, 3000, 4000, 6000, 8000, recheck 1000 then test 500 and 250 before changing to the other ear and beginning again at 1000

14. A false negative response in pure-tone audiometry is
    a. When a patient responds when no signal was presented
    b. When the examiner believes the patient has responded when no response was given
    c. When the examiner fails to recognize that a response was given
    d. When a patients fail to indicate that they have heard the tone

15. Air conduction thresholds reveal
    a. The degree of hearing loss
    b. The degree of cochlear hearing loss
    c. The degree of sensory/neural involvement
    d. The amount of loss due to abnormality in the conductive mechanism

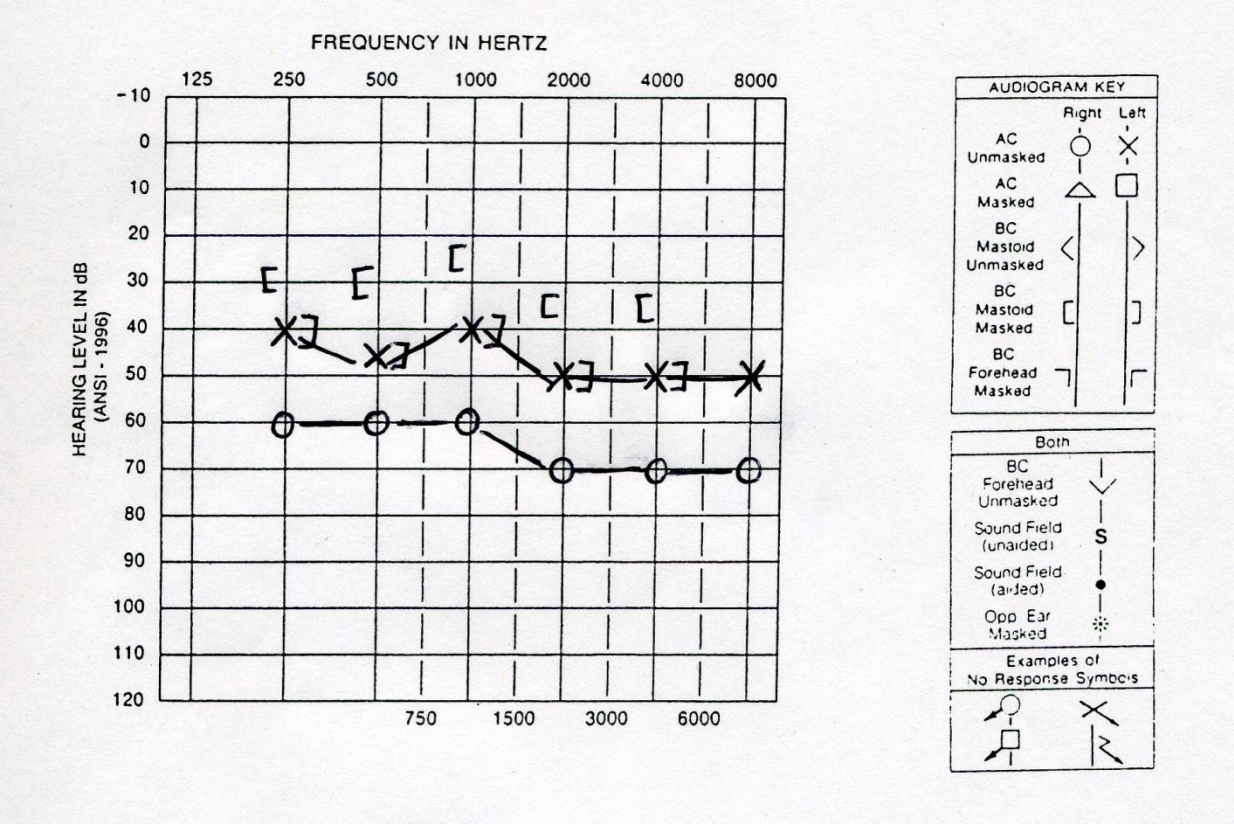


The following 3 questions refer to the above audiogram

16. The air-bone gap at 4000 Hz in the left ear is
    a. 25 dB
    b. 30 dB
    c. 35 dB
    d. 55 dB

17. The type(s) of hearing loss found in this patient are
    a. left normal, right sensory/neural
    b. left sensory/neural, right conductive
    c. left mixed, right conductive
    d. left conductive, right sensory/neural

18. An audiometric Weber test is to be performed at 1000 Hz. From the above audiogram, you would expect the patient to
    a. hear the tone in her right ear
    b. hear the tone in her left ear
    c. hear the tone in both ears
    d. not hear the tone at all



The following 2 questions refer to the above audiogram (#2).

19. The above audiogram illustrates what type of hearing loss in the right ear at 4000 Hz?
    a. mixed
    b. normal hearing
    c. sensory/neural
    d. conductive

20. The above audiogram illustrates what type of hearing loss in the left ear?
    a. normal hearing
    b. conductive
    c. sensory/neural
    d. mixed