COMPREHENSIVE CLINICAL MASKING : A WORKBOOK

Rog.No.M9811

Independent Project as a part fulfilment of first year M.Sc, (Speech and Hearing), submitted to the University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE 570 006
MAY 1999

Dedicated to

GOD ALMIGHTY

In loving memory of
my grandparents
&
my beloved parents

-With much love beyond words

CERTIFICATE

This is to certify that this Independent Project entitled : **COMPREHENSIVE CLINICAL MASKING : A WORKBOOK** is the bonafide work in part fulfilment for the degree of Master of science (Speech and Hearing) of the student with Register **No.M9811.**

Mysore
May, 1999

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CERTIFICATE

This is to certify that this Independent Project entitled COMPREHENSIVE **CLINICAL MASKING : A WORKBOOK** has been prepared under my supervision and guidance.

Mysore
May, 1999

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DECLARATION

This Independent Project entitled : **COMPREHENSIVE CLINICAL MASKING: A WORKBOOK** is the result of my own study under the guidance of *Animesh Barman,* Lecturer in Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other diploma or degree.

Mysore
May, 1999

Reg. No.M9811

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Thank you so much sir for bearing with me and guiding me throughout and helping me successfully complete this proejct.

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Thfc 2 wonderful people in my life who mean the most to me -Thanks for everything my dear mummy and daddy - for loving, listening, caring, understanding, supporting, reassuring, encouraging and the blessings for my success in all my endeavours. I am grateful to God for having given me such lovely parents.

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Dear Nalini Akka and Uncle Thanks for your timely help, encourgement and caring.

I am at loss of word when I have to thank all of my well wishes especially Muthaiahr. uncle, Ramkumar Uncle and Ravannan Sir. Thanks a billion to you all.

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God bless you all

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INTRODUCTION

Workbook is a material mainly used to provide in depth information on a particular topic and also it is used for practicing/ exercising in a particular topic for a student. According to English dictionaries workbook refers to "a manual of operating instructions" or "a book designed to guide the work of a student by inclusion of some instructional material and usually providing questions, exercises, etc".

The present workbook is designed to provide information as well as guide the students mainly in the area of 'CLINICAL MASKING".

The term clinical masking is one of the very important topic in the field of Audiology.

Masking is a complex and somewhat variable phenomenon. The application of clinical masking is often essential during audiometric testing. Because the goal in audiologic measurements is to obtain valid and reliable results, audiologists must gain skills in clinical masking procedures to evaluate each ear independently. Therefore, clinicians, especially the less experienced ones, may have difficulty in making appropriate masking decisions and correctly interpreting the results.

"Therefore various writers hove presented procedures designed to simplify the clinician's task. Unfortunately the simplest procedures provide the greatest opportunity for error" (Studebaker, 1967).

"For some clinicians the approach to masking is a hapazard, hit-or-miss, bit of guess work with no basis in any set of principles" (Sanders, 1978).

When we see the above two statements, it seems to be surprising that these problems exist inspite of many clinical audiology books as well as journal articles that deal separately on clinical masking.

Some of the reasons underlying for the still existing problems during masking are :

Some books give only theoretical information whereas others give only clinical procedures without much theoretical background and the students who stick to these kind of books go 'blind'.

Many authors describe and emphasize their own method. So students will have to keep switching of text books and they show lot of difficulties in setting on a single text.

And also these books do not provide any chance for the readers who are wishing to test their understanding of different concepts and clinical procedures involved in masking.

Because of all these reasons which are mentioned above, there is a need for developing a workbook on masking which is also intended to serve as a basic text in audiometric masking.

In order to deal with masking more effectively, the overall task of masking can be broken down into simple steps which the clinician can follow.

The present work book will give valuable information regarding the basics of masking such as

* What is masking
* Interaural attenuation
* When is masking needed
* Appropriate use of masking for puretone audiometry, speech audiometry and suprathreshold audiometry
* Types of maskers
* Varieties of masking and
* The problems encountered in masking and also focus on a series of clinical questions such as, multiple choice, fill up the blanks, match the following, true or false and simple questions like, when to employ masking and what are the adequate levels to use, etc. as well as various types of masking problems along with audiograms.

All the information regarding masking are collected from various journal articles as well as some of the clinical audiology books. The following books and journals nre selected for the present study :

Books

1. Audiological Assessment (Rose)
2. Audiology (Newby)
3. Audiology for the Physician (Keith)
4. Audiometric Interpretation (Lloyd and Kaplan)
5. Audiometry-Principles and Practice (Armgloric)
6. Auditory Diagnosis (Silman and Silverman)
7. Bases of Auditory Brainstem Evoked Response (Moore)
8. Clinical Audiometry (Portmann and Portmann)
9. Fundamentals of Hearing (Yost)
10. Foundations of Modern Auditory Theory (Jobias)
11. Handbook of Clinical Audiology (Katz)
12. Handbook of Experimental Psychology (Stevens)
13. Hearing (Gelfand)
14. Hearing and Deafness (Davis and Silverman)
15. Introduction to Audiology (Martin)
16. Hearing Assessment (Rintelmann)
17. Manual of Practical Audiometry (Stig Arlinger)
18. Modern Developments in Audiology (Jerger)
19. Principles and Applications in Auditory Evoked Potentials (Jacobson)

Journals

1. Acta Otolaryngotogica
2. Acta Otolaryngologica Supplementary
3. Archives of Neurology
4. Archives of Otolaryngology
5. Audiology
6. British Journal of Audiology
7. Ear and Hearing
8. Hearing aid Journal
9. Inner Ear Physiology
10. Journal of American Audiological Society
11. Journal of Auditory Research
12. Journal of Speech and Hearing Disorder
13. Journal of Speech and Hearing Research
14. Journal of the Acoustical Society of America
15. The Laryngoscope.

Since clinical masking procedure appears to be difficult, an attempt has been made to explain the masking procedure with many examples. It is hoped that this workbook on clinical masking would be useful to the audtologists and is designed primarily with undergraduate students in mind.

Thus, this workbook on clinical masking is mainly developed as a clinical training device for students in audiology and speech and language pathology.

AIM OF THE STUDY

To serve as a guide for students as well as other concerned pofessionals.

To understand the various terminologies used inclinical masking and also to make the students grasp the fundamental concepts of clinical masking.

To make it useful for the students for both clinical and practical point of view.

To judge the need to mask for each frequency for air-conduction and bone-conduction and also to determine the minimum as well as maximum amount of noise required to mask the non-test ear based on the audiograms.

To check the user's knowledge of each topic after going through the given material.

WHAT IS MASKING

Noise, is something that we all face in one form or the other. Noise is any unwanted signal that causes hinderance in perception of the required signal. During travelling in a bus or train, in a party, in discussions and in places such as industries, market, etc. wherever there is more than one person or one stimuli, noise is mostly inevitable. So in such situations, we automatically tend to increase our voices. Because we cannot hear the faint speech clearly during the above mentioned conditions.

But the very fact that this unwanted signal could be useful, and suggests the human brain's capacity of thinking in most vivid possible ways. It is true that this noise when modified and filtered and custom made according to need is a very important tool in the diagnosis of hearing disorders.

It is this basic principle which has been greatly put to use, by the audiologist, in routine audiometric testing, under the title of ' "clinical Masking'.

The study of masking is concerned with the interaction of sounds. The experimenter is interested in the amount of interference one stimulus can cause in the perception of another stimulus. Whenever a client has one better ear and one poorer ear, it is important to ensure that the better ear does not hear the tone presented to the poorer ear. If such precautions are not taken, misdiagnoses can easily be made, leading to inappropriate hearing aid fitting, unnecessary ear surgery, etc.

We all know from personal experience that faint sounds cannot be heard in the presence of background (ambient) noise. The faint sound is said to be masked by the noise. The extent of the masking depends on the frequency and intensity of the test tone and the spectrum and intensity of the masker. We can determine the masked threshold for our test tones in a noise just as we determine the absolute threshold in quiet.

Masking has been defined in various ways by a number of authors. However, for clinical purposes, the American National Standards Institute (ANSI) specification for audiometers (S3.6-1939) defines masking as "... The process by which the threshold of audibility for one sound is raised by the presence of another (masking) sound". In an excellent review of auditory masking, Studebaker (1973) provided additional definitions by Meyer (1959), Carter and Kryter (1962), and Deatherage and Evans (1969). These definitions are concerned basically with the concepts of interference with the primary signal by a secondary source and the elevation or shift in threshold.

Thus, masking is best defined operationally as an elevation in the threshold of one signal produced by the introduction of a second signal. The first signal is called the maskee or the test signal and the second signal is called the masker or the noise.

Before we peep into the masking we should be familiar with the following terminologies.

TEST SIGNAL	The signal (puretone or speech) which is presented to the test ear (poorer ear).
TEST EAR	The ear to which the test signal (puretone or speech) is being directed, i.e. It is usually the poorer ear.
NON-TEST EAR	The ear to be eliminated or "kept busy" with masking noise is called the non-test ear. i.e. It is usually the better ear.
MASKER	The signal (background noise) which ″. elevates the threshold is called the masker.
MASKEE	The test signal (puretone or speech) which is masked by the masker is called the maskee.
INTERAURAL ATTENUATION (IA) OR INTERAURAL TRANSMISSION LOSS	It is the reduction in the physical intensity of an acoustic signal in passing from a transducer on one side of the head to the opposite cochlea.

CROSS OVER It refers to the actual transmission of sound (introduced either by headphone or bone oscillator) from one ear to the cochlea of the other ear.

Ex. If puretone of 80 dB HL presented through the headphone to the right ear, if interaural attenuation is 40 dB HL, then the cross over will be 40 dB HL to the lei\ ear.

CROSS HEARING When we present a tone to one ear, it may be transferred and heard in the other ear well before reaching the threshold of the other ear. This is called cross-hearing.

SHADOWGRAM A shadow gram is obtained when the non-test ear participates while obtaining the AC threshold of the test ear. It has the configuration of the AC threshold of the non-test ear. This occurs when there is anair-bone gap of 40 dB or more.

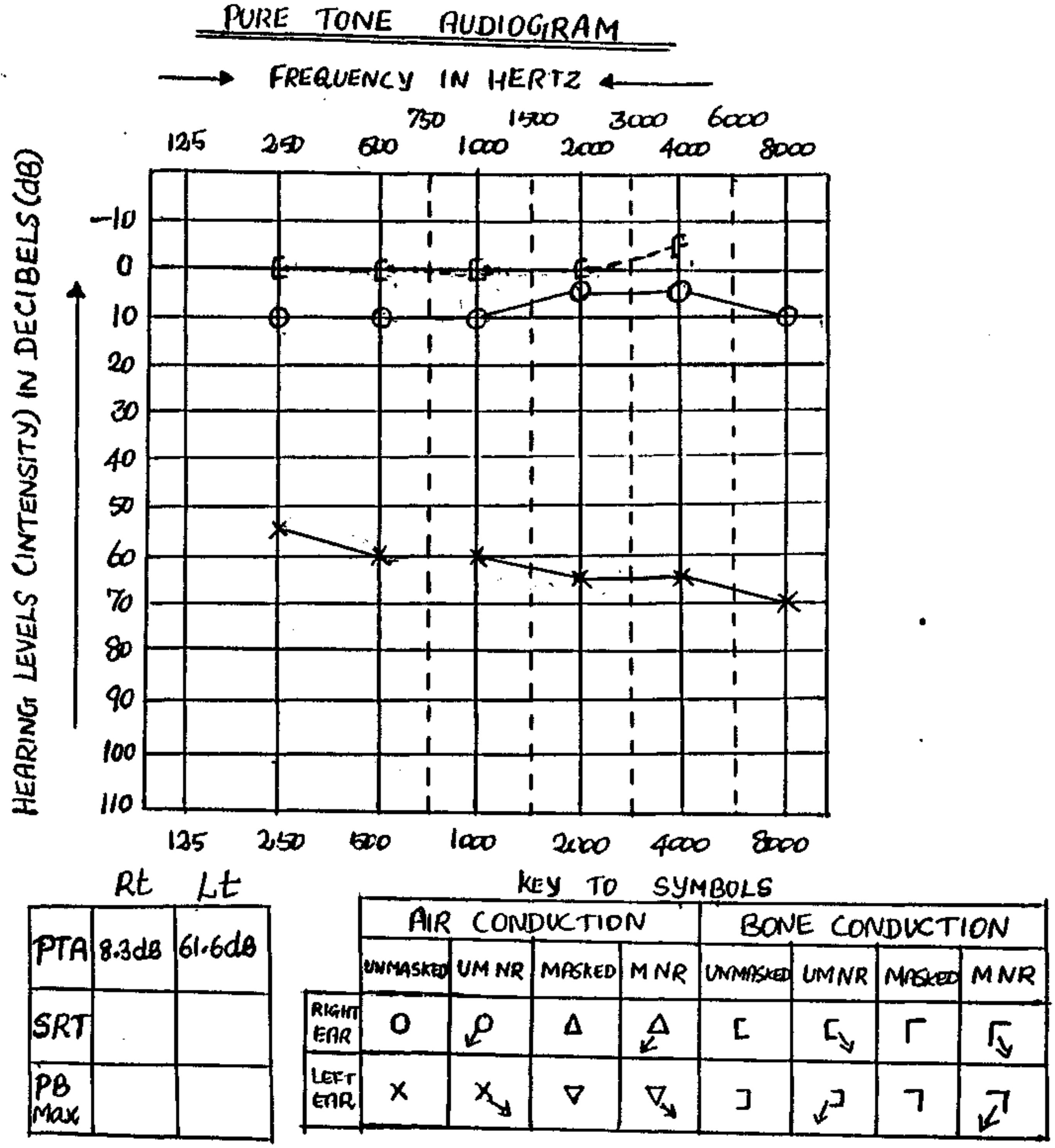


Fig. 1 : This figure is an audiogram showing an air bone gap with bone conduction obtained in the unmasked condition, indicating cross hearing (which results shadow curve).

OVER MASKING When the noise level presented to the non-test ear is sufficient enough to mask the test signal in the test ear is known as over masking.

UNDER MASKING When the noise presented to the nontest ear is not sufficient to mask the test signal in the non-test ear is known as under masking.

Ex: If you present 30 dB HL masking noise through the headphone to the nontest ear when the air conduction threshold of the nontest ear is 50 dB HL, it is called under masking. Because 30 dB HL noise is not sufficient to overcome 50 dB HL noise and mask the test signal in the non-test ear.

EFFECTIVE MASKING: LEVEL (EML) The level to which the threshold of test signal is shifted by the masker is the effective level of the masker. Effective level can be expressed in sound pressure level, hearing level, or any other level depending upon the reference above which the level of the test signal is expressed. The effective level of a masker at a given intensity level varies across different test signals. That is, a given noise intensity elevates the thresholds of various test signals to different intensity levels.

The effective application of clinical masking requires a good understanding of the answers to the following 3 questions :

* When should masking be used?
* What kind of masking noise should be used?
* How much masking should be used?

The following chapters of this book answer these questions through a discussion of the principles of masking based on experimental evidence.

QUESTIONS

I Compare and contrast

1. Masker vs. Maskee
2. TE vs.NTE
3. Over masking vs. under masking.
4. Minimum masking vs. maximum masking -

5. Crossover vs. cross hearing

II Multiple Choice

1. While masking the threshold of audibility is

(a) Constant

(b) Reduced

(c) Raised

2. The ear to be eliminated or kept busy with noise is

(a) Test ear

(b) Nontest ear ,

(c) Poorer ear

3. The ear for which threshold is to be obtained is

(a) Test ear

(b) Non-test ear

(c) Better ear

4. The energy lost as sound travels from one ear to the other is called:

(a) interaural attenuation

(b) cross hearing

(c) lateral ization

III Fill up the blanks

1. Faint speech cannot be heard in the presence of ....noise
2. Signal which masks the test signal is called .... and the test signal is called ....
3. Masking signal is applied to the. . . . . .ear.
4. The process by which the threshold of audibility for one sound is raised by the presence of another sound is called ....
5. Masking is used to keep the non-test ear…. while evaluating the test ear.
6. The signal presented to the test ear is called. . . . .signal

IV True/False

1. Faint speech is said to be masked by background noise.
2. In clinical masking noise is applied to the test ear.
3. The level to which the threshold of test signal is shifted by the masker is the effective level of the masker
4. Masking signal produces permanent hearing loss in the non-test ear.
5. Masking is the psychoacoustic phenomenon
6. Separate audiological evaluation of each ear is important for diagnostic and rehabilitative decisions (True/False)
7. In case of bilateal sensoryneural hearing loss, we can see the shadowgram.

ANSWERS

I Compare and Contrast

1. Refer Page No.9
2. Refer Page No.9
3. Refer Page No. 12
4. Minimum Masking / Maximum Masking

Minimum Masking	Maximum Masking
The masking level which is just sufficient to mask the test signal in the car to which the masker is presented.	It is the masker level at the masked ear which is just insufficient to mask the test signal in the ear.

5. Refer Page No. 10

II Multiple choice

(1) c (2) b (3) a (4) a

III Fill up the blanks

1. background
2. masker, maskee
3. nontest
4. masking
5. busy
6. test

IV True/False

1. True 2. False 3. True 4. False. 5.True 6. True. 7.True.

VARIOUS SIGNALS USED FOR MASKING

There is an amount of threshold shift in the test ear produced by the presence of masking noise in the non-test ear.

This amount of threshold shift produced by a masking noise depends not only on the intensity but also on the nature of the sound.

There are different kinds of masking signal available on commercial puretone audiometers. Each signal has a specific spectrum and therefore provides a different degree of masking efficiency at different frequencies. They range from simple pure tones to very complex speech.

The masking signal may be classified as :

* Puretones
* Warble tones
* Noises
  - Complex noise
  - Pink noise
  - Broad Band Noise (BBN)
  - Narrow Band Noise (NBN)
  - Speech noise

* Puretones

Here puretones have been used to mask puretones. They cannot mask complex signals like speech because or their frequency position.

Experiments which involve masking of puretone by puretone have many difficulties especially at medium and higher levels of the masker.

Disadvantages : Masking of puretones by puretones is

-> Very confusing and complicated by the fact that distortion products may arise, i.e. combination of tones.

-> These disadvantages are almost certain if both maskee and masker are closer in intensity and frequency.

-> Problem of beats : Beats are audible when the frequency of the test tone is in the neighbourhood of the masking signal. The subject listening to such a beating tone hears something different from the steady state masker and therefore responds.

-> Inexperienced subjects : respond for the difference tone which is produced through non-linear distortions that originates in our own hearing system and not for the test tone as they have difficulty in differentiating between them at frequencies near 1-4 kHz.

*** Warble tones**

Warble tone is produced by frequency modulation and is a periodic variation of a base or center frequency with amplitude held constant.

"Masking of puretones with warble tone is characteristic of masking puretones with narrow band noise" (Staab, 1974).

However this is not a commonly used masking stimulus.

. Masking of test tone in the non-test ear by a puretone or warble tone has been outdated.

Thus a standard and a conventional procedure for clinical masking is to place an earphone over the non-test ear and introduce noise to that ear. The following types of noise are used in modern clinical audiometers.

I Complex noise

Complex noise is a broad-band signal composed of a low frequency fundamental plus the multiples of that fundamental. The acoustic spectrum of a typical complex noise is shown in figure 1.1. For this particular noise, the fundamental frequency is 78 Hz, and the additional frequencies are multiples of that fundamental (156 Hz, 234 Hz, etc.)

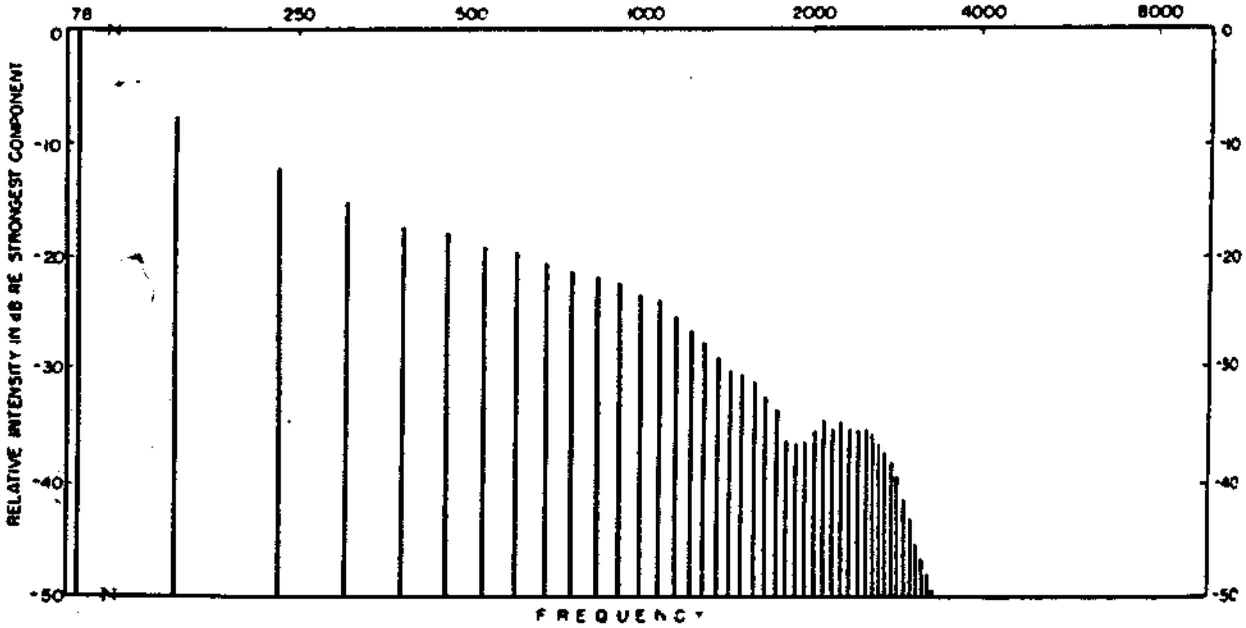


Fig.2 : The line spectrum of figure 1.1 demonstrates two basic problems in complex noise as a masker of puretones.

Disadvantages :

1. First, acoustic energy is present only at the frequencies designated by the lines and is not spread continuously across the frequency range of the noise. With energy only at discrete frequencies, it is possible for the frequency of a test puretone to fall within 3 or 4 cycles of a frequency component of the noise, producing a 'beat' or pulsing phenomenon in the ear of the listener. Liden et al. (1959) pointed out that the 5th harmonic of a 50 Hz fundamental will beat with a test tone of 254 Hz. A 254 Hz tone is well within the permissible variability of an audiometer test tone (ANSI, S3.6-1969).

2. A second problem with complex noise as a masker in purelone audiometry is the significant decrease in acoustic energy in the higher frequencies. For the noise shown in Figure 1.1, the energy present hear 1000 Hz is down about 23 dB from the intensity level at 78 Hz, At 4000 Hz, the decrease in energy is greater than 50 dB. This characteristic suggests that complex noise may not be a very effective masker, at least for test tones in the middle and higher frequencies; Although the spectrum may differ somewhat from one noise generator to another, the basic limitations of the complex noise as a masker are generally characteristic of the noise. Because of these limitations, complex noise is usually no longer provided on clinical audiometers. This noise is included here because some older units still in use may include it.

II Pink noise

It provides a relatively broad spectrum with equal energy per octave below about 2000 Hz. Pink noise has not been used much in masking for puretones and is not available on commercial clinical audiometers.

Advantage:

It can be used when predominantly low frequencies require to be masked particuarly in speech.

Disadvantage:

It cannot be used to mask all frequencies i.e. its dynamic range is restricted.

III **Broad Band Noise (BBN)**

It is possible to generate a noise that has approximately equal energy per cycle and covers a relatively broad range of frequencies. Because of this analogy to white light, which contains all the frequencies in the light spectrum, this noise has been called white noise. White noise, which has also been called thermal and Gaussian noise, sounds very much like hissing. Since the earphones accompanying most audiometers are in expensive, they do not provide much response in the higher frequencies and therefore limit the. intensity of white noise above about 6000 Hz. Hence, that which is generated in the audiometer as white noise is more accurately termed broad band or wide band noise as it emanates form the earphone.

There are numerous methods availble to produce white noise and each is based on the requirements of the audiometer design. The noise is selectively filtered via electronic band pass active filters to create the required noise spectra.

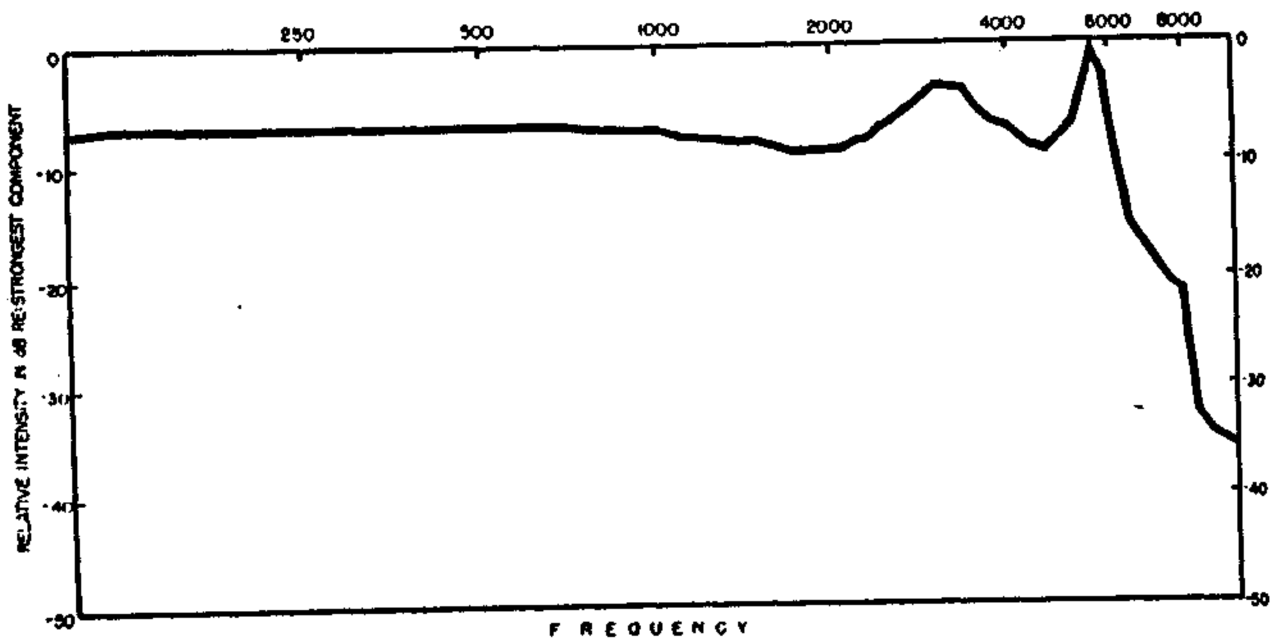


Fig.3 Acoustic spectrumof a broad band white noise through a TDH-39 earphone (From J.W.Sanders & W.F.Rintelmann, 1964, Archives of Otolaryngology, 80, 541-556).

As shown in figure 3, however, the acoustic spectrum of the noise is determined by the frequency response of the transducer. Through a TDH-39 earphone, the spectrum is essentially Hat till 6000 Hz but drops off rapidly beyond that point. The acoustic spectrum of white noise is constant from one audiometer to another, provided that the same earphone is used. In contrast to complex noise, white noise is essentially equal in intensity across the frequency range to about 6000 Hz. With the newer TD1 1-39,49R 50 and 50 P earphones, the spectrum is more nearly flat at 3000 and 4000 Hz by 1 or 2 dB, but the band width continues to be essentially 6000 Hz.

Advantage:

It has got uniform energy throughout the audible spectrum.
Maximum masking for broad band noise is higher than narrow band noise.

%

But according to Studebaker (1962) the range of permissible masking for the two types of noise is approximately the same. He says although maximum masking for broad band noise is higher than for the narrow band noise its minimum masking is also higher. Thus the range of permissible masking is also higher. Thus, the range of permissible masking is same for both narrow band noise and broad band noise.

Disadvantages

Only the noise components within narrow frequency band surrounding the test tone, contribute to the masking of the tone. The rest of the noise spectrum not only unnecessary but also increases the intensity of noise and thereby reducing the threshold of pain.

IV Narrow Band Noise (NBN)

Narrow band noise is restricted band of frequencies surrounding a particular frequency and is obtained by band pass filtering broad band noise. The signal is continuous within the frequency band, and intensity is essentially equal across the band.

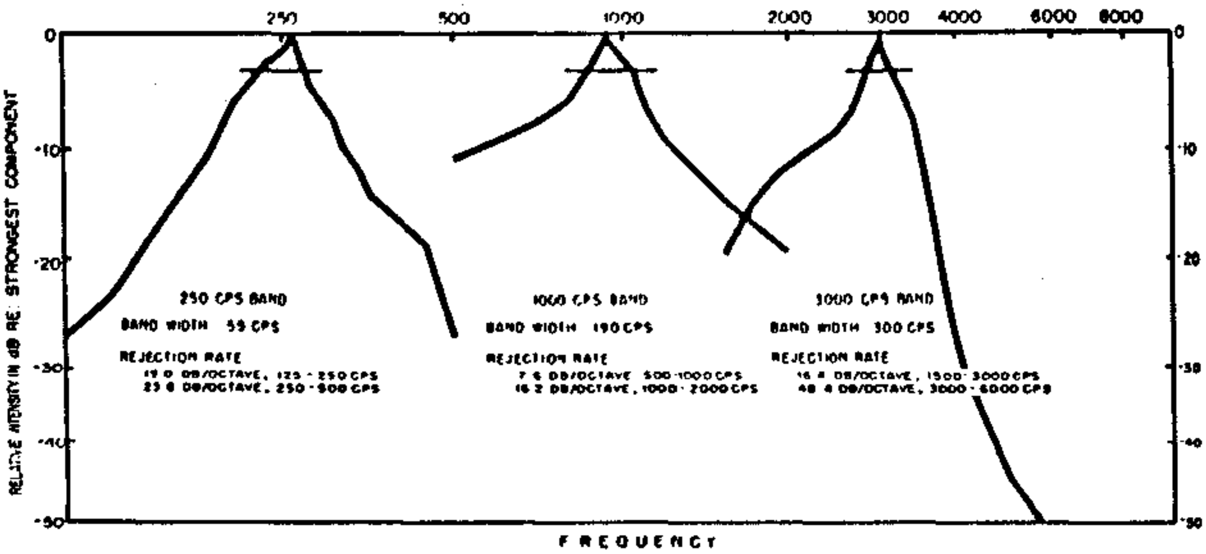


Fig.4: Acoustic spectra of three narrow bands of noise through a hearing aid type receiver (From J.W.Sanders & W.F. Rintelmann, 1964..Archives of Laryngology, 80, 541-556.

The acoustic spectra of narrow band noises at three test frequencies are shown in figure 4. A given noise band is described in terms of its center frequency, its band width (the span of frequencies whose intensities are no more than 3 dB below the peak component of the band), and its rejection rate (the decrease in intensity over a range of one octave on each side of the band).

Narrow band noise is created by passing a broad-band white noise source masking signal through a series of narrow band electronic active filters, each having its pass band centered at the test one frequency. (NBN can also be produced by a narrow-band noise masking generator that creates a different noise for each bandwidth. This method is not commonly used in audiometers today.

The critical bandwidth for the audiometric test frequencies are 50 Hz at 250 Hz, 50 Hz at 500 Hz, 56.2 Hz at 750 Hz, 64 Hz at 1000 Hz, 79.4 Hz. at 1500 Hz, 100 Hz at 2000 Hz, 158 Hz at 3000 Hz, 200 Hz at 4000 Hz, 379 Hz at 6000 I Iz and 501 Hz at 8000 Hz.

Advantages:

1. Narrow band noises are preferred for puretone test procedures because of their masking efficiency.

2. Surrounding every puretone there is a critical band of frequencies that provides maximum masking with minimum sound pressure . (Fletcher, 1940; Fletcher and Munson, 1937). Narrowing the band to less than the critical band width requires greater intensity for masking a given level of tone, and conversely, adding frequencies outside the critical band increases intensity without increasing masking (Fletcher, 1940).

NBN, therefore has the greatest, masking efficiency if the important factor in terms of intensity is the level per cycle in the critical band rather than the overall intensity. The use of NBN offers the further convenience that each band can be calibrated in effective level independently. Thus the numerical masking dial reading equals, the test signal intensity that will be just masked at all test tone

Disadvantages:

According to Glorig (1966) is of the opinion that the narrow band masking noise are considerably more expensive, since a separate narrow band masking noise is required for each test frequency.

In this regard to quote Palva and Palva (1954) as quoted by Studebaker (1967) : "the gain in efficiency over broad band noise is not sufficient to justify the additional cost and complexity **of narrow band noise generators.**

V Speech noise

Speech by nature is broad frequency and the speech noise needed for masking during speech audiometry is filtered to mimic the long term spectrum of speech. A description of ANSI's requirement for "masking for speech tests" and a frequency response of such a noise is presented in figure 5. Speech noise for audiometers is produced by filtering white noise using a "two pole" low pass active filter having a corner frequency of 1000 Hz and a rejection rate of 12 dB/octave above the corner. Speech noise is broad band noise with a narrower frequency range extending from at least 250 Hz to 4000 Hz. The slope of the speech noise spectrum is +3 dB per octave from 250 Hz to 1000 Hz; the slope is - 12 dB per octave from 1000 Hz to 4000 Hz. The acoustic spectrum of speech noise follows the configuration of the acoustic spectrum of a speech signal, masking of speech signals can be done using either broad band noise shaped by the earphone or speech noise. Many audiometers calibrate speech noise in effective masking, that is, 50 dB HL of speech noise will masking a 50 dB ML speech signal (Broadband noise is generally not calibrated ineffective masking; it is calibrated in dB SPL). For narrow band noise signals we recommend generating normative data on the minimum effective masking (MRM) using speech noise nnd broad band noisemaskers, the minimum effective masking normative data for monosyllable phonetically balance (PB) words should be obtained separately from those for spondaic words. The obtain the normative data on masking of spondaic and monosyllabic phonetically balanced words, the speech signals should be introduced at alevelof 50 dB HL and the speech noise or broad band noise increased in the same ear until the subjects can no longer repeat 6 of 6 words.

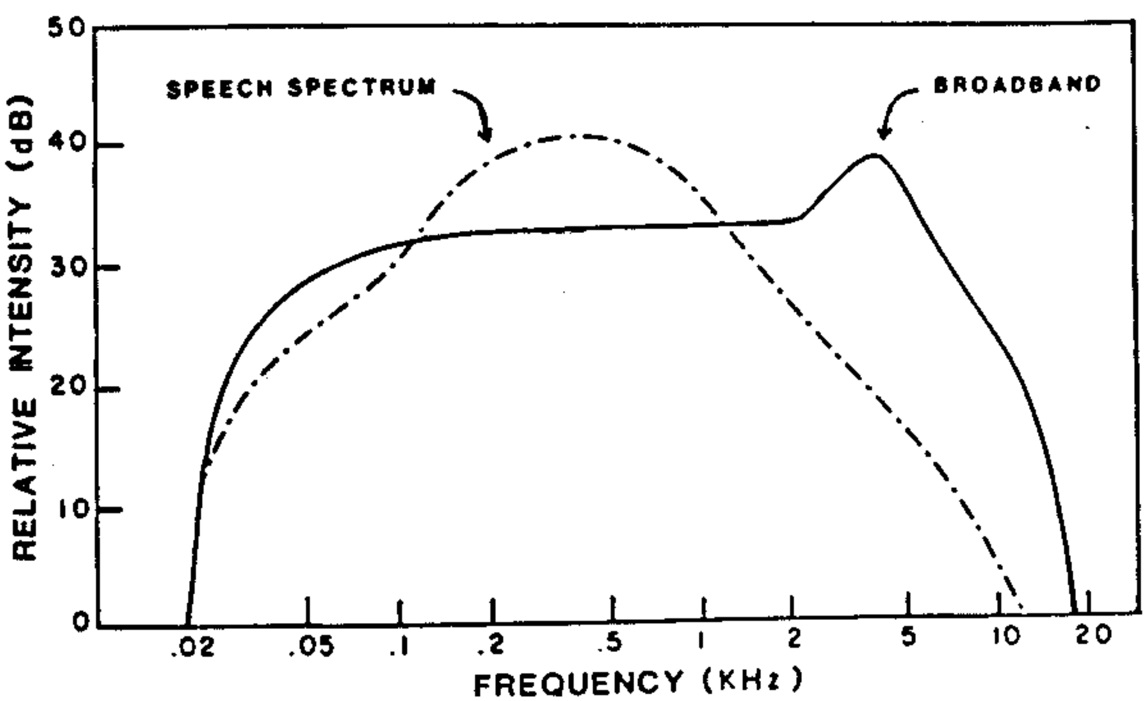


Fig.5: Acoustic amplitude spectra for speech spectrum and broad-band typically used for masking the contralateral ear in speech audiometry representive of these stimuli when they are transduced by a TDH-39 earphone (From Konkle D.F. & Rintelmann, W.F. Principles of Speech Audiometry. Baltimore : University Park Press, 1983.

This figure shows, acoustic amplitude spectra for speech spectrum and BBN typically used for masking the contralateral ear in speech audiometry, representative of these stimuli when they are transduced by a TDH-39 earphone (From Konkle DF, and Rintlemann, WF, Principles of speech audiometry, Baltimore: University Park Press, 1983).

Choice of masking noise:

With a verified prediction of relative masking efficiency, the question of what kind of masking noise to use has been answered. Whenever the clinician has a choice of masking noise for puretone audiometry, narrow band noise should be selected for its superior masking efficiency. The second choice is white noise. Although not as efficient as narrow band noise, white noise is clearly superior to complex noise and will provide adequate masking in most cases if the output of the noise generator is sufficiently high.

QUESTIONS

I Yes or No Questions

1. Complex noise canbe used tomask non-test ear effectively while puretone masking.
2. A standard and a conventional procedure for clinical masking is to place an earphone over the NTE and introduce noise to that ear.
3. Complex noise is a type of BBN having a low frequency fundamental plus the multiples of the fundamental.
4. In pink noise, usually the base frequency varies between 60 Hz to 120 Hz.
5. Puretones mare widely used to mask puretones.
6. Warble tone can have simultaneos effect of narrow band noise.
7. Complex noise is effective only at higher frequencies.
8. Complex noise is often used in modern clinical audiometers.
9. BUN has got uniform energy throughout the audible spectrum.
10. Speech by nature is broad frequency, and the speech noise needed for masking during speech audiometry is filtered to mimic the long term spectrum of speech.
11. Pink noise has been used much in masking for puretones and is available on commercial clinical audiometers.
12. Narrow band noise is produced selectively filtering white noise

II Choose the best answer

1 . . . . .has been called variously, such as wide band noise, thermal noise and white noise.

a)NBN

b)BBN

c) Complex noise

d) Pink noise

2. ... is produced by selectively filtering white noise.

a)NBN

c) BBN

d) Speech noise

d) Complex noise

3. . . . . .is created by passing a broad band white noise source masking signal through a series of narrow-band electronic active filters.

a) Puretone

b) Warble tone

c) Narrow band noise

d) Speech noise

4. . . . . . .almost appears in all newer clinical audiometers

a) Pink noise

b) Speech noise

c) BBN

d) NBN

5. . . . . .noise is usually calibrated into effective masking level.

a) Thermal noise

b) Complex noise

c) Speech noise

d) Pink noise

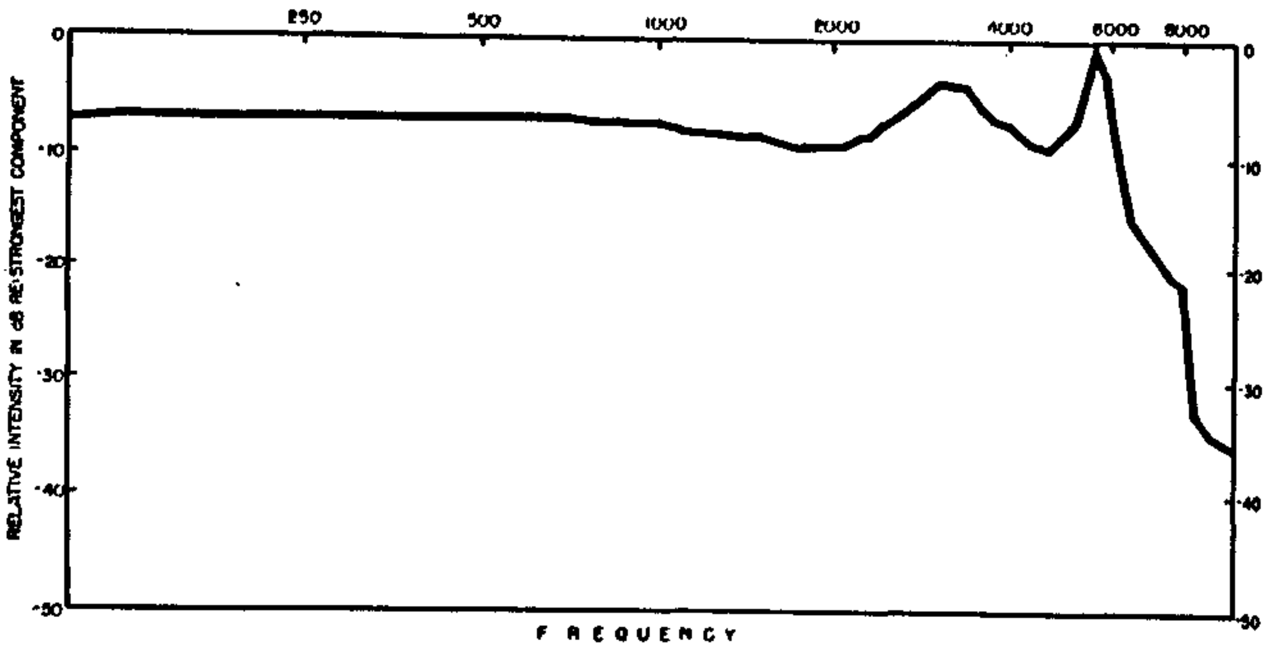
III Fill up the blanks

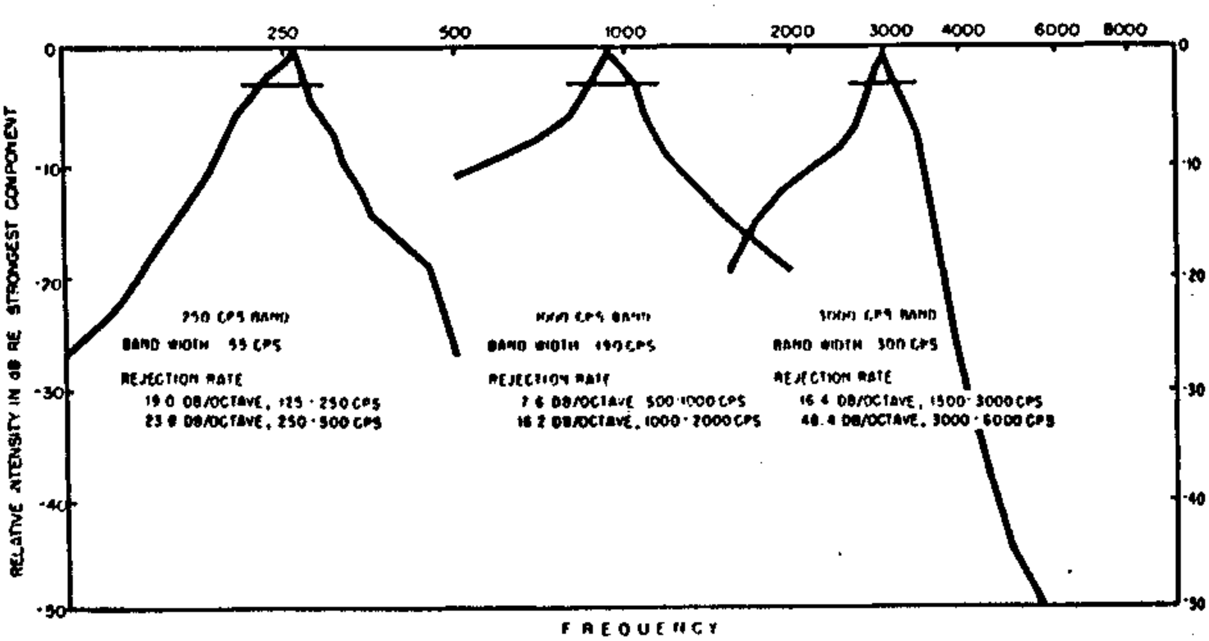
1. Masking of test tone in the non-test ear by a ...,..., or by means of.... has been outdated.
2. In ... noise, the base frequency varies between 60 Hz to 120 Hz.
3 A masking signal composed of random energy at all frequencies with approximately equal intensity has been termed .... or .... noise.
4 Energy in the complex noise is concentrated in the .... frequencies with a rapid drop off energy in the .... and. frequencies.
5. . . . . .has got uniform energy throughout the audible spectrum.
6. . . . . .provides a relatively broad spectrum with equal energy per octave below about 2000 Hz.

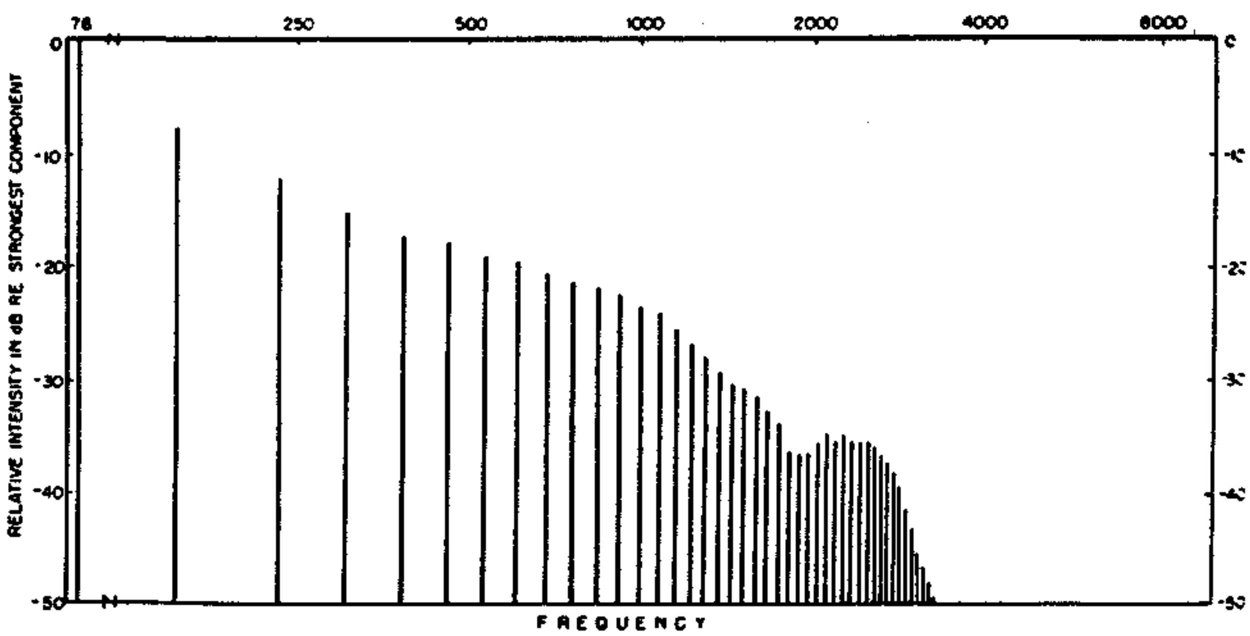
IV Match the following

1. Narrow band noise	a) is effective only at lower frequencies
2. Pink noise	b) has also been called thermal and Gaussian noise
3. Broad band noise	c) is less fatigue and discomfort.
4. Speech noise	d) is not available on commercial clinical audiometers
5. Complex noise	e) is obtained by filtering white noise above 1000 Hz at the rateof about 12 dB per octave.

V Identify the noise







VI Answer the following :

1. Why complex noise seldom appears in modern clinical audiometers?
2. Name the 3 characteristic features of NBN.
3. What kind of masking noise should be used?

Answers

I Yes/No questions

(1)No (2) Yes (3) Yes (4) No (5) No (6) No
(7)No (8)No (9)Yes (10) Yes (11) No (12) Yes

II Choose the best answer

1.(b) 2. (b) 3. (c) 4.(d) 5. (c)

III Fill up the blanks

1. Puretone, warble tone, compressed gas.
2. Complex
3. Thermal, White
4. Lower, middle, higher
5. Broadband noise (BBN)
6. Pink noise

IV Match the following

1-c
2-d
3-b
4-e
5-a

V. Identify the noise

(1) Broad band noise

(2) Narrow band noise

(3) Complex noise

VI Answer the following

1. The energy decreases as the frequency increases. Thus, it is effective only at lower frequencies. Because of this, it seldom appears.

2. (i) the center frequency

   (ii) the bandwidth in Hz at 3 dB below the intensity of the peak component and,

   (iii) the filter rejection rate of decrease in intensity per octave above and below the bandwidth.

3. To mask puretones, narrow band noise (NBN) should be used for superior masking efficiency (Sanders, 1978).

INTERAURAL ATTENUATION

Interaural attenuation (IA) is the reduction in the intensity of sound in passing from one ear to the other ear. This is also called as skull attenuation or interaural transmission loss.

Wegel and Lane (1924) and Zwislocki (1948) consider this interaural attenuation to be due to bone conduction, i.e. sound travels from one ear to the other ear primarily by vibrating the bones of the skull, it looses energy. According to Bekesy (1948), a signal presented at high intensities through the test earphone can leak from under the rubber cushions and cross over to the non-test earphone. **Other** investigators said that the cross over occurs by means of **the bone** conduction mechanism (Sparrevohn, 1946;Studebaker, 1962b; **Wegel** and Lane, 1924; Zwislocki, 1953). That is, when a sound is presented by air conduction to the test ear, it will be transmitted through the skull bones to the non-test ear cochlea.

The amount of interaural attenuation varies with the following factors :

* Mode of conduction of signal
* Kind of signal
* Frequencies
* Types of earphones
* Across subjects and
* Miscellaneous factors.

I Interaural attenuation and mode of conduction of signal

Signals can reach cochlea either through air conduction or bone conduction. When signals are conducted through air conduction interaural attenuation is much larger than when conducted through bone conduction.

Air Conduction

Chaiklin (1967) suggested that cross over can occur through the bone conduction (through-the-head) as well as the air-conduction (around-the-head) mechanism. In the process, the sound will be attenuated by 40 dB or above because sound has to travel from the air into the skull.

The interaural attenuation for air conducted stimuli can be determined by obtaining the unmasked air conduction thresholds bilaterally in patients with complete unilateral deafness and 0-10 dB HL air and bone conduction thresholds in the normal hearing ear, and then subtracting the good ear air conduction or bone conduction thresholds from the poor ear air conduction thresholds. The threshold obtained in the poorer ear should be due to cross over as well as the cross hearing responses.

Table 1 : Mean thresholds for each ear with phones and interaural attenuation.

Frequency (Hz)	Mean thresholds (dBSPL) Deaf ear	Better ear	Mean	Interaural attenuation Maximum	Minimum
125	87	49	38	45	32
250	77	26	51	58	44
500	70	11	59	65	54
750	74	5	69	71	62
1000	66	5	61	66	57
1500	73	6	67	76	45
2000	69	8	61	72	55
3000	75	7	68	72	56
4000	73	3	70	85	61
6000	83	18	65	76	56
8000	76	19	57	69	51

This Table-1 shows the unmasked air-conduction threshold levels for both ears of subjects with unilateral deafness presented by Chaiklin (1967). As can be seen from this table, a tone of 70 dB SPL at 500 Hz presented to the dead ear is heard in the non-test eat at 11 dB SPL. Thus, the interaural attenuation for air-conduction at 500 Hz is 59 dB on average, with a minimum value of 54 dB and a maximum value of 65 dB.

Bone Conduction

A signal presented through a bone-conduction oscillator can cross from the test ear to the non-test cochlea by bone-conduction.

Thai is, a signal presented to the test ear causes vibration of the skull so sound travels through the skull bones to the non-test cochlea. Consequently, the better cochlea lesponds to the stimulus regardless of which ear is being tested by bone conduction. The bone conducted stimulus crosses from the test ear to the non-test cochlea without loss of intensity.

Our clinical experience shows that the interaural attenuation for bone conduction at 2000 and 4000 Hz ranges from 0 to 15 dB. At the low frequencies, the skull vibrates as a whole so the signal crosses by bone conduction through the skull unattenuated. At the high frequencies, the temporal bone vibrates first; then the whole skull vibrates segmentally. So interaural attenuation for high frequencies can be upto 15 dB. The interaural attenuation for bone conducted stimuli with forehead placement of the bone oscillator is approximately 0 dB (Studebaker, 1967).

The following example illustrates the interaural attenuation for bone conduction. Suppose a 55 dB HL sound is presented by bone conduction to the right ear and if thecrossed over energytotheleft ear is 40dB HL thenwe cansay that the interaural attenuationis 15 dB.

II Interaural Attenuation and Kind of Signal

Kind of signal here means, whether signal is puretone, speech or noise. The interaural attenuation values are different for different stimuli. So it is recommended that clinicians should consider different interaural attenuation values for different stimuli. For example, Vijaynrnghavan (1978) found mean internurnl attenuation value for put clone and narrow band noise to be 5K and 65 dB respectively. Martin (1950) said that interaural attenuation for speech audiometry varies from 40 dB to 50 dB.

III Interaural Attenuation Across Frequencies

The average minimum and maximum interaural values for air conduction at each frequency are also shown in Table 1. The minimum interaural attenuation at frequencies between 250 Hz to 8000 Hz found by Chaiklin (1967) was 44 dB at 250 Hz. Note that the interaural attenuation for air-conducted stimuli increases directly with frequency.

Table-2: Mean and range of interaural attenuation values according to various authors

Authors		125	250	500	IK	2K	4K	8K
		(in Hz)						
Zaislocki (1953)	Mean	40	40	50	55	60	65	70
	Range	-		-	-	-	-	
Coles & Pride (1968)	Mean		62					
	Range	-	50-80	45-80	40-80	45-75	50-85	-
Vijaya Raghavan (1978)	Mean		46	57	58	60	66	58
	Range	-	45-49	55-59	58-59	60-6 1	65-68	56-57

Table-2 shows how interaural attenuation changes across frequencies given by Coles and Pride (1968), Zwislocki (1953) and Vijayaraghavan (1978).

Interaural attenuation values between authors differs perhaps because of type of earphone subjects or method used to find out interaural attenuation.

IV Interaural Attention and Kinds of Earphones

Larger the earphone lesser the attenuation, smaller the earphone more the attenuation value. Size of the earphone is indirectly proportional to the amount of interaural attenuation.

For example : for headphone lowest interaural attenuation is 40 dB and for insert receiver the lowest interaural attenuation is 70 dB. So, use of insert receiver increases the interaural attenuation value for noise there by increasing the maximum permissible noise.

V Interaural Attenuation and Individual Differences

Interaural attenuation varies from person to person, even when we use same frequency tone, same earphone, and same mode of conduction. For example, in Coles and Pride's (1968) study at 1 kHz minimum interaural attenuation was 40 dB and maximum was 80 dB.

VI Miscellaneous Factors

Interaural attenuation may vary depending upon the external auditory canal's volume. Vijayaraghavan (1978) studied the head circumference as a variable in interaural attenuation. And he concluded that the interaural attenuation value may not differ significantly as a function of the size of the head.

The amount of interaural attenuation may vary with all the above mentioned factors.

It is recommended that, for clinical purposes, the interaural attenuation value for air conducted stimuli be considered as 40 dB to minimize the possibility of cross-hearing. The interaural attenuation for bone conducted stimuli "with mastoid placement of the bone oscillator ranges from approximately 0 dB at 250 Hz to approximately 15 dB at 4000 Hz (Studebaker, 1967).

Questions

I Fill up the blanks

1. Interaural attenuation is also called as .... or ....
2. Signals can reach cochlea either through.... or.....
3. The bone conducted stimulus crosses from the test ear to the non-test cochlea without loss of intensity at.... frequencies.
4. Larger the earphone.... the attenuation, smaller the earphone .... the attenuation value.
5. Use of.... increases the interaural attenuation value for noise there by increasing the....

II Choose the best answer

1. For clinical purposes, interaural attenuation value for air conducted stimuli is considered as.... to minimize the possibility of cross hearing

   (a) 60dB (b) 40 dB (c) lOdB (d) 0 dB

2. According to Studebaker (1967) interaural attenuation for bone conducted stimuli with mastoid placement of the bone oscillator is .... at 250 Hz.

   (a) 4O dB (b) 2O dB (c) O dB (d) 7O dB

III True/False

1. When signals are conducted through air conduction interaural • attenuation is much larger than when conducted through bone conduction.

2. Interaural for bone conduction is greater for higher frequencies.
3. According to Studebker (1967), the intcrauraJ attenuation for bone conducted stimuli with forehead placement of the bone oscillator is approximately 40 dB.
4. The intreaural attenuation values, are different for different stimuli.
5. Size of the earphone is indirectly proportional to the amount of interaural attenuation.

6. If we use same frequency tone, same earphone and same mode of conduction, interaural attenuation does not vary from person to person.

7. Interaural attenuation may vary depending upon the external auditory canal's volume.

IV Answer the following

1. What is I A?
2. How does the interaural attenuation vary?
3. How dos the interaural attenuation takes place?

Answers:

I Fill in the blanks

1. Skull attenuation, inter aural transmission loss.
2. Air conduction, bone conduction
3. low
4. Less, more
5. Insert receive, maximum permissible noise.

II Choose the best answer

1. b
2. c

III True/False

(1) True (2) True (3) False (4) True

(5 True (6) False (7) True

IV Answer the following

1) Interaural attenuation is the reduction in the intensity of sound in passing from one ear to the other ear.

2) Mode of conduction of signal, kind of signal, frequencies, types of earphones, across subjects and miscellaneous factors.

3) It is due to bone conduction by the vibration of the bones of the skull.

WHEN TO MASK

Clinical masking is used to eliminate participation of the non-test ear when evaluating the test ear. More specifically, a second source (usually some type of noise presented via the air conduction mode through an earphone is employed to shift the sensitivity of the non-test cochlea to prevent the non-test ear from responding when presenting a signal to the test ear. Masking must be used during an audioiogic assessment when the patient presents air and/or bone conduction thresholds that are not similar bilaterally. Thus, masking is typically used in the cases of unilateral or asymmetric bilateral hearing loss.

When a signal is presented to the poorer ear (test ear) at a sufficiently loud intensity level, it may pass across the skull and be perceived by the opposite, better ear (non-test ear). Without using masking for the non-test ear, patients will respond to the signal in the better ear.

The above example illustrates the necessity to mask. Without application of appropriate masking procedures, validity of test findings is in question. Clinicians must, therefore, examine the obtained results to determine whether they represent the actual hearing levels or may be due to cross hearing. The consequences of failing to mask, or the inappropriate use of masking have potentially serious negative ramifications on both medical and audioiogic management.

"The understanding of when to mask places the tester half way towards the goal of properly using masking in puretone testing" (Staab, 1974).

Masking should be applied to the better ear whenever the danger of cross hearing is indicated. The danger of cross hearing is determined by the following factors :

* Presentation level of the test signal.
* Interaural attenuation
* Bone conduction threshold of the non-test ear.

Presentation level of the test signal

It is the level of the test signal, presented to the test ear. This presentation level minus the interaural attenuation is level of test tone reaching the opposite ear (NTE). After a particular point, (when presentation level becomes more than 40 dB) the level of the test signal reaching the non-test ear is linear with the presentation level.

Bone conduction threshold of the non-test ear

Even when the test signal is presented by air-conduction it will cross the skull by bone conduction. Thus the threshold sensitivity of non-test cochlea plays an important role. Higher the threshold sensitivity of the non-test ears cochlea, lesser the danger of cross hearing and lesser the threshold sensitivity of the non-test ears cochlea, higher the danger of cross hearing.

We have different rules for "when to mask" in puretone air conduction, puretone bone conduction and in speech audiometry.

Because of this reason, the chapter has been divided into 3 sub-divisions :

* When to mask in puretone air conduction
* When to mask in puretone bone conduction
* When to mask in speech audiometry

When to mask in puretone air conduction

The non-test ear must be masked whenever there is a possibility that it will respond to the tone presented to the test ear. Studebaker (1964) suggests that masking should be used whenever differences between the thresholds (air-conduction) of the 2 ears equal or exceed 35 dB at 250 Hz, 40 to 45 dB at 500, 1000 or 2000 Hz; or 50 dB at 4000 Hz.

It is important to recognize that a determination of when to mask should be based on sensory-neural sensitivity in the non-test ear. Even when the test signal is presented by air conduction, it will cross the skull by bone conduction whenever its intensity at the test ear is about 50 dB greater than the bone conduction threshold of the non-test ear, regardless of air-conduction threshold in the non-test ear.

In cross-hearing, the non-test ear is apparently stimulated largely through the mechanism of bone conduction (Zwislocki, 1953). Therefore,when we decide whether masking is needed to obtain an accurate air conduction threshold, we must compare the air conduction threshold of the ear being tested with the bone conduction threshold, of the contralateral ear. If the difference exceeds interaural attenuation values for that frequency, the air-conduction threshold must be re-established using masking in the non-test ear. So we can say when the,

PTL - IA > BCNH-, masking is required

Wherein, PTL -> Presentation level

IA -> Interaural attenuation

BC -> Bone conduction

NTE -> Non-test ear.

Thus, Studebaker's (1967) rule for when to mask in air conduction puretone audiometry is :

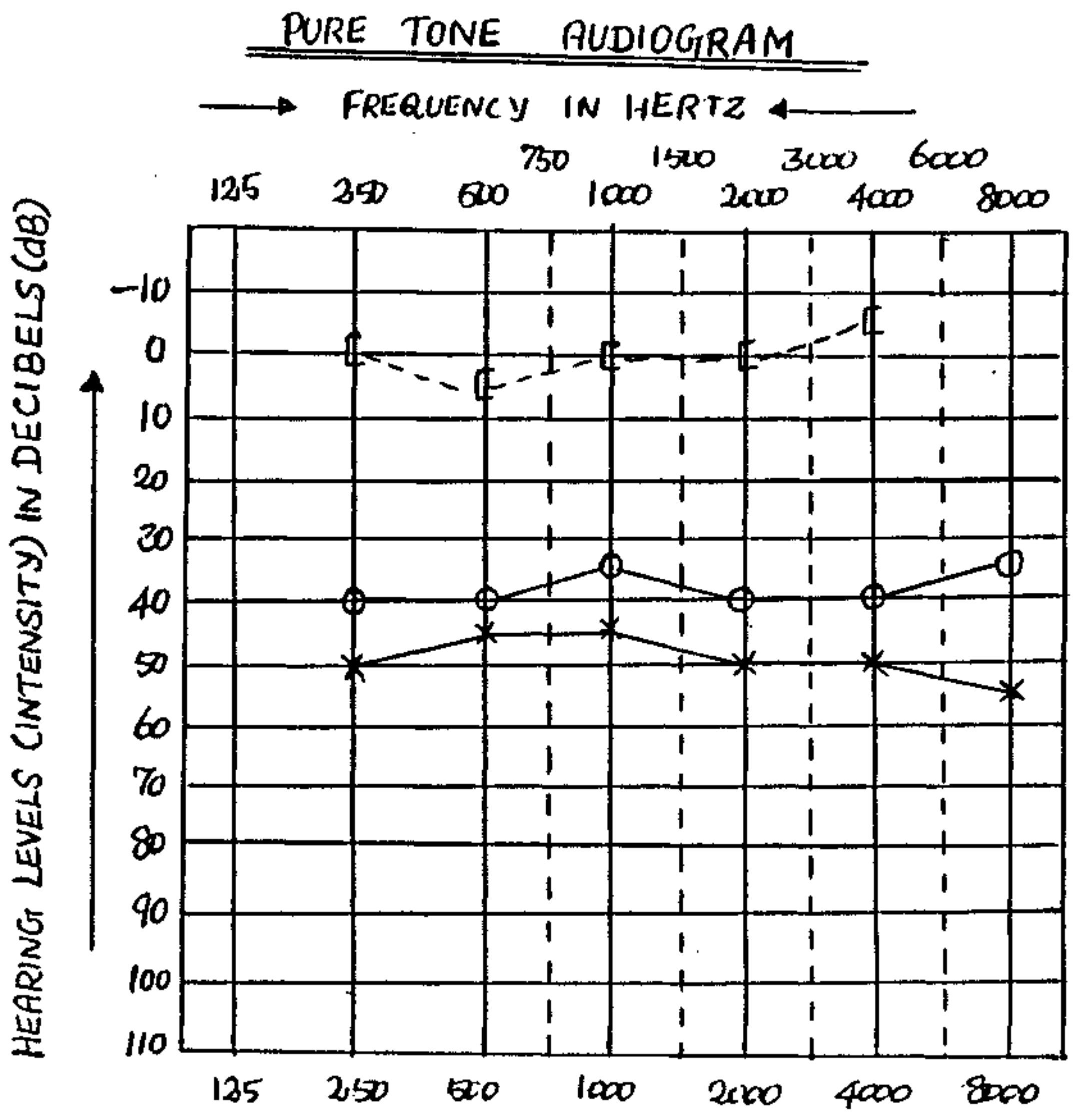
"In air conduction audiometry, the non-test ear should be masked whenever the intensity of the signal presented to the test ear exceeds bone conduction sensitivity in the non-test ear by more than 40 dB".

An air conducted tone to travel from test ear to non-test ear, the amount of energy lost ranges from 40 dB to 80 dB, depending upon frequency, and subject. In this situation it is reasonable to adopt Studebaker's (1967) suggestion of taking an extreme value. In this case we should take minimum value i.e. 40 dB.

Puretone air-conduction audiometry

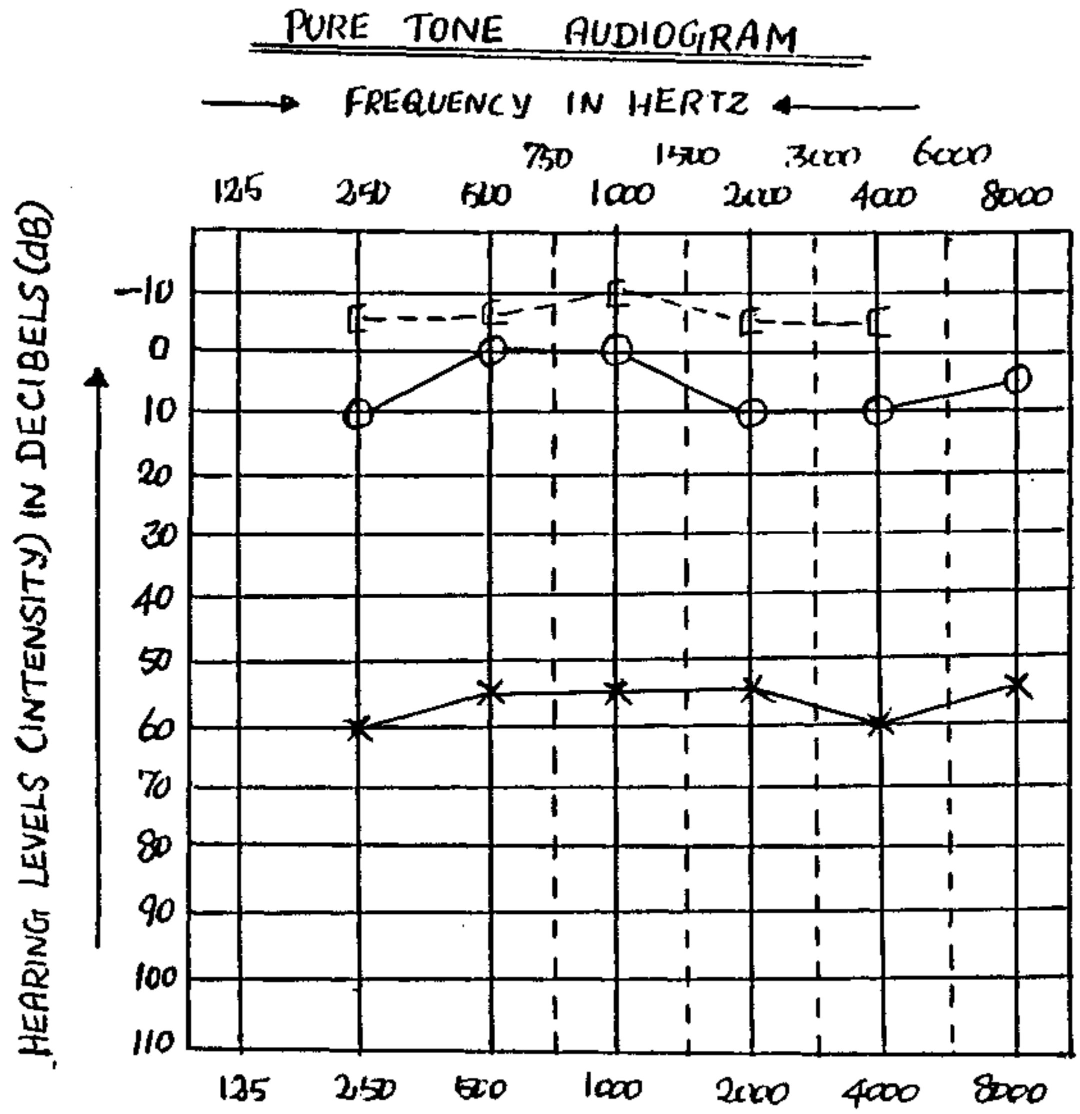
(a) When the air conduction threshold of the test ear and the bone conduction threshold of the nontest ear differ by IA or more, use masking.

Example :



(b) When the air conduction threshold of the test ear and the air conduction threshold of the non-test ear differ by IA for the test frequency or more, use masking.

Example



When to mask in puretone bone conduction

Since at low frequencies the skull vibrates as a unit, the two cochlea imbedded within the same skull, are stimulated almost equally regardless of whether the receiver is on the same or opposite side of the head. Because of this reason, many author suggest interaural attenuation for bone conducted signal should be considered as zero dB.

Studebaker's (1964) rule for when to mask in bone-conduction audiometry is :

"In bone conduction, the non-test ear should be masked whenever the test ear exhibits an air-bone gap"

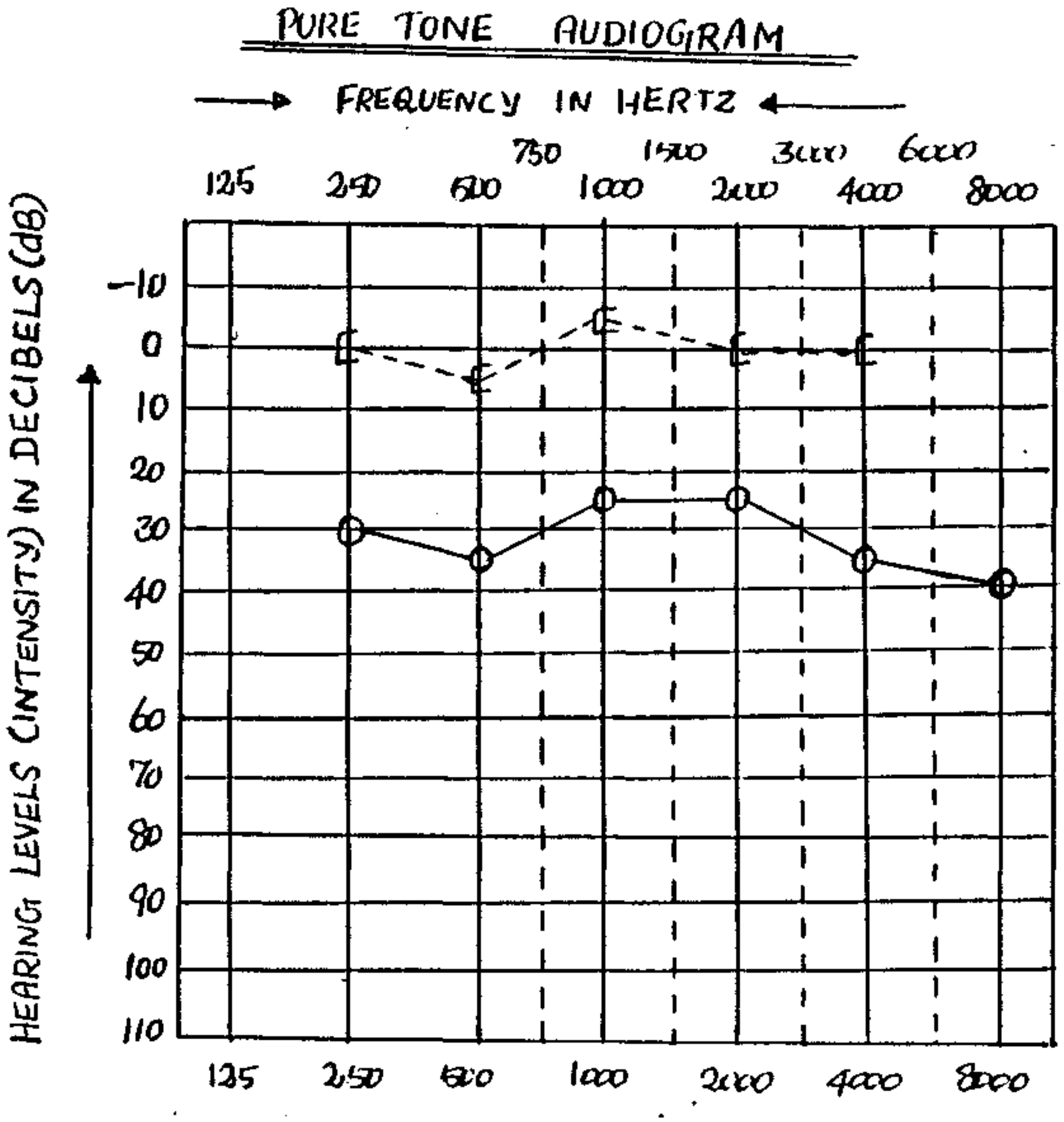
It is the consensus of opinion that interaural attenuation for a signal presented through bone conduction should be considered zero (Katz, 1972; Martin, 1975; Studebake, 1967; Sanders and Rintelmann, 1964).

Although slight amounts of attenuation at the higher frequencies may exist for some subjects, the values are extremely variable and cannot be depended upon. Therefore, it is well to expect no interaural attenuation for bone conduction. Since we cannot count on interaural attenuation for sounds presented through bone conduction, the only way to rule out the participation of the contralateral ear is to always use masking when testing bone conduction. Other wise, regardless of where the bone receiver (vibrator) is placed, there is no way of knowing which ear is being evaluated. However, Weber test had been used for determining when to mask during bone conduction test. If the patient lateralizes the test tone to one ear then masking is applied to that ear. No masking is needed, if the subject does not lateralize the tone. However, this procedure is not being used because of misleading results.

However, it is not always necessary to know which ear is being evaluated by bone conduction. The purpose of obtaining bone conduction thresholds is to compare them with air conduction thresholds to determine whether the loss is conductive, sensorineural or mixed. If an air bone gap of 10 dB HL or more exists between unmasked bone conduction and the air conduction thresholds of either ear, it signifies a conductive component. It is then necessary to determine in which ear this conductive component exists, and therefore masking is indicated. However, if an air-bone gap does not exist in either ear we may conclude that the hearing loss is sensorineural in both ears, and individual bone conduction thresholds for the 2 ears are not necessary. Studbaker (1964) recommends masking should be used any time the bone conduction thresholds are better than air conduction thresholds in the ear being tested by more than 10 dB. Thus we canconclude that masking is required while puretone bone conduction audiometry.

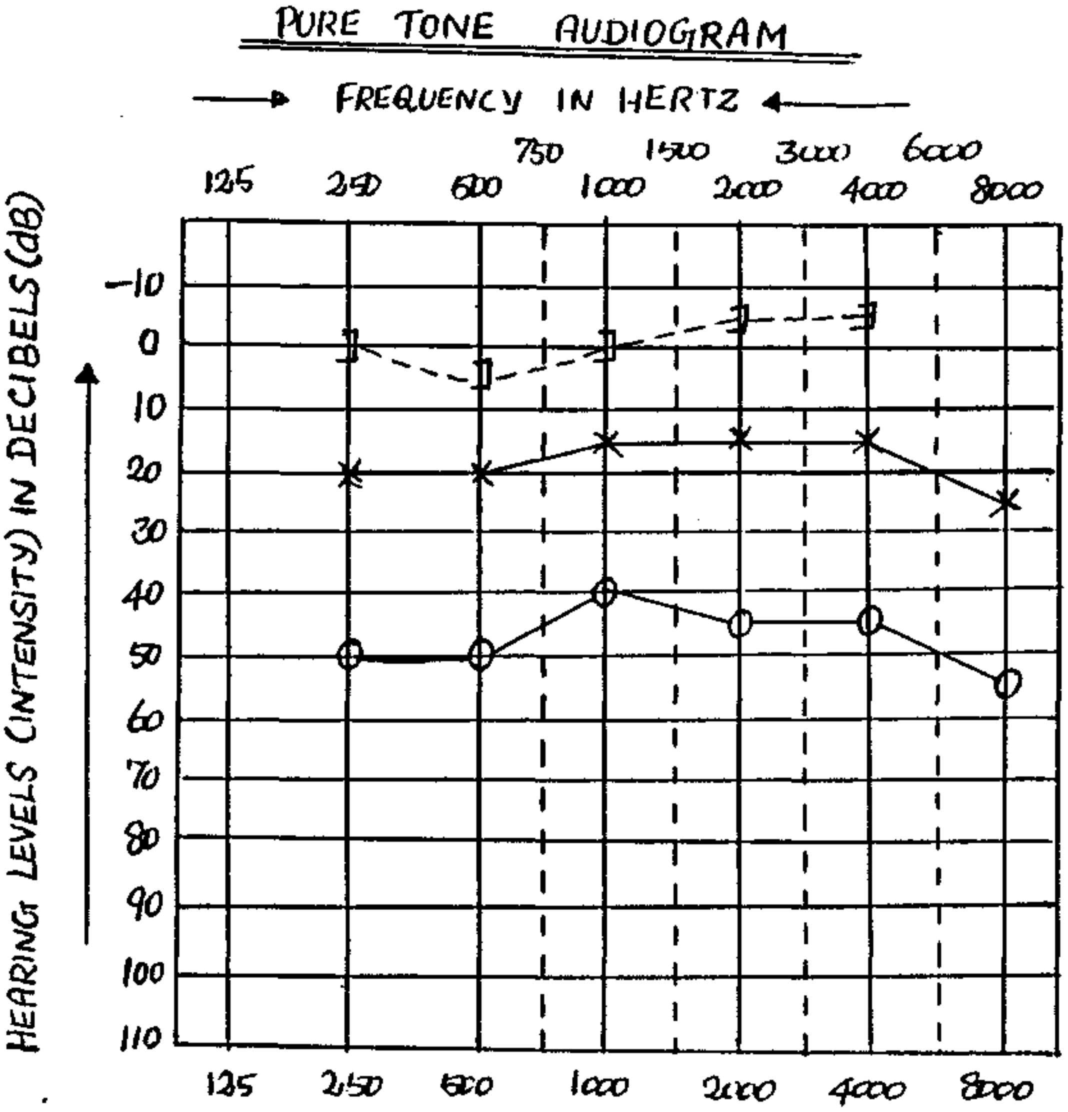
a) When the air conduction threshold of the test ear and the bone conduction threshold of the non-test ear differ by more than 10 dB use masking.

Example



b) When the air conduction threshold of the test ear and air conduction threshold of the non-test ear is greater than 10 dB, use be masking.

Example



When to mask in speech audiometry

Speech Reception Thresholds (SRT)

Minimal interaural attenuation for speech is considered to be 40 to 50 dB (Martin, 1975). It is assumed that contralateralization for speech stimuli occurs through bone conduction similar to contralateralization for puretone stimuli. Therefore, there is a need to use masking in the non-test ear whenever the SRT of the test ear exceeds the lowest bone conduction threshold of the non-test ear by 40 dB or more

i.e. PL of SRT - IA > lower BCTNTK

Minimum interaural attenuation for speech is considered to be 40 to 50 dB (Martin, 1975). Owing to the use of large earphones the interaural attenuation value is set at 40 dB. This may lead to unnecessary masking in some cases. An alternate indicator for the need for masking is a difference of 40 dB or more between the speech reception thresholds of the two ears in the unmasked condition (Veteran Administration Hospital, Washington, DC, Personal Communication)

i.e. SRTn: - SRTNTK. > 40 dBmax

So when the spondee threshold of the test ear and the puretone bone conduction threshold average of the speech frequencies (500, 1000 and 2000 Hz) of the non-test ear differ by 45 dB or more, use masking.

i.e. PL of SRT - IA > Avg. BCT(NIT:)

Example : SRT of the test ear -> 70 dB HL.

Average BC threshold of the nontest ear -> 15 dB HL

b) When the spondee threshold of the test ear and the spondee threshold or puretone average of the non-test ear differ by 45 dB or more, use masking.

Example SRT of non-test ear => 30dB HL
SRT of test ear => 80 dB HL.

Speech discrimination

Since speech discrimination is tested at suprathreshold levels, the danger of cross hearing is greater than with threshold testing. So, Frequent masking is needed for discrimination although it is not necessary for obtaining speech reception thresholds.

According to Martin (1975), "it is necessary to mask for speech discrimination whenever the presentation of the PB words in the test ear, minus the interaural attenuation for the low frequency components of the speech, is above the bone conduction thresholds of the opposite ear".

i.e. PL of PB max. - IA > Best of the BCTNTF.

This means that masking in the non-test ear is necessary whenever the presentation level of the PB words is 40 dB or more above the best bone conduction threshold of the opposite ear.

i.e. PL - SRT NIE 40 dB.

An alternate criterion used in some clinical facilities is to mask the good ear if the presentation level to the poor ear is 40 dB or more above the SRT of the good ear (Veterans Administration Hospital, Washington, DC, Personal Communication).

The folloiwng chapter describes the bases for "How much masking is needed for each test".

Questions

I True or False

1. Masking should be applied to the better ear whenever the danger of cross hearing is indicated.
2. Presentation level is the level of the test signal, presented to the non-test ear.
3. In airconduction audiometry, non-test ear should be masked whenever the intensity of the signal presented to the test ear exceeds bone conduction sensitivity in the non-test by more than 40 dB. 4. Weber test had been used for determining when to mask during bone conduction test.
5. In Speech Audiomery, the non-test ear should be masked whenever the test ear exhibits an air-bone gap of 1 OdB.

II Identify the worng one and correct it.

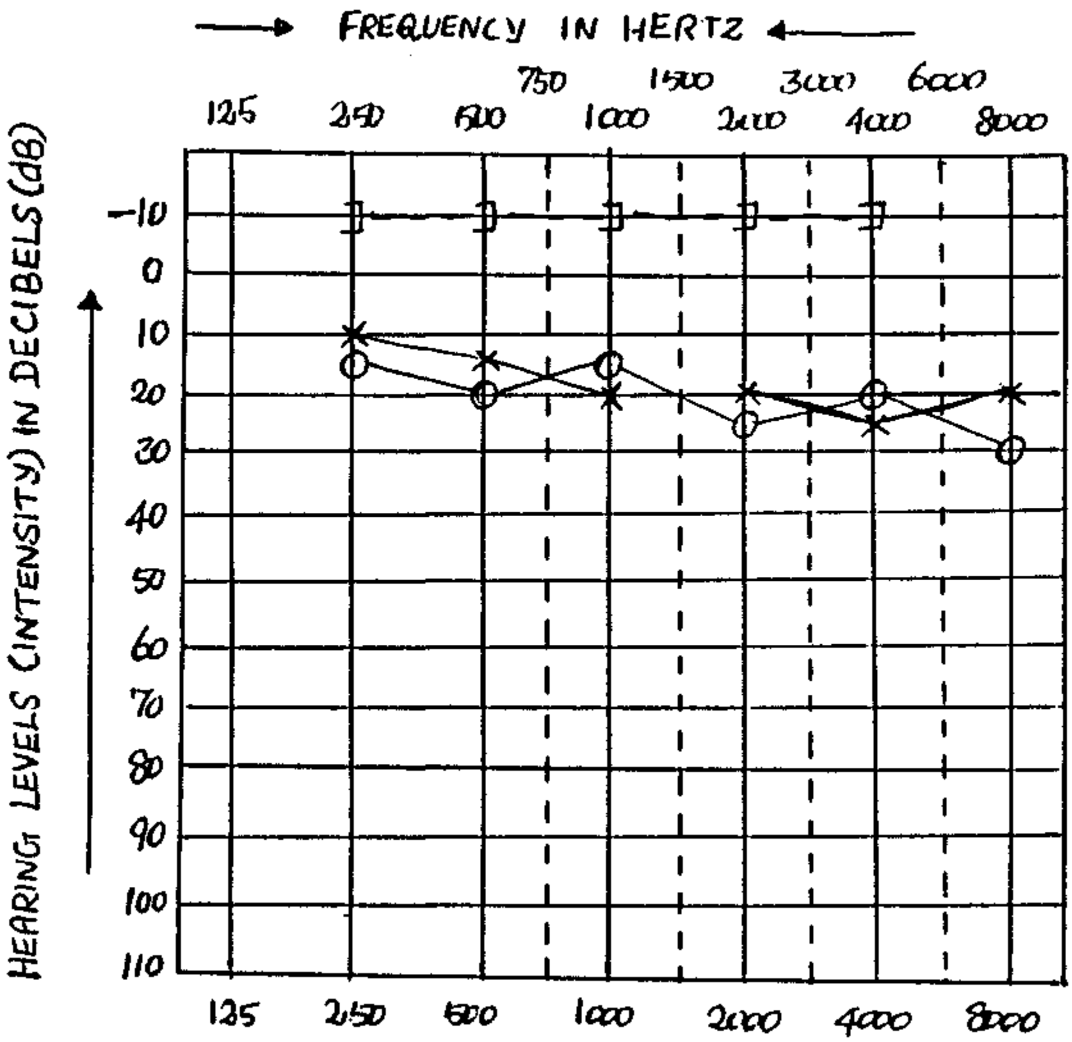
l.AC masking is needed when ACTE- BCTE- > 40dB

2. BC masking is neded when BCTE -BCNTE >10 dB.

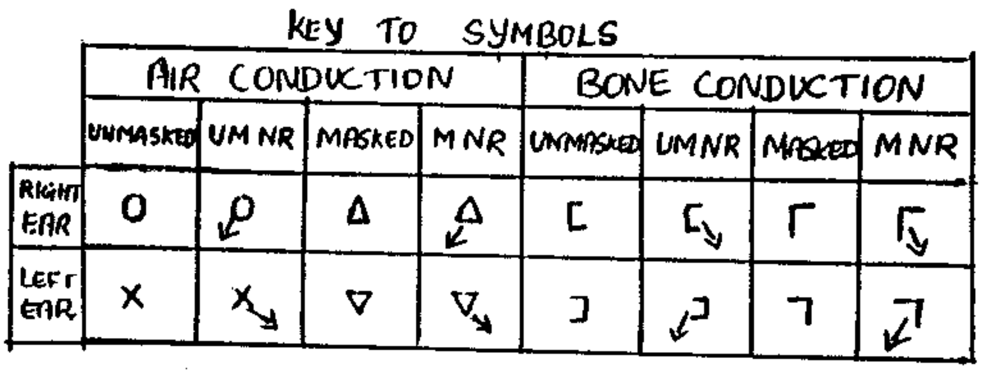
3. SRT masking is needed when PL ACTE: - BCNTE > 40dB.

4. PB max. masking is needed when PL of SRT- BC:NTE > lOdB.

PURE TONE AUGIOGRAM



	Rt	Lt
PTA	20 dB	18.3dB
SRT		
PB Max		

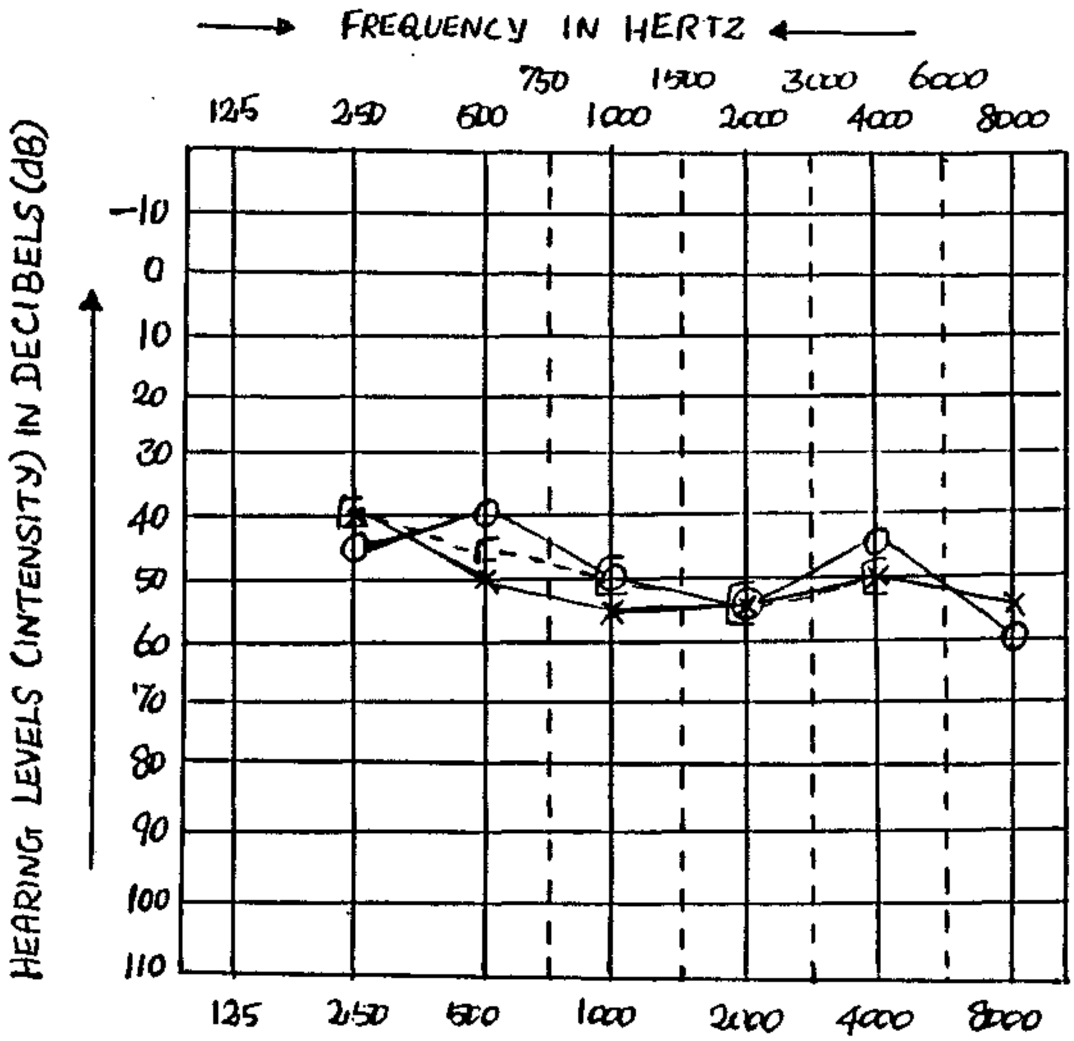


III Answer the following

I. a) Is masking needed for air conduction?

b) What type and degree of hearing loss are we looking at in each ear?

PURE TONE AUDIOGRAM

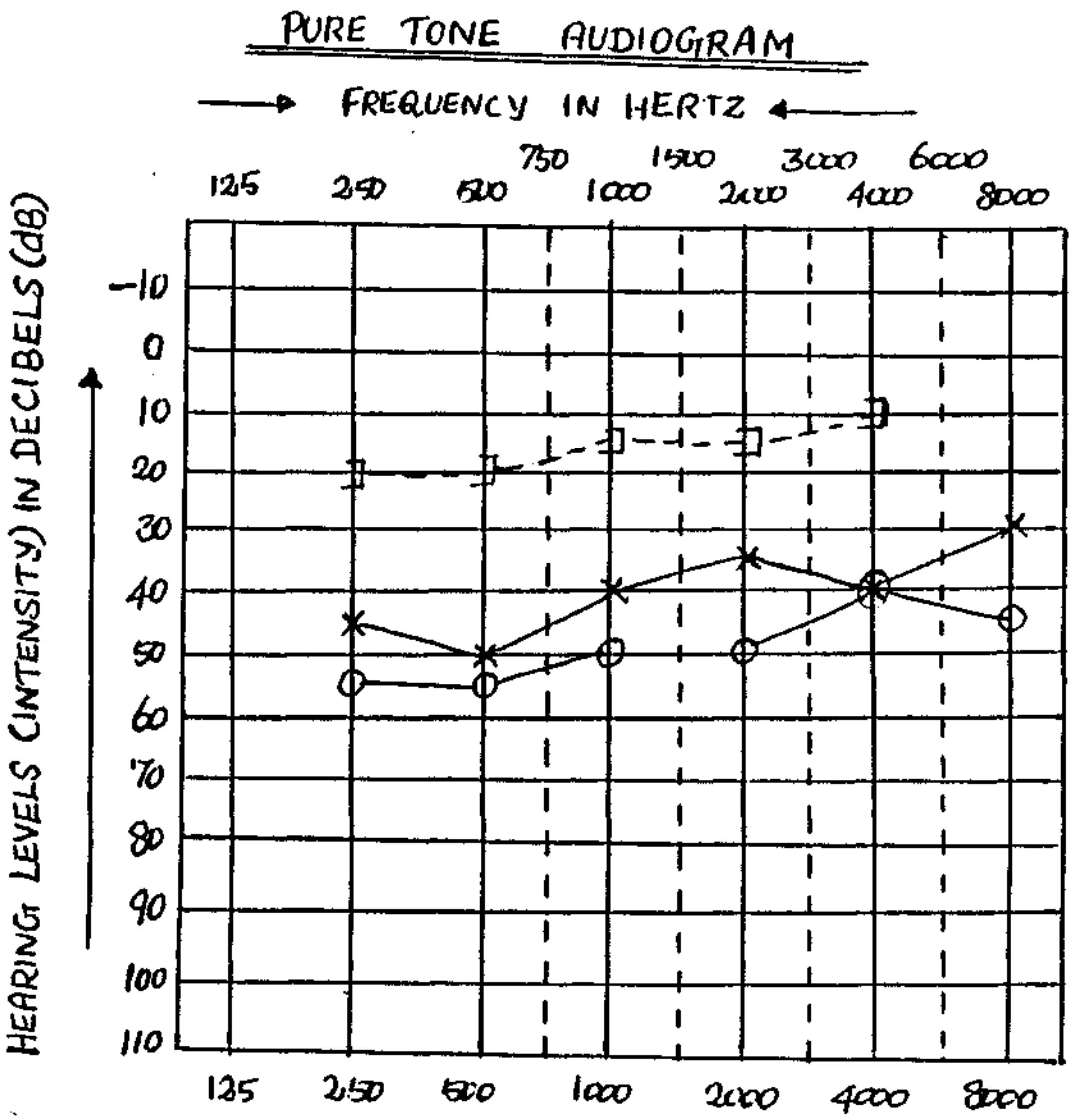


	Rt	Lt
PTA	48.3dB	53.3dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

2) a) Fs masking needed ? Justify your answer?

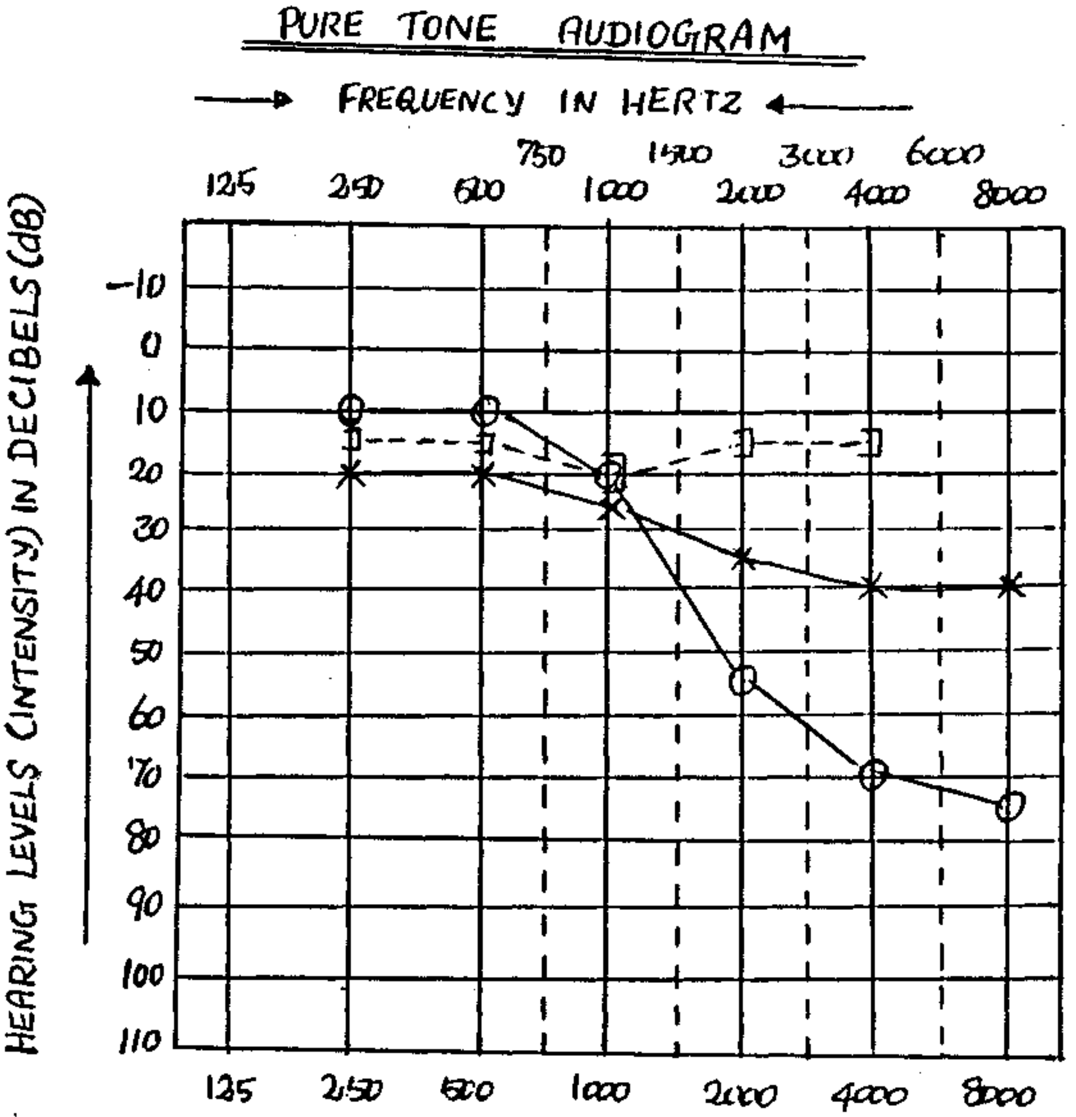


	Rt	Lt
PTA	51.6dB	41.6dB
SRT		
PB Max		

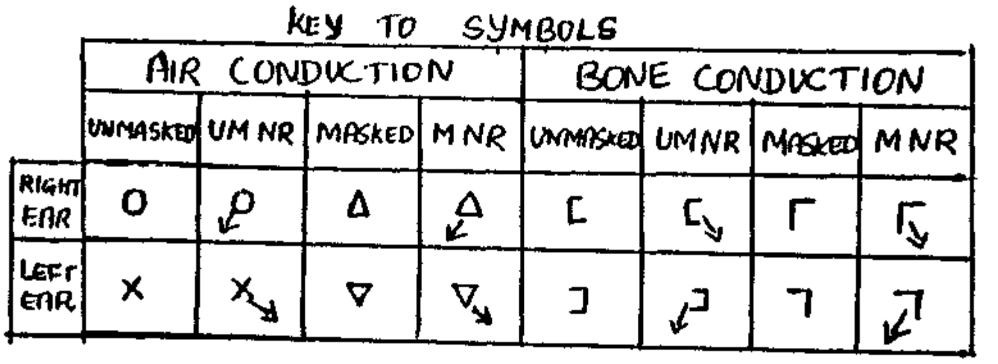
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	▽	▽↘	]	↙]	˥	↙˥

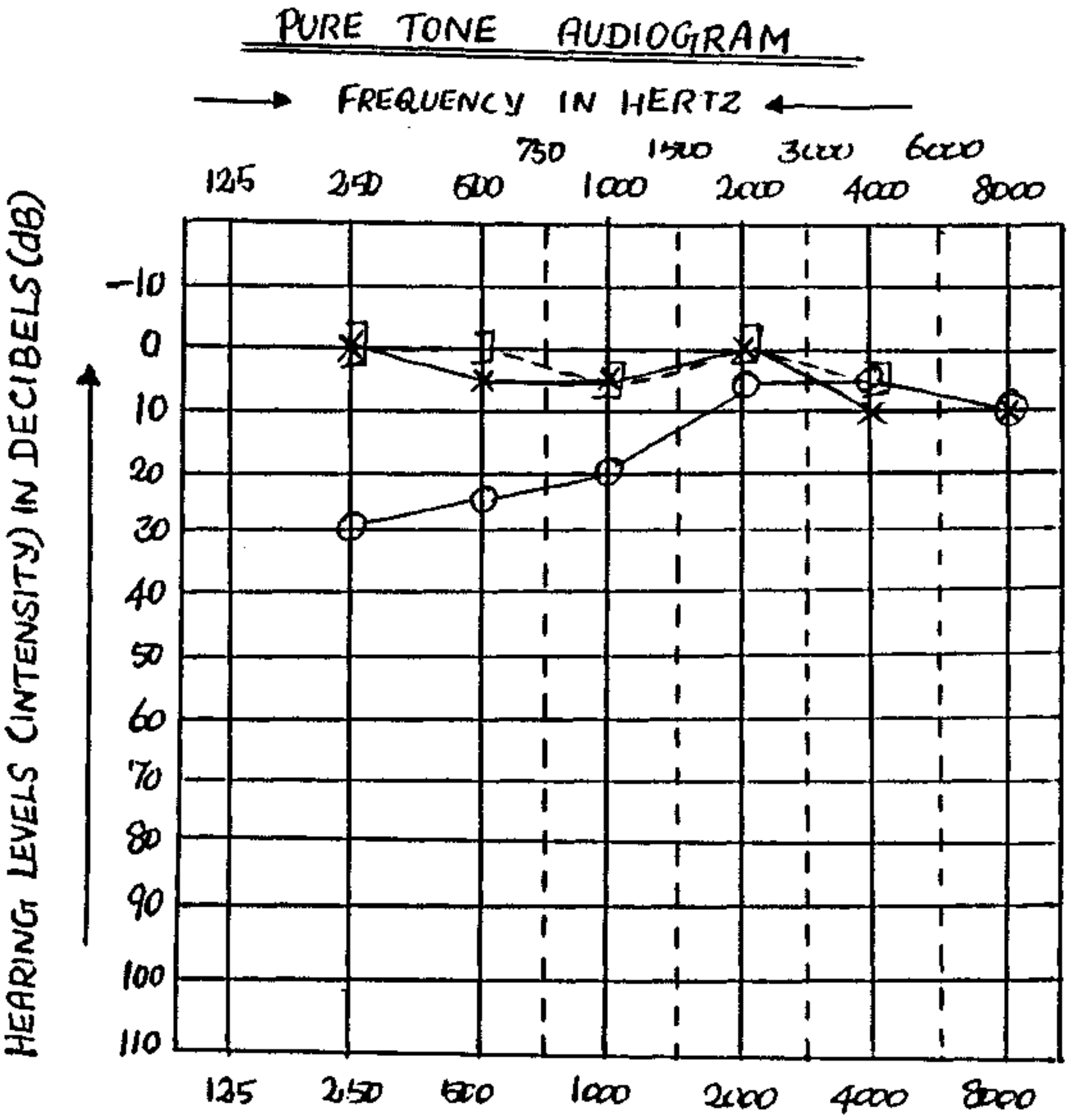
3. a) Is masking needed? Give reason.



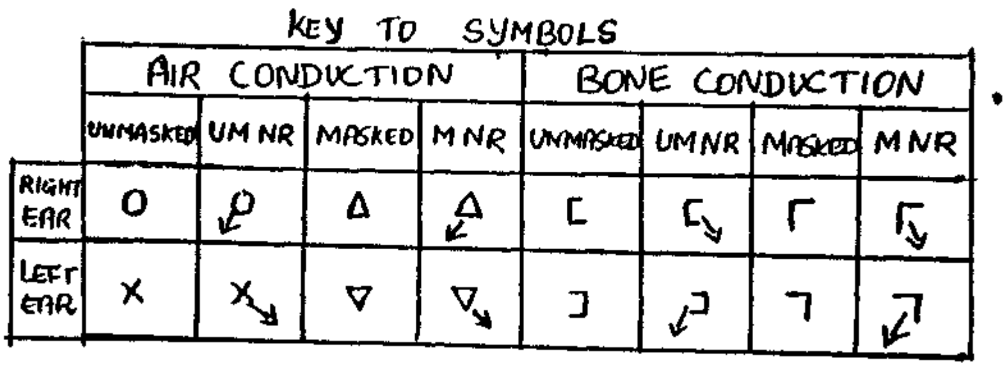
	Rt	Lt
PTA	28.3dB	26.6dB
SRT		
PB Max		



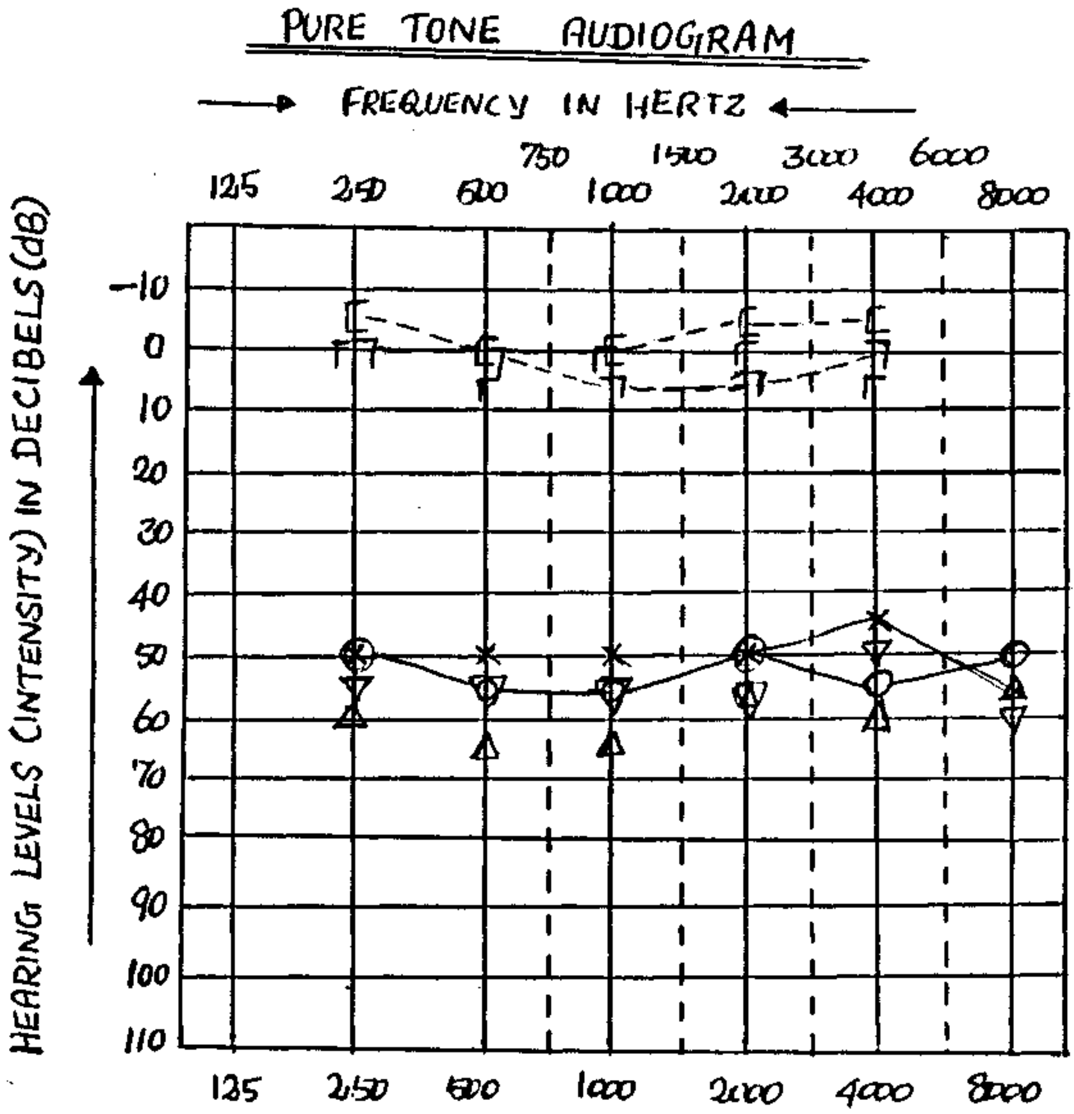
4.a) At which frequencies in which ear masking needed for air conduction or bone conduction?



	Rt	Lt
PTA	16.6dB	3.3dB
SRT		
PB Max		



5a) Do you think that masking is needed for the above case? Why?



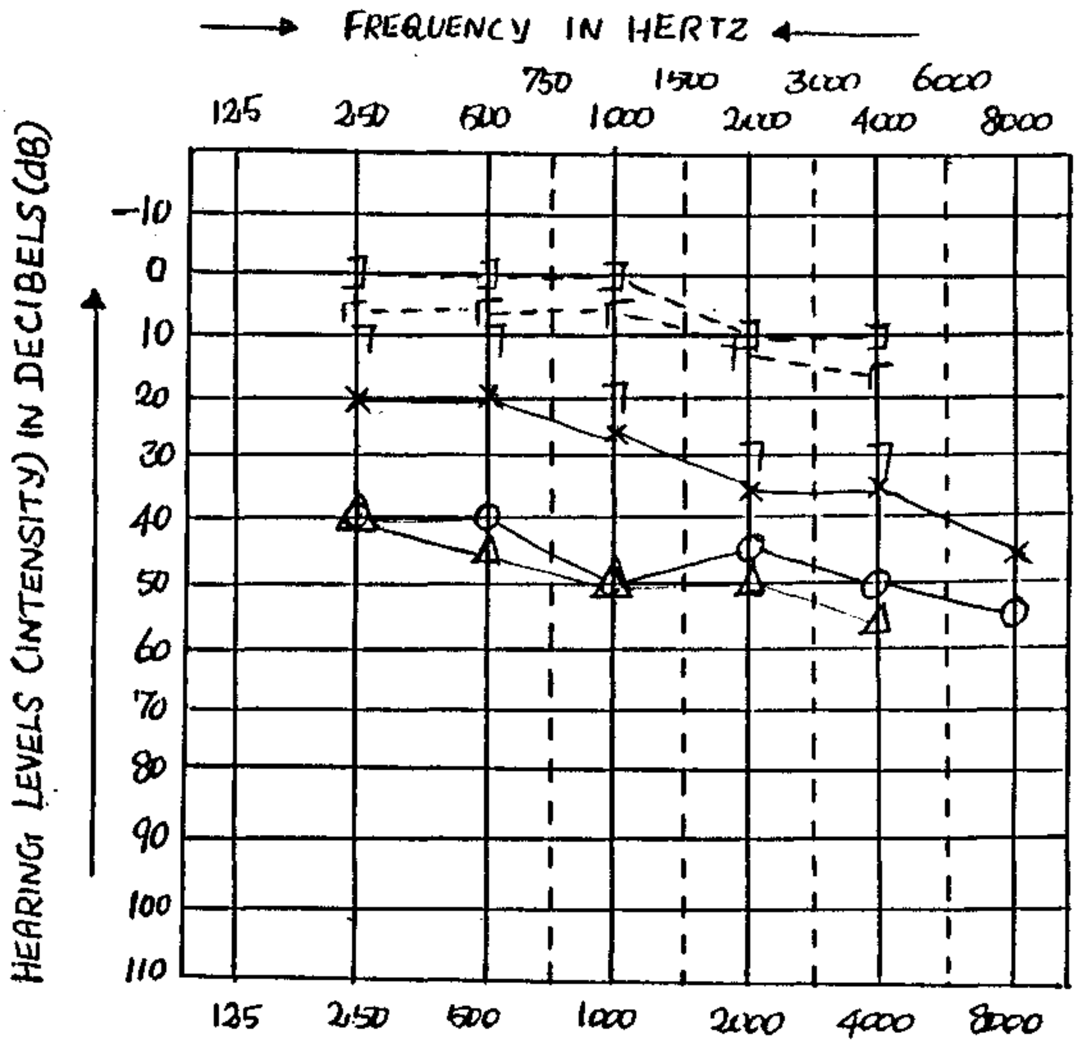
	Rt	Lt
PTA	53.3dB	50 dB
SRT		
PB Max		

KEY TO SYMBOLS

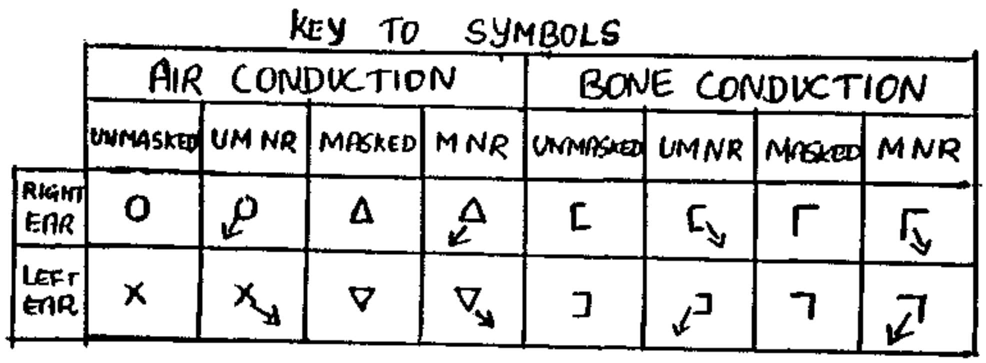
	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

6.a) Why was it necessary to mask for both air-conduction and bone-conduction

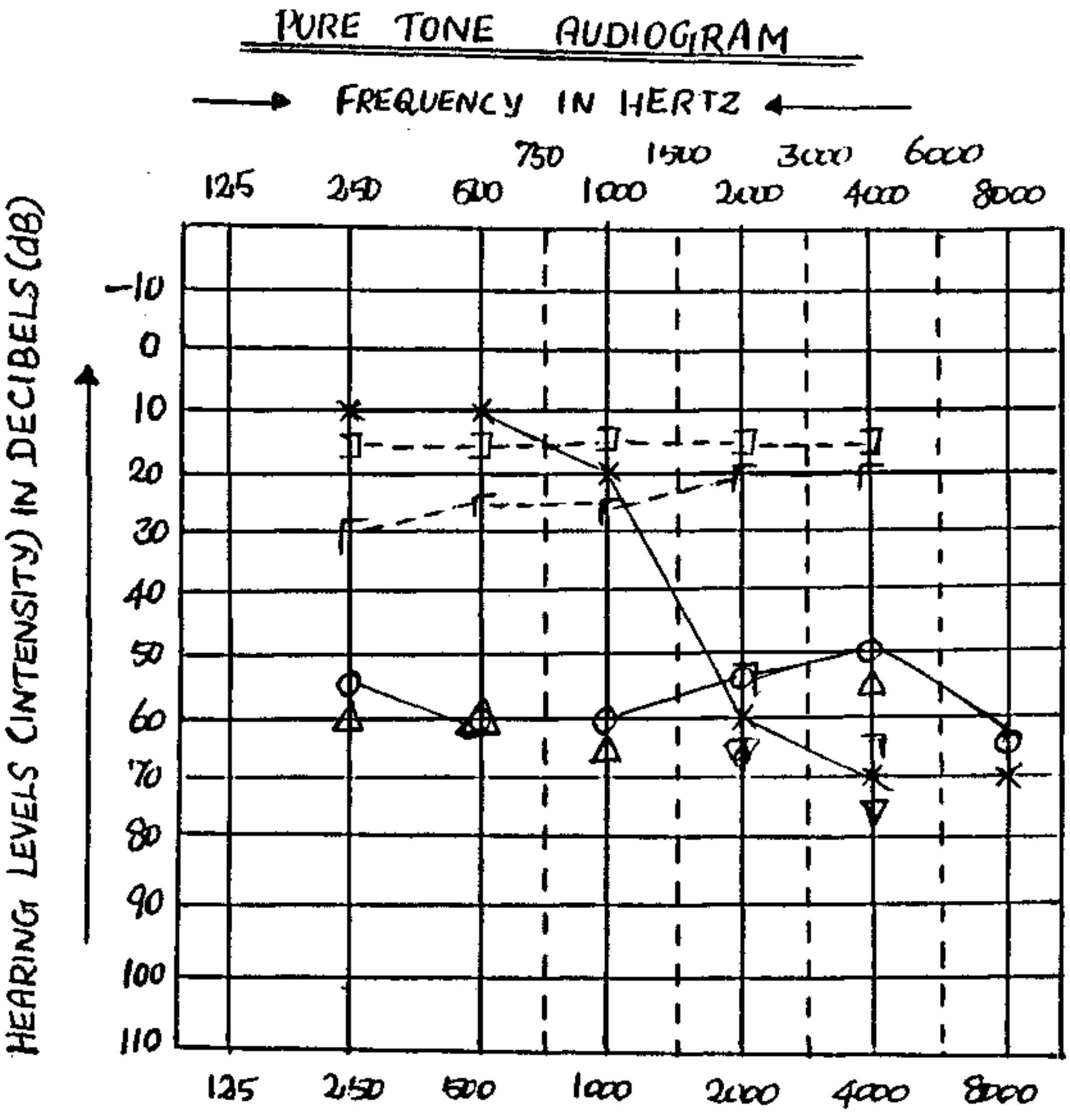
PURE TONE AUDIOGRAM



	Rt	Lt
PTA	45dB	26.6dB
SRT		
PB Max		



7. a) Which ear(s) were masked for air conduction? Why?
   b) Which ear(s) were masked for bone conduction why?
   c) What type of loss exists in the right ear? What type of loss exists in the left ear?



	Rt	Lt
PTA	58.3dB	30dB
SRT	56dB	12dB
PB Max		

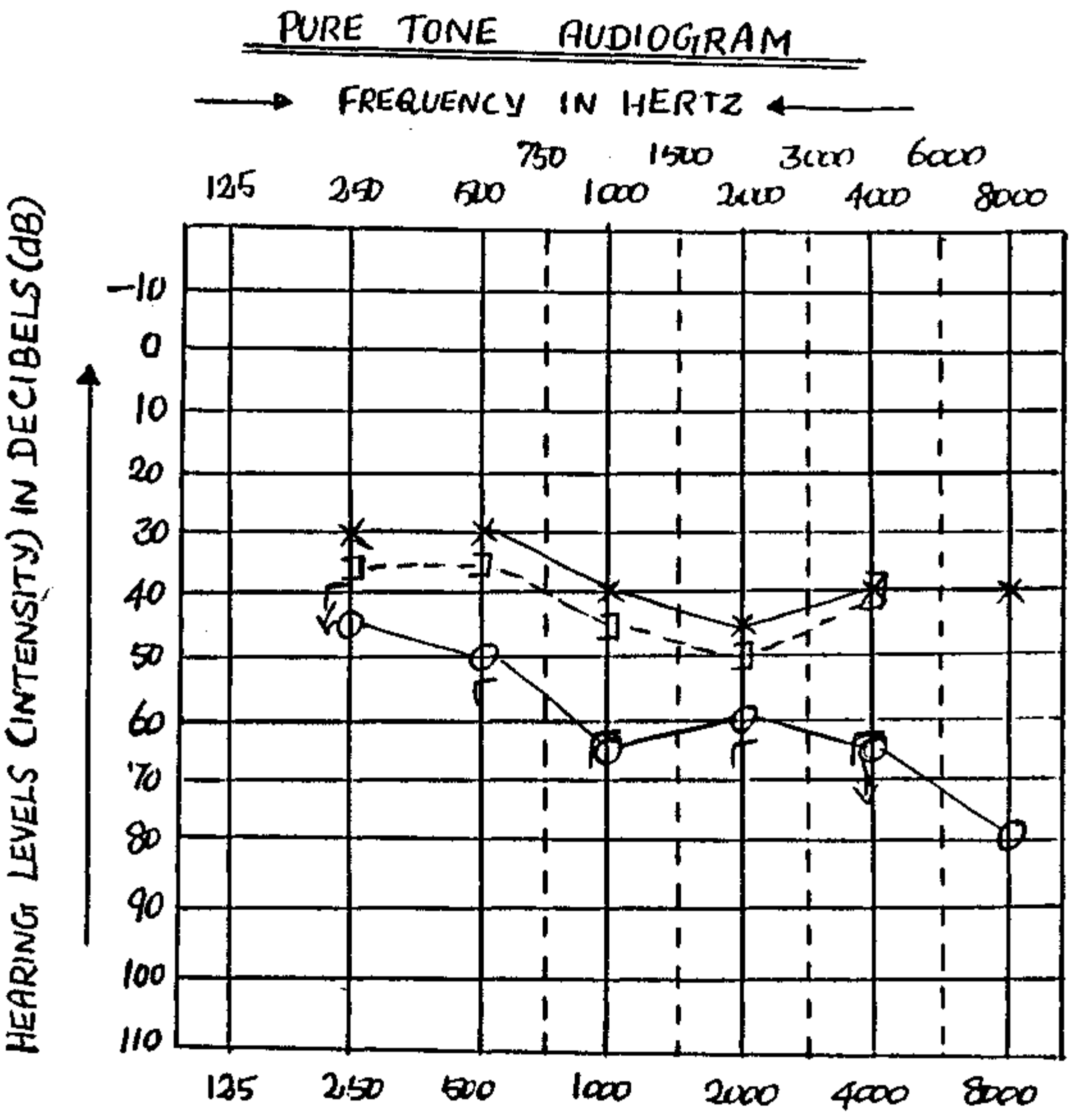
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	˥	↙˥

8a) Which ear(s) were masked for air-conduction and at which frequencies? Why?

b) Which ear(s) were masked for bone-conduction and at which - frequencies? Why

c) Why was it necessary to use masking for right ear SRT?



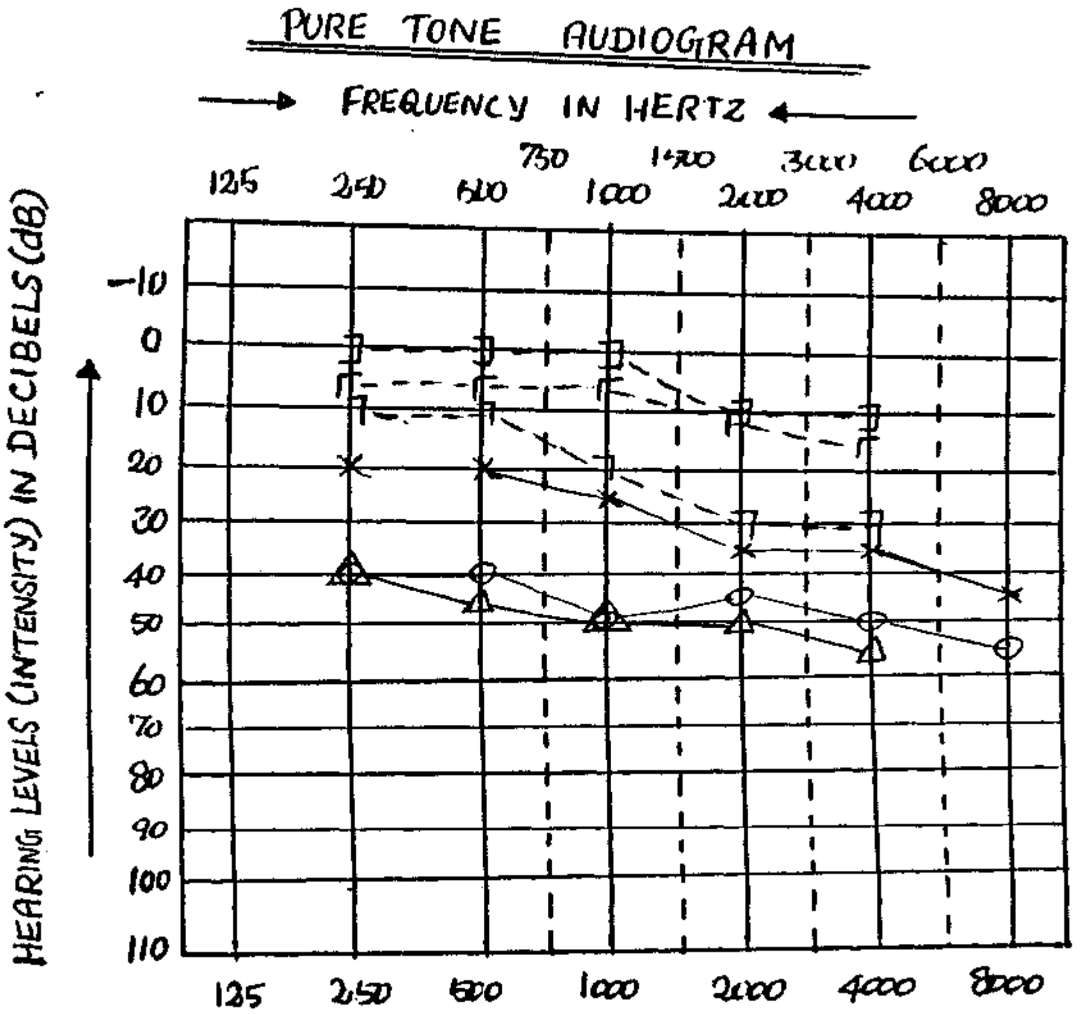
	Rt	Lt
PTA	58.3dB	38.3dB
SRT	52dB	32dB
PB Max	90%	82%

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

9.a) Why was masking not presented to the left ear when the SRT was obtained in the right ear?

b) Why was masking used to obtain a discrimination score in the right ear? Why was it not necessary for the left?



	Rt	Lt
PTA	45dB	26.6dB
SRT	42dB	30dB
PB Max	90%	94%

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

10. a) Is masking needed for SRT in either ear?

b) Is masking needed for discrimination testing in either ear?

I True or false

(l)True (2)False (3) True (4) True (5) False

II Identify the wrong one and correct it.

1. AC masking is needed when

   ACTE -BCNTE 40 dB

2. BC masking is needed when

   ACTE -BCNTE 10 dB

3. SRT masking is needed when

   PL of SRT - BCNTK 40 dB

4. PB max masking is needed when

   PL of PB max - BCNTE 40 dB

III Answer the following

la) Masking for AC is not needed at any frequency in either ear. Although airbone gaps exist at all frequencies, none of the gaps are great enough to make suspect the AC thresholds. When an air-conducted signal is delivered to the test ear we can count hear on 40 to 50 dB of interaural attenuation before that reaches the non-test ear. From our bone conduction thresholds we know that neither cochlea can hear better than -10 dB, all signals delivered to the test ear would be attenuated for below - 10 dB by the time they reached the non-test ear. Therefore masking for AC is not necessary.

b) Both ears show thresholds which are within normal limits. However, an airbone gap exists in at least one ear. Without masked bone conduction thresholds we cannot be sure which ear has the air-bone gap or whether gaps exist in both ears. It is possible that one or both ears have middle ear abnormalities despite the fact that thresholds are within normal limits.

2. a) Since air conduction thresholds in both ears and unmasked BC thresholds are essentially the same, it is not necessary to mask at any frequency. The audiogram indicates that each ear shows a pure sensorineural hearing loss. The unmasked BC scores give us the BC thresholds of the better ear. We know that BC cannot be significantly poorer than AC. Therefore, since the 2 ears show essentially similar AC thresholds, and there are no air bone gaps, we can assume that BC is similar in the 2 ears and comparable to the AC thresholds.

3. a) Masking is not needed for air conduction because none of the air bone gaps are as great as 40 dB and Masking is needed for bone conduction at all frequencies in both ears because all airbone gaps exceed 10 dB.

4a) For AC, it is necessary to mask the left ear when 2000 and 4000 Hz are being tested in the right ear. At these 2 frequencies there are air-bone gaps of 40 dB or more. Although air bone gaps exist in the left ear at 2000 and 4000 hz, they are not of sufficient magnitude to necessitate the use of masking. At 250, 500 and 1000 Hz there are no airbone gaps in either ear.

For BC, it is necessary to use masking at 2000 and 4000 Hz in both ears. The criterion for masking with BC is the presence of an air bone gap of 10 dB or more. In both left and right ears air bone gaps of 20 dB or greater exist at 2000 and 4000 Hz. Therefore, masking must be used to determine whether the hearing losses at these frequencies are conductive, sensorineural or mixed.

5 a) Masking is not needed for air conduction at any frequency in either ear. The left ear shows normal thresholds for both air and bone conduction. In the right ear airbone gaps exist at 250, 500 and 1000 Hz, but none of the gaps are as great as 40 dB.

Masking is needed for BC in the right ear at 200,500 and 1000 Hz. At these frequencies air bone gaps of more than 10 dB exist. It is important to determine whether air bone gaps continue exist when the left ear is masked, indicating a conductive loss in the right ear. If the bone conduction shifts when masking is introduced to the left ear, the loss in the right ear is mixed or sensorineural.

6. a) It was necessary to retest AC in both ear because airbone gaps of more than 40 dB exist in both ears at all frequencies, masked BC thresholds had to be obtained to find out whether one or both ears had a conductive loss and which ear it might be. With only unmasked BC the following situations were possible.

i) a conductive loss in the right ear and a pure sensorineural loss in the left (if that were the case the unmasked BC thresholds would represent the right ear).

ii) the reversed situation, with the unmasked and thresholds representing the left ear.

iii) a bilateral conductive hearing loss with unmasked BC thresholds similar in both ear (this is the actual situation depicted in the audiogram), and

iv) a pure conductive loss in one ear and a mixed loss in the other (in this situation, BC thresholds would be poorer in one ear but not as poor as AC).

So only with appropriate contralateral masking we can determine which of the above possibilities exists.

7. a) Only the right ear was masked for AC. It was not necessary to test the left ear with contralateral masking because the air-bone gaps were not as great as 40 dB at any frequency. Thus we can assume that unmasked AC thresholds in the left ear were not influenced by participation of the right. In the right ear, on the other hand, the air bone gaps all exceeded 40 dB, contralateral masking is necessary.

b) It was necessary to obtain masked BC thresholds for both ears because significant air bone gaps were present. With unmasked bone conduction thresholds only, it was not possible to determine which ear had the conductive loss.

c) The right ear has a pure conductive loss. The left ear shows a mixed loss which is borderline conductive in the low frequencies and purely sensorineural at 1000 Hz and above.

8. a) It was necessary to mask the left ear for AC testing of the right ear at all frequencies because air bone gaps of 40 dB or more exist between AC and unmasked BC thresholds. In the left ear, however, significant air-bone gaps exist only at 2000 and 4000 Hz. Therefore, in testing the left ear masking was necessary only at those frequencies.

b) The same situation exists for BC as for AC. Airbone gaps of more than 10 dB are present at all frequencies in the right ear but only at 2000 and 4000 Hz in the left. Since AC and BC thresholds are the same at 250, 500, and 1000 Hz in the left ear, we can assume that no middle ear component exists at those frequencies. However, we cannot make that assumption about the other frequencies in the left ear or any of the frequencies in the right ear without obtaining marked BC thresholds.

c) It was necessary to mask the left ear while obtaining SRT in the right ear because the unmasked SRT was 44 dB poorer than the SRT in the left. In addition, unmasked SRT was 41 dB poorer than the most sensitive BC threshold in the left car. According to the rules for masking for SRT, noise must be used in the non-test ear: i.e. (a) whenever the SRT exceeds the lowest BC threshold of the non-test ear by 40 dB or more, or (b) whenever there is a difference of 40 dB or more between the two unmasked SRTs. In this case, both rules indicate that the need for masking

9) a) It was not necessary to use masking for SRT in the right ear because the difference between the SRTs of the 2 ears is only 16 dB. The difference between SRT of the right ear and best BC threshold of the left is 17 dB. Contralateral masking is necessary only when differences of 40 dB or more exist.

b) In discrimination testing, the need for masking must be determined on the basis of the presentation level of the words. In the right ear the words were presented at 40 dB above SRT or 92 dB HL. The difference between 92 dB HL and the SRT of the left ear is 56 dB. Since we can depend only 40 dB of IA. It is possible that without masking the left car will participate in the task. If we compare presentation level of the PB words to the best BC threshold of the left ear we find a difference of 57 dB, which is greater than the allowable 40 dB.

10) a) Masking is not needed for the SRT in either ear. In the right ear the SRT of 42 is less than 40 dB above the SRT of the left ear or the best conduction threshold of the left ear (10 dB at 500 Hz). The SRT of the left ear is less than 40 dB above the best bone conduction of the right ear (5 dB at 500 and 1000 Hz) and is less than the SRT of the right ear.

b) For discrimination testing, however, masking is required for both ears. In the right ear the presentation level of the words is 82 dB, this level is 52 dB above the SRT in the left ear and 72 dB above the best bone conduction threshold of the left ear.

In the left ear the presentation level of the words is 70 dB, although this level is not 40 dB above the SRT of the right ear it is more than 40 dB above the best bone conduction threshold of the right ear (70-5=65 dB).

HOW MUCH MASKING

It is necessary to understand how much masking noise is appropriate to the non-test ear so that we can reassure exact thresholds of the test ear.

"It may be seen that the problem of obtaining true threshold responses from a poorer ear might not be overcome in many cases simply by putting a noise into the opposite ear" (Sanders and Rintlemann, 1964).

Clinical masking is basically an effort to avoid the presentation of too much or too little noise. Avoidance of improper masking intensities requires consideration of a number of factors influence minimum and maximum masking levels.

* The first factor is the presentation level of the test signal.
* The second is the interaural attenuation of the test signal for each mode of presentation.
* The third is the noise level required to mask the test signal.
* The fourth is the occlusion effect.
* The fifth are the air-bone gaps exhibited by each ear.

Factors involved in minimum effective level are different from factors involved in maximum effective level. So each of them is dealt separately.

The optimum intensity of the masking signal should satisfy the following 2 conditions given by Portman and Portman, 1961).

* Criterion of minimum masking level
* Criterion of maximum masking level

Criterion of minimum masking level

That is the masking signal should be effective to mask the ear to be eliminated. This criterion stresses upon the minimum effective amount of masking noise should be presented in the non-test ear. If the noise is not sufficient to mask the non-test ear, it is called Under masking.

Criterion of maximum masking level

That is the masking noise should have no repurcussion in the ear being tested. In other words, the masking noise in the non-**teal** ear **should** not influence the thresholds of the test ear. This criterion stresses upon amount of maximum noise one can use without affecting the thresholds of the test ear. If it affects the thresholds of the test ear, it is called over masking.

Thus, we should know minimum amount of masking noise needed to mask without the danger of under masking and the maximum amount of masking noise needed to mask without the danger of over masking.

Thus, for clinical purpose we should know,

* Minimum effective masking level,
    - air conduction testing
    - bone conduction testing, and
    - speech reception threshold measurement.

* Maximum effective masking level for,
    - air conduction testing
    - bone conduction testing, and
    - speech reception measurement.

* Minimum Effective Masking Level (Mmin)

The minimum effective masking level is the minimum amount of noise presented in the non-test ear which is just sufficient to mask a test signal that might appear in the non-test ear because of cross hearing.

In short, the noise level just sufficient to mask the test signal in the ear to which noise is presented.

Calculation of minimum effective masking level in air conduction :

The minimum effective masking level in air conduction is determined by the following factors:

1) Level of the test tone reaching the cochlea of the non-test ear.
2) Effective level of masking, and
3) Air bone gap in the non-test ear.

Let us see how the above mentioned factors can effect in calculating minimum effective masking level.

1. **Level of the test tone reaching the cochlea of the non-test ear**

The level of the test tone reaching the non-test ear is determined by 2 factors, that is, a) Presentation level of the test signal and, (b) Interaural attenuation.

The level of the tone reaching in the non-test ear is given by presentation level of the test signal minus interaural attenuation,

i.e., PTL - IA = Test tone level in the non-test ear.

2) Effective level of masking

This is the noise level needed to mask a threshold tone or produce a threshold shift. For example when 0 dB HL tone and 0 dB SPL noise are presented to the same ear, the tone is heard. The level of the masking noise must be increased to about 20 dB hearing level before an appreciable shift in the puretone threshold. Thus the level of the noise just sufficient to mask a 0 dB tone is called effective level of the noise. This is a property of the masking noise and varies with the frequency and the type of noise used (Staab, 1975). This is also called as 'masking factor'.

Currently available diagnostic audiometers are usually calibrated in effective masking level i.e. OdB HL noise can mask OdB HL tone so that masking factor can be eliminated.

3) Air bone gap in the non-test ear

The third and the final factor in determining the minimal effective level masking in air conduction is the air bone gap in the non-test ear.

Studebaker (1964) suggested that presence of air bone gap in the non-test ear changes the signal (test tone) to noise (masking) ratio. This is because the signal is heard by bone conduction, which is not affected or less affected, while the noise is being presented through air conduction which is more affected. Thus air bone gap in the non-test ear interferes with the level of masking noise reaching the cochlea of the non-test ear. Thus if there is air bone gap in the non-test ear, which brings about a change in the signal to noise ratio, is compensated by adding the amount of air bone gap to the level of the masking noise.

Thus minimum effective masking level is equal to level of the tone reaching the non-test ear plus effective level masking and plus air bone gap in the non-test ear.

i.e.Mmin =PTL - LA + (AC NTE - BC NTE)

Calculation of minimum effective masking level in bone conduction:

The minimum effective masking level in bone conduction is determined by the following factors :

1) Level of the test tone reaching cochlea of the non-test ear.
2) Effective level of masking.
3) Air bone gap in the non-test ear or the occlusion effect.

The level of the test tone reaching cochlea is determined by presentation level minus the interaural attenuation. Since interaural attenuation for bone conduction is generally considered as zero almost all the energy reaches the cochlea of the non-test ear. Thus energy present in the non-test ear is the presentation level at the test ear.

Effective level of masking and air bone gap in the non-test ear will have similar effect as discussed for air conduction masking.

The occlusion effect (OE)

The occlusion effect, described by Liden et al. (1959), Feldman (1961), Studebaker (1962), Dirks and Swindeman (1967), and others, is an improvement in bone conduction responses in an ear covered (occluded) by an earphone. The improved responses are a result of sound pressure generated in the enclosed external auditory canal and transmitted through the middle ear. Sensitivity is not changed, but responses are obtained at a better hearing level as a result of the additional energy reaching the cochlea. Because the additional energy is transmitted through the conductive mechanism, the effect does not occur in the ear with conductive impairment. The effect might be as great as 25 dB (Dirks and Swindeman, 1967) but is limited to the lower frequencies, primarily 250 and 500 Hz and 1 kHz in normal hearing person or sensori-neural hearing cases. To overcome the occlusion effect, the minimum effective level must be increased by 30 dB when testing at these frequencies, unless the masked ear is known to have conductive impairment.

For example, the occlusion effect will occur when occluding a normal ear or one with a sensory-neural hearing loss and therefore should be considered while calculating minimum effective masking level. In contrast, no additional improvement is noted in bone conduction when an earphone is placed on an ear with a middle ear disorder. Conductive pathology produces an improvement in bone conducted responses equal to the occlusion effect regardless of ear canal occlusion. Therefore, no correction for the occlusion effect is made in cases with conductive losses.

Table : Average occlusion effect values of four studies and ' recommanded values for clinical use

Study	Freuency in Hz			
	250	500	1000	2000
Huizing(1960)	13.0	15.0	8.0	1.0
Elpern & Naunton (1963)	28.0	20.0	9.0	0
Goldstein & Hayes (1965)	19.4	126	5.8	1.1
Dirks & Swindeman (1967)	22.9	20.2	8.8	0.5
Recommended	15	15	10	0

In occlusion effect, actually the bone conduction threshold does **not** improve but what really happens is an increase in the level of the stimulus reaching the inner ear.

Occlusion effect should not be added in the following situations.

* **Air conduction testing**

Since both ears are covered at all times, an occlusion effect is not created, when masking is introduced into the non-test ear.

* **When air bone gap is present in the non-test ear**

This is because small changes in air pressure in the external ear canal caused by the occlusion effect are not sufficiently intense to overcome the conductive component of the hearing loss (Rose, 1978).

In other words, conductive loss produces a built in occlusion effect (Studebaker, 1962). Thus minimum effective masking level for bone conduction is either.

Mmin = PTL + (ACT - BCT) or

Mmin=PTL + OE

Calculation of minimum effective masking level in speech reception threshold measurement.

The minimum effective masking level is to rule out the participation of the non-test ear in speech reception threshold measurment is determined by the same factors as in the case of air conduction puretone testing.

If we are finding out the speech reception threshold through bone conduction occlusion effect may or may be added depending upon the presence or absence of air bone gap in the non-test ear.

Maximum Effective Masking Level

Unfortunately many a time the noise in the non-test ear become high enough to lateralize to test ear through bone conduction and thereby affecting thresholds in the test ear. Thus it is indispensable to find out the maximum amount of noise that can be used in the non-test ear without affecting the thresholds of the test ear.

Definition of Maximum Effective Masking Level

It is the highest level of nosie that can be presented to one ear via an earphone before the noise crosses the skull and shifts the threshold of the opposite ear (Martin, 1975).

Calculation of Maximum Effective Disking level (Mmax).

"The maximum masking that can be used without affecting substantially the threshold of the tested ear depends on the attenuation of sound travelling from the one side to the other and on the bone conduction loss of the tested ear" (Studebaker, 1962).

Thus while calculating maximum effective masking level, we have to consider the following 2 factors :

• Bone conduction threshold of the test ear and
* Interaural attenuation

Masking noise is presented through an earphone should be more than the interaural attenuation for noise to opposite ear. However the level or noise which crossed over to the other ear need not mask the test signal in the test ear. If the cross over noise is higher than the bone conduction sensitivity of the test ear then it may cause over masking.

Even if the crossed signalis 5 db less than the bone conduction threshold of the test ear, over masking will not occur. 1 his principle is used in calculating maximum effective masking level.

So, Max.EM = BC TE +• LA for noise
However Martin (1975) stated that

Mmax =IA (for noise)+BCT TE -5 dB, 5dB as a sefety factor.

Since we present the masking noise always through one earphone, irrespective of kind of testing (whether air conduction, bone conduction or speech reception threshold measurement, suprathreshold audiometry) the same formula holds good for all kinds of testing.

Thus, it is important to determine what the minimum effective masking level is to avoid undermasking, it is equally important to determine what maximum level of masking can be used without over masking.

Few clinicians find it feasible to manipulate this number of variables in day-to-day clinical practice. Therefore, various writers have presented procedures designed to simplify the clinician's task. Unfortunately, the simplest procedures provide the greatest opportunity for error. For example, the use of a single masking noise intensity level (Harbert and Sataloff, 1955; Hawkins and Stevens, 1950; Hood, 1960) may result in over and under masking in many cases.

It is recommended that clinicians acquire a set of general rules which provide a foundation for masking appropriate decisions regarding "how to mask". Presented below are the masking formulas for both air conduction and bone conduction.

Masking Formulas

Minimum Effective Masking Level (EML) for AC testing

Min EML = ACTE + ABGNTE - IA (40)

Minimum Effective Masking Level for BC testing

Min EML = BCTE + ABGNTE - IA (0)

= BCTE + OE - IA(0)

Maximum Effective Masking Level for AC testing

a) Assumed Max EML = Common BC threshold + IA for the noise.
b) Real Max EML = BCTE + IA for the noise (It can 40dB or 70 dB depending upon headphone or insert receiver used to present signal).

Maximum Effective Masking Level for BC testing

a) Assumed Max EML = Common BC threshold + IA for noise
b) Real Max EML = BCTE + IA for noise

Wheras, AC = air conduction
BC = Bone conduction
ABG = Air bone gap
TE = Test ear
NTE = Non-test ear
IA = Interaural attenuation
Min EML = Minimum Effective Masking Level
Max EML = Maximum Effective Masking Level

Methods of masking

The 'Hit-or-Myth " method

It is possible, in a large number of cases, for clinicians to mask by using some fixed or arbitrary level of noise in the masked ear without really understanding what they are doing. In uncomplicated cases the procedure often appears to be satiasfactory.

Because of insufficient feedback about their errors, individuals peforming hearing tests fail to profit by their mistakes and continue with such erroneous philosophies as "Just use 70 dB of noise "with no recognition of the properties of the noise or of its effectiveness. Clinicians may be unaware of when they have used too little or too much masking noise so that this method is not practically used.

Smith's method of masking

Owing to the difficulty in determining how much masking should be used at a particular frequency for a given patient. Smith (1968) gave a new approach to clinical masking.

Technique:

Establish the unmasked threshold of the test frequency in the good ear using an interrupted tone.

Then present 5 dB SL pulsed tone continuously to the same ear. This is because tone should be clear to him/her and to compensate for central masking.

Give narrow band noise to the poorer ear, preferably via insert receiver.

Increase the level of masking noise in the poorer ear until the 5 dB SL tone in the better ear is just audible.

Note down the level of masking noise. Subtract 5 dB from this level which is the amount of narrow band noise that should be used in the better ear.

- Repeat this procedure for all test frequencies.

The Pleateau Method

This technique has been variously called such as, threshold shift procedure, shadowing method. This technique is being used in almost all clinics even today.

The concept of finding a plateau was introduced by Hood (1960), Ventry, Chaiklin and Dixon, (1971) and is a part of every masking method.

This method consists of the following steps :

When it is believed that a tone presented to the test ear is actually being heard by the non-test ear, a masking noise is introduced into the non-test ear at a minimum level of intensity.

Threshold is re-established in the test ear. If a threshold shift is noted in the test ear it is assumed that the non-test ear is participating in the peception of the tone burst to a lesser degree than before the introduced of the masking noise..

The level of the masking noise is increased in 5 or 10 dB steps with threshold in the test ear reestablished each time there is an increase in masking level.

Along as threshold in the test ear continues to shfit it is assumed that the non-test ear is not adequately masked.

When the level of the masking noise can be increased several times (20 to 30 dB) without shifting the threshold in the test ear, the plateau has been reached.

The non-test ear may be assumed to be adequately masked, and the test ear threshold may be recorded on the audiogram using the appropriate symbols.

The levels of masking at which the plateau was found are also recorded on the audiogram.

If masking levels are increased beyond maximum effective masking level the threshold in the test ear will again increase.

This threshold shift is not caused by participation of the non-test ear but the masking effect of the noise which has crossed over into the test ear.

Masking noise must not be increased beyond maximum effective masking level.

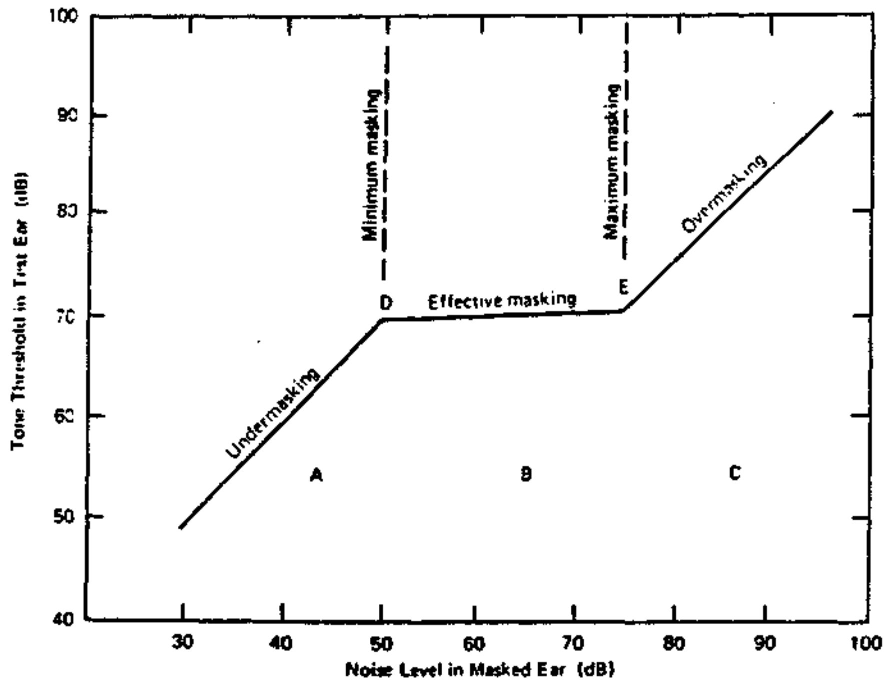


Fig.6: The plateau method for masking (A) undermasking. The tone (b ycross-hearing) continues to be heard in the masked ear despite the noise, since the tone level is below the threshold of the test ear (B) The plateau. The tone has reached the threshold of the test ear. Therefore, raising the masking level in the masked ear does not shift the threshold of the tone, (c) Over masking. The masking level is so intense that it crosses to the test ear, resulting inc ontinuous shifts in the threshold of the tone with increases in the masking noise, minimum (D) and maximum (E) masking are found at either side of the plateau.

This figure illustrates the plateau method : In this figure

A) undermasking -i.e. both tone and the noise are stimulating the non-test ear.

B) Plateau - i.e. tone is stimulating test ear and noise stimulating the non-test ear.

C) Overmasking - i.e. both noise and tone stimulating the test ear.

The plateau method is often used by introducing a masking noise at some low level or some arbitrary beginning point. It can be combined with the minimum masking method, beginning with the initial masking level (air conduction threshold of the masked ear). The pleateau range depends on air bone gaps in both ears. The larger the airbone gap, the narrower the plateau, and the smaller the air bone gap, the broader the plateau.

The width of the masking plateau is determined by 3 variables:

1) The air conduction threshold of the non-test ear.
2) The bone conduction threshold of the test ear
3) The interaural attenuation.

The higher the air conduction threshold of the masked ear, the greater must be the initial masking level; and the higher that level is, the greater are the chances that the noise will cross to the test ear. The lower the bone conduction threshold of the test ear, the greater the likelihood that a noise reaching the cochlea of that ear from a masking receiver on the opposite ear will exceed its threshold, producing a threshold shift in the test ear. The smaller the interaural attenuation, the higher the level of the noise that crosses to the test ear. By increasing interaural attenuation, unsert receivers decrease the chances of over masking and widen the masking plateau. These concepts are summarized in the following table.

Factors that influence the width of the masking plateau

	Narrow plateau	Wide plateau
AC threshold of masked ear	High	Low
BC threshold of test ear	Low	High
Interarual attenuation	Larger	Larger

Martin (1980) has reduced the masking plateau for both air conduction and bone conduction to a series of models and formulas involving effective masking.

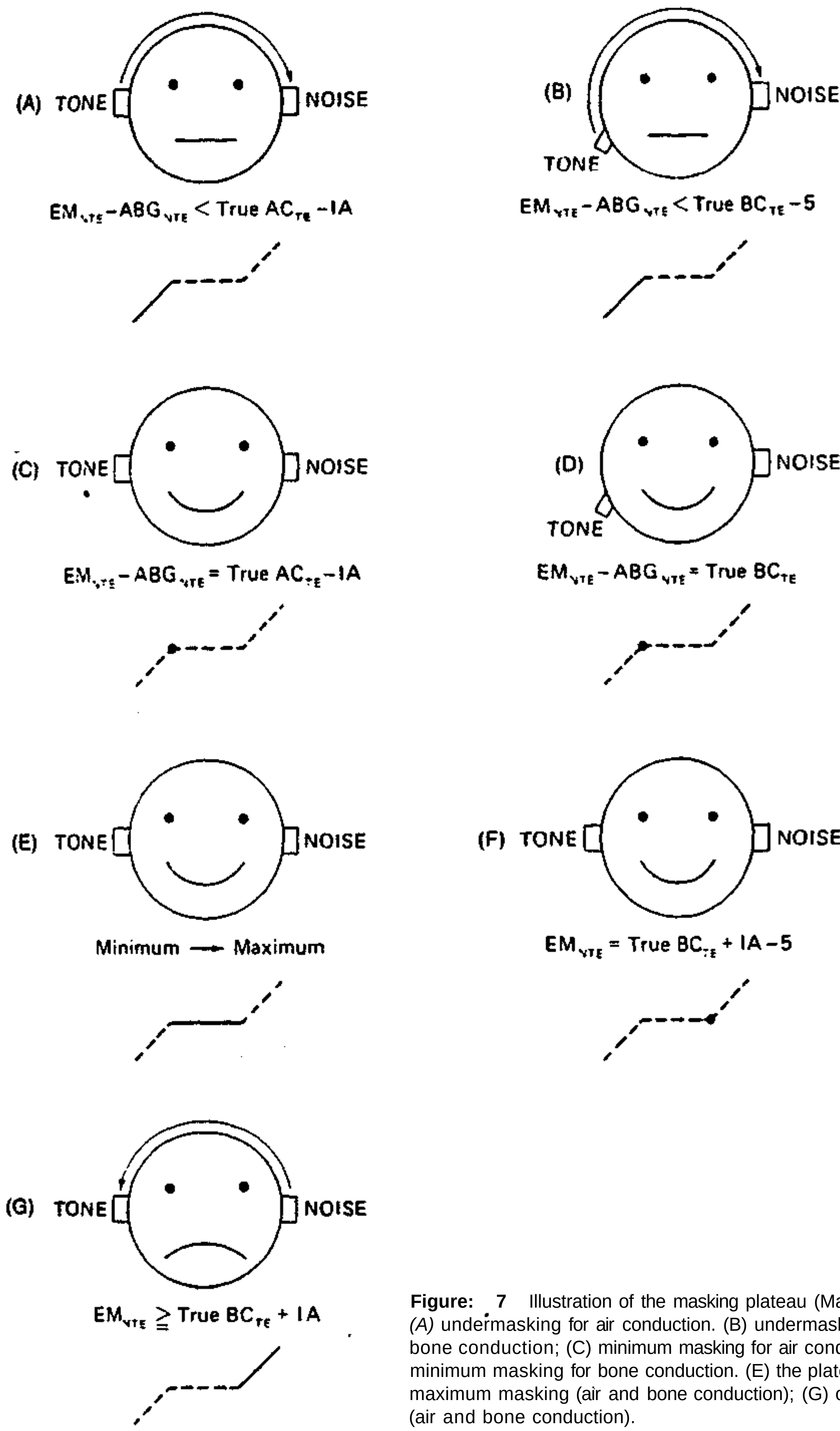


Figure: 7 Illustration of the masking plateau (Martin 1980): *(A)* undermasking for air conduction. (B) undermasking for bone conduction; (C) minimum masking for air conduction; (D) minimum masking for bone conduction. (E) the plateau; (F) maximum masking (air and bone conduction); (G) overmasking (air and bone conduction).

Fig: 7 shows:

A) Under masking for air conduction

B) Under masking for bone conduction

C) Minimum masking for air conduction

D) Minimum masking for bone conduction

E) The pleateau

F) Maximum masking (for air conduction and bone conduction),&

G) Over masking (for air conduction and bone conduction)

Recommended masking procedures for the basic audiologic test battery.

Threshold procedures for air conduction

Obtain and record the unmasked air conduction threshold of the test ear.

Compare the obtained unmasked threshold with the air and bone conduction thresholds of the non-test ear and determine if the rules for when to mask air conduction are applied. If the differences is equal to or greater than IA, the better ear should be masked when testing the poorer ear.

Select the initial amount of masking for the non-test ear (i.e. non-test ear air conduction threshold plus 15 dB EM)

Re-establish threshold in the test ear with this initial amount of masking in the non-test ear.

Each time the client responds to the puretone signal presented to the test ear, increase the masking presented to the non-test ear by 5 dB.

Each time the client does not respond to the tone presented to the test ear, increase the signal in 5 dB steps until the client again responds.

Continue the procedure until the masking can be increased 3 consecutive 5 dB steps without producing a shift in the threshold level of the test ear. When this is accomplished, a "plateau" in threshold response has been reached.

At this point, record both the threshold and the final masking level.

Threshold procedures for bone conduction

Obtain and record the unmasked bone conduction threshold of the test ear with the non-test ear unoccluded.

Compare the bone conduction threshold of the test ear to the air conduction threshold of the test ear. If the difference is greater than 10 dB, masking should be needed.

Select the initial amount of masking for the non-test ear.

Clinicians should not account for the occlusion effect when employing masking procedures with conductive hearing losses.

Re-establish threshold in the test ear with this initial amount of masking in the non-test ear.

Each time the client responds to the puretone signal presented to the test ear, increase the masking presented to the non-test ear by 5 dB.

Each time the client does not respond to the tone presented to the test ear, increase the signal in 5 dB steps until the client again responds.

Continue the procedure until the masking can be increased 3 consecutive 5 dB steps without producing a shfit in the threshold level of the test ear. When this is acomplished, a "plateau" in threshold response has been reached.

At this, record both the threshold and the final masking level.

Threshold procedure for spondee threshold

Obtain and record the unmasked spondee threshold of the test ear.

Compare the obtained unmasked spondee thrshold with(a) spondee threshold (b) bone conduction puretone average of the non-test ear and determine if the rules for when to mask sponde threshold are applied.

If the difference is equal to or greater than interarual attenuation for speech (45 dB), the better ear should be masked, when testing the poorer ear.

When masking for speech audiometry, it is better to choose one adequate level of masking at the outset, so that the masking remains constant for the entire test.

The recommended rule is to use a masking level in the non-test ear which is no less than 30 dB below the spondee threshold of the test ear.

Suprathreshold procedures for speech discrimination

Determine the presentation level in dB HL at which the procedure will be administered in the poorer test ear. (If masking was necessary for spondee threshold, it will again be necessary for speech discrimination).

Compare the presentation level of the test ear to the spondee threshold and the bone conduction puretone average of the non-test ear and determine if rules of when to mask speech discrimination are applied.

If the difference is equal to or greater interaural attenuation for speech (45 dB) masking should be used.

One adequate level of masking is chosen at the outset. Which level is relatively easy to determine because the procedure is completed at a constant hering level.

As in masking for spondee threshold, the recommended rule is to use a masking level in the non-test ear which is no less than 30 dB below the presentation level of the test ear.

Masked threshold

Masked threshold is the actual threshold of the patient obtained by ruling out the participation of the non-test ear. Before plotting the masked threshold student should consider the following suggestions.

To use appropriate symbols to indicate air conduction, bone conduction with and without masking.

5 dB should be subtracted from the obtained threshold value due to central masking.

Questions

I Choose the best answer

1. Unmasked results on a patient with one normal ear and one ear a total sensorineural loss show the poorer ear to have

   a) moderate conductive hearing loss

   b)moderate sensorineural hearing loss

   c)Profound conductive hearing loss

   d)Normal hearing.

2) When a patient's interaural attenuation is not known, it is safest to assume that it may be as little as

   a) 30dB

   b)40dB

   c)5OdB

   d)60dB

3) The result of over masking during speech recognition threshold testing may be that

   a) the SRT appears better than it truely is

   b) the SRT appears worse than it truly is

   c) the interaural attenuation is increased

   d) none of the above

4) Cross hearing is a possibility during puretone air conduction tests when:

   a) SRT TE - 35 dB =BC NTE

   b)ABG>10dB

   c) AC TE - IA > BC NTE

   d) AC TE -BC NTE =ABG

5) The primary way by which cross hearing for air conduction takes place is by

a) skin conduction

b)air conduction

c)bone conduction

d) cartilage conduction

6) For speech discrimination tests, overmasking creates the greatest problem in cases with:

a) bilateral mixed loss

b) unilateral mixed loss

c) bilateral sensorinerual loss

d) unilateral sensorineural loss

7) The result of not masking during speech recognition threshold testing may be that the :

a) SRT was obtained by bone conduction in the non-test ear.

b) SRT was obtained by air conduction in the non-test ear.

c) SRT was actually lower (better) than what was observed

d) none of the above.

8) Chances of overmaking is the greater problem in

a) Bilateral conductive loss

b)Unilateral conductive loss

c) Bilateral sensorineural loss

d)unilateral sensorineural loss

9) Overmasking takes place for air conduction when

a)BCre + IA =EM

b)BCTE +IA -lOdB =EM

c)EM NTE -ABG NTE < true A C T E

d)EM NT - ABG NTE =True ACTE

10) Over masking occurs during SRT testing when the

a)test presentation level exceeds 95 dB

b)Interaural attenuation is greater than 60-dB

c)test presentation level exceeds the SRT of the non-test ear

d)Effective masking level minus the patients' interaural attenuation equal or exceeds the bone conduction thresholds of the test ear.

11) The result of overmasking during speech discrimination testing may be that the

a) Speech discrimination score appears better than it truely is

b) speech discrimiantion score appears poorer than it truely is

c) sensation level of the discrimination test is raised

d)None of the above.

12) Over masking occurs during spech discrimination testing when the

a) test presentation level exceeds 95 dB

b) interaural attenuation is greater than 60 dB

c) test presentable level exceeds at the SRT of the non-test ear

d) effective masking level minus the patient's interarual attenuation meets or exceess the bone conduction thresholds of the tast ear.

13) The result of not masking during speech discrimination testing may be that the

a) speech discrimination score is actually poorer than what is observed

b) non-test ear actually took the speech discrimination test

c)speech discrimination test was actually taken by both ear.

d) All the above.

14) If the interaural attenuation for speech can be determined to be greater than 40 dB, it is better to use the larger number to

a) increase the likelihood of under masking

b) decrease the likelihood of under masking

c) increase the likelihood of over masking

d) increase the likelihood of over masking

15) Overmaksing during SRT testing results in

a) the thresholds of the non-test ear getting higher (poorer)

b) the thresholds of the non-test ear getting lower (better)

c) the thresholds of the test ear getting higher (poorer)

d) the thresholds of the test ear getting lower (better)

16) Overmasking during speech discrimination testing results in the

a) Speech discrimination score of the test ear getting higher

b) Speech discrimination score of the test ear getting lower

c) Speech discrimination score of the nontest ear getting higher

d) Speech discrimination score of the nontest ear getting lowerr

17) The masking plateau becomes narrower as

a) The bone conduction threshold in the test ear gets lower (better)

b) The bone conduction threshold in the test ear gets higher (pooer)

c) the interaural attenuation gets greater

d) the airbone gap in the non test ear gets larger

18) As the interaural attenuation increases, the masking plateau

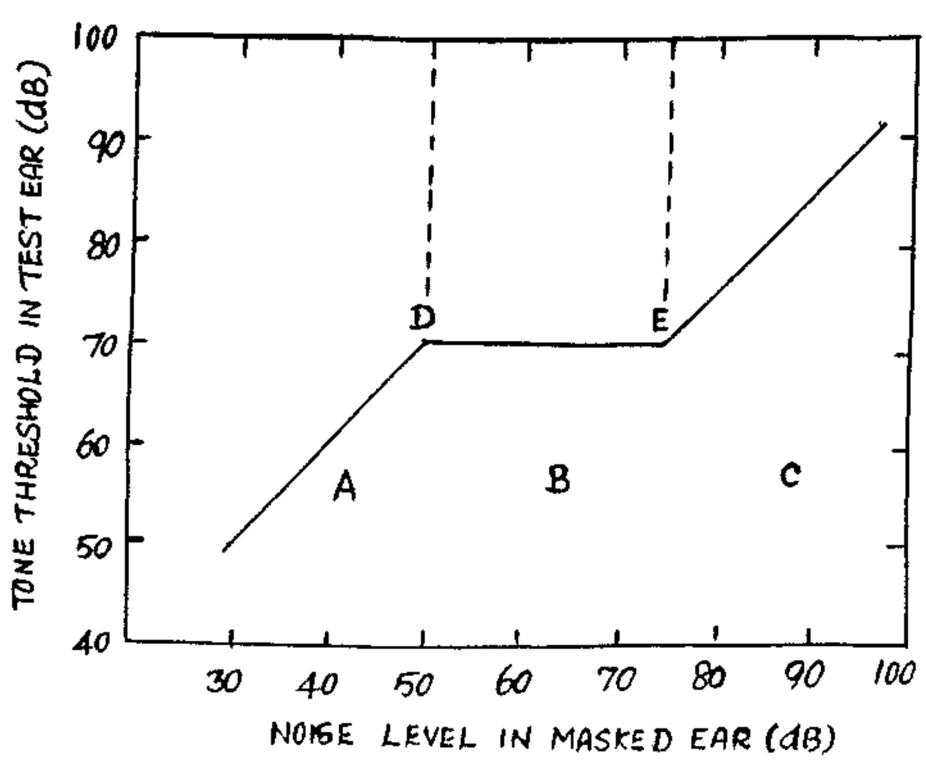
a) stays the same

b)gets narrower

c) gets wider

d) changes in mid frequencies.

II Label the five components of pleatau model.



A)..........

B).........

C).........

D)........

E)........

Aimers

1. (a) 2(c) 3(b) 4(c) 5 (c) 6 (a) 7 **(a)** 8 (a) 9(a)

10 (d)ll (b) 12 (d) 13 (d) **14** (c) 15 (c) 16(b) 17(a) 18(c)

11 Label the five components of plateau model

A) undermasking

B) plateau

C) overmasking

D) minimum masking

E) maximum masking

PROBLEMS ENCOUNTERED IN MASKING

Special problems may be encountered during masking that will require different strategies and approaches by the audiologist. One such problem is adequately masking for bilateral conductive pathology, while avoiding over masking.

The need to mask for bilateral conductive pathology is generally suspected first (with adequate case history information) during air conduction testing. If the air conduction thresholds of either ear equal or exceed the levelof interaural attenuation, an immediate assessment of the cochlear reserve (bone conduction) should be obtained. If the bone conduction thresholds are within normal limits and the air conduction thresholds equal or exceed interaural attenuation, then masking is necessary. However, if bone conduction is in the normal range and air conduction thresholds exceed interaural attenuation, then it will not be possible to obtain valid results employing standard audiologic procedures if masking is used.

The problem that exists with clinical masking is "Masking Dilemma" as described by Naunton (1960) in bilateral conductive hearing loss cases. A conductive loss in the test ear reduces the test signal level but not the noise level at the test cochlea. Therefore the maximum permissible level is decreased by the amount of air bone gap. In the case of an air bone gap of about 45 to 50 dB or more, the maximum permissible level for air conduction tests is equal to the maximum level for bone conduction tests.

In other words, minimum masking level increases and maximum masking level decreases resulting in subjects with moderately severe conductive hearing loss in both ears or whenever the air bone gap exceeds the value of interaural attenuation.

This problem can be solved by using an insert receiver.

Use of insert receive increases the interaural attenuation value for noise there by increasing the maximum permissible noise.

Thus,

Mmax = 0+70 (interaural attenuation for insert receiver)

For example :

	Rt	Lt
BC	0	
AC	45	50

In this case Naunton's dilemma occurs because Maximum effective masking level for both AC and BC is 40 dB. Minimum effective masking level for BC is 45 and AC is 55.

Here minimum masking exceeds the maximum masking.

So to overcome this problem, if we use insert receiver, then Mmax will be 70dB.

Thus Mmax. is more than Mmin, so masking can be done.

Through use of an insert receiver, over masking problems can be reduced by increasing interaural attenuation. An insert receiver is an earphone that is placed and sealed at the opening of the external auditory meatus and is designed to reduce the area of the head exposed to the tone or masking signal. The effects of reduction in earphone size and cushion exposure area to a small opening close to the eardrum reduce the amount of energy that needs to be generated for the appropriate masking level. Because less energy strikes the skull; more effective masking can be produced without masking the opposite cochlea.

Insert receivers also cause reduction of the occlusion effect in the low frequencies for normals and sensory-neurals, stabilizing bone conduction threshold responses (Chaiklin, 1967). Zwislocki (1953) found increases of 30 to 40 dB in interaural attenuation when employing an insert receiver.

Fusion Inferred Test (FIT)

In case of bilateral conductive hearing loss/asymmetrical conductive hearing loss/mixed hearing loss, there is a possibility of minimum effective masking level of the air conduction threshold equals or exceeds the maximum effective masking level. So to overcome Naunton"s dilemma Bergman (1964) developed find out actual AC threshold of the poorer ear.

Fusion Inferred Test (FIT) was developed by Bergman (1964). It is based upon the Stenger's principle i.e. if 2 tones are presented simultaneously to both the ears, the ear in which the person is hearing the louder sound will lateralize to that ear. It is mainly used to find the threshold for pseudohypacusis cases (Malingering).

Instruction

The patient is asked to indicate when he/she hears the stimulus in the centre (midline)/poorer ear.

Procedure

Stimulus should be given through the earphone to both ears.

The tone which is presented to the better ear should be above the threshold level (10 to 15 dB SL).

In the poorer ear, stimulus should be presented below the threshold level.

The stimulus presentation of the better ear should be constant whereas the intensity level of the poorer ear should be increased by 5 dB step until he/she hears the sound in the (central (midline)/ poorer ear.

At that point note down the intensity level which is presented to the poorer ear.

Now the threshold of the poorer ear will be IL-SL (intensity level-sensation level)

The same procedure should be followed at all the frequencies.

It is of interest to note in this connection that the change of loudness is always attributed to the ear in which the stimulation is greater (Bekesy, 1948; Stenger, 1907). This is true even if the stimulation in one ear is constant and it is varying in the other ear.

This phenomenon has been observed both for continuous tones of single frequency and clicks (Bekesy, 1948)

Questions

I Multiple choice

1. Naunton's dilemma occurs,

   a) When AC greater than BC

   b) Minimum effective masking level < maximum effective masking level

   c) When BC greater than AC

   d) Minimum effective masking level > maximum effective masking level.

2) Naunton's dilemma usually occurs in subjects with

   a) Mild sensoryneural hearing loss

   b) Bilateral minimal conductive hearing loss

   c) Bilateral moderately severe conductive hearing loss

   d) All the above.

3) Use of insert receiver increases the interaural attenuation value for noise thereby increasing the maximum permissible noise, thus,

   a) Mmax = BC TE + 40

   b) Mmax = BC TK + 45

   c)Mmax = AC TE + 70

   d) Mmax =BC TE + 70

4) Fusion inferred test is given by

   a) Stenger

   b) Bergman

   c) Jerger

   d) Studebaker

5) Fusion inferred test is usually applicable for

a) Bilateral conductive hearing loss

b) Asymmetrical conductive hearing loss.

c) Mixed hearing loss

d) All the above.

II Fill in the blanks

1) Naunton's dilemma can be solved by using an....

2) Whenever the air bone gap exceeds the value of interaural attenuation......can occur.

3) Fusion inferred test is mainly based upon .... principle.

III True/False

1)

	Rt	Lt	
BC	10	-	This case is a good example for
AC	50	55	Naunton's dilemma

2) In fusion inferred test, the stimulus should be presented through the bone vibrator.

Answers

I Multiple choice

1) d(2) c (3) d (4) b (5) d

II Fill in the blanks

1) insert receiver

2) Naunton's dilemma

3) Strenger's

III True/False

l)True (2) False

MASKING IN SUPRATHRESHOLD AUDIOMETRY
(Special tests)

While doing special tests like short increment sensitivity index (SISI) and tone decay test (TDT), it is essential to know when both ears should be masked. For testing site of lesion several tests have been developed. In most of these tests that presentation above the threshold level. Since during clinical audiometry there are many chances of the signal crossing from the test ear to the non-test ear, masking is required while administered special tests. In suprathreshold audiometry, we said mask the opposite ear whenever the presentation level minus the interaural attenuation value is higher or equal to the bone conduction threshold of the opposite ear at that respective frequency. We know in suprathreshold audiometry, presentation levels are always higher. Thus, it is evident that the level of the presentation vary often will exceed the bone conduction threshold of the non-test ear, by more than 40 dB. Thus for practical reasons masking is always necessary in suprathreshold audiometry. Since the mechanism of cross hearing is same even in suprathreshold audiometry, i.e. the rules for when to mask do not vary.

SISI and TDT

a) When the presentation level to the test ear and the bone conduction threshold of the non-test ear differ by IA for the test frequency or more, use masking.

b) When the presentation level to the test ear and the air conduction threshold of the nontest ear differ by IA for the test frequency or more, use masking.

Masking in SISI

There is considerable controversy in using contralateral masking while administering SISI test. Blegvad and Terkildsen (1967) showed that contralateral masking would improve the difference limen for intensity in the middle and high frequency range.

Osterhammel et al. (1969) while studying evoked responses to SISI stimuli with contralateral masking concluded that enhancement of 2, 3 and 5 dB increment occurs by the application of contralateral masking noise.

Blegvard, (1969) tested the influence of contralateral masking on SISI scores in unilateral perceptive hearing loss cases. He found significant improvement in the intensity discrimination at 1 and 4 kHz.

When to mask

Mask the opposite ear when the presentation level of SISI minus the interaural attenuation is equal or greater than the bone conduction threshold of the opposite ear.

i.e. SISI PTL -IA > BCT NTE

How much to mask

a) Minimum masking

Mmin = SISI PTL -1A + (ACT -BCT)

b) Maximum masking

Mmax =BCTTE + LA - 5 dB

Masking in Tone Decay Test

Masking of the nontest ear is necessary in testing adaption at threshold in many patients with unilateral hearing loss.

Blegvard and Josephson (1971) as quoted by Snashall (1974) have recommended that contralateral masking should always be used with tone decay tests in order to avoid false negative results. Snashall (1974) prefers to mask tone decay test as little as possible to avoid unnecesary alarm due to false positive results. However, Martin (1978) advocates not to use minimum masking since the level of the signal may be constantly increased during a threshold tone decay test.

The effect of contralateral masking was greatest for the most sensitive tests of tone decay (Snashell, 1974).

When to mask

Mask the opposite ear when the presentation level of S1S1 minus the interaural attenuation is equal or greater than the bone conduction threshold of the opposite ear.

i.e. TDT PTL -IA > BCTNTE

How much masking

Minimum masking . Mmin = SISI PTL -IA + (ACT -BCT)

Maximum masking : Mmax =BCTTE + **IA** - 5dB

Masking during Auditory Brainstem Response (ABR)

It is important to consider the application of contralateral masking during ABR recording when the possibility of signal crossover to the non-test ear exists. As in puretone and speech audiometry, it would be difficult toi nterpret ABR findings without appropriate use of masking.

Finitzo-Heiber et al. (1979) examined the effects of contralateral masking on ABR in 2 adults and 4 infants with unilateral hearing loss. These investigators noted that the absence of crossover for click signals up to 110 dB SPL, andsuggested that masking is unnecessary for air-conducted ABR recordings in patients with asymmetrical hearing loss.

In contrast, Chiappa et al. (1979) demonstrated that without the use of masking in the non-test (better) ear, replicate waveforms could be recorded from the test (non-functional) ear. This study provided evidence of crossover for ABR click signals. Similar findings were also reported by Stockard and Stockard (1983) in a patient with a unilateral severed auditory nerve pathology.

According to Fraigang et al. (1974), the patient with unilateral deafness showed no difference in characteristics between ipsilateral and contralateral stimulation by bone conduction. The only way to avoid cross hearing is masking the opposite ear just as in subjective audiometry. Their study also indicated that examination of the shadow curves for patients with unilateral deafness by means of evoked response audiometry showed same value as by subjective audiometry. This suggest that the rules of masking common in conventional threshold audiometry should be used in evoked response audiometry to eliminate cross hearing.

Auditory brainstem response : When to mask

Masking the opposite ear when the presentation level of the click minus the interauraJ attenuation is equal or greater than the bone conduction threshold of the opposite ear.
i.e.. PTL (of clicks) -IA (for clicks) > BCNTE (for clicks)

Interaural attenuation (IA) is influenced by factors such as the test stimulus and transducer type. For a click, estimates of IA range from about 50-80 dB (Ozdamar and Stein, 1981; Humens and Ochs, 1982; Reid and Thornton, 1983; Van Campen et al. (1990).

From a conservative audiologic perspective, it would appear that the application of contralateral masking in ABR testing should follow the same principles as in behavioural audiometry using a minimum estimate of 50 dB LA; that is, you need to mask whenever the intensity of the stimulus exceeds sensory sensitivity in the non-test ear by more than about 50 dB (i.e. IA for a click).

An alternative method of determining when to mask is based on the interaural latency difference of corresponding peak components. The ABR produced by transcranial stimulation is significantly longer in latency and reduced in amplitude owing to the lower signal intensity reaching the contralateral cochlea. Such a crossover response would be delayed relative to the better ear that the need for masking would be apparent. The advantage of this approach to determining when to mask is that it does not assume knowledge of cochlear sensitivity in the non-test ear.

How much masking

Rowe (1981) emphasized the need to mask during ABR when testing infants and patients with significant asymmetrical hearing loss. He recommended application of a contralateral white noise masker presented 30 dB below the signal intensity of the test ear.

FORMULA

a) Minimum masking

Mmin = PTL (of clicks) -IA (for clicks) + airbone gap

b) Maximum masking

Mmax. = IA (forclicks) + BCNTE - 5 dB

When we give noise to the non-test ear and clicks to the test ear, in evoked response audiometry student may get a doubt that noise will influence the cortical evoked potential there by affecting the test result. But this is not the case. Hreden (1972) while studying the masking noise and its effect upon the human cortical evoked potential concluded that with binaural stimulation the brain responds only to the distinct clear cut stimulus more or less ignoring the steady state masking noise will be effective centrally and seem to have no influence upon the summation of the human cortical evoked potential.

Unlike puretone audiometry where effective masking is computed for each puretone center frequency, it need only be determined at the resonant frequency of the transducer for a click stimulus. This can be obtained from the special analysis during routine calibration. If this is not available, 3000 Hz would serve as a good approximation. Although effective masking level can also be derived through direct measurement of ABR threshold in normal listeners, this method is inordinately time consuming.

Questions

I True/False

1) In suprathreshold audiometry, we should mask the opposite ear whenever, PTL -IA > BCNTE.

2) Contralateral would improve the difference limen for intensity in the low frequency range.

3) Masking of the non-test ear is necessary in testing adaptation at threshold in many patients with unilateral hearing loss.

4) It is important to consider the application of contralateral masking during ABR recordings when the possibility of signal cross-over to the non-test ear exists.

5) We can easily interpret ABR findings without appropriate use of masking.

II Multiple choice

1) Maximum masking for SISI

a) Mmax = BCTTE + IA - 5 dB

b) Mmax = BCTTE + IA + 5 dB

c) Mmax = SISI PTL - IA + (ACT-BCT)

d) Mmax = BCTTE - IA

2) Minimum masking for TDT

a) BCTTE + IA - 5 dB
b) BCTTE + 5dB
c) TDT PTL -IA + (ACT - BCT)
d) TDT PTL + IA - (ACT-BCT)

3) In ABR findings masking should be applied when,

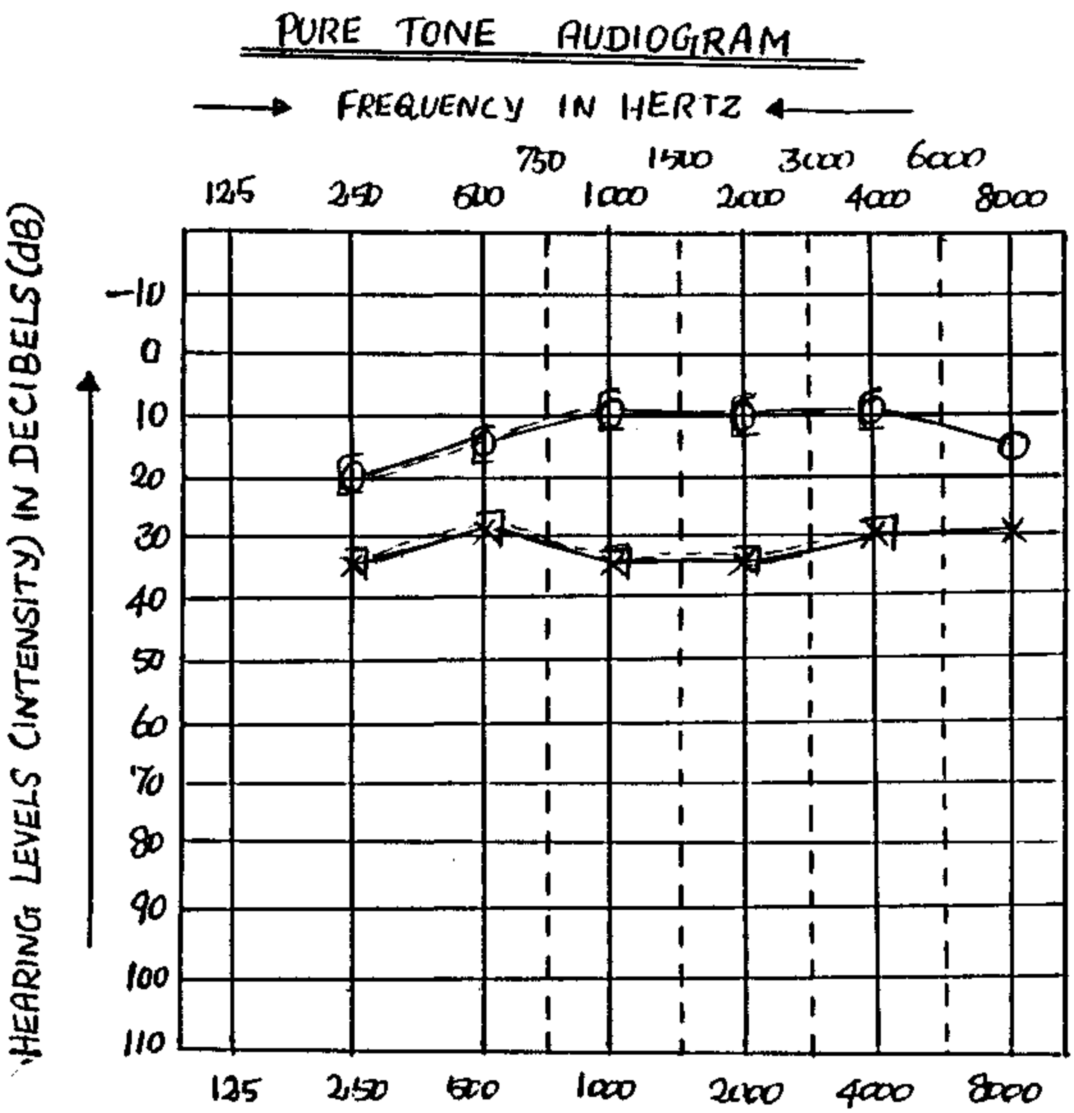
a) PTL (of clicks) - IA (for clicks) < BCNTE (for clicks)
b) PTL + IA < BCNTE (for clicks)
c) PTL (of clicks) - IA (for clicks > BCNTE (for clicks)
d) PTL - IA < ACTNTE

4) IA range for click is,

a) 20-30
b) 10-40
c) 15-45
d) 50-80

5) Maximum masking for ABR,

a) Mmax = IA (for clicks) + BCTNTE - 5dB
b) Mmax = IA (for clicks) - BCTNTE - 5dB
c) Mmax = IA (for clicks) + ACTNTE - 5dB
d) Mmax = IA (for clicks) - ACTNTE- 5dB



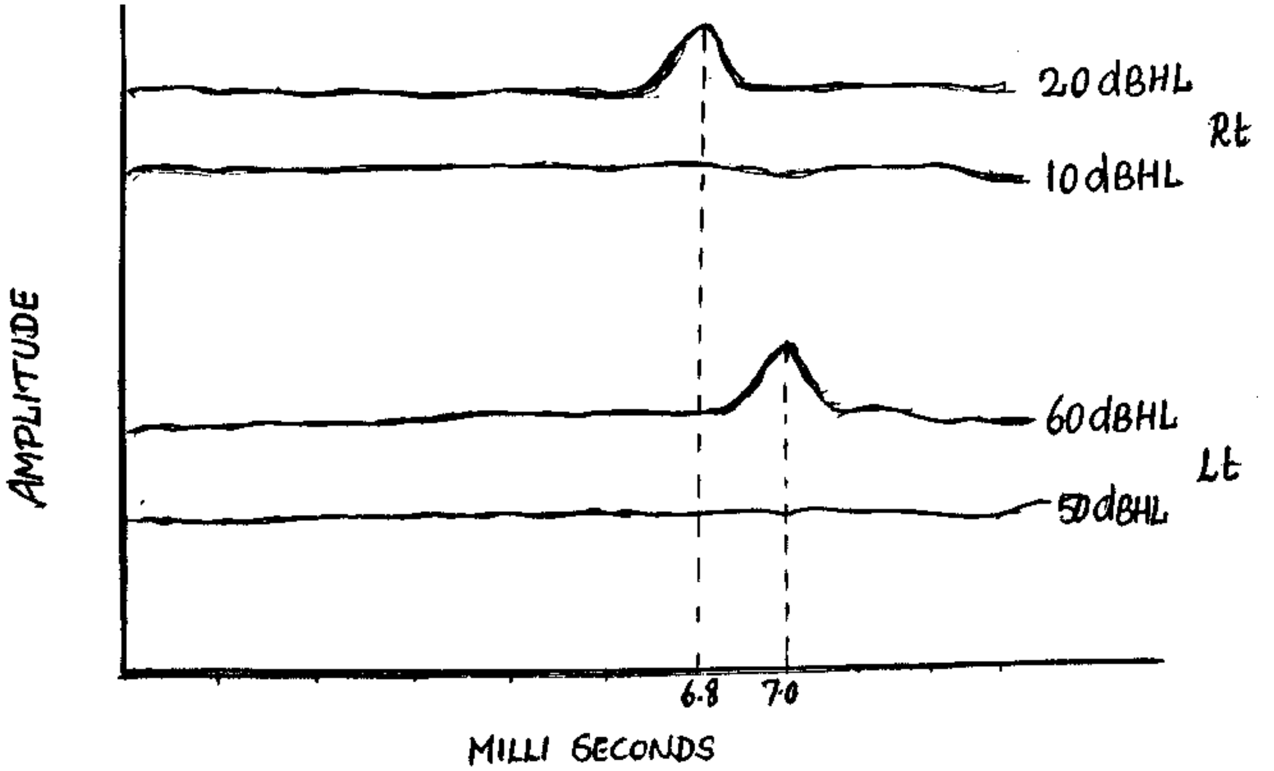
	Rt	Lt
PTA		
SRT		
PB Max		

KEY TO SYMBOLS

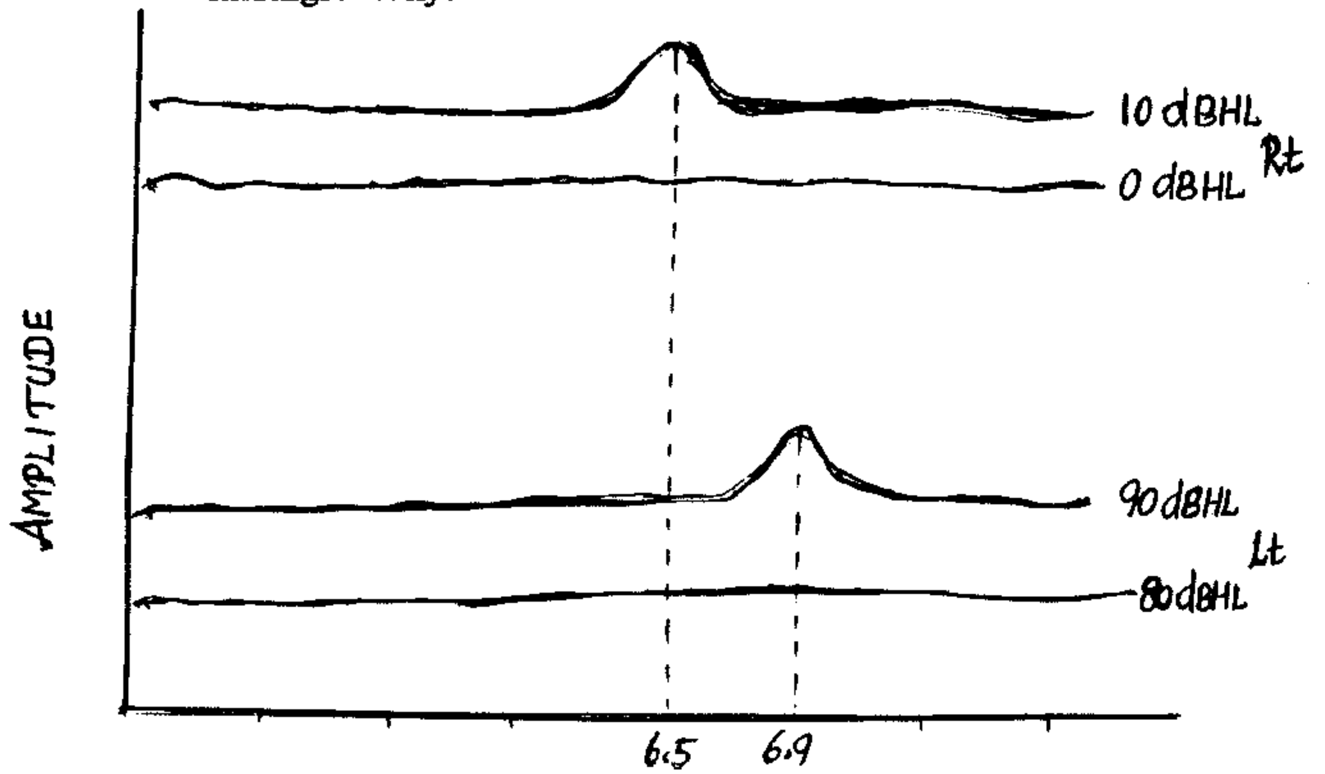
	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	↙O	Δ	↙Δ	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

III Answer the following

1) Is there a need to mask during tone decay test, at I kHz and 2 kHz? Why?



2) Is there a need to masking the non-test ear during ABR findings? Why?



MILLI *SECONDS*

3) Is there a need to mask the non-test ear during ABR findings why?

Answers

I True/false

1) True, (2) False (3) True (4) True (5) False

II Multiple choice

(I) a (2)c (3) c(4)d (5) a

HI Answer the following

1) Yes. because tone decay test is administered at 20 dB SL. thus when we give 55 dB above tone to left ear, there is chance for cross hearing. So contralateral masking is needed for IK and 2K during TDT.

2) No need to mask the non-test ear during ABR findings because the difference between both the ears is 40 dB HL.

3) In this case, masking is needed during ABR findings because the difference between both the ears is 80 dB HL.

VARIETIES OF MASKING

There are several kinds of masking available on commercial puretone audiometers. They may be classified as :

Ipsilateral masking
contralatral masking
Peripheral masking
Remote masking
Central masking
Temporal masking
- Simultaneous masking
- Non simultaneous masking
  * Forward masking
  * Backward masking

Monaural masking
Binautal masking

Ipsilateral masking

Ipsilateral masking functions refer to mixing the test signal and masking noise in the same ear.

Clinical Appliations

* Ipsilateral maskingis used to determine the amount of threshold shift that is produced by a particular masking noise. This shift is

dependent on the intensity/bandwidth relationship of the test signal and masking noise.

* Ipsilateral masking can also be used for calibrating the masking noise.

Contralatral masking

Contralateral masking refers to the presentation of the test signal to one ear and the masking noise to the opposite ear.

Clinical Application

Contralateral masking is used to elevatethe thrshold in the non-test ear so that it cannot respond to the signal being presented to the test ear.

Peripheral masking

Peripheral masking refers to either the shifting of threshold in an ear by a second signal presented to it, or by a signal that is presented to the nontest ear which crosses over and shifts the test ear threshold-

Remote masking

Bilger and Hirsh (1965) found that threshold shifts (masking) occurs at low frequencies when a higher frequency noise bands (maskers) are presented at intense levels. This is called "remote masking", because the threshold shifts occur at frequencies below and remote from the masker.

The amount of remote masking increases when the bandwidth of the masking is widened or its spectrum level is raised (Bliger, 1958).

Occurance of remote masking

Its proposed that remote masking is the result of the low frequncy effect of the acoustic reflex since it occurs at higher masker levels. However, remote masking has been reported to occur even in the absence of the acoustic reflex.
Remote masking is mostly likely primarily due to envelops detection of distortion products generated within the cochlea at higher masker intensities (cochear nonlinearities).

There are two theoris to explainthis phenomenon :

(1) Remote masking results from unsymmetrical mechanical action in the inner ear that generatess broad band noise within the inner ear. The broad band noise is said to mask tones to frequencies remote from and below the narrow band masker.

(2) Remote masking is the result of attenuation provided by the acoustic reflex.

Karlovich and Osier (1977) concluded that two tone complexes adds support to the hypothesis that remote masking is primarily a result of aural distortion i.e. asymmetrical mechanical action in the inner ear.

Keith and Anderson (1969), while investigating remote masking with cochlear impairment, concluded that dual mechanism of middle ear plus inner ear actively is a more suitable explanation of remote masking than either theory alone.

Clinical Appliation

Remote masking values indeed reduced symmetrically in both ears and progressively as a result of aging. Thus remote masking demonstrates the existence of cochlear conductive presbycusis and can be considered as a useful test of stiffness of the cochlear partition.

Central masking

Central masking, a term coined by Wegel and Lane (1924), refers to a shift or worsening in threshold of the test ear due to the introduction of masking in the non-test ear at masking intensities below the level of cross-over. The central masking shift begins to occur at low masking intensities and appears to increase with increased masking (Studebaker, 1962; Martin and DiGiovanni, 1979).

In short, central masking occurs when the test sound is presented to one ear and masking sound to the other ear. Central masking is a very smaller effect when compared to monaural masking. Different authors have got different amount of threshold shifts due to central masking. However Martin (1975) states that the threshold shift averages about 5 dB. The amount of threshold shift increase with,

* the intensity of the masker (Studebaker, 1962).
* the increase in frequency of the test tone (Snyder, 1973) and
* the decrease in masker band wi^V^Snyder, 1973).

Clinical Application

Central masking may never become a routine clinical tool because of the smallness of the threshold shifts it produces. Nevertheless it could play a role in clinical research aiming at understanding of neural pathologies" (Zwislocki, 1971).

According to Menzel (1968), the error that is likely to result by ignoring the central masking phenomenon is not likely to large, However, Martin (1975), suggest, 5dB should be subtracted from the threshold values obtained to compensate for central masking. And he recommends this for both puretone threshold and speech reception threshold

* Menzel (1968) suggest the following technique. If there is a suspicion that the central masking effect is unusually large.

mask the poorer ear and re-establish thresholds for the better ear. Naturally the thresholds should not be shifted. If they are then the extent of such shift should be an indication of central masking factor.

Temporal masking

Based on temporal features masking can be divided into simultaneous and non-simultaneous masking.

Simultaneous masking	Non-simultaneous masking
* Simultaneous masking is the term used to describe those situations where the masker is present for the whole time that the signal occurs.	* This term is used to describe those situations where the masker is not prsented along with the signal but is presented just before or after a brief signal is presented.
* The masking stimulus and the signal are presented simulta-neously.	* Masker is not presented along with the signal. It is presented either before or after a brief signal.
* Beats and combination tones produced by the interaction of signal and masker in masking of puretones by puretones.	* Absent,

* Frequency selectivity is observed to be lesser.	Frequency selectivity is observed greater (Sharper).

- Non-simultaneous masking

There are 3 types of non-simultaneous masking, namely:

* Backward masking
* Forward masking
* Pre-stimulatory masking

*** <u>Backward masking</u>**

It is also called as premasking/prestimulus masking. Here the test sound has to be a short burst or sound impulse which is presented before the masker stimulus is switched on

i.e.the masker follows the signal.

*** <u>Forward masking</u>**

It is also called as post-stimulatory masking/post masking. Here, the test sound is presented after the masker is switched

i.e. masker preceeds the signal.

*** Pre-stimulatory masking**

In this a relatively short probe (signal) is presented at various times during the on-time of the masker and the course of masking as a function of time is determined.

Backward Masking	Forward Masking
* The amount of masking decreases dramatically as the interval between probes masker increases from 0 to 15 msec. For longer delays the amount of backward masking decreases very little.	• Same situation occurs but to a lesser degree
* This does not appear for backward masking.	* Duration of masker influences the amount of forward masking. it is seen that more forward masking is produced by a masker 200msec. in duration than by a 25 msec, masker.
* Backward masking may occur because the masker is presented before the signal has been fully processed within the auditory nervous systems thus interfering with the process of its perception.	* Forward masking may be due to a persistent of the masker's representation in the auditory neural channel, and/or to a temporary reduction in the absolute sensitivity of the stimulated units resulting from stimulation by the masker.

More masking occurs when backward and forward masking are combined than from individual contributions of both masking were simply added together.

Temporal masking depends upon the frequency relationship between the probe signal and the masker. More masking occurs when the signal and masker are close together in frequencies than when they are far apart.

Monaural masking

The masking produced by a particular sound is largely dependent upon its intensity and spectrum.

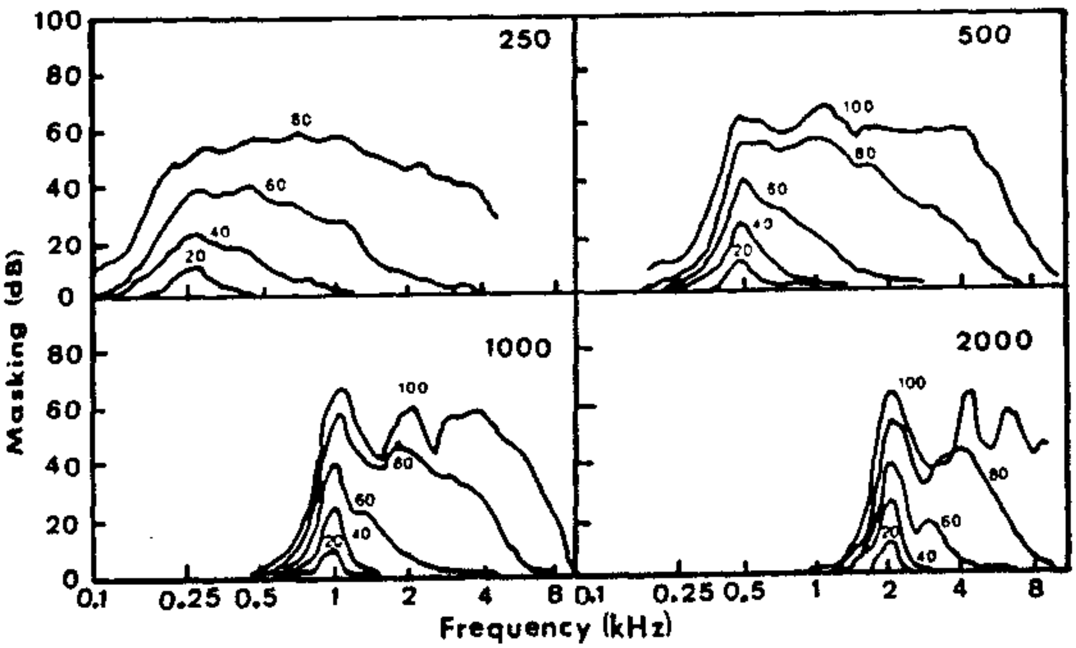


Figure 8 ' Masking patterns produced by various pure tone maskers (masker frequency indicated in each frame). Numbers on curves indicate masker level. (Adapted from Ehmer [6]. Permission *J. Acoust. Soc. Amer.)*

Fig 8 shows a series of masking patterns (sometimes called masking audiograms) obtained by Ehmer. Each panel shows the amount of masking produced by a given puretone masker presented at different intensities. In other words, each curve shows as a function of maskee frequency the masked thresholds of the maskee which ear produced by a given masker presented at a given intensity. Masker frquency is indicated in each frame and masker level shown near each curve. Several observations may be made from these masking patterns.

First, the strongest masking occurs in the immediate vicinity of the masker frequency; the amount of masking tapers with distance from this "center" frequency.

Second, masking increases as the intensity of the masker is raised.

The third observation deals with how the masking pattern depends upon the intensity and frequency of the masker. Concentrate for the moment upon the masking pattern produced by the 1000 Hz masker.

Note that the masking is quite symmetric around the masker frrquency or relatively low masker levels (20 and 40 dB). However, the masking patterns become asymmetrically wider with increasing masker intensity, with the greatest masking occuring for tones higher than the masker frequency, but will very little masking at lower frequencies.

Thus, as masker intensity is raised, there is considerable spread of masking upward in frequency but minimal downward spread. Note too that there are peaks in some of the masking patterns corresponding roughly to the harmonic of the masker frequency. Actually, however, these peaks are probably not due to aural harmonics because they do not correspond precisely to multiples of the masker. Small found that these peaks occurred when the masker frequency was about 0.85 times the test tone frequency.

Finally, note that the masking patterns are very wide for low frequency maskers, and are considerably more restricted for high frequency maskers. In other words, high frequency maskers are only effective over a selectively narrow frequency range in the vicinity of the masker frquency, bu tlow frequencies tend to be effective masker over a very wide range of frequencies.

Binaural masking

Many experiments have shown that the threshold for detecting a signal masked by noise is lower when th enoise and signal are presented in a particular way to both ears. In these experiments subjects first determined their masked thresholds when both the noise and tonal signal were presented equally to both ears.

In one test experiment, the tonal signal was removed from one ear, and thus the noise was at both ears and the signal at only one ear. In this case the signal was easy to detect, and therefore the level of the tone had to be reduced to obtain masked thresholds. Subsequently in detection associated with presenting stimuli to both ears. A certain nomenclature has been developed to describe the various types of binaural configurations of signal and noise.

monotic : stimuli presented to only one ear.
diotic : identical stimuli presented to both ears,
dichotic : different stimuli presented to the two ears.

Investigators have found that the masked threshold of a signal is the same when the stimuli are presented in a monotic or diotic condition. If the masker and signal are arranged in a dichotic situation, however, the signal has a lower threshold than in either the monotic or diotic conditions.

Questions

I Match the following :

a) If the masker follows the signal 1 .Ipsilateral masking

b) If the masking stimulus and **the** signal are presented simultaneously 2Backward masking

c) If the test signal and masking noise are presented to the same ear. 3Contralateral masking

d) If the masker preceeds the signal 4. Simultaneous masking

e) If the test signal presented to one ear and the masking noise to the opposite ear. 5.Forward masking

II Fill up the blanks

1) Backward masking is are called as. . . . . .or. . . . .
2) Based on the temporal features masking can be divided into .... and. . . . . .
3) Forward masking is also called as. . . . .and. . . .
4) Backward masking,forward masking and prestimulatory masking are the types of.... masking.

III True/False

1. Peripheral masking refers to either the shifting of threshold in an ear by a second signal presented to it, or by a signal that is presented to the non-test ear which crosses over the shifts the test ear thresholds.

2. Remote masking refers to either the shifting of threshold in an ear by a second signal presenetd to it, or by a signal that is presented to the non-test ear which crosses over and shifts the test ear threshold.

3. The amount of signal masking increases when the bandwidtho f the masking as widened orits spectrum level is raised.

4. Temporal masking depends upon the frequency relationship between the probe signal and the masker.

5. In central masking a relatively short probe signal is presented at various times during the on time of the masker and the course of masking as a function of time is detemined.

Answer

I Match the following

1) a)-2 b)-4 c)-l d)-5 e) - 3

II Fill up the blanks

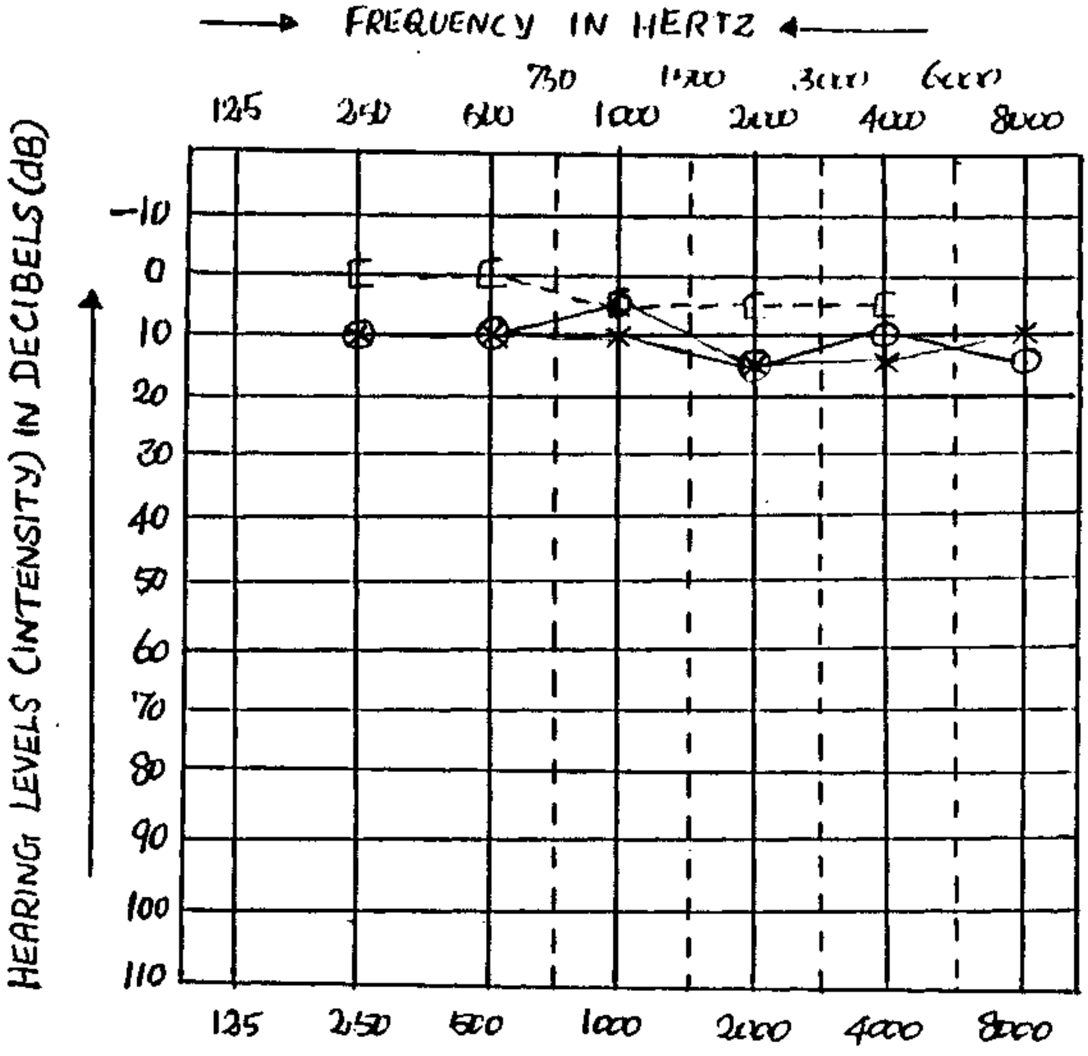
1) Pre masking/prestimulus masking
2) Simultaneous and non-simultaneous masking
3) Post masking /post stimulatory masking.
4) Temporal

III. True/Fasle

(1) True (2) False (3) True (4) True (5) False.

LET US CHECK YOUR KNOWLEDGE IN MASKING

PURE TONE AUDIOGRAM



	Rt	Lt
PTA	10dB	11.6dB
SRT		
PB Max		

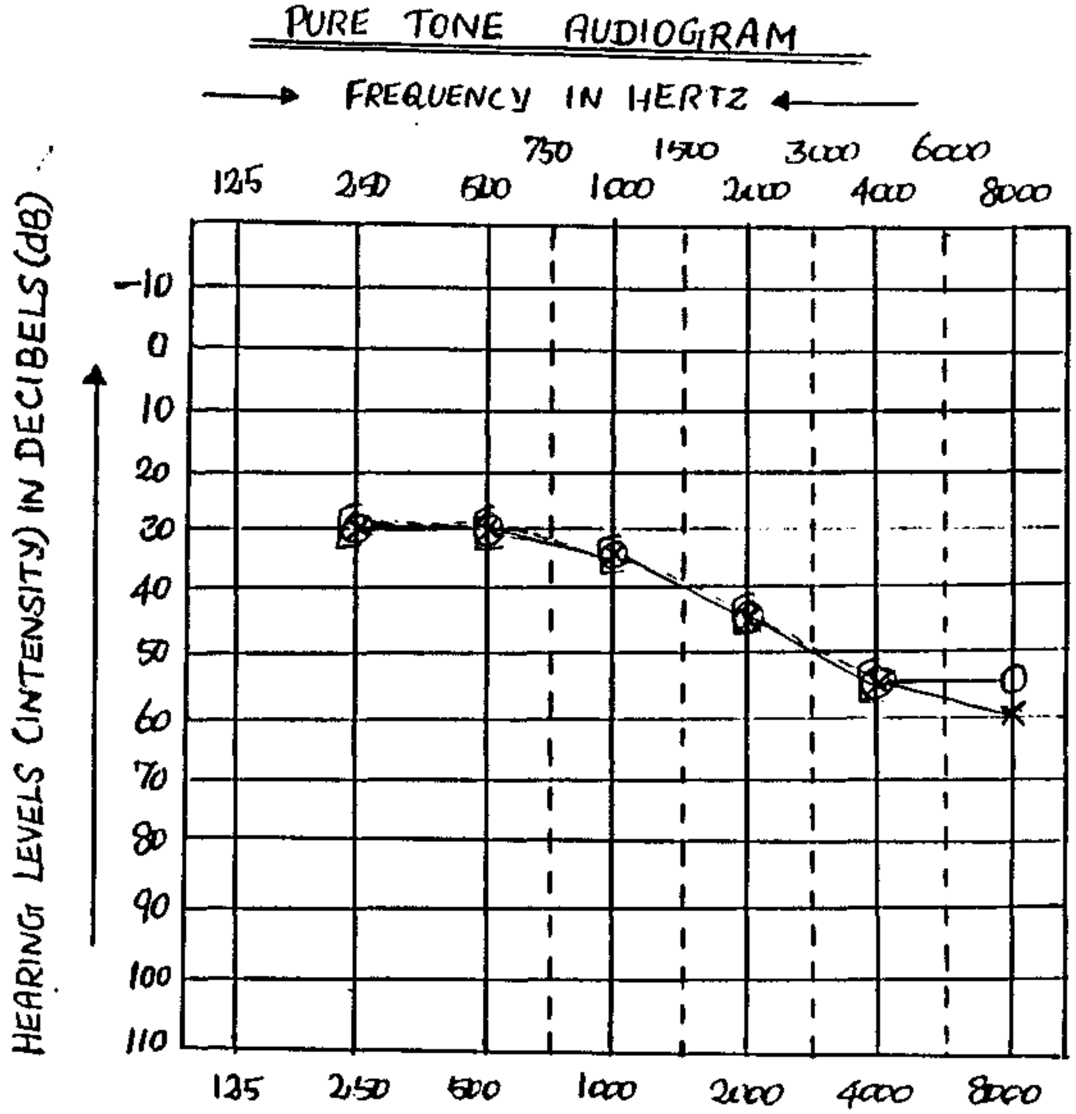
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

1a) Is masking needed for AC in either ear?

b) Is masking needed for BC in either ear? Why?

c) What type and degree of hearing loss are you looking at in each ear?



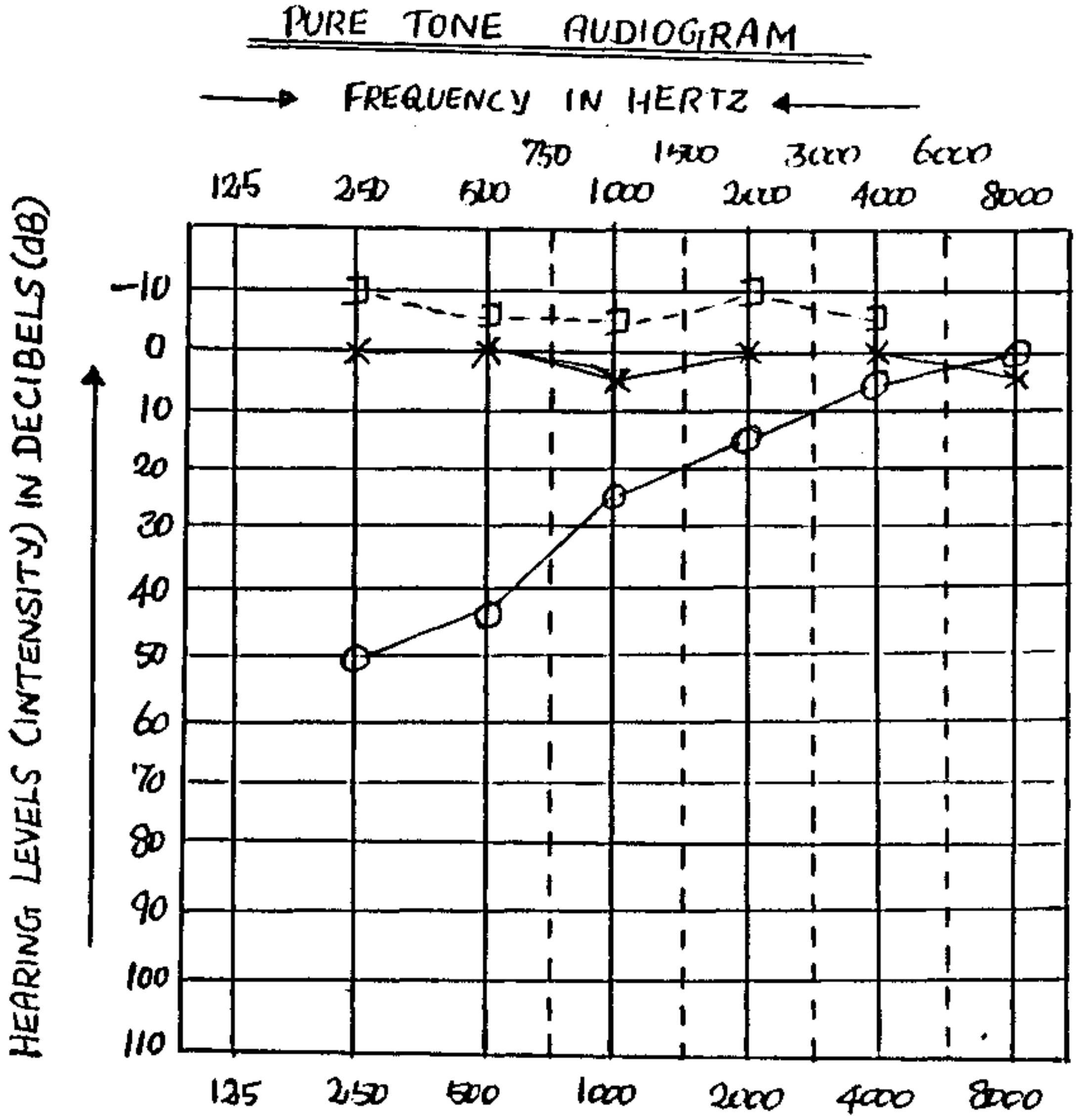
	Rt	Lt
PTA	36.6dB	36.6dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	┌	┌↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	┐	↙┐

2a) Is it necessary to mask either ear? Why?

b) What is the diagnosis?



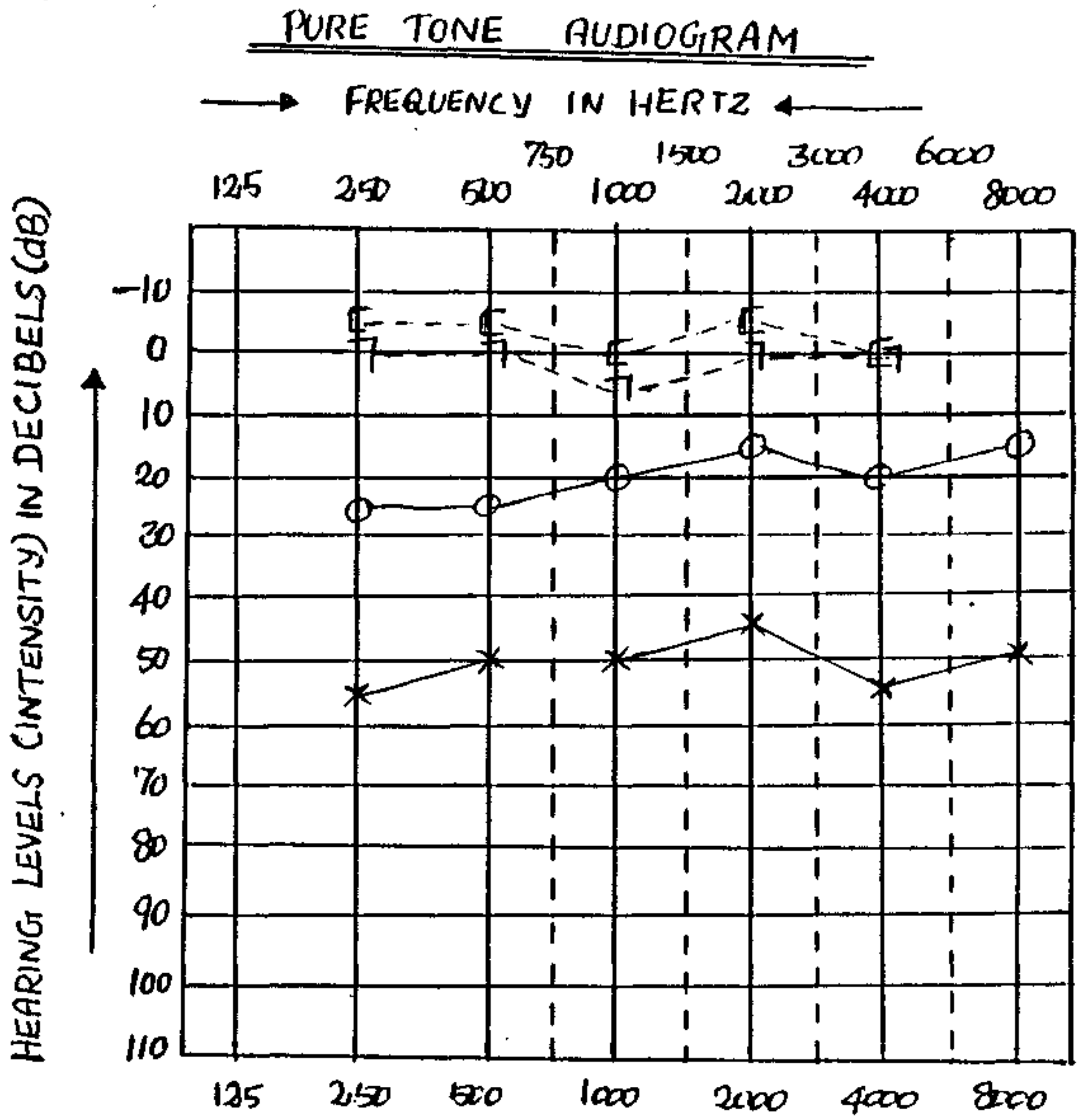
	Rt	Lt
PTA	28.3dB	1.6dB
SRT		
PB Max		

KEY TO SYMBOLS

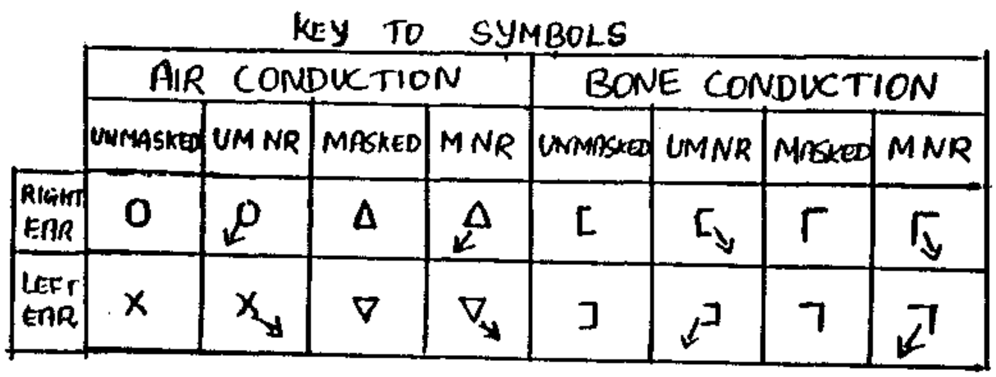
	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

3a) Is BC masking needed? why?

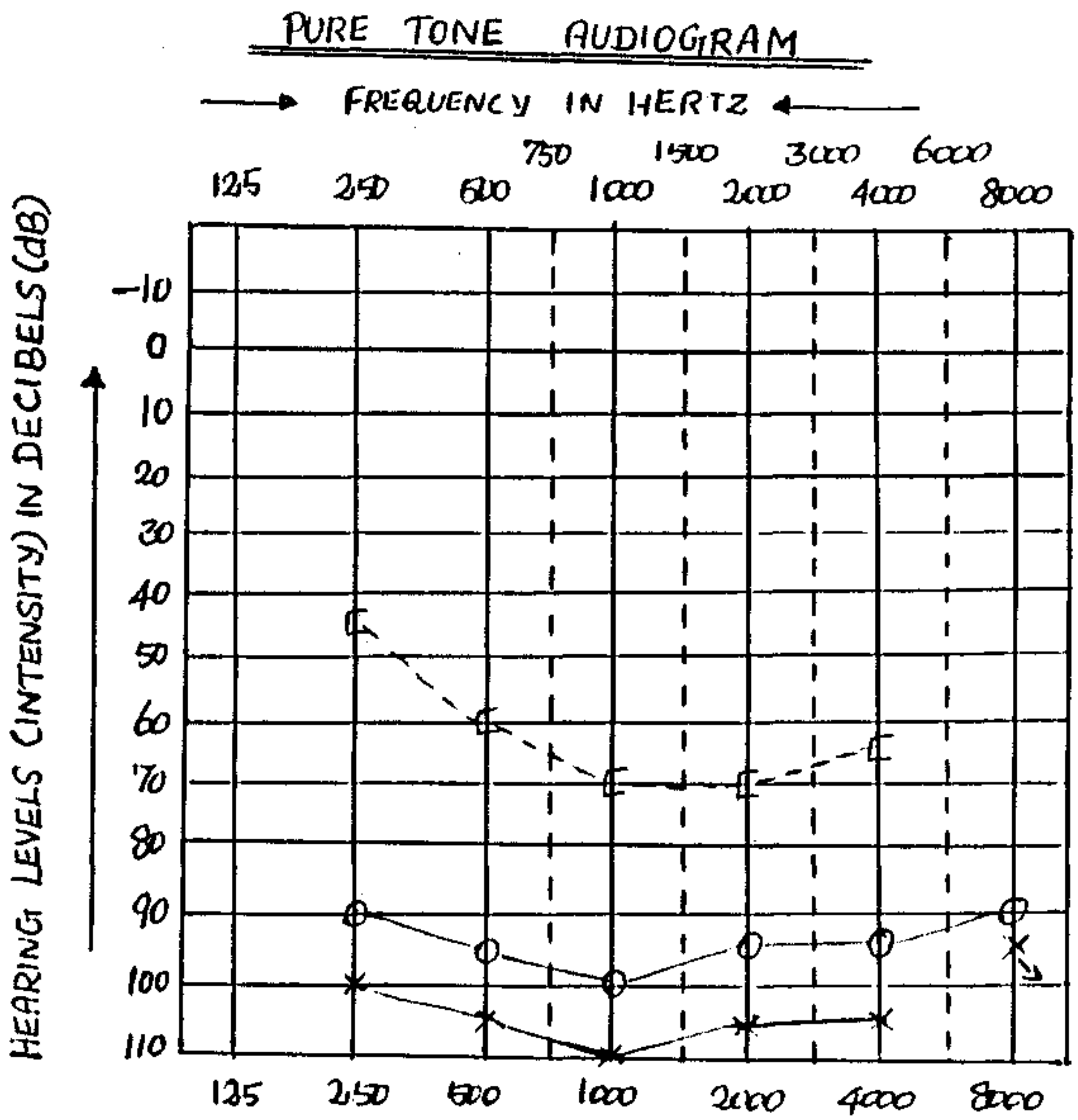
b) At which frequencies AC masking is needed? Why?



	Rt	Lt
PTA	20dB	48.3dB
SRT	25dB	* 50dB
PB Max	100%	* 100%



4a) What else should be done? Why?



	Rt	Lt
PTA	96.6dB	103.3dB
SRT		
PB Max		

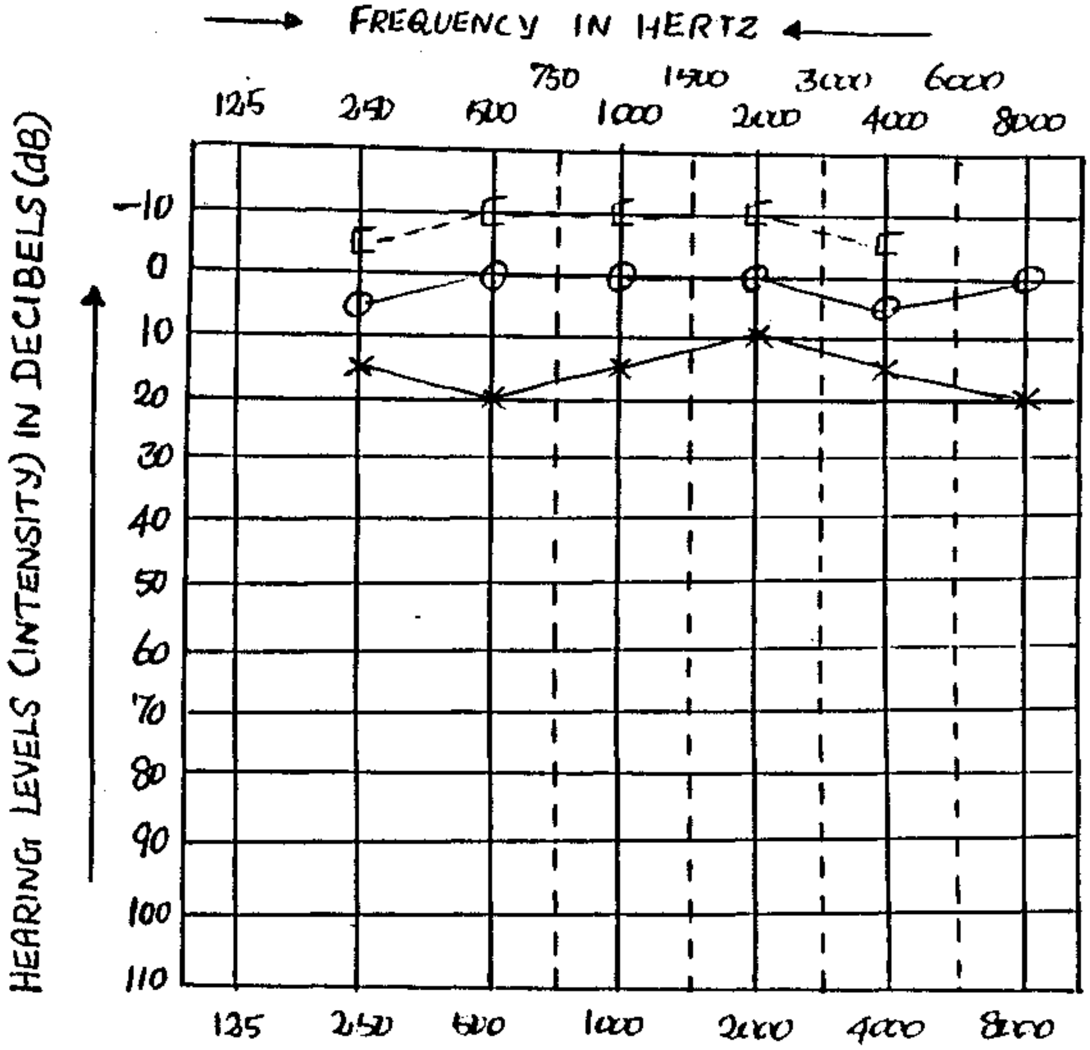
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

5a) What are the masking needed?

b) Is it masking passible in this case? If not why?

PURE TONE AUDIOGRAM



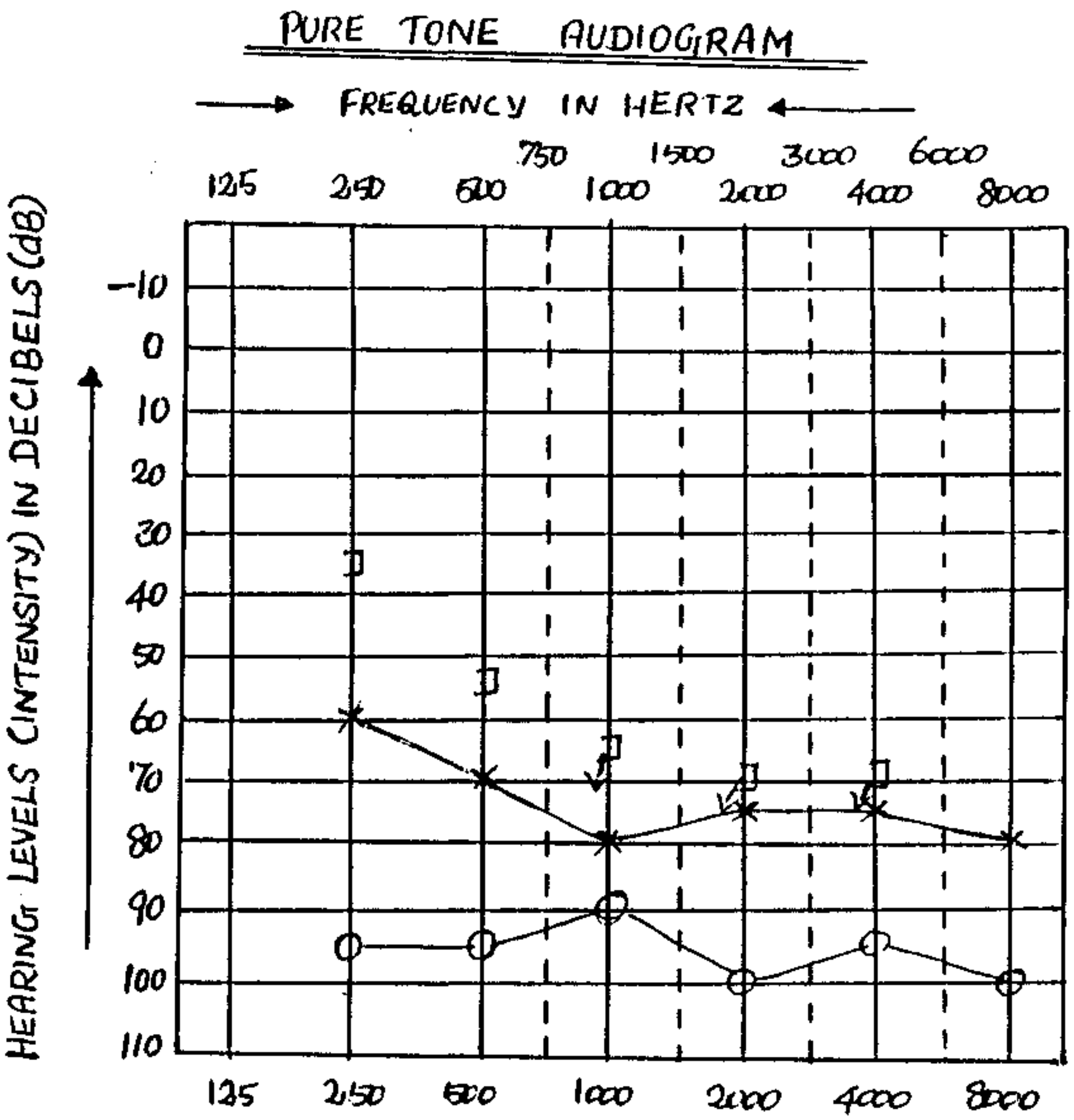
	Rt	Lt
PTA	0dB	15dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	┌	┌↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	┐	↙┐

6a) What is the diagnosis?

b) Why BC masking is necessary?



	Rt	Lt
PTA	95dB	75dB
SRT		
PB Max		

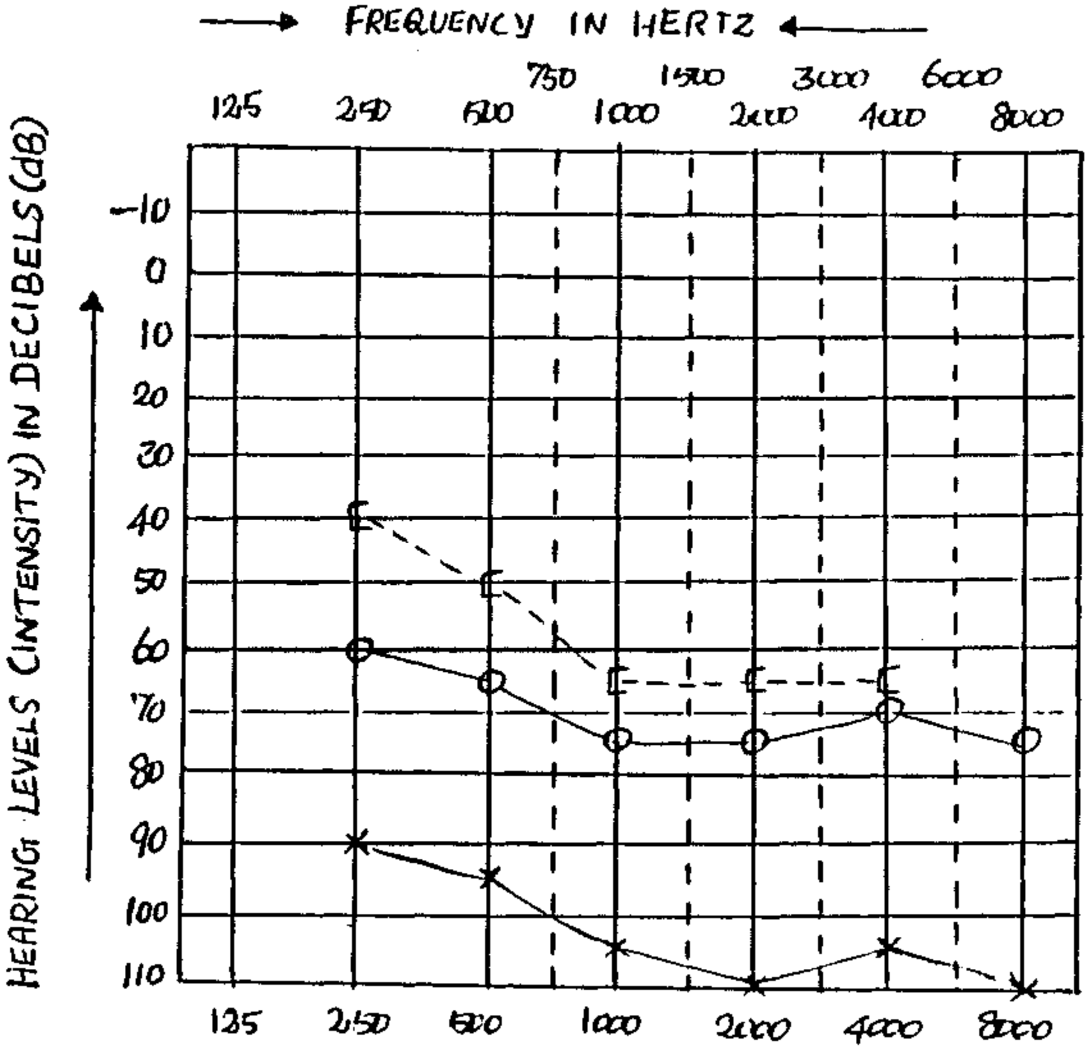
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	┌	┌↘
LEFT EAR	X	X↘	▽	▽↘	]	↙]	┐	↙┐

7a) Is AC masking needed?

b) Is BC masking needed?

PURE TONE AUDIOGRAM



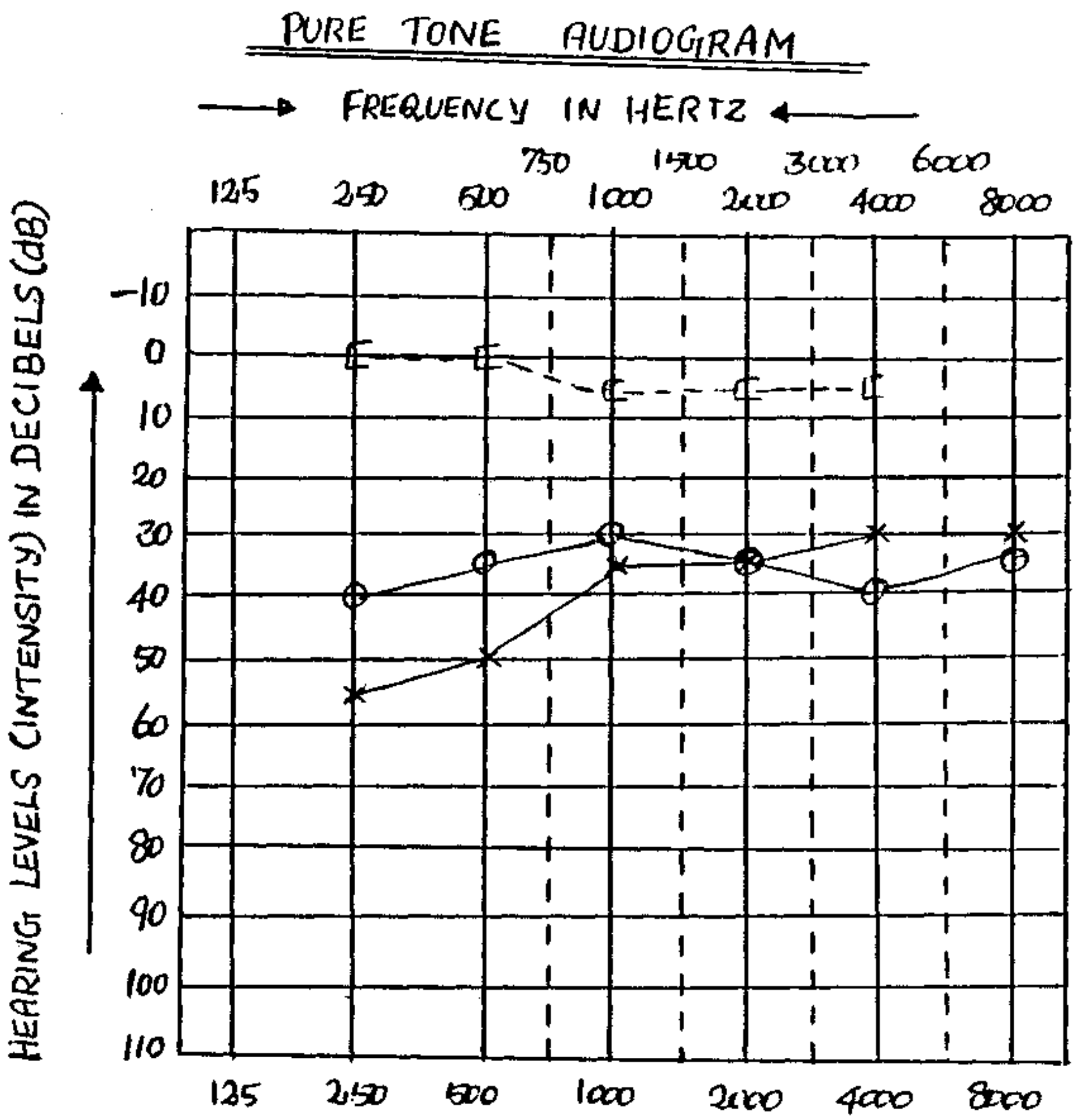
	Rt	Lt
PTA	71.6dB	101.6dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

8a) Where is masking needed?

b) Using the formulas discussed in the text compute minimum and maximum masking level for both air and bone conduction at each frequency.



	Rt	Lt
PTA	33.3dB	40 dB
SRT		
PB Max		

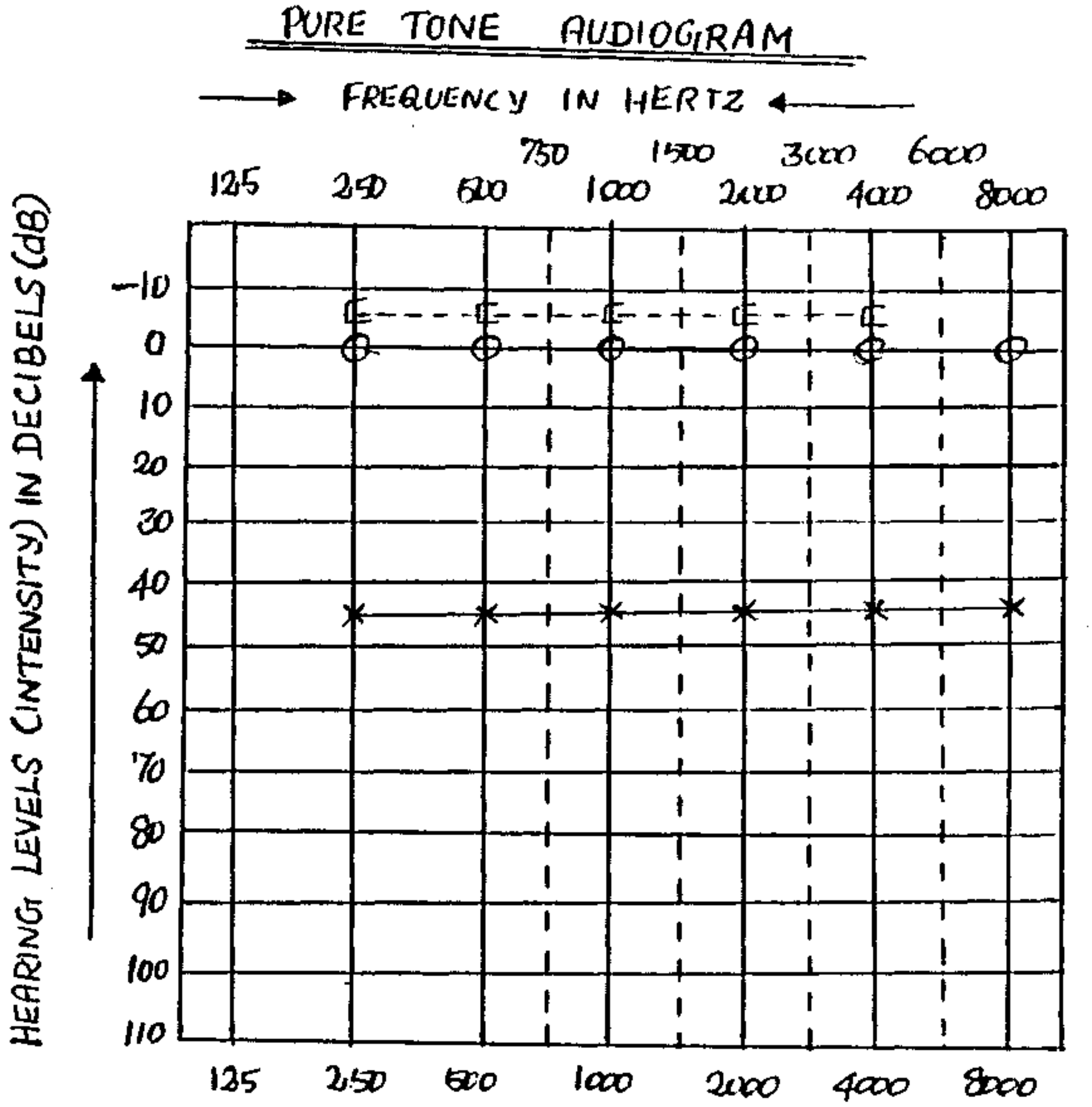
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

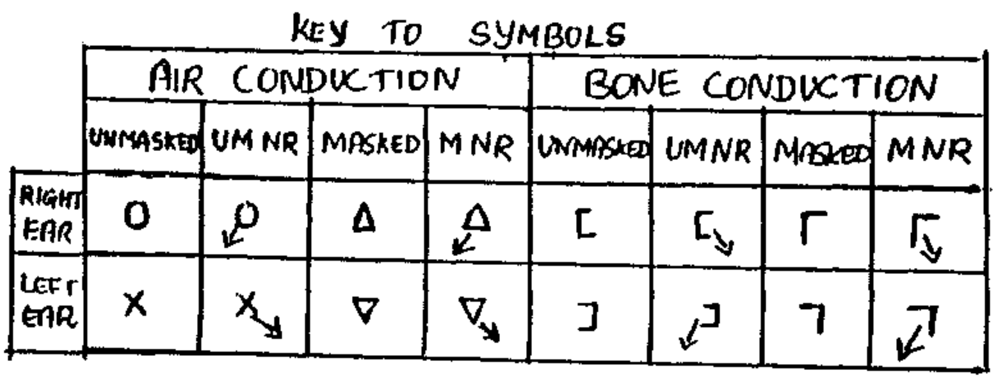
9a) At which frequencies masking is needed for AC and what are the minimum and maximum masking for AC?

b) At which frequencies masking is needed for BC and What are the minimum and maximum masking for BC?

c) If minimum masking is exceeding the maximum what is the condition called? At which frequencies it occurs here?

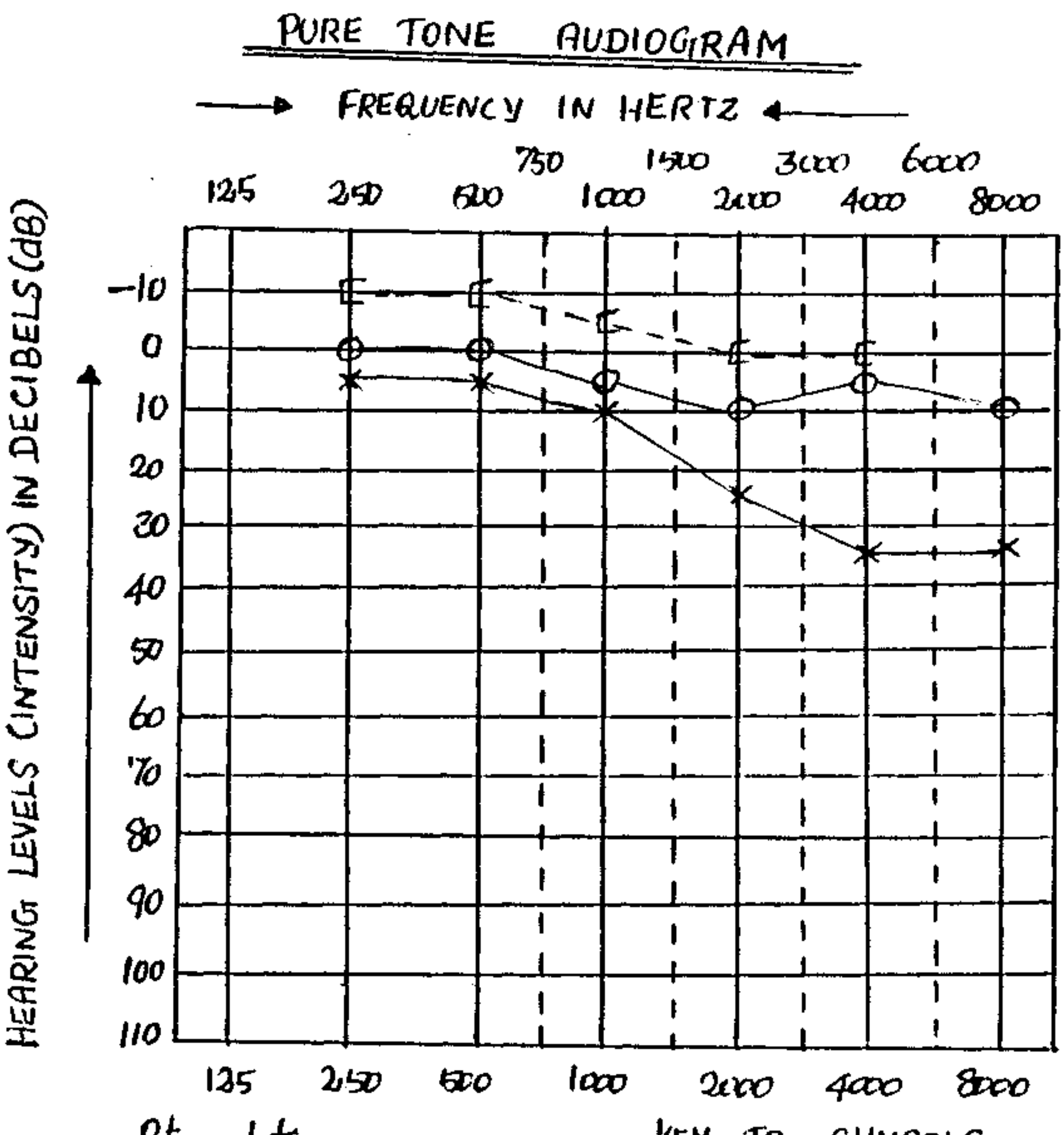


	Rt	Lt
PTA	0dB	45dB
SRT		
PB Max		



10 a) Which ear should be masked for air and bone conduction ? Why?

b) What are the minimum and maximum masking levels for AC and BC?



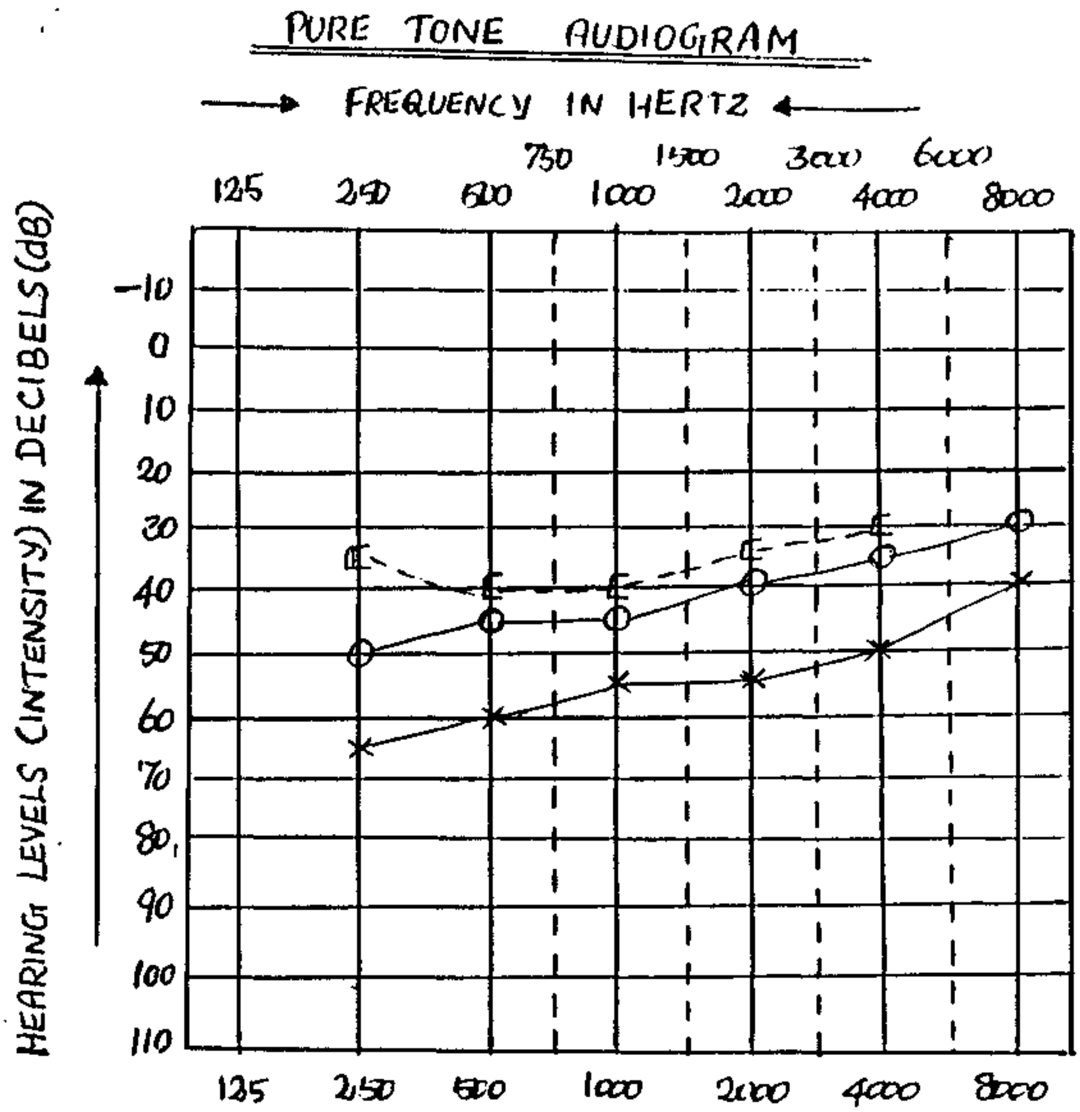
	Rt	Lt
PTA	5dB	13.3dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

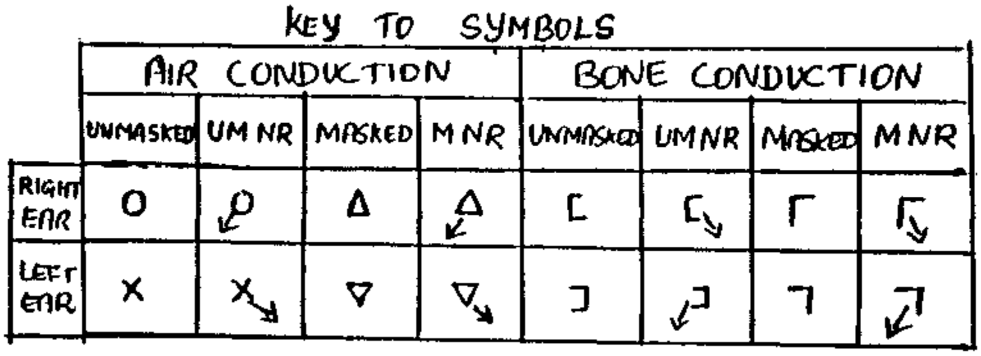
11 a) What are the masking required?

b) What are the minimum and maximum masking levels for BC?



	Rt	Lt
PTA	43.3dB	56.6dB
SRT		
PB Max		

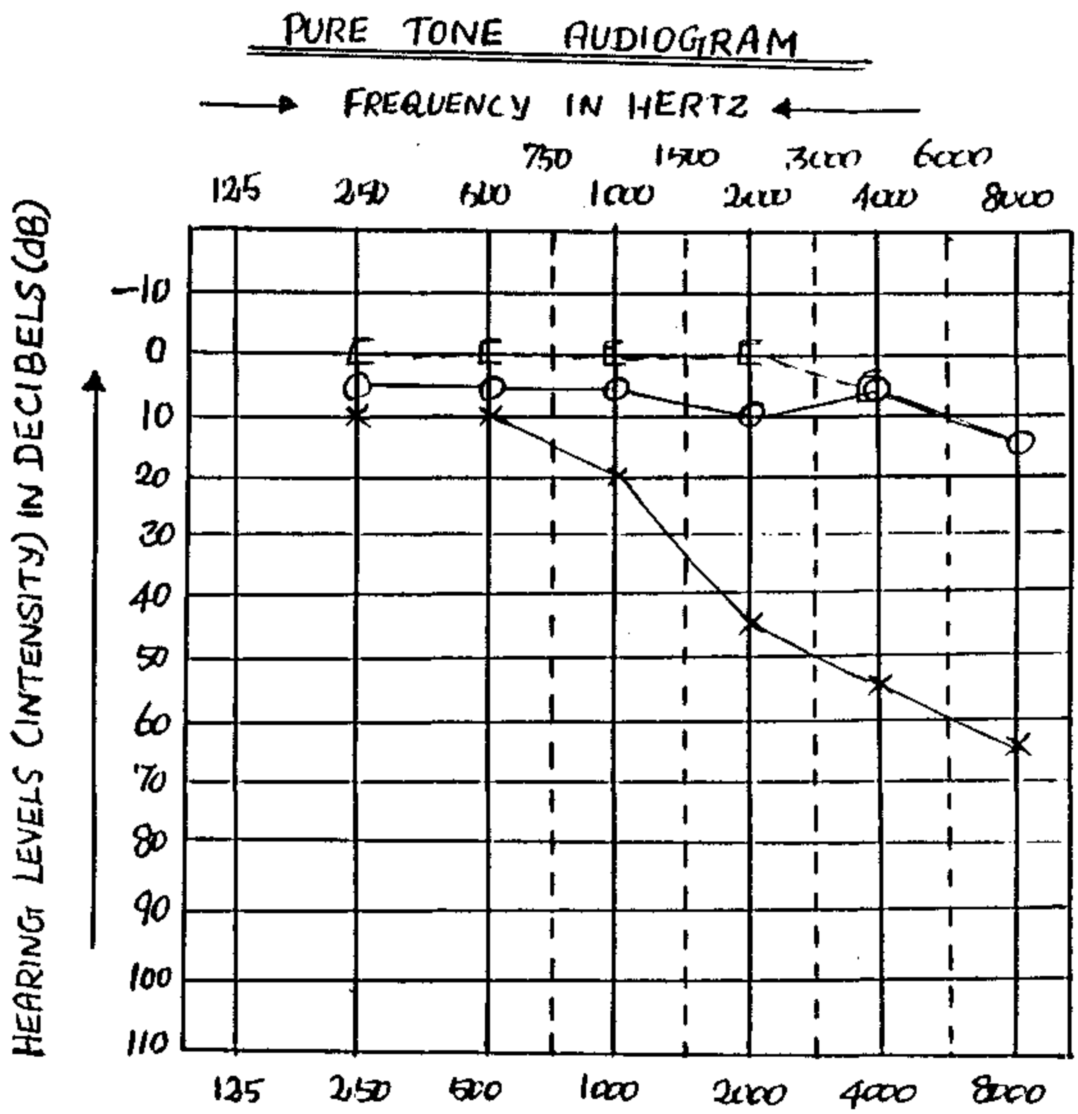
KEY TO SYMBOLS



12 a) Is masking necesary while testing AC thresholds of the left ear?

b) Is masking needed for BC while testing the thresholds of the left ear?

c) At which frequencies occlusion effect should added? Why? How much should be added?



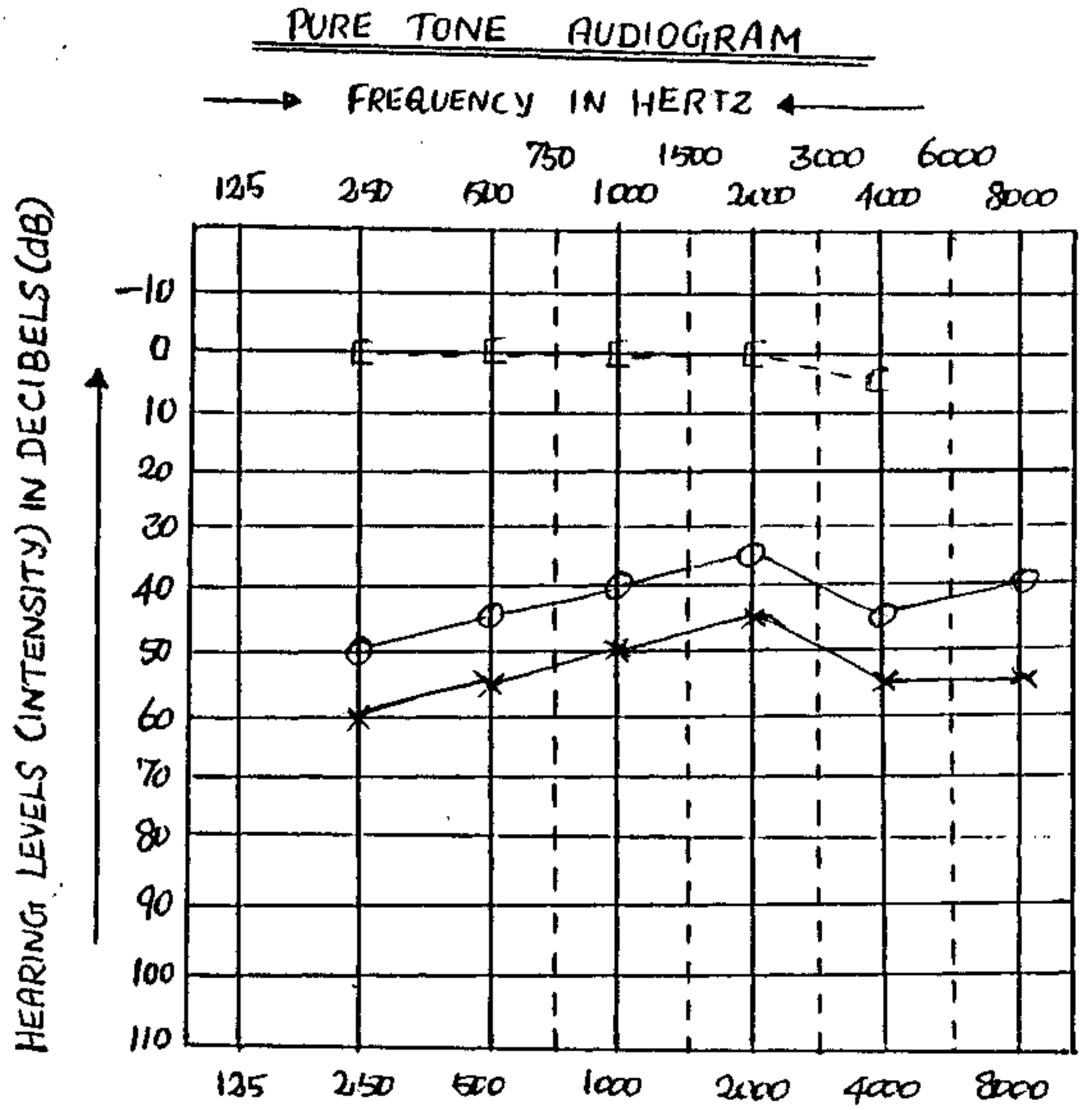
	Rt	Lt
PTA	6.6dB	25dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

13 a) Is masking AC masking necesary for all frequencies? Why?

b) What are minimum masking levels for BC?



	Rt	Lt
PTA	40dB	50dB
SRT	45dB	55dB
PB Max	100%	100%

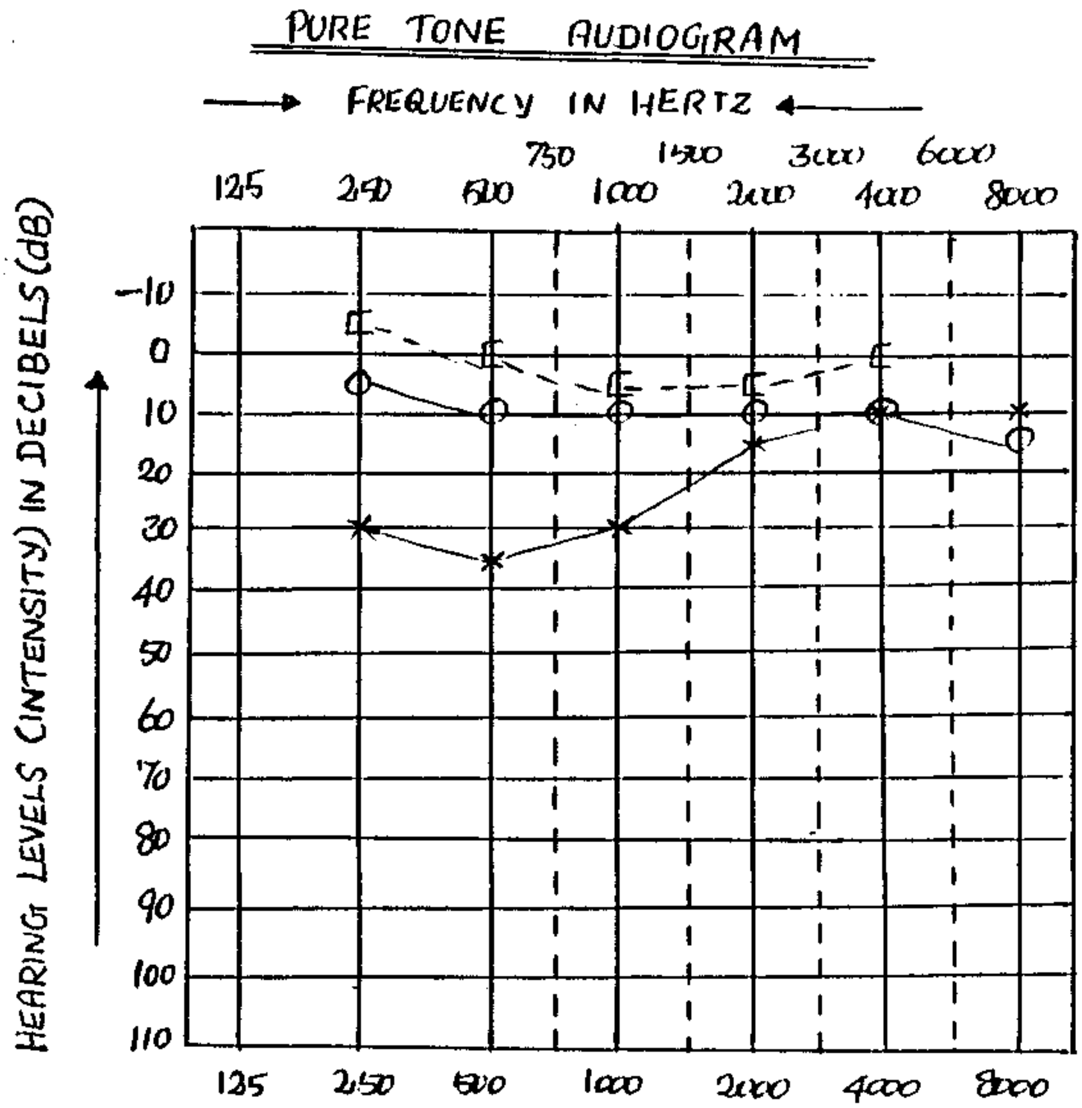
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

14 a) What would you do next?

b) How would you go about doing it?

c) If the masked BC thresholds come down to 50 dB on an average what would you recheck?



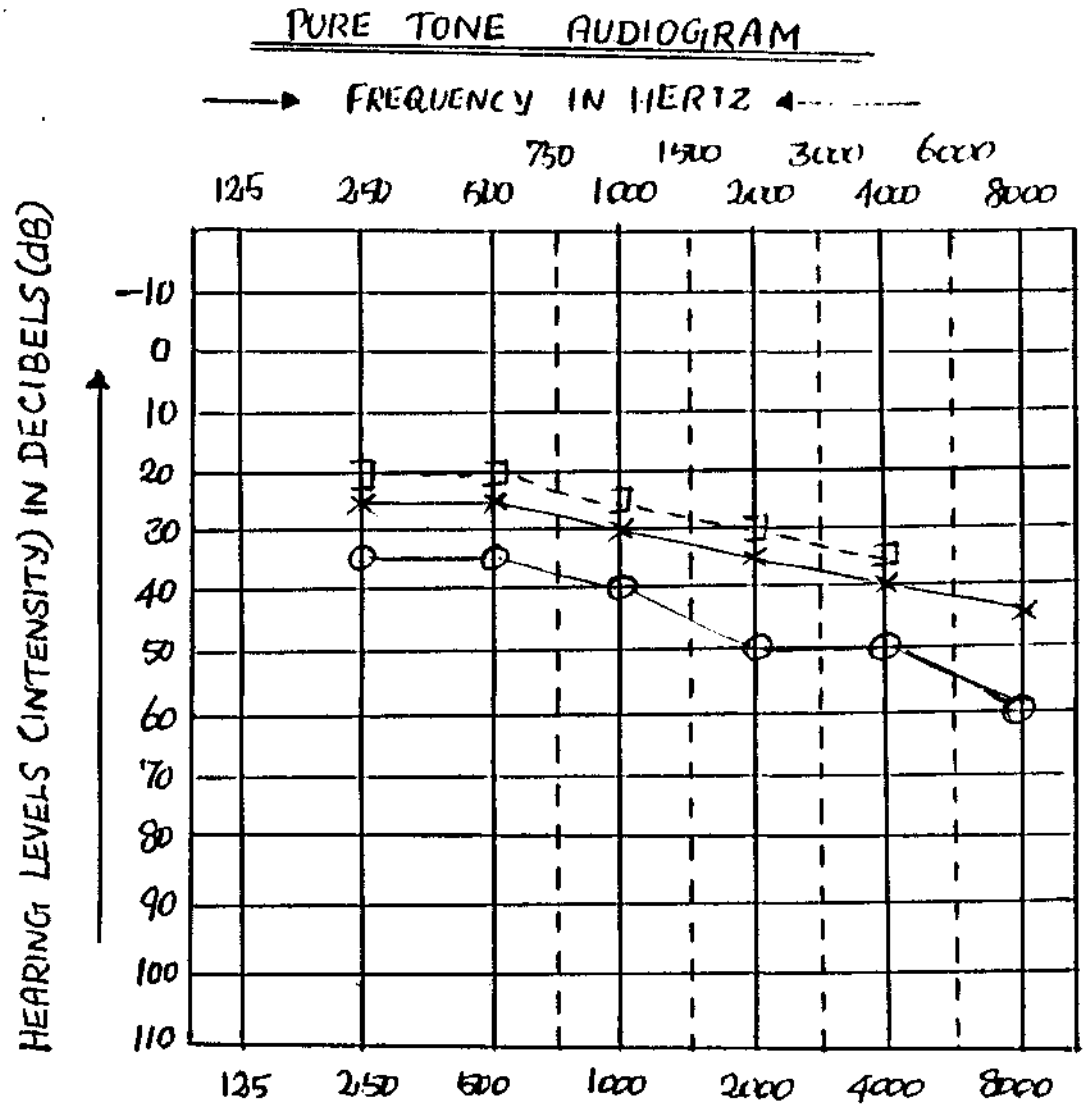
	Rt	Lt
PTA	10 dB	26.6 dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

15 a) What else should be done further? why?

b) What are the minimum and maximum masking level for BC?



	Rt	Lt
PTA	41.6dB	30dB
SRT		
PB Max		

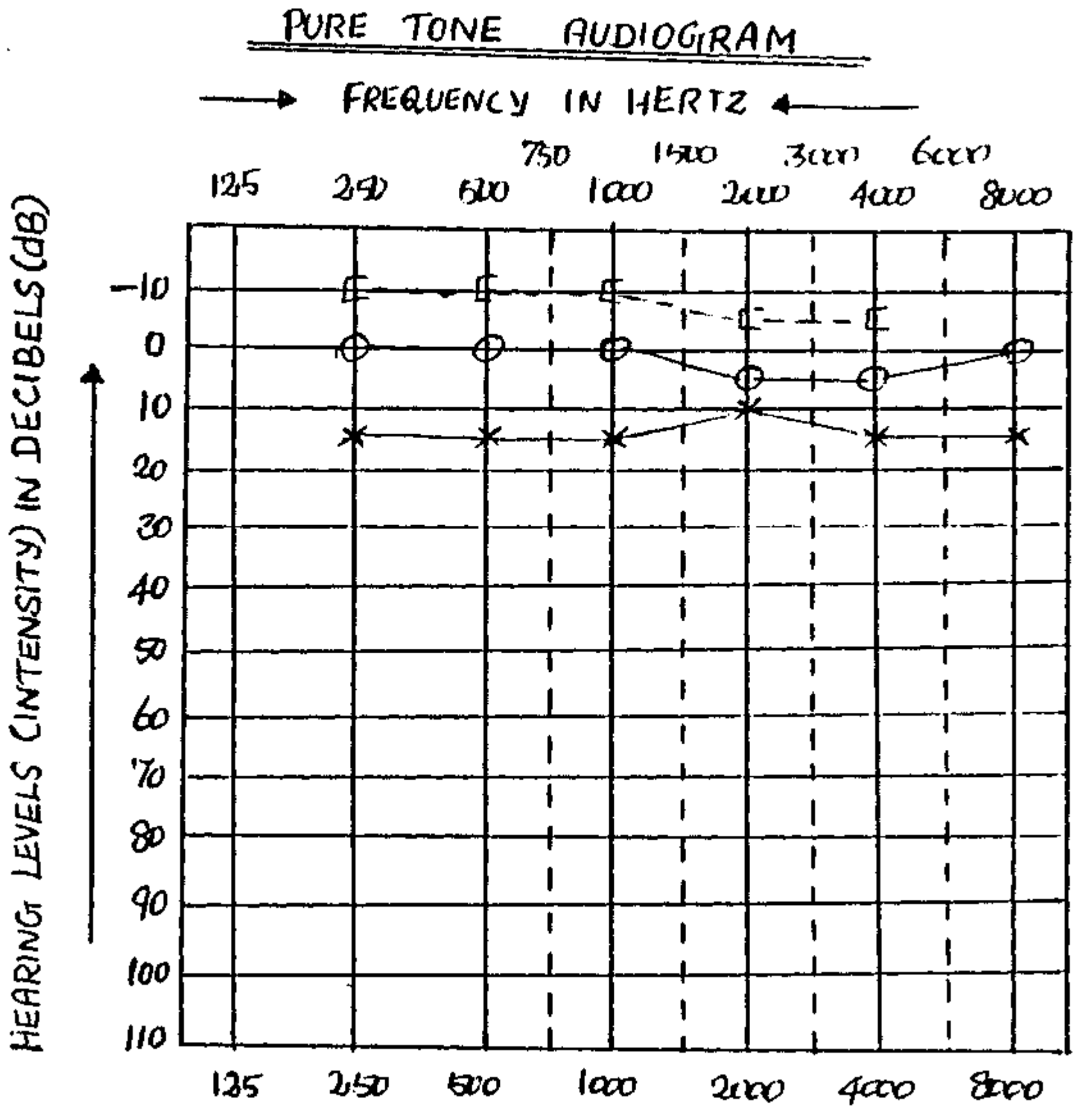
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	ㄱ	↙ㄱ

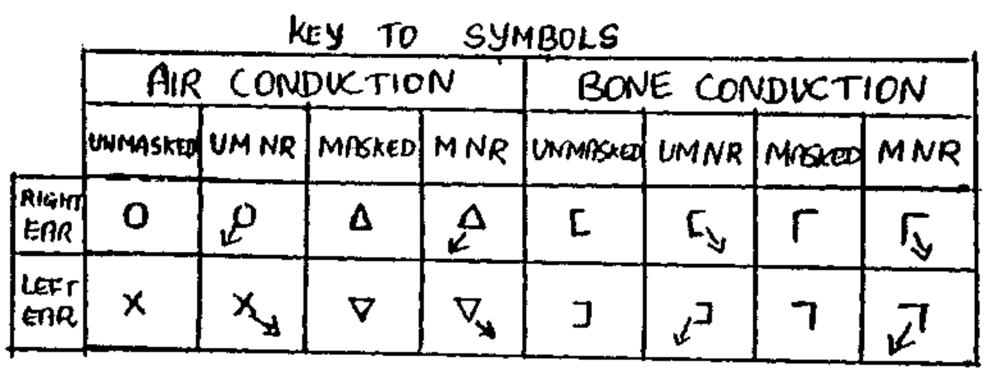
16 a) Is masking needed for bone conduction in both the ear? If not, why?

b) Compute minimum and maximum masking levels for BC and how much occlusion effect should be added for each frequency while calculating minimum masking levels?

c) Are there any masking problems?



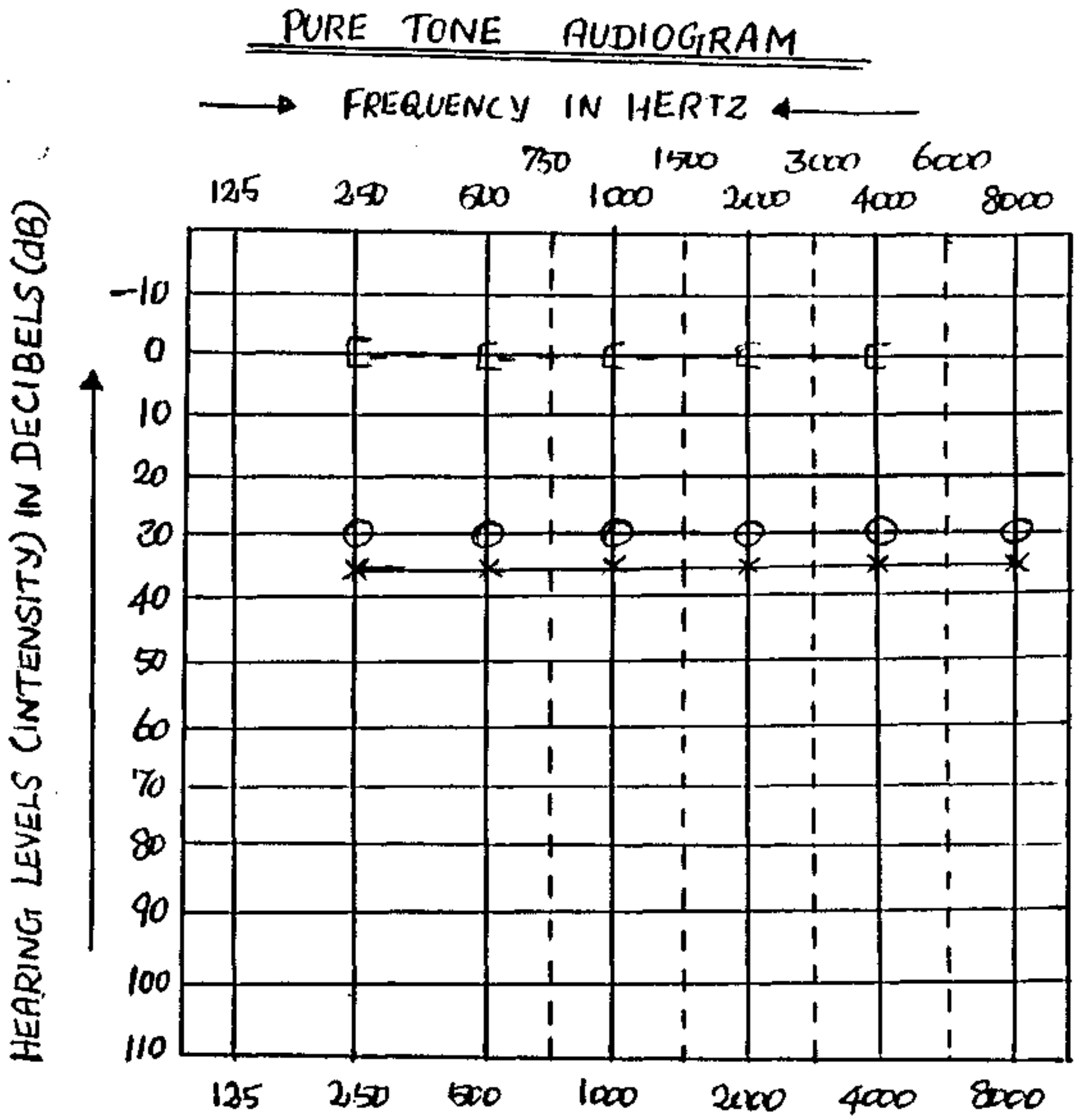
	Rt	Lt
PTA	1.6dB	13.3dB
SRT		
PB Max		



17 a) Which ear should be masked? Why"

b) What are the minimum and maximum masking levels?

c) What type and degree of hearing loss are you looking at in each ear?



	Rt	Lt
PTA	30dB	35dB
SRT		
PB Max		

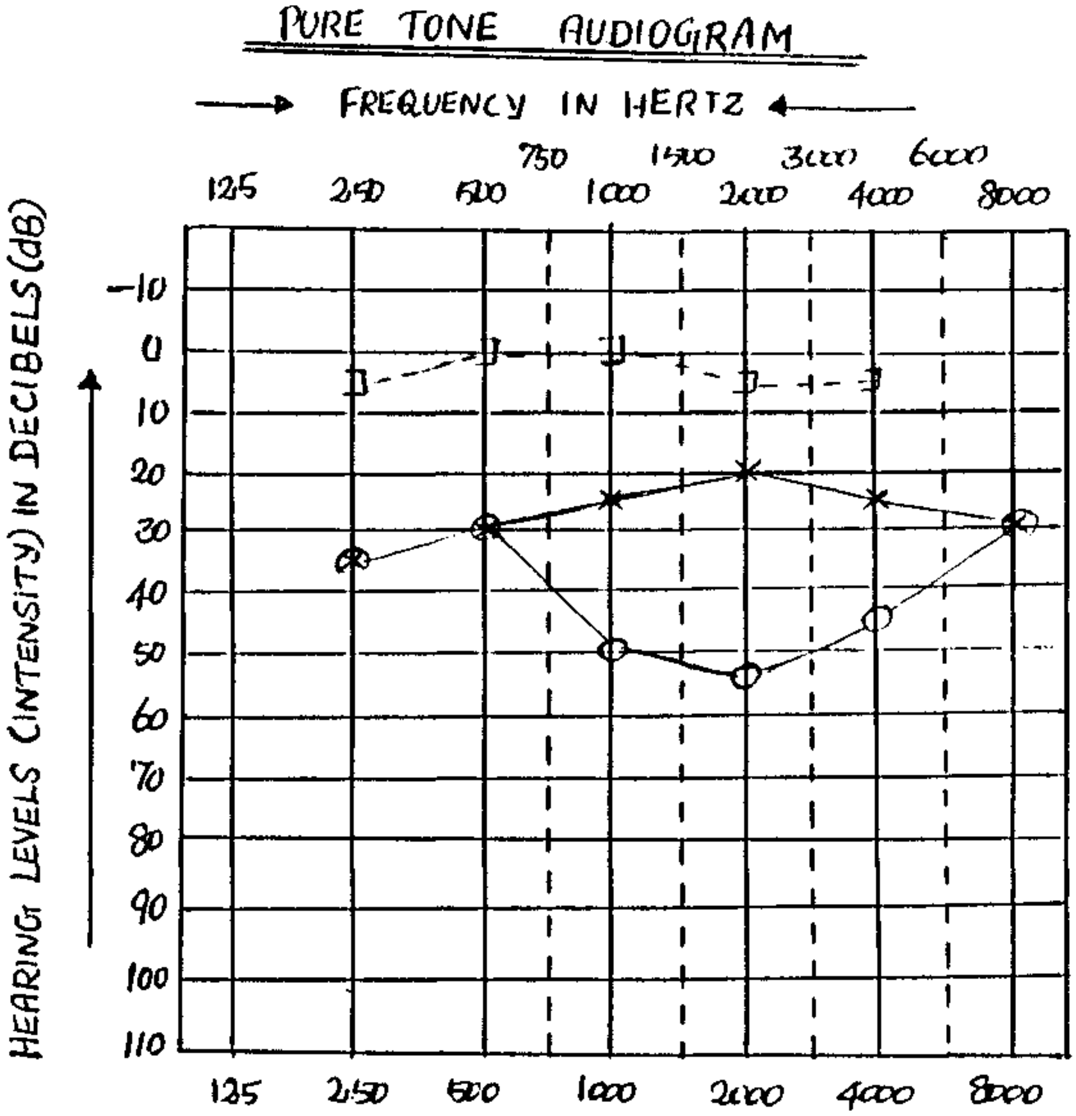
KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

18 a) Is masking needed for AC? Why?

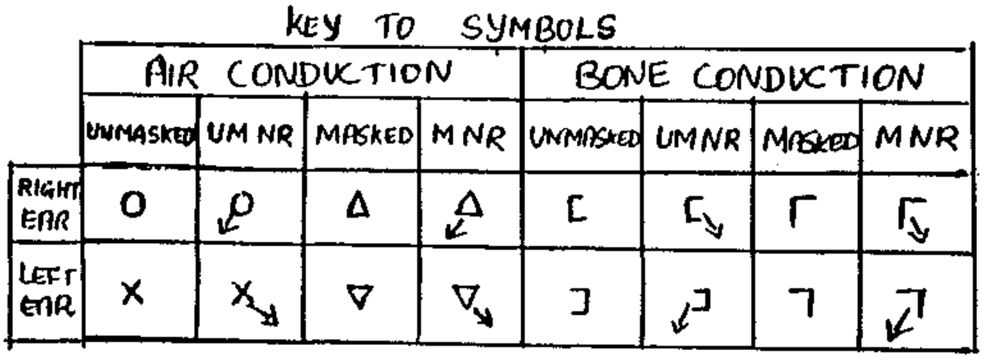
b) Why was it necessary to mask both ears for bone conduction?

c) What are the possible mis-interpretation can occur with only unmasked BC thresholds?



	Rt	Lt
PTA	45dB	25dB
SRT		
PB Max		

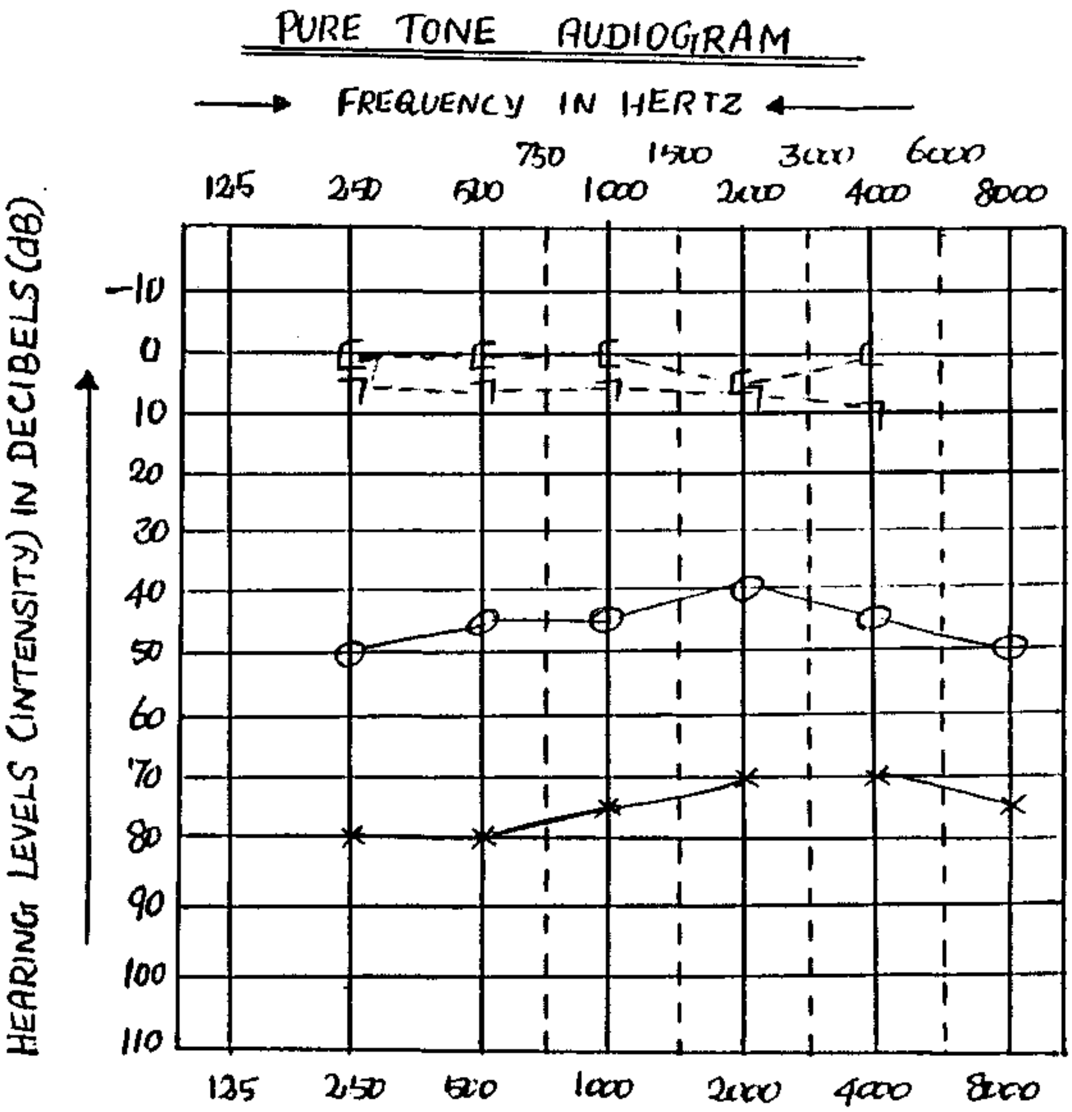
KEY TO SYMBOLS



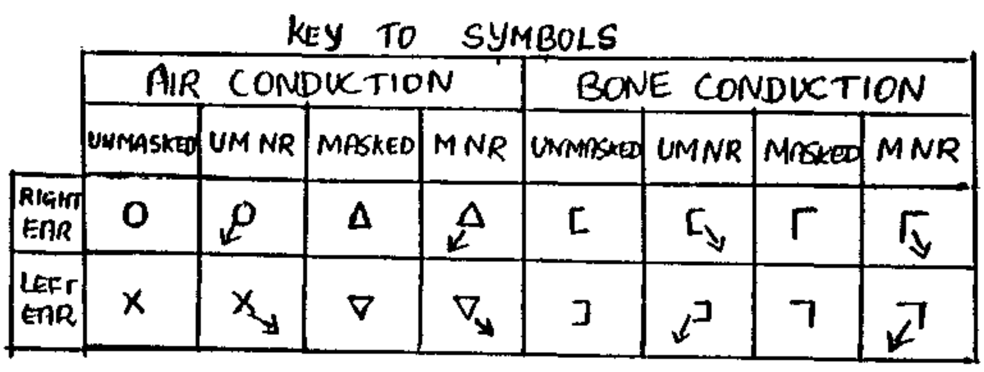
19 a) At which frequencies masking is needed for AC and what are the minimum and maximum masking levels?

b) Is BC masking needed for either ear? And what are the minimum and maximum masking levels?

c) Is there any need for insert receiver? If not, why? What is the use of insert receiver?

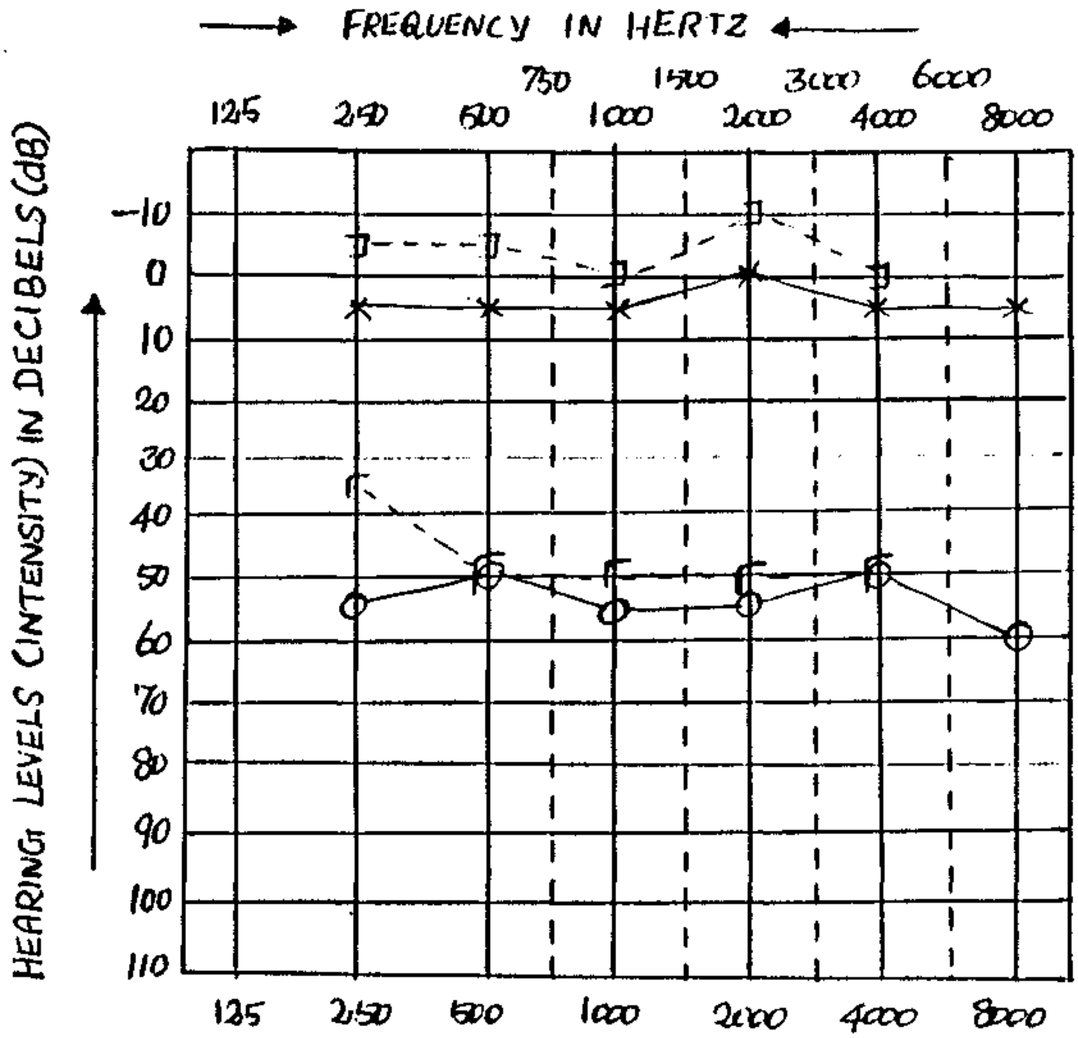


	Rt	Lt
PTA	43.3dB	75dB
SRT		
PB Max		



20, a) What should be done next?
b) What are the masking needed?
c) What else migh tbe necessary to cross check?

PURE TONE AUDIOGRAM



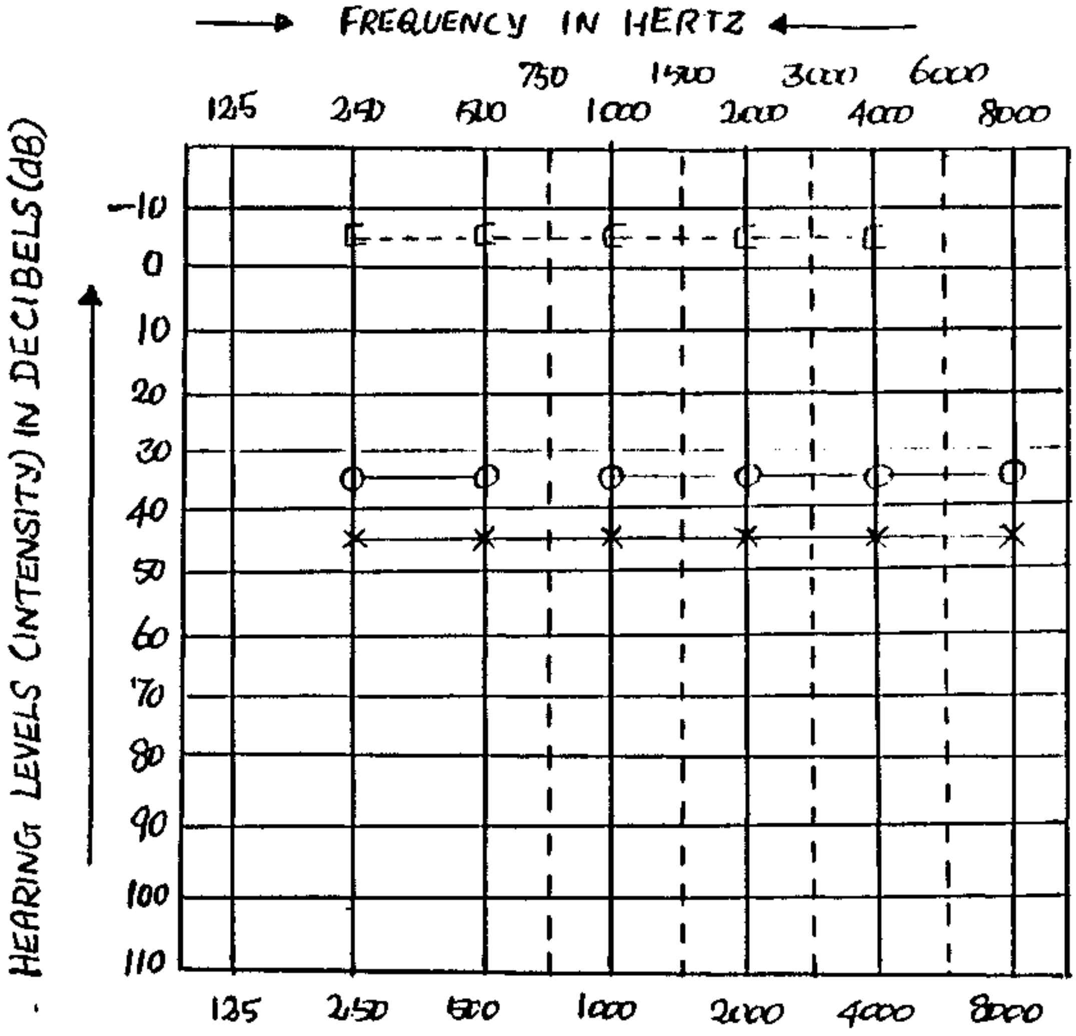
	Rt	Lt
PTA	53.3dB	3.3dB
SRT	55dB	10 dB
PB Max	95%	100%

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	Γ	Γ↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⅂	↙⅂

21 a) Why AC masking is needed?

PURE TONE AUDIOGRAM



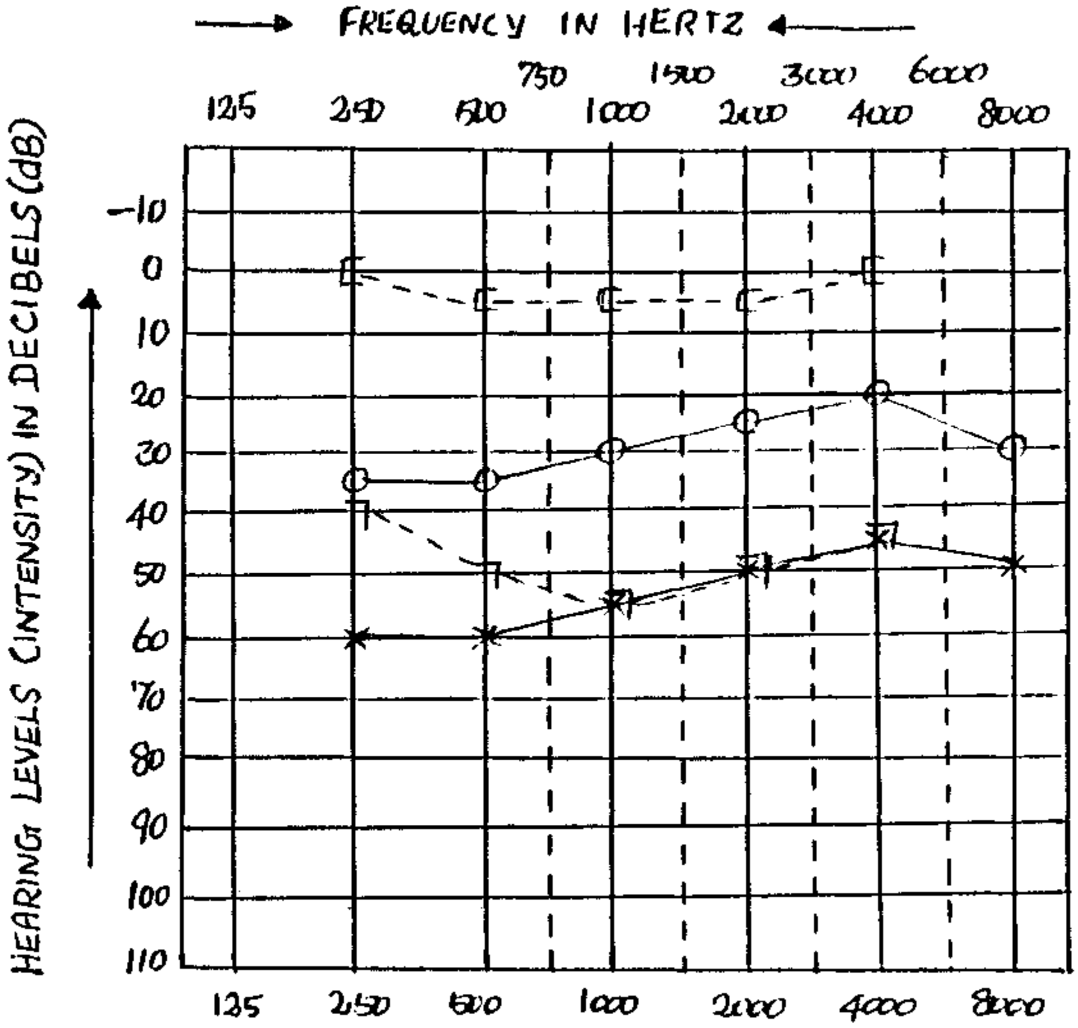
	Rt	Lt
PTA	35dB	45dB
SRT		
PB Max		

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

22 a) Is masking necessary for both AC and BC? Why?
b) Do we have any masking problems?

PURE TONE AUDIOGRAM



	Rt	Lt
PTA	30dB	55dB
SRT	30dB	*NR
PB Max	55dB	*NR

KEY TO SYMBOLS

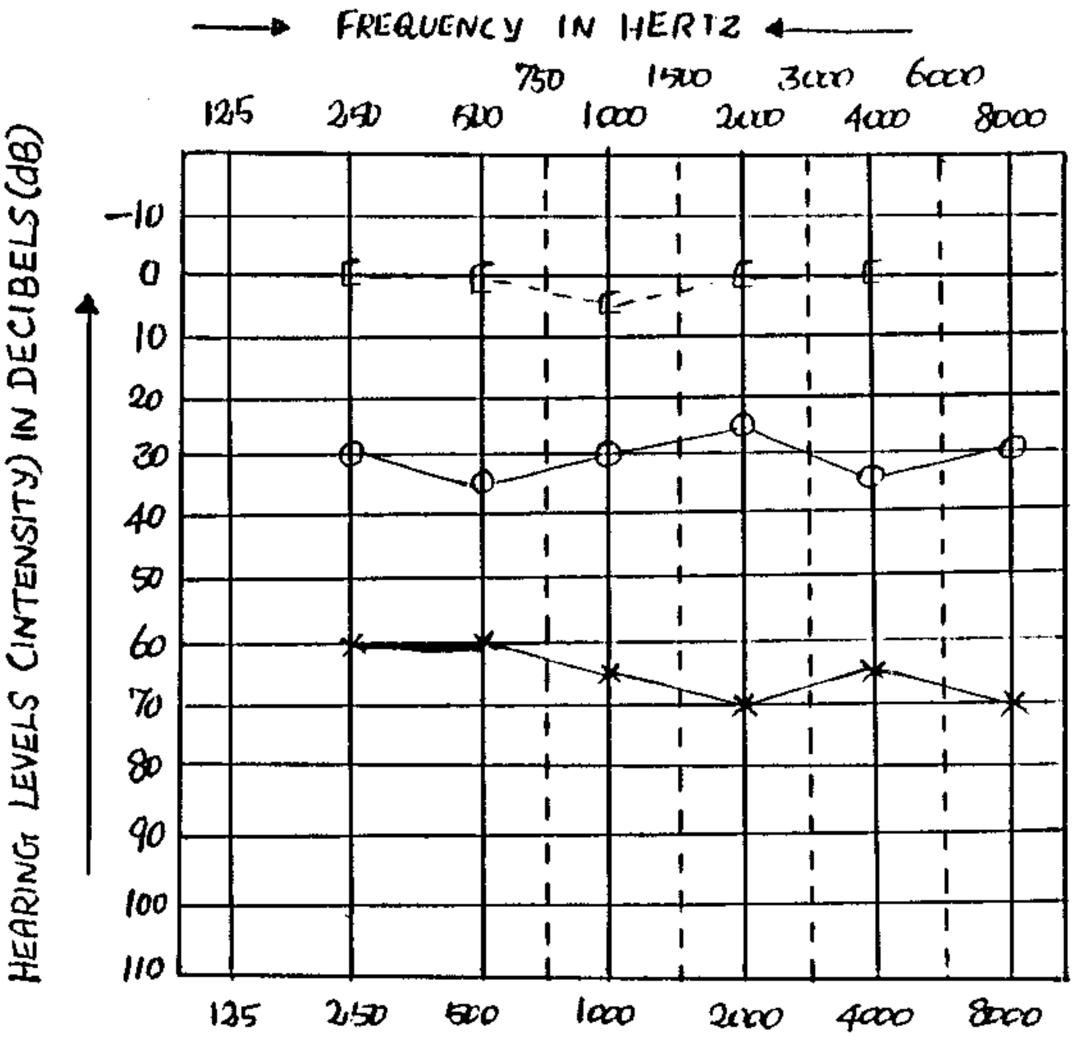
	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	↙O	Δ	↙Δ	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

* Masked

23 a) What else should be done?

b) What are the expected results? Why'

PURE TONE AUDIOGRAM



	Rt	Lt
PTA	30dB	65dB
SRT		
PB Max		

KEY TO SYMBOLS

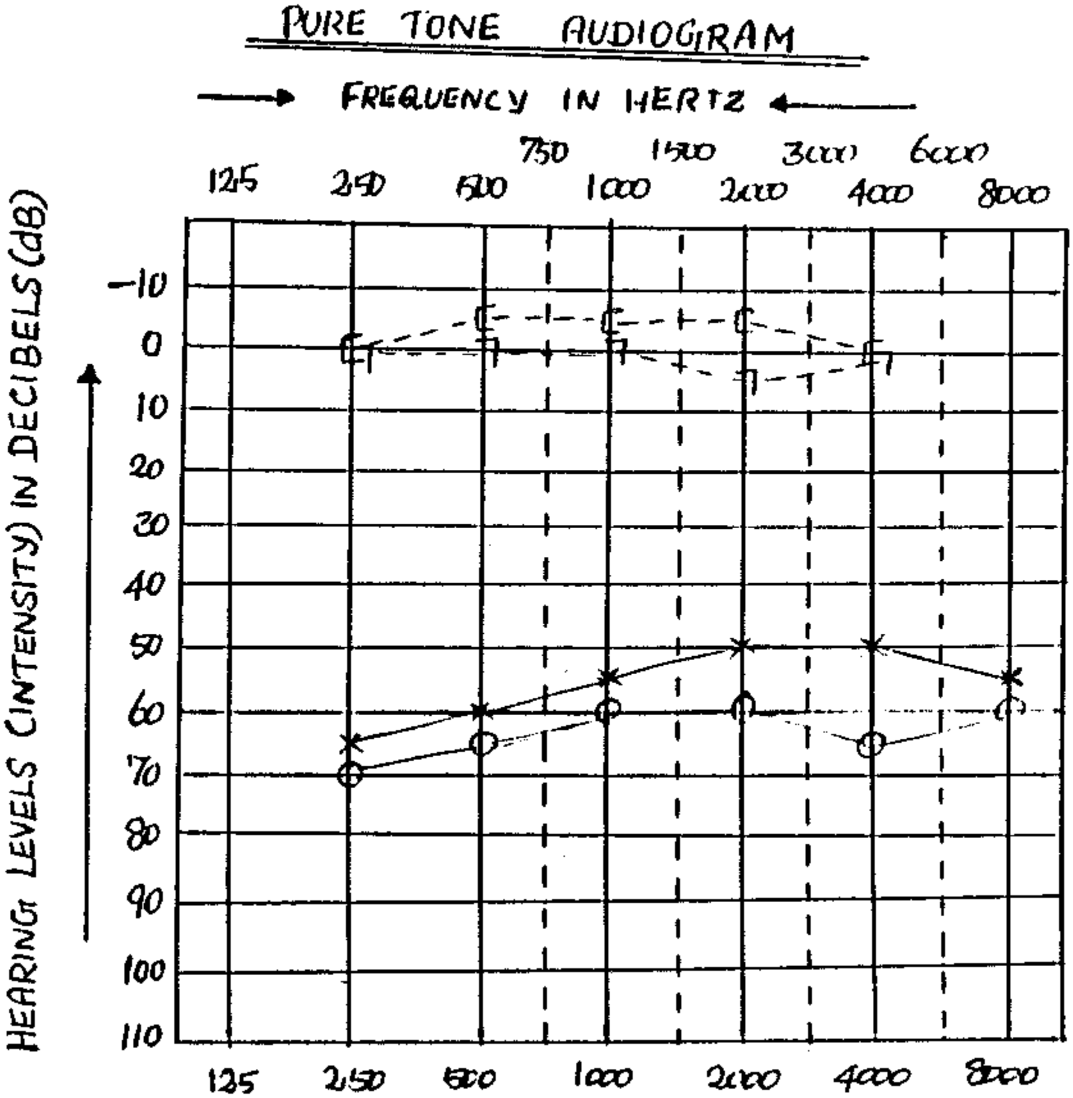
	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌈	⌈↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	⌉	↙⌉

24a) Which ear should be masked for AC? Why?

b) What are the minimum and maximum masking levels for BC and BC at each frequency?

c) Are there any masking problems with either AC or BC? If there, what kind of masking problems exist? How do you over come those problems?

d) Calculate the maximum masking levels for BC and BC while using insert receiver?



	Rt	Lt
PTA	61.6dB	65 dB
SRT	65dB	55dB
PB Max	100%	100%

KEY TO SYMBOLS

	AIR CONDUCTION				BONE CONDUCTION			
	UNMASKED	UM NR	MASKED	M NR	UNMASKED	UM NR	MASKED	M NR
RIGHT EAR	O	O↙	Δ	Δ↙	[	[↘	⌐	⌐↘
LEFT EAR	X	X↘	∇	∇↘	]	↙]	¬	↙¬

25.a) What else should be done? Why?

b) Is there any problem while doing AC masking? How to overcome that problem?

Answer

1 a) Masking for air conduction is not needed at any frequency in either ear?

b) Maksing is not needed for BC in either ear, because the air bone gap of both ears is not exceeding more than 10 dB.

c) Hearing sensitivity within normal limits in both the ears.

2a) In both ears maskingis not necessary. Because the criteria/rules of when to mask for both air and bone conduction are not fulfilled, so that masking is unnecessary.

b) Bilateral mild sloping sensorineural hearing loss?

3a) BC masking is needed for all the frequencies because air bone gaps of more than 10 dB exist,

b) Only the low frequencies (200 Hz and 500 Hz) should be masked because air bone gap exceeds 40 dB at 250 Hz and 500 Hz.

4a) Both BC masking and SRT masking are already done. To confirm the SRT masking, AC masking should be done and also AC masking is needed because

ACTE - BCNTE > 40 dB.

5a) All the masking are needed. We have to mask AC and BC because,

ACTE - BCNTE > 40 dB.

ACTE:- BCNTE. > 10 dB.

SRT and PB mx. are also needed because

PTL-BCNNTE>40dB.

b) In this case masking cannot be done, because minimum noise level for each frequency for different masking is equal or greater than the maximum audiometric limits.

6a) Audiogram indicates hearing sensitivity within normal limits in both the ears.

b) BC maskingis necessary because from the audiogram. It is clear cut that left ear AC theshold is slightly poorer than that of the right ear. And also some case with normal hearing might have a minimal conductive component. So rule out the presence of absence of conductive component, here there is a need for BC masking

7a) ACmaskingisnot necesary.

b) There is no need to mask BC because there is no response at 1 kHz, 2 kHz and 4 kHz. So the unmasked threshold of bone conduction which is obtained at the frequencies 250 Hz and 500 Hz could be a tactail response.

8a) Masking is needed for both AC and BC in the left ear.

b) Maximum masking fomula for both AC and BC.

	BC TE + 40 (IA) - 5						M max
250 Hz	40	+	40	-	5	=	75 dB HL
500Hz	50	+	40	-	5		85 dB HL
1000 Hz	65	+	40	-	5	=	lOOdBHL
2000 Hz	65	+	40	-	5	=	100 dB HL
4000 Hz	65	+	40	-	5	=	lOOdBHL

Minimum masking formula forAC

	AC TE	+	ABG NTE	-	IA (40)		M.min. for AC
250 Hz	90	+	20	-	40	=	70 dB HL
500Hz	95	+	15	-	40	=	70 dB HL
1000 Hz	105	+	10	-	40	=	75dBHL
2000 Hz	110	+	10	-	40	=	80 dB HL
4000 Hz	105	+	5	-	40	=	70 dB HL

Minimum masking formula for BC

	BC TE	+	ABG NTE	-	IA (0)		M.min. for BC
250 Hz	40	+	20	-	0	=	60 dB HL
500 Hz	50	+	15	-	0	=	65dBHL
1000 Hz	65	+	10	-	0+10(OE)=85 dBHL		
2000 Hz	65	+	10	-	0	=	75 dB HL
4000 Hz	65	+	5	-	0	=	70 dB HL

Note: Th eair bone gap betwen the non-test ear is 10 dB at 1 kHz. which indicates that need to add occlusion effect. OE for 1 kHz in 10 dB.

9 a) AC masking is needed for both ears at 250 Hz and for only at 500 Hz to the left ear because only at these frequencies air bone gap is more than 40dB.

	Minimum masking for AC		Minimum masking for BC	
	Rt	Lt	Rt	Lt
250 Hz	40	50	35	35
500 Hz		45		35

b) BC masking is needed for all frequencies and for only at 1000 Hz, 2000 Hz and 4000 Hz to the left ear, because at these frequencies the difference between AC threshold of both ears is less.

	Maxim		Minimum	
	Rt	Lt	Rt	Lt
250 Hz	35		40	
500 Hz	35		35	
1000 Hz	40	40	30	35
2000 Hz	40	40	35	35
4000 Hz	40	40	40	30

c) If the minimum masking equals or exceeds the maximum, the condition is called as Naunton's dilemma.

Here almost all the frequencies for both AC and BC minimum masking equals or exists the maximum which indicates the need to use insert receiver.

10 a)Both AC and BC should be administerd to the left ear because the ABGs are exceeding 40 dB at allf requencies

b) According to the formula

Mmax. for both AC and BC is 30 dB at all frequencies.

Mmin for AC and BC is 10 dB and 0 dB respectively at all frequencies.

11 a) Only BC maskingis needed for all the frequencies because air bone gaps of al the frequencies exceed 10 dB.

b) Bone Conduction

	Maximum	Minimum
250 Hz	25 dB HL	15dB HL
500 Hz	25	15
1000 Hz	30	15
2000 Hz	35	10
4000 Hz	35	5

12 a) Masking is not nceeded for AC because none of the air bone gaps are as great as 40dB.

b) Masking is needed for BC at all frequencies because all air bone gaps are exceeding 10 dB.

c) Occlusion effect should be added only at 500 Hz and 1000 Hz when left ear is being tested by bone conduction because the air bone gap of the non-test ear is less than 10 dB. For 500 Hz and 1 kHz, we should add 15 dB and 10 dB respectively with the minimum masking level.

13 a) AC masking is necessary only at 2 kHz and 4 kHz because air bone gap exceeds 40 dB at these frequencies,

b) Minimum masking levels for BC

250 Hz	25 dB HL
500 Hz	25
1000 Hz	15
2000 Hz	25
4000 Hz	5

14.a) BC masking and AC masking should be done because

ACTE -BCNTE> IOdB

ACTE: -BCNTE: > 40dB

b) While doing BC masking we have to use insert receiver because of the existence of Naunton's dilemma.

c) SRT masking.

15.a) BC masking should be done because air bone gap is more than 10dB.

	Bone conduction	
	Maximum	Minimum
250 Hz	30 dB HL	20dB HL
500 Hz	35	25
1000 Hz	30	20
2000 Hz	30	10
4000 Hz	35	10

16a) BC masking is needed only for the right ear. No air bone gaps exist in the left ear between AC and unmasked BC, therefore, we can assume that the unmasked BC thresholds represent the actual thresholds of the left ear (The BC cannot be significantly poorer than the AC). However, large air bone gaps exist between AC and unmasked BC in the right ear, there is no way to determine the actual BC thresholds of that ear without contrlateral masking.

b)

	Bone conduction		
	Maximum	Minimum	
250 Hz	55dBHL	40 dB HL	(25 + 15)
500 Hz	55	40	(25+15)
1000 Hz	60	40	(30+10)
2000 Hz	65	35	(35 + 0)
4000 Hz	70	40	(40 + 0)

c) We do not have masking problems at any frequency

17 a) Only the left ear should be masked because the air bone gaps are exceeding l0dB at all frequencies.

b)

		Bone conduction	
	Maximum	Minimum	
250 Hz	25 dB HL	15 dB HL	(0 +15)
500 Hz	25	15	(0+15)
1000 Hz	25	10	(0+ 10)
2000 Hz	30	5	(5 + 0)
4000 Hz	30	5	(5 + 0)

Note : Theair bone gap between the non-test ear is 10 dB at all the frequencies which indicates the need for occlusion effect.

c) Hearing level within normal limits in both the ear. However, an air bone gap of more than 10 dB exists in the left ear. Without masked BC threshold we cannot be sure whether the left ear has middle ear abnormlities despite the fact that thresholds are within normal limits.

18a) Masking for AC is not needed at any frequency in both the ears, because none of the air-bone gaps are as great as 40 dB.

b) Masked BC thresholds should be obtained to findout whether one or both ears had a conductive loss and which ear it might be. Because there is only 5 dB difference between both the ears in the AC thresholds, therefore the unmaksed BC threshold may represent left/right ear.

c) With only unmasked bone conduction the following situations are possible :

i) a conductive loss in the right ear and a pure SNHL in the left ear (if that is the case the unmasked bone conduction thresholds would represent the right ear),

ii) the reversed situation, with the unmasked bone conduction thresholds representing the left ear.

iii) a bilateral conductive hearing loss with unmasked BC thresholds similar in both ears (this is the actual situation depicted in the auduigram), and

iv) a pure conductive loss in one ear and a mixed loss in the other (in this situation, BC thresholds would be poorer in one ear but not as poor as AC)

Only with appropriate contralateral masking we can determine which of the above possibilities exists.

19. a) AC masking is needed for the right ear only at 1 kHz, 2 kHz and 4 kHz because only at these frequencies air bone gap is more than 40 dB.

	Air Conduction	
	Minimum	Maximum
1000 Hz	35	40
2000 Hz	30	45
4000 Hz	25	25

b) BC masking is needed for the right ear at all the frequencies and for only at 250 Hz and 500 Hz to the left ear, because AC thresholds are same for both the ears at these frequencies.

Bone Conduction

	Minimum		Maximum	
	Rt	Lt	Rt	Lt
250 Hz	35	35	45	45
500 Hz	30	30	40	40
lOOOHz	25		40	
2000 Hz	15		45	
4000 Hz	20		45	

c) There is no need touse insert receiver because minimum masking does not exceeding the maximum at all frequencies insert receiver is used to increase the amount of interaural attenuation to allow higher levels of masking noise to be used without risk of over masking. Whenver there are large air bone gaps there is an increased risk of over masking and insert receiver reduce this risk.

20 a) At this condition masking is not possible. Because air bone gap cannot be more than 60 dB. Here either masked BC is wrong or AC threshold of the left ear. So first we have to check the AC threshold of the left ear, if it remains the same then we have to check the masked BC threshold of the left ear.

b) Air conduction masking, SRT masking and PB Max masking should be done for all the frequencies.

c) Before doing all these, we should check whether noise is going through the transducer or not/whether tone and noise in calibration or not.

21 a) AC masking is needed because like the masked BC thresholds masked AC thresholds also can come down.

22,a) Masking is necessary for both air conduction and bone conduction because air bone gaps of 40 dB exist in both ears at all frequencies and also masked bone conduction thresholds should be obtained to findout whether one or both ears had a conductive loss.

b) We have masking problems when air and bone conduction are being tested with masking noise. Since minimum masking levels exceed maximum levels at all frequencies, appropriate masking is not posible unless an insert receiver is used to deliver the noise in both the ears.

23. a) AC masking should be done,

b) AC masking is expected to be NR at maximum levels because masked SRT is NR.

24.a) Only the left ear should be masked for AC. It is not necessary to test the right ear with contrlateral masking because the air bone gaps are not as great as 40 dB at any frequency. Thus we can assume that unmasked AC thresholds in the right ear are not influenced by participation of the left. It the left ear, on the other hand, all the air bone gaps exceeding 40 dB which indicates the need for masking.

	Air conduction		Bone conduction	
Frequency	Maximum	Minimum	Maximum	Minimum
250Hz	35 dB HL	50 dB HL	35 dB HL	30 dB HL
500 Hz	35	50	35	35
1000 Hz	40	50	40	30
2000 Hz	35	55	35	25
4000 Hz	35	60	35	35

c) Masking problems exist during AC as welas BC testing, since minimum masking exceeds maximum masking at all frequencies in AC and minimum masking equals maximum masking only at 500 Hz and 400 Hz in BC, appropriate masking is not possible, unless an insert reciever is used.

d)

	Air conduction Maximum	Bone conduction Maximum
250 Hz	65 dB HL	
500 Hz	65	65 dB HL
1000 Hz	70	
2000 Hz	65	
4000 Hz	65	65

25. a) In the case air bone gap is more man 60 dB which is not possible.

So we have to recheck unmasked

BC thresholds of the left ear and

AC thresholds of both the ears

b) Here, for AC masking almost minimum masking level exceeds the maximum. To obtain true AC thresholds of the left ear we can use fusion inferred test (FIT) for both AC and SRT masking.

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