VIDEO QUIZ ON CALIBRATION OF AUDIOMETERS

REG. NO. M-9515

AN INDEPENDENT PROJECT SUBMITTED IN PART
FULFILLMENT FOR THE FIRST YEAR MASTER'S DEGREE
IN SPEED AND HEARING TO THE UNIVERSITY OF MYSORE

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE-570 006
INDIA

1996

DEDICATED TO

MY DEAREST DAD AND MUM

MY DEARY CHINKU

MY LOVING $(AMMUMMA)^2$ AND $(APPUPPAN)^2$

AND MY BELOVED BIJU

DECLARATION

I *hereby declare that this Independent Project entitled* ***"VIDEO QUIZ*** **ON CALIBRATION OF AUDIOMETERS" is** *the result of my* own *study undertaken* under *the* guidance Of Dr. *[MISS]* S. **Nikam, Director.** *All India Institute of* Speech *Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.*

Mysore

May:96 **Reg.**No. **M-9515**

CERTIFICATE

*This is to certify that this lndependent Project entitled "**VIDEO QUIZ ON CALIBRATION OF AUDIOMETERS" has** been prepared under my supervision and guidance.*

Mysore

May'96

Dr. (Miss) S. NIKAM
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CERTIFICATE

This is to certify that this lndependent Project entitled ***"V1DE0 QUIZ*** **ON CALIBRATION OF AUPIOMETERS"** is *the.* bonafide wor*k, done in part fulfillment for the First Year* of *the Master's Degree in Speech and* Hearing *of the student with Registration No.* M-9575.

Mysore

May'96

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Place: Mysore

Date : REG.NO. M-9515

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INTRODUCTION

An audiologist mainly deals with the evaluation of hearing and rehabilitation of hearing disordered person. In clinical work, to arrive at a diagnosis he may use two types of testing methods - subjective and objective. Objective testing methods play very significant role in audiology. Measurements made by objective method has significant advantage over other methods. An instrument is that by means of which we can quantify and measure a particular kind of data. There are a vast range of instruments in the field of audiological sciences. With the help of new instruments, the field of audiology is marching towards the path of progress, by laps and bounds.

While today's instruments are often much more complex, more accurate and more reliable than the devices of the past, they are nonetheless easier to use. But electronic equipments may loose their precision and accuracy over time. It is only when the equipment gives precise and accurate information that the results of the measurements can be reported with confidence. Periodic calibration of the equipment is necessary even though there is no obvious damage. When the instrument is used for a long period of time exposure to heat, dust, humidity, etc. A shock hazard can adversely affect the functioning of the equipment. Periodic check on the calibration ensure that the instrument is functioning as desired.

Use of calibrated equipment is a pre-requisite for an accurate audiological evaluation failure to calibrate the instruments at approximate intervals may be a major cause of unreliable test results. Calibration of the equipment though an extremely important issue is often the most neglected one in India. There are many clinics in India where equipment bought several years ago may not be calibrated even once. Most organizations don't have facilities of their own and depend on supplies or other organization for this purpose. But even when calibration of the audiometer is reported on, often there is little awareness about the standard norms to which the equipment is calibrated.

"Regardless of whether the audiometer is new or has been in use for sometime, it is the responsibility of the user to check its calibration, personally at least to arrange for the regular calibration of equipment by outside sources".

- Wilber (1985)

Life is a quiz - solve it

The proverb sounds rather difficult even for those among you, who have immense experience and age on your side, for there is no one answer to the riddles of life. But here I bring to you a very simple quiz program on "Calibration of Audiometer".

This project is an attempt to give a concrete body to the vagueness, confusion and queries arising regarding calibration settings and procedures and it also aims to enrich the readers' knowledge in the same.

It also serves efficiently for those who have the task of setting, asking and answering questions.

This project is intended to be a self test designed for the audiologist who seek detailed information about the calibration of audiometers. It is hoped that it will inculcate in the reader a new sense of confidence, clarity and competence.

It is also expected to serve as a basic test for all those who have been recently introduced to sophisticated instrumentations in audiology. It aims to build a strong foundation for the beginner so as to help him to steadily gain more knowledge in calibration.

The main purpose of preparation of this video film on audiometric calibration is to make it accessible even for professionals unable to afford the equipment necessary for learning or teaching about calibration.

It would also come in handy as a tutorial on audiometric calibration which may be utilized as resource material for short/long term teaching programmes for professionals in speech and hearing, allied professionals and also graduates or post-graduate students.

METHODOLOGY

This project aims at conducting a quiz on calibration of audiometers.

The methodology of the present study is described under the following headings:

1. SUBJECTS
2. SELECTION OF QUESTIONS AND ROUNDS
3. INSTRUMENTS
4. QUESTIONS
5. SCORING

1. SUBJECTS

Four graduates and four post-graduate of speech and hearing field were selected as participants for the quiz programme.

The participants were divided into four team - two members in each team being randomly selected by lots.

2. SELECTION OF QUESTIONS AND ROUNDS

The questions for the quiz were prepared from literature (references are listed at the end of the project).

Questions were classified into five rounds

A. Identification of instruments: visual round

B. Connection of instruments: Visual round

C. Scramble or word maze puzzles: Visual round

D. Wrong connections: Visual round

E. Rapid fire

i. Fill ups

ii. True or false

iii. Simple questions

A. Identification of instruments

Here the instruments were displayed on the monitor and the respective team was to identify and name the instrument.

B. Connection of instruments

Here, in this round, different instruments were connected as in calibration of audiometers. The visuals of these were shown on the monitor and the participants were asked to identify the procedure underway and to interpret it.

C. Scramble puzzles

This set of questions were simple scramble puzzles on parameters, stimulus, instruments and standards used in the calibration of audiometers which were displayed usually on the monitor. The answers are in up, down, across right to left and left to right direction.

D. Wrong connections

In this particular round, various settings of the instruments for the calibration of audiometers were shown on the monitor and the participants were expected to identify the accuracy of the connections.

E. Rapid fire round

In this round there were three sets of questions:

1. Fillups
2. True/false
3. Simple questions

The questions were asked by the quiz master and the teams which had the correct answers were expected to depress the buzzer as fast as they could so that the teams which depressed the buzzer first was given the opportunity to answer the question.

3. INSTRUMENTS

Instruments need for the programme were as follows:

1. Artificial ear
2. Artificial mastoid
3. Audiometer with accessories
4. Microphone (1/2" and 1")
5. Pistonphone
6. Frequency counter
7. Sound level meter
8. Spring balance

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4. QUESTIONS

Round-I

Q: Identify the picture on the monitor

1st visual: a. Frequency counter model DFC-1

Q: Identify the picture on the monitor

2nd visual: b. Piston phone B & K type 4220

Q: Identify the picture on the monitor

3rd visual: c. 1/2 inch microphone type 4155

Q: Identify the picture on the monitor

4th visual: d. Artificial ear B & K type 4152

Round-II

Q: Identify the procedure and interpret it

1st visual: a. Picture showing the pistonphone in 'on' position and then putting it on 'battery' position

Interpretation: Checking the battery of the pistonphone

2nd visual: b. Picture showing the SLM in 'battery' position with the needle in white position.

Interpretation:The battery voltage is alright

3rd visual: c. Picture of artificial mastoid with the spring balance

Interpretation: Adjusting the tension on the bone vibrator

4th visual: d. Picture of pistonphone on SLM in 'on' position with the meter reading of 124 dB.

Interpretation: SLM calibration

Round-III

Scamble puzzle

(i)

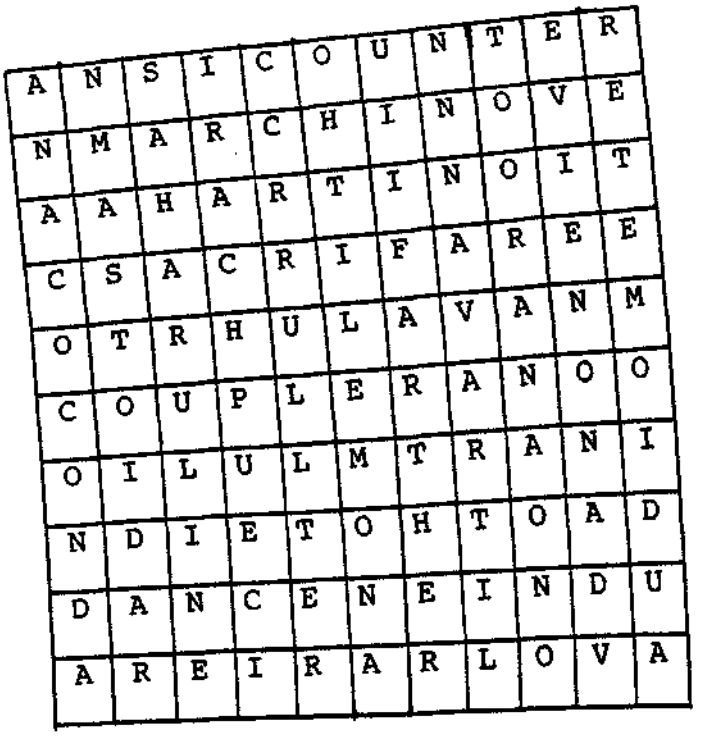
A	W	A	Z	A	N	T	E	L	E	C
S	A	N	G	A	W	A	L	L	0	0
P	T	A	0	K	A	A	R	R	I	M
E	E	R	N	A	R	H	E	A	T	M
R	R	K	G	S	B	C	V	I	B	S
G	A	L	A	M	L	E	F	T	G	I
I	W	A	T	C	E	E	S	I	L	M
S	A	N	0	P	0	P	P	0	S	I
T	E	E	N	0	I	S	E	S	T	N
E	A	T	E	N	A	I	A	N	A	I

Clue: Stimulus

Ans. (i)

A	W	A	Z	A	N	T	E	L	E	C
S	A	N	G	A	W	A	L	L	0	0
P	T	A	0	K	A	A	R	R	I	M
E	E	R	N	A	R	H	E	A	T	M
R	R	K	G	S	B	C	V	I	B	S
G	A	L	A	M	L	E	F	T	G	I
I	W	A	T	C	E	E	S	I	L	M
S	A	N	O	P	0	P	P	0	S	I
T	E	E	N	O	I	S	E	S	T	N
E	A	T	E	N	A	I	A	N	A	I

(ii)



Clue: Instruments

Ans. (ii)

A	N	S	I	C	0	U	N	T	E	K
N	N	A	R	C	H	I	N	0	V	E
A	A	H	A	R	T	I	N	0	I	T
C	S	A	C	R	I	F	A	R	E	E
0	T	R	H	U	L	A	V	A	N	M
C	0	U	P	L	E	R	A	N	0	0
0	I	L	U	L	M	T	R	A	N	I
N	D	I	E	T	0	H	T	0	A	D
U	A	N	C	E	N	E	I	N	D	0
A	R	E	1	R	A	R	L	0	V	A

(iii)

S	A	A	L	T	I	M	I	D	E	N
A	F	R	E	Q	U	E	N	C	Y	I
N	R	E	A	U	R	W	T	A	A	S
I	A	W	R	A	0	A	E	R	R	E
A	T	I	S	L	P	R	N	T	R	C
N	0	I	T	R	0	T	S	I	D	E
I	0	L	A	G	E	R	I	C	A	L
L	I	N	E	A	R	I	T	Y	A	L
E	N	0	P	I	A	T	Y	T	R	D
E	E	M	N	A	M	E	S	E	T	0

Clue: Parameters

Ans. (iii)

S	A	A	L	T	I	M	I	D	E	N
A	F	R	E	Q	U	E	N	C	Y	I
N	R	E	A	U	R	W	T	A	A	S
I	A	W	R	A	0	A	E	R	R	E
A	T	I	S	L	P	R	N	T	R	C
N	0	I	T	R	O	T	S	I	D	E
I	0	L	A	G	E	R	I	C	A	L
L	I	N	E	A	R	I	T	Y	A	L
E	N	0	P	I	A	T	Y	T	R	D
E	E	M	N	A	M	E	S	E	T	0

(iv)

0	S	N	A	6	9	7	9	A	N	T
S	8	0	S	0	L	0	V	I	S	N
L	6	E	I	A	N	6	S	S	I	S
0	9	1	S	N	0	9	I	0	L	N
9	1	9	5	S	A	I	S	1	0	A
5	I	A	T	I	E	C	1	9	7	0
0	S	E	S	1	9	7	5	7	6	9
1	I	N	1	9	9	6	A	5	0	S
A	I	E	T	8	1	S	9	C	0	E
W	9	9	9	1	9	2	0	E	0	C

Clue: Standards

Ans. (iv)

0	S	N	A	6	9	7	9	A	N	T
S	8	0	S	0	L	O	V	I	S	N
L	6	E	I	A	N	6	S	S	I	S
0	9	1	S	N	0	9	I	O	L	N
9	1	9	5	S	A	I	S	1	0	A
5	I	A	T	I	E	C	1	9	7	0
0	S	E	S	1	9	7	5	7	6	9
1	I	N	1	9	9	6	A	5	0	S
A	I	E	T	8	1	S	9	C	0	E
W	9	9	9	1	9	2	0	E	0	C

Round-IV

Wrong connections

Q: Settings of the instruments for the calibration of audiometers is being shown here. You have to identify whether the settings are correct, if not give the correct answers.

First visual: a. Frequency weighting network dial is pointing to 'linear' position of SLM for pure tone calibration.

Ans: Wrong

Correct answer: Frequency weighting network dial should be pointing on 'external filter'

Second visual: b. Artificial ear being connected to SLM for air conduction calibration

Ans: Wrong

Correct answer: Artificial ear should be connected to condensor mic and then to SLM

Third visual: c. While checking the tension on the bone vibrator the spring balance reads 700 gms

Ans: Wrong

Correct answer: Spring balance reading should be 500 gms

Fourth visual: d. For the speaker calibration, SLM, being connected to pressure mic is kept at 1 inch distance from the speaker.

Ans: Wrong

Correct answer: The pressure mic should be kept at a distance of 1 meter from the speaker.

Round-V

Rapid fire questions

I. Fill in the blanks with appropriate answers

a. Listening checks should be done _____

Ans: daily

b. Response curve of 'A' network is equivalent to _____

Ans: response of the human ear

c. For steady speech calibration the VU meter should be reading_____

Ans: zero

d. For the calibration of pistonphone_____is used

Ans: Barometer

ii. True or False

Q. If the battery of SLM is in working condition, the needle should rest in red position (True/False)

Ans: False

Q. In calibration of SLM the frequency network of SLM should be on 'A' position (True/False)

Ans: False

Q. If the observed value is less than the expected value, the correction factor should be negative (True/False)

Ans: True

Q. Pressure microphone is necessary for BC calibration (True/False)

Ans: False

iii. Short answers

Q. What is the frequency that a pistonphone (B & K) generates and at what intensity ?

Ans: 250 Hz and 124 dB

Q. For calibrating the output SPL, the attenuator of the audiometer should be at what intensity level according to ANSI standards ?

Ans: 70 dB HL

Q. What is the angle of SLM microphone for free field calibration ?

Ans: 0° Azimuth and 45° Azimuth

Q. Which microphone is used for the calibration of loudspeakers ?

Ans: Free field microphone

5. SCORING

Visuals were displayed on the monitor for 20 seconds and each team was expected to answer within this duration. If the respective teams answered correctly they got 10 points. But if they did not get the correct answer then the question passed on to the next team. The next team (second) was given 15 seconds to answer. If they answered correctly they scored 5 points only. If they got their answers wrong, then the question was not passed on to the third team.

The team scored zero for the wrong answer. This rule of passing the questions to the next team held good only for Round I, II and IV.

For Round III, scramble puzzles, the puzzles were not passed to the next team. Each team was given a clue for this puzzle. Each puzzle had four words in the scramble/maze. The respective teams were given one minute time to work it out. If they gave all the words correctly (4) they scored 10 points. But if they traced 1 word or 2 words or 3 words, i.e. less than four words they did not score any points in this round.

In the last round, Vth round, rapid fire questions, each team was given equal chance of answering the questions. The team which depressed the buzzer first was given the opportunity to answer. If they answered wrong, then lost 5 points. The questions did not pass on to the next team.

APPENDIX

By keeping the audiometer calibrated, the audiologist can report his finding with great confidence. He can ascertain that the instrument meets the national/ international standards or norms. He can also establish reference values for his own equipment to detect any change that may arise over time.

How frequently should the audiometer be calibrated ?

Asha (1978) recommended the following schedule for the calibration of audiometer.

- A daily listening check to detect any gross deviation.

A monthly detailed timely check to induce examination of cross talk in earphone, signal distortion and abnormal noise.

- A quarterly electro-acoustic calibration of solid state (transistorized) audiometers. This include the measurement of output SPL of pure tone masking noise and speech signals in both earphone and in sound fields.

The measurement should be carried out once in a month in the case of non-solid state instruments.

Often, the listening checks are called subjective calibration or biological calibration procedures, while the electroacoustic measurements, are referred to as 'Objective Calibration Procedures'.

For biological calibration: Select normal hearing person with no middle ear pathology. The audiometer is set up just as it would be for regular BC testing. The Bone vibrators attached to the individual with known hearing and the intensity at threshold as a function of frequency is noted.

Electro-acoustic calibration

i. Calibration of audiometer output intensity via air conduction

Purpose

To measure the output SPL of an audiometer at various frequencies and to check the attenuator linearity via the ear phone:

Equipment necessary:

1. Audiometer to be calibrated
2. Artificial ear (B & K 4152)
3. Condenser microphone (eg. B & K 4144)
4. Sound level meter (eg. B & K 2209)
5. Microphone adaptor (eg. B & K D B 0962) whenever necessary
6. Pistonphone (eg. B & K 4220) or sound level calibrator (4230)
7. Octave filter set (eg. B & K 1613)

Procedure

Phase I : Calibration of sound level meter using pistonphone

Phase II : Mounting of microphone and the earphone on the artificial ear

Phase III: Measurement of output sound pressure level

Phase IV : Preparation of correction chart

Phase V : Linearity check

Phase I: Calibration of sound level meter (SLM) using pistonphone (PP)

Procedure

a. Screw on the microphone to the **SLM**

b. Check the pistonphone by switching it 'on' and then shifting it to the 'batt' position. A change in the pitch of the sound indicate that the pistonphone is in calibration. If the pitch doesn't change, replace the pistonphone batteries and check again. If the defect persists, check the calibration of the pistonphone, as described in the manual and then use it.

c. Check the batteries in the SLM by turning the switch of batt. If the needle doesn't rest in white position of the battery indicating scale, change the battery.

d. Set the weighting network to 'C and set the meter switch to 'fast' response.

e. Set the attenuator of second level meter to 120 dB.

f. Place the pistonphone over on the microphone which is screwed onto the SLM.

g. Turn the SLM on 'on' position.

h. The SLM should now read 124 dB. If not adjust the 'gain adjust[1]. Screw till the reading corresponds to 124 dB at 250 Hz.

i. Turn off the pistonphone and the SLM.

J. Remove the microphone.

Phase II: Mounting the microphone and the earphone on the artificial ear

a. Unscrew the coupler from the artificial ear.

»

b. Unscrew the protection grid from microphone. Without touching the diaphragm fit the microphone into the socket inside the artificial ear.

c. Place the coupler on the artificial ear.

d. Remove the earphone to be calibrated from its headband clamp. Place it on the coupler so that the earphone perforations face the coupler cavity.

e. Unscrew the adjustable clamp on the artificial ear slightly and adjust the weight on the earphone to 0.5 kg or as per the specifications provided by the manufacturer.

f. Connect the artificial ear and the octave filter set to the SLM.

Phase 3: Measurement of output SPL

a. Switch on the audiometer.

b. Set the attenuator to 60 dB or 70 dB depending upon the specifications provided by the manufacturer.

c. Set the output selector to 'right[1] or 'left' depending upon the earphone placed on the artificial ear.

d. The octave filter set is connected to SLM. Set it to the required frequency, i.e. the same frequency as that selected on the audiometer.

e. Switch on the SLM and set it to 'slow' response and to 'external filter'.

f. Adjust the tone switch on the audiometer so that the signal is continuously on.

g. Set the attenuator on the SLM to 60 or 70 dB. If the needle deflects to either extreme; vary the attenuator setting suitably so that the needle deflects to the centre of the meter.

h. Note down the combined reading from the attenuator and the meter.

i. Repeat this procedure for each of the test frequencies. Remember to vary the frequency setting on the octave filter set.

j. Repeat the entire procedure with the other earphone.

Phase IV: Preparing the correction factor chart

a. Compute the expected SPL by adding the values given in Appendix 1.

b. The difference should not exceed + 3 dB at frequencies from 250 to 4000 Hz, 5 dB at 6000 and 8000 Hz.

When the observed value is more than the expected value, the correction has a positive sign. Whenever it is lesser than a standard value, assign a negative sign. When the difference is,very large, it is ideal to carry out an internal calibration so that the agreement between the observed and expected value is within the permissible range.

c. Write the correction chart as follows and fix it beside the audiometer.

Frequency Right Left Bone

Phase V: Linearity check

The procedure involved here is basically similar to that noted in phase 3. However, linearity need not be checked at all frequency. It may be done at one frequency.

a. Follow the steps (a) to (f) in phase 3 except in step (b) where the intensity dial should be set at maximum level, frequency dial should be set at 1000 Hz.

b. Set the attenuator on the SLM at a level that corresponds to the maximum level on the audiometer.

c. Decrease the attenuator setting on the audiometer in 5 dB steps and note down the corresponding reading on the SLM.

d. Repeat (c) till the audiometer reads 30 or 40 dB HL. Record the level on the SLM. If with every decrease in the dial reading the SLM indicates a corresponding reduction, then the intensity variation is linear.

II. Calibration of audiometer output intensity via bone conduction

Purpose

To measure the output pressure of an audiometer at various frequencies via the bone conduction vibrator.

Instruments necessary

1. Audiometer that has to be calibrated
2. Artificial mastoid (eg. B & K 4920)
3. Sound level meter (eg. B & K 2209)
4. Adaptor (eg. B & K JJ 2612)
5. Octave filter set (eg. B & K 1613)
6. Piston phone (eg. B & K 4220)

Procedure

Phase I : Calibration of SLM (as described before)

Phase II : Mounting of the bone conduction vibrator on the artificial mastoid and connecting artificial mastoid to the sound level meter.

Phase III: Measurement of sound pressure levels

Phase IV : Preparation of correction chart (as described before)

Phase II: Mounting of BC vibrator on the artificial mastoid and connecting artificial mastoid to SLM

a. Ensure that the artificial mastoid is placed on a horizontal plane.

b. Detach the BC vibrator from the head band and place it on the artificial mastoid.

c. Note the level, with the help of level indicator and remove the BC vibrator.

d. With the help of the spring balance, check the weight (500 gms) on the clamp/arm of the artificial mastoid and readjust the level of the clamp with reference to the level indicator (provided along with the artificial mastoid).

e. Remove the spring balance and the level indicator.

f. Connect the adaptor to the SLM.

g. Plug in the output jack of the artificial mastoid to the adaptor and thus the artificial mastoid is connected to the SLM.

h. Connect the octave filter set to the SLM.

Phase III: Measurement, of output. SPL

a. Switch on the audiometer.

b. Set the intensity dial at 40 dB or 50 dB depending upon the specifications provided by the manufacturer and frequency dial at 125 Hz or 250 Hz as the case may be.

c. Set the output selector to 'Bone'.

d. Set the Octave filter set to the required frequency same as selected in the audiometer.

e. Switch on the SLM and set it to 'slow' response and to 'external filter'.

f. Set the tone switch on the audiometer so that the signal is continuously on.

g. Set the attenuator depending upon expected output reading on the SLM, eg. 60 dB except at 4000 Hz where it should be set at 40 dB. If the needle deflects to either extremes, change the attenuator setting suitably so that the needle deflects to the central area of the meter.

h. Note down the combined reading from the attenuator and the meter.

i. Repeat the procedure for each of the test frequencies. Adjust the frequency setting on the octave filter set to correspond with the test frequency.

Phase IV: Correction chart: preparation (same as AC)

III. Frequency calibration of pure tones

Purpose

To determine the deviation of the output frequency from that of the dial reading.

Equipments necessary:

1. Audiometer to be calibrated
2. Digital frequency counter

Procedure

a. Remove one of the earphone jacks from the output socket.

b. Insert a spare earphone jack into the socket.

c. Connect a spare jack into the input terminals of the frequency counter with a wire.

d. Switch on the frequency counter and the audiometer.

e. Set the audiometer frequency dial to 125 Hz or 250 Hz as the case may be.

f. Set the output intensity to maximum.

g. Adjust the tone switch to 'continuously on' position.

h. Turn the function selector on the frequency counter to 'frequency'.

i. Note down the reading on the frequency counter. Adjust the 'sensitivity' of the counter to obtain a stable frequency value.

j. Compute the deviation of the frequency generated by the audiometer from the expected frequency.

k. Repeat the procedure for the other frequencies.

1. Whenever the deviation exceeds $\pm$ 3% (IS 9098, 1979) internal calibration is warranted.

IV. Frequency response of earphones

Purpose

To determine the frequency response characteristics of the audiometer earphones.

Equipments and materials necessary

1. Earphone

2. Beat frequency oscillator (BFO) (eg. B & K 1020)

3. Audio frequency analyser (AFA) (eg. B & K 2107)

4. Artificial ear (eg. B & K 4152)

5. Condenser microphones (eg. B & K 4144)

6. Graphic level recorder GLR (eg. B & K 2307)

7. Recording paper (eg. B & K QP 1124).

Procedure

Phase I : Calibration of BFO (as described in the manual)

Phase II : Calibration of AFA (as described in the manual)

Phase IIIs Setting up the instruments

a. Unscrew the coupler from the artificial ear.

b. Screw on the condenser microphone to the artificial ear and replace the coupler.

c. Connect the earphone cord to the output terminals of the BFO.

d. Place the earphone on the artificial ear, such that the perforations face the microphone.

e. Connect the artificial ear to the condenser microphone (or pre-amplifier) input of the audio frequency analyser.

f. Connect the output terminal of audio frequency, analyser to the input socket of the graphic level recorder.

g. The recording paper must be properly loaded on the graphic level recorder.

Phase IV: Obtaining the frequency response characteristics

a. Switch on the instruments.

b. Set the BFO to 'Auto Sweep' from 50 Hz.

c. Set the impedance of the BFO to match with that of the earphone.

d. The needle of the GLR must be on the 50 Hz mark on the recording paper. Select a paper drive that permits a synchronization of paper speed with BFO sweep.

e. Turn on the BFO and simultaneously switch on the motor drive of the GLR.

f. Repeat the procedure with the other earphone.

g. The frequency response characteristics should be almost flat at all frequency with a small peak between 4000 to 6000 Hz.

V. Frequency response characteristics of bone conduction vibrators

The procedure involved in determining the frequency response characteristics of a BC vibrator is similar to the one described in Section IV. An artificial mastoid is used in place of artificial ear and condenser microphone.

VI. Calibration of the speech audiometer MIC input

The instruments and the preliminary stage involved here are similar to those described in 'Calibration of output level via air conduction'.

Procedure

a. Switch on the audiometer.

b. Make appropriate adjustments to present the signal through microphones.

c. Select either the left or right earphone and set the output selector correspondingly to right or left.

d. Set the intensity level at 70 dB.

e. Present a 1000 Hz tone, speech noise or the vowel 'a' in case either of the first two are not available.

f. Set the VU gain so that the needle peaks at zero.

g. Note down the reading on the SLM on 'linear' response.

h. Note the reading on the SLM. If the reading deviates more than $\pm$ 3 dB from the expected value (89.5 dB SPL) then internal calibration is required.

VII. Calibration of tape inputs

The procedure involved is similar to that described in the calibration of microphone input. But the signal must be presented through the tape recorder which is to be used with the audiometer. Recorded speech noise may be used for this purpose.

Before using a given tape recorder with an audiometer, the following method may be used to rule out any mismatch between the two instruments.

Procedure

a. Record pure tones of frequency 250, 500, 1000, 2000 Hz on a magnetic tape.

b. Play the above tape on the recorder to be coupled with the audiometer.

c. Measure the SPL of each tone using a set up similar to those used for 'calibration of output level via air conduction'.

d. Compare the levels of the tones with reference to that of the 1000 Hz signal. If the difference in the level are within ± 4 dB there is no mismatch between the tape recorder output and the audiometer input.

VIII. Distortion measurements

This is carried out by giving the electrical output from the audiometer to the distortion factor meter. The sound pressure levels of any given harmonic should be at least 30 dB below that of the fundamental.

IX. Temporal parameters

The temporal parameters of the puretones generated by the audiometer may be checked by feeding the audiometer output to an oscilloscope. The display may be observed to check if the rise and decay time are uniform and if there is an over shoot during the on-time. The rise and decay times should be within the specified limits (usually about 50 msec) and there should be no overshoot during the on-time.

The length of the paper moved divided by paper speed will indicate the duration of various parameters

Rise time	Decay time
The frequency of pulsing can be determined in the same manner	
The presence of any unwanted signal on pressing the interruptor switch may also be detected by this method	

X. SISI test

The rise decay time, the on-time and the inter-stimulus interval may be measured using the set up. An oscilloscope may also be employed for this purpose. The level of the increment may be directly read on the AF analyser or on a SLM in a set up for measurement of output SPL.

XI. ABLB test

The on-time and off-time of the signal may be determined as for the SISI mode. The tracing for the two earphones may be compared to ensure that signals presented are of equal duration. A listening check would help ensure that the signals if alternating between the two ears and that there is no overlap in the presentation of the signals to the two ears.

XII. Masking noise

The output level of the noise may be checked as in section I. The noise spectrum may be analysed using the following set up, for each frequency separately.

Audiometer –> Earphone –> Artificial ear –> AFA –> GLR

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