GAIN (TAPER) CHARACTERISTICS OF SOME INDIAN HEARING AIDS

REG.NO.8810

AN INDEPENDENT PROJECT WORK SUBMITTED IN HART FULFILLMENT FOR FIRST YEAR MASTER OF SCIENCE (SPEECH AND HEARING), UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SPEECH AND HEARING : MYSORE 570006

MAY - 1989

TO THOSE HEROES

WHO WERE DISABLED

WHO LOST THEIR LIVES IN FIGHTING VALIANTLY

ON LAND, IN AIR AND ON SEA FOR DEFENCE OF

MY GREAT MOTHER LAND

REPUBLIC OF INDIA

CERTIFICATE

This is to certify that the Independent Project entitled "Gain (Taper) Characteristics of Some Indian Hearing Aids" is the bonafide work on part fulfillment for the Degree of Master of Science (Speech and Hearing) of the student with Register No.8810.

Director 17/5/89

All India Institute
of Speech & Hearing
Mysore - 6+

CERTIFICATE

This is to certify that the Independent Project entitled "Gain (Taper) Characteristics of Some Indian Hearing Aids" has been prepared under my supervision and guidance.

Dr.(Miss) S.Nikam.
Prof, and Head,
Audiology Department.

DECLARATION

I hereby declare that this Independent Project entitled "Gain(Taper)Characteristics of Some Indian Hearing Aids* is the result of my own study under the guidance of Dr.(Miss)S. Nikam, Professor and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore has not been submitted earlier at any University for any other diploma or degree.

Mysore Reg. No.8810

May 1989

ACKNOWLEDGEMENTS

To

My parents and sister for encouraging me in difficulties.

My dearest guide Dr.(Miss) S.Nikam. Because of her I learned to apply many things in life.

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INTRODUCTION

Hearing impairment, in general is categorized into, conductive, sensori-neural and mixed type of hearing loss. Most cases in the latter two categories require amplification to over come their hearing handicap and in some instances all of them do.

Amplification is provided by an electronic device called "Hearing aid". Hearing aids broadly may be divided into the desk type and those that are worn on the body. The latter may be further categorized into -

i) Body level hearing aid: These hearing aids can be worn on the body like in the shirt pocket etc.

ii) Ear level hearing aid: These are at the level of the ear. Again here we have got behind-the-ear hearing aids, and canal aids. Behind-the-ear hearing aids are hook shaped with internal receiver. A tube which is hook shaped leads to the mould in the canal. This tube conducts sound as well as helps in retaining the aid. Whereas canal aids are placed in the EAM. The entire mic, amplification etc. are assembled and made so small that they fit into the EAM.

The amount of amplification needed for a particular individual depends on the severity of the hearing impairment. So, the hearing aid for the particular patient is decided on following hearing aid trial where different hearing aids of the

required category (mild/moderate/strong) have been tried on the patient.

In the past it has been the experience of many audiologists that the claims made by the hearing aid manufacturer are not true - often the hearing aids do not meet the specification. So in India standards have been established by the B.I.S. on hearing aid specifications. They include methods of measurement of electroacoustical characteristics of hearing aid, specifications for control and markings on hearing aids etc.

These standards specify the physical and electroacoustic characteristics of hearing aids of all categories (mild/moderate/strong). Hence, the quality is controlled and a uniformity is brought about on a national basis. They also specify the methods of measurement of the eleetroacouatic characteristics of hearing aid. These provide the hearing aid manufacturer with a standard to be achieved.

So, going back to the hearing aid trial, in the process of fitting a patient the volume control of the hearing aids is adjusted so that speech at 70 dB SPL is most comfortable and as clear as possible. This volume control setting is called the "use gain" of the hearing aid. In our experience it has been observed that the "use gain" is usually at "volume control" at '3' or '1/3' setting of the volume control. At this position, the hearing aid should have reserved of at least 10 to 15 dB more gain, which may be needed for listening to soft sounds

or if the hearing loss gets worse. The volume control should not be at its lowest setting, because at this setting it cannot be tamed down for loud sound* (Skinner, 1988).

Another infrequently considered, bat nevertheless important, factor related to volume controls is their taper characteristic. This refers to the relationship between volume (gain) control rotation and amount of signal attenuation, i.e. how much of the maximum amplification is provided at various rotation points (25, 50, 75 and so on).

A study by Kasten and Lotterman (1969) indicated that "The gain control taper does not provide a linear growth in gain". Their examination of 33 different hearing aids revealed a wide range of taper characteristics. A number of generalizations were drawn from the study. They are-

1. Relatively little gain is available once the volume control is beyond 50% of its total range. Moat of an instrument's gain is delivered in the lower half of the control, while only a limited amount is available in the last half. The implications of these data are that while a user may receive some additional amplification by rotating the gain control beyond 50% setting, he may also encounter an unusually high increase in harmonic distortion that could decrease hie aided performance (Lotterman and Kasten, 1967b; Jerger et al, 1966? Kasten et al, 1967a).

2. A wide variety of taper characteristics and potentiometer ranges available in modem hearing aids may lead both the aid fitter and user to overestimate the amount of reserve gain available. For a group of higher power instruments (more than 45 dB average gain) the median value was 60 dB, bat only 13 dB of gain remained above 50% rotation. Some of their instruments achieved maximum amplification at or below the 50% point, leaving no reserve.

3. It is important for the clinician to know not only the taper characteristic of the aids he uses, bat also the potentiometer ranges in order to have some realistic expectations for hearing aids and their performance. It should be noted that the hearing aid manufacturers rarely provide this information on model specification sheets.

So, the aim of this study is to study the volume control characteristics of hearing aids.

Need for the study:

This study will enable us to know -

1) the taper characteristics of the volume control
2) the use gain value at the recommended volume control/setting (R.T.G)
3) There serve gain.

INSTRUMENTATION

1.	Audio-Test-Station -	B&K 2118
2.	Anechoic Test Chamber -	B&K 4222
3.	Microphone -	B&K 4134
4.	Preamplifier -	B&K 2642
5.	2cc Coupler -	B&K DB 0138
6.	Adaptor -	B&K DB 0225
7.	Piston phone -	B&K 4220
8.	Recording paper -	B&K QP 0019

METHODOLOGY

Selection of the hearing aids:-

A total of 120 hearing aids were taken up for the study. Out of these 120, 102 hearing aids were those newly received from the manufacturers while the rest belonged to the group used.

Of these 120 hearing aida 51 belonged to the strong catagory, 65 belonged to the moderate category, 4 belonged to the mild category (IS:1O775-1984), as per the manufactarers claims.

The hearing aids came from 7 manufacturers.

Calibration:-

Before starting with the experiment, calibration using piston phone (B&K 4220) was earried out. The piston phone was hel against the microphone (B&K 4134) using the 1/2" adaptor (B&K DB0225). The piston phone was switched on and "calibrate" button was depressed on audio test station (B&K 2118). It was observed that the pen rested against 126 dB on the lefthand aide of the chart. If not the level was adjusted using the potentiometer above the 'Calibrate' button on the audio-test-station (B&K 2118).

Connection:- The preamplifier of audio test station is connected with microphone. The anechoic test chamber is connected to audio-test station.

Recording compression curvet-

After the calibration was done, the piston phone was removed along with adaptor. The microphone was kept at the centre of the circle in the anechoic test chamber (B&K 4222). Compression switch (rear panel of audio test station B&K 2118) was turned on, the "Read in" and the "ream" buttons were simultaneously pressed. The pen moved along the upper most line of the graph (140 dB). The pen remained raised. (The pen paused at the left extreme of the graph for 10 seconds before moving towards the right end.

Recording gain control characteristics:-

Connection:- The protection grid of the microphone was removed. The microphone was connected to preamplifier from the audio-test station (B&K 2118). To the microphone 2ec coupler was connected. Each hearing aid was placed such that the microphone of the hearing aid lied within the 2nd circle of the anechoic test chamber (B&K 4222), the receiver of hearing aid wgs connected to the 2cc coupler.

The input intensity of 60 dB was selected at 1.6KHz. The hearing aids under test wave switched 'on' and gain control was turned to full on. Acoustic gain was determined. This was repeated with a sufficient number of other settings of the gain control to cover the range of the control. The acoustic

gain was plotted relative to the fall on acoutic gain versus settings of the gain control, using a linear scale for the positions of the control.

Fall-on gain was also noted simultaneously* After presentation, the output was noted from the scale on the left hand side of the recording paper (B&K SP 0019), and the gain was computed, and was determined at similarly at other gain control positions.

The results were tabulated.

DATA SHEET

Table-1: Indicating various models and number of hearing aids tested under each model and their full ongoing is shown. On right hand extreme the number of hearing aids that met manufacturers claim under each model have been mentioned.

Models	Average gain dB	Expected Gain dB	No.of hearing aids tested	No.of hearing aids agree with manufacturers claims.
Model-I	59	65	41	7
Model-II	69	69	1	1
Model-III	67	69	1	1
Model-IV	73	72	1	1
Model-V	66	69	1	-
Model-VI	72	72	1	1
Model-VII	71.5	72	2	2
Model-VIII	63	72	1	
Model-IX	61	70	1	
Model-X	52	69	1	-
Model-XI	59.4	62	61	53
Model-XII	62	64.5	3	1
Model-XIII	53	53	1	1
Model-XIV	42	62	1	-
Model-XV	53	54	1	1
Model-XVI	44	54	1	-
Model-XVII	42	53	1	

Total no.of hearing aids - 120

Total no.of hearing aids that meet manufacturers claim-69

Table-11 : Showing the seserve gain and gain at 50% volume control setting for different hearing aids belonging to different models.

Models	Gain at 100% setting* dB	Gain at 50% settings dB	Reserve gain dB
Model-I	59	49	10
Model-II	69	65.5	3.5
Model-III	67	55	12
Model-IV	73	60.5	13
Model-V	66	62	4
Model-VI	72	38	34
Model-VII	71.5	43.5	28
Model-VIII	71.4	43	28.5
Model-IX	61	27.5	33.5
Model-X	52	38	14
Model-XI	5.5	45.5	13.9
Model-XII	62	38.2	23.8
Model-XIII	53	33.5	19.5
Model-XIV	42	40.5	1.5
Model-XV	53	20.5	22.5
Model-XVI	44	37.5	6.5
Model-XVII	42	36.5	5.5

RESULTS

By looking at data sheet and graphs for taper characteristics we can draw some information.

Table-1 shows that out of 120 hearing aids only 69 hearing aids met the manufacturer's claim. Among these 120 hearing aids 51 hearing aids belonged to strong category. Among these 51 hearing aids only 13 hearing aids met the manufacturer's claim of gain. There are 65 hearing aids which belonged to moderate category, out of these only 54 hearing aids met the manufacturer's claim of gain. There are 4 hearing aids which belonged to mild category. Out of these 4 hearing aids only 2 hearing aids met the manufacturer's claim. So out of 120 hearing aids only a total of 69 hearing aids (13 of strong category, 54 of moderate category and 2 of mild category) met the manufacturer's claim. Out of these 69, 5 hearing aids varied from manufacturer's claim, but below 3 dB.

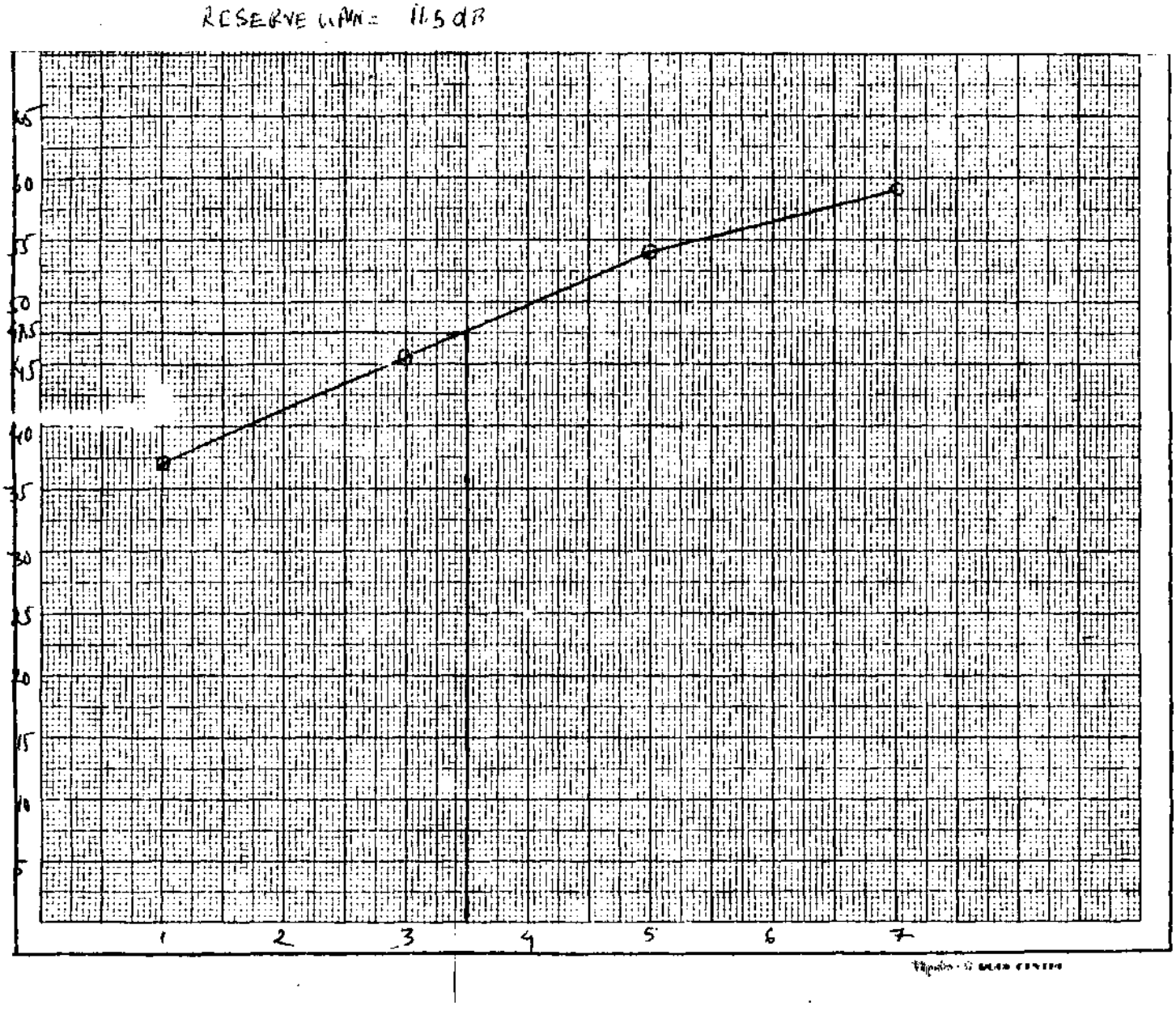
If we take the number, a total of 51 hearing aids did not meet the manufacturers claim.of gain. If we take percentage into account 42.5 percent of hearing aids did not meet the manufacturer's claim and 57.5 percent met the manufacturer's claim.

Taking a look at Table-11, we got 17 graphs.While drawing graphs, the average gain at each volume control setting has been taken into consideration. Out of the 17 models of hearing aids, 7 models of hearing aids were having reserve gain

Graph-1: Showing relationship between volume control setting and corresponding gain in Model-I

Gain at 50% volume control setting - 47.5dB

Volume control settings	Gain (Average) dB
7	59
5	54.02
3	45.73
1	37.34

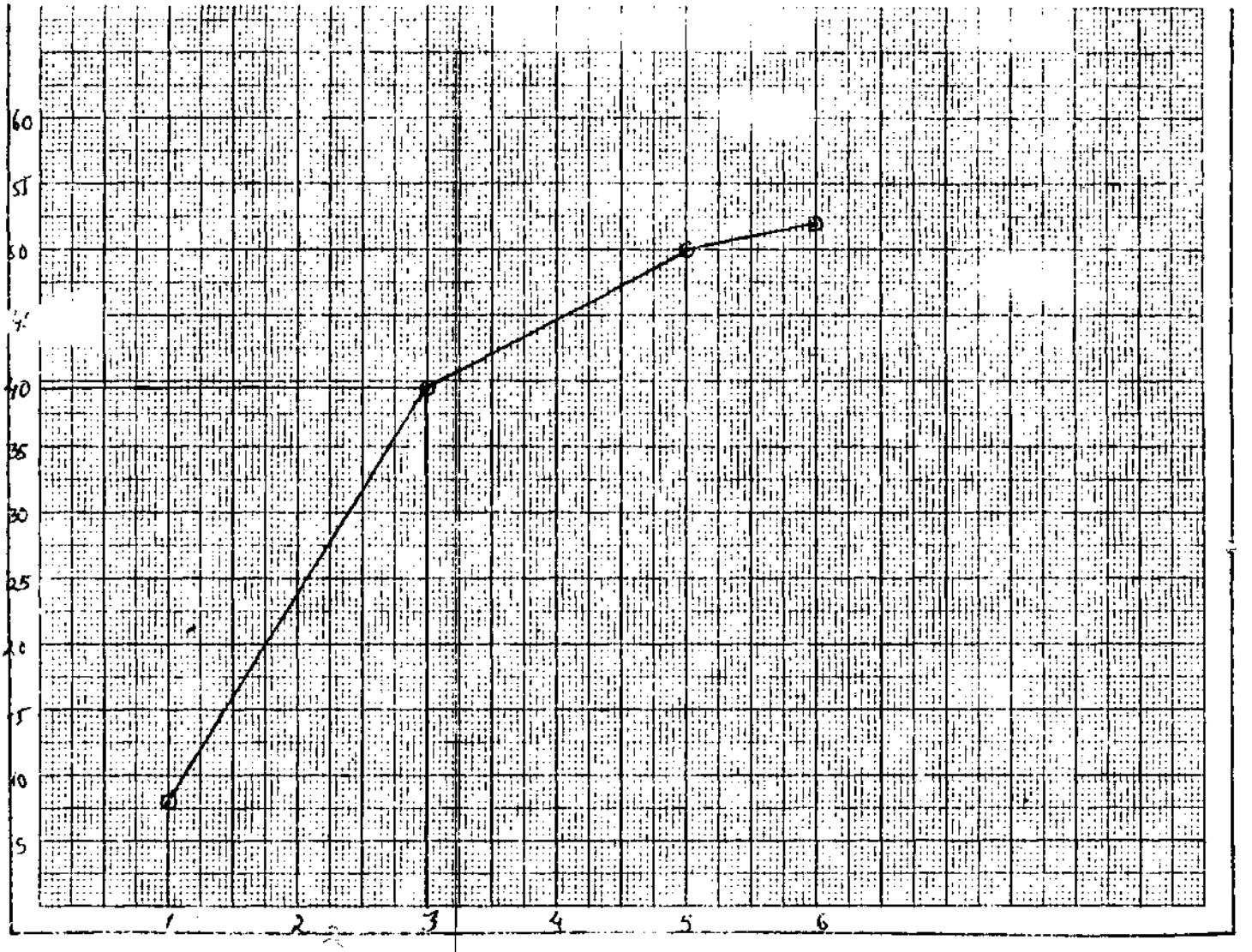


Graph-10: Showing relationship between volume control setting and corresponding gain in Model-X.

Grain at 50% volume control setting - 30 dB.

Reserve gain - l3 dB.

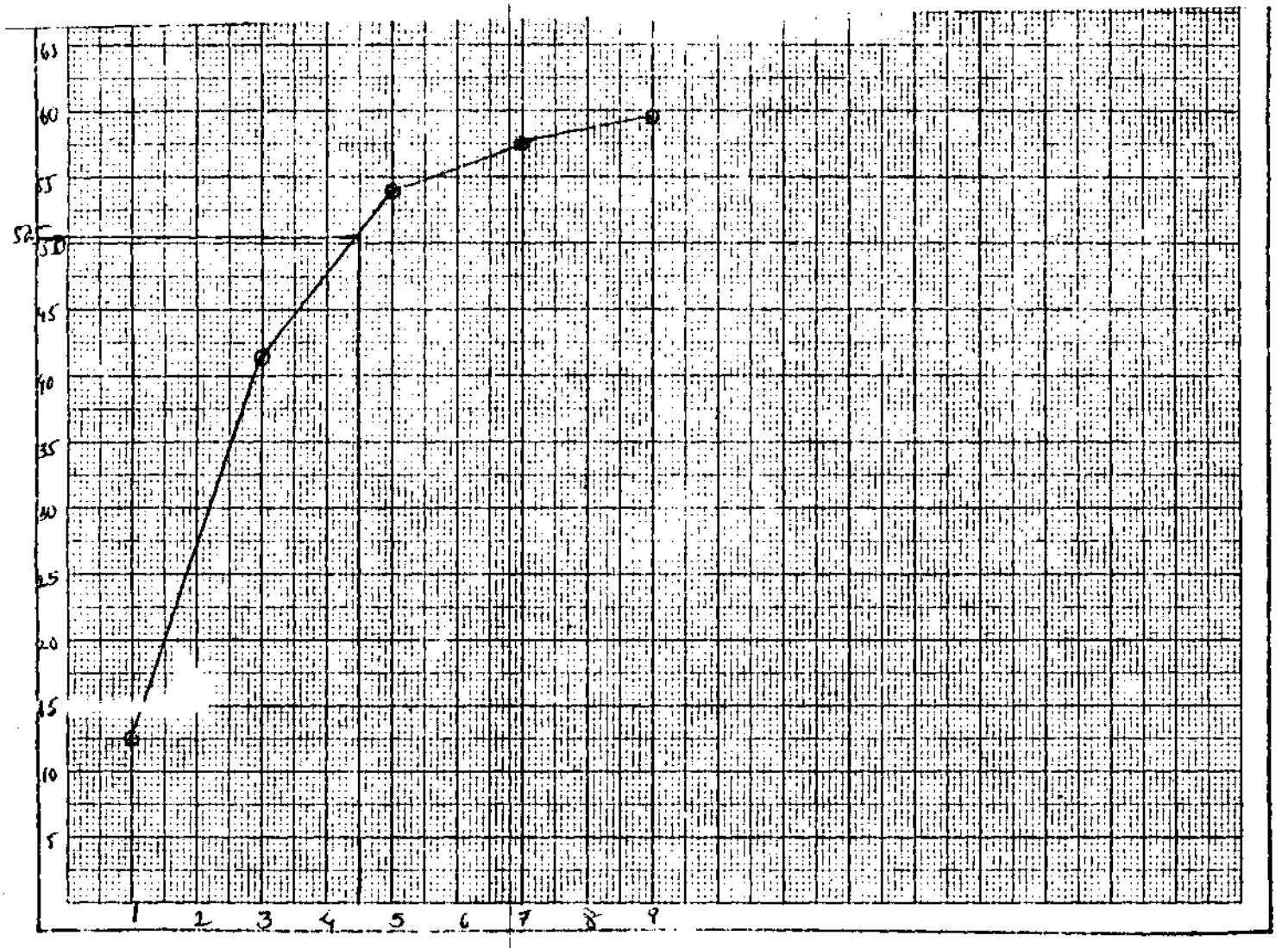
Volume control setting	Gain (Average) dB
6	52
5	50
3	39
1	8



Graph-11: Showing relationship between volume control setting and corresponding gain in Model-XI.

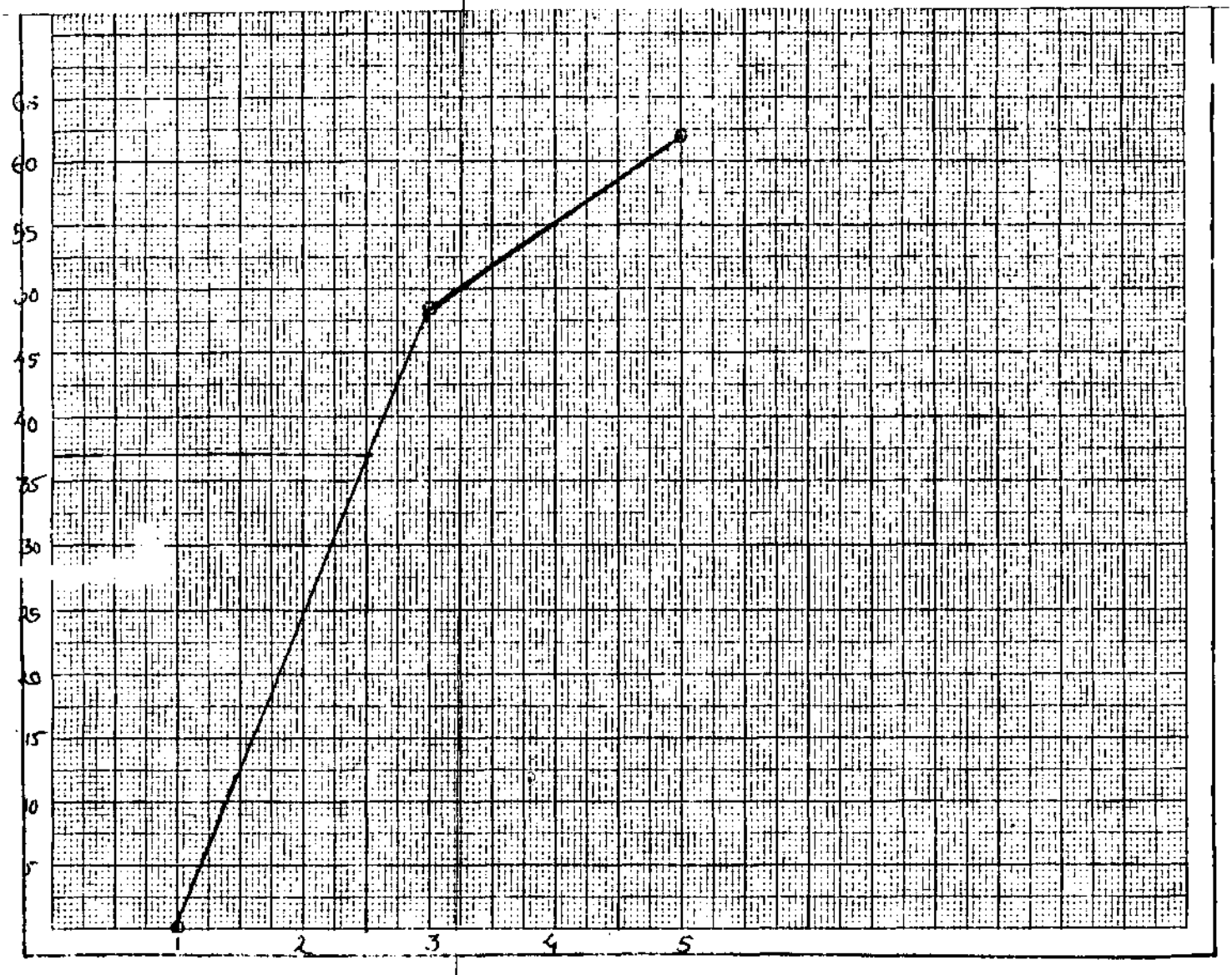
Cain at 50%, volume control setting -50.5 dB.
Reserve gain - 08.9 dB.

Volume control setting	Gain(Average) dB
9	51.4
7	57.7
5	53.9
3	41.4
1	12.6



Graph-1_2: Showing relationship between volume control setting and corresponding gain in Model-XII. setting - Gain at 50% volume control setting - 37.08 dB.
Reserve gain - 25.0 dB.

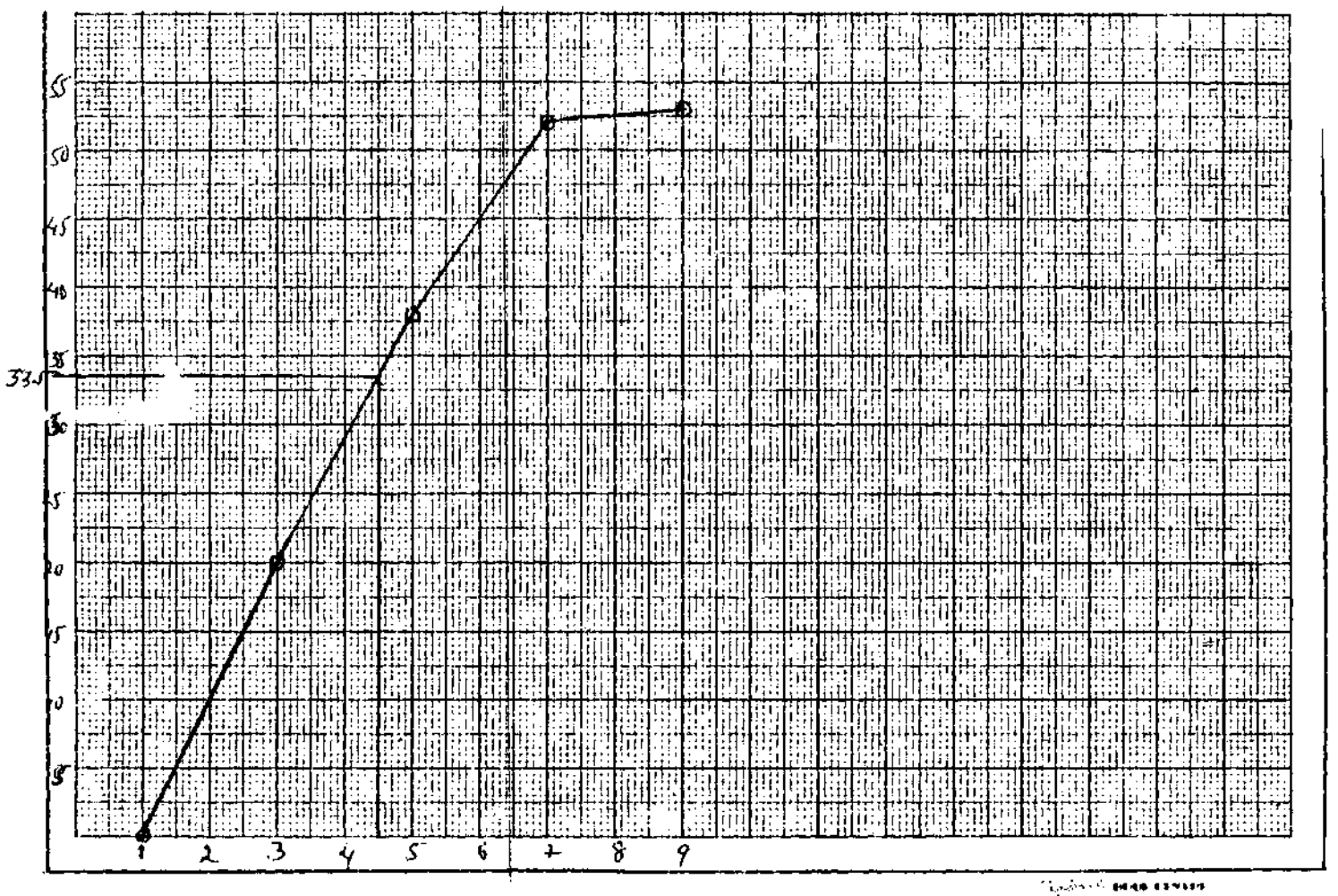
Volume control setting	Gain (Average)dB
5	62
3	48.6
1	0



Craph-13: Showing relationship between volume control setting and corresponding gain in Model-XIII.

Gain at 50% volume control setting - 33.5 dB.
Reserve gain -19}.5 dB.

Volume control setting	Gain(Average) dB
9	53
7	52
5	38
3	20
1	0

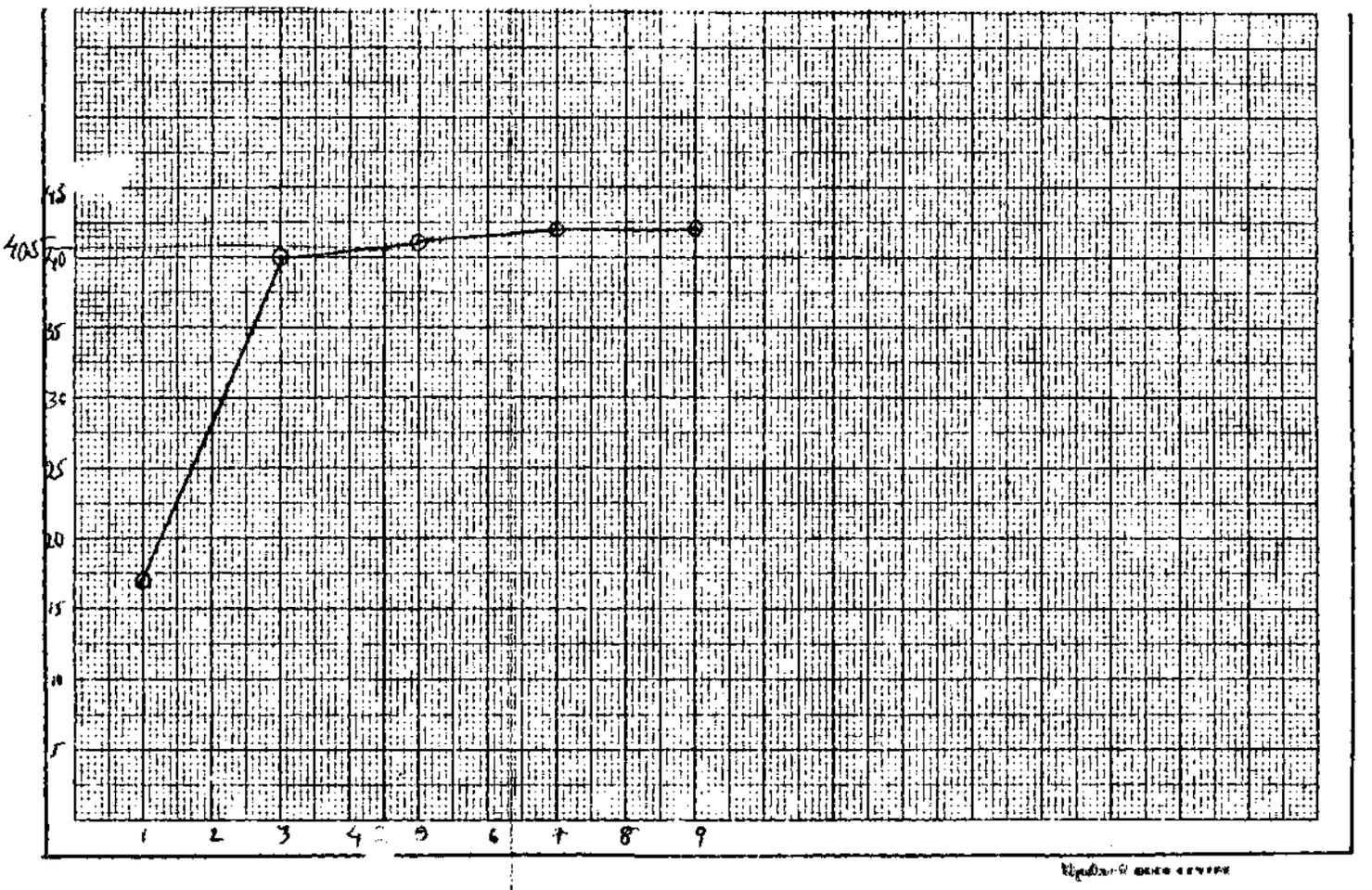


Graph-14: Showing relationship between volume control setting and corresponding gain in Model-XIV.

- Gain at 50% volume control set ing - 40.5 dB

Reserve gain - 1.5 dB.

Volume control setting	Gain(Average) dB
9 42	
7	42
5	41
3	40
1	17

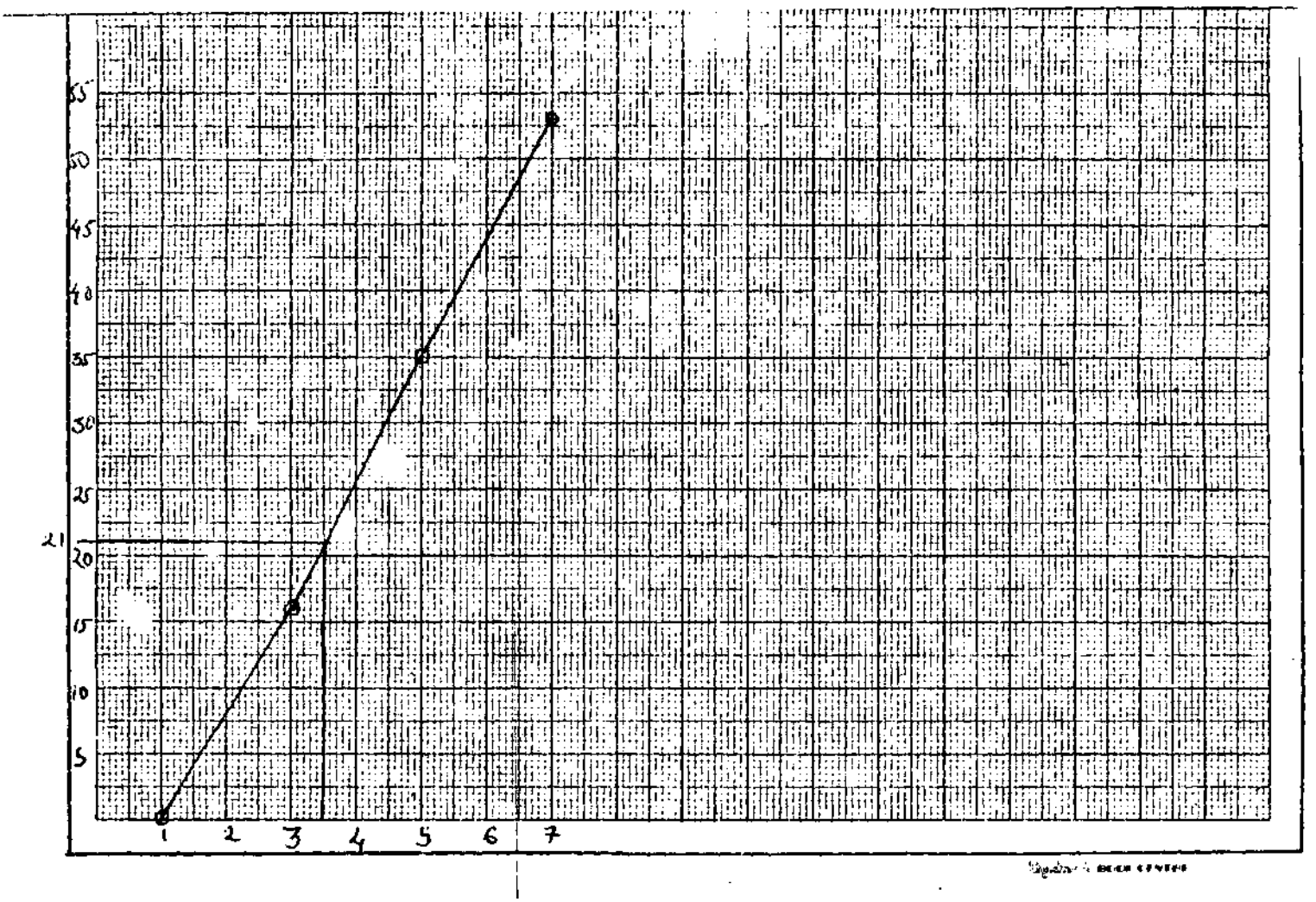


Graph-15: Showing relationship between volume control setting and corresponding gain in Model-XV.

Gain at 50'% volume control setting - 20.8 dB.

Reserve gain - 32.0 dB.

Volume control setting	Gain (Average) dB
7	53
5	35
3	16
1	0

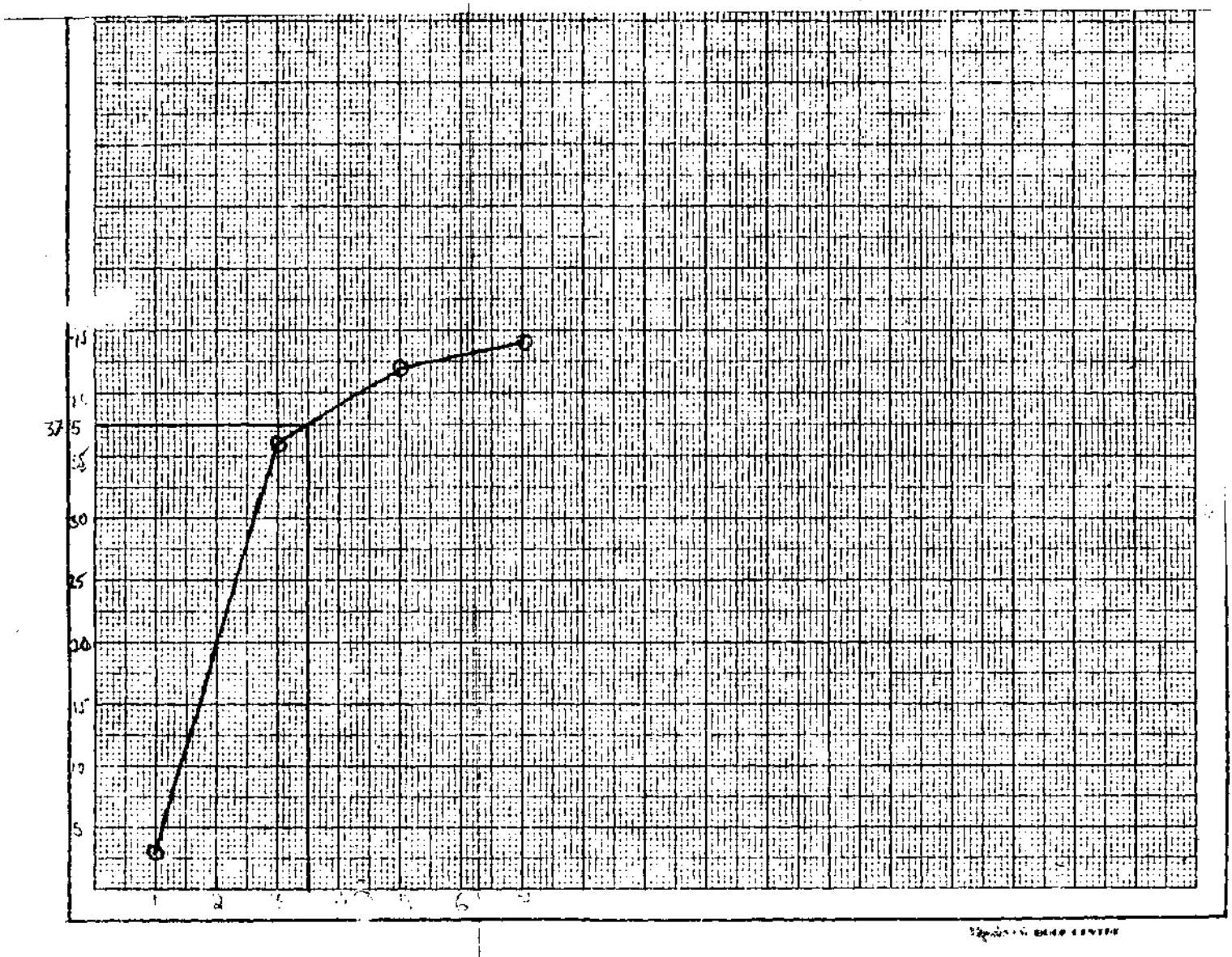


Graph-16: Showing relationship between volume control setting and corresponding gain in Model-XVI.

Gain at 50% volume control setting - 37.5 dB.

Reserve gain - 6.5 dB.

Volume control setting	Gain(average) dB
7	44
5	42
3	36
1	3

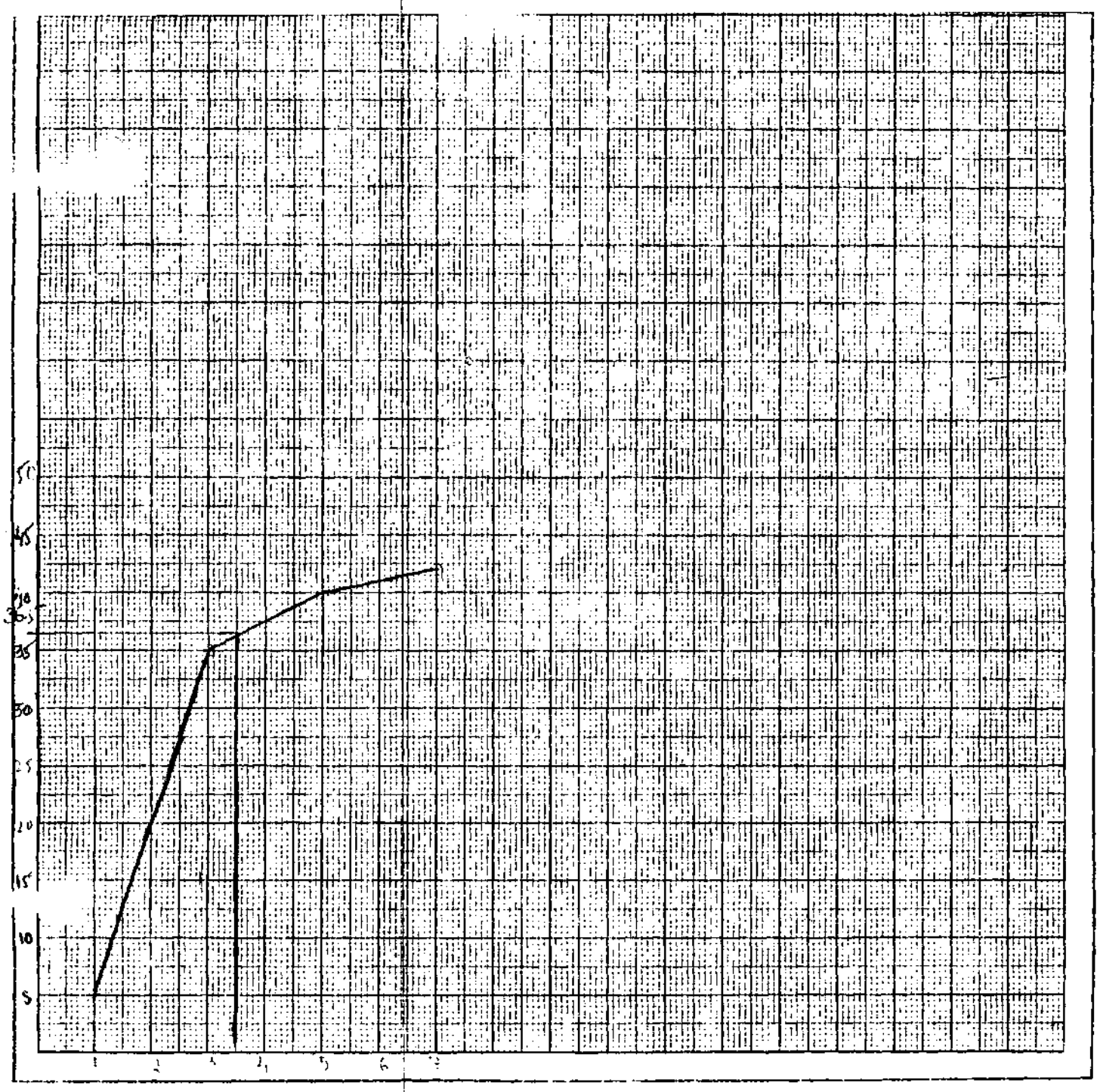


Graph-17: Showing relationship between volume control setting and corresponding gain in Model-XVII.

Gain at 50% volume control setting - 36.5 dB.

Reserve gain - 5.5 dB.

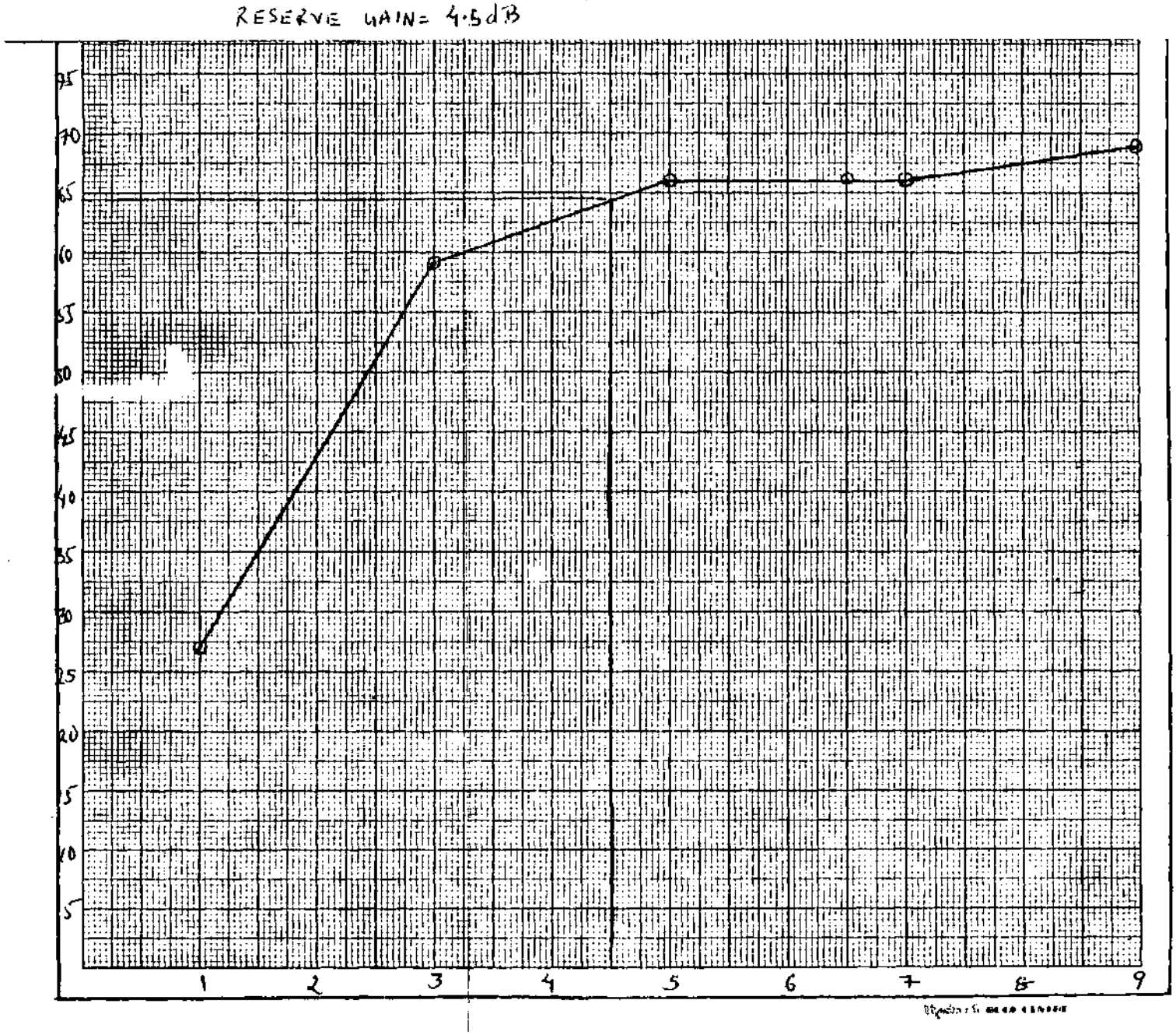
Volume control setting	Gain(average) dB
7	42
5	40
3	35
1	5



Graph-2: Showing relationship between volume control setting and corresponding gain in Model-11

Grain at 50% volume control setting - 64.5 dB

Volume control setting	Gain (Average) dB
9	69
7	66
5	66
3	59
1	27

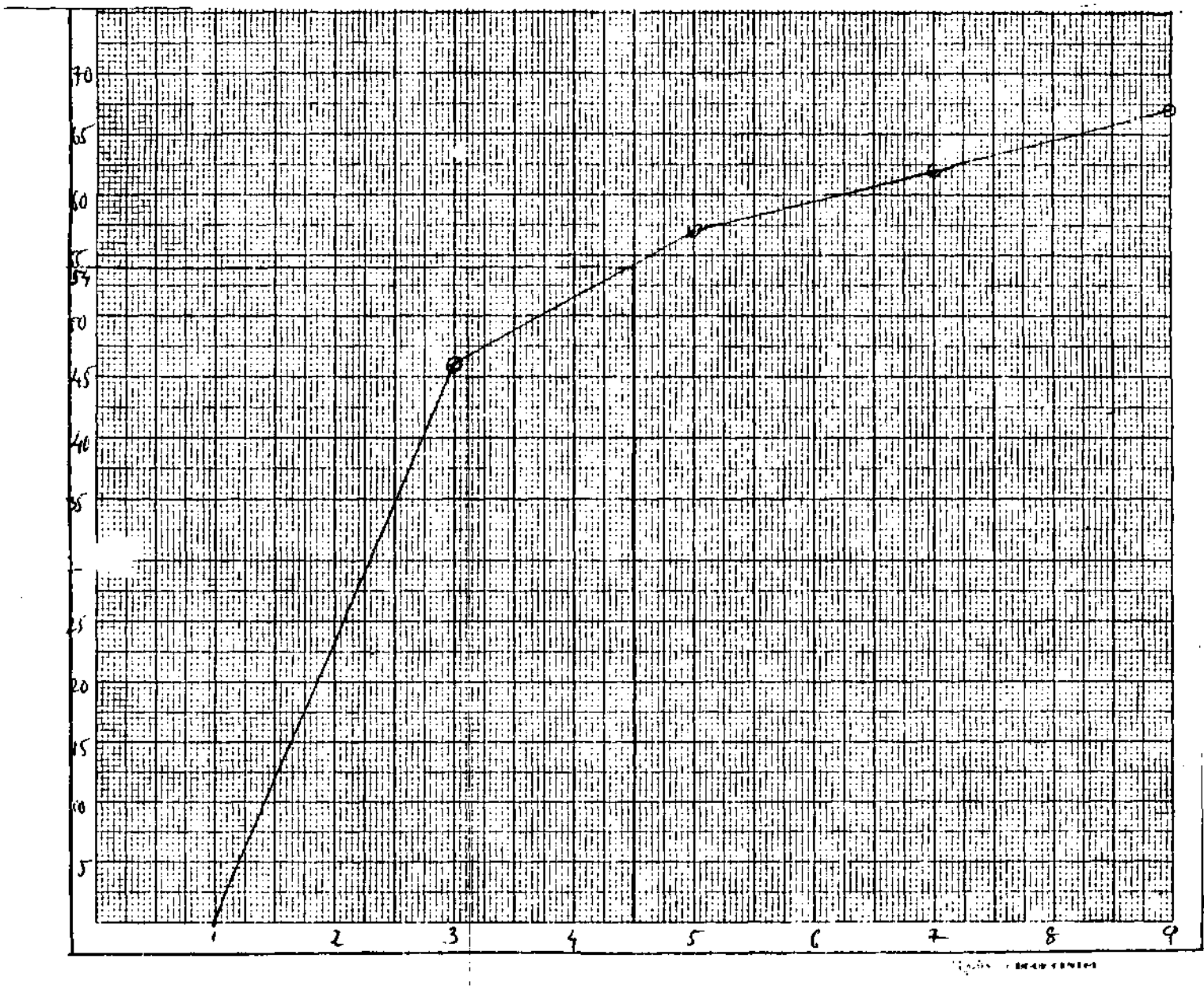


Graph-3: Showing relationship between volume control setting and corresponding gain in Model-Ill

Gain at 50% volume control setting - 54 dB

Volume control setting	Gain(Average) dB
9	67
7	62
5	57
3	46
1	0

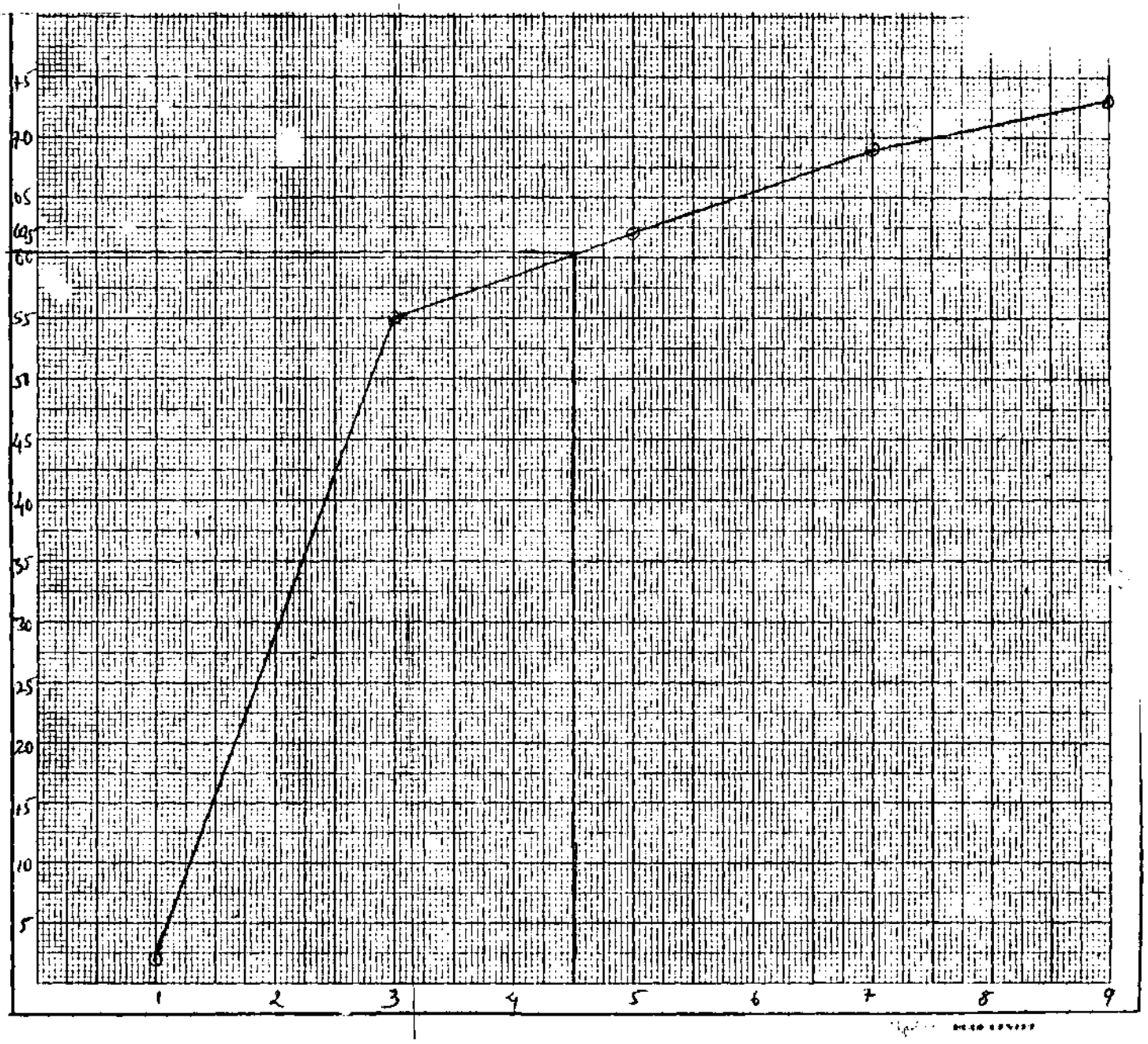
RESERVE GAIN = 13dB



Graph-4: Showing relationship between volume control setting and corresponding gain in Model-IV.

Gain at 50% volume control setting - 60.5 dB
Reserve gain - 12.5 dB.

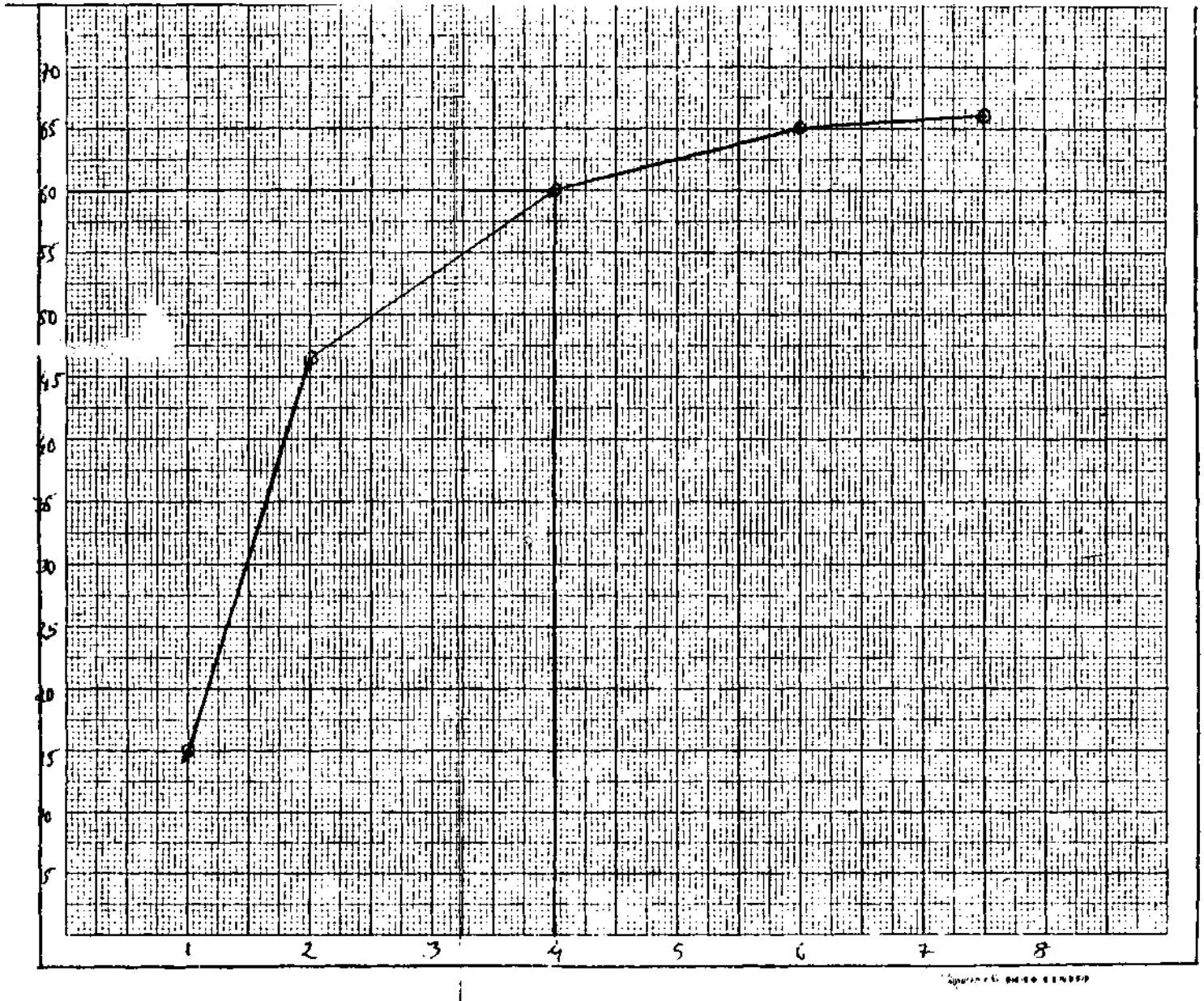
Volume control settings	Gain(Average) dB
9	73
7	69
5	62
3	55
1	2



Graph-5: Showing relationship between volume control setting and corresponding gain in Model-V

Gain at 50% volume control setting - 60 dB.
Reserve Gain - 46dB.

Volume control settings	Gain(Average) dB
8	66
6	65
4	60
2	46
1	15

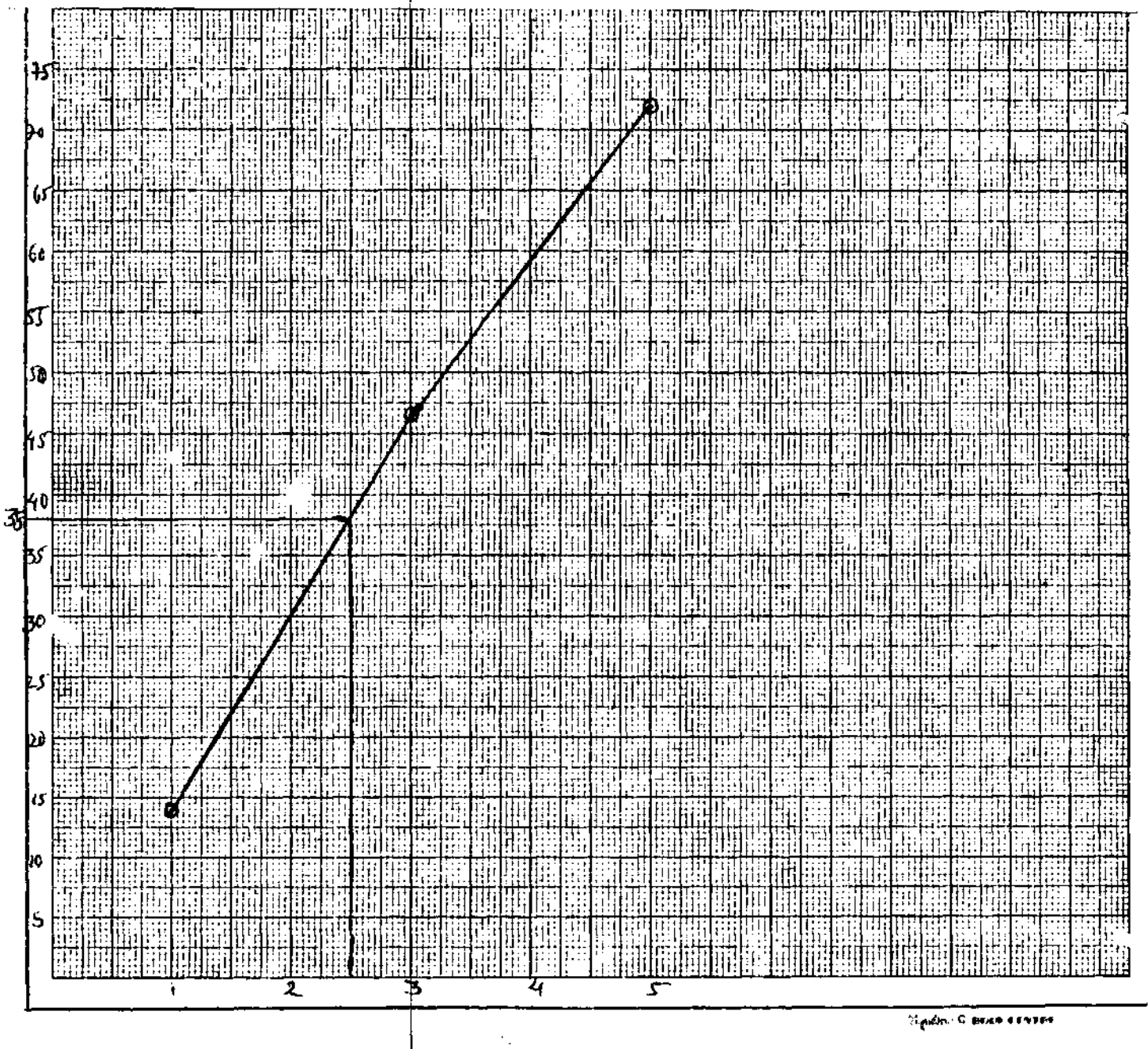


~~Graph-6~~: showing relationship between volume control setting and corresponding gain in Model-VI.

Gain at 50% volume control setting - 38 dB.

Reserve gain - 34 dB.

Volume control settings	Gain (Average) dB
5	72
3	46
1	14

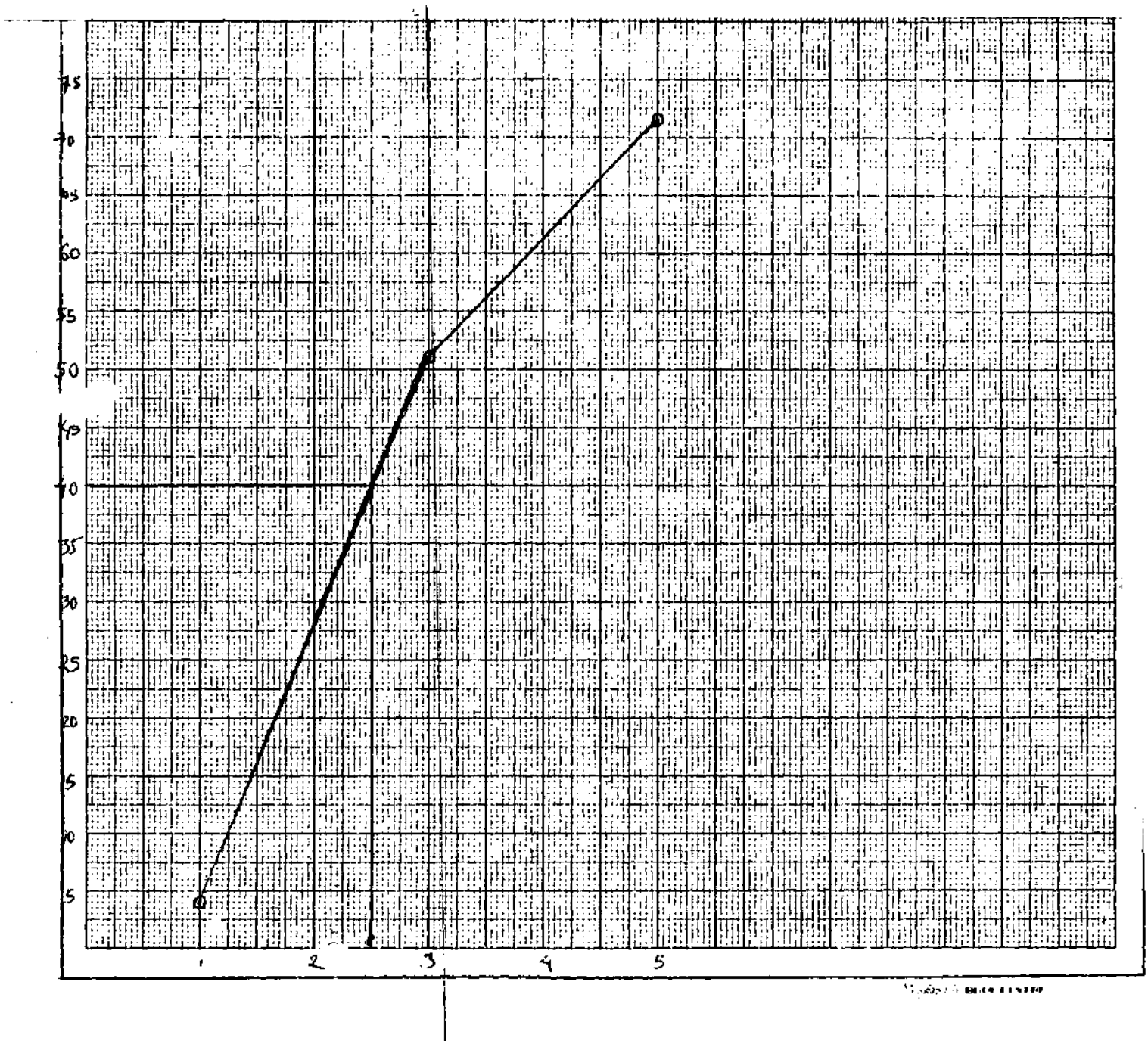


Graph-7: Showing relationship between volume control setting and corresponding gain in Model-VII.

Gain at 50% volume control setting - 40.0 dB.

Reserve gain - 31.5 dB.

Volume control settings	Gain (Average) dB
5	71.5
3	51
1	4

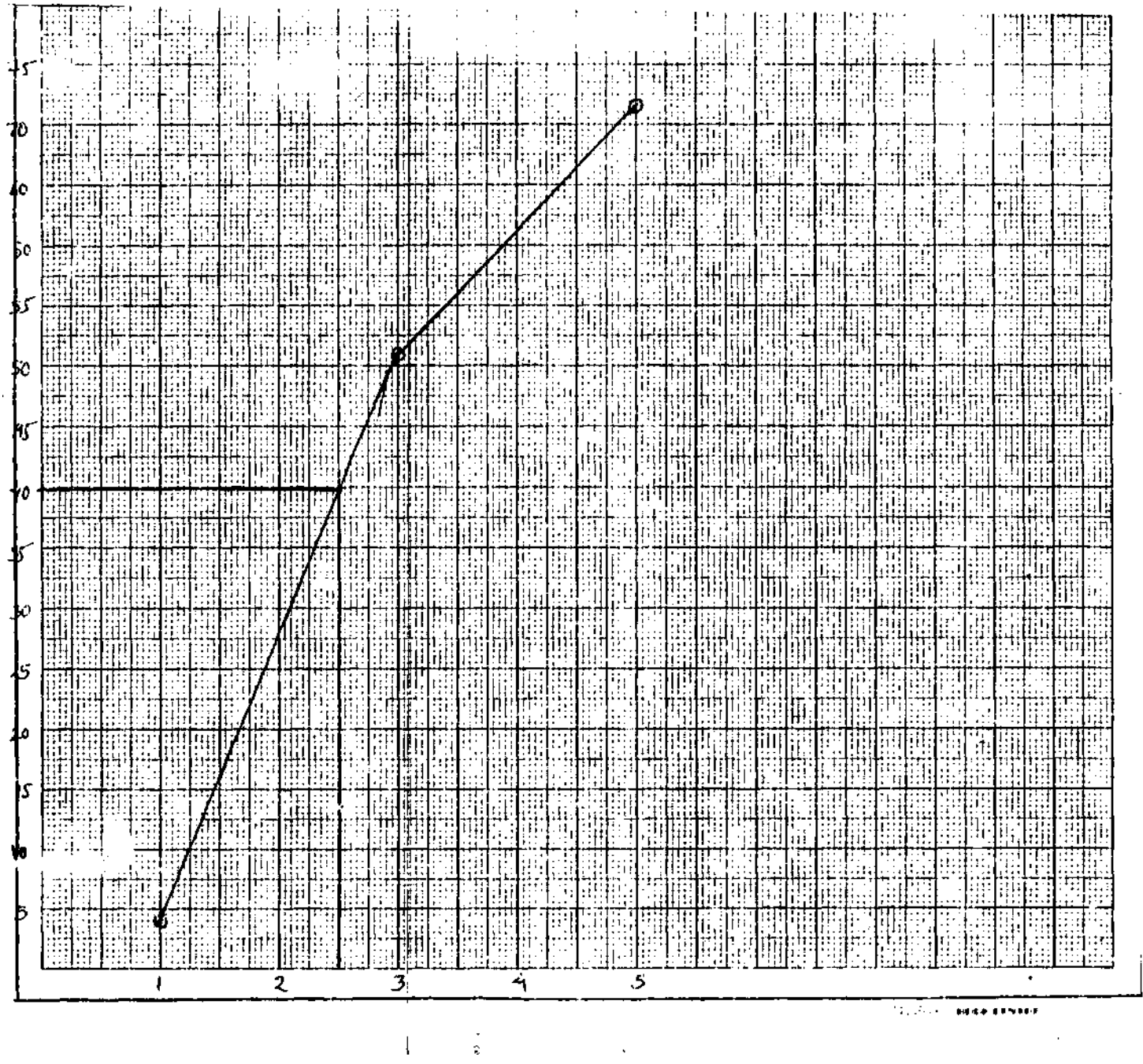


Graph-8: Showing relationship between volume control setting and corresponding gain in Model-VIII.

Gain at 50% volume control setting - 48 dB.

Reserve gain - 30.5 dB.

Volume control settings	Gain(Average) dB
5	71.5
3	51
1	4

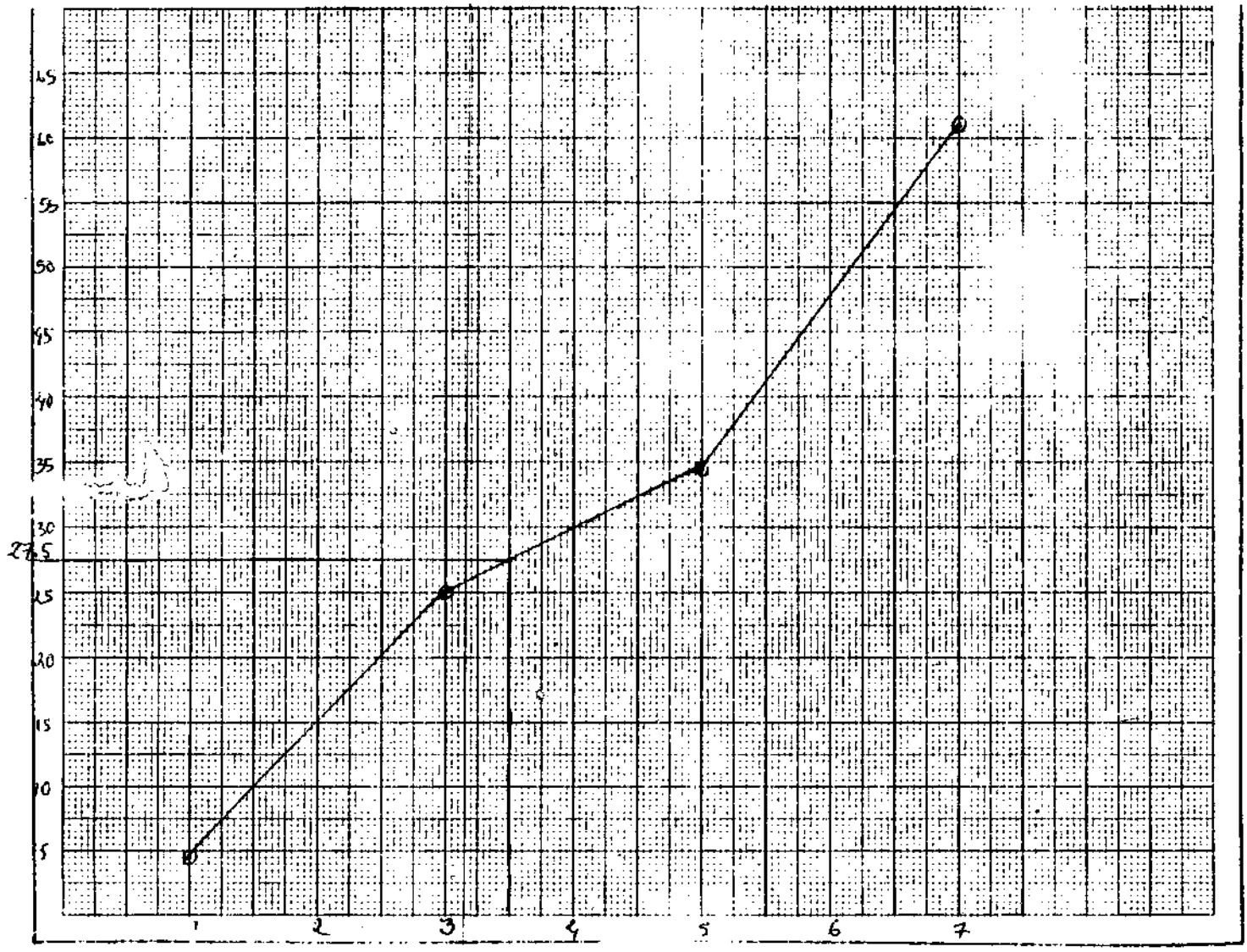


Graph-9: Showing relationship between volume control setting and corresponding gain in Model-IX.

- Gain at 50% volume control setting - 27.5 dB.

Reserve Gain - 33.5 dB.

Volume control setting	Gain (Average) dB
7	61
5	34
3	25
I	4



(after 50% volume control settings) below or upto 13 dB. Out of these 17 hearing aids, only one hearing aid had reserve gain more than the gain provided at 50% volume control setting (Model-IX). For remaining hearing aids, the reserve gain is less than half of the full gain.

DISCUSSION

Results indicate that only 57.5 percent of hearing aids only meet the manufacturer's claim of gain. 42.5 percent of hearing aids did not meet the manufacturer's claim of gain.

This indicates that before a hearing aid reaches the client, it needs to be examined whether it meets the claims made by manufacturer or not. Results also indicate that around 42% of hearing aids may not meet claims made by the respective manufacturers.

Regarding taper characteristics, at present manufacturers do not provide any information about their product. Results here indicate that relationship between increase in volume control setting and increase in gain is not a linear one. Out of 17 models of hearing aids, 7 models had reserve gain as mentioned by Raster) and Lotterman (13 dB) in/a study in 1969. Out of these, 17 models of hearing aids only 1 hearing aid had reserve gain more than the gain provided at 50% volume control setting (Model IX). For remaining hearing aids, though reserve gain is more than the reserve gain claimed by Kasten and Lotterman (13 dB) but, they have reserve gain is less than half of the full-on gain (9 Models),

Data also indicates that in 41% of hearing aids, very little gain (13 dB) is available even if we increase the volume control setting to 100% from 50% volume control setting.

If we increase beyond 50% volume control setting, it may be of little help to the patient because there is no significant increase in gain. Apart from this, there may be increase in distortion.

So, these results clearly indicate that we are in need of information on taper characteristics from the manufacturer. Results also indicate that, there is a need for frequent cross-cheks upon the information provided by the hearing aid manufacturers. We might also request that standards should be followed more strictly. There is a need for thorough checking of all electroacoustic characteristics of hearing aid before it reaches the aurally handicapped so that aural rehabilitation can be more efficient.

SUMMARY

A total of 120 body level hearing aids were taken up for the study. Out of these 102 were newly received from the manufacturers while the rest belonged to the group used. Of these 120 hearing aids, 51 belonged to strong category, 65 belonged to moderate category, 4 belonged to mild category. Hearing aids came from 7 manufacturers.

Hearing aid's taper characteristics as well as full-on acoustic gain was determined and curves for taper characteristics were drawn.

Only 57.5 percent of hearing aids met the manufacturer's claim of full-on gain, Fourty two percent of hearing aids did not meet the manufacturer's claim of gain.

Out of 17 models of hearing aids, 7 models of hearing aids were having reserve gain (after 50% volume control setting) below or upto 13 dB. Only 1 model had a reserve gain more than the gain provided at 50% volume control setting (Model IX). For the remaining 9 models of hearing aids, reserve gain was less than half of the full-on gain. This indicated that an increase in gain with an increase in volume control settings was not linear. Beyond 50% volume control settings little reserve gain was found.

These necessitate more strict imposition of standards, and the need for supplying of information on taper characteristics of each hearing aid model by respective hearing aid manufacturer.

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