

Puspa Shrestha

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Puspa Shrestha

A NEW PRESENTATION OF
Sagarmatha[®]

PHYSICS

Practical Note Book



Name: Dinesh

Class : Roll No Sec:

School/College:

Pages

120 ☐

144 ☐

192 ☒

240 ☐

Name of the institute.....

LABORATORY CERTIFICATE

This is to certify that Smt./Sri.....

..... has satisfactorily completed the
course of experiments in practical prescribed by the

..... course in the Laboratory of this
college in the year.....

Date:

Signature of the Teacher-in-charge of the batch
Head of the Department

Name of the Candidate.....

Registration No.....

Examination Centre

Date of the Practical Examination.....

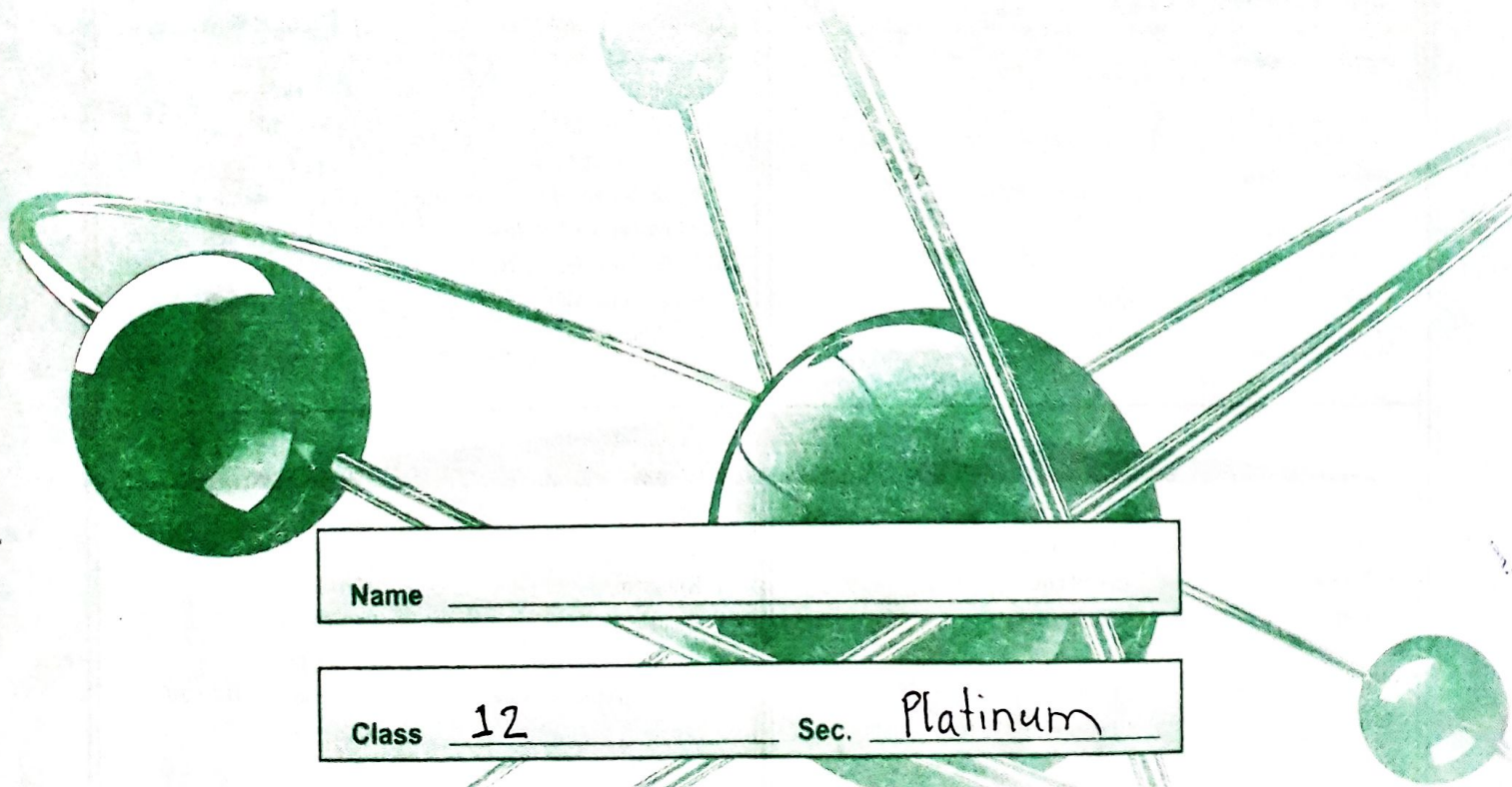


Sagarmatha



Physics

Practical Note Book



Name _____

Class 12 Sec. Platinum

Name Dinesh Shrestha Roll No. 11

HOW TO WRITE AN EXPERIMENT (EXPERIMENT NO.)

Date

Room Temp. =

At Pressure =

OBJECT :

Give the object of this experiment.

APPARATUS :

Write down the apparatus used in the experiment. (A line diagram of the main apparatus should be drawn on the left page and must be properly labelled.)

THEORY :

Give the theory involved in this experiment. The formula, used to calculate the result, should be given explaining the used symbols.

METHOD :

Describe briefly the procedure of the experiment.

OBSERVATION :

Write down the actual readings taken upon the apparatus. Take at least three readings of each observation and record them in tabular form as far as possible. Avoid over writing. This part of the record of the experiment is most important and hence should be written clearly and carefully.

CALCULATIONS :

Write down the formula to be used and substitute the values obtained to calculate the result.

RESULTS :

Simplification etc. should be done systematically on the left page. Do logarithmic calculation.

PRECAUTIONS AND

Write down clearly the actual results obtained from your observation. Over look the readings to get correct results.

SOURCES OF ERRORS :

Give the precautions taken in the experiment. Discuss the reasons for not getting standard results

SOME FORMULAE

Circumference of a circle, radius, r	-	$2\pi r$
Area of circle	-	πr^2
Area of ellipse, semi axes a & b	-	πab
Surface of a sphere	-	$4\pi r^2$
Volume of a cylinder	-	$\pi r^2 \times \text{height}$
Volume of a sphere	-	$\frac{4\pi}{3} r^3$
Volume of a cone	-	$\frac{1}{3} \pi r^2 \times \text{height}$
Volume of a pyramid	-	$\frac{1}{3} \text{ area of base} \times \text{height}$
Volume of a prism	-	$\text{Area of base} \times \text{height}$

SOME USEFUL CONSTANTS

Velocity of Light c	-	2.9982×10^{10} cm/sec.
Velocity of sound	-	332 Metres per sec
Acceleration due to Gravity g	-	981/cm/sec ² (Lahore)
Acceleration due to Gravity g	-	979.3cm/sec ² (Lucknow)
Gravitational Constant G	-	6.658 c.g.s. Unit.
Electronic Charge e	-	4.77×10^{-10} e.s.u.
Mass of Electron	-	9.0×10^{-28} gms.
Mass of Proton M	-	1.66×10^{-24} gms.
Faraday Constant	-	9.648×10^5 e.m.u.
Avogadro's Constant	-	6.023×10^{23} mole ⁻¹
Gas Constant for 1 mole Rm	-	8.314×10^7 erg/deg/mole
Volume of one mole at N.T.P.	-	22.414 Litres
One Electronic Volt	-	1.60203×10^{-12} ergs.
Joules Equivalent	-	4.18 Joule/cal.
Ice Point T	-	273.16°K

CONVERSION FACTORS

1 Inch	-	2.54 cm
1 Grain	-	64.8 miligram
1 Pound	-	453.59 gm.
1 Pint	-	0.568 litre
1 Gallon	-	4.546 litre
1 Radian	-	57.296 s.
1 Joule	-	10 ergs = 23.731 ft. poundal
1 Horse Power	-	746K watts = 550 ft. lbs/sec.
1 Ampere	-	$10^{-1} = 1.9 \times 10^{-9}$
1 Ohm	-	$10^{-9} = 1.9 \times 11^{-11}$
1 Calorie	-	4.118×10^7 egs.

1 cm.	-	0.394 inch
1 Quince	-	28.35 gm.
1 Kilogram	-	2.2046 lbs.
1 Quart	-	1.136 litres
1 Kw	-	1.340 h.p.
1 Atomospheric pressure	-	$14.7 \text{ lb/in}^2 = 1.014 \times 10^5$
		dynes/cm ²
1 Columb	-	$10^{-1} \text{ e.m.u.} = 3 \times 10^9 \text{ e.s.u.}$
1 Volt	-	$10^8 \text{ e.m.u.} = 1/3 \times 10^7 \text{ e.s.u.}$
1 Faraday	-	$10^8 \text{ e.m.u.} = 9 \times 10^{11} \text{ e.s.u.}$
1 B.Th.U.	-	251.9 cal.

• HOW TO USE LOGARITHMIC TABLES •

How to use logarithmic tables is a problem to the new students. With an idea to facilitate those students who are slow pickers or who forget soon, this article will be helpful. The calculations, as every student knows, must be done by using Logarithmic table. It has two advantages. Firstly the examiner wants the calculations to be done by logarithmic method and sometimes he explicitly mentions it. Thus this method obviously fetches more marks and secondly the calculations become very easy as the multiplications and division here changes to addition and subtraction respectively. To make calculations by this method students must remember the following very important and necessary formula.

$$\begin{aligned}\log(mn) &= n \log m & \dots & (1) \\ \log(m^n) &= \log m + \log n & \dots & (2) \\ \log(m/n) &= \log m - \log n & \dots & (3)\end{aligned}$$

All kind of calculations by Logarithmic method can be broadly divided into three parts and a detailed knowledge of all the three parts will enable students to solve all problems that arise in the calculations for an experiment. The part are :

- (a) To find the Logarithm of a number.
- (b) To find the Antilogarithm of a number.
- (c) to find the sines, cosines, tangent and cotangent of an angle.

- (a) The logarithm of any number contains two parts. One before the decimal called characteristic and other the decimal term called the mantissa. It is only the mantissa which we know from Logarithmic table and the characteristic is found by the rule that it is always less by unity from the number of digits before decimal, if any a number. Thus in 980 number of digits are 3 and hence the characteristic is 2. In 0.486 number of digits before decimal is 0 and hence the characteristic is -1 written as $\bar{1}$. This is because it is the characteristic which can be in certain cases negative as in the second example but the mantissa always remains positive.

How to make the mantissa would be clear from the following example. Let us suppose we are to find the logarithm of 3.14 (i.e.) which is the most common factor in the calculation. Its characteristic will be : 0. Now mantissa of a number is the same irrespective of the position of the number and hence the mantissa of 3.14 will be the same as that of 314. We therefore find the mantissa for 314.

Put your finger in the first column of the logarithm table at 31 and then note number in the sixty column of the row of 31. You will see that at the top of sixth column is written a digit 4 which is the third digit of our number. Thus we find that

$$\log 3.14 = 0.4969$$

- (b) Antilogarithm is the inverse of logarithm i.e. we are now to find the number whose logarithm will be the given term. Proceed for decimal part exactly as in part (a) for mantissa using the Antilogarithm table. The digits before decimal tells us about the position of decimal in the number. In the case number of digits will be more by unity than the digit of the characteristic.
- (c) Need of finding the sines, cosines, tangents and cotangents arise whenever they occur in the formula e.g. in verifying inverse. Square Law by Deflection Magnetometer we are required to find tangents. Generally the tables for sines give tangents. Cosines and cotangents are found with the help of trigonometrical formulae.

$$\begin{aligned}\sin(90^\circ - \theta) &= \cos \theta & \dots & (4) \\ \tan(90^\circ - \theta) &= \cot \theta & \dots & (5)\end{aligned}$$

Name of the cells	Positive Electrode	Negative Electrode	Electrolyte	Depolariser	e.m.f. in volts	Internal resistance in ohms (approx)	Remark
Primary cells	Copper	Zinc	H ₂ SO ₄ (dil)	Nil	1.5	High	Gets paralysed
Voltaic Cell	Copper	Zinc	H ₂ SO ₄ (dil)	CuSO ₄	1.1	1 to 4	Current not steady.
Daniel Cell	Copper	(Amalgamated)			(app.)		Gives low but fairly constant e.m.f. used for comparison work
Lecianche cell	Carbon	Do	NH ₄ Cl	MnO ₂ + C	1.4	0.25 to 4	Depolarisation is not complete and hence gives intermittent current.
Dry cell	Do	Zinc cylinder	Paste of NH ₄ Cl and ZnCl ₂	Mixture of MnO ₂ , Carbon, NH ₄ Cl and ZnCl ₂	1.45	0.25 to 4	It is portable and hence used in torches.
Bichromate Cell (Single fluid)	Do	Zinc (Amalgamated)	H ₂ SO ₄	K ₂ CrO ₄ + H ₂ SO ₄	1.9 to 2.1	0.5	It is expensive, Gives large and steady current.
Secondary cells	PbO ₂	Pb	H ₂ SO ₄	Direct and reverse chemical	2.1	0.01	Gives large and steady current.
Lead accumulator	NI (OH)	Fe	20% KOH solution and a lithium chloride	Do	1.35	0.1	More robust than the lead accumulator

1. DENSITY OR MASS IN GRAMPER C.C.

Elements	Common Substances	Liquids
Aluminium 2.7	Bee Was 0.96-0.97	Alcohol (Ethyl) 0.8070°C
Antimony 7.62	Box Wood 0.95-1.16	Alcohol (Methyl) 0.8100°C
Bismuth 9.80	Brass 8.4-3.7	Aniline 1.0350°C
Copper 8.3-8.95	Cork 0.3-0.6	Castor Oil 0.970°C
Gold 19.3	Cork 0.22-0.26	Ether 0.7360°C
Iron 7.5-7.9	Ebonite 1.15	Glycerine 1.260°C
Lead 11.3	Glass (Common) 2.4-2.8	Kerosene Oil 0.800°C
Magnesium 1.74	Glass (Flint) 2.9-5.9	Mercury 13.60°C
Nickel 8.6-8.9	Ice 0.927	Mustard Oil 0.8-0.830°C
Osmium 22.5	Mahogany 0.85	Olive Oil 0.91-0.930°C
Platinum 21.45	Oak 0.60-0.90	Paraffin Oil 0.8780°C
Silver 10.5	Paraffin Wax 0.87-0.91	Petrol 0.70-0.80 15°C
Tin 7.5	Pitch Pine 0.83-0.85	Spirit 0.880°C
Zinc 7.1	Wal Nut 0.64-0.70	Water 0.99990°C
	Yellow Pine 0.37-0.60	

2. ELASTIC CONSTANTS

Substance	Young modulus y 10^{11} dynes/cm ²	Rigidity 10^{11} dynes/cm ²	Bulk modulus-k 10^{11} dynes/cm ²	Poisson's Ratio b
Aluminium	7.2-7.5	2.5-3.4	7.46	0.84
Brass	9.7-10.1	3.5	10.6	0.34-0.40
Copper	10.5-12.5	3.5-4.5	14.3	0.26
German Silver	11.6	4.3-4.7	—	0.37
Glass	5.1-7.1	3.1	3.75	0.13-0.32
Iron (cast)	10-13	3.5-5.3	9.6	0.23-0.31
Iron (Wrought)	19.20	7.7-8.3	14.6	0.27
Lead	1.6	5.6	5	—
Magnin	12.4	4.65	12.1	0.33
Phosphorbronze	—	12.0	4.4	0.46-40
Rubber	.00015 - .0005	.00005	—	0.46-40
Silver	7.1	2.5	10.9	—
Steel	20.9	8.12	16.4	0.29

3. OPTICAL CONSTANTS

Refractive indices (Sodium Lines)	Critics! Angles
Air (N.T.P.) 1.00029	41°
Glass, Crown 1.48 to 1.46	37°
Glass, flint 1.58 to 1.96	24°
Glycerine 1.47	44°40
Diamond 2.42	44°30
Paraffin Oil 1.44	—
Quartz 0.55	—
Turpentine 1.47	—
Water 1.44	41°30

ELECTRICAL CONSTANTS —e.m.f. of CELLS—

Bichromate 2.0	Volts
Bunsen 1.8-1.9	Volts
Cadmium 1.0183(at 20°C)	Volts
Clark (Standard) 1.433	Volts
Daniell 1.08	Volts
Grove 1.8-1.9	Volts
Lead Accumulator 2.2	Volts
Leclanche 1.5	Volts
Ni-Fe Accumulator 1.3	Volts
Standard (Weston) 1.018	Volts

4. TERRESTRIAL MAGNETIC CONSTANTS

Place	Declination	Inclination	H Horizontal Intensity (Gauss)	V Vertical Intensity
Agra	0°1CE	40°40	9.348	—
Aligarh	0°20E	41°50	0.346	—
Allahabad	0°20W	37°10	0.363	—
Bareilly	0°20E	42°20	0.344	—
Mumbai	0°40E	25°30	0.376	—
Calcutta	0°32W	30°59	0.382	0.1669
Chandausi	0°30E	42°40	0.374	0.2246
Dehra Dun	0°30E	45°50	0.343	—
Delhi	0°40E	42°52	0.332	—
Greenwich	14°18W	66°54	0.345	—
Gorakhpur	0°20W	39°40	0.1845	0.4325
Khurja	0°30E	42°10	0.343	—
Lucknow	0°10E	40°00	0.354	—
Meerut	0°41E	46°30	0.339	—
North Pole	—	90°	—	—
South Pole	—	90°	—	—
Udaypur	0°00	35°50	0.362	—

SPECIAL RESISTANCE MICHROMS PER CM CUBE

Aluminium	3.21	Manganin	44.5
Brass	6.6	Mercury	99
Copper	1.78	Nichrome	110
Constantan	49	Platinum	11
Eureka	36 to 49	Phosphor-Bronze	5-10
Iron (cast)	16.8	Silver	1.66
Iron (wrought)	13.9	Steel	19.9
Lead	20.8	Tungsten	5
Carbon	3.5	Plantinold	14.4
Tantalum	14.6		

ELECTRO-CHEMICAL EQUIVALENT

Element	Chemical symbol	Atomic weight	Valency Equivalent	Chemical Equivalent	E.C.E. in gms/coulomb
Aluminium	Al	27.1	3	9.03	.0000936
Chlorine	Cl	35.46	1	35.46	.0003676
Chromium	Cr	52.01	3	17.34	.0001796
Copper	Cu	63.57	2	38.785	.0003294
Gold	Au	197.2	3	65.73	.0006812
Hydrogen	H	1.0078	1	1.0078	.00004125
Nickel	Ni	58.68	2	29.45	.0003040
Oxygen	O	16.00	2	8	.00008291
Silver	Ag	107.88	1	107.38	.0011180
Zinc	Zn	65.38	2	32.69	.0003387

COEFFICIENT OF EXPANSION

Coefficient of Linear Expansion of Solids

Aluminium	0.000022	Iron	0.0000114
Brass	0.000019	Lead	0.000029
Copper	0.000017	Platinum	0.000004
German Silver	0.000018	Silver	0.000019
Glass	0.000085	Tin	0.0000219

Coefficient of Cubical Expansion of Liquids

Alcohol	0.00122	Olive Oil	0.0007
Aniline	1.00085	Sulphuric Acid	0.0095
Glycerine	0.00052	Turpentine	0.00093
Mercury	0.00018	Water (10-30)	0.000203

Coefficient of Cubical Expansion of Gases

The Coefficient of increase of volume of all gases at constant pressure and the coefficient of increase of pressure of all gases at constant volume may be taken to be $1/273$ or .00365

Specific Heats of Solids

Aluminium	2.21	Iron	0.11
Brass	0.09	Lead	0.08
Charcoal	0.19	Marble	0.22
Copper	0.095	Sand	0.19
Glass	0.16-0.19	Silver	0.056
Gold	0.03	Tin	3.055
Bismuth	0.03	Zinc	0.033
India Rubber	0.48	Paraffin	0.64
Ice (0°C)	0.50	Sulphur	0.164
Common Salt	0.02	Nickel	0.11

Specific of Heats of Liquids

Alcohol	0.62	Mustard Oil	9.50
Aniline	0.50	Mercury	0.030
Glycerine	0.58	Turpentine	0.43
Paraffin Oil	0.58	Water	1.00

Specific Heats of gases (at Const Pressure)

Air	0.937	Oxygen	0.917
Steam	0.465	Hydrogen	0.41

Latent Heats of Fusion (Calories)

Ice	80.0	Mercury	2.8
Sulphur	9.4	Lead	5.4
Silver	12.0	Bismuth	21.0

USEFUL FORMULAE

1. GENERAL PROPERTIES

1. Radius of curvature by spherometer

$$R = \frac{C^2}{6h} + \frac{h}{2}$$

where h = distance by which central leg is raised

c = distance between any two outer legs

2. Young's modulus

$$Y = \frac{mg \times h}{\pi r^2 l} \text{ dynes/cm}^2$$

3. R of solid (Nicholson's Hydrometer)

$$= \frac{W_1 - W_2}{W_1 - W_3}$$

$$\text{Liquid} = \frac{W_1 - W_2}{W_1 - W_3}$$

Where W_1 = wt. required to sink the hydrometer upto the mark in water

W_2 = wt. required when body is in upper pan.

W_3 = wt. required when body is in lower pan of water.

W_4 = wt. required when body is in lower pan in liquid.

2. HEAT

1. Coefficient of linear expansion

$$L = \frac{l_2 - l_1}{h(t_2 - t_1)} \text{ per } ^\circ\text{C}$$

where l_1 = length at t_1 $^\circ\text{C}$

l_2 = length at t_2 $^\circ\text{C}$

2. Specific heat (mixture method)

$$S = \frac{(w + w_s)(T - t_1)}{m(t_2 - T)}$$

where m = mass of solid

S = Sp. ht. of solid

t_1 = Initial temp. of water

t_2 = Initial temp. of solid

T = Final temp. of mixture

3. Pressure coefficient

$$Y = \frac{P_2 - P_1}{P_1 t_2 - P_2 t_1}$$

where P_1 = Pressure of gas at t_1 $^\circ\text{C}$

P_2 = Pressure of gas at t_2 $^\circ\text{C}$

4. Specific heat (cooling method)

$$S = \left(\frac{m + w}{M} \right) \frac{T_1}{T_2} \cdot \frac{w}{M}$$

where

m = mass of solid

S = sp. ht. of solid

m = mass of water

w = water equivalent of calorimeter

T_1 = Time taken by liquid in cooling

T_2 = Time taken by water in cooling

5. Latent Heat $L = \frac{(m + M_s S_o)(t_2 - t_1)}{M} - (T - t_1)$

where M = mass of steam condensed

m = mass of water taken

m_1 = mass of cal. meter t = Int

temp. T_1 = final temp. of steam

3. OPTICS

1. Focal length of concave mirror by pin method $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

2. Focal length of convex lens U-V method $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

3. Focal length of convex lens by displacement method $f = \frac{D^2 - x^2}{4d}$

where D = Distance between object and screen

x = Distance between the two position of lens.

4. Focal length of combination of concave and convex lenses.

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

5. Candle powers of two lamps by Photometer. $\frac{P_1}{P_2} = \frac{d_1^2}{d_2^2}$

where d = distance of P. power lamp from greased spot.

d = distance of P. power lamp from greased spot screen.

6. Refractive index of glass by Minimum Deviation method

$$\mu = \frac{\sin \left(\frac{A + D}{2} \right)}{\sin A/2}$$

where A = Angle of Prism, D = Angle of min. deviation.

7. μ of glass of liquid by travelling microscope (Depth Microscope)

$$\mu = \frac{\text{Real Thickness}}{\text{Apparent thickness}} = \frac{3\text{rd reading} - 1\text{st reading}}{3\text{rd reading} - 2\text{nd reading}}$$

4. SOUND

1. Frequency of a source by sonometer $m = \frac{1}{2l} \frac{T}{\sqrt{\mu}}$

where l = length of Sonometer wire between two bridges

T = tension applied

m = mass per unit length of wire

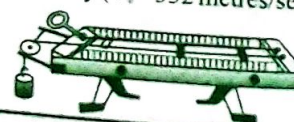
2. Velocity of sound by Sonometer $V = 2n(l_2 - l_1)$

where n = frequency of tuning fork

l_1 = length of air column at first resonance

l_2 = length of air column at second resonance

$V_1 = V_0(1 + 0.00183t)$ V_0 denote velocities at t $^\circ\text{C}$ and 0°C respectively ($V_0 = 332$ metres/sec.)



5. MAGNETISM

1. Pole strength of magnet

$$m = \frac{(d^2 - l^2)^{3/2}}{4ld} \times H$$

Tan A Position

$$m = \frac{(d_1^2 - l_1^2)^{3/2}}{2l} \times H$$

Tan B Position

$$\frac{H}{\left(\frac{\cos \theta_1}{d_1} - \frac{\cos \theta_2}{d_2} \right)}$$

East West Position

$$\left[\frac{1}{a} - \frac{d^{1/2}}{d^2 + 4/2} \right]$$

Vertical magnet

2. Compare of Magnetic Moment

(a) By deflection Magnetometer

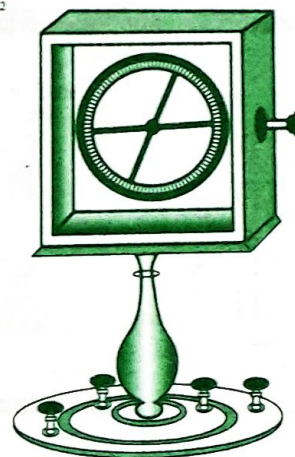
$$\frac{M_1}{M_2} = \frac{(d_{22} + l_{12})_2}{2} \times \frac{d_1}{d_2} \times \frac{\tan Q_1}{\tan Q_2} \quad \text{Tan A Position}$$

$$\frac{M_1}{M_2} = \frac{(d_{22} + l_{12})_{3/2}}{(d_{12} + l_{12})_{3/2}} \times \frac{\tan Q_1}{\tan Q_2} \quad \text{Tan A position}$$

(b) Vibration Magnetometer

$$\frac{M_1}{M_2} = \frac{T_1}{T_2} \times \frac{T_{22}}{T_{12}} \quad \text{Separate Method } \frac{l^2 + b^2}{l^2} \times m$$

$$\frac{M_1}{M_2} = \frac{T_{12}}{T_{13}} + \frac{T_{12}}{T_{22}} \quad \text{Combination Method}$$



6. ELECTRICITY

1. Resistance by P.O. Box and meter Bridge

(1) $S = R \times P/Q$ - P.O. Box

R = Resistance in 3rd arm.

P & Q = Resistance in Ratio arm.

$$(2) S = R \times \frac{h}{100 - l_1} - M. \text{ Bridge}$$

l_1 = length of the wire at the null point from one end.

2 e.m.f. of cells :-

$$(a) \text{ By potentiometer : } \frac{E_1}{E_2} = \frac{l_1}{l_2}$$

l_1, l_2 = length of the Potentiometer wire as divided by null point.

(b) By Tangent Galvanometer.

$$\frac{E_1}{E_2} = \frac{\tan Q_1 + \tan Q_2}{\tan Q_1 + \tan Q_2} \quad \begin{matrix} Q_1, Q_2 \text{ Deflection in} \\ \text{Tangent galvanometer for} \\ \text{first and second cell} \end{matrix}$$

(3) Reduction factor

Where w = wt. of deposit on cathode

t = time for which current is passed

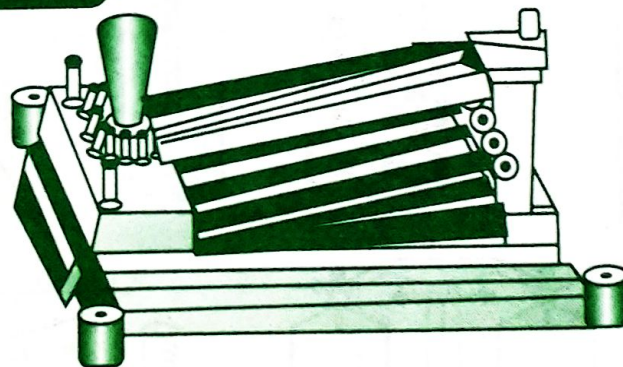
Q = Deflection in Tangent Galvanometer.

(4) e.c.e. of copper :-

$$z = W/\text{ext.}$$

w = wt. of deposit on cathode

c = Amps current passed for t sec.



5. Value of J by Electrical method :

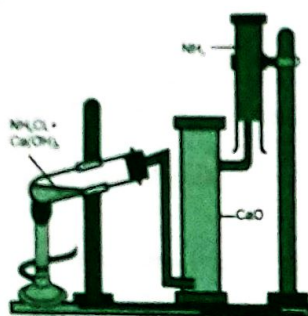
$$J = \frac{Ect}{H} + 10^7 \text{ ergs per cal.}$$

E = Voltage applied

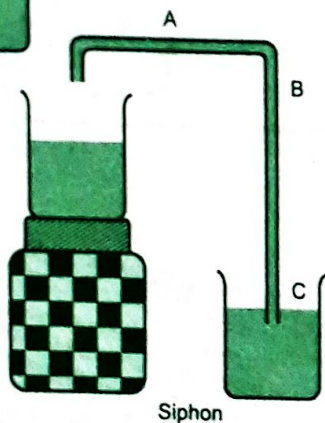
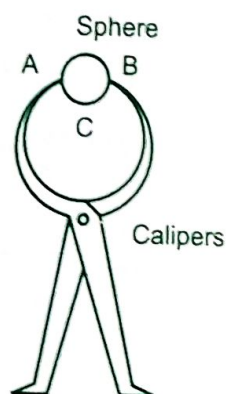
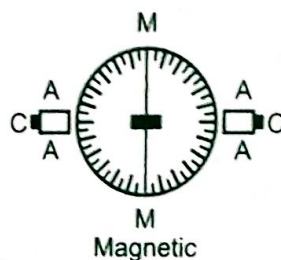
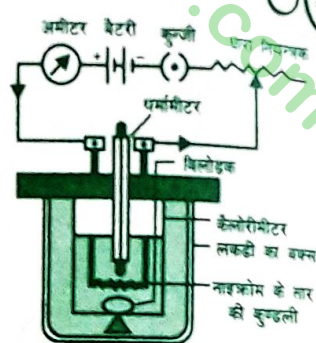
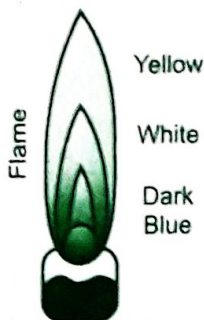
C = Current passed for time t

H = Heat taken by calorimeter and water.

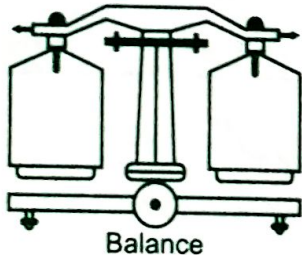
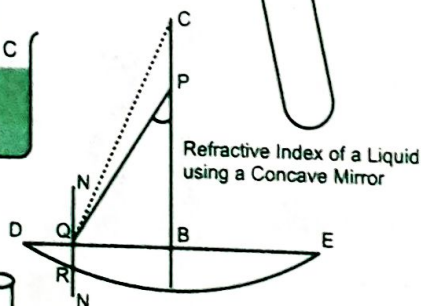
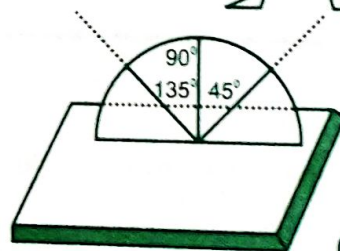
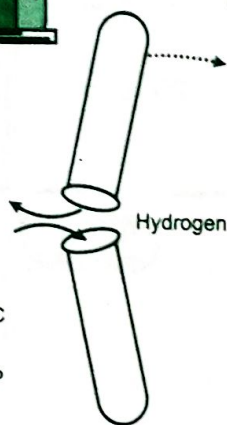




Lab preparation of Ammonia



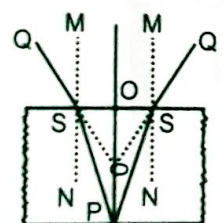
Siphon



Balance



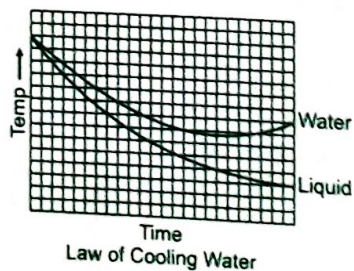
Meridian Plan



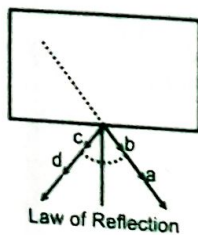
Apparent Thickness



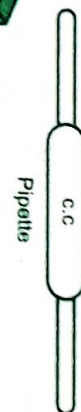
Burette



Law of Cooling Water

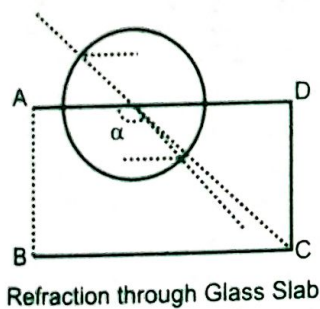
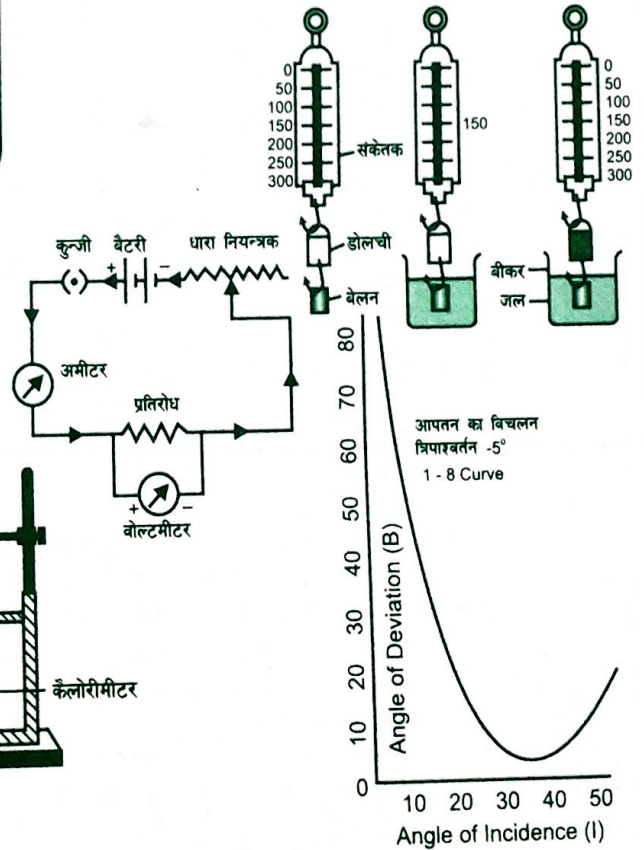
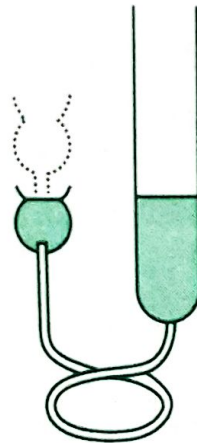
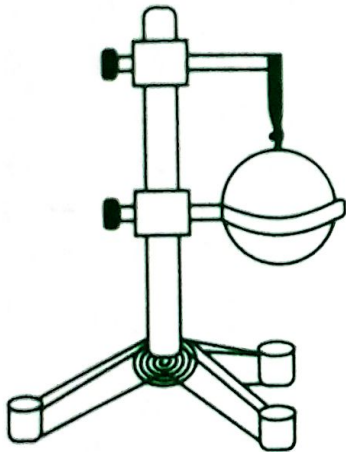
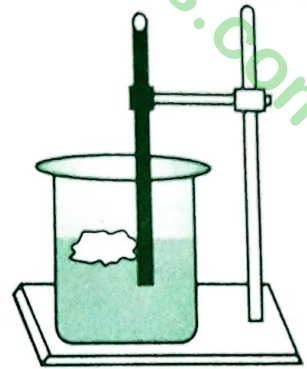
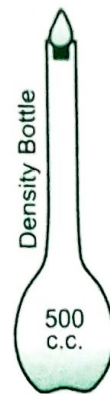
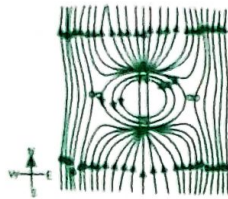
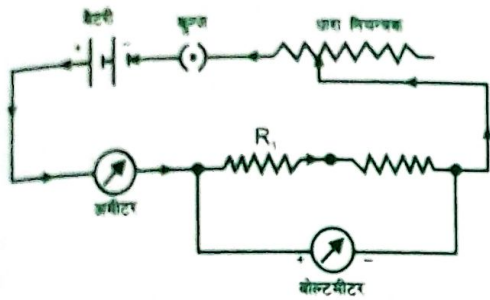


Measuring Cylinder

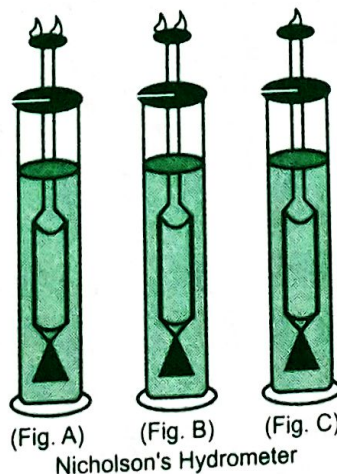
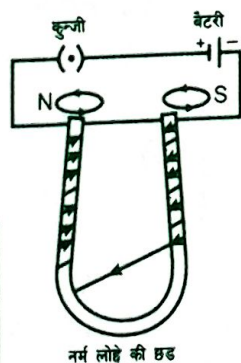
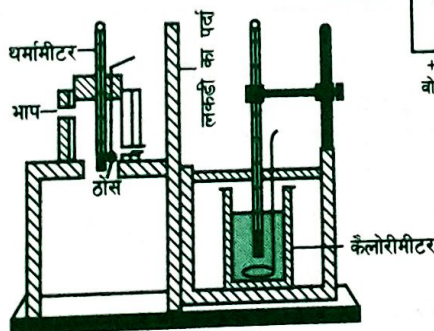


Pipette

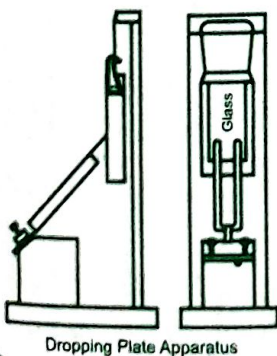




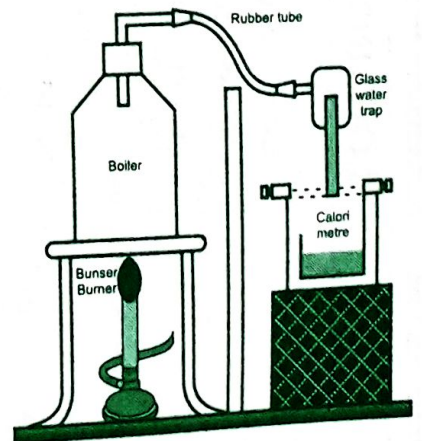
Refraction through Glass Slab



Nicholson's Hydrometer



Dropping Plate Apparatus



LOGARITHMS

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11 0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	51 7076	7084	7093	7101	7110	7118	7126	7135	7143	7152
12 0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	52 7160	7168	7177	7185	7193	7202	7210	7218	7226	7235
13 1139	1175	1206	1239	1271	1303	1335	1367	1399	1430	53 7243	7251	7259	7267	7275	7284	7292	7300	7308	7316
14 1461	1492	1523	1555	1584	1614	1644	1673	1703	1732	54 7324	7332	7340	7348	7356	7364	7372	7380	7388	7396
15 1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	55 7404	7412	7419	7427	7435	7443	7451	7459	7466	7474
16 2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	56 7482	7490	7497	7505	7513	7520	7528	7536	7543	7551
17 2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	57 7569	7576	7582	7589	7597	7604	7612	7619	7627	7634
18 2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	58 7634	7642	7649	7657	7664	7672	7679	7686	7694	7701
19 2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	59 7709	7716	7723	7731	7738	7745	7752	7760	7768	7774
20 3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	60 7782	7789	7796	7803	7810	7818	7825	7832	7839	7846
21 3222	3243	3265	3284	3304	3324	3345	3365	3385	3404	61 7853	7860	7868	7875	7882	7889	7896	7903	7910	7917
22 3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	62 7924	7931	7938	7945	7952	7959	7966	7973	7980	7987
23 3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	63 7993	8000	8007	8014	8021	8028	8035	8041	8048	8055
24 3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	64 8062	8069	8075	8082	8089	8096	8102	8109	8116	8122
25 3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	65 8129	8136	8142	8149	8156	8162	8169	8176	8182	8189
26 4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	66 8195	8202	8209	8215	8222	8228	8235	8241	8248	8254
27 4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	67 8261	8267	8274	8280	8287	8293	8299	8306	8312	8319
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29 4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	69 8388	8395	8401	8407	8414	8420	8426	8432	8439	8445
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31 4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	71 8513	8519	8525	8531	8537	8543	8549	8555	8561	8567
32 5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	72 8573	8579	8585	8591	8597	8603	8609	8615	8621	8627
33 5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	73 8633	8639	8645	8651	8657	8663	8669	8675	8681	8686
34 5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	74 8692	8698	8704	8710	8716	8722	8727	8733	8739	8745
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										93 9685	9689	9694	9699	9703	9708	9713	9717	9722	9727
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ANTILOGARITHMS

NATURAL SINES

NATURAL SINES

NATURAL SINES																
		0°	6'	12'	18'	24'	30'	36'	42'	48'	54'	Mean differences				
		0°	6'	12'	18'	24'	30'	36'	42'	48'	54'	2	3	4	5	
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9	1564	1582	1599	1616	1633	1650	1668	1685	1702	1719	3	6	9	12	15	
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68	9827	9839	9851	9863	9875	9887	9899	9911	9923	9935	3	6	9	12	15	
69	9947	9959	9971	9983	9995	1000	1000	1000	1000	1000	3	6	9	12	15	
70	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
71	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
72	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
73	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
74	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
75	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
76	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
77	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
78	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
79	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
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81	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
82	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
83	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
84	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	3	6	9	12	15	
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NATURAL COSINES

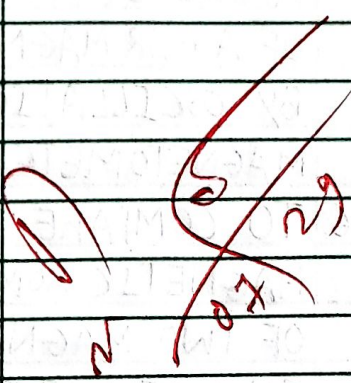
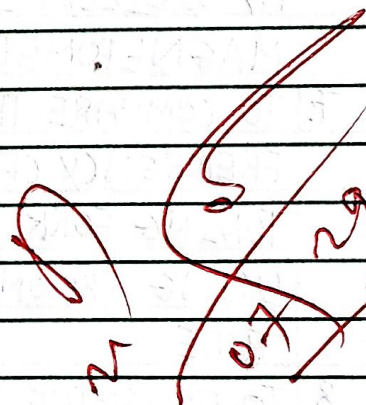
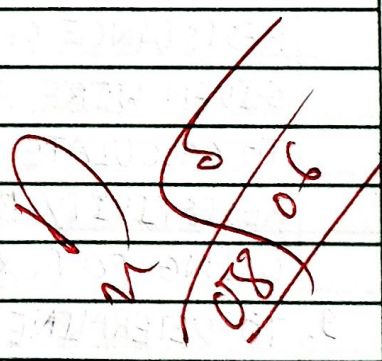
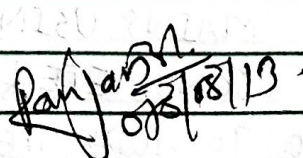
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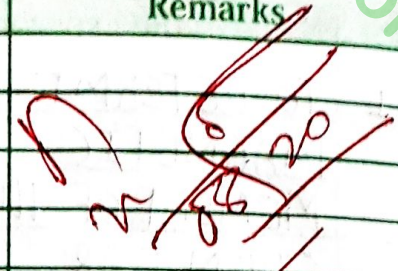
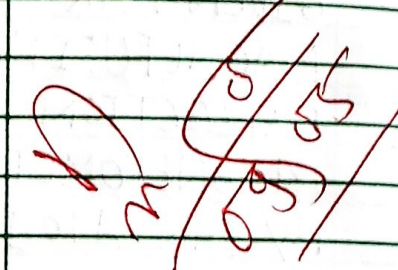
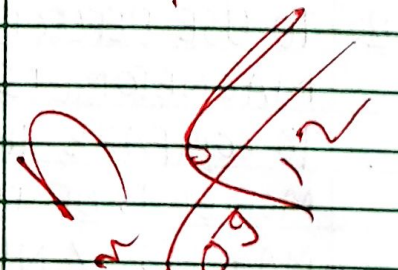
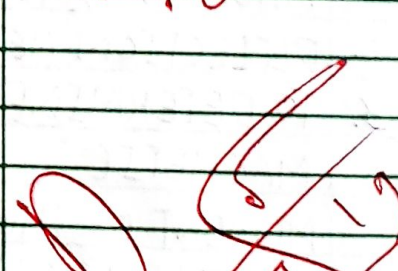
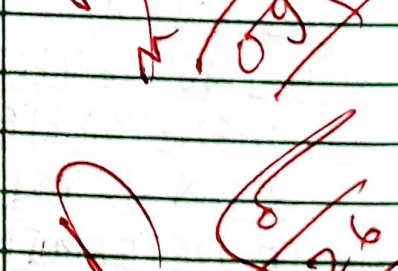
	0'	0'	12'	18'	24'	30'	36'	42'	48'	54'	Mean differences				
	0° 0'	0° 1'	0° 2'	0° 3'	0° 4'	0° 5'	0° 6'	0° 7'	0° 8'	0° 9'	1	2	3	4	5
5	7071	7059	7046	7034	7022	7009	6997	6984	6972	6959	2	4	6	8	10
6	6947	6934	6921	6909	6896	6884	6871	6858	6845	6832	2	4	6	8	11
7	6820	6807	6794	6782	6769	6756	6743	6730	6717	6704	2	4	7	9	11
8	6691	6678	6665	6652	6639	6626	6613	6600	6587	6574	2	4	7	9	11
9	6561	6547	6534	6521	6508	6494	6481	6468	6455	6441	2	4	7	9	11
10	6428	6414	6401	6388	6374	6361	6347	6334	6320	6307	2	4	7	9	11
11	6293	6280	6266	6252	6238	6225	6211	6198	6184	6170	2	5	7	9	11
12	6157	6143	6129	6115	6101	6088	6074	6060	6046	6032	2	5	7	9	12
13	6018	6004	5990	5976	5962	5948	5934	5920	5906	5892	2	5	7	9	12
14	5878	5864	5850	5835	5821	5807	5793	5779	5764	5750	2	5	7	9	12
15	5736	5721	5707	5693	5678	5664	5650	5635	5621	5606	2	5	7	10	12
16	5592	5577	5563	5548	5534	5519	5505	5490	5476	5461	2	5	7	10	12
17	5446	5432	5417	5402	5388	5373	5358	5343	5328	5314	2	5	7	10	12
18	5299	5284	5270	5255	5240	5225	5211	5195	5180	5165	2	5	7	10	12
19	5150	5135	5120	5105	5090	5075	5060	5045	5030	5015	3	5	8	10	13
20	5000	4985	4970	4955	4939	4924	4909	4894	4879	4863	3	5	8	10	13
21	4848	4833	4818	4802	4787	4772	4756	4741	4726	4710	3	5	8	10	13
22	4695	4679	4664	4648	4633	4617	4602	4586	4571	4555	3	5	8	10	13
23	4540	4524	4509	4493	4478	4462	4446	4431	4415	4399	3	5	8	10	13
24	4384	4368	4352	4337	4321	4305	4289	4274	4258	4242	3	5	8	11	13
25	4226	4210	4195	4179	4163	4147	4131	4115	4099	4083	3	5	8	11	13
26	4067	4051	4035	4019	4003	3987	3971	3955	3939	3923	3	5	8	11	14
27	3907	3891	3875	3859	3843	3827	3811	3795	3778	3762	3	5	8	11	14
28	3746	3730	3714	3697	3681	3665	3649	3633	3616	3600	3	5	8	11	14
29	3584	3567	3551	3535	3518	3502	3486	3469	3453	3437	3	5	8	11	14
30	3420	3404	3387	3371	3355	3338	3322	3305	3289	3272	3	5	8	11	14
31	3256	3239	3223	3206	3190	3173	3156	3140	3123	3107	3	5	8	11	14
32	3090	3074	3057	3040	3024	3007	2990	2974	2957	2940	3	5	8	11	14
33	2924	2907	2890	2874	2857	2840	2823	2807	2790	2773	3	5	8	11	14
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35	2586	2571	2554	2538	2521	2504	2487	2470	2453	2436	3	5	8	11	14
36	2419	2402	2385	2368	2351	2334	2317	2300	2284	2267	3	5	8	11	14
37	2250	2233	2215	2198	2181	2164	2147	2130	2113	2096	3	5	8	11	14
38	2079	2062	2045	2028	2011	1994	1977	1959	1942	1925	3	5	9	11	14
39	1908	1891	1874	1857	1840	1822	1805	1788	1771	1754	3	5	9	11	14
40	1736	1719	1702	1685	1668	1650	1633	1616	1599	1582	3	5	9	12	14
41	1584	1557	1530	1513	1495	1478	1461	1444	1426	1409	3	5	9	12	14
42	1392	1374	1357	1340	1323	1305	1288	1271	1253	1236	3	5	9	12	14
43	1219	1201	1184	1167	1149	1132	1115	1097	1080	1063	3	5	9	12	14
44	1045	1028	1011	993	976	958	941	924	906	889	3	5	9	12	14
45	0872	0854	0837	0819	0802	0785	0767	0750	0732	0715	3	5	9	12	15
46	0696	0680	0663	0645	0628	0610	0593	0576	0558	0541	3	5	9	12	15
47	0523	0506	0488	0471	0454	0436	0419	0401	0384	0366	3	5	9	12	15
48	0349	0332	0314	0297	0279	0262	0244	0227	0209	0192	3	5	9	12	15
49	0175	0157	0140	0122	0105	0087	0070	0052	0035	0017	3	5	9	12	15

NATURAL TANGENTS

	0°	6°	12°	18°	24°	30°	36°	42°	48°	54°		Mean differences				
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45	1 0000 0353	0070	0105	0141	0176	0212	0247	0283	0319	0359	1	24	18	24	30	36
46	1 0355 0392	0428	0468	0514	0558	0575	0612	0649	0686	0723	2	12	18	24	30	36
47	1 0724 0761	0799	0837	0875	0913	0951	0990	1028	1067	1105	3	12	18	25	31	37
48	1 1106 1145	1184	1224	1263	1303	1343	1383	1423	1463	1503	4	13	19	25	32	39
49	1 1504 1544	1585	1626	1667	1708	1750	1792	1833	1875	1917	5	13	20	27	33	40
												14	21	28	34	41
50	1 1918 1960	2002	2045	2088	2131	2174	2218	2261	2305	7	14	22	29	36	43	50
51	1 2349 2393	2437	2482	2527	2572	2617	2662	2708	2753	8	15	23	30	37	44	51
52	1 2799 2846	2892	2938	2985	3032	3079	3127	3175	3222	9	16	24	31	38	45	52
53	1 3270 3319	3367	3416	3465	3514	3564	3613	3663	3713	10	16	25	33	41	49	56
54	1 3794 3814	3865	3916	3968	4019	4071	4124	4176	4229	11	17	26	34	43	51	59
55	1 4281 4335	4388	4442	4496	4550	4605	4659	4715	4770	12	18	27	36	45	54	63
56	1 4826 4882	4928	4974	5031	5088	5145	5202	5262	5320	13	19	29	38	48	58	68
57	1 5399 5458	5517	5574	5637	5697	5758	5818	5878	5941	14	20	30	40	50	60	70
58	1 6003 6068	6128	6191	6255	6319	6383	6447	6512	6577	15	21	32	43	53	64	75
59	1 6643 6709	6775	6842	6909	6977	7045	7113	7182	7251	16	21	34	45	56	67	78
60	1 7321 7321	7391	7461	7532	7603	7675	7747	7820	7893	17	24	36	48	60	72	84
61	1 8040 7966	8115	8190	8265	8341	8418	8495	8572	8650	18	25	38	51	64	77	90
62	1 8807 8807	8896	8984	9072	9160	9248	9335	9425	9512	19	27	41	55	69	83	97
63	1 9628 9711	9797	9883	9972	2 0067	2 0165	2 0263	2 0362	2 0461	20	29	44	59	74	89	104
64	2 0503 0594	0636	0778	0872	0965	1060	1155	1251	1348	21	31	47	63	79	95	111
65	2 1445 1543	1842	1742	1842	1943	2045	2148	2251	2355	22	34	51	68	85	102	119
66	2 2480 2586	2673	2781	2889	2998	3109	3220	3332	3445	23	37	55	73	92	110	128
67	2 3550 3673	3789	3906	4023	4142	4262	4383	4502	4627	24	40	60	79	99	119	139
68	2 4751 4876	5002	5129	5257	5386	5517	5649	5786	5916	25	43	65	87	110	133	156
69	2 6051 6187	6325	6464	6605	6746	6889	7034	7179	7326	26	47	78	95	117	140	163
70	2 7475 7625	7776	7929	8083	8237	8391	8556	8716	8878	28	52	78	104	133	162	191
71	2 9042 9208	9375	9544	9714	9887	10061	10237	10415	10596	29	56	87	116	146	176	205
72	3 0777 0961	1146	1324	1504	1684	1864	2045	2226	2406	30	64	96	126	156	186	216
73	3 2709 2914	3122	3332	3547	3759	3977	4197	4420	4646	31	72	108	144	180	216	252
74	3 4874 5105	5339	5578	5815	6059	6305	6554	6806	7062	41	81	122	163	204	245	286
75	3 7321 7583	7846	8116	8391	8667	8947	9232	9522	9812	46	93	139	186	233	280	327
76	4 0108 0408	0713	1022	1335	1653	1970	2303	2635	2972	53	107	160	213	266	319	372
77	4 3316 3662	4015	4374	4737	5107	5483	5864	6246	6646	60	118	176	234	292	350	408
78	4 7546 7453	7867	8288	8716	9152	9594	10045	10505	10986	67	132	194	256	318	380	442
79	5 1447 1929	2422	2924	3435	3955	4486	5025	5578	6140	74	148	214	276	338	400	462
80	5 6136 3998	7894	8502	9124	9758	10405	11066	11742	12432	81	166	232	294	356	418	480
81	6 1144 7207	8002	8535	9122	9710	10305	10916	11542	12182	88	186	252	314	376	438	500
82	7 1154 2066	3064	3592	4147	4749	5368	5996	6632	7284	95	208	274	336	398	460	522
83	8 1443 2636	3663	5126	6227	7769	9152	10279	11232	12032	102	232	294	356	418	480	542
84	9 1544 9 677	8 845	10 02	10 20	10 39	10 58	10 78	10 99	11 20	109	258	320	382	444	506	568
85	11 43	11 66	11 91	12 16	12 43	12 71	13 00	13 30	13 62	13 95	110	284	346	408	470	532
86	14 30	14 67	15 06	15 46	15 89	16 35	16 85	17 37	17 92	18 46	111	304	366	428	490	552
87	19 08	19 74	20 45	21 20	22 02	22 90	23 86	24 90	26 03	27 27	112	324	386	448	510	572
88	26 14	27 14	31 62	33 69	35 80	38 19	40 92	44 07	47 74	52 08	113	344	406	468	530	592
89	57 29	63 86	71 62	81 85	95 49	114 6	143 2	191 0	285 5	571 0	114	364	426	488	550	612
90																

Mean differences
cases to be sufficiently
accurate.

S.N.	Name of the Experiment	Date	Page	Remarks
1	TO DETERMINE MAGNETIC MOMENT OF THE GIVEN BAR MAGNET USING DEFLECTION MAGNETOMETER BY TAN-A POSITION	2078/07/08	1-5	
2	TO USE DEFLECTION MAGNETOMETER TO COMPARE THE MOMENTS OF TWO MAGNETS BY NULL DEFLECTION METHOD	2078/07/15	6-10	
3	TO DETERMINE MAGNETIC MOMENT OF THE GIVEN MAGNET USING DEFLECTION MAGNETOMETER BY TAN-B POSITION	2078/07/29	11-15	
4	TO DETERMINE THE VELOCITY OF SOUND IN THE LAB BY RESONANCE AIR COLUMN METHOD	2078/08/06	16-20	
5	TO DETERMINE	2078/08/13	21-24	

S.N.	Name of the Experiment	Date	Page	Remarks
	MAGNETIC MOMENT OF A BAR MAGNET BY OSCILLATION MAGNETOMETER			
6.	TO COMPARE THE MAGNETIC MOMENTS OF TWO MAGNETS BY OSCILLATION MAGNETOMETER	2078/08/20	25-29	
7.	TO COMPARE THE FREQUENCY OF TWO TUNING FORK BY USING A RESONANCE TUBE	2078/09/05	30-33	
8.	TO DETERMINE THE RESISTANCE OF THE GIVEN WIRE AND TO CALCULATE ITS RESISTIVITY BY USING PO BOX	2078/09/12	34-37	
9.	TO DETERMINE THE FREQUENCY OF A.C. MAINS USING A SONOMETER	2078/09/19	38-41	
10.	TO STUDY THE VERIFICATION OF LOGIC GATES	2078/09/26	42-47	

EXPERIMENT NO 1

NAME OF EXPERIMENT: TO DETERMINE MAGNETIC MOMENT OF THE GIVEN BAR MAGNET USING DEFLECTION MAGNETOMETER BY TAN-A POSITION

APPARATUS REQUIRED

- 1) Deflection magnetometer
- 2) Bar magnet

THEORY

Tangent A position of Gauss

In this position, the centre of the needle is on the prolongation of the axis of the bar magnet. Hence the intensity F due to magnet is

$$F = \frac{2Md}{(d^2 - l^2)^2} \quad \text{--- (i)}$$

Where M is the moment of the magnet, d is the distance of the centre of the needle from the centre of the magnet, l is the semi-magnetic length of the magnet.

Since the needle is under the influence of two mutually perpendicular fields F due to the magnet and H due to the earth, the

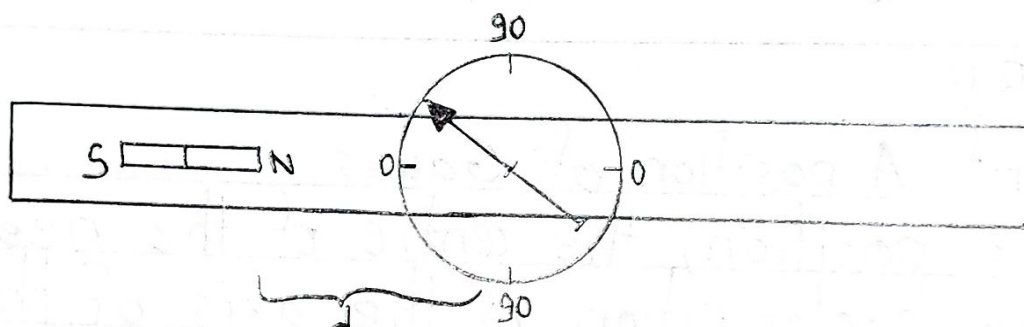


fig. Tangent A position
of gauss

tangent law holds good.

$$F = M \tan \theta \quad \text{--- (ii)}$$

from (i) and (ii)

$$F = \frac{2Md}{(d^2 - l^2)^2} = M \tan \theta$$

$$\text{or, } M = \frac{M(d^2 - l^2)^2 \tan \theta}{2d}$$

$$\therefore m = \frac{M(d^2 - l^2)^2 \tan \theta}{2l \times 2d}$$

PROCEDURE

1. First of all, the magnetometer was adjusted so that its arms were perpendicular to the magnetic meridian, when the pointer reads $90^\circ - 90^\circ$ in the scale.
2. The bar magnet NS was placed on one of the arms with its axis perpendicular to the magnetic meridian i.e. placed along the arms with its center at a distance 'd' from the centre of the pivoted needle. The distance 'd' was adjusted such that the deflection θ should be between 30° and 60° . The deflection of the needle was read from both the ends of the pointer. That gave two readings.
3. Next the magnet was placed on the same

arm at the same distance with its S-pole pointing towards the needle. The deflection was again noted. This gave two more readings.

4. Operations (2) and (3) were repeated on the other arms at the same distance. This gave 4 more readings. Thus we had 8 readings, the mean of these gave θ .

OBSERVATIONS

Real length of the magnet ($2l$) = 15.1 cm

$$\frac{2l}{2} = 7.55 \text{ cm}$$

Effective length of the magnet ($2l$) = 85% of real length ($2l$)

$$\text{or, } 2l = \frac{85}{100} \times 15.1$$

$$\text{or, } 2l = 12.83 \text{ cm}$$

$$\therefore l = 6.415 \text{ cm}$$

Horizontal component of earth magnetic field at lab (H) = 0.34 oersted.

OBSERVATION TABLE

No of Obs.	Distance of the magnet in cms.	Position of the magnet in arm	N-pole pointing	Deflection			$M = \frac{H(d^2 - l^2)^2}{2d} \times \tan \theta$	Mean (M)
				End I	End II	Mean (θ)		
1)	30.5	East	East	36'	40'			
			West	41'	42'	71'	3085.14	
			East	31'	30'	35'		
			West	30'	30'			
2)	29.5	East	East	41'	44'			3457.72
			West	42'	43'	43.5'	3693.98	
			East	40'	41'			
			West	46'	47'			
3)	28.5	East	East	45'	47'			
			West	46'	52'	45.38'	3594.05	
			East	41'	43'			
			West	44'	45'			

CALCULATION

$$1. \quad M = \frac{H(d^2 - l^2)^2}{2d} \times \tan \theta = \frac{0.34(30.5^2 - 6.415^2)^2}{2 \times 30.5} \times \tan 35'$$

$$= 3085.14$$

$$2. \quad M = \frac{H(d^2 - l^2)^2}{2d} \times \tan \theta = \frac{0.34(29.5^2 - 6.415^2)^2}{2 \times 29.5} \times \tan 43'$$

$$= 3693.98$$

$$3. \quad M = \frac{H(d^2 - l^2)^2}{2d} \times \tan \theta = \frac{0.34(28.5^2 - 6.415^2)^2}{2 \times 28.5} \times \tan 45.38'$$

$$= 3594.05 \text{ c.g.s. unit}$$

$$\text{But, } M = m \times 2l$$

$$m = \frac{M}{2l}$$

$$= \frac{3457.72}{2 \times 6.415}$$

$$= 269.5$$

$$\therefore \text{Magnetic moment} = 3457.72 \text{ c.g.s. unit}$$

$$\text{Pole strength} = 269.5$$

RESULT

Magnetic moment of the given bar magnet using deflection magnetometer by tan-A position was determined.

PRECAUTIONS

1. Reading should be done accurately.
2. Magnetometer should be placed properly.
3. All the glassware should be handled with care.

07 29

EXPERIMENT NO. 2

NAME OF EXPERIMENT: TO USE DEFLECTION MAGNETOMETER TO COMPARE THE MOMENTS OF TWO MAGNETS BY NULL DEFLECTION METHOD

APPARATUS REQUIRED

1. Deflection magnetometer
2. Two bar magnets.

THEORY

Tangent A position of Gauss

The first magnet is placed on one of the arms of the magnetometer at distance d from the centre producing a deflection θ so that;

$$F_1 = \frac{2M_1d_1}{(d_1^2 - l_1^2)^2} = \mu \tan \theta$$

The second magnet is placed on the other arm with a similar pole containing towards the needle and the distance adjusted such that the needle is brought back to zero position.

$$F_2 = \frac{2M_2d_2}{(d_2^2 - l_2^2)^2} = \mu \tan \theta$$

That the needle is brought back to zero shows

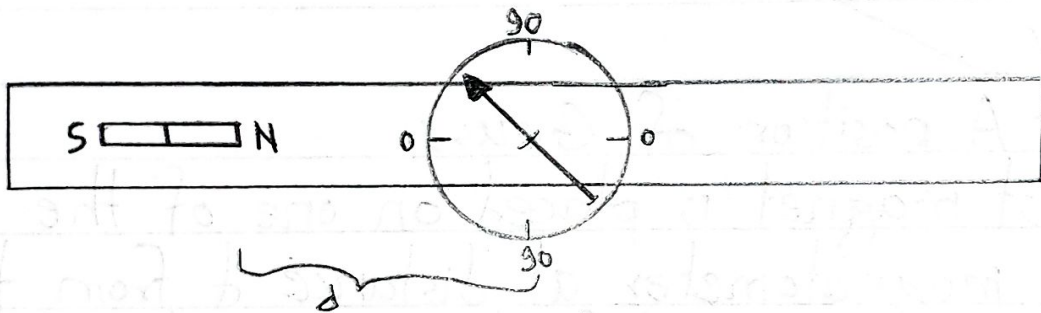


fig. Tangent A position
of gauss

that the deflection in the 2nd case is the same as that in the 1st case. i.e,

$$F_1 = F_2$$

$$\frac{2 M_1 d_1}{(d_1^2 - l_1^2)^2} = \frac{2 M_2 d_2}{(d_2^2 - l_2^2)^2}$$

$$\frac{M_1}{M_2} = \frac{(d_1^2 - l_1^2)^2}{(d_2^2 - l_2^2)^2} \times \frac{d_2}{d_1}$$

PROCEDURE

1. First of all, the deflection magnetometer was placed in the magnetic meridian.
2. The 1st magnet was placed on one of the arms say the east arm at a certain distance d_1 , with its axis at 45° angles to the magnetic meridian and with its N-pole pointing towards the needle.
3. The 2nd magnet was similarly placed on the other arms with its N-pole pointing towards the needle. Its distance was adjusted such that the needle was brought back to zero position. Then, the distance d_2 was noted.
4. The first magnet was then placed in the same position with its south pole pointing towards the needle. The 2nd magnet was also reversed and its distance d_2 was adjusted to produce null deflection.

5. Placing the 1st magnet on the west arm at the same distance d_1 operation (3) and (4) were repeated. The mean of these 4 readings gave the value of d_2 for the 1st set of observations.
6. The 1st magnet was placed at some other distance and operations (3) and (5) were repeated.

OBSERVATIONS

For 1st magnet,

Real length of magnet, $2l_1 = 15.1 \text{ cm}$

Effective length of magnet, $2l_1 = \text{Real length} \times 0.85$

$$\text{or, } 2l_1 = 12.84$$

$$\therefore l_1 = 6.42$$

For 2nd magnet,

Real length of magnet, $2l_2 = 15 \text{ cm}$

Effective length of magnet, $2l_2 = \text{Real length} \times 0.85$

$$\text{or, } 2l_2 = 12.75$$

$$\therefore l_2 = 6.38 \text{ cm}$$

OBSERVATION TABLE

No.	Distance of the magnet	Position of the magnet	n-pole of 1 st magnet pointing	Distance of the magnet	Mean d_2 (cm)	$\frac{M_1 - (d_1^2 - d_2^2)^2 \times d_2}{M_2 - (d_2^2 - d_1^2)^2 \times d_1}$	Mean
Obs.							
	1			2			
	d_1 (cm)			d_2 (cm)			
1.	24 ± 7.5	East	East	31.3			
	= 31.5		West	30.6	30.8	1.07	
		West	East	30.7			
			West	30.4			
2.	22 ± 7.5	East	East	29.4			1.07
	= 29.5		West	28.8	28.83	1.07	
		West	East	28.6			
			West	28.5			
3.	20 ± 7.5	East	East	27.4			
	= 27.5		West	26.9	26.9	1.07	
		West	East	26.6			
			West	26.7			

CALCULATION

$$\begin{aligned}
 1. \quad \frac{M_1}{M_2} &= \frac{(d_1^2 - d_2^2)^2 \times d_2}{(d_2^2 - d_1^2)^2 \times d_1} = \frac{(992.25 - 41.216)^2 \times 30.8}{(948.64 - 40.704)^2 \times 31.5} \\
 &= \frac{904465.669}{824347.78} \times \frac{30.8}{31.5} \\
 &= 1.07
 \end{aligned}$$

$$2. \frac{M_1}{M_2} = \frac{(d_1^2 - l_1^2)^2}{(d_2^2 - l_2^2)^2} \times \frac{d_2}{d_1} = \frac{(870.25 - 41.216)^2}{(831.169 - 40.704)^2} \times \frac{28.83}{29.5} = 1.07$$

$$3. \frac{M_1}{M_2} = \frac{(d_1^2 - l_1^2)^2}{(d_2^2 - l_2^2)^2} \times \frac{d_2}{d_1} = \frac{(756.25 - 41.216)^2}{(723.61 - 40.704)^2} \times \frac{26.9}{27.5} = 1.07$$

Mean $\frac{M_1}{M_2}$

RESULT

The magnetic moment of first magnet is greater than magnetic moment of second magnet. The ratio of magnetic moment of first and second magnet is 1.07.

PRECAUTIONS

1. The needle of deflection magnetometer must be managed at 0-0.
2. Magnet must be taken far from deflection magnetometer to manage it at 0-0.
3. Magnetometer should be placed properly.

EXPERIMENT NO. 3

NAME OF EXPERIMENT: TO DETERMINE MAGNETIC MOMENT OF THE GIVEN MAGNET USING DEFLECTION MAGNETOMETER BY TAN-B POSITION

APPARATUS REQUIRED

1. Deflection magnetometer.
2. Bar magnet

THEORY

Tangent B position of gauss:

In this position the centre of the needle is on the equatorial line of the bar magnet.

Hence, the intensity due to magnet is,

$$m = \frac{M}{(d^2 + l^2)^{3/2}} \quad \text{--- (i)}$$

But according to tangent law of magnetic forces;

$$f = H \tan \theta \quad \text{--- (ii)}$$

From (i) and (ii)

$$m = \frac{M}{(d^2 + l^2)^{3/2}} = H \tan \theta$$

$$\text{or, } \frac{M}{H} = (d^2 + l^2)^{3/2} \tan \theta \quad \text{--- (iii)}$$

$$\text{or, } M = H (d^2 + l^2)^{3/2} \tan \theta$$

$$\text{or, } m \cdot 2l = H (d^2 + l^2)^{3/2} \tan \theta$$

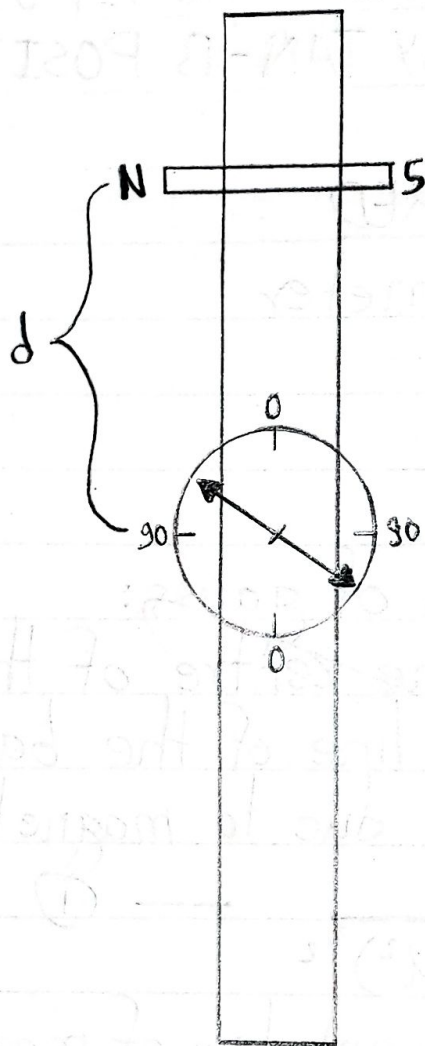


fig. Tangent - B position
of gauss

$$\therefore m = \frac{H(d^2 + l^2)^{3/2} \tan \theta}{2l} \quad \text{--- (iv)}$$

PROCEDURE

1. Magnetometer was adjusted so that its arms were along the magnetic meridian when the pointer reads 90° - 90° in the
2. The bar magnet NS was placed on one of the arms with its axis perpendicular to the magnetic meridian with adjusted distance ' d ' that makes deflection ' θ ' between 30° and 60° .
3. Deflection of the needle was read and subtracted from 90° to get θ and two readings were taken.
4. Again, bar magnet was placed on the same arm, N-pole pointing to west. The deflection was again noted and two readings were taken.
5. Operations (2), (3), (4) were repeated on another arm at the same distance which gave 3 more readings.

OBSERVATIONS

Value of H in lab = 0.34 oersted

Real length (l) = 15.1 cm

$$\text{Effective length } (2l) = 15.1 \times 0.85$$

$$= 12.84$$

$$\therefore l = \frac{12.84}{2}$$

$$= 6.42 \text{ cm}$$

OBSERVATION TABLE

No	Distance of the magnet cms. (d)	Position of the magnet	n-pole pointing	Deflection θ			$m = \frac{H(d^2 + l^2)^{3/2}}{2l \times \tan \theta}$	Mean m
				End I	End II	Mean θ		
1.	26+0.6 = 26.6	North	East	37	35			
			West	27	32	33.13	354.09	
		South	East	37	35			
			West	32	30			
2.	24+0.6 24.6	North	East	41	38			350.
			West	39	41	39.88	363.59	73
		South	East	46	42			
			West	35	37			
3.	22+0.6 22.6	North	East	35	44			
			West	43	44	44.25	334.52	
		South	East	49	47			
			West	43	49			

CALCULATIONS

$$\begin{aligned}
 1. \quad m_1 &= \frac{H(d^2 + l^2)^{3/2}}{2l} \times \tan \theta \\
 &= \frac{0.34(26.6^2 + 6.42^2)^{3/2}}{2 \times 6.42} \times \tan 33.13 \\
 &= 354.09
 \end{aligned}$$

$$\begin{aligned}
 2. \quad m_2 &= \frac{H(d^2 + l^2)^{3/2}}{2l} \times \tan \theta \\
 &= \frac{0.34(24.6^2 + 6.42^2)^{3/2}}{2 \times 6.42} \times \tan 39.88 \\
 &= 363.59
 \end{aligned}$$

$$\begin{aligned}
 3. \quad m_3 &= \frac{H(d^2 + l^2)^{3/2}}{2l} \times \tan \theta \\
 &= \frac{0.34(22.6^2 + 6.42^2)^{3/2}}{2 \times 6.42} \times \tan 44.25 \\
 &= 334.52
 \end{aligned}$$

$$\begin{aligned}
 \therefore \text{Mean}(m) &= \frac{m_1 + m_2 + m_3}{3} = \frac{1052.20}{3} \\
 &= 350.73
 \end{aligned}$$

$$\therefore \text{Pole strength (m)} = 350.73 \text{ c.g.s unit}$$

$$\begin{aligned}\text{Magnetic moment (M)} &= m \times 2l \\ &= 350.73 \times 2 \times 6.42 \\ &= 4503.37 \text{ cgs unit}\end{aligned}$$

RESULT

Hence, the pole strength and magnetic moment was calculated.

SOURCE OF ERROR

1. There might be magnetic substance near magnetometer.
2. Pointer of the magnetometer might be thick or not straight.
3. There might be friction at the point of the needle.

PRECAUTIONS

1. All magnetic substance should be removed from the table.
2. Magnetometer compass should not be disturbed.
3. The deflection of about 30° to 60° should be produced.

EXPERIMENT NO. 4

NAME OF EXPERIMENT: TO DETERMINE THE VELOCITY OF SOUND IN THE LAB BY RESONANCE AIR COLUMN METHOD.

APPARATUS REQUIRED

1. Resonance Apparatus
2. Tuning fork
3. Rubber pad

THEORY

A vibrating tuning fork held slightly above the free end of the Resonance tube forces the air column in it to vibrate and sets up stationary waves in it. While adjusting the length of the air column, a position will be obtained when the intensity of sound will be maximum. This will occur when the frequency of the vibrating air column will be the same as that of the tuning fork. There will be an antinode at the open end and a node at the closed end. In this position for the 1st resonance,

$$v = 4f(l_1 + \lambda) \quad \text{--- (i)}$$

where, v = velocity of sound

f = frequency of the tuning fork

EXPERIMENT NO. 4

NAME OF EXPERIMENT: TO DETERMINE THE
VELOCITY OF SOUND IN THE LAB BY
RESONANCE AIR COLUMN METHOD.

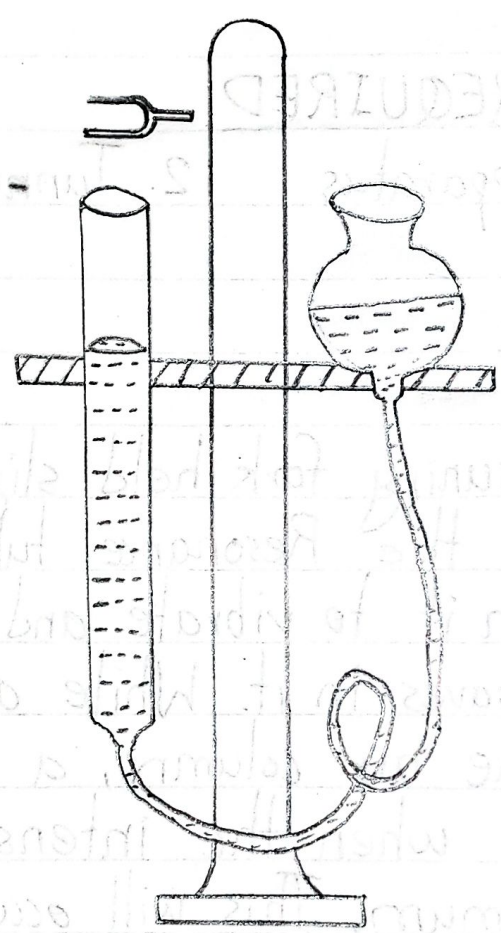


Fig. Resonance tube

$$v = \lambda f \quad (1)$$

where v = velocity of sound

λ = wavelength of the tuning fork

l_1 = length of the 1st resonance air column.

λ = end correction = $0.3d$, d is the internal diameter of the tube.

For the 2nd resonance,

$$V = \frac{4f(l_2 + \lambda)}{3}$$

$$\text{or, } 3V = 4f(l_2 + \lambda) \text{ — (ii)}$$

where, l_2 = length of the 2nd resonance.

From (i) and (ii) by subtraction,

$$V = 2f(l_2 - l_1)$$

This gives the velocity of sound in the lab temp. and pressure. To convert it into vel. in dry air at N.T.P. we have

$$V_0 = V \sqrt{\frac{P - 0.375f}{P} \left(1 - \frac{1}{2} \alpha t\right)}$$

where, P = atmospheric pressure in cm. in the lab.

f = aqueous tension at the lab. temp.

α = coeff. of cubical expansion of air,

t = lab. temp.

PROCEDURE

1. The tuning fork was struck against a rubber pad and was held slightly above free end of the tube. The water level was adjusted till an approximate resonance was obtained with the smallest length of the air column.
2. The length of the air column was adjusted properly by raising or lowering the water level till maximum resonance was obtained. This was adjusted once by gradually increasing the length of air column and next decreasing it.
3. These operations were repeated at least thrice. The mean was taken as the 1st resonance air column.
4. The length of the air column was gradually increased till the second resonance was heard. The mean was taken as in (3). Then the velocity of sound was calculated by using the above formula.
5. The Barometer reading P was taken. The lab. temp. was noted. The aqueous tension at lab. temp. was found out from the Physical Tables. Then V was calculated.

OBSERVATIONS

Barometer reading = 74 cm of Hg

Laboratory temperature = 24°C
 Aqueous tension from tables = 22.351 mm of Hg
 $= 2.235 \text{ cm of Hg}$
 Coefficient of cubical expansion in air (α) = $\frac{1}{273}$

OBSERVATION TABLE

Positions	No. of Obs.	Length of the air column $l \text{ cm}$		Mean length $l \text{ cm}$	Freq. of the fork	Velocity $v = 2f(l_2 - l_1)$
		Increasing	Decreasing			
1 st Resonance	1	19.8	19.8			
l_1	2	19.7	19.7	19.67	426	
	3	19.5	19.5			336.54
2 nd Resonance	1	59.1	59.1			m/s
l_2	2	59.2	59.2	59.17	426	
	3	59.2	59.2			

CALCULATIONS

$$\begin{aligned}
 v_0 &= 2f(l_2 - l_1) \\
 &= 2 \times 426 (59.17 - 19.67) \\
 &= 336.54 \text{ m/s}
 \end{aligned}$$

Lab temp, $\theta = 24^{\circ}\text{C}$

Velocity of sound at 24°C ,

$$v = 336.54 \text{ m/s}$$

Again,

$$V_{NTP} = V \sqrt{\frac{P - 0.375f}{P}} \times \left(1 - \frac{1}{2} \alpha t\right)$$

$$= 336.54 \sqrt{\frac{74 - 0.375 \times 2.235}{74}} \times 1 - \frac{1}{2} \times \frac{1 \times 24}{273}$$

$$V_c = 327.19 \text{ m/s}$$

$\therefore$ Value of sound at N.T.P,

$$V_s = 332 \text{ m/s}$$

$$\% \text{ Error} = \frac{V_s - V_c}{V_s} \times 100\%$$

$$= \frac{332 - 327.19}{332} \times 100\%$$

$$= 1.45\%$$

RESULT

Hence, the velocity of sound in air at 24°C was calculated as 336.54 m/s .

EXPERIMENT NO. 5

NAME OF EXPERIMENT : TO DETERMINE MAGNETIC MOMENT OF A BAR MAGNET BY OSCILLATION MAGNETOMETER

APPARATUS REQUIRED

1. Weight bar
2. Oscillation magnetometer
3. Stop watch
4. Compass needle
5. Bar magnet

THEORY

When a magnet is suspended freely in a uniform magnetic field it comes to rest in a direction parallel to the field. When the magnet is slightly displaced from the equilibrium position and released, it begins to vibrate in simple harmonic motion about the equilibrium position with a time period.

$$T = 2\pi \sqrt{\frac{I}{MH}} \quad \text{--- (i)}$$

where I is the moment of Inertia of the magnet. M is the moment of the magnet. H is the horizontal component of the earth's field.

$I = \frac{a^2 + b^2}{12} \times \text{mass of rectangular bar}$, a is the

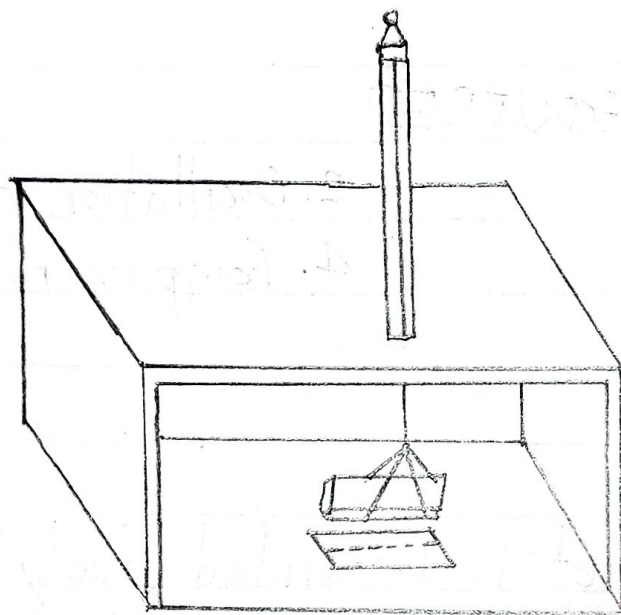


fig. Oscillation magnetometer

$$(1) \quad \frac{I}{H} = \frac{M}{4\pi}$$

where I is the moment of inertia of the magnet.

M is the magnetic moment of the magnet.

H is the horizontal component of the earth's magnetic field.

4π is a constant.

length of the bar and b is the breadth.

$$\text{or, } t^2 = 4\pi^2 \frac{I}{MH}$$

$$\text{or, } MH = \frac{4\pi^2 I}{t^2} \quad \text{--- (ii)}$$

$$\therefore M = \frac{4\pi^2 I}{Ht^2} \quad \text{--- (iii)}$$

PROCEDURE

1. The levelling screws of the box were adjusted to make the box horizontal and all the magnetic substances were removed from the working table.
2. A compass was placed on the reference line and the box was adjusted to become parallel to magnetic needle.
3. A bar was placed on the stirrup and torsion head was adjusted to make the bar parallel to the reference line. When the bar oscillated equally on both sides of the reference line, there was no torsion in the thread.
4. The stirrup was held with the fingers and bar was replaced with a magnet with n-pole pointing north. The sliding door was closed.
5. The magnet was slightly disturbed by another

- magnet from outside the windows.
6. The time for 20 oscillations was noted with the help of stop watch.
 7. The process was repeated for 10 times.

OBSERVATIONS

Length of magnet (a) = 5.1 cm

Breadth of magnet (b) = 1.1 cm

Mass of magnet (W) = 31.17 gm

$$\begin{aligned} \therefore \text{Moment of Inertia (I)} &= \frac{a^2 + b^2}{12} \times \text{mass} \\ &= \frac{(5.1)^2 + (1.1)^2}{12} \times 31.17 \\ &= 70.7 \text{ gcm}^2 \end{aligned}$$

Value of H = 0.34 Oersted

OBSERVATION TABLE

No. of Obs.	Time for 20 oscs	Time period t secs	Mean (t)	$M = \frac{4\pi^2 I}{Ht^2}$
1.	67.19	3.35		
2.	66.41	3.32		
3.	66.44	3.32		
4.	65.31	3.26	3.35	731.49
5.	69.69	3.49		
6.	68.28	3.41		
7.	67.53	3.37		

8.	66.87	3.34		
9.	66.31	3.31		
10.	65.97	3.29		

CALCULATION

$$\begin{aligned}
 \text{Magnetic moment (M)} &= \frac{4\pi^2 I}{H^2} \\
 &= \frac{4\pi^2 \times 70.7}{0.34 \times (3.35)^2} \\
 &= 731.49 \text{ cgs unit}
 \end{aligned}$$

RESULT

From the above experiment the magnetic moment of given magnet was found to be 731.49 cgs unit.

PRECAUTION

1. Reading should be done accurately.
2. Time should be taken properly.
3. Magnetometer should be placed properly.

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EXPERIMENT NO. 6

NAME OF EXPERIMENT: TO COMPARE THE MAGNETIC MOMENTS OF TWO MAGNETS BY OSCILLATION MAGNETOMETER.

APPARATUS REQUIRED

1. Weight box
2. Oscillation magnetometer
3. Stop watch
4. Compass needle
5. Bar magnet

THEORY

When a magnet is suspended freely in a uniform magnetic field, it comes to rest in a direction parallel to the field. When the magnet is slightly displaced, it begins to vibrate in simple harmonic motion with a time period,

$$T = 2\pi \sqrt{\frac{I}{MB_H}} \quad \text{--- (i)}$$

where, M is the magnetic moment, I is the moment of Inertia and B_H is the horizontal component of earth's magnetic field.

And, $I = \frac{a^2 + b^2}{12} \times \text{mass of magnet of length 'a' and breadth 'b'}$.

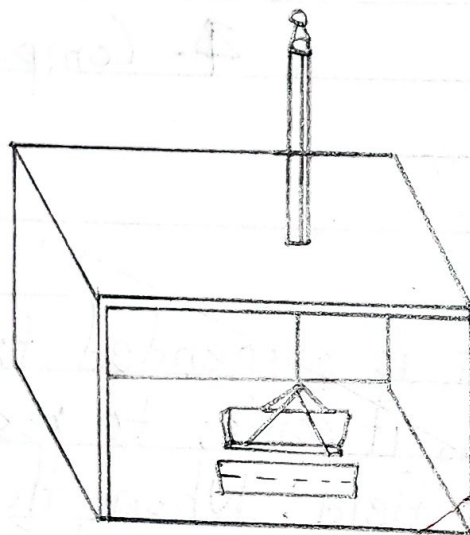


Fig. Oscillation magnetometer

From (i)

$$M = \frac{4\pi}{T^2} \frac{I}{B_H} \quad \text{--- (ii)}$$

If M_1 and M_2 are magnetic moments, I_1 and I_2 are the moment of Inertia and T_1 and T_2 are the time period for two magnets respectively, then,

$$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2} \quad \text{--- (iii)}$$

PROCEDURE

1. The leveling screw of the box were adjusted to make box horizontal and all magnetic substances were removed.
2. A compass needle was used to make a reference line to make the box parallel with the magnetic meridian.
3. A brass bar was kept on the stirrup and the torsion head was adjusted to make the bar parallel to reference line.
4. The brass bar was replaced with the bar magnet with N-pole pointing north. The sliding door was closed and the magnet was left to come at rest.
5. The magnet was slightly disturbed from outside with another magnet.

6. The time for 20 oscillations of the magnet was noted.
7. The process was repeated for four more times.
8. Steps (4-7) were repeated by replacing the magnet with another bar magnet.

OBSERVATIONS

For first magnet.

$$\text{Length (a)} = 5.1 \text{ cm}$$

$$\text{Breadth (b)} = 1.24 \text{ cm}$$

$$\text{Mass (m)} = 33.13 \text{ gm}$$

$$\begin{aligned}\therefore \text{Moment of Inertia (I}_1\text{)} &= \frac{a^2 + b^2}{12} \times m \\ &= \frac{5.1^2 + 1.24^2}{12} \times 33.13 \\ &= 76.05 \text{ gcm}^2\end{aligned}$$

For second magnet.

$$\text{Length (a)} = 5.1 \text{ cm}$$

$$\text{Breadth (b)} = 1.15 \text{ cm}$$

$$\text{Mass (m)} = 29.99 \text{ gm}$$

$$\begin{aligned}\therefore \text{Moment of Inertia (I}_2\text{)} &= \frac{a^2 + b^2}{12} \times m \\ &= \frac{5.1^2 + 1.15^2}{12} \times 29.99 \\ &= 68.31 \text{ gcm}^2\end{aligned}$$

OBSERVATION TABLE

	No. of	Time for 20	Time period	Mean	$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2}$
Magnet	Obs.	oscillations	t secs	t	
		secs			
	1	66.75	3.34		
1 st	2	62.53	3.31		
Magnet	3	65.63	3.08	3.2	
	4	63.62	3.18		
	5	61.65	3.08		0.85 : 1
	1	56.13	2.81		
2 nd	2	55.27	2.77		
magnet	3	56.91	2.85	2.8	
	4	55.75	2.79		
	5	55.28	2.76		

CALCULATIONS

$$\text{Mean time for 1st mag. } (T_1) = \frac{3.34 + 3.31 + 3.08 + 3.18 + 3.08}{5}$$

$$= 3.2 \text{ sec}$$

$$\text{Mean time for 2nd mag. } (T_2) = \frac{2.81 + 2.77 + 2.85 + 2.79 + 2.76}{5}$$

$$= 2.8 \text{ sec}$$

$$\frac{M_1}{M_2} = \frac{I_1}{I_2} \times \frac{T_2^2}{T_1^2} = \frac{76.05}{68.31} \times \left(\frac{2.8}{3.2} \right)^2$$

$$= 0.85 : 1$$

RESULT

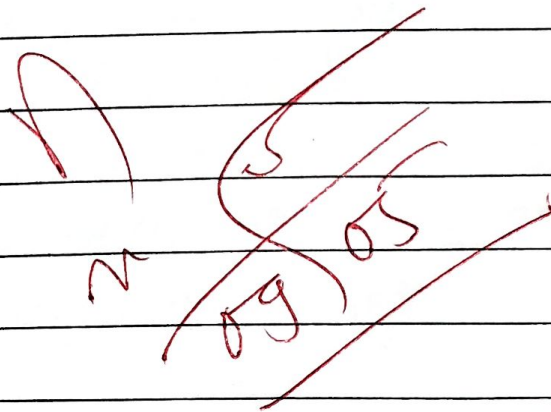
From the above experiment, the ratio of magnetic moment of the given two magnets was found to be $0.85:1$.

SOURCES OF ERROR

1. The magnetic stirrup may not be horizontal.
2. There may be presence of magnetic substances on working table.
3. The reference line may not be parallel to magnetic meridian.

PRECAUTIONS

1. The magnetic stirrup must be horizontal.
2. Every magnetic substances should be removed from the working table.
3. The reference line must be drawn parallel to the magnetic meridian.



EXPERIMENT NO. 7

NAME OF EXPERIMENT: TO COMPARE THE FREQUENCY OF TWO TUNING FORK BY USING A RESONANCE TUBE

APPARATUS REQUIRED

1. Two tuning fork of different frequency
2. Rubber pad
3. Resonance apparatus

THEORY

Resonance is the specific response of a system which is capable to vibrate with a certain frequency to an external source force acting with the same frequency. In a resonance tube, intensity of sound will be maximum at resonating length. The sound is produced due to formation of stationary wave having node at closed end and antinode at open end. The length of first maximum intensity of sound is 1st resonating length of 1st resonance. Similarly, 2nd resonating length and 3rd resonating length is for 2nd and 3rd resonance.

So, velocity of sound, $v = 2f_1(l_2 - l_1)$ — (i)

Where, f_1 = frequency of 1st tuning fork

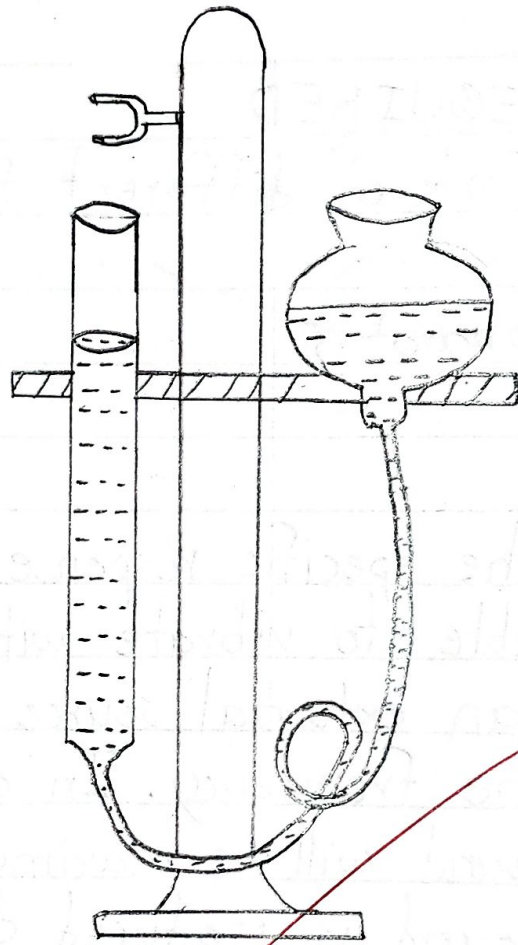


Fig. Resonance tube

$\lambda_2 = 2^{\text{nd}}$ resonating length using 1st tuning fork.

$\lambda_1 = 1^{\text{st}}$ resonating length using 1st tuning fork.

Again,

$$\text{Velocity of sound, } v = 2f_2 (\lambda_2' - \lambda_1') \quad \text{--- (ii)}$$

Where,

$f_2 =$ frequency of 2nd tuning fork

$\lambda_2' = 2^{\text{nd}}$ resonating length

$\lambda_1' = 1^{\text{st}}$ resonating length

Then, from (i) and (ii)

$$\frac{v}{v} = \frac{2f_1 (\lambda_2 - \lambda_1)}{2f_2 (\lambda_2' - \lambda_1')}$$

$$\text{or, } \frac{f_1}{f_2} = \frac{\lambda_2' - \lambda_1'}{\lambda_2 - \lambda_1} \quad \text{--- (iii)}$$

PROCEDURE

The first tuning fork was set into vibration and kept above the tube horizontally. At first, the intensity of sound heard was small but adjusting the length of the tube decreasing the water level by adjusting reservoir. Hence the length of the water level was measured from the top at maximum intensity of sound which is called first resonating length. Similarly, the resonating length for same resonance was

measured and mean was calculated. Again, reservoir was moved to adjust the length of resonance at another maximum intensity of sound called second resonating length. Likewise, the mean of second resonating length was taken.

Same process was done to calculate the first and second resonating length for the second tuning fork.

OBSERVATION TABLE

No. of Obs.	Frequency of tuning fork	Resonance	Resonating length	Mean resonating length
1.	384 Hz	1st	1) 22.5 cm	
		Resonance	2) 22.1 cm	$l_1 = 22.4 \text{ cm}$
			3) 22.6 cm	
		2nd	1) 68 cm	
		Resonance	2) 67.8 cm	$l_2 = 67.9 \text{ cm}$
			3) 67.9 cm	
2.	426 Hz	1st	1) 19.3 cm	
		Resonance	2) 19.6 cm	$l_1' = 19.3 \text{ cm}$
			3) 19.1 cm	
		2nd	1) 59.5 cm	
		Resonance	2) 59.7 cm	$l_2' = 59.5 \text{ cm}$
			3) 59.3 cm	

CALCULATION

$$l_1 = 22.4 \text{ cm}$$

$$l_2 = 67.9 \text{ cm}$$

$$l_1' = 19.3 \text{ cm}$$

$$l_2' = 59.5 \text{ cm}$$

$$\therefore \left(\frac{f_1}{f_2} \right)_{\text{cal.}} = \frac{l_2' - l_1'}{l_2 - l_1} = \frac{59.5 - 19.3}{67.9 - 22.4} = 0.88$$

$$\left(\frac{f_1}{f_2} \right)_{\text{observed}} = \frac{384}{426} = 0.90$$

$$\% \text{ Error} = \frac{\left(\frac{f_1}{f_2} \right)_{\text{obs.}} - \left(\frac{f_1}{f_2} \right)_{\text{calc}}}{\left(\frac{f_1}{f_2} \right)_{\text{obs.}}} \times 100\%$$

$$= \frac{0.90 - 0.88}{0.90} \times 100\%$$

$$= 2.22\%$$

RESULT

Hence, the frequency of first tuning fork was found to be 0.88 times the frequency of 2nd tuning fork.

PRECAUTION

1. Resonating length should be noted carefully.
2. Calculation should be done accurately.
3. Sound should be listened carefully.

EXPERIMENT NO. 8

NAME OF EXPERIMENT: TO DETERMINE THE RESISTANCE OF THE GIVEN WIRE AND TO CALCULATE ITS RESISTIVITY BY USING PO BOX

APPARATUS REQUIRED

1. PO Box
2. Galvanometer
3. Resistance wire
4. Connecting wire
5. Leclanche cell

THEORY

Wheatstone bridge principle states that if P , Q , R and X be four resistance (X) being unknown resistance connected as shown in figure. 'G' a moving coil galvanometer and 'E' a leclanche cell, then for null deflection and galvanometer,

$$\frac{X}{R} = \frac{P}{Q}$$

Where, P and Q are resistance in the ratio arms, R that in the resistance arms and X is the unknown resistance to be determined.

$$X = R \times \frac{P}{Q} \quad \text{--- (i)}$$

Hence, Resistivity of the wire is

$$\rho = \frac{\pi d^2}{4} \times \frac{X}{L}$$

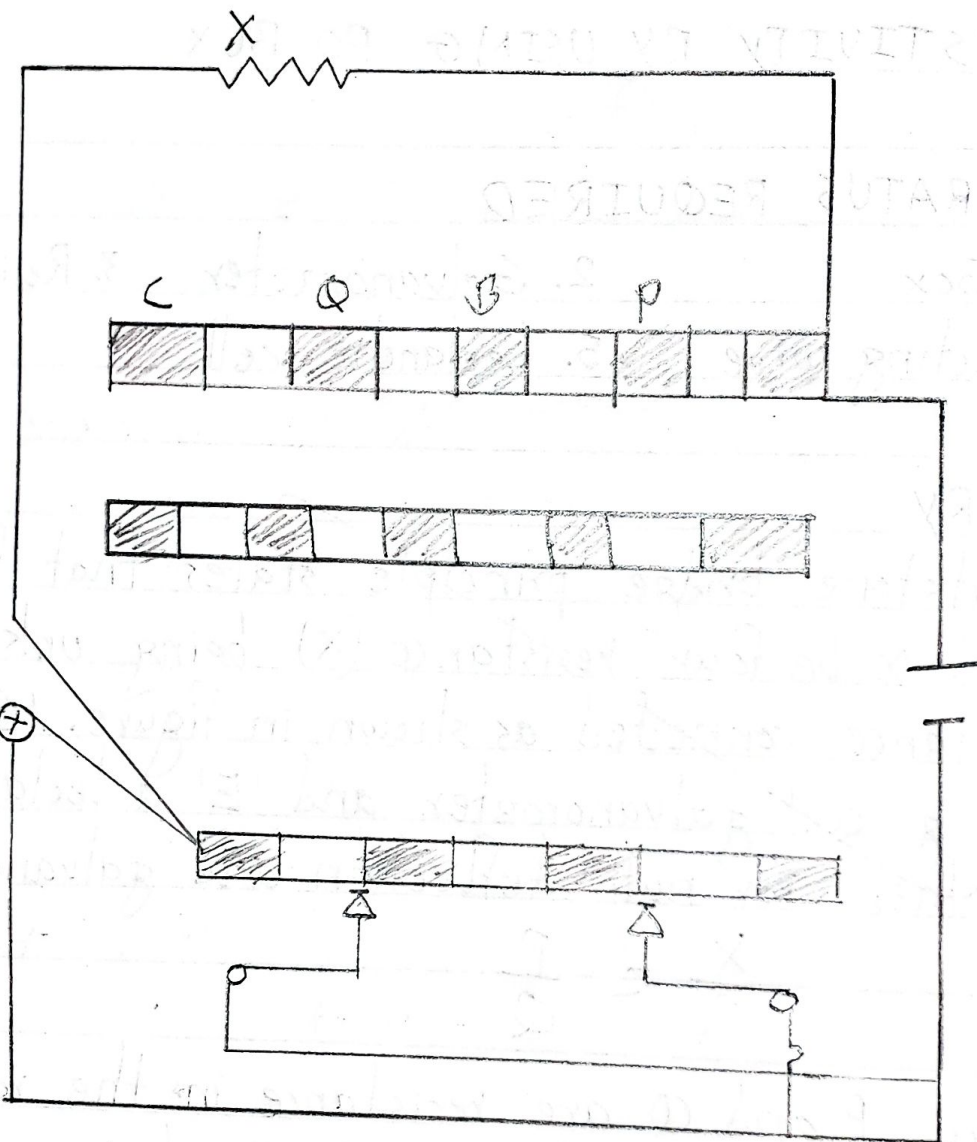


fig. P.O. box

Where, 'd' is the diameter of the resistance wire.
'L' is the length of the resistance wire.

PROCEDURE

1. A circuit diagram was drawn and connections were made.
2. Resistance plugs 10:10 were taken out from the ratio arms AB and BC. After this, in the third arm CD, resistance plugs '0' was taken out and battery key was pressed which shows deflection in the left. Likewise, ∞ resistance plug was taken out and battery key was pressed which shows deflection in the right. So, the circuit was right.
3. This operation was repeated by alternating taking out a low and a higher resistance plug from the resistance arm CD unless the deflection becomes narrower.
4. Next, resistance plugs 10, 100 were taken out from the ratios arm AB and BC and the value of resistance was also increased by 14 times and the process (3) was again repeated.
5. Deflection was observed and direction were noted in the table.

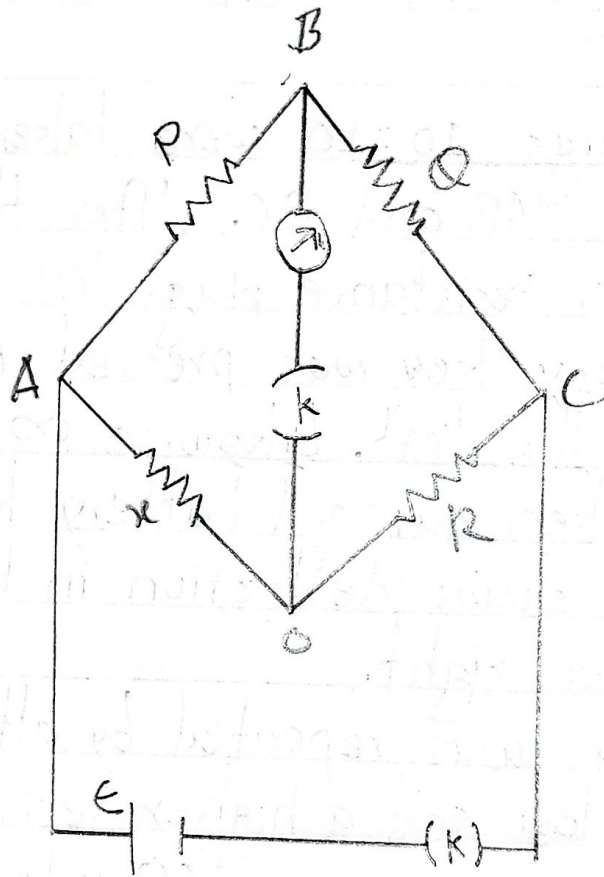


fig. Connecting wire

OBSERVATION TABLE

No. of Obs.	Ratio arms P:Q	Resistance in 3 rd arm	Galvanometer deflection	Inference about unknown resistance compared to R
1.	10:10	0	too left	Value of X
		∞	too right	lies between
		1	too right	0 and 1.
2.	10:100	0	too left	Value of X lies
		4	slow left (1 div)	between 4 and
		5	slow right (24 div)	5. It means
				0.4 and 0.5

CALCULATIONS

$\therefore$ Change in deflection of $(1+14)$ division i.e. - 15 division is due to a different of 1Ω

$$\therefore 1\Omega = 15 \text{ divs.}$$

$$\text{or, } \frac{1}{15} \Omega = 1 \text{ div}$$

$$\therefore 1 \text{ div} = 0.06\Omega$$

$$\therefore \text{Required value of } R = 4 + 0.06\Omega = 4.06\Omega$$

Now, we know

$$\frac{X}{R} = \frac{P}{Q}$$

$$\text{or, } \frac{X}{4.06} = \frac{10}{100}$$

$$\therefore X = 0.406 \Omega$$

Again,

$$\text{Resistivity } (\rho) = \frac{\pi d^2}{4} \times \frac{X}{L}$$

$$= \frac{22}{7} \times \frac{(0.49 \times 10^{-3})^2}{4} \times \frac{0.46}{57.5 \times 10^{-2}}$$

$$= 1.5 \times 10^{-7} \Omega \text{ m}$$

RESULT

Hence, the resistance of the given wire is found to be 0.406Ω and resistivity is $1.5 \times 10^{-7} \Omega \text{ m}$.

PRECAUTIONS

1. Calculations should be done accurately.
2. PO box should be used properly.
3. Reading of galvanometer should be taken accurately.

EXPERIMENT NO. 9

NAME OF EXPERIMENT: TO DETERMINE THE FREQUENCY OF A.C. MAINS USING A SONOMETER

APPARATUS REQUIRED

- | | |
|---------------------|-------------------------|
| 1. Sonometer | 2. Spring balance |
| 3. Physical balance | 4. Horseshoe magnet |
| 5. Kg. weight | 6. Stepdown transformer |

THEORY

When the wire resonates the frequency (f) of the mains is equal to the frequency of vibration of the spring. Then,

$$f = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$$

where, μ = mass per unit length (m/l)

T = Tension on the wire

So,

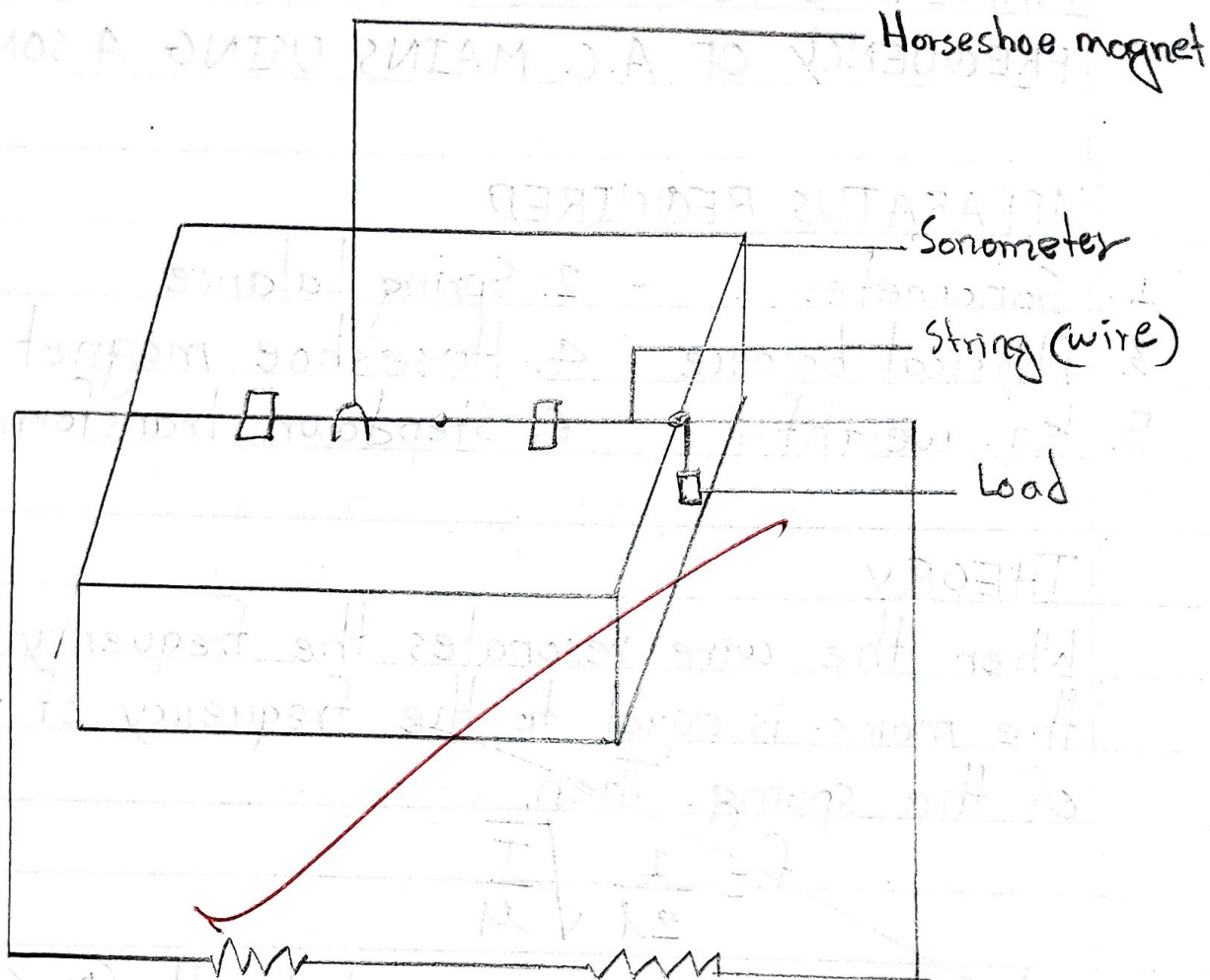
$$f = \frac{1}{2l} \sqrt{\frac{T}{m/l}} \quad \text{--- (i)}$$

Since,

$$\frac{m}{l} = \frac{\rho V}{l} = \frac{\rho \cdot A \cdot l}{l} = \frac{\pi d^2}{4} \cdot \rho$$

Putting the value in eqⁿ (i)

$$f = \frac{1}{2l} \sqrt{\frac{T}{\frac{\pi d^2}{4} \cdot \rho}} = \frac{1}{2l} \times \frac{2}{d} \sqrt{\frac{T}{\pi \rho}}$$



Sonometer figure

$$f = \frac{1}{\delta\sqrt{\pi g}} \cdot \frac{\sqrt{T}}{l}$$

$$\therefore f = \frac{1}{\delta\sqrt{\pi g}} \cdot \frac{\sqrt{mg}}{l} \quad [\because T = mg]$$

Where, $\frac{1}{\delta\sqrt{\pi g}}$ is a constant.

PROCEDURE

1. The sonometer was placed on the table and the string was stretched.
2. The horse shoe magnet was placed on the box in exactly mid way between the bridge and poles perpendicular to the place of wire.
3. The step down transformer was connected across the wire with a secondary voltage of 6V.
4. A load was placed on the initial mass hanged to the string and the position of bridges were adjusted to get the max frequency.
5. The distance of bridges i.e. resonating length and mass hanged on string wire was noted.
6. Steps (4) and (5) were repeated by adding masses two more times.
7. The diameter of the wire was measured with the help of screw gauge.

OBSERVATIONS

In micrometer screw gauge,
0 lies in 7 division up the lines
least count (1) = 0.01 mm

$$\therefore \text{Error} = 7 \times 0.01 = 0.07 \text{ mm}$$

$$\text{Diameter of wire (d)} = 0.46 \text{ mm}$$

$$\therefore \text{Actual diameter} = (0.46 + 0.07) \text{ mm} \\ = 0.53 \times 10^{-3} \text{ m}$$

$$\text{Density of wire (s)} = 8400 \text{ kg/m}^3.$$

OBSERVATION TABLE

No. of Obs.	Weight on scale in kg	Total load in 'N' $T = m \cdot g$ ($g = 10 \text{ m/s}^2$)	Resonating length (l)	Frequency 'f' Hz	Mean (m) frequency Hz
1.	0.5035 kg	5.035 N	0.5 m	51.65	
2.	1.0035 kg	10.035 N	0.7 m	52.08	52.07 Hz
3.	1.5035 kg	15.035 N	0.85 m	52.50	

CALCULATIONS

$$1. f_1 = \frac{1}{l \sqrt{\pi s}} \times \frac{\sqrt{T}}{1}$$

$$= \frac{1}{0.53 \times 10^{-3} \sqrt{\frac{22}{7} \times 8550}} \times \frac{\sqrt{5.035}}{0.5}$$

$$= 11.51 \times \frac{\sqrt{5.035}}{0.5}$$

$$= 51.65 \text{ Hz}$$

$$2. f_2 = \frac{1}{2\sqrt{\pi g}} \times \frac{\sqrt{T}}{l} = 11.51 \times \frac{\sqrt{10.035}}{0.7} = 52.08 \text{ Hz}$$

$$3. f_3 = \frac{1}{2\sqrt{\pi g}} \times \frac{\sqrt{T}}{l} = 11.51 \times \frac{\sqrt{15.035}}{0.85} = 52.50 \text{ Hz}$$

$$\begin{aligned} \therefore \text{Mean (m)} &= \frac{f_1 + f_2 + f_3}{3} \\ \text{frequency} &= \frac{(51.65 + 52.08 + 52.50) \text{ Hz}}{3} \\ (\text{obs.}) &= \frac{156.23}{3} \text{ Hz} \\ &= 52.07 \text{ Hz} \end{aligned}$$

$$\text{Frequency observed (f}_{\text{obs}}) = 52.07 \text{ Hz}$$

$$\text{Frequency standard (f}_{\text{stnd}}) = 50 \text{ Hz}$$

$$\begin{aligned} \therefore \text{Error \%} &= \frac{f_{\text{obs}} - f_{\text{stnd}}}{f_{\text{stnd}}} \times 100\% \\ &= \frac{52.07 - 50}{50} \times 100\% \\ &= 4\% \end{aligned}$$

RESULT

Hence the frequency of AC mains was found to be 52.07 Hz.

PRECAUTION

1. Wire of uniform thickness should be used.
2. Resonating length should be measured carefully.

EXPERIMENT NO. 10

NAME OF EXPERIMENT: TO STUDY THE VERIFICATION OF LOGIC GATES (OR, AND, NOR, NAND, NOT)

APPARATUS REQUIRED

Trainer board designed for various logic gates and set of leads for connection.

THEORY

Gates are digital circuits because input and output signals have only two states either low (0) or high (1).

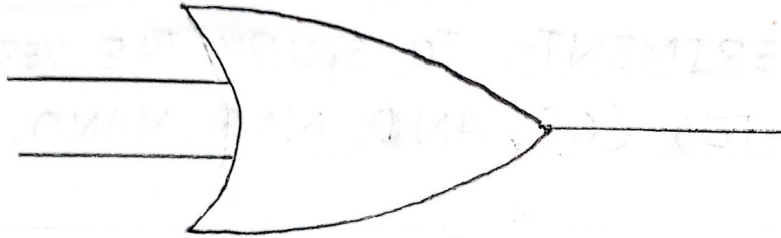
1. OR GATE: An OR gate has two or more than two inputs and only one output which is equal to the sum of all inputs.

Truth table

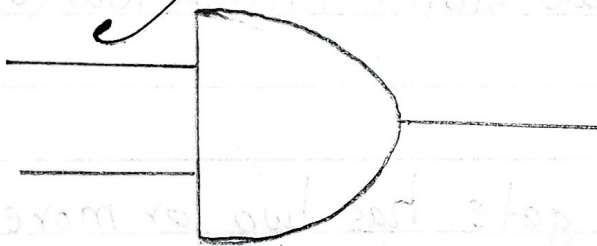
Inputs		Output
A	B	$Y = A + B$
low	low	low
low	high	high
high	low	high
high	high	high

Logical diagram

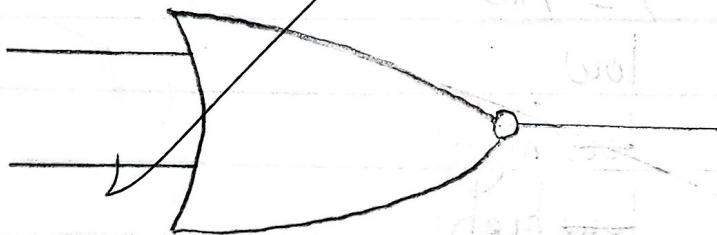
1. OR gate



2. AND gate



3. NOR gate



2. AND gate: An AND gate has two or more than two inputs and only one output which is equal to AND products of all input as shown below:

Truth Table

Inputs		Output
A	B	$y = AB$
low	low	low
low	high	low
high	low	low
high	high	high

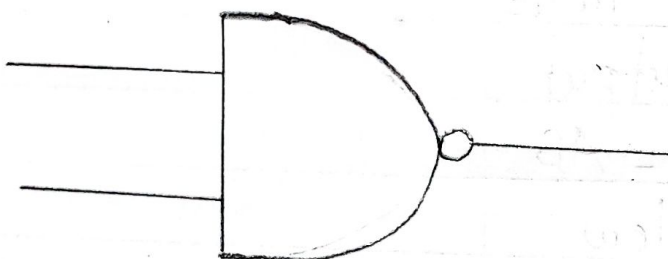
3. NOR gate: NOR gate actually means NOT-OR. It has two or more than two inputs but only one output which is the complement of the gate OR sum of two or more inputs as shown below:

Truth Table

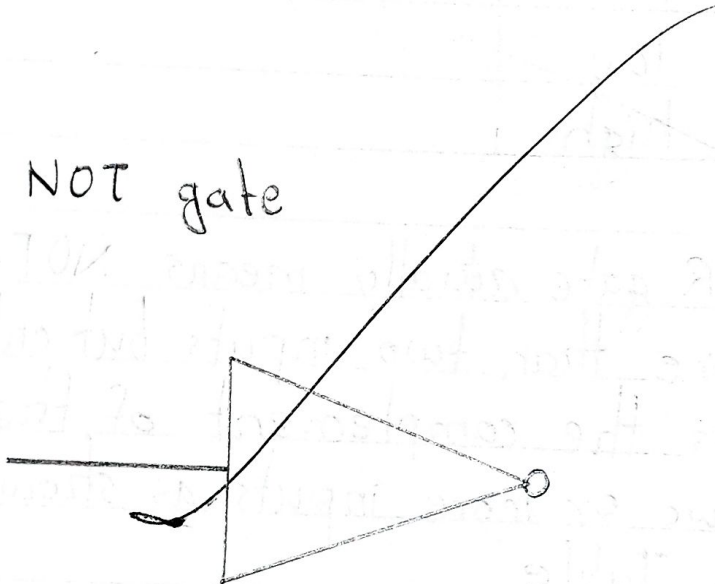
Inputs		Output
A	B	$y = \overline{A+B}$
low	low	high
low	high	low
high	low	low
high	high	low

4. NAND gate: NAND gate actually means NOT-AND. It has two or more than two inputs but only one output which is the complement of the AND

4. NAND gate



5. NOT gate



product of all inputs as shown below:

Truth Table

Inputs		Output
A	B	$Y = \overline{AB}$
low	low	high
low	high	high
high	low	high
high	high	low

5. NOT gate: An inverter or NOT gate has only a single output and always a single input signal. Output logic is complement of input logic as shown below:

Truth Table

Inputs	Output
A	Y
low	high
high	low

PROCEDURE

- Two ideal diodes D_1 and D_2 were connected in parallel across the output Y to make OR gate.
- When A was at $+5V$, D_1 was forward bias and hence conducted. The circuit current flowed via R dropping 5V across it. In this way, point Y achieved a potential of $+V$.

3. When $+V$ was applied to B_1 , D_1 conducted causing point Y to go to $+V$.
4. When both A and B were $+5V$, the potential drop across R was $5V$ because of A and B were parallel. Again, point Y was driven to $+5V$.

Obviously, when there was no voltage either at A or B output Y is $0V$. For the other gate same procedure was followed.

OBSERVATION TABLE

1. OR gate

Input		Output
A	B	$Y = A + B$
0	0	0
0	1	1
1	0	1
1	1	1

2. AND gate

Inputs		Output
A	B	$Y = AB$
0	0	0
0	1	0
1	0	0

1	1	1
---	---	---

3. NOR gate

Inputs		Output
A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

4. NAND gate

Inputs			Inputs			Output
A	B	Output	A	B		$Y = \overline{AB}$
0	0	$Y = \overline{AB}$	0	0		1
0	1	1	0	1		1
1	0	1	1	0		1
1	1	1	1	1		0

5. NOT gate

Inputs	Output
A	Y
0	1
1	0

RESULT

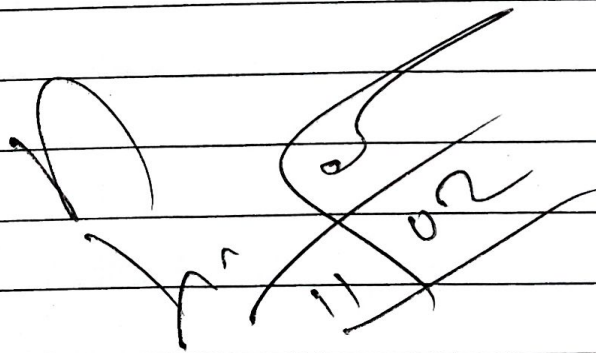
- For OR gate: The truth table shows that for the

OR function the output is high when any input is high.

- For AND gate: The truth table shows that for the AND function, the output is high when both inputs are high.
- For NOT gate: The truth table shows that for NOT function, the output is high when its input is low.

PRECAUTIONS

1. The circuit should be properly connected.
2. The current in the circuit should not be suddenly increased.
3. Suitable voltage and current should be applied.
4. Connected wire should be uniform, low resistivity like copper, etc.
5. Reading should be noted carefully.



EXPERIMENT NO. 11

NAME OF EXPERIMENT: TO VERIFY THE LAW OF SERIES AND PARALLEL RESISTANCE USING P.O. BOX

APPARATUS REQUIRED

1. P.O. Box
2. Galvanometer
3. Resistance wire
4. Connecting wire
5. Leclanche cell

THEORY

When resistance are joined in series, the equivalent resistance R is given by

$$R_s = R_1 + R_2$$

Where, R_1 and R_2 are specific resistance.

When resistance are in parallel, the equivalent resistance R is given by,

$$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$$

Wheatstone bridge principle states that if P , Q , R and X be four resistance, X being unknown resistance connected, 'G' a moving coil galvanometer, E a Leclanche cell then for null deflection of galvanometer,

$$\frac{P}{Q} = \frac{X}{R}$$

$$\therefore X = \frac{P}{Q} \times R$$

(i)



(ii)

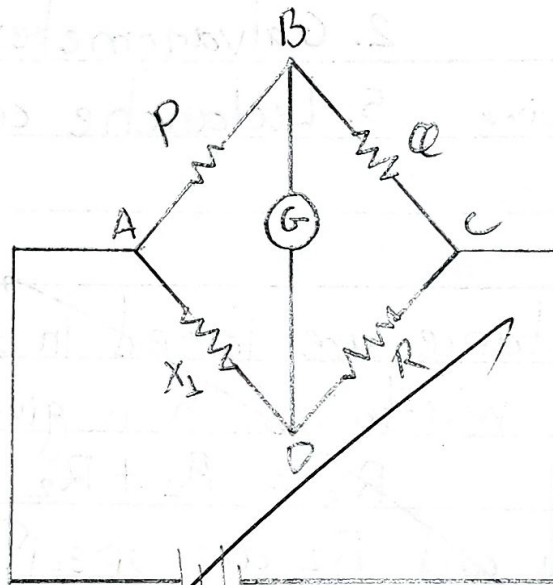
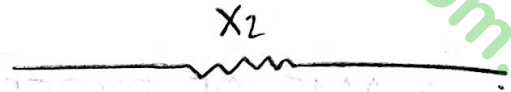


fig. (a)

$X_1 = ?$

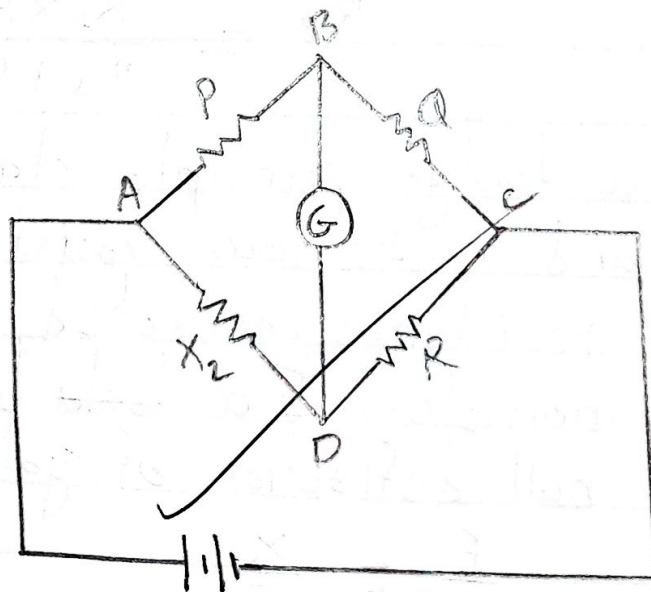
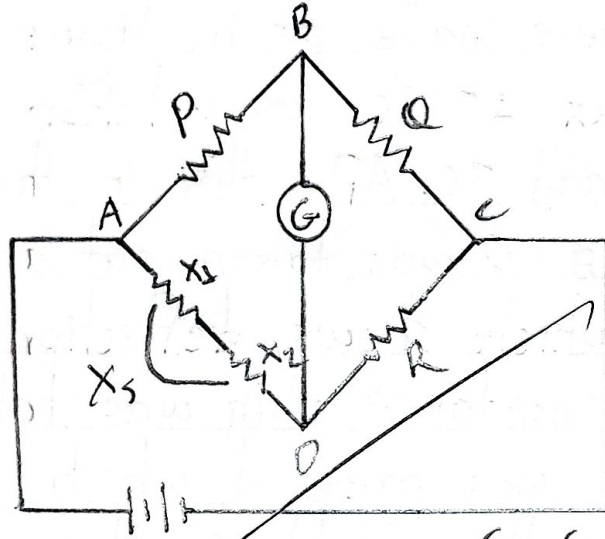


fig. (b)

$X_2 = ?$

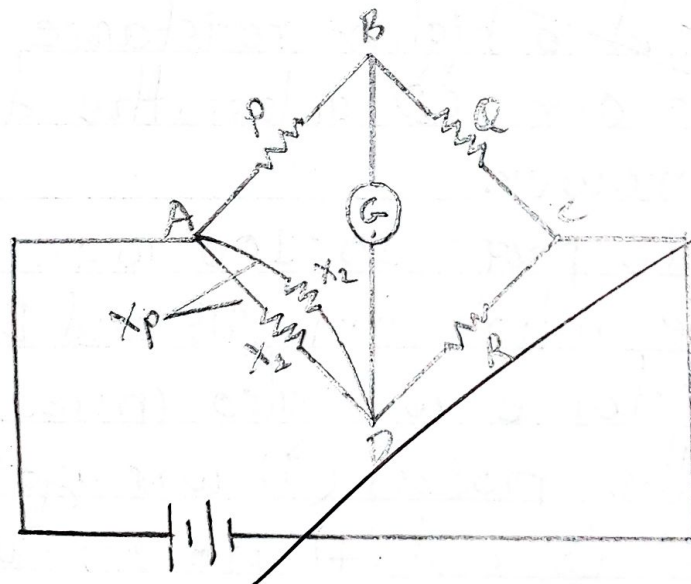
PROCEDURE

1. A circuit diagram was drawn and continuous connections were made as in figure.
2. Resistance plug $10:10$ were taken out from the ratio arm AB and BC. After this, in the third arm CD, resistance plug 0 was taken out and battery key was pressed which shows deflection in the left. Likewise, ∞ resistance plug was taken out and battery key was pressed which shows the deflection in the right. So, the circuit was right.
3. This operation was repeated by alternating taking out a low and a higher resistance plug from the resistance arm CD unless the deflection becomes narrower.
4. Next, resistance plugs $10:100$ were taken out from the ratios arm AB and BC and the value of resistance was also increased by 10 times and the process (3) was again repeated.
5. The above (2), (3) and (4) process were repeated for other circuits too.
6. Observed deflection and direction were noted in the table.



$X_s = ?$

fig (e)



$X_p = ?$

fig. (f)

OBSERVATION TABLE

For X_1

No. of Obs.	Ratio arms P:Q	Resistance in 3rd arm	Galvanometer deflection	Inference about unknown resistance
1.	10:10	0	Too left	Value of X_1 lies between 0 and 1.
		∞	Too right	
		1	Too right	
2.	10:100	1	Too left	Value of X_1 lies between 0.4 and 0.5
		4	Slow left (5 divs)	
		5	Slow right (29 divs)	

Change in deflection $(5+29) = 1 \Omega$ or, $1 \Omega = 34$ division

$$\therefore \frac{1}{34} \Omega = 1 \text{ div}$$

$$\therefore R_1 = 4 \Omega + 5 \text{ div}$$

$$= 4 \Omega + 5 \times \frac{1}{34} \Omega$$

$$= (4 + 0.147) \Omega$$

$$= 4.147 \Omega$$

For X_2

No. of Obs.	Ratio arms P:Q	Resistance in 3rd arm	Galvanometer deflection	Inference about unknown resistance
1.	10:10	0	Too left	Value of X_2 lies between 0 and 1.
		∞	Too right	
		1	Too right	

2.	10:100	1	Too left	Value of X_2 lies
		3	Slow left (16 div)	between 0.3 and
		4	Slow right (25 div)	0.4

Change in deflection $(16+25)$ div = 1Ω

or, $1 \Omega = 41$ divisions

or, $\frac{1}{41} \Omega = 1$ div

$$\therefore R_2 = 3 \Omega + 16 \text{ div}$$

$$= 3 \Omega + 16 \times \frac{1}{41} \Omega$$

$$= 3 \Omega + 0.39 \Omega$$

$$= 3.39 \Omega$$

When two resistors X_1 and X_2 are connected in series.

For X series.

No. of Obs.	Ratio arms	Resistance in 3 rd arm	Galvanometer deflection	Inference about unknown resistance
1.	10:10	0	Too left	Value of X_s lies
		∞	Too right	between 0 and
		1	Too right	1
2.	10:100	1	Too left	Value of X_s lies
		7	Slow left (17 div)	between 0.7 and
		8	Slow right (14 div)	0.8

Change in deflection $(17+14)$ divs = 1Ω

or, $1 \Omega = 31$ divisions

or, $\frac{1}{31} \Omega = 1$ division

$$\begin{aligned}
 \therefore R &= 7 \Omega + 17 \text{ divisions} \\
 &= 7 \Omega + 17 \times \frac{1}{31} \Omega \\
 &= 7.548 \Omega
 \end{aligned}$$

CALCULATION

For Table (i)

$$R = 4.147 \Omega$$

We know at balanced condition,

$$\frac{P}{Q} = \frac{X_1}{R}$$

$$\text{or, } \frac{10}{100} = \frac{X_1}{4.147}$$

$$\text{or, } X_1 = \frac{10}{100} \times 4.147$$

$$\therefore X_1 = 0.4147 \Omega$$

For Table (ii)

$$R = 3.39 \Omega$$

We know at balanced condition

$$\frac{P}{Q} = \frac{X_2}{R}$$

$$\text{or, } \frac{10}{100} = \frac{X_2}{3.39}$$

$$\text{or, } X_2 = \frac{10}{100} \times 3.39$$

$$\therefore X_2 = 0.339 \Omega$$

For Table (iii), if connected in series

$$R = 7.548 \Omega$$

We know at balanced condition

$$\frac{P}{Q} = \frac{X_s}{R}$$

$$\text{or, } \frac{10}{100} = \frac{X_s}{7.548}$$

$$\therefore X_s = 0.7548 \Omega$$

For series

$$R_{\text{observed}} = R_1 + R_2$$

$$= \cancel{4.147 + 3.39} \Omega$$

$$= 7.537 \Omega$$

$$0.7537$$

$$R_{\text{calculated}} = \cancel{7.548 \Omega} \quad 0.7537$$

OBSERVATION TABLE

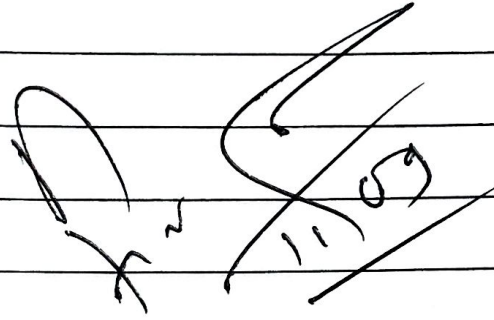
S.N.	Resistance (R_1)	Resistance (R_2)	$R = R_1 + R_2$ (series)	
			Observed	Calculated
1.	4.147 Ω 0.4147	3.39 Ω 0.339	7.537 Ω 0.7537	7.548 Ω 0.7548

RESULT

Hence, the resistance was calculated and compared with the observed and verified.

PRECAUTION

1. Calculation should be done accurately.
2. P.O. Box should be used properly.
3. Reading of galvanometer should be taken accurately.



EXPERIMENT NO. 12

NAME OF EXPERIMENT: TO DETERMINE THE VALUE OF DIP IN THE LABORATORY USING A DIP CIRCLE

APPARATUS REQUIRED

1. Dip circle
2. A spirit level

THEORY

- a) Bringing the Dip circle in the magnetic meridian

The dip at a place may be defined as the angle between the direction of the total intensity of the earth's magnetic field and horizontal component at that place.

- b) Without bringing the Dip-circle in the magnetic meridian.

If δ_1 and δ_2 be the value of apparent Dip at a place in any two positions of two vertical planes at right angles to each other. The value of true dip δ at the place is given by,

$$\cot^2 \delta = \cot^2 \delta_1 + \cot^2 \delta_2$$

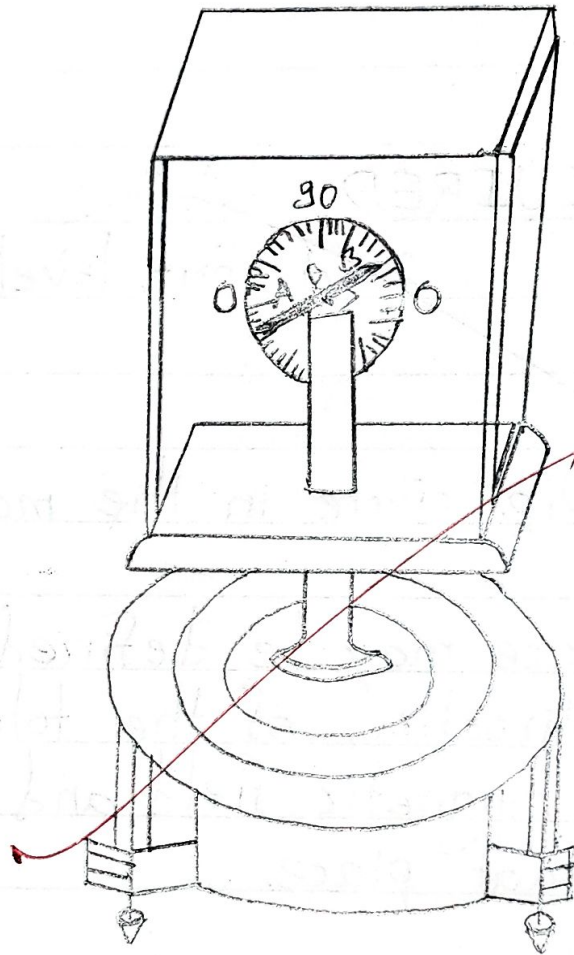


Fig. Dip Circle

PROCEDURE

1. The dip circle was levelled properly with the help of the levelling screw and the spirit level.
2. The box was rotated about a vertical axis till and magnetic field becomes vertical and pointed along the $90^\circ-90^\circ$ line. The index mark was brought to zero position by rotating the horizontal circular scale at the base.
3. From that position, the box was rotated further through 90° about the vertical axis over the horizontal scale to bring the needle in the magnetic meridian. The reading of upper end and lower end was noted.
4. The box was turned through 270° and again the value of upper end and lower end was noted.
5. The box was rotated through 90° over the horizontal scale. i.e. it was kept at $90^\circ + \theta$, $180^\circ + \theta$ and $270^\circ + \theta$ and value of upper end and lower end was noted.
6. The needle was remagnetised, operation was repeated and mean the value of δ_1 and δ_2 .

OBSERVATION

Bringing the dip circle in the magnetic meridian.

Position at which box is filled.	Position of needle	Needle reading		Mean δ	
		Upper end	Lower end		
90°	Front reversed	68°	72°	66.25°	
270°	Front reversed	64°	60°		

Needle Remagnetised

90°	Front reversed	64°	60°	66.25°	
270°	Front reversed	68°	72°		

Without bringing the dip circle in the magnetic meridian

	Position at which needle is fitted	Position of the needle	Needle Readings		Mean δ_1	Mean δ_2
			Upper end	Lower end		
1.	$\theta = 20^\circ$	Front reversed	82°	80°	76.5°	
	$\theta + 180^\circ = 200^\circ$	"	70°	74°		
	$\theta + 90^\circ = 110^\circ$		68°	73°		66.75°
	$\theta + 270^\circ = 290^\circ$		64°	62°		
2.	$\theta = 30^\circ$		79°	82°	75.75°	
	$\theta + 180^\circ = 210^\circ$		72°	70°		
	$\theta + 90^\circ = 120^\circ$		79°	81°		75.75°
	$\theta + 270^\circ = 300^\circ$		73°	70°		

CALCULATION

$$\cot^2 \delta = \cot^2 \delta_1 + \cot^2 \delta_2$$

$$\text{or, } \frac{1}{\tan^2 \delta} = \frac{1}{\tan^2 \delta_1} + \frac{1}{\tan^2 \delta_2}$$

$$\text{or, } \frac{1}{\tan^2 \delta} = \frac{\tan^2 \delta_2 + \tan^2 \delta_1}{\tan^2 \delta_1 \cdot \tan^2 \delta_2}$$

$$\text{or, } \tan^2 \delta = \frac{\tan^2 \delta_1 \cdot \tan^2 \delta_2}{\tan^2 \delta_1 + \tan^2 \delta_2}$$

$$\text{or, } \delta = \tan^{-1} \left(\sqrt{\frac{\tan^2 \delta_1 \cdot \tan^2 \delta_2}{\tan^2 \delta_1 + \tan^2 \delta_2}} \right)$$

(where, $\delta_1 = 76.5^\circ$; $\delta_2 = 66.75^\circ$)

$$\therefore \delta_{20} = \tan^{-1} \left(\sqrt{\frac{\tan(76.5)^\circ \cdot \tan(66.75)^\circ}{\tan(76.5)^\circ + \tan(66.75)^\circ}} \right)$$

$$\text{or, } \delta_{20} = \tan^{-1}(2.026)$$

$$\text{or, } \delta_{20} = 63.72^\circ$$

Again,

($\delta_1 = 75.75^\circ$; $\delta_2 = 75.75^\circ$)

$$\therefore \delta_{30} = \tan^{-1} \left(\sqrt{\frac{\tan(75.75)^\circ \cdot \tan(75.75)^\circ}{\tan(75.75)^\circ + \tan(75.75)^\circ}} \right)$$

$$\text{or, } \delta_{30} = \tan^{-1}(2.73)$$

$$\text{or, } \delta_{30} = 69.88^\circ$$

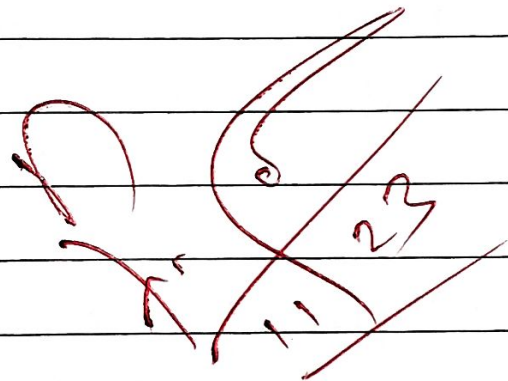
$$\begin{aligned} \therefore \text{Mean } (\delta) &= \frac{\delta_{20} + \delta_{30}}{2} \\ &= \frac{63.72^\circ + 69.88^\circ}{2} \\ &= 66.8^\circ \end{aligned}$$

RESULT

Hence, the dip value in the laboratory was 66.8° .

PRECAUTIONS

1. The instrument must be properly leveled to make; (a) the base horizontal; (b) the plane of rotation of needle vertical; (c) to avoid any obstruction in needle during its rotation.
2. All magnets and magnetic substance should be removed from the working table.



EXPERIMENT NO. 13

NAME OF EXPERIMENT: TO DETERMINE THE RESISTANCE OF GIVEN WIRE BY USING METER BRIDGE

APPARATUS REQUIRED

- | | | |
|--------------------|--------------------|-------------------|
| 1. Meter bridge | 2. Resistance box. | 3. Leclanche cell |
| 4. Connecting wire | 5. Two way key | 6. Galvanometer |

THEORY

The principle used in the determination of resistance by meter bridge lies in the application of wheatstone bridge.

According to wheatstone bridge principle, if P , Q , R , X be four resistance (X) being an unknown resistance connected with the galvanometer and E , a leclanche cell then for null deflection,

$$\frac{X}{R} = \frac{P}{Q} \quad \text{--- (i)}$$

Now, if the wheatstone bridge circuit be applied in the meter bridge, the circuit will be as shown in fig. (ii). Let 'B' be the point along the bridge wire when the galvanometer deflection zero. Then, if γ = resistance per cm.

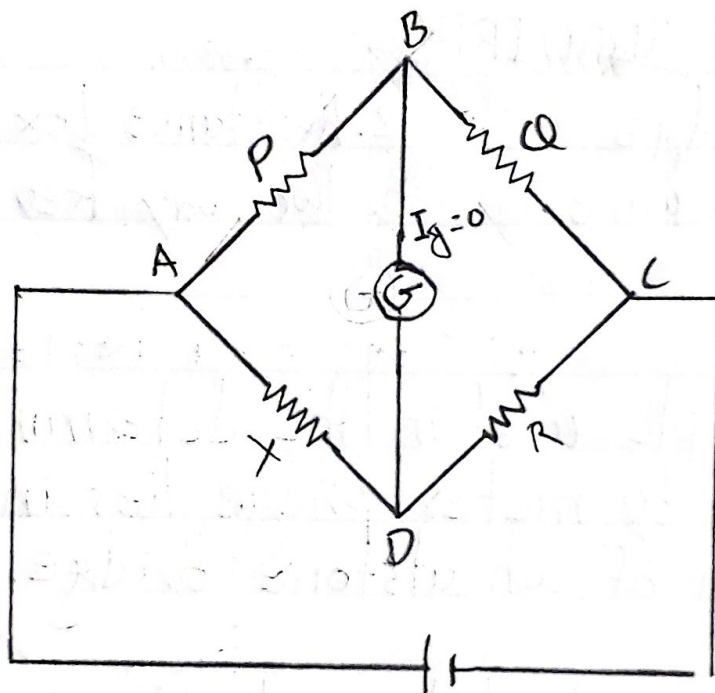


fig. (i) Wheat stone bridge.

of the bridge wire, length of $AB = l$ and that of $BC = 100 - l$ then from (i)

$$\frac{X}{R} = \frac{P}{Q}$$

$$\text{or, } \frac{X}{R} = \frac{l}{100-l}$$

$$\text{or, } \boxed{X = \frac{l}{100-l} \times R} \quad (\text{when, } X \text{ is in left})$$

Again, for conditions when X and R are interchanged with each other then,

$$\frac{P}{Q} = \frac{R}{X}$$

$$\text{or, } \frac{R}{X} = \frac{l}{100-l}$$

$$\text{or, } \boxed{X = \frac{100-l}{l} \times R} \quad (\text{when } X \text{ is in right})$$

PROCEDURE

1. A circuit diagram was drawn and completed.
2. The key was closed. The jockey was pressed at one end of the bridge wire. There was a deflection in the galvanometer say to the left. Next, the jockey was moved to right end and pressed. The galvanometer deflected towards the right.
3. In the diagram, the unknown resistance X was in the left gap and known resistance was plugged

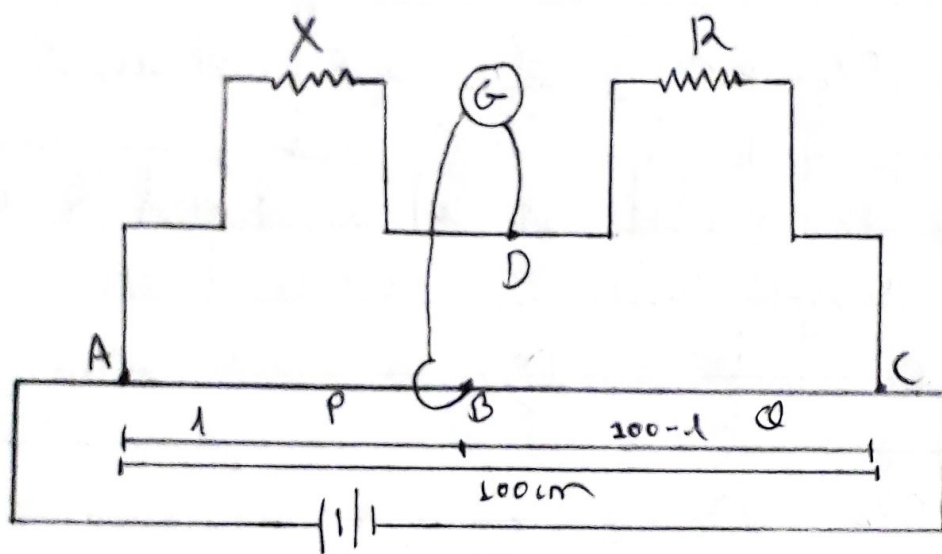


Fig. (ii) Meter bridge (When X is in left)

- out from the box R. Keeping the key closed the jockey was moved from left side and a null point such as B was obtained from the galvanometer null deflection. The position of B in the wire was noted.
4. The current was reversed by means of two way key in the battery circuit. Operation (3) was repeated.
 5. Next the resistance of 3, 4 & 5 ohms are plugged out from the resistance box R. and operation (3) & (4) are repeated in order.
 6. After that, the resistance box and the unknown resistance X are interchanged. Operation (3), (4) & (5) are repeated.

OBSERVATION TABLE

No. of Obs.	Resistance in the gap		length 'l'	length 100-l	X = left $X = \frac{lR}{100-l} \Omega$	X = right $X = \left(\frac{100-l}{l}\right)R \Omega$	Mean Ω
1.	X = ?	R = 1 Ω	29.5 cm	70.9 cm	0.41 Ω		
	R = 1 Ω	X = ?	71 cm	29 cm		0.40 Ω	
2.	X = ?	R = 2 Ω	17.2 cm	82.8 cm	0.41 Ω		
	R = 2 Ω	X = ?	83.9 cm	16.1 cm		0.38 Ω	
3.	X = ?	R = 3 Ω	15.9 cm	88.1 cm	0.40 Ω		0.39 Ω
	R = 3 Ω	X = ?	89 cm	11 cm		0.37 Ω	
4.	X = ?	R = 4 Ω	9.1 cm	90.9 cm	0.40 Ω		
	R = 4 Ω	X = ?	91.6 cm	8.4 cm		0.36 Ω	
5.	X = ?	R = 5 Ω	7.5 cm	92.5 cm	0.40 Ω		
	R = 5 Ω	X = ?	93 cm	7 cm		0.37 Ω	

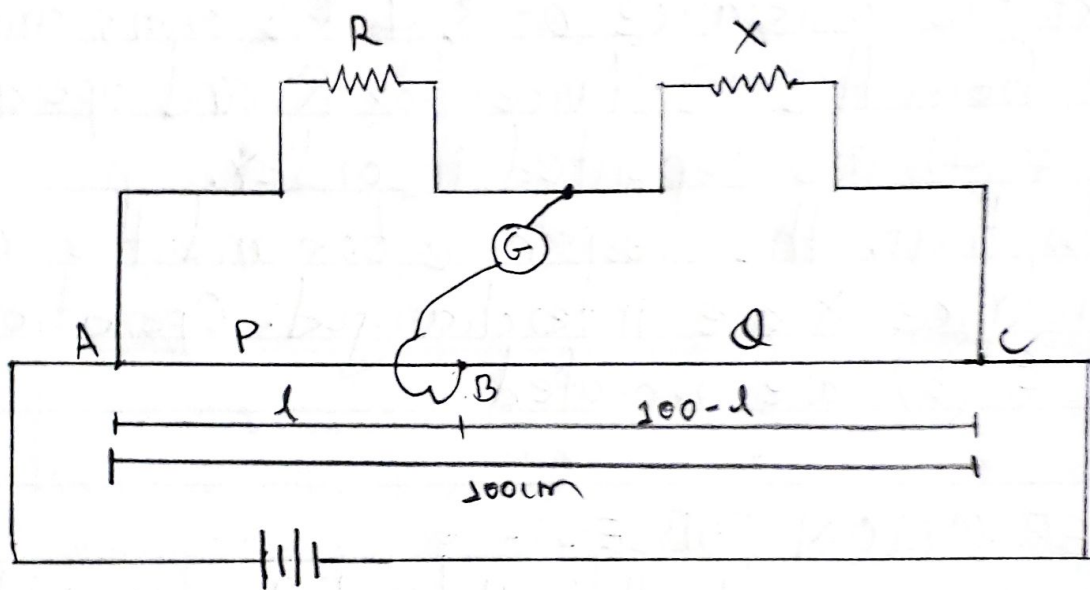


fig. (iii) Meter bridge (When X is in Right)

CALCULATIONS (When X is in left & R is in right)

1. For $R = 1 \Omega$

$$l = 29.1 \text{ cm}$$

$$100 - l = 100 - 29.1$$

$$= 70.9 \text{ cm}$$

$$\therefore X_1 = \frac{lR}{100 - l}$$

$$= \frac{29.1 \times 1}{70.9}$$

$$= 0.41 \Omega$$

2. $R = 2 \Omega$

$$l = 17.2$$

$$100 - l = 100 - 17.2$$

$$= 82.8 \text{ cm}$$

$$\therefore X_2 = \frac{17.2 \times 2}{82.8}$$

$$= 0.41 \Omega$$

3. For $R = 3 \Omega$

$$l = 11.9 \text{ cm}$$

$$100 - l = 100 - 11.9$$

$$= 88.1 \text{ cm}$$

$$\therefore X_3 = \frac{11.9 \times 3}{88.1}$$

$$= 0.40 \Omega$$

4. $R = 4 \Omega$

$$l = 9.1 \text{ cm}$$

$$100 - l = 100 - 9.1$$

$$= 90.9 \text{ cm}$$

$$\therefore X_4 = \frac{9.1 \times 4}{90.9}$$

$$= 0.40 \Omega$$

5. For $R = 5 \Omega$

$$l = 7.5 \text{ cm}$$

$$100 - l = 100 - 7.5$$

$$= 92.5 \text{ cm}$$

$$\therefore X_5 = \frac{7.5 \times 5}{92.5}$$

$$= 0.40 \Omega$$

When X is in Right & R is on left

1. For $R = 1\Omega$

$$l = 71\text{ cm}$$

$$100 - l = 100 - 71$$

$$= 29\text{ cm}$$

$$\therefore X_1' = \frac{(100 - l) \times R}{l}$$

$$= \frac{29 \times 1\Omega}{71}$$

$$= 0.40\Omega$$

2. For $R = 2\Omega$

$$l = 83.9\text{ cm}$$

$$100 - l = (100 - 83.9)\text{ cm}$$

$$= 10.1\text{ cm}$$

$$\therefore X_2' = \frac{10.1 \times 2}{83.9}$$

$$= 0.38\Omega$$

3. For $R = 3\Omega$

$$l = 89\text{ cm}$$

$$100 - l = 100 - 89$$

$$= 11\text{ cm}$$

$$\therefore X_3' = \frac{11 \times 3}{89}$$

$$= 0.37\Omega$$

4. For $R = 4\Omega$

$$l = 91.6\text{ cm}$$

$$100 - l = 100 - 91.6$$

$$= 8.4\text{ cm}$$

$$\therefore X_4' = \frac{8.4 \times 4}{91.6}$$

$$= 0.36\Omega$$

5. For $R = 5\Omega$

$$l = 93\text{ cm}$$

$$100 - l = 100 - 93$$

$$= 7\text{ cm}$$

$$\therefore X_5' = \frac{7 \times 5}{93}$$

$$= 0.37\Omega$$

$$\therefore \text{Mean}(X) = \frac{X_1 + X_2 + X_3 + X_4 + X_5 + X_1' + X_2' + X_3' + X_4' + X_5'}{10}$$

$$= \frac{(0.41 + 0.41 + 0.40 + 0.40 + 0.40 + 0.40 + 0.38 + 0.37 + 0.36 + 0.37) \Omega}{10}$$

$$= 0.39 \Omega$$

RESULT

Hence, the resistance of the given wire (X) was calculated as 0.39Ω

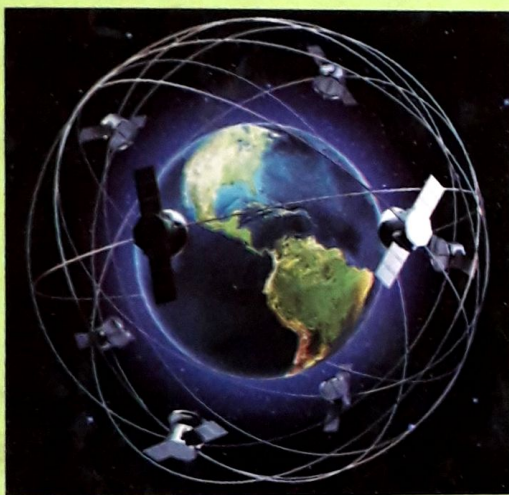
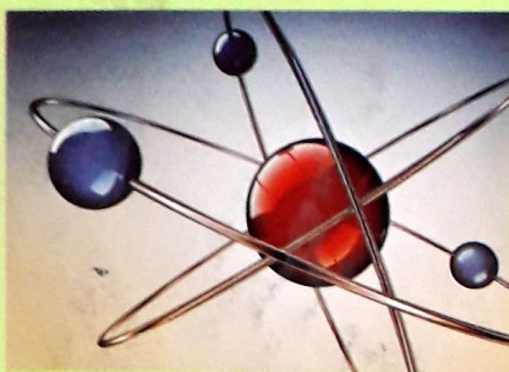
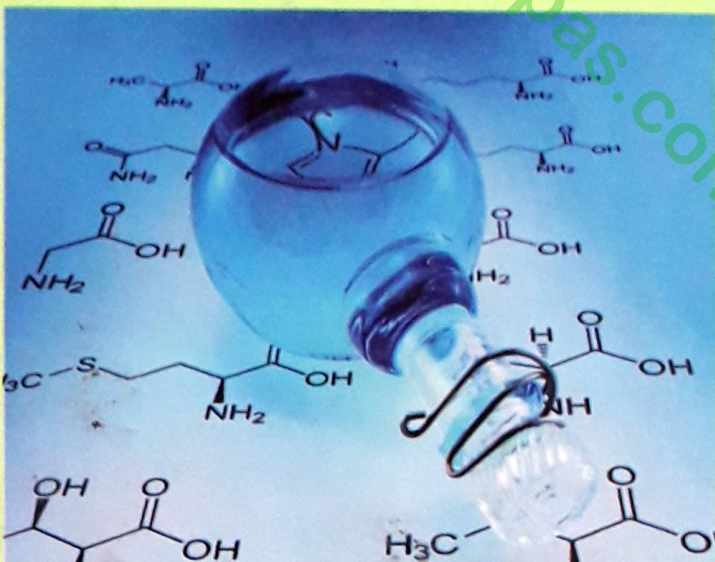
PRECAUTION

1. Calculation should be done properly.
2. Length in the meter bridge should be taken accurately by null deflection of galvanometer.

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