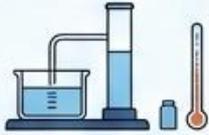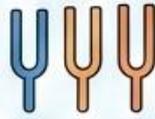# PHYSICS PRACTICAL GUIDE:
VELOCITY OF SOUND
USING A RESONANCE TUBE

OBJECTIVE: To determine the velocity of sound in air using a resonance tube.

APPARATUS REQUIRED

- Resonance tube apparatus
- Tuning forks of known frequencies (e.g., 25Hz, 256Hz, 384Hz, 512Hz)
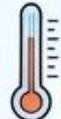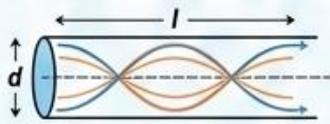- Rubber mallet
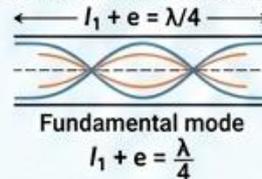- Meter scale
- Vernier calipers
- Water
- Thermometer

PRINCIPLE & FORMULA

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

With end correction

$$V = 4f(l_1 + e) = \frac{4f}{3}(l_2 + e)$$

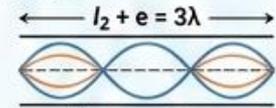Where f = frequency is resonance mode expooted and antnoder ts avn sound and other fite-up fouse.

f = frequency
l_1 = 1st resonance length
l_2 = 2nd resonance length
e = end correction

Resonance and standing waves with nodes and antinodes when a most arwanes snow to the save levet, with nodes and antinodes.

$l_1 + e = \lambda/4$

Fundamental mode
$l_1 + e = \frac{\lambda}{4}$
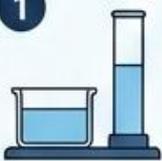
$l_2 + e = 3\lambda$

First overtone
$l_2 + e = \frac{3\lambda}{4}$

PROCEDURE

1 Set Up Apparatus
Level the base, fill water to mepare tuning tube.

2 Measure Diameter
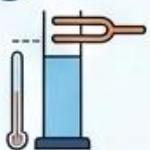Find internal diameter (d) with Vernier calipers. Calculate $e \approx 0.3d$.
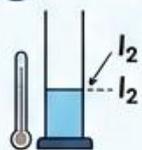
3 Strike Tuning Fork
Gently strike it with a rubber mallet.

4 Find 1st Resonance (l_1)
Hold vibrating fork above tube, adjust adjust water level for maximum sound. Mark l_1. mark l_1.

5 Find 2nd Resonance (l_2)
Lower water level to find the next louder sound. Mark l_2.

6 Repeat
Do this for multiple tuning forks. Measure temperature.

OBSERVATIONS TABLE

Tuning Fork Freq (f in Hz)	Trial 1	Trial 2	Mean	Trial 1	Trial 2	Mean	Mean	Temperature (°C)
f	/	/	/	/	/	/	-	
f	-	-	=	-	-	=	-	

CALCULATIONS & RESULT

1. Calculate the meature V using mean $(l_2 - l_1)$, averaged the values.

2. Step to step $V = \dfrac{\text{mean }(-l_1)}{(l_1 + e)}$ or average $V = \dfrac{(l_2 - l_1)}{(l_1 + e)}$.

3. Calculate in average for values.

RESULT: Velocity of sound at room temperature (T°C) = [Value] m/s.

PHYSICS PRACTICAL GUIDE:
DYNAMICS OF A CANTILEVER

OBJECTIVE: To determine the time period of a cantilever and investigate factors affecting it.

APPARATUS REQUIRED

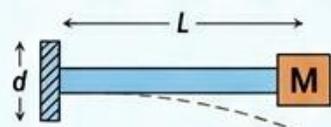|						
Cantilever beam (clamped at one end)	Known weights (e.g., 50g, 100g, 200g)	Stop clock stopwatch	Rubber mallet	Meter scale	Vernier calipers	Thermometer

PRINCIPLE & FORMULA

Time period $T = K_i - m$

$$T = 2\pi\sqrt{\frac{M}{K}}$$

Where f = frequency T' and restoring force T and in restoring force to edge the restoring force.

M= M= effective mass
L = length, b = width
d = depth
Y = Young's modulus

$$T = 2\pi\sqrt{\frac{4ML^3}{Ybd^3}}$$

Fundamental mode
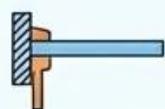$T^2 \propto M/K$

First overtone
$T^2 \propto L^3$

$T^2 \propto M/K$

$T^2 \propto L^3$

PROCEDURE
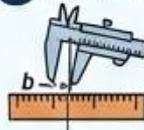
1 Set Up Apparatus
Clamp the cantilever, ensuring it's horizontal.

2 Measure Beam Dimensions
Find width (b), depth (d), and clamped length (L) scale. Calculate e = 0.3d.
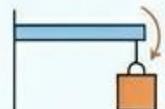
3 Attach Mass
Place a known mass (M) at the free end.

4 Excite and Measure
Displace the free end slightly and release release. Start the stop clock for 10-20 oscillations.

5 Calculate Time
Divide total time by the number of oscillations to find time period (T).

6 Repeat
Vary mass (M) and clamped length (L) to collect more data. Record temperature.

OBSERVATIONS TABLE

Mass (M in g)	Clamped Length (L in cm)	Time for [N] oscillations	Average Time	Time Period (T)	T²
M in	cm	/	/	/	/
Mass of the beam itself = [Value] g		-	-	=	-

CALCULATIONS & RESULT

1. Plot graphs of T^2 vs M and T^2 vs L^3.
2. Calculate time period using the graph or formula for a specific mass.
3. Discuss sources of error and the effect of different parameters.

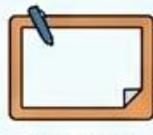**RESULT:** Time period of the cantilever for [M] g mass is [Value] seconds. Experimental value of K = [Value] N/m.

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PHYSICS PRACTICAL GUIDE:
VERIFICATION OF LAWS OF REFLECTION

OBJECTIVE: To verify the laws of reflection from a plane mirror / interface.

APPARATUS REQUIRED

Plane mirror with stand	Drawing board	White paper (A4)	Drawing pins	Optical pins	Protractor	Metric scale	Pencil

PRINCIPLE & FORMULA

Normal

Incident Ray

θ_i θ_r

Reflected Ray

Angle of Incidence = Angle of Reflection ($\theta_i = \theta_r$)
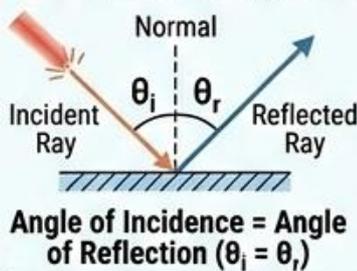
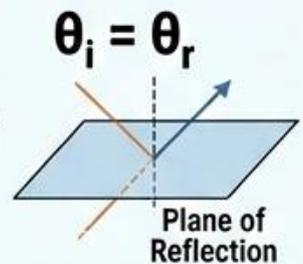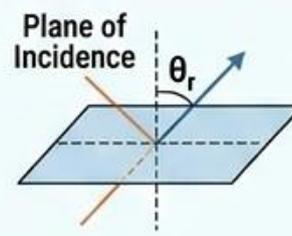**Law 1: $\theta_i = \theta_r$**

Law 2: Incident ray, reflected ray, and normal all lie on the same plane (the A4 paper).

Plane of Incidence

θ_r

$\theta_i = \theta_r$

Plane of Reflection

PROCEDURE

1 Set Up Drawing Board
Secure paper to the drawing board.
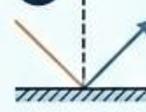
2 Place Plane Mirror
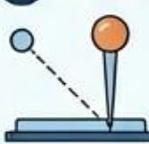Position the mirror on a marked line.

3 Draw Normal
Draw a normal line to the mirror surface.

4 Position Incident Pin
Fix an optical pin (e.g., at $\theta_i = 30°$).

5 View Image & Place Reflected Pins
Look from the other side, align image of incident pin with reflection, place reflected pins (P_1, P_2).
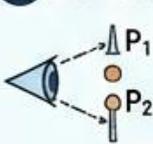
6 Repeat
Vary θ_i (e.g., 40°, 50°) and record θ_r. Ensure all rays are on the paper.

OBSERVATIONS TABLE

Sl. No.	Angle of Incidence (θ_i in Degrees)	Angle of Reflection (θ_r in Degrees)	Remarks/Diff ($\theta_i - \theta_r$)	Temperature (°C)
1	30	30	0	/
2	40	39.5	-0.5	-

CALCULATIONS & RESULT

1. Plot a graph of θ_i vs θ_r (or show a representative graph).
2. Calculate the average difference ($\theta_i - \theta_r$).
3. Discuss sources of error and precision.

RESULT: Angles of incidence and reflection are found to be equal within experimental error ($\theta_i \approx \theta_r$). The experiment verifies the laws of reflection.

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PHYSICS PRACTICAL GUIDE:
VERIFICATION OF LAWS OF REFRACTION (SNELL'S LAW)

OBJECTIVE: To verify the laws of refraction (Snell's law) using a glass slab.

APPARATUS REQUIRED

| Glass slab with stand | Drawing board | White paper (A4) | Drawing pins | Optical pins | Protractor | Metric scale | Pencil |

PRINCIPLE & FORMULA

Normal

Air
Incident Ray

i_i r_r

Reflected Ray

Glass

r

Angle of Incidence = Angle of Reflection ($\theta_i = \theta_r$)

Law 1: Incident ray, refracted ray, and on the same plane.

Law 2 (Snell's Law):
$$n = \sin(i) / \sin(r)$$
where n is refractive index.

i

r

d

$$n_1 \sin(i) = n_2 \sin(r)$$

d = lateral shift

$\rightarrow |d| \leftarrow$

Node   Node   Antinode

$$n_1 \sin(i) = n_2 \sin(r)$$

PROCEDURE

① Set Up Drawing Board
Secure paper to the drawing board.

② Place Glass Slab
Mark its boundary on a marked line.

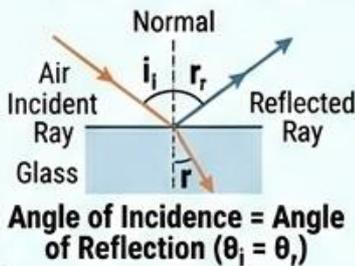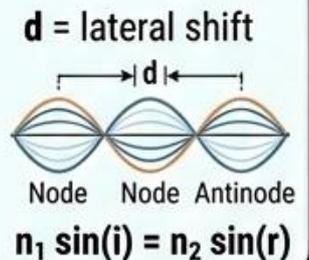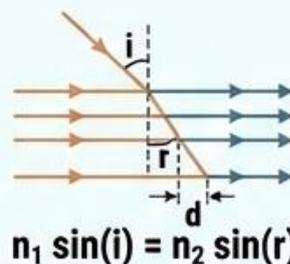**③ Draw Normal**
At the point of incidence.

④ Position Incident Pin
Fix a pin on a pin (e.g., at i = 30°).

⑤ View Image & Place Refracted Pins
Look through the slab, placi image of incident pin with reflection, place reflected pins (P₁, P₂).

P_1
P_2

⑥ Repeat
Vary angle 'i' (e.g., 40°, 50°) and record angle 'r'. are on the paper.

OBSERVATIONS TABLE

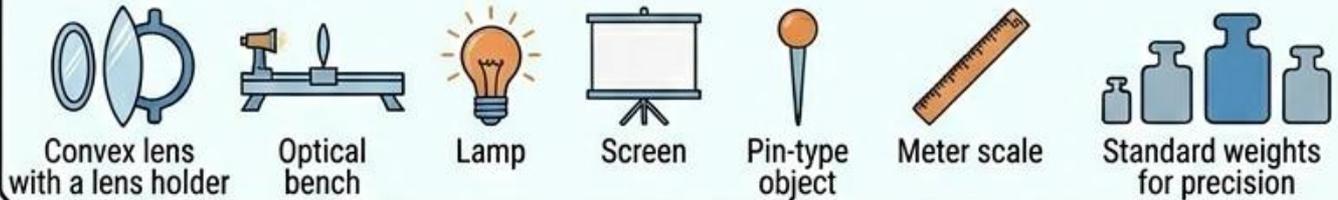| Sl. No.	Angle of Incidence (i)	Angle of Refraction (r)	sin(i)	sin(r)	Refractive Index (n = sin(i)/sin(r))	Temperature (°C)
1	30	30	0.00	0.30	-	/
2	40	39.5	0.20	0.25	-	-

CALCULATIONS & RESULT

1. Plot a graph of sin(i) vs sin(r). (or show a representative graph).
2. Calculate the average refractive index (n).
3. Discuss sources of error and precision.

RESULT: The average refractive index (n) of glass is found to be [Value]. The graph of sin(i) vs sin(r) is a straight line, verifying Snell's Law.
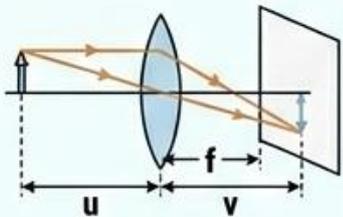
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PHYSICS PRACTICAL GUIDE:
FOCAL LENGTH & MAGNIFYING POWER OF A CONVEX LENS

OBJECTIVE: To determine the focal length (f) and magnifying power (M) of a convex lens.
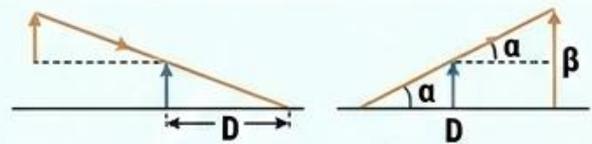
APPARATUS REQUIRED

Convex lens with a lens holder	Optical bench	Lamp	Screen	Pin-type object	Meter scale	Standard weights for precision

PRINCIPLE & FORMULA

Lens Formula:

$$1/f = 1/v - 1/u$$

(with u negative)

Power P = 1/f

Magnifying Power Formulas:

M = D/f (image at infinity)

M = 1 + D/f (image at least distance D)

$$M = \frac{D \times \tan(\beta)}{\tan(\alpha)}$$

PROCEDURE

1 Set Up Apparatus
Level the optical bench and mount the lens, lamp, and screen.

2 Rough Focal Length
Find the approximate focal length by focusing on a distant object.

3 Focus Object & Screen
Place an illuminated object (pin) at a distance 'u' (e.g., 2f) and focus its image on the screen.

4 Measure Distances
Use the meter scale to measure 'u' and 'v' from the lens center.

5 Calculate & Repeat
Calculate 'f' using the lens formula. Repeat for different 'u' values (e.g., 1.5f, 2.5f).

6 Vary for Magnifying Power
Measure D. Place the object at 'f' for for visual angle α. Observe the magnified image for angle β. Record data.

OBSERVATIONS TABLE

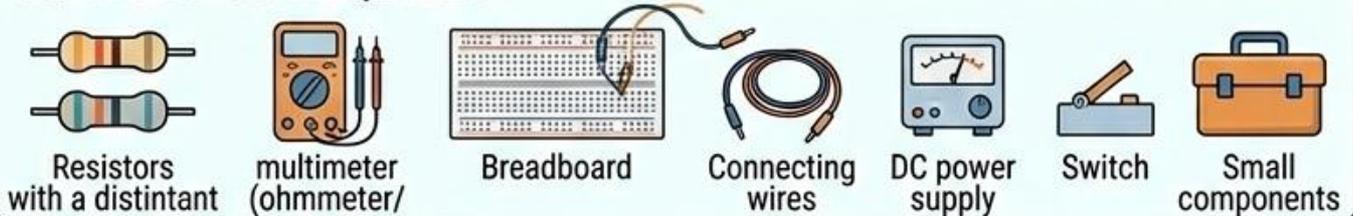| Sl. No.	Object Dist. (u in cm)	Image Dist. (v in cm)	1/u (cm^{-1})	1/v (cm^{-1})	Focal Length (f in cm)	Magnification (M = v/u)
1	-	-	/	/	-	/
				Mean Focal Length (f_{mean}) = [Value] cm		

CALCULATIONS & RESULT

1. Average the 'f' values.
2. Calculate magnifying power using the formulas (M = D/f or M = 1 + D/f). (D is near point, e.g., 25 cm).
3. **RESULT:** (1) Focal length of the convex lens = [Value] cm.
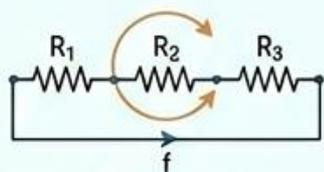   (2) Magnifying power = [Value].

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PHYSICS PRACTICAL GUIDE:
RESISTANCES IN SERIES & PARALLEL

OBJECTIVE: To verify the laws of resistances in series and parallel combinations.
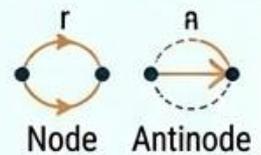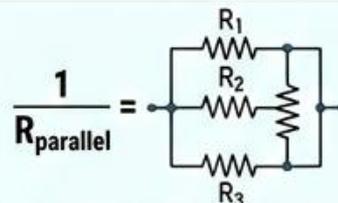
APPARATUS REQUIRED

| Resistors with a distintant | multimeter (ohmmeter/ | Breadboard | Connecting wires | DC power supply | Switch | Small components |

PRINCIPLE & FORMULA

$R_{series} = R_1 + R_2 + R_3$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{parallel}} =$$

Node   Antinode

Series: Current is constant, voltage divides.
Paralr: Voltage is constant, current divides.

Series: Current is constant, voltage divides.
Parallel: Voltage is constant, current divides.

PROCEDURE

1 Measure Individual Resistances
Measure R_1, R_2, R_3.

2 Connect in Series
Connect the series combination.

3 Measure R_{series}
Record R_{on} series combinater.
Record $R_{measured}$.

4 Connect in Parallel
Connect the parallel combination to parallel rails.

5 Measure $R_{parallel}$
Record $R_{measured}$ combinator.
Record $R_{measured}$.

6 Vary for Combination
Try more complex connections to collect more data. Record and calculate theoretical values for each trial.

OBSERVATIONS TABLE

Sl. No.	Individual Resistance (in Ω)	Connection Type	Theoretical Resistance (R_{th}, in)	Measured Resistance (R_{me}, in)	Error (%Diff)
1	R1, R2, R3 ...	Series/Parallel	R_{th} in Ω	R_m in Ω	/
			Mean Measured Resistance (R_{mean}) = [Value] Ω		

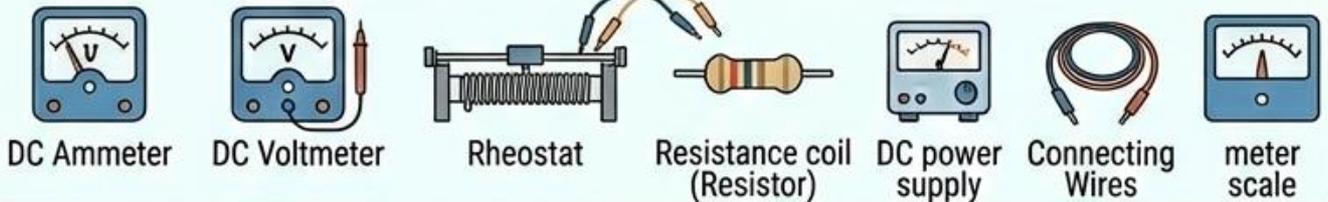## CALCULATIONS & RESULT

1. Plot a graph of $R_{measured}$ vs $R_{theoretical}$.
2. Average the %Error values.
3. **RESULT:** (1) Values of resistors (R1, R2, R3) are [Value] Ω.
   (2) Measured values of series and parallel combinations closely match theoretical values with minimal error, verifying the laws.
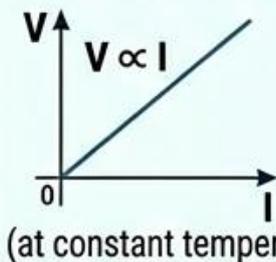
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PHYSICS PRACTICAL GUIDE:
VERIFICATION OF OHM'S LAW

OBJECTIVE: To verify Ohm's Laws by drawing a graph between voltage and current.
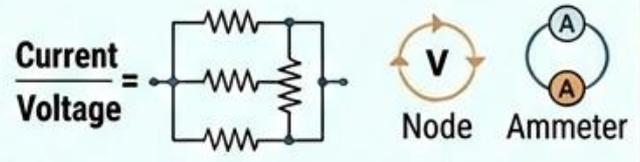
APPARATUS REQUIRED

DC Ammeter   DC Voltmeter   Rheostat   Resistance coil (Resistor)   DC power supply   Connecting Wires   meter scale

PRINCIPLE & FORMULA

$V \propto I$

$$R = \frac{V}{I}$$

V = Voltage
I = Current
R = Resistance

(at constant temperature)

$$\frac{Current}{Voltage} =$$

Node   Ammeter

Voltage (V) is constant, current **(I)** is constant. Voltage divides. Current divides.

PROCEDURE

1 Measure and Set Up
Ensure measure connections.

2 Connect in Circuit

3 Record (V_1, I_1)
Record multimet ters I_1.
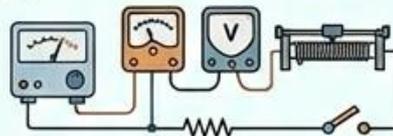
4 Vary Rheostat
Adjust to get new (V, I) pairs.

5 Record Mean Resistance
$R = \frac{V}{I}$ Record calculated resistance.
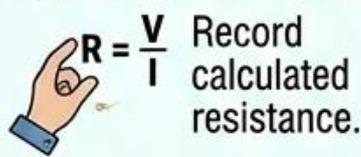
6 Vary for Multiple Trials
Collect multiple data points for the graph.
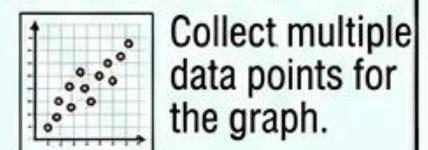
OBSERVATIONS TABLE

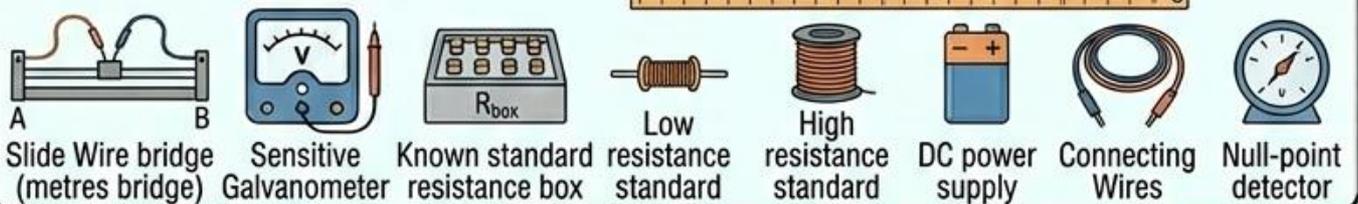| Sl. No.	Applied Voltage (V)	Measured Current (I)	Calculated Resistance (R = V/I) (in Ω)	Remarks
1	(in Volts)	(in Amperes)	(in Ω)	/
			Mean Measured Resistance (R_{mean}) = [Value] Ω	

CALCULATIONS & RESULT

1. Plot a graph of V vs I (or I vs V).
2. Calculate the average resistance from the graph.
3. **RESULT:** (1) The V-I graph is a straight line through the origin, verifying $V \propto I$.
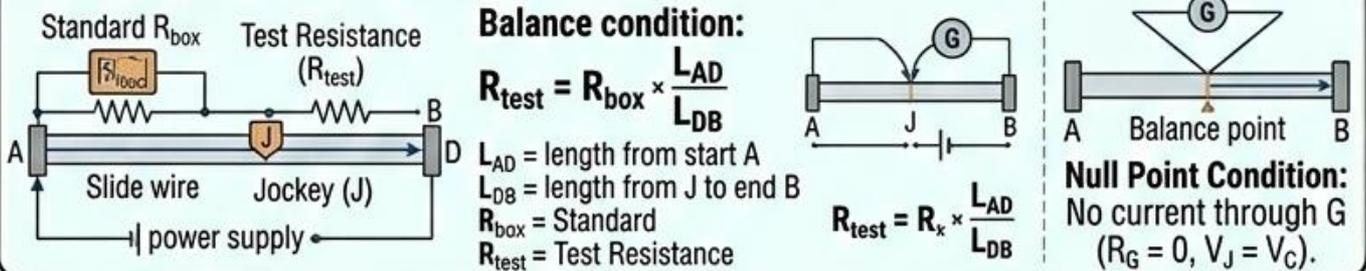   (2) The average resistance from the graph is [Value] Ω.

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PHYSICS PRACTICAL GUIDE:
LOW & HIGH RESISTANCE MEASUREMENT (SLIDE WIRE BRIDGE)

OBJECTIVE: To measure very low resistance and very high resistances using a Slide Wire bridge.

APPARATUS REQUIRED

| Slide Wire bridge (metres bridge) | Sensitive Galvanometer | Known standard resistance box | Low resistance standard | High resistance standard | DC power supply | Connecting Wires | Null-point detector |

PRINCIPLE & FORMULA

Balance condition:

$$R_{test} = R_{box} \times \frac{L_{AD}}{L_{DB}}$$

L_{AD} = length from start A
L_{DB} = length from J to end B
R_{box} = Standard
R_{test} = Test Resistance

$$R_{test} = R_x \times \frac{L_{AD}}{L_{DB}}$$

Null Point Condition:
No current through G
($R_G = 0$, $V_J = V_C$).

PROCEDURE

1 Measure and Set Up
Ensure measure connections, connect the power supply.

2 Low Resistance Measurement
Connect. Measure R_{test} for a trial.

3 Find Null Point (L_{AD})
Move jockey to find G=0. Record L_{AD}.

4 Repeat for Low Trials
Collect multiple low data points for averaging.

6 High Resistance Measurement
Replace low R standard with high. **R = Value** Collect high data points.

7 Record Mean High Resistance
Record calculated resistance.

OBSERVATIONS TABLE

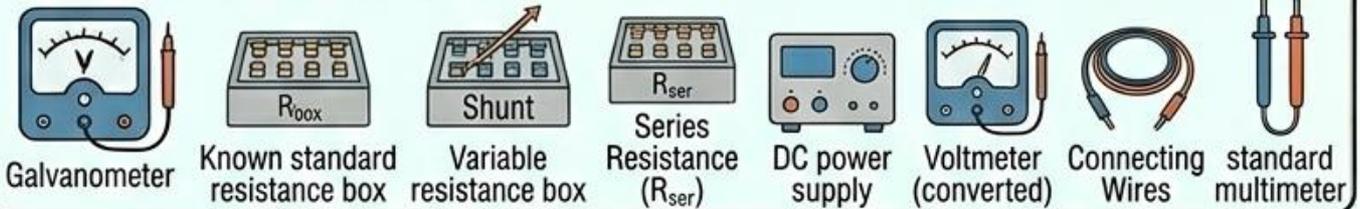| SI. No.	Test Resistor (R_{test})	Standard Resistance (R_{box})	Balancing Length (L_{AD})	Remaining Length (L_{08})	Calculated Resistance (R_{cal}) (in Ω)	Remarks
1	Low/High	(in Ω)	(in cm)	(in cm)	(in Ω)	/
Mean Measured Low Resistance (R_{mean_low}) = [Value] Ω			Mean Measured High Resistance (R_{mean_high}) = [Value] Ω			

CALCULATIONS & RESULT

1. Average the calculated resistance for low and high cases.
2. Compare average to standard.
3. **RESULT:** (1) Measured value of very low resistance is [Value] Ω.
   (2) Measured value of very high resistance is [Value] Ω.

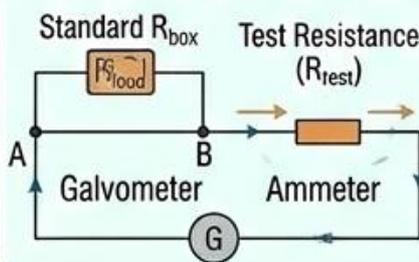**Government Polytechnic Moradabad**

PHYSICS PRACTICAL GUIDE:
CONVERSION OF GALVANOMETER

OBJECTIVE: Conversion of a Galvanometer into an Ammeter and Voltmeter of given range.
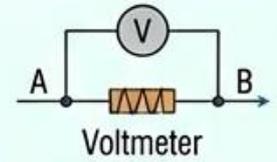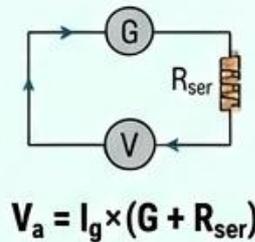
APPARATUS REQUIRED

Galvanometer	Known standard resistance box	Variable resistance box	Series Resistance (R_{ser})	DC power supply	Voltmeter (converted)	Connecting Wires	standard multimeter

PRINCIPLE & FORMULA

Standard R_{box} Test Resistance (R_{test})

A   B
Galvometer   Ammeter
G

Balance condition:

$$I_a = I_g \times \frac{G + S}{S}$$

$$S = \frac{I_g \times G}{I_a - I_g}$$

R_{ser}
G
V

$$V_a = I_g \times (G + R_{ser})$$

V
A   B
Voltmeter

Null Point Condition: No current through G ($R_G = 0$, $V_J = V_C$).
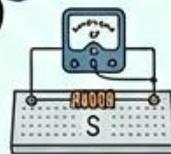
PROCEDURE

1 Measure Galvanometer Resistance (G) & Fig. of Merit (k)
Measure G, then find k by connecting to a power supply.
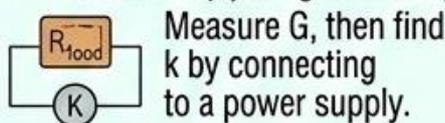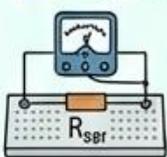
2 Convert into Ammeter
Calculate required S for range I_a. Adjust and connect to trial.

3 Find Conversion Error
Measure to collect multiple current data. Record.
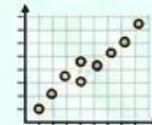
4 Repeat for Voltmeter
Calculate required R_{ser} for range V_a. Adjust and connect.

5 Find Conversion Error
Measure to collect multiple voltage data points. Record.

6 Vary standard resistance to collect more data
Collect data for averaging and validation.

OBSERVATIONS TABLE

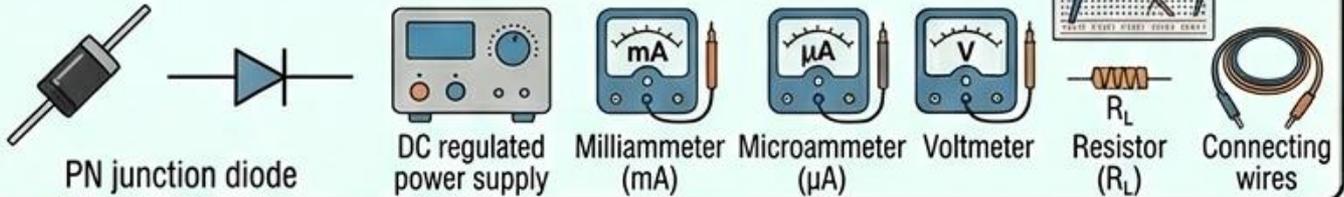| Sl. No.	Range	Desired Range	Calculated S / R_{ser}	Measured G (in Ω)	Standard R (in Ω)	Converted Reading	Diff (Converted - G)	Error (%Diff)
1	I_a / V_a	[Value] A	/	/	/	/	/	/
2	I_a / V_a	[Value] V	/	Mean Measured Resistance ($R_{mean\_converted}$) = [Value] Ω				

CALCULATIONS & RESULT

1. Average the converted reading and the %Error values.
2. Calculate the shunt/series resistance using standard formulas.
3. **RESULT:** (1) Converted to Ammeter: S = [Value] Ω (Error [Value]%).
   (2) Converted to Voltmeter: R_{ser} = [Value] Ω (Error [Value]%).
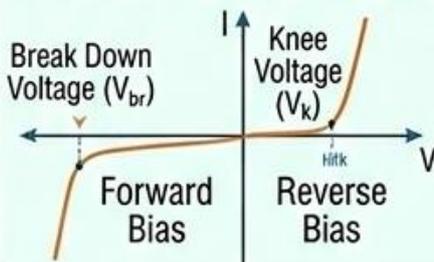
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PHYSICS PRACTICAL GUIDE:
PN JUNCTION DIODE CHARACTERISTICS

OBJECTIVE: To draw V-I characteristics of a PN junction diode and determine knee and break down voltages.

APPARATUS REQUIRED

| PN junction diode | DC regulated power supply | Milliammeter (mA) | Microammeter (μA) | Voltmeter | Resistor (R_L) | Connecting wires |

PRINCIPLE & FORMULA

Break Down Voltage (V_{br}) — Knee Voltage (V_k) — Forward Bias — Reverse Bias

Forward current
$$I_f = \frac{V_f}{R_f}$$

Reverse current
$$I_r = V_f + R_b$$

Forward current
$$V_R = \frac{V_f}{R_f}$$

Reverse current
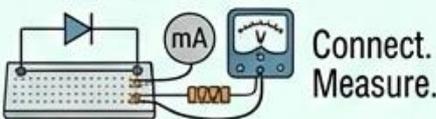$$I_r = I_r + V_{ber}$$

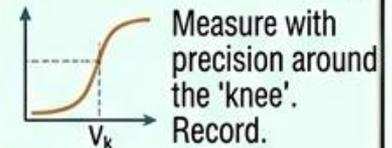Diode Resistance
$$R_d = \frac{\Delta V}{\Delta I}$$

Voltmeter
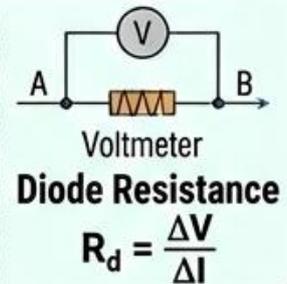
PROCEDURE

1 Set Up Apparatus for Forward Bias
Connect. Measure.

2 Connect and Measure I_f
Measure for small forward voltage steps. Record I_f.

3 Find Knee Voltage (V_k)
Measure with precision around the 'knee'. Record.

4 Set Up for Reverse Bias
Change connections. Measure.

5 Connect and Measure I_r
Measure for small reverse voltage steps. Record I_r.

6 Find Break Down Voltage (V_{br})
Measure with precision around 'break down'. Record.
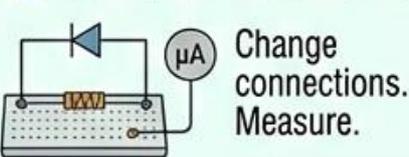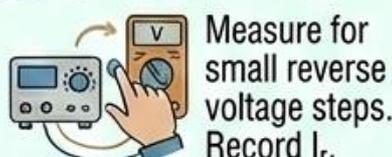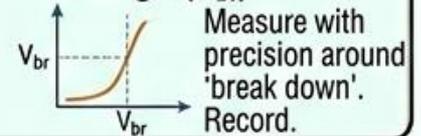
OBSERVATIONS TABLE

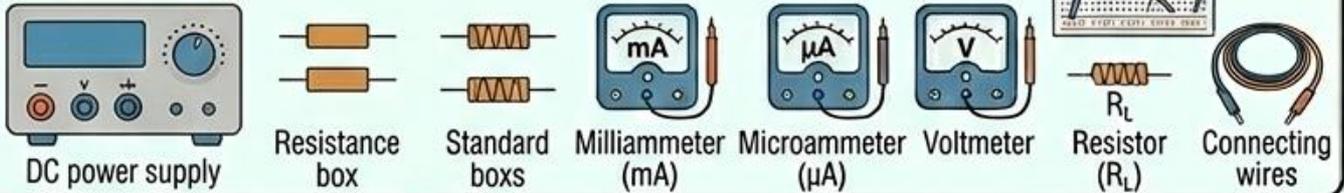| Sl. No.	Forward Voltage	Forward Current	Reverse Voltage	Reverse Current	
1	V_f in V)	I_f in mA)	V_r in V)	I_r in μA)	Knee Voltage (V_{k_meas}) = [Value] V
2	/	/	/	/	Break Down Voltage (V_{br_meas}) = [Value] V

CALCULATIONS & RESULT

1. Plot the complete V-I graph with V_k and V_{br} marked.
2. Determine V_k and V_{br} from the graph. Calculate forward and reverse resistances.
3. **RESULT:** (1) Measured Knee Voltage (V_k) = [Value] V. (2) Measured Break Down (Value) V. (3) The V-I characteristic curve is successfully drawn.
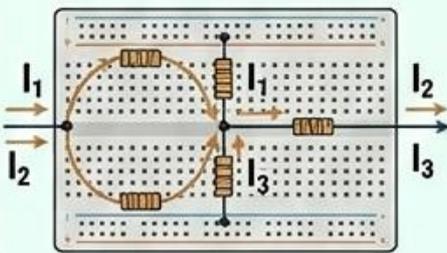
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PHYSICS PRACTICAL GUIDE:
KIRCHHOFF'S LAWS VERIFICATION

OBJECTIVE: To verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) using an electric circuit.
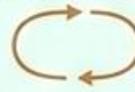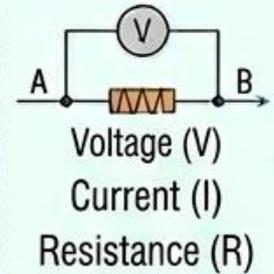
APPARATUS REQUIRED

DC power supply · Resistance box · Standard boxs · Milliammeter (mA) · Microammeter (µA) · Voltmeter · Resistor (R_L) · Connecting wires

PRINCIPLE & FORMULA

KCL (node)

Division

$$\sum I_{in} = \sum I_{out}$$

KVL (loop)

Voltage division

$$\sum V = \sum (IR)$$

Voltage (V)
Current (I)
Resistance (R)

PROCEDURE

1. Measure Resistance & Set Up
Connect. Measure.
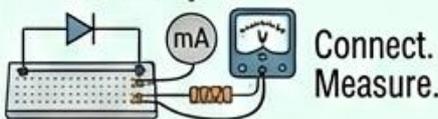
2. Connect for KCL Node
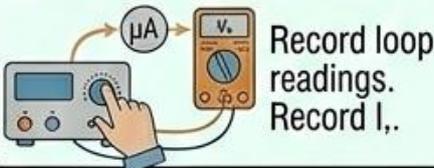Measure and standard voltage steps. Record I_1.

3. Find Mean Current (I_{mean})
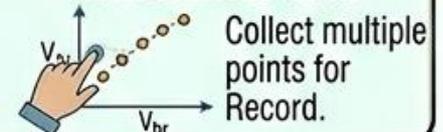I_{node_mean} = Measured current value. **[Value] A**

4. Connect for KVL Loop
Record loop readings. Record I,.

5. Find Mean Voltage (V_{mean})
V_{loop_mean} = Calculated voltage value. V_{loop_mean} = **[Value] V**

6. Vary resistors to collect more data
Collect multiple points for Record.

OBSERVATIONS TABLE

Sl. No.	Apparent Applied V	Loop Name/ Node Name	IR Drop (V)	Node I_{in} (A)	Loop Diff ($\sum V_{in}$)/ Node Diff ($\sum I_{in}$)	Trial Diff ($\sum V$) ($\sum I$)
1	V (V)	Loop	IR (V)	I_{in} (A)	**Mean Measured Voltage** (V_{mean_loop}) = [Value] V	
2	/	/	/	/	**Mean Measured Current** (I_{mean_node}) = [Value] A	

CALCULATIONS & RESULT

1. Plot graphs of Measured $\sum V$ vs Theoretical $\sum V$ and Measured $\sum I$ vs Theoretical $\sum I$.
2. Calculate mean %Error.
3. **RESULT:** (1) Measured $\sum I_{in}$ closely matches Measured $\sum I_{out}$ (KCL, Error [Value]%).
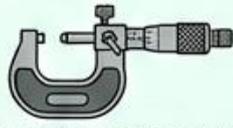   (2) Measured $\sum V$ in loops closely matches $\sum (IR)$ (KVL, Error [Value]%)

PHYSICS PRACTICAL GUIDE:
FINDING NUMERICAL APERTURE OF AN OPTICAL FIBER

OBJECTIVE: To find the numerical aperture of an optical fiber.
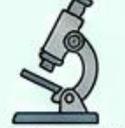
APPARATUS REQUIRED

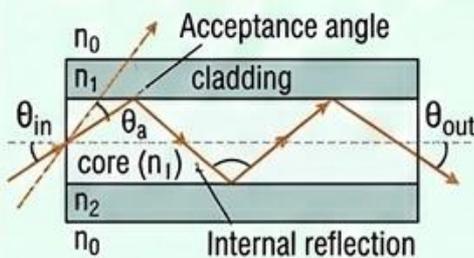Laser source, power adjustment | Precision micrometer stage with ane holder | Fiber spool | Measuring grid | Microscope (or eyepiece | Standard weights | Weights for precision

PRINCIPLE & FORMULA

Acceptance angle, n_0, n_1 cladding, θ_{in}, θ_a, core (n_1), n_2, n_0, Internal reflection, θ_{out}

Sin· (θ_{in})

Division

$$NA = \sin(\theta_a)$$

Ray acceptance

$$\sin(\theta) = \sin(\theta)$$
n_1 = rahonar core
n_2 = refractive indices

$$NA = \sqrt{\frac{n_1^2 - n_2^2}{n_0}}$$
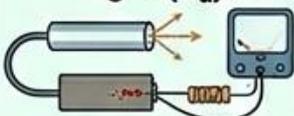
Exit · output

Division

$$N_{out} = \sin(\theta_a)$$

PROCEDURE

1 Measure Acceptance Angle (θ_a) & Set Up

Set up. Measure.
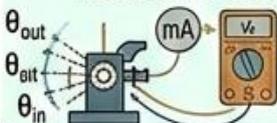
2 Connect and Measure Fiber End Measure for standard position maximum power. Record I_f

3 Find Mean Angle (θ_{mean})

Acceptance angle mean = Calculated angle value [Value] Degrees

4 Vary fiber position and measure acceptance

θ_{out}, θ_{ett}, θ_{in}

Record and calculate the mean numerical aperture.

5 Repeat and record results

numerical aperture = Calculated numerical aperture = Value

6 Vary input to collect more data

V_{ff}, V_{bf}

Collect multiple points for Record.

OBSERVATIONS TABLE

Sl. No.	Fiber Type (SM/MM)	Fiber Length (m)	Micrometer Reading (x, y, z mm)		Input Angle (Degrees)	Measured Accept. Angle (Degrees)	Calculated NA (mean)
1	SM/MM	m	x, y, z	z mm	Mean Measured Acceptance Angle (θ_{meonas}) = [Value] Degrees		
2	/	/	/	/	Mean Measured Numerical Aperture (NA_{mesn_meas}) = [Value]		

CALCULATIONS & RESULT

1. Average the NA and Acceptance Angle values.
2. Calculate the theoretical NA using refractive indices. ($NA_A = (n_1^2 - (n_2^2 = /n_0)$).
3. **RESULT:** (1) Acceptance angle mean = [Value] Degrees.
   (2) Mean Numerical Aperture = [Value].

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