ENGINEERING PHYSICS LABORATORY MANNUAL FOR DIPLOMA STUDENTS

Prepared By :-
BIKASH KUMR NAIK
Msc. , CSIR NET / JRF
Lecturer in Physics
Govt. Polytechnic , Bolangir.

CONTENTS

Vernier Calipers

Exp. No: 1
Date:

Aim

(i) To find the volume of the given cylinder by measuring its length and diameter

(ii) To find the volume of the given rectangular block by measuring its length, breadth and thickness

Apparatus

Vernier caliper, metallic cylinder and rectangular block

Principle

Vernier caliper consists of a metal scale graduated in mm which forms the main scale. It has a fixed jaw J_1 at one end and a movable jaw J_2 provided with a vernier scale which slides over the main scale. The least count of the vernier is the smallest distance that can be measured with it and it can be calculated using the equation,

$$\text{Least count of vernier (LC)} = \frac{\text{Value of one main scale division (MSD)}}{\text{Number of divisions on the vernier scale}} \tag{1}$$

$$\text{Total reading} = MSR + (VSR \times LC) \tag{2}$$

where MSR is the main scale reading and VSR is the vernier scale reading.

If l is the length of the cylinder and r is the radius of the cylinder,

$$\text{Volume of the cylinder, } V = \pi r^2 l \tag{3}$$

If l is the length, b is the breadth and t is the thickness of the rectangular block,

$$\text{Volume of the rectangular block, } V = lbt \tag{4}$$

Procedure

The value of one main scale division and number of divisions on the vernier scale are noted. The least count of the vernier is calculated using equation (1).

To find the volume of the cylinder

The given cylinder is gently gripped lengthwise between the jaws of the vernier caliper. The main scale reading (MSR) just before the zero of the vernier scale is noted. The vernier scale reading (VSR) coinciding with some division on the main scale is also noted. The length of the cylinder is then calculated using equation (2). The experiment is repeated five times and the average value of the length of the cylinder is calculated.

The cylinder is gently gripped diameter-wise between the jaws. Main scale reading and vernier scale reading are noted and the diameter of the cylinder is then calculated using equation (2). The experiment is repeated five times and the average value of the diameter of the cylinder is calculated. The half of the mean diameter gives the radius of the cylinder. The volume of the cylinder is then calculated using equation (3).

To find the volume of the rectangular block

The given rectangular is gently gripped lengthwise between the jaws of the vernier caliper. The main scale reading (MSR) just before the zero of the vernier scale is noted. The vernier scale reading (VSR)coinciding with some division on the main scale is also noted. The length of the rectangular block is then calculated using equation (2). The experiment is repeated five times and the average value of the length of the rectangular block is calculated. The same procedure is repeated to find the breadth and thickness of the rectangular block. The volume of the rectangular block is then calculated using equation (4).

Result

Volume of the given cylinder = m^3

Volume of the given rectangular block = m^3

Observations and Calculations

Value of one main scale division = cm

Total number of divisions on the vernier scale =

$$\text{Least count of vernier (LC)} = \frac{\text{Value of one main scale division (MSD)}}{\text{Number of divisions on the vernier scale}}$$

$$=$$

$$= \quad cm$$

(i) **To find the volume of the cylinder**

Dimension	Trial No	MSR (cm)	VSR	Total Reading = MSR + (VSR x LC) (cm)	Mean (cm)
Length of the cylinder	1				
	2				
	3				
	4				
	5				
Diameter of the cylinder	1				
	2				
	3				
	4				
	5				

$$\text{Length of the cylinder } (l) = \qquad cm$$
$$\text{Diameter of the cylinder } (D) = \qquad cm$$
$$\text{Radius of the cylinder } (r) = \frac{D}{2}$$
$$=$$
$$= \qquad cm$$
$$\text{Volume of the cylinder} = \pi r^2 l$$
$$=$$
$$= \qquad cm^3$$
$$= \qquad \times 10^{-6}\ m^3$$

(i) **To find the volume of the rectangular block**

Dimension	Trial No	MSR (cm)	VSR	Total Reading = MSR + (VSR x LC) (cm)	Mean (cm)
Length of the rectangular block	1				
	2				
	3				
	4				
	5				
Breadth of the rectangular block	1				
	2				
	3				
	4				
	5				
Thickness of the rectangular block	1				
	2				
	3				
	4				
	5				

$$\text{Length of the rectangular block } (l) = \qquad cm$$
$$\text{Breadth of the rectangular block } (b) = \qquad cm$$
$$\text{Thickness of the rectangular block } (t) = \qquad cm$$
$$\text{Volume of the rectangular block (V)} = lbt$$
$$=$$
$$= \qquad cm^3$$
$$= \qquad \times 10^{-6}\ m^3$$

Screw Gauge

Exp. No: 2
Date:

Aim

(i) To find the volume of the given wire by measuring its length and diameter

(ii) To find the volume of the given glass plate by measuring its thickness and area

Apparatus

Screw Gauge, metal wire and glass plate

Principle

Screw gauge works on the simple principle of converting small distances into larger ones by measuring the rotation of the screw. When the head of the screw gauge is rotated, the distance moved by the screw for every complete rotation is a constant called pitch of the screw.

$$\text{Pitch of the screw gauge (P)} = \frac{\text{Distance moved}}{\text{Number of rotations}} \tag{1}$$

$$\text{Least count of the screw gauge (LC)} = \frac{\text{Pitch (P)}}{\text{Number of divisions on the head scale (N)}} \tag{2}$$

$$\text{Total reading} = PSR + (Corrected\ \ HSR \times LC) \tag{3}$$

where PSR is the pitch scale reading and HSR is the head scale reading.

If l is the length of the wire and r is the radius of the wire,

$$\text{Volume of the wire, } V = \pi r^2 l \tag{4}$$

If t is the thickness and A is the area of the glass plate,

$$\text{Volume of the glass plate, } V = At \tag{5}$$

Procedure

The pitch, least count and zero error of the screw gauge are determined first. The head of the screw gauge is given six complete rotations and distance moved by head over the pitch scale is noted. The pitch of the screw gauge is calculated using equation (1). The number of divisions on the head scale is noted and least count of the screw gauge is calculated using equation (2).

To find the zero error, the screw head is rotated until the two plane faces are just in contact. If the zero of the head scale coincides with the reference line on the pitch scale, the instrument has no zero error and hence, no zero correction. If the zero of the head scale is above the reference line (say by 5 divisions), the zero error is -5 div and zero correction is +5 div. If the zero of the head scale is below the reference line (say by 5 divisions), the zero error is +5 div and zero correction is -5 div.

This correction is to be added to the observed head scale reading (HSR) when the measurement is taken.

To find the volume of the wire

The diameter of the wire is measured by gently gripping the wire between the plane faces of the screw gauge. Pitch scale reading (PSR)just before the head of the screw gauge is noted. Head scale reading (HSR) coinciding with the reference line on the pitch scale is also noted. The diameter of the wire is then calculated using equation (3). The experiment is repeated five times and the average value of the diameter of the wire is calculated. The half of the mean diameter gives the radius of the wire. The length of the wire is measured using a meter scale. The volume of the wire is then calculated using equation (4).

To find the volume of the glass plate

The given glass plate is gently gripped between the plane faces of the screw gauge. The pitch scale reading and head scale reading are noted. The thickness of the glass plate is then calculated using equation (3). The experiment is repeated five times and the average value of the thickness of the glass plate is calculated. To find the area of the glass plate, its outline is taken on a graph paper and the number of millimeter squares enclosed in it is counted. The volume of the glass plate is then calculated using equation (5).

Result

Volume of the given wire = m^3

Volume of the given glass plate = m^3

Observations and Calculations

$$\text{Value of one pitch scale division} = \qquad mm$$

$$\text{Distance moved for 6 rotations of the head} = \qquad mm$$

$$\text{Pitch of the screw gauge (P)} = \frac{\text{Distance moved}}{\text{Number of rotations}}$$

$$=$$

$$= \qquad mm$$

$$\text{Total number of divisions on the head scale (N)} =$$

$$\text{Least count of screw gauge (LC)} = \frac{P}{N}$$

$$=$$

$$= \qquad mm$$

Dimension	Trial No	PSR (mm)	HSR	Corrected HSR	Total Reading = PSR + (Corrected HSR x LC) (mm)	Mean (mm)
Diameter of the wire	1					
	2					
	3					
	4					
	5					
Thickness of the glass plate	1					
	2					
	3					
	4					
	5					

(i) **To find the volume of the wire**

$$
\begin{aligned}
\text{Length of the wire } (l) &= \qquad\qquad mm \\
\text{Diameter of the wire } (D) &= \qquad\qquad mm \\
\text{Radius of the wire } (r) &= \frac{D}{2} \\
&= \\
&= \qquad\qquad mm \\
\text{Volume of the wire} &= \pi r^2 l \\
&= \\
&= \qquad\qquad mm^3 \\
&= \qquad\qquad \times 10^{-9}\ m^3
\end{aligned}
$$

(ii) **To find the volume of the glass plate**

$$
\begin{aligned}
\text{Area of the glass plate } (A) &= \qquad\qquad mm^2 \\
\text{Thickness of the glass plate } (t) &= \qquad\qquad mm \\
\text{Volume of the glass plate (V)} &= At \\
&= \\
&= \qquad\qquad mm^3 \\
&= \qquad\qquad \times 10^{-9}\ m^3
\end{aligned}
$$

Simple Pendulum

Exp. No: 3
Date:

Aim

(i) To determine the acceleration due to gravity (g) at the place

(ii) To determine the length of the seconds pendulum from (l, T^2) graph

Apparatus

Simple pendulum, stop clock and meter scale

Principle

The simple pendulum consists of a small metallic bob suspended by a light string. The length of the pendulum (l) is the distance between the centre of the bob and the point of suspension. The period (T) of the pendulum is the time taken to complete one oscillation. The relation between length of the pendulum, its period and acceleration due to gravity is given by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T^2 = 4\pi^2\left(\frac{l}{g}\right)$$

$$g = 4\pi^2\left(\frac{l}{T^2}\right) \tag{1}$$

Procedure

The radius of the bob is measured using vernier calipers. The length of the pendulum is equal to the distance from the point of suspension to the top of the bob plus the radius of the bob. The length is initially adjusted to be 0.5 m. The time (t) for 20 oscillations is determined twice using a stop clock and mean value of t is calculated. The period T is calculated as $T = \frac{t}{20}$. The value of $\frac{l}{T^2}$ is determined. The experiment is repeated for $l = 0.6$ m, 0.7 m, 0.8 m, 0.9 m, 1 m and 1.1 m. The mean value of $\frac{l}{T^2}$ is calculated. The acceleration due to gravity (g) is calculated using equation (1).

(l, T^2) graph

A graph is plotted with l along X-axis and T^2 along Y-axis. This graph is called (l, T^2) graph. It can be seen that (l, T^2) graph is a straight line and can be used to calculated the length corresponding to any period. For a seconds pendulum, $T = 2$ seconds and hence, $T^2 = 4$. The length corresponding to $T^2 = 4$ gives the length of the seconds pendulum.

Result

Acceleration due to gravity at the place = m/s^2

Length of the seconds pendulum = m

Observations and Calculations

Radius of the bob (r) = cm

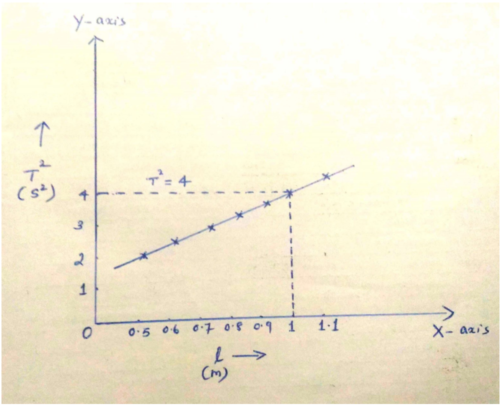
Trial No	Legth of the pendulum (l) m	Time for 20 oscillations			T (s)	T^2 (s^2)	l/T^2 (m/s^2)
		1 (s)	2 (s)	Mean (s)			
1	0.5						
2	0.6						
3	0.7						
4	0.8						
5	0.9						

Mean value of (L/T^2) = m/s^2

$$\text{Acceleration due to gravity } g = 4\pi^2 \left(\frac{l}{T^2}\right)$$

$$=$$

$$= \qquad m/s^2$$



From (l, T^2) graph, length of the seconds pendulum = m

EXPERIMENT - 4

AIM

To determine radius of curvature of a given spherical (convex) surface by a spherometer
.

APPARATUS

Spherometer, convex surface (it may be unpolished convex mirror), a big size plane glass

THEORY

Radius of curvature $R = \frac{l^2}{6h} + \frac{h}{2}$

PROCEDURE

1. Raise the central screw of the spherometer and press the spherometer gently on the practical note-book so as to get pricks of the three legs . Mark these pricks as A,B and C.
2. Measure the distance between the pricks (points) by joining the points as to form a triangle ABC.
3. Note these distances (AB, BC, AC) on note book .
4. Find the value of one *pitch* scale division.
5. Determine the pitch and the least count of the spherometer and record it stepwise.
6. Raise the screw sufficiently upwards.
7. Place the spherometer on the convex surface so that its three legs rest on it.
8. Gently turn the screw downwards till the screw tip just touches the convex surface..
9. Note the reading of the circular scale which is in line with the pitch scale. Let it be *a*.
10. Remove the spherometer from over the convex surface and place over large size plane glass slab.
11. Turn the screw downwards and count the number of complete rotations *(*n_1*)* made by the disc (one rotation becomes complete when the reference reading crosses past the pitch scale).
12. Continue till the tip of the screw just touches the plane surface of the glass slab.
13. Note the reading of the circular scale which is finally in line with the pitch scale. Let it be *b*.
14. Find the number of circular scale division in last incomplete rotation.
15. Repeat steps 6 to 14, three times. Record the observation in tabular form.

OBSERVATIONS

1. .Distance between two legs of the spherometer.

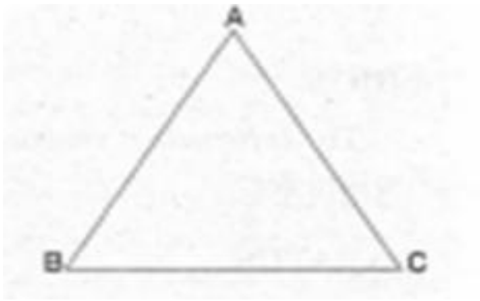
In ABC marked by legs of the spherometer

AB = …cm

BC = …cm

Ac = …cm

Mean value of *l* = …..cm



. Distance between the
legs of the spherometer.

2. Least count of spherometer

1Pitch scale division = 1mm
Number of full rotations given to screw == 4
Distance moved by the screw == 4 mm
Hence, pitch$= \frac{4mm}{4}$ =1mm
Number of divisions on circular scale = 100
Hence, least count = $\frac{1mm}{100} =$ 0.01 mm

Serial. No.	Circular Scale Reading		Number of Complete Rotations (n_1)	No. of Disc Scale divisions In incomplete rotation	Total Reading $H = n_1 \times p + x \times (L.C.)$ (mm)
	Initial(a)	Final(b)			

CALCULATIONS
. mean value 'of h= .
RESULT
The radius of curvature of the given convex surface is____cm.
PRECAUTIONS
1. The screw should **move freely** without friction.
2. The screw should be moved in **same** direction to avoid **back-lash error** of the screw.
3. **Excess rotation** should be avoided.

SOURCES OF ERROR
1. The screw may have **friction.**
2. The spherometer may have **back-lash error. '**
3. Circular scale divisions may not be of **equal** size.

Refractive Index of material of a Prism (i-D curve method)

AIM: To determine refractive index of the material of the given prism by the method of i-d curve.

APPARATUS:i)Drawing board ii)Prism iii)Drawing pins iv)Needle point steel pins v) Drawing sheet vi)Scale,set square,protractor and a sharp pencil.

PRINCIPLE:When the prism is at minimum deviation position "Angle of incidence $\angle i$ = Angle of emergence $\angle e$ i.e ($\angle i = \angle e$) and the angle of refractions at both the surfaces of the prism will be equal i.e $\angle r_1 = \angle r_2$. From geometry we have

$$r_1 + r_2 = A$$

d=i+e-A ;

but when the prism is in minimum deviation d=D_m ,

D_m=2i-A since $\angle i = \angle e$

$\Longrightarrow$2i = A+D_m

$\Longrightarrow$ i = $\frac{A+D_m}{2}$ – – – – – – – – – – – – – (a)

and 2r =A since $\angle r_1 = \angle r_2 = \angle r$

$\Longrightarrow r = \frac{A}{2}$ – – – – – – – – – – – – – (b)

But according to snell's law $\mu = \frac{Sini}{Sinr}$

substituting the values of i and r in the above equation from equations (a) and (b) we get

$$\mu = \frac{sin\frac{(A+D_m)}{2}}{sin\frac{A}{2}}$$

THEORY:If the angle of the prism is $\angle A$ then angle of deviation $\angle D = \angle i + \angle e - \angle A$ and $\angle r_1 + \angle r_2 = \angle A$

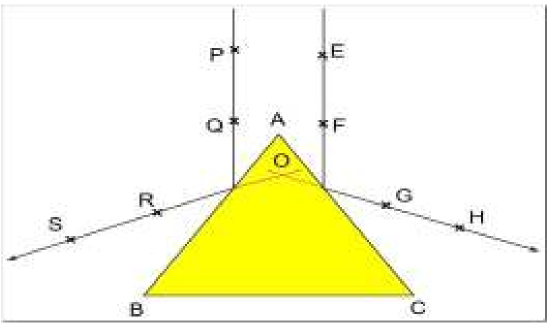
If $\angle A$ is the angle ofthe prism, $\angle D_m$ the angle of minimum deviation.

Then the refractive index of the material of the prism $\mu = \frac{sin\frac{(A+D_m)}{2}}{sin\frac{A}{2}}$

PROCEDURE:

We can divide the entire procedure of this experiment in to two parts i) we have to first determine the angle of the prism A then ii) We have to determine the angle of minimum deviation D of the prism.

Part i: Determine the angle of the prism A lace the drawing board on the table and fix the drawing sheet on the drawing board using drawing pins.Place the prism on the drawing sheet,holding the prism trace the outer boundary of the pris which will be triangle.Mark the three vertices of the triangle as A,B and C.Now draw two parallel lines so that the edge A lies symmetrically between parallel lines.

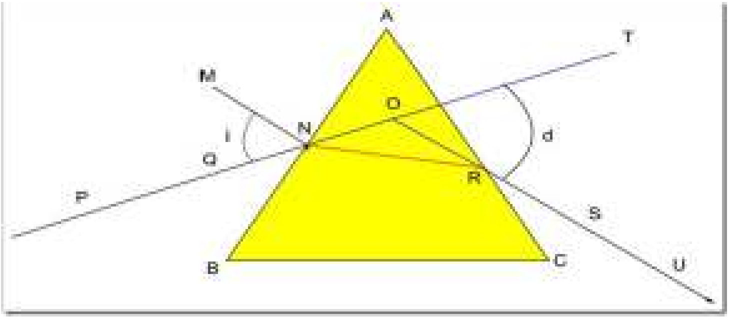


Then two pins are fixed on one of the lines at points P and Q.Looking through the face AB two more pins are fixed at the points R and S so that the reflective images of the pins at P an Q lie in the same straight line with these two pins without any parallax error.Now join the points R and S using a scale .The RS line represents the reflected ray of PQ.In the same way repeat the procedure on the other face of the prism AC, to get the reflected images G,H of the incident ray passing through EF.Remove the prism and extend the st.lines passing through RS and GH in to triangle ABC so that they meet at a point O.

Measure the angle ROG which will be equal to 2A

Hence $\angle A = \frac{\angle ROG}{2}$

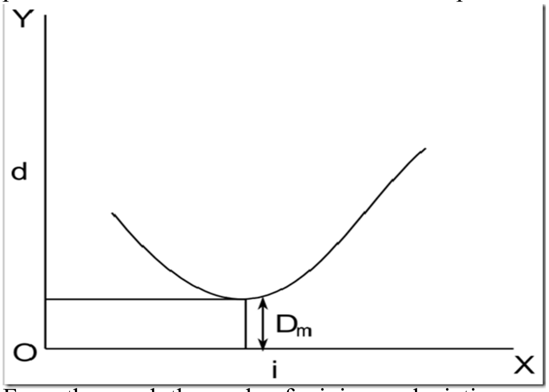
Part ii:Determine the angle of minimum deviation $\angle D_m$:Fix the drawing sheet on the drawing board using drawing pins,keep the prism on the paper and trace the prism.The trace will give us a triangle ABC.



AB reflecting surface , AC refracting surface and BC is the base of the prism.Draw a normal line MN to the reflecting surface at N.Draw a incident line PQ making some angle (>30degrees) with the normal line MN.Now place the prism on its trace along ABC.Fix two pins on the incident ray at two points P and Q .Now observing through the face AC two pins S and U are fixed so that these two pins at S and U will be in the line with P and Q.Remove the prism join the points S and U with a st line which meets the face AC at R.Extend the incident ray PQ forward and emergent ray SU backwards till the meet at O.
Measure the $\angle TOR = d$.
repeat the experiment in the above said procedure for various angles of incidences i.e 35,40,45,50,55 ……. and measure the respective angles of deviations d1,d2,d3,d4,d5….. record these values in the table.

s.no	Angle of incidence (i)	Angle of deviation (d)
1		
2		
3		
4		
5		

i-d curve:Now draw a graph taking the angles of incidences(i) on X-axis and the angles of deviations(d) on the Y-axis.join these points with a smooth curve which will be a parabola.



From the graph the angle of minimum deviation can be calculated.
OBSERVATIONS: i) Angle of the prism A =
ii) Angle of minimum deviation D_m = (from graph)
substituting the values of the angle of prism A and the angle of minimum deviation D_m in the formula o refractive index $\mu = \frac{sin\frac{(A+D_m)}{2}}{sin\frac{A}{2}}$, we can calculate the refractive index of the material of the prism.
PRECAUTIONS: i)Pins should be fixed perfectly vertical ii)while fixing the pins in line with the refractive or reflective images of incident rays care should be taken for the parallax error.iii) there should be some space between the pins iv)pins should not be disturbed during the experiment v)Same edge of the prism should be taken as vertex A for all the observations vi) Clean both the faces AB and AC of the prism proper before taking the readings.
RESULT: Refractive index of the material of the prism $\mu =$ ________ .

EXPERIMENT -

OBJECTIVE: - Verification of Ohm’s law.

EQUIPMENT REQUIRED: - Accumulator or battery eliminator, ammeter, voltmeter, rheostat, coil, connecting wires and key (if necessary).

THEORY: - Ohm's Law deals with the relationship between voltage and current in an ideal conductor. This relationship states that:
The potential difference (voltage) across an ideal conductor is proportional to the current through it. The constant of proportionality is called the "resistance", R. Ohm's Law is given by:

$$V = I R$$

Where V is the potential difference between two points which include a resistance R. I is the current flowing through the resistance.

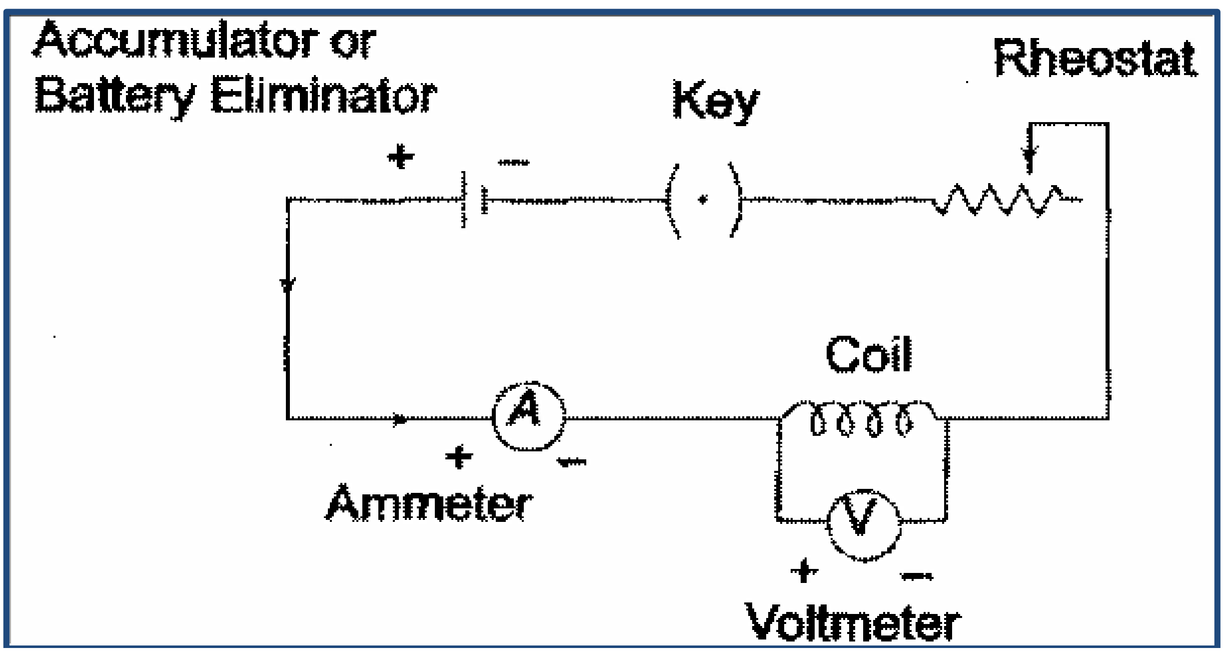
Or

Ohm’s law states that the current through a conductor between two points is directly proportional to the voltage
across the two points, and inversely proportional to the resistance between them. V, I, and R, the parameters of Ohm's law.

$$I = V / R$$

Ohm's law is among the most fundamental relationships in electrical engineering. It relates the current, voltage, and resistance for a circuit element so that if we know two of the three quantities we can determine the third. Thus, if we measure the current flowing in a resistor of known value, we can deduce the voltage across the resistance according to V = IR. Similarly, if we measure the voltage across a resistor and the current through it, we calculate the resistance of the element to be R = V/I. Not only does this reduce the number of measurements that must be made, it also provides a way to check the results of several different measurement methods.

CIRCUIT DIAGRAM:-



PROCEDURE:- 1) Connect the battery eliminator, ammeter, the given coil, rheostat and key (if necessary) in series.

2) The voltmeter is connected in parallel connection across the given coil. The circuit is closed.

3) Now the rheostat is adjusted so that a constant current flows through the coil. Note down the ammeter reading I and the corresponding potential difference across the coil in the voltmeter as
V. Use the formula to calculate the resistance of the coil.

4) The experiment is repeated for different values of current and the corresponding potential difference is noted. Calculate the value in each trial. These values will be found to be a constant. Thus verifying Ohm's law.

OBSERVATION TABLE:-

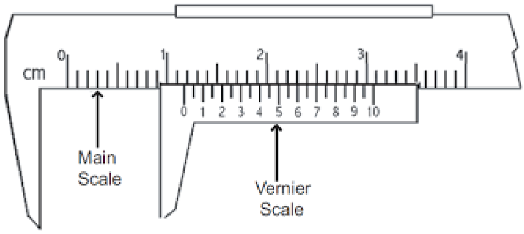
Trail no.	Ammeter reading **I (**ampere)	Voltmeter reading **V(**volt)	Resistance of coil **R**= **V/ I** (ohm)
1			
2			
3			
4			
5			

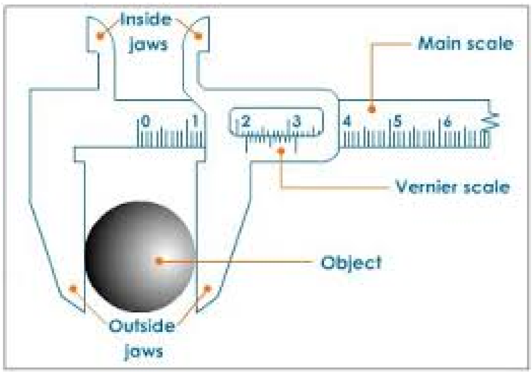
RESULT:- By observing the observation table, it is proved that the ratio of potential difference and current is constant .Thus, potential difference at the ends of the conductor is directly proportional to the current flowing through it. Thus, ohm's law is verified by this experiment.

PRECAUTIONS: - 1) All the connection should be tight.
2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3) The electrical current should not flow the circuit for long time, Otherwise its temperature will increase and the result will be affected.
4) Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6) Before the circuit connection it should be check out working condition of all the Component.

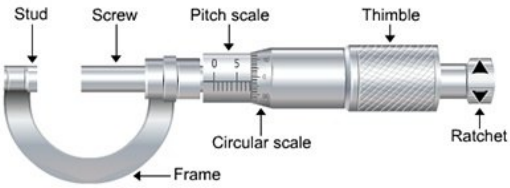
Appendix

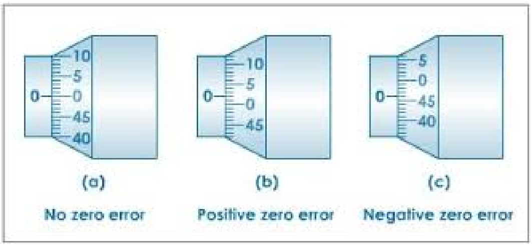
1. Vernier calipers





2. Screw Gauge





3. Simple pendulum