WORKBOOK

For

Physics Lab 1 (PH-103)

First Year

Name: ____

Class Roll No: ________________ **Seat No.**____________________

Department: ____

SESSION: ____

PRACTICAL WORK BOOK

For The Course

Physics Lab 1

(PH-103)

Prepared By: Dr. Saqib Anjum/Dr. Saba Javaid

Revised By: Ms. Ayesha Khurshid

Reviewed By: Dr. Saba Javaid

Approved By:

The Board of Studies of Department of Physics

DEPARTMENT OF PHYSICS

CERTIFICATE

Certified that Mr. / Ms.____

of Class **First Year** Bearing Seat No. ________________________________

Department_______________________________________ has completed

the course in **Physics Practical** as Prescribed by the NED University of Engineering &

Technology, Karachi for the Academic Session__________________________

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Lab. In charge

<u>Physics Practical</u>

EXPERIMENT # 01

OBJECT:

To determine the value of the modulus of rigidity of the material of a metal rod by the static method.

APPARATUS:

(1) Static method apparatus (it consists of a pulley, two pointers and a rod etc.)
(2) Micrometer screw gauge (3) Meter scale (4) Slotted weight of 200 gm each with hanger.

THEORY:

The modulus of rigidity η of the material of a metal rod is given by

$$\eta = \frac{360\, m\, g\, l\, R}{\pi^2 r^4 \theta}$$

Where *m* is the mass suspended in the hanger, *g* is the acceleration due to gravity, *l* is the length of the rod between two pointers, ***R*** is the radius of the pulley, *r* is the radius of rod, and θ is the angle of twist.

PROCEDURE:

1. Set the apparatus. Determine the radius of pulley by measuring its circumference using meter scale. Now find the radius by using formula

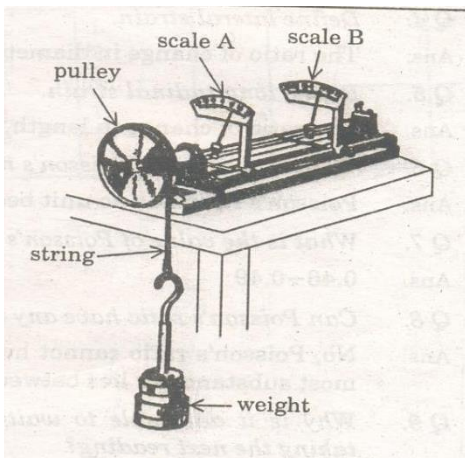
$$Circumference = 2\pi R$$

2. Determine the pitch, least count and zero error of the micrometer screw gauge.

3.Measure the diameter ***D*** of the rod at three different places with the help of micro meters crew gauge. Take the mean value of diameter and calculate radius *r* of wire *i.e.*

$$r = \frac{D}{2}$$

4. Fix the two pointers at two suitable pointers in the rod (say 30 cm apart). Measure the length *l* of rod meter scale.



Modulus of rigidity apparatus

5. Note the initial reading of the pointers on scales *A* and *B* when no load is suspended from the string. Both pointers will read zero. If otherwise, then adjust the pointers.

6. Now suspend a load of 200 gm from the string which will twist the rod and both pointers will move over the scale.

7. Note down the angles, θ_1 and θ_2 due to the deflection of pointers on scale *A* and *B*.

8. Increase the load suspended *m* in steps, say of 200 gm, for about five times and note down the corresponding angles θ_1 and θ_2 due to the deflection of pointers on scales *A* and *B*.

9. Now decrease the load suspended *m* by equal steps, say of 200 gm and note down the corresponding angles θ_1 and θ_2.

10. Arrange the observations in a tabular form. Take the mean of angles θ_1 and θ_2 for loading and unloading weights in each step. The angle of twist θ is equal to the difference between mean angles θ_1 and θ_2 in each step. Find the angle of twist θ for each 200 gm by subtracting first angle of twist reading from the second one, second reading from the third one, and so on. Calculate the mean angle of twist θ for each 200 gm.

11. The modulus of rigidity of the materials of rod can be calculated by the formula

$$\eta = \frac{360\, m\, g\, l\, R}{\pi^2 r^4 \theta}$$

OBSERVATIONS

1. Radius of pulley = $R = \frac{cercumference}{2\pi}$ = ____________ cm
2. Radius of the rod r = ____________
3. Length of rod between two pointers = l = _________ cm

Table For Angle of Twist θ

S. No	Mass Suspended m (gms)	Pointer's Reading on Scale *A* degrees			Pointer's Reading on Scale *B* degrees			Angle of Twist $\theta = \theta_1 - \theta_2$ degree	Angle of Twist θ for each 500 gms degree	Mean Angle of Twist θ for each 500 gms degree
		Loading	Unloading	Mean θ_1	Loading	Unloading	Mean θ_2			
1	200									
2	400									
3	600									
4	800									
5	1000									

CALCULATIONS:

The modulus of rigidity of the materials of rod is given by

$$\eta = \frac{360\, m\, g\, l\, R}{\pi^2 r^4 \theta}$$

RESULT:

The modulus of rigidity of the material of rod = ____________ dyne/cm^2

PRECAUTIONS AND SOURCES OF ERROR:

1. The pulley of the apparatus should be frictionless.
2. The loads should be placed or removed from the hanger gently and a considerable time should be given before taking each reading.
3. The maximum load suspended from the string should be such that it keeps the rod within elastic limits.
4. Since the radius occurs in fourth power in the formula, it must be measured accurately at several points of the rod.

5. Length of rod between two pointers *A* and *B* should be measured carefully.

EXPERIMENT # 02

OBJECT:

To determine the young's modulus of the materials of a rectangular bar by bending (static method by using spherometer).

APPARATUS:

1. A uniform rectangular bar 2. Two knife edges fixed on rigid support 3. Spherometer
4. Pan 5. A set of 50 gm weights 6. Meter scale 7.Vernier calipers 8.Screw gauge

THEORY:

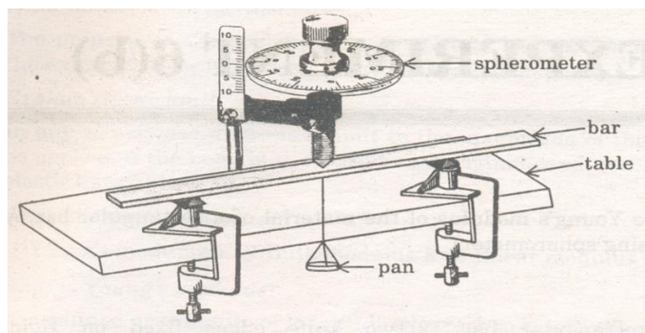
Consider a bar supported on two knife edges *l* cm apart in a horizontal plane, so that equal lengths of the bar projects beyond the knife edges. If a weight *mg* is suspended at the middle point, a depression *y* is produced. For a rectangular bar of breath *b* and thickness *d* the depression is equal to

$$y = \frac{m g l^3}{4 Y b d^3}$$

where Y is the Young's modulus of the material of the bar.

$$\therefore \quad Y = \frac{m g l^3}{4 y b d^3}$$

Young's Modulus Apparatus



PROCEDURE:

1. Measure the breath *b* of rectangular bar with a Vernier calipers and thickness *d* with a screw gauge at three different points.(If the bar is of circular cross-section, then measure its radius).
2. Find the center of gravity(CG) of the bar and mark this point by drawing a sharp line at this position.
3. Now place the knife-edges about 90 cm apart and place the bar on the knife-edges such that it projects practically equal beyond each knife-edge and the knife-edges are perpendicular to the length of the rod.
4. Suspend the empty pan at the CG of the bar.
5. Find the least count (***LC***) of the spherometer. Raise the central screw of spherometer and place it at the middle of the bar. Turn the screw down slowly till it just touches the surface of bar. Read the main and the circular scale reading. (For the depression read the circular scale in reverse direction or simply read the circular scale in forward direction and subtract this reading from 100).
6. Place a suitable weight in pan say 50 gm. The bar will depress at the middle. Turn the screw of spherometer down slowly till it again just touches the surface of bar. Note the reading from both the main scale and the circular scale.

7. Increase the weight in steps, say of 50 gm, in pan for about five times and note down the corresponding reading of spherometer.
8. Now unload the weight by equal steps, say of 50 gm, from pan and take the readings as before. Thus, for a given load there will be two readings, one while the load is increasing and the other while the load is decreasing.
9. Remove the bar carefully without disturbing the position of the knife-edges. Place the meter scale across the knife-edges with its graduated side up and measure the distance between the two knife-edges accurately.
10. Arrange the observations in a tabular form and take the mean reading for loading and unloading weights in each step. Find the depression *y* for each 50 gm by subtracting second spherometer reading from the first one, third reading from the second one, and so on. Calculate the mean depression *y* for each 50 gm.
11. The Young's modulus of the material of a rectangular bar can be calculated by the formula

$$Y = \frac{mgl^3}{4ybd^3}$$

<u>OBSEVATIONS:</u>

1. Distance between two knife-edges l = ___________ cm
2. Breath b of rectangular bar b= _____________cm
3. Thickness d of rectangular bar d=____________cm

<u>CALCULATIONS:</u>

$$Y = \frac{mgl^3}{4ybd^3}$$

RESULT:

Young's modulus of the materials of rectangular bar = **_________** dyne/cm^2

PRECAUTIONS AND SOURCES OF ERROR:

1. The knife-edges should be rigid and fixed on a right support.
2. The knife-edges should be at equal distances from the **CG** of the bar.
3. The loads should be placed or removed from the pan gently and a considerable time should be given before taking each reading.
4. The Maximum load placed in pan should be such it keeps the bar measured elastic limits.
5. The distance between two knife-edges and depth of the beam should be measured carefully as they occur in third power.
6. The exact position of coincidence between the tip of central screw and the rectangular bar has to be carefully observed.

EXPERIMENT # 03

OBJECT:

To find out the ratio of the specific heats at constants pressure and volume for air.

APPARATUS:

Clements & Dorm's apparatus, Manometer, Air pump.

THEORY:

The apparatus consists of a big, thick-walled glass flask (in actual experiment of clement and SESORME'S flask had a capacity of 28 liters) placed in a wooden box packed with cotton wool or some other non-conducting material to avoid loss of heat. It is provided with a wide bore stop cock a side tube having a gas tight top T and manometer M. The monometer contains either H_2O or some oil of low density at the normal temperature. In order to strong H_2SO_4 is kept in the vessel. Let P1 and V1 be the initial pressure and volume of the enclosed gas as shown in fig.

If P is the atmospheric pressure which is the pressure of the gas after adiabatic expansion and V_2 the corresponding volume which the gas should possess as shown at B. then the point A and B lie on the Sam adiabatic AB.

If P_2 is the pressure V_2 is the corresponding volume, which the gas should possess after the room temperature, has been attained at C. then the point A and C will on the same isothermal. As there is no temperature change from A to C.

If P is the atmospheric pressure which is the pressure of the gas after adiabatic expansion and V2 the corresponding volume which the gas should possess as shown at B. then the point A and B lie on the Sam adiabatic AB.

$$P_1 V_1^{\gamma} = P V_2^{\gamma}$$

$$\left(\frac{V_2}{V_1}\right) = \frac{P_1}{P} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad 1$$

If P_2 is the pressure V_2 is the corresponding volume, which the gas should possess after the room temperature, has been attained at C. then the point A and C will on the same isothermal. As there is no temperature change from A to C.

$$P_1 V_1 = P_2 V_2$$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}$$

Substituting the value of $\frac{V_2}{V_1}$ in eq ………… 1

$$\left(\frac{P_1}{P_2}\right)^{\gamma} = \frac{P_1}{P}$$

Taking log both sides

$$\gamma \quad (\log P_1 - \log P) = (\log P_1 - \log P)$$

$$\gamma = (\log P_1 - \log P) \ / \ (\log P_1 - \log P)$$

Let H represent the height of the liquid used in apparatus corresponding atmospheric pressure P.

$$P_1 = H + h_1$$

$$P_2 = H + h_2$$

Substituting the value of P, P_1 and P_2 in the above eq

$$\gamma = \frac{\log(H + h_1) - \log H}{\log(H + h_1) - \log(H - h_2)}$$

$$\lambda = \log\frac{(H + h_1)}{H} \Big/ \log\left(\frac{H + h_1}{H + h_2}\right)$$

$$\lambda = \log\left(1 + \frac{h_1}{H}\right) \Big/ \left(\frac{H + h_1}{H + h_2}\right)$$

$$\lambda = \log\left(1 + \frac{h_1}{H}\right) \Big/ \log H\left(1 + \frac{h_1}{H}\right) - \log H\left(1 + \frac{h_2}{H}\right)$$

$$\lambda = \log\left(1 + \frac{h_1}{H}\right) \Big/ \log H\left(1 + \frac{h_1}{H}\right) - \log H\left(1 + \frac{h_2}{H}\right)$$

Since h_1 and h_2 are very small as compared to H we have

$$\lambda = \frac{h_1}{H} \Big/ \frac{h_1}{H} - \frac{h_2}{H}$$

$$\lambda = \frac{h_1}{h_1 - h_2}$$

This relation is fairly accurate and convenient to find the value of   in the laboratory.

PROCEDURE:

1. Adjust the manometer plane so that taps are airtight.
2. Pump air till the diff. of two column is 10 to 15 cm, note when the difference manometer limbs of when it gain steady state.
3. Open the tap so that excess pressure goes out in no time. Close the tap as soon as the manometer shows no diff. of levels.
4. Wait for a few min. till there is no more rise in level.
5. Note the diff. of the two columns. Repeat it 5 times.

OBSERVATION:

Monometer Readings

After exerting pressure			After releasing pressure			$\lambda = \frac{h_1}{h_1 - h_2}$
Upper U_1	Lower L_1	$h_1 = U_1 + L_1$	Upper U_2	Lower L_2	$h_2 = U_2 + L_2$	

CALCULATIONS:

RESULTS:

The ratio of the specific heat at constant pressure & volume of air is find to be_______________.

PRECUATIONS:

1. Monometer must be leveled.
2. Care about overflow of liquid when exerting pros souse.
3. Vibration start in the manometer when extra pressure is given out.
4. There must be some quantity of reservoirs, which keeps the air inside dry.

EXPERIMENT # 04

OBJECT:

To determine the Co-efficient of Viscosity of a given liquid by Stock's Method.

APPARATUS:

Large glass tube, small steel ball-bearings of three different Diameters, Stop watch, Vernier caliper, Micrometer screw gauge, Meter scale.

THEORY:

When a body falls through a viscous medium, the layer of liquid which is in contact with it and the other layers of liquid beneath this layer of liquid opposes the motion of the body with a force, which increases with the velocity of the body.
If the falling body is small in size, then the opposing force is balanced by the down word driving force and so the body attains a constant velocity called the "*terminal velocity".*

According to Stock's law the opposing force F_d provided by the viscous medium of coefficient of viscosity η, on a spherical body of radius "r" moving with a velocity v_o in the medium is given by: -

$$F_d = 6\pi \eta r v_o$$

If d is the density of the spherical body, g is the acceleration due to gravity then:

Weight of the body = (volume of the body).g.d

$$W = \frac{4}{3}\pi r^3 g\, d$$

The upward thrust due to the displaced medium action on the bc is given by

$$F_b = \frac{4}{3}\pi^3 \; D\, g$$

where D is the density of the liquid.

For Small spherical bodies when it attain terminal velocity

$$W = F_b + F_d$$

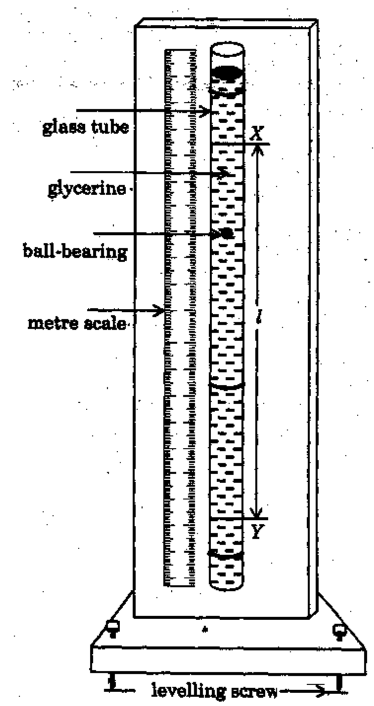
Or

$$F_d = W - F_b$$

$$F_d = \frac{4}{3}\pi r^3 g\, d - \frac{4}{3}\pi r^3 D g$$

$$6\pi \eta r v_o = \frac{4}{3}\pi r^3 g\,(d - D)$$

Or



$$\eta = \frac{2r^2 g(d - D)}{9v_\circ}$$

Where

η is the coefficient of viscosity of the fluid.
r is the radius of the ball bearing
g is acceleration due to gravity
d is density of the ball bearing
D is density of the liquid
$v_\circ$ is the terminal velocity
R is the inner radius of the glass tube
v is observed velocity $= \frac{s}{t}$

In Stock's method small spherical balls are allowed to fall through a viscous medium, which is contained in a long glass tube of radius 'R'.

To get an accurate result correction must be applied in terminal velocity v_o .The correction to be applied is

$$v_\circ = v \left(1 + \frac{2.4r}{R}\right)$$

Where v is the observed velocity of the body, r is the radius of the ball, 'R' is the inner radius of the tube, which contains the given liquid.

PROCEDURE:

1. Take small ball bearings of three different sizes (i-e. three ball bearings of each size). Measure the diameter of each ball bearing, with the help of screw gauge and calculate the radius of ball bearing of each size.
2. Determine the inner diameter 'R' of the glass tube with the help of a vernier caliper.
3. Mark two points X and Y on the tube, one 10 to 15 cm below the upper surface of the liquid and the other 10 to 15 cm above the bottom of the glass tube. Measure the distance between these two points.
4. Release small balls out of given balls from just above the surface of the liquid. As soon as the ball crosses the point X start a stop watch and stop when it crosses Y and note down the time taken to cover the distance XY in sec.
5. Repeat this at least two times and find out the meantime t, taken to cover the distance s. so calculate the velocity v of the ball by:

$$v = \frac{s}{t}$$

6. Repeat steps 4 &5with medium and large size ball bearings and find their respective velocities.
7. Calculate the terminal velocity for each size ball bearing and then calculate the coefficient of viscosity 'η' of the liquid in each case. Calculate mean value of 'η'.

OBSERVATIONS:

Density of the ball bearings d = ……………..…gm / c.c.

Density of the given liquid D = ...…………….…..gm / c.c.

Diameter of the tube a = …………… cm

∴ Radius of the tube $R = \frac{a}{2}$ =…………..…cm

Acceleration due to gravity g = …………..…cm / sec^2

Diameter of small ball bearing = …………….cm

Diameter of medium ball bearing = …………….cm

Diameter of large ball bearing = …………….cm

Radius of the small ball bearing r_1= …………….cm

Radius of the medium ball bearing r_2=…………….cm

Radius of the large ball bearing r_3= ……………cm

Distance between points X and Y = s = …………... cm

S.No.	***Size of the Ball Bearing***	***Time taken to travel distance 's' cm between points X and Y 't' sec***				***Observed Velocity*** $v = \frac{s}{t}$ ***cm/sec***	***Terminal velocity*** v_o ***cm/sec***
		t_1	***t_2***	***t_3***	***Mean***		
1	Small						
2	Medium						
3	Large						

CALCULATION:

$$v_o = v\left(1 + \frac{2.4r}{R}\right) \quad \& \quad \eta = \frac{2r^2 g(d - D)}{9v_o}$$

RESULT:

Coefficient of viscosity of the given liquid by Stock's method is found to be =……………..poise at temperature =………………°C

PRECAUTIONS AND SOURCES OF ERROR:

(i) The ball bearing must be wet with the liquid to prevent it catching from air bubbles.
(ii) The ball bearing must be released slowly from just above the liquid surface.
(iii) The temperature of the liquid should be kept constant throughout the experiment, since the coefficient of viscosity varies with temperature.
(iv) Ball bearings must be released at the center of the tube.
(v) The liquid should be transparent and should be free from dust particles.

EXPERIMENT # 05

OBJECT:

To determine the surface tension of water by capillary rise method.

APPARATUS:

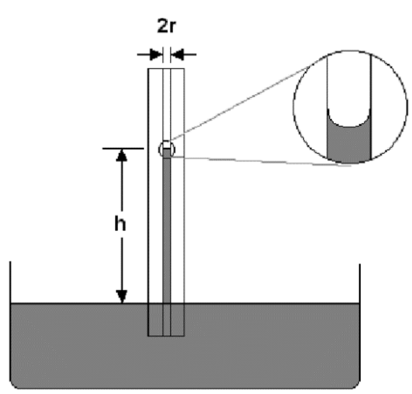
Capillary Tubes, Graduated Cylinder, Traveling Microscope, Stand with Clamp

THEORY:

At the interface between two materials physical properties change rapidly over distances comparable to the molecular separation scale. Molecules sitting at a free liquid surface against vacuum or gas have weaker binding than molecules in the bulk. Free liquid surface against vacuum or gas have weaker binding than molecules in the bulk. The missing (negative) binding energy can therefore be viewed as a positive energy added to the surface itself. Since a larger area of the surface contains larger surface energy, external forces must perform positive work against internal surface forces to increase the total area of the surface. Mathematically, the internal surface forces are represented by surface tension, defined as the normal force per unit of length.

Surface tension produces several observable phenomena. The rise of a liquid in a capillary is the result of surface tension.

Consider the situation depicted in Fig, in which the end of a capillary tube of radius, r, is immersed in a liquid. For sufficiently small capillaries, one observes a substantial rise of liquid to height, h, in the capillary, because of the force exerted on the liquid due to surface tension. Equilibrium occurs when the force of gravity on the volume of liquid balances the force due to surface tension. The balance point can be used to measure the surface tension.



Capillary rise due to surface tension

At equilibrium

Downward force due to gravity = upward force due to surface tension

$$\rho g(\pi r^2)h = \gamma(2\pi r) \qquad (1)$$

Where r is the radius of the capillary, h is the capillary rise, ρ is the liquid density, g is the acceleration due to gravity, and ϒ is the surface tension of the liquid. Rearrangement of the equation 1 gives a simple expression for the surface tension.

$$\gamma = \frac{\rho g r h}{2}$$

PROCEDURE:

1. Determine the least count of the travelling microscope.
2. Determine the diameter d of the capillary tube with the help of the travelling microscope, three times. Then find the radius r of the capillary tube.
3. Fill the graduate cylinder with water, to overflowing, & dip the capillary tube in it.
4. Measure the rise h of the water in the capillary, with the help of the travelling microscope. Focus on the water level first, and then, on the lower part of the meniscus of the raised water in the capillary. Repeat three times.
5. Repeat step 2 to 4 for different capillary tubes.

PRECAUTIONS & SOURCES OF ERROR:

1. The radius of the capillary should be determined accurately.
2. The travelling microscope should be leveled properly.
3. The capillary tube should be uniform in thickness.
4. There must not be any air bubble inside the capillary tube.
5. The capillary tube should be cleaned properly.

OBSERVATION:

1. Least count of the travelling microscope: _______________ cm.
2. Acceleration due to gravity g = _____________ cm/sec^2.

For radius of the capillary tube.

S.No.	a (cm)	b (cm)	Radius (cm)

							r = (b – a) / 2
	MSR	VSR	TR	MSR	VSR	TR	

Mean radius of the capillary tube r_n = ________________________ cm.

For height of the water column

S.No.	Cylinder level a (cm)			Meniscus level b (cm)			Height (cm) h = b – a
	MSR	VSR	TR	MSR	VSR	TR	

Mean height of the water column h_n = ________________________ cm.

CALCULATION:

Place the data obtained in the working formula and find the value of the surface tension of water.

$$\gamma = \frac{1}{2} g \rho r h$$

RESULT:

The surface tension of water is found to be ϒ = ___________________ dynes/cm.

EXPERIMENT # 06

OBJECT:

Determine Thermal Conductivity of Material of A Bar By Searl`s Method.

APPARATUS: -

Searl`s Apparatus, Four fractional thermometers, stop watch, graduated cylinder, Vernier caliper, rubber tubing, heating arrangement, boiler, water, beaker.

THEORY FORMULA: -

The quantity of heat Q that flows from a face of higher temperature T2 ^{o}c to the opposite face at a lower temperature T1 ^{o}c is found to depend upon the following factors.

i- It is directly proportional to area "A" of the face of the plane.
ii- Directly proportional to difference of temperature (T2 – T1) between the two faces.
iii- Directly proportional to "t" in second and inversely proportional to thickness "L" of the face.

Negative sign indicates that temperature decreases as a distance increase between the face.
In Searl`s apparatus heat Q is conducted by the bar is received by water falling (m) per second round the hot bar and produces a change in the temperature from T3 to T4 therefore heat passing through per second =

$$K = m\frac{(T_4 - T_3)L}{A(T_2 - T_1)}$$

Where m = mass of water collected in one second.
A = Area of cross section of the
L= Length between thermometers at hot end.

T1 = Temperature of the outlet of hot water.
T2 = Temperature of the inlet of hot water (Steam).
T3 = Temperature of inlet of cold water.
T4 = Temperature of the outlet of water.

OBSERVATION: -

1. Least count of the stop watch ______________________sec.
2. Least count of Vernier caliper ______________________cm.
3. Length of the rod ________________________________cm.
4. Radius of the rod ________________________________cm.
5. Area of cross section of face of the rod _______________cm^2
6. Mass of the water collected ________________________gm.
7. Time for which water is collected ___________________sec.
8. Mass of water collected per second __________________gm/sec.

CALCULATIONS: -

$$K = m\frac{(T_4 - T_3)L}{A(T_2 - T_1)}$$

RESULT: -

Thermal conductivity of the material of bar = _______________ Cal/cm-Second C.

PRECAUTIONS: -

1. Temperature should be taken very accurately.
2. Length and radius of the bar should be taken accurately.
3. Temperature at steady state should be taken accurately.

EXPERIMENT # 07

OBJECT:

Determination of Temperature Coefficient of Resistance and draw Thermocouple Characteristic Curve(Thermal EMF and Temperature Diagram).

APPARATUS: -

Galvanometer a linear wire about half meter long wound on a bad conductor, voltmeter, thermocouple, beaker water centigrade thermometer. Heating arrangement and connecting wires.

A. THEORY FORMULA: -

The resistance offered by a conductor depends upon its temperature. In most of the cases the resistance of a wire increases as temperature rises. For small range of resistance R of a conductor at temperature T ^oC is connected with a resistance R_o (Resistance at zero degrees centigrade) by the relation.

$$R_t = R_o(1 + \alpha\Delta T)$$

$$\alpha = \frac{R_2 - R_1}{R_1\Delta T}$$

Where α = temperature co-efficient
R_t = Resistance at T ^oC.
ΔT = Temperature difference

B. THEORY/FORMULA:-

The conversion of temperature difference to electric current and vice-versa is termed as thermoelectric effect. In 1981, Thomas Johann See beck found that a circuit with two dissimilar metals with different temperature junctions would deflect a compass magnet. He realized that there was an induced electric current, which by Ampere's law deflect the magnet. Also, electric potential or voltage due to the temperature difference can drive the electric current in the closed circuit. An explanation of the **See beck** effect requires an understanding of the behavior of electrons inside a metal. Not all the electrons inside a metal are bound to specific atoms; some are free to move about. These free electrons behave like a gas. The density of the "free" electrons (the number per unit volume) differs from metal to metal. Consequently, when two different metals are placed in contact, their electron gases diffuse into one another. Because of the different densities of the electron gases and because electrons carry an electrical charge, the metals at the junction become oppositely charged. This difference in charge produces a potential difference across the junction. The extent of diffusion of the "electron gases" depends on the temperature. If the two junctions are at different temperatures, a potential difference will exist between the junctions and a current will flow. The magnitude of the current depends mainly on the temperature difference between the two junctions—in general, the greater the temperature difference, the larger the current. As we know that junction potential is responsible for this current therefore, we can conclude that junction potential increases with temperature.

PROCEDURE:-

1. Note down room temperature.
2. Now put the resistance wire wended and bed conducted in the beaker containing water and connect the terminals with circuits. The coil should be well dip in the water also put a thermometer in the beaker.
3. Start heating as the temperature of the water will go on increasing the resistance of the wire will also go on increasing. At a regular increasing temperature, (say at 10^o c rise) note down the change in resistance. Increase temperature till about 95 ^{o} c and also note down corresponding change in resistance of the coil through P.O. Box as usual manner. Tabulate all the reading in the observation column.
4. Plot a graph between temperature and resistance showing change in resistance of the coil with temperature.
5. Produce graph line backward till it cuts the axis of 'y'. The point of intersection represent the resistance of coil at 0^o C.
6. Replace the junction of copper and iron wires in it along with a thermometer.
7. Now (say after every 10 ^{o}C) note down corresponding temperature and voltage
8. Plot a graph between temperature and voltage and determine the value of k.

OBSERVATION: -

Least count of the thermometer ----------------
Room temperature ---------------

For variation of resistance with temperature: -

S.No.	Temperature (°C)	Resistance (Ω)
1		
2		
3		
4		
5		

Plot a graph (showing temperature in axis of 'x' and resistance of the wire in axis of 'y'). Find resistance at 0^oC through graph. (Point of intersection of graph line with axis of 'y').

S.No.	Temperature (ºC)	Voltage(mv)
1		
2		
3		
4		
5		

CALCULATION:-

1.Resistance of the wire at 0º C R_o (from the graph) = ______________Ω.

2. Resistance at (say 90^{0}c) R_t = _____________ Ω.

3. Change of temperature ΔT = ____________º C

$$\alpha = \frac{R_2 - R_1}{R_1 \Delta T}$$

$$V \propto T$$

$$V = kT \qquad k = \frac{V}{T}$$

RESULT: -

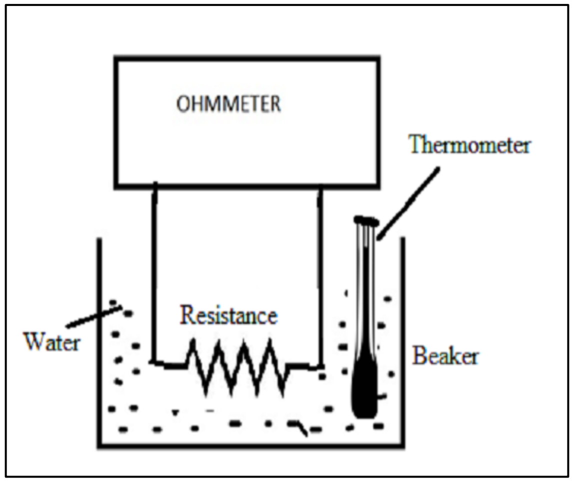
1) The temperature co-efficient of the material of the given wire = ___________________.
2) The graph between Voltage and temperature is straight line (linear)
3) The value of k is ___________________________ V/K

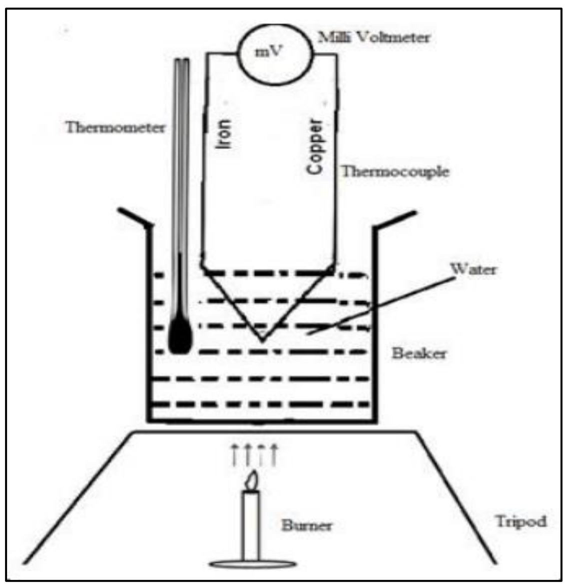
PRECAUTIONS:

1. Whole coil of the resistance wire should be well dip in the water.
2. Rise of temperature should be taken as short steps.
3. Resistance of the wire at room temperature should be taken accurately.
4. Cold junction must be protected from heat radiation.
5. In potentiometer circuit all positive terminal must be connected to a common terminal.

6. Temperature should be taken carefully.

CIRCUIT DIAGRAM:





EXPERIMENT # 08

OBJECT:

Determination of the value of acceleration due to gravity 'g' by compound pendulum

APPARATUS:

A bar pendulum with holes at equal intervals, meter rod, knife edges, stop watch.

THEORY:

The compound pendulum you will use in this experiment is a one meter long bar of steel which may be supported at different points along its length, as shown

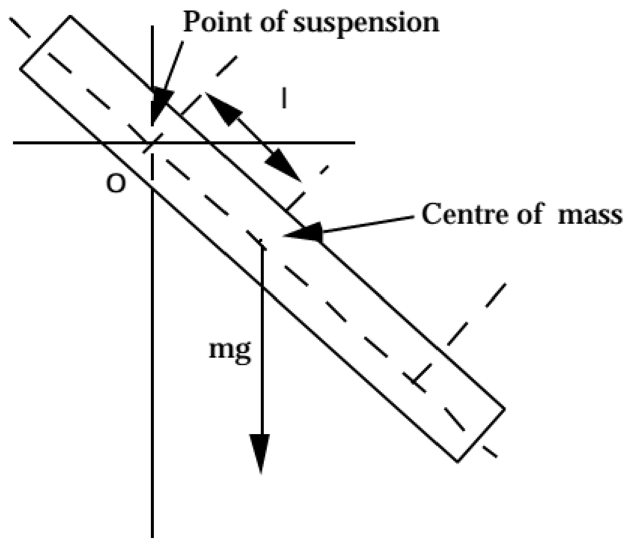


Figure 1 ***A compound pendulum.***

The theory of compound pendulum experiment is same as that of the Kater's pendulum experiment because both pendulums are examples of physical pendulum. As you have learned in Kater's pendulum experiment that time period of Kater's pendulum for knife edge K1 and K2 is related with the value of g by the expression.

$$g = 8\pi^2 \left[\frac{T_1^2 + T_2^2}{h_1 + h_2} + \frac{T_1^2 - T_2^2}{h_1 - h_2} \right]^{-1}$$

For the case when $T_1 = T_2 = T$ above equation gives

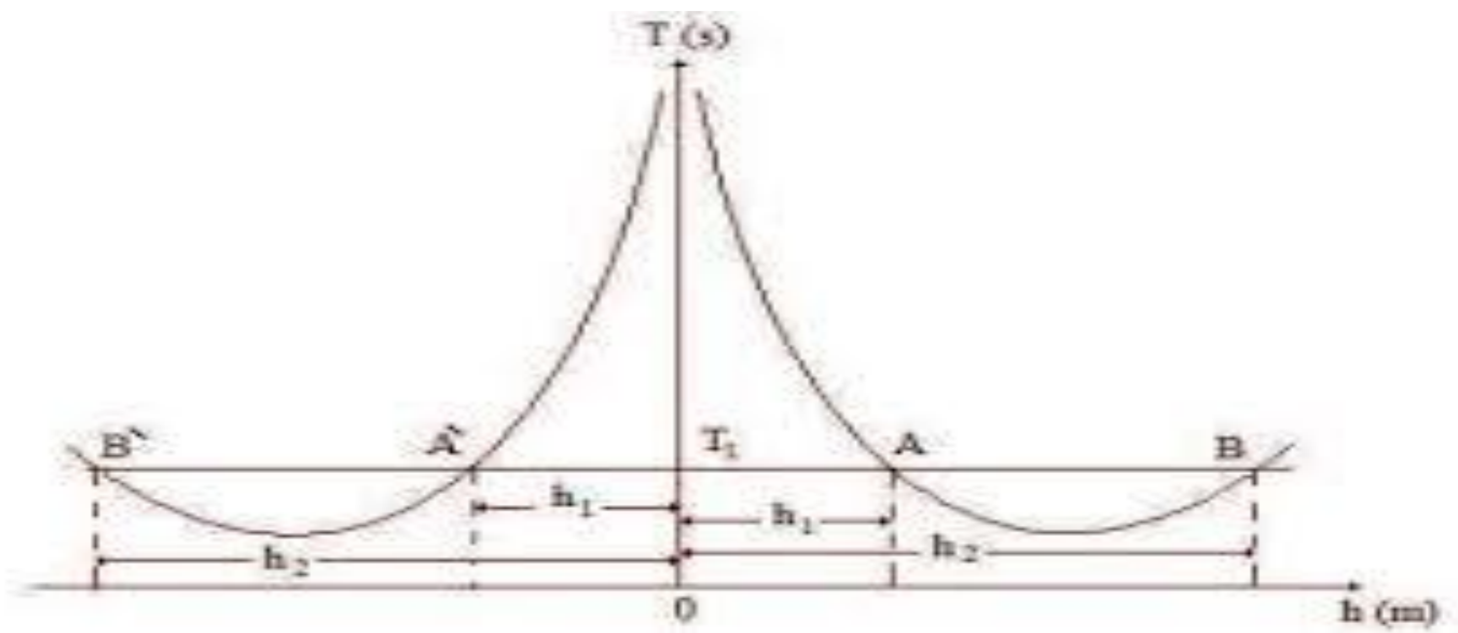
$$g = 4\pi^2 \left[\frac{T^2}{l} \right]$$

Where $l = h_1 + h_2$ is the length of the equivalent simple pendulum

We can find "l" and the corresponding time period "T" from the graph as shown below

PROCEDURE:

1) Mark the position of the center of gravity of the rod by balancing it horizontally on the wooden edge.
2) Measure the distance of each hole between A and C.
3) Suspend the bar through the holes using a knife edge.
4) Give slight displacement on either side, the bar oscillates. Make sure it oscillates in a one plane.
5) Find time for ten oscillations.
6) Find the time period by dividing the time by 10.
7) Repeat steps (v) and (vi) three times for each hole.
8) Now invert the rod and measure the distance of each hole between B and C.
9) Repeat steps (iii) to (vii) for each of the holes between B and C



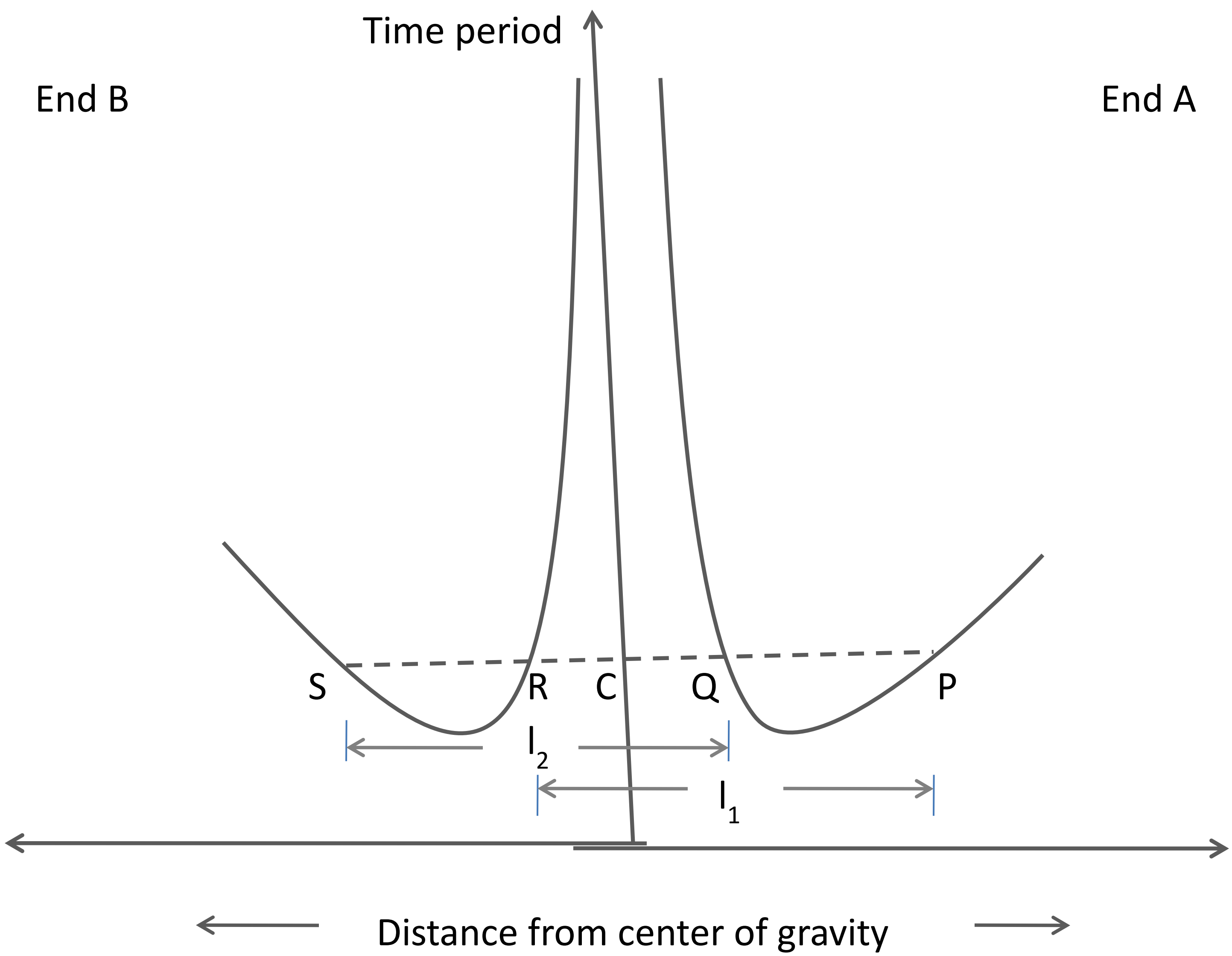
OBSERVATIONS:

The least count of the stop watch =__________s.

End 'A'						End 'B'					
length / cm	time for ten vibrations /sec			Mean $t=(t1+t2+t3)/3$ sec	time period sec	length / cm	time for ten vibrations / sec			Mean $t=(t_1+t_2+t_3)/3$ sec	time period $T=\frac{t}{10}$ sec
	t_1	t_2	t_3				t_1	t_2	t_3		

CALCULATIONS:

Plot a graph between distance from center of gravity (along horizontal-axis) and time period (along vertical axis). Draw both parts of the graph on the same paper with same scale. Take y – axis in the middle, on right side plot the data obtained from the holes between A and C, and on left side plot the data obtained from the holes between B and C.



Meausre the distances SQ (l_1), and PC (l_2). Take the average of l_1 and l_2, this gives the length of equivalent simple pendulum. Substitute the values in the working formula and evaluate the value of ‘g’ acceleration due to gravity.

RESULT:

The value of acceleration due to gravity is found to be ______________________ cm/sec^2.

PERCENTAGE ERROR:

$$\varepsilon = \frac{(calculated\ value - actual\ value)}{actual\ value} x100$$

The actual value of acceleration due to gravity is 980 cm/sec^2.

PRECAUTIONS AND SOURCES OF ERRORS:

1. The stand should be rigid.
2. The motion of the pendulum should be in one plane.
3. Amplitude of the vibration must be small.
4. Support and knife edge should be firm.
5. Air may cause buoyancy and drag.

EXPERIMENT # 09

OBJECT:

To determine the moment of inertia of a fly wheel.

APPARATUS:

Flywheel, string, weight, Vernier Caliper, stop watch

WORKING FORMULA:

$$I = M \frac{\frac{2gh}{\omega^2} - r^2}{(1 + \frac{n_1}{n_2})}$$

where I is the moment of inertia of the fly wheel

M is the mass attached to the string

g is the acceleration due to gravity

h is the height descended by the mass on just before detachment

ω is the average angular speed of the when after the mass was detached

r is the radius of the axle

n_1 is the number of turns of the string on the axle

n_2 is the number of rotations of made be the flywheel after the detachment of string and before it comes to rest.

PROCEDURE:

1. Note down the least counts of Vernier Caliper and stop watch.
2. Measure the diameter of the axle using Vernier Caliper from three different positions, find out mean diameter, and then the radius of the flywheel.
3. Attach a mass with one end of the string. Make a small loop at other end of the string so that the mass can be hanged from the knob on the axle.
4. Give five turns (n_1)to the wheel so that string winds evenly around the axle.
5. Allow the mass to descend to the floor.
6. As soon as string detaches note down simultaneously the time taken by the fly wheel and number of rotations it makes till it comes to rest. Repeat this step three times.
7. Repeat steps (4) to (6) for $n_1 = 7$ and $n_1 = 9$.

OBSERVATIONS:

Least count of Vernier Caliper = ____________________________________ cm

Mass attached to the string = _______________________________________cm

Radius of the axle:

S.No.	Main Scale Reading MSR/cm	Vernier Scale Reading VSR/divisions	Diameter of the axle =MSR+LSR*Least count d/cm	Mean diameter d/cm	Radius of the axle r =d/2 cm
1					
2					
3					

Measurement of time and no. of rotations of wheel before it comes to rest

S. No.	No. of turn of string on axle n_1	No. of rotations after the detachment of string n_2			Mean n_2	Time taken by the wheel before coming to rest t / sec			Mean time t sec
1									
2									
3									

CALCULATIONS:

Height descended by the string before detachment of string = $h = 2\pi r n_1$ = ________________ cm

Average angular speed of the fly wheel = $\omega = \frac{4\pi n_2}{t} =$ ______________________________ rad/sec

Calculate moment of inertia for $n_1 = 5, 7, 9$. Find mean moment of inertia.

RESULT:

The moment of inertia of the fly wheel is found to be = _______________________ $gm\ cm^2$

PRECAUTION AND SOURCES OF ERROR:

1. Axle ball bearing must be properly lubricated.
2. The diameter of the axle must be measured carefully.
3. String must be wound evenly on the axle.
4. Time and number of rotations n_2 must be measured simultaneously.
5. The length of string must be such that it slips off the knob easily before the mass is about to touch the ground.
6. Number of rotations n_2 must be counted carefully.