EXPERIMENT : 1

THERMISTER AS THERMOMETER - CALIBRATION

Aim : To Calibrate the given thermistor with standard thermistor , hence to find the temperature of the unknown liquid.

Apparatus: Thermistor , thermometer (0-110 ℃ range) ,multi-meter (200 Ohm's range)' Calorimeter , Water , unknown liquid.

Principle: The resistance of a thermistor increases with decreases in temperature has negative temperature co-efficient (α). The resistance varies exponentially with temperature.

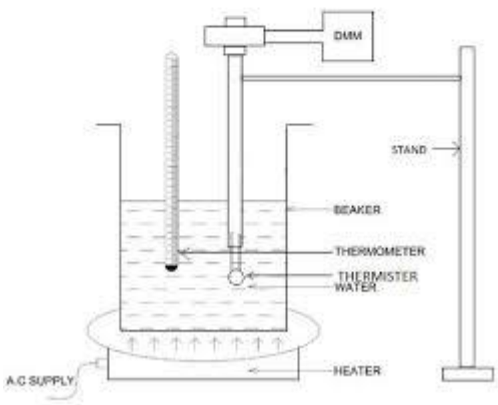
Formula: $\Omega\Delta R = \alpha\Delta t$

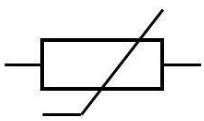
Where - ΔR is change in resistance (Ω),

Δt is change in temperature (℃), and

α is temperature co-efficient of resistance of thermistor (℃$^{-1}$).

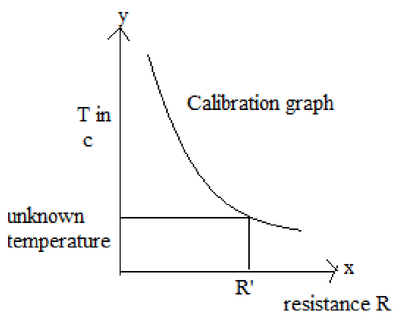
Diagram:





Thermistor symbol

Expected Graph:



Procedure: The experimental arrangement is made on shown in figure. Initial temperature of water in calorimeter is measured using 0-110 ℃ range thermometer and corresponding resistance in the multi-meter is recorded. The water is heated up to the thermometer of 85℃. The corresponding resister is noted using multi-meter. The values of temperature and respective resistance are tabulated for every fall in temperature reads 45℃. A graph of temperature, t (y-axis) versus R (x-axis) is plotted (Calibration graph). The thermistor is removed from the water and immersed in a liquid whose temperature is to be determined. The resistance (R') for unknown liquid is noted,, and hence the temperature of unknown liquid is determined using calibration graph.

Observation: Initial Temperature of water: _____ ℃, corresponding resistance in the multi-meter: ___℃

Tabular Column:

Temperature of water t in ℃	Resistance of Thermistor R in Ω
85	
80	
75	
70	
65	
60	
55	
50	
45	

Calculations:

The resistance (R') for unknown liquid ________ Ω

The temperature of unknown liquid obtained from calibration graph is _____℃

Result: The given thermistor is calibrated with the standard mercury thermometer and calibration graph is plotted, Using which the temperature of unknown liquid is found to be _______ ℃

EXPERIMENT : 2

Study Of Thermocouple

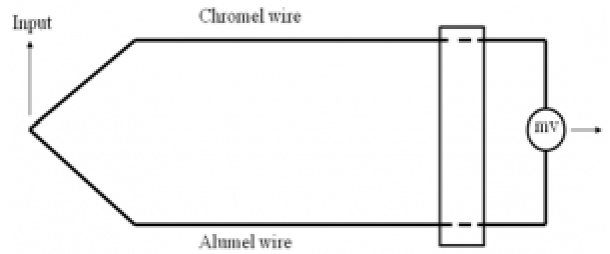
Aim : Analysis of thermo Emf in a Thermocouple.

Apparatus: Thermocouple, Thermometer, Millivoltmeter.

Thermocouple :

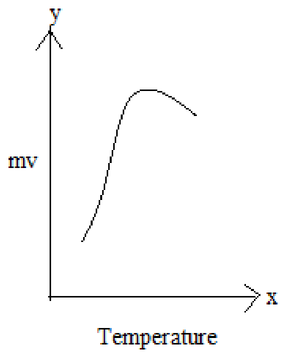
When a pair of electrical conductors (metals) are joined together, a thermal emf is generated when the junction are at different temperatures. This phenomenon is known as the Seekbeck effect. Such a device is called a thermocouple. The resultant emf developed by the thermocouple is in the milivolt range when the temperature difference b/w the junction is 100 ℃. To determine the emf of a thermocouple as a function of the temperatures, one junction is maintained at some constant reference temperature, such as ice-water mixture at a temperature of 0 ℃. The thermal emf, which can be measured by a digital voltmeter as shown in the figure 1, is proportional to the temperature difference b/w the two junctions. To calibrate such thermocouple the temperature of the second junction can be varied using a constant temperature bath and the emf recorded as a function of the temperature b/w difference b/w the two two nodes.

Diagram:



Tabular Column:

SL.NO.	TEMPERATURE in t^0c	Voltage (mv)



Main features of the kit

1. Inbuilt digital mill voltmeter 0-200 millivolts.
2. Inbuilt oven with separate on/ off switch.
3. Circuit diagram printed on the panel.
4. Copper constantan thermocouple is provided with special
5. Attachment and connecting leads.
6. A thermometer 0-100℃ is also provided.

Procedure:

1. Place the thermocouple attachment carefully on the oven so that the junction of the thermocouple should so inside the hole of the oven properly.
2. Also place the thermometer inside the hole of the oven as shown in the Figure.
3. Connect the leads of thermocouple with the sockets of mollivoltmeter by taking care of proper polarity.
4. Switch on the instrument and also switch on the oven on/off switch.
5. Wait for some time till then the readings in the meter reaches the Maximum value and stops increasing.
6. Now switch off the oven on/off switch and records the readings in the table with decreasing value of temperature in the thermometer.
7. Plot the graph in temperature and millivolts.

Result: Temperature versus thermo emf is plotted & straight line in the graph shows that it obeys seeback effect

EXPERIMENT : 3

NEWTON'S LAW OF COOLING

Aim : To determine the specific heat of liquid by the method of cooling.

Apparatus : Calorimeter with an insulated box , thermometer , stop clock, physical balance , Weight box , Water and liquid.

Principle: Newton's law of cooling states that the rate at which heat is lost by radiation from a hot body is proportional to difference of Temperature b/w the hot body and the surrounding medium.

Amount of heat lost by a body temperature of (θ_2-θ_1)

Formula: Let t_{water} and t_{oil} be the time taken by water and oil of equal volume to fall the temperature from $\theta_2\,^0C$ to $\theta_1\,^0C$ under identical Conditions then.

$$\frac{[\text{m1cc} + (\text{m2}-\text{m1})\ \text{cw}\ ]\ (\theta 2-\theta 1)}{t_1} = \frac{[\text{m1cc} + (\text{m3}-\text{m1})\ \text{coil}\ ]\ (\theta 2-\theta 1)}{t_2}$$

Specific heat of liquid, $\left[\frac{\text{Coil= m1cc+m2}-\text{m1cw}}{m_3-m_1}\right]\frac{t_2}{t_1} - \frac{mc_1}{(m_3-m_1)}$

Where C_c= Specific heat of copper calorimeter in Jkg^{-1}= 386 $Jkg^{-1}k^{-1}$

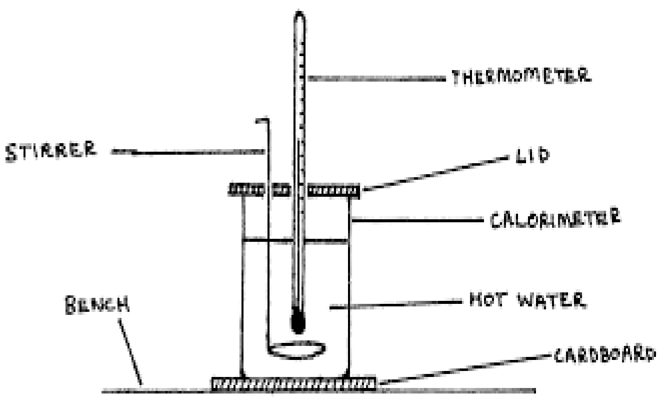
C_w= Specific heat of water= 4200 $Jkg^{-1}k^{-1}$

m_1= Mass of the calorimeter in kg

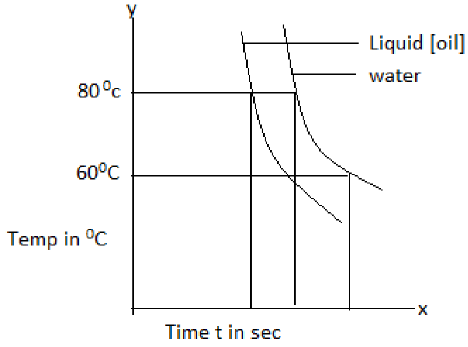
m_2= Mass of the calorimeter t mass of water in kg

C_{oil}= Specific heat of oil in $Jkg^{-1}k^{-1}$

Diagram:



Graph:



PROCEDURE: The mass of the empty copper calorimeter is found using a balance. A known volume of hot water at about 80 ^{0}C is taken in the calorimeter and it is kept in the insulated water and time (t_1) is noted for every $^1/_2$ ^{0}C fall the temperature till the temperature of water reaches 60^{0}C. The mass of the calorimeter with water (m_2) is weighed. Next the water is replaced by equal volume of hot oil. The thermometer is introduced into the oil and time (t_2) is noted for every $^1/_2$ ^{0}C fall of temperature [from 80 ^{0}C to 60^{0}C] The mass of calorimeter with oil (m_3) is weighed. The value of specific heat of oil (c_{oil}) is calculated by using formula.

Observation:

Mass of the empty calorimeter m_1 = ----------

Mass of the calorimeter + water m2 = --------

Mass of the calorimeter + oil m3 = ----------

Specific heat of copper calorimeter Cc= --------

Specific heat of water Cw = ------------

Time taken by water to fall the temperature from 86^{0}C to 60 ^{0}C t1= ----------sec

Time taken to fall the temperature from 86^{0}C to 60 ^{0}C t2 = ----------sec

Calculation:

Result: Specific heat of c_{oil} = ----------- $Jkg^{-1}k^{-1}$-

EXPERIMENT: 4

VISCOSITY Of LIQUID

Aim: To determine the coefficient of viscosity of given liquid castor oil by storks method.

Apparatus: A long cylindrical glass tube, castor oil , stop clock, small steel balls of different radii, screw gauge, meter bridge.

Formula:

Co-efficient of viscosity of a liquid = $\eta = \frac{2}{9} g(\rho - \sigma)[\frac{r^2}{v}]_{mean}$ = ---------NSm^{-1}

Where,

g = is the acceleration due to gravity

ρ = is the density of steel (7740 kg m)

σ = is the density of castor oil (960 kg m)

r = is the radius of the steel ball

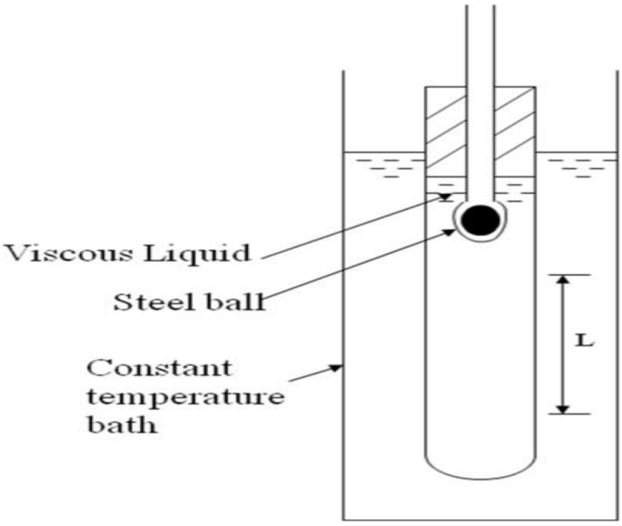
Procedure:

- The liquid where co-efficient viscosity is to be determined is taken in a tall and wide glass jar as shown in the figure. Two marks say x and y are drawn on the jar. The distance b/w them (1)is noted.
- A steel ball whose radius us already determined using a screw gauge is gently dropped into the jar. The time taken by the steel ball (t) to travel the distance xy is found out using a stopwatch the terminal velocity of the ball is determined using the formula $v=\frac{l}{t}$
- The experiment is repeated for steel balls of different radii . The value of $[\frac{r^2}{v}]$ is calculated in each trial. The co-efficient of viscosity of the given liquid is calculated using the formula [1] mentioned.

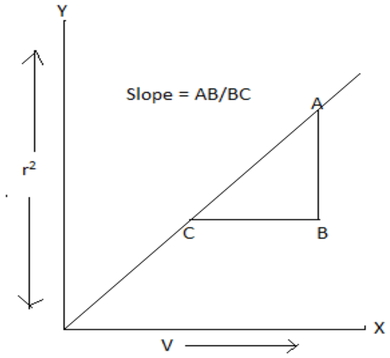
Part-2 :

- A graph of (r^2) versus (v) is drawn, the slope of the graph is determined. The value of co-efficient of viscosity is determined using the formula [2] mentioned above.

Diagram:



Graph:



Part 1 : Distance b/w the marks x & y (l) = _____m

Part 2 : To determine the radius of the steel ball

Zero error ZE= -2 divisions

Pitch $= \frac{Distance\ uncovered}{no.of\ rotation\ given} = \frac{1}{1} = 1mm$

Least count LC = $\frac{pitch}{no.of\ HSD} = \frac{1}{100} = 0.01mm$

Total reading TR = PSR+ [HSR-ZE] LC

Tabular Column:

Ball no.	PSR mm	HSD div	Diameter of the ball TR in mm	Radius of the ball r = $\frac{d}{2}$ mm into 10^{-6}	Time taken (t)in sec	Terminal velocity v=$\frac{l}{t}$ ms^{-1} $*10^{-2}$	$[\frac{r^2}{v}]$ $*\frac{10^{-6}}{10^{-2}}$
1							
2							
3							
4							

Calculation:

Result: The value of co-efficient of viscosity of the given liquid is found to be

By Calculation ƞ = ----------NSm^{-2}

By graph ƞ = ----------NSm^{-2}

EXPERIMENT: 5

SURFACE TENTION AVD INTERFACIAL TENSION

Aim: To determine a) Surface tension of water,

b) The interfacial tension b/w water and kerosene by drop weight method.

Apparatus: A glass fitted with a rubber tube, glass tube, beaker, stand, stop clock, screw gauge, pinch cock.

Formula: a) Surface tension of water $T_1 = \frac{mg}{3.8R}$ ----Nm^{-1}

Where, m = average mass of one drop of water

R = external radius of glass tube

g = acceleration due to gravity

b) Interfacial Tension b/w kerosene water $T_2 = \frac{mg}{3.8R}\left[1 - \frac{p_2}{p_1}\right]$ ----Nm^{-1}

Where, m = mass of one drop of water formed inside kerosene

g = acceleration due to gravity

R = external radius of glass tube

P_1 & P_2 = densities of water and kerosene

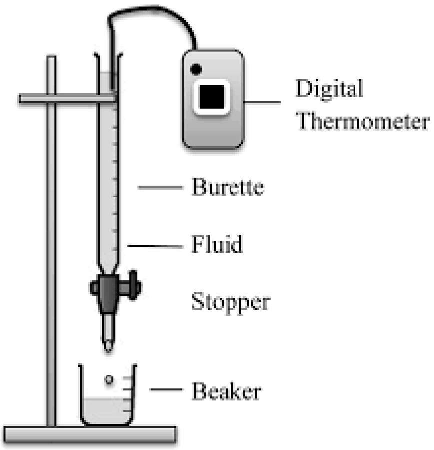
Procedure: **Part:1**

- The experimental arrangement is shown in the fig. (a). A beaker is arranged under the glass tube. The water is collected in the weighed beaker dropping from the funnel. The stop clock is adjusted to such that the liquid drops are formed slowly [8-10 drops per minute] A known mo. of drops are collected [say 25 drops] in the beaker.
- The mass of the beaker with water is again found the difference gives the mass of 25 drops of water from this mass of each drops of water is calculated.
- The procedure is repeated and the average mass of m of single drop of water is calculated. Also the external radius of the glass tube is accurately determined using a screw gauge.
- The surface tension of water at laboratory temperature is calculated using formula (1) mentioned above .

Part:2

- The mass of the beaker with kerosene oil is found the beaker is placed below the glass tube such that water drops are formed inside the kerosene oil as shown in the fig (b)
- 25 drops of water is collected in the kerosene and the mass of each is determined. The experiment is repeated as before.
- The interfacial tension b/w water and erosene is calculated using formula (2)

Diagram:



Observation:

Part-1: Radius of the glass tube (R)

Zero error ZE = ------------

$$\text{pinch} = \frac{Distance\ uncovered}{No.of\ rotations\ given} = \frac{1}{2} = 1\text{mm}$$

$$\text{Least count LC} = \frac{pinch}{No.of\ HSD} = \frac{1}{100} = 0.01\text{mm}$$

Total reading TR= PSR + (HSD -ZE) LC

Tabular Column

Trial no.	PSR mm	HSD in div	TR in (mm)
1			
2			

TR_{mean} = ------mm = --------$\times 10^{-3}$m

Here, mean radius R= ---------$\times 10^{-3}$m

Part-2: To determine surface tension.

1. Mass of empty beaker , m_1 = -----kg = -----× 10^{-3}kg
2. Mass of beaker + 25 drops of water, m_2 = ----× 10^{-3}kg
3. Mass of beaker + 50 drops of water, m_3 = -----× 10^{-3}kg
4. Mass of the beaker + 75 drops of water = m_4---------× 10^{-3}kg
5. Mean mass of 25 drops of water = -------× 10^{-3}kg
6. Average mass of one drop of water m = ------- × 10^{-3}kg

Trail no.	Mass of 25 drops of water in kg
1	M_2-M_1 =
2	M_3-M_2 =
3	M_4-M_3 =

Part:3

1. Mass of empty beaker + kerosene m_1= ------- × 10^{-3}k
2. Mass of beaker + kerosene + 25 drops of water m_2= -------- × 10^{-3}kg
3. Mass of beaker + kerosene + 50 drops of water m_3 = -------- × 10^{-3}kg
4. Mass of the beaker + kerosene + 75 drops of water = m_4---------×10^{-3}kg
5. Mean mass of 25 drops of water = -------× 10^{-3}kg
6. Average mass of one drop of water m = ------- × 10^{-3}kg

Tabular Column:

Trial no.	Mass of 25 drops of water in kg
1	M_2-M_1 =
2	M_3-M_2 =
3	M_4-M_3 =

Result : The value of Surface tension of water = T_1 = --------

Interfacial tension b/w kerosene in water = T_2 = -----------Nm^{-1}

EXPERIMENT : 6

CONSERVATION OF ENERGY

Aim : To verify the law of conservation of energy in the gravitational field.

Apparatus : Inclined plain with a channel, metal sphere , cylindrical , disc , metal scale and stop watch

Principle : A body placed at the top of n inclined plane has potential energy to roll down the inclined plane . The potential energy gets converted into rotational kinetic energy and translational kinetic energy.

Formula : Potential energy = Rotational energy + Translational kinetic energy

$$\text{ie, } mgh = \frac{1}{2}mv2 + \frac{1}{2}Tw^2$$

where , h = height of the inclined plane in m,

v = Linear velocity of the body = s/t ms-1

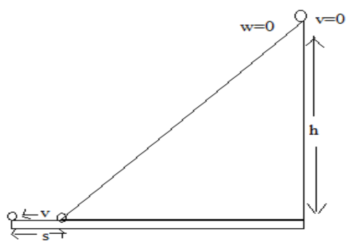
w = Angular velocity of the body = v/r rads-1

I = Moment of inertia of the rolling body about the axis of rotation in kgm2

g = Acceleration due to gravity in ms-2

Procedure : The mass (m) & radius (r) of the solid sphere are measured. The height (h) of the inclined Plane above the horizontal distance (s) from the foot of the inclined plane and end point of horizontal plane is measured , the solid sphere is allowed to roll down the inclined plane when the sphere reaches, the foot of the inclined plane , the time stop watch is started. The time (t) taken to cover the distance (s) is noted. The experiment is repeated for 3 trails and mean time is calculated. The linear speed v is calculated using relation, v = s/t The experiment is repeated with hallow sphere / cylinder / disc and also by changing the height (h) of the inclined plane. Readings are tabulated. The potential energy and kinetic energy are calculated.

Diagram:



Observation:

1. Determination of MI of solid sphere, hallow sphere/cylinder.

Object	Mass m in Kg	Radius 'r' in m	MI about axis of rotation I in Kgm^2
Solid sphere			$I=\frac{2}{5}mr^2$
Hallow sphere			$I=\frac{2}{5}mr^2$
Hallow cylinder			$I=\frac{1}{2}mr^2$

2. Determination of linear velocity (V) and angular velocity (w)

Object	Distance travelled S in m	Time taken to travel the distance s in sec				Linear velocity v=s/t in ms^{-1}	Angular velocity w=v/r in $rads^{-1}$
		t_1	t_2	t_3	Mean t in sec		
Solid sphere							
Hallow sphere							
Hallow cylinder							

3. Determination of PE translational KE and rotational KE

Object	Height of inclined plane in m	PE= mgh in J	Rotational KE $E_R=\frac{1}{2}IW^2$ in J	Translational KE $E_f=\frac{1}{2}mv^2$ in J	PE= E_R+E_f

Result: In all cases, it is observed potential energy= rotational Kinetic energy+ translational kinetic energy

The principle of conservation of energy is verified.

EXPERIMENT : 7

Dependence of the Period on the Amplitude of Oscillation

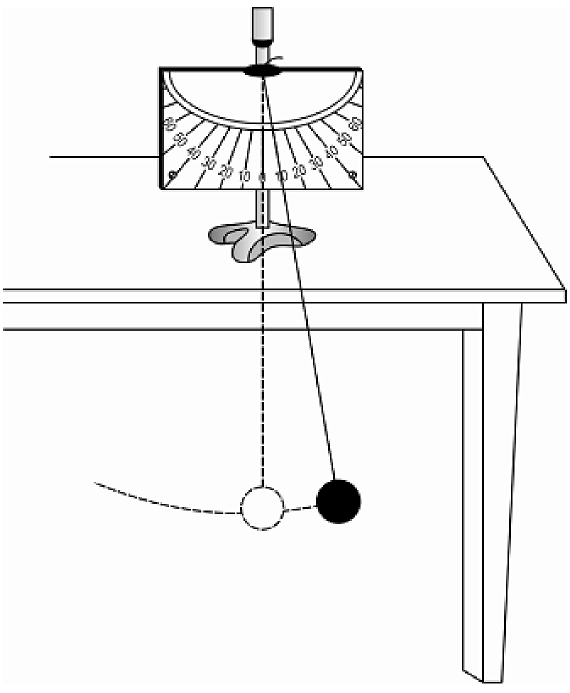
Apparatus: Bob, protractor, thread etc...

Principle:

In practice a simple pendulum is realized by suspending a heavy metallic bob from a rigid support by means of an ordinary string. It can freely oscillate to and fro about the point of suspension in a plane. The maximum displacement of the bob on either side of its equilibrium position is called the **amplitude** of oscillation. The time taken by the pendulum to complete one oscillation is called **time period**.

Procedure:

To study the effect of amplitude of oscillation on the period of the pendulum, we have to keep the length of the string and the mass of the bob constant in this part of the experiment. First, fix a protractor as shown in Fig. You may work with a length of about 1.5 m and in the beginning take the angular amplitude in the range 5°. This ensures simple harmonic motion (SHM). Note the time for 30 oscillations and record it in Observation Table. Repeat it at least three time and compute the period of oscillation. Compare your observations. Next, take larger angular amplitudes of say, 20°, 30°, 40°, 50° and 60° and determine the time period in each case.



Observation Table: Variation of time period with angular amplitude & Period of a Pendulum

Number of complete oscillations counted each time (N) = 30

Length of the pendulum = ………………………………m

Time period **T=t/30**

S.No.	Angular amplitude (degree)	Time for N (=30) oscillations (s)				Time period (s)
		(i)	(ii)	(iii)	(Mean)	
1.						
2.						
3.						
4.						
5.						
6.						

Result:

1. For small angular amplitudes, the period of the simple pendulum is…………s

2. For large angular amplitudes, the period of the simple pendulum is…………s

Experiment:8

FUNDAMENTALS

VERNIER CALLIPERS

Aim: To measure diameter of a small spherical body.

Apparatus : Vernier callipers , Spherical Bob.

Principle: The magnitude of n vernier scale division is equal to the magnitude of (n-1) number of main scale division.

n V.S.D = (n-1) M.S.D

(a) To measure the diameter of a small spherical

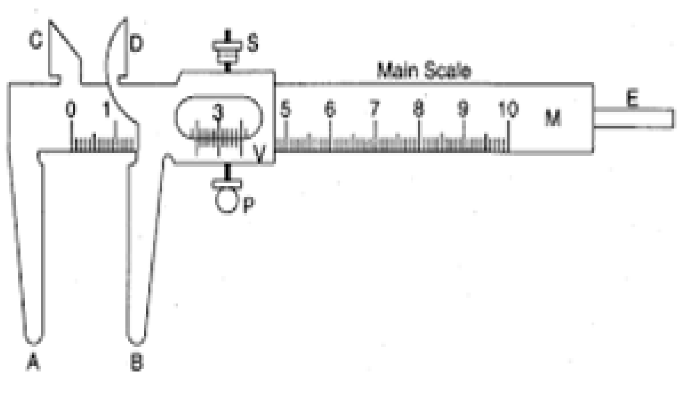
Formula: 1) Least Count = $\frac{value\ of\ 1\ MSD}{Total\ no.of\ VSD}$

2) TR=MSR+(CVD+LC)

Where, TR = Total Reading   MSR = Main scale reading

CVD = Coinciding Vernier Division   LC = Least Count

Diagram:



Procedure :

a) The least count and zero error of the callipers is found.

b) The Spherical body whose diameter D to be measured is held b/w the lower jaws of the Vernier callipers firmly.

c) When the lower jaws P and Q are in contact firmly. the position of the vernier zero with respect to main scale zero is noted. if the vernier zero coincides with the main scale zero there is no zero error. if not so, there is zero error. The zero error will be positive or negative based on whether the vernier scale zero lies either to right or the left of main scale zero.

The number (n) of the vernier scale division coinciding with some division of the main scale is noted. Then zero error (ZE) = n x LC

a) The Position of the vernier scale zero against the main scale is noted. Note down main scale reading (MSR) just to the left of vernier scale zero.

b) The number of particular vernier scale division with same division of the main scale is noted. This gives coinciding Vernier scale division(CVD).

c) The total reading calculated using the formula TR=MSR+(CVD X LC) this gives diameter.

d) The experiment is repeated for different positions of the object and readings are tabulated.

e) The mean diameter of the object is found

f) Zero error is subtracted from the mean diameter to get the corrected diameter D.

Observation :-

value of 1 MSD = ----- cm

Total number of VSD = ____

$$LC = \frac{value\ of\ 1\ MSD}{Total\ no.of\ VSD} = \_\_\_ = \text{-----}\ cm$$

Tabular Column :

Object	Diameter	Trial no.	MSR in cm	CVD	TR in cm	Mean TR in cm
Spherical Ball	Diameter	1				
		2				
		3				

Mean TR = _________ cm

Calculations:

Result: Diameter D of the spherical body = _____cm = _______m

Screw Gauge

Aim: Measure diameter of a given wire

Apparatus: wire, screw gauge.

Principle: The linear distance moved by the screw is directly proportional to the rotation given to the screw gauge.

Formula: **1)** TR=PSR+(HSR x LC)

TR= Total reading

PSR= Pitch scale reading

HSR= Head scale reading

LC = Least count

2) $LC = \frac{Pitch}{Total\ No.of\ head\ scale\ division}$

$$Pitch = \frac{Distance\ moved\ on\ the\ pitch\ scale}{No.of\ complete\ rotations\ given\ to\ the\ screw\ head}$$

Procedure:

a) A known number of rotations given to the screw head N, distance moved on the pitch scale is noted and pitch is calculated.

b) The total number of divisions on the head scale is noted.

c) Least Count is found.

d) When the studs A and B are in contact firmly, the position of the zero of the head scale observed. The number n of head scale division which are below or above the reference line of the pitch scale is counted. Then zero error **(ZE = ± n x LC).**

e) The given wire is firmly held between the two studs by rotating the screw head.

f) The number of divisions uncovered completely and pitch scale is noted as pitch scale reading PSR.
g) The number of head scale division which coincides with the reference line of pitch scale is noted as head scale reading HSR.
h) The total reading is calculated using the formula TR= PSR+(HSR x LC) which gives diameter of the wire
i) .The experiment is repeated for different position of the wire and the reading are tabulated.
j) The mean diameter of the wire is found.
k) The zero error subtracted from mean diameter to get corrected value of the wire.

Diagram:

Observation

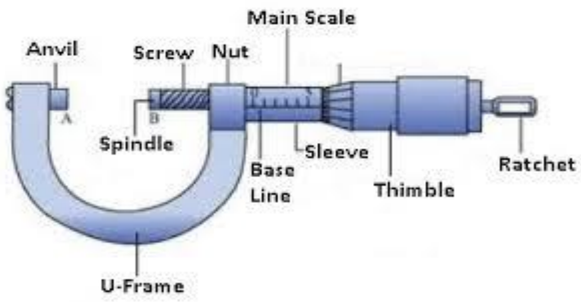
Pitch = $\frac{Distance\ moved\ on\ the\ pitch\ scale}{No.of\ complete\ rotations\ given\ to\ the\ screw\ head}$

Pitch = ------ = ___mm

Total number of divisions on head scale = ______

LC = $\frac{Pitch}{Total\ No.of\ head\ scale\ division}$

LC= ------ = ____mm



Tabular column:

Object	Dimension	Trial No	PSR in mm	HSR	TR in mm	Mean TR in mm
Wire	Diameter	1				
		2				
		3				

Mean diameter = _____mm

Corrected diameter (D) = Mean diameter - ZE

= ------- mm = ------- m

Calculation:

Result: The diameter of the given wire as measured by the screw gauge

= ____mm _____m

Experiment: 9

Work Done By a Variable Force

Aim: To determine the work done on the spring by a variable force bringing about an extension of the spring.

Apparatus: Spring , Stand , Scale pan , Weights , Scale. **Principle:** Consider a vertical spring hang vertically with one end rigidly clamped when a force $\vec{F}$ is applied at the free end it produces an extension $\vec{e}$ when the spring is in equilibrium , an internal spring force Fs comes into play , Which balances within the limits of elasticity.

Where K is the spring constant

$$\vec{F} \, \alpha \, \vec{e}$$

or $\vec{F} = -K\vec{e}$, Where K is the spring constant

In equilibrium

$$|\vec{F_s}| = |\vec{F}| = K\vec{e}$$

The workdone by the applied force in strecting the spring from an extension e_1 to e_2 is given by ,

$$W = \int_{e_1}^{e_2} F.de = \int_{e_1}^{e_2} Kede = {}^1/_2 \text{ K } (e_2{}^2 - e_1{}^2)$$

If we measure 'e' for variable values of , then workdone can be calculated by the area under the F-e curve ,

Formula:

$$W = {}^1/_2 \text{ K } (e_2{}^2 - e_1{}^2) \text{.........J}$$

Where,

W = Workdone is extending spring from $e_1$to e_2 in Joules

K= is the spring constant in Nm and =

slope of the straight line = $\frac{y}{\lambda}$= $\frac{AB}{BC}$= ……

$e_1$and e_2 is the extension of the spring.

Procedure:

- The upper end of the spring is fixed to a stand and is suspended vertically.
- The spring is extended by hanging a load from the free end (say 100gm) [pan + weight]
- The scale reading from the top of the spring to the pointer $x=x_0$ is measured using the scale as shown in the figure.
- The mass in the scale pan is increased in steps of 20gm (0.02kg) up to 0.3kg and the corresponding scale reading x are measured and recorded in the tabular column.
- The average value of x is calculated each time, for load increased and load decreasing.
- The corresponding stretched force F=mg and the corresponding extension of the spring $e=x-x_0$ are calculated and tabulated.
- A graph of F along y-axis and e along x-axis is plotted we get a straight line passing through the origin.
- The work done on the spring is bringing about an extension from e_1 to e_2 when the stretching force increases from F_1 to F_2 is given by the area under the curve.
- The slope of the graph gives K, the spring's constant. The work done in bringing about an extension of the spring from e_1 to e_2 is given by the formula.

$$\int W = \frac{1}{2} K \left(e_2{}^2 - e_1{}^2\right)$$

Tabular Column:

Trial No	Mass in scale pan(Kg)m	Scale reading of the pointer in m		Mean $x = \frac{x_1+x_2}{2}$ m	Stretching force F=mg (N) 9.8	Extension e =(x_1-x_0) m
		Load increasing $X_1 x10^{-2}$	Load decreasing $X_2 x10^{-2}$			
1	W=0					
2	W+					
3	W+					
4	W+					
5	W+					
6	W+					
7	W+					

Calculation:

$W = {}^1/_2$ K ($e_2{}^2$-$e_1{}^2$)………J

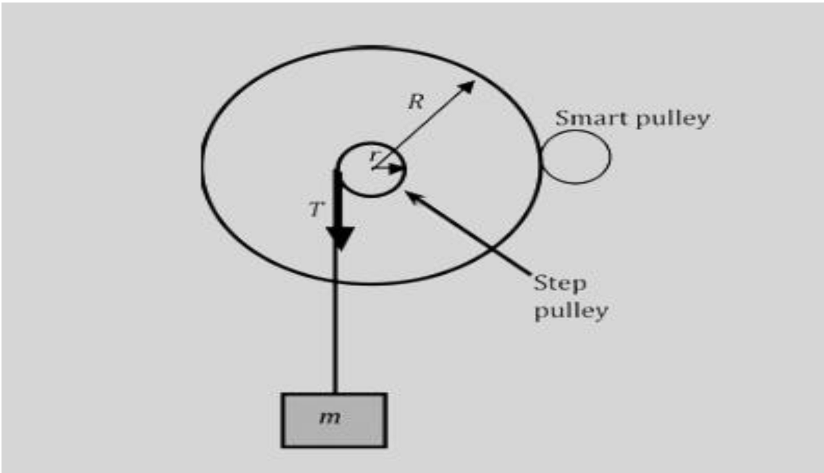
Graph:

W= $\frac{1}{2}(F_1+F_2)\ (e_2-e_1)$

Result:

The work on the spring in bring about an extension from
e_1=……… to e_2………..
W=…………..J (from graph)
W=…………..x10^{-2}J (from formula)

DIAGRAM:



OBSERVATION:

Radius of the axle

Trial no.	MSR (cm)	CVD	TR=MSR+(CVD×LC) (cm)	Mean Diameter ‘d’ in cm
1				
2				
3				

Mean Diameter d=…………X10^{-2}m

ANGULAR ACCELERATION:

Mass in the scale pan ×10^{-3} kg	No. of revolutions (n)	Time for n revolutions in sec			Angular acceleration $\alpha=\frac{4\pi n}{t^2}$ rad/s^2	Mean α rad/s^2
		t_1	t_2	Mean ‘t’		
m_1=50	2					α_1=
	4					
	6					
	8					
m_2=100	2					α_2=
	4					
	6					
	8					

CALCULATIONS:

EXPERIMENT NO: 01

EXPERIMENT NAME: MOMENT OF INERTIA OF FLY WHEEL

AIM: To determine the moment of inertia of fly wheel and to find mass of the fly wheel.

APPARATUS: Fly wheel, thread, weights, stop clock, scale pan, slide clipper (vernier).

PRINCIPLE: The angular acceleration of a flywheel depends on the couple acting on it. By applying a known couple, the angular acceleration and hence moment of inertia is calculated.

FORMULA:

1) $$\mathbf{I}=\frac{(\mathbf{m_2}-\mathbf{m_1})\mathbf{gr}}{(\boldsymbol{\alpha}_2-\boldsymbol{\alpha}_1)} \text{ kg m}^2$$

Where α_1, $\boldsymbol{\alpha}_2$ are the angular acceleration for masses m_1,m_2 to elimimate the frictional force f.

I= moment of inertia of the fly wheel (kg/m^2).

r= radius of the axle of the fly wheel (m).Where **r**=d/2=……………..X10^{-2}m

m= mass acting at distance 'r' from the axis of the fly wheel (kg).

2) $$\mathbf{M}=\frac{\mathbf{2I}}{\mathbf{R^2}}$$

Where, M= mass of the fly wheel (kg).

R=radius of the fly wheel (m).

PROCEDURE:

1) Arrange the fly wheel as shown in figure.
2) Determine the radius of the axle(r) with a slide caliper.
3) Mark a line on the fly wheel, load with mass m_1. It begins to rotate. Note the time 't' for number of rotations using a stop clock. Calculate $\boldsymbol{\alpha}=\frac{\mathbf{4\pi n}}{\mathbf{t^2}}$.
4) Repeat steps 3 for mass m_2.
5) Calculate $\mathbf{I}=\frac{(\mathbf{m_1}-\mathbf{m_2})\mathbf{gr}}{(\boldsymbol{\alpha}_1-\boldsymbol{\alpha}_2)}$.
6) Measure the circumference(c) of the fly wheel and hence radius R=$\frac{c}{2\pi}$.

RESULT: Moment of inertia of the fly wheel, I = ………… kg m^2

Mass of the fly wheel, M=…………kg

DIAGRAM:

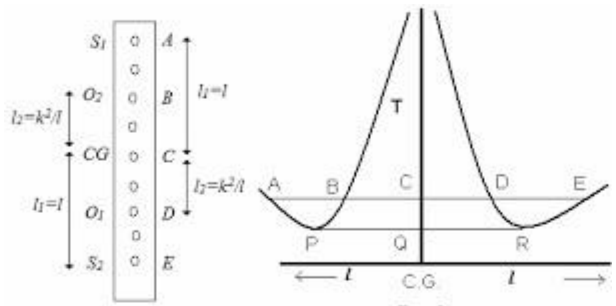


Fig 1 Fig 2

TABULAR COLUMN:

Hole no.	one side of centre of gravity					other side of centre of gravity				
	Distance from C.G (m)	Time for 20 oscillations (s)			Period T (s)	Distance from C.G (m)	Time for 20 oscillations (s)			Period T (s)
1										
2										
3										
4										
5										
6										
7										

Calculations from the graph:

No.	Equivalent length of simple pendulum L (m)		Mean L (m)	Period T (s)	$\left[\frac{L}{T^2}\right]$ ms^{-2}.
1	AB=	CD=	$\frac{AB+CD}{2}$		
2	A^1B^1=	C^1D^1=	$\frac{\text{A1B1}+\text{C1D1}}{2}$		
3	PQ=	QR=	PQ+QR		

CALCULATIONS:

EXPERIMENT NO: 02

EXPERIMENT NAME: BAR PENDULUM

AIM: To determine the acceleration due to the gravity at a given place using bar pendulum by graphical method.

APPARATUS: Bar pendulum, knife edge, stop clock, meter scale.

PRINCIPLE: A simple pendulum whose period is equal to the period of a given oscillating body is called equivalent simple pendulum and length as equivalent length.

When a bar pendulum execute simple harmonic motion, on one side of centre of gravity there are two positions of centered suspensions about which time periods are same similarities on other side of centre of gravity. The distance between two such a symmetry centre of suspension on either side of centre of gravity given "the value length", this is determine from the graph from which 'g' is calculated.

FORMULA: The acceleration due to gravity at a given place is given by
$g = 4\pi^2 \left[\frac{L}{T^2}\right] ms^{-2}$.

Where, g = acceleration due to gravity (ms^{-2})

L =length of the equivalent simple pendulum (m)

T = time for oscillations (sec)

PROCEDURE:

PART – A: Determination of period of equivalent simple pendulum.

1) The bar pendulum is suspended by passing the knife edge through first hole. The distance of the hole 'h' from the centre of gravity measured using meter scale.
2) The bar pendulum is made to oscillate with a small amplitude in vertical plane. The time for 20 oscillations is calculated using $T = \frac{t}{20}$.
3) The experiment is repeated for all the holes on one side of CG. In each case, the distance of the hole from first CG is measured and readings are tabulated.
4) The pendulum is inverted and experiment is repeated for all the holes on other side of CG.
5) A graph is drawn by taking time period T along the Y – axis and distance of the hole from CG along X – axis, two curves symmetrical w.r.t Y – axis are obtained.

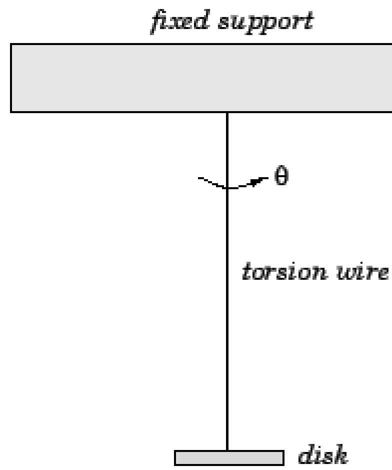
PART – B: Determination of equivalent length from the graph.

1) To determine the length of equivalent of simple pendulum corresponding to any period T, a line is drawn parallel to X – axis through the point on Y – axis corresponding to that period curve at A, B, C and D.
2) The distance corresponds to AB and CD are determined from the graph.
3) The length of equivalent simple pendulum is calculated by using $\alpha = \frac{AB+CD}{2}$. For that period T and hence $\frac{L}{T^2}$ is calculated $\frac{1}{T^2}$ value is determined. The men value of $\frac{1}{T^2}$ is calculated and the value of g is determined.

<u>RESULT</u>:

The acceleration due to gravity at the given place is:

DIAGRAM:



OBSERVATION:

Mass of the rectangular disc (M) = kg

Length of the rectangular disc (L) = m

Breadth of the rectangular disc (B) = m

Axis	Moment of inertia I (kgm^2)	Time for 20 oscillations (s)				Period T (s)	$\frac{I}{T^2}$ Kgm^{2}s^{-2}
		Trial (1)	Trial (2)	Trial (3)	Mean		
Passing through the centre and perpendicular to the plane	$I=\frac{M(L^2+B^2)}{12}$						
passing through the centre and parallel to the breadth	$I=\frac{ML^2}{12}$						
passing through the centre and parallel to the length	$I=\frac{MB^2}{12}$						

$\mathbf{K}=\left(\frac{1}{T^2}\right)_{mean}=$

OBSERVATIONS:

Thickness of the wire:

Using screw gauge:

$LC=\frac{\text{value of one pitch}}{\text{total no head scale divisions}}=$

Tr. No.	PSR (mm)	HSR	CHSR (HSR-ZE)	TR=PSR+(CHSR×LC)=[d] (mm)
1				
2				
3				

Mean d= m

Radius of the wire r=d/2= m

CALCULATIONS:

EXPERIMENT NO: 03

EXPERIMENT NAME: MOMENT OF INERTIA OF TORSIONAL PENDULUM

AIM: To determine the rigidity modulus of the material of given wire.

APPARATUS: Thin wire with different lengths, metallic disc, split, stop clock, meter scale and screw gauge.

PRINCIPLE: In rotational motion, moment of inertia of a body place the same role as mass is translatory motion. When set into tensional oscillations, the moment of inertia of a body about its axis of suspension is directly proportional to the square of its period of oscillations about the same axis.

FORMULA:

(1) **For a rectangular plate:**

(a) Moment of inertia about an axis passing through the centre and perpendicular to the plane:

$$I=\frac{M(L^2+B^2)}{12} \quad (\text{kgm}^2)$$

(b) Moment of inertia about an axis passing through the centre and parallel to the breadth:

$$I=\frac{ML^2}{12} \quad (\text{kgm}^2)$$

(c) Moment of inertia about an axis passing through the centre and parallel to the length:

$$I=\frac{MB^2}{12} \quad (\text{kgm}^2)$$

(2) **Couple per unit twist for given wire:**

$$C=4\pi^2 K \qquad \text{here } K=\frac{1}{T^2}$$

Where T=period of torsional oscillations of the disc(s)

(3) **Rigidity modulus of the material of the given wire:**

$$\eta=\frac{2lC}{\pi r^4}$$

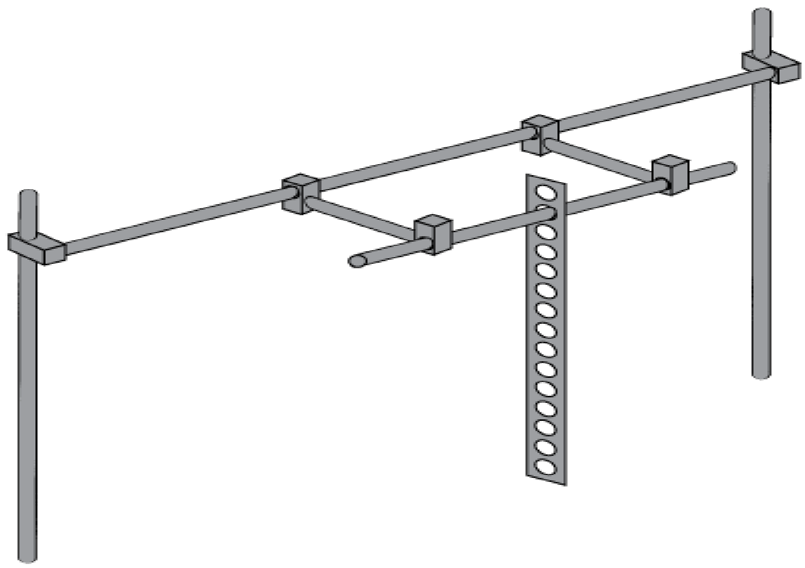
Where r= radius of the wire (m).

PROCEDURE:

(1) Measure the mass of the rectangular disc(M) using a scale pan.
(2) Measure the length(L) and breadth(B) of the rectangular disc using meter scale.
(3) Calculate the moment of inertia of the disc using formula (1).
(4) The disc is hang from an iron stand by means of the given wire along different axes. The system is made to execute torsional oscillations and the mean period T is calculated using a stop watch each time.
(5) $\frac{1}{T^2}$ is calculated in each case and the mean value K is determined.
(6) Couple per unit twist of the wire using the formula (2).
(7) Measure the radius of the wire (r) using screw guage.
(8) Measure the length of the wire (l) using a meter scale.
(9) Calculate the rigidity modulus of the material of the wire using the formula (3).

RESULT: The rigidity modulus of the material of the wire is -------------------

DIAGRAM:



OBSERVATIONS:

Mass of the bar pendulum:

Length of the bar pendulum:

Acceleration due to gravity (g) = $9.8ms^{-2}$

Moment of inertia of the bar pendulum about an axis passing through its centre of gravity and parallel to the axis of suspension:

$\mathbf{I_0=\frac{ML^2}{12}} =$

I_0=

Hole no.	Distance from CG X (m)	Time for 20 oscillations (s)				Period T (s)	Experimental value $I=\frac{Mg\text{x}T^2}{4\pi^2}$	Theoretical Value $I=I_0+Mx^2$
		Trial(1)	Trial(2)	Trial(3)	mean			
2								
4								
6								
8								

CALCULATIONS:

EXPERIMENT NO: 04

EXPERIMENT NAME: PARALLEL AXES THEOREM

AIM: To verify the parallel axes theorem of moment of inertia.

APPARATUS: Bar pendulum, meter scale, stop clock etc.

PRINCIPLE: **Theorem of parallel axes:** The moment of inertia of a body about any axes is equal to the sum of the moment of inertia of the body about a parallel axes to the centre of mass and the product of the mass of the body and the square of the perpendicular distance between the two axes.

FORMULA:

(1) Moment of inertia of the bar pendulum about an axis passing through its centre of gravity and parallel to the axes of suspension:

$$I_0=\frac{ML^2}{12} \text{ (kgm}^2\text{)}$$

Where M= mass of the bar pendulum (kg)
L= length of the bar pendulum (m)

(2) Moment of inertia of the bar pendulum about an axis parallel to the axis passing through the centre of gravity:

$$I=\frac{MgxT^2}{4\pi^2} \quad \text{(kgm}^2\text{)}$$

Where M=mass of the bar pendulum (kg)
g=acceleration due to gravity at the place ($9.8ms^{-2}$)
x=distance of the axis of rotation from the CG (m)
T=period of oscillation(s)

(3) Moment of inertia:

$$I=I_0+Mx^2$$

PROCEDURE:

(1) The mass of the bar pendulum (M) is determined using a balance.
(2) The length of the bar pendulum (L) is determined using a meter scale.
(3) The moment of inertia of the bar pendulum about an axis passing through its centre of gravity and parallel to the axis of suspension (I_0) is calculated using the formula (1).
(4) The position of centre of gravity of the bar pendulum is marked. Hole numbers are counted with this as reference. The distance(x) of the holes 2, 4, 6 and 8 on one side are measure from CG.
(5) The knife edge is fixed to the 2nd hole and the bar pendulum is suspended over a supporting. The pendulum is made to oscillate in a vertical plane with small amplitude.

The time for 20 oscillations is noted separately for 3 trials. The mean time and hence the period (T) is calculated.

The moment of inertia of the bar pendulum about an axis parallel to the axis passing through the centre of gravity (I) is calculated using formula (2).

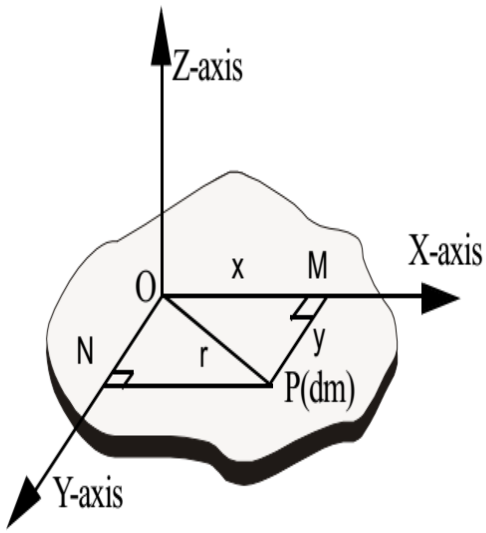
(6) The experimental value of I is compared with the theoretical value obtained using the formula (3).
(7) The experiment is repeated for the holes 4, 6 and 8. The readings are tabulated.

RESULT:

Hole no.	Experimental value	Theoretical
2		
4		
6		
8		

The moment of inertia of the bar pendulum about an axis parallel to the axis passing through the centre of gravity obtained experimentally is found to be in good agreement with that of the theoretical. Hence parallel axes theorem is verified.

DIAGRAM:



OBSERVATIONS:

To find moment of inertia of rectangular plate:

Axis	Body	Time for 20 oscillations (s)				Time for 20 Oscillations 't' (s)	Time Period T=t/20	Mean 'T' (s)
		No. of Oscillations	Time (s)	No. of Oscillations	Time (s)			
Passing through the centre and perpendicular to the plane		0						T_Z
		5						
		10						
		15						
passing through the centre and Perpendicular to the breadth		0						T_y
		5						
		10						
		15						
passing through the centre and Perpendicular to the length		0						T_x
		5						
		10						
		15						

T_Z=

T_X+T_Y=

EXPERIMENT NO: 05

EXPERIMENT NAME: PERPENDICULAR AXES THEOREM

AIM: To verify the perpendicular axes theorem and moment of inertia.

APPARATUS: Bar pendulum, rectangular plate, stand, stop clock, etc

PRINCIPLE: **Theorem of the perpendicular axes:** The moment of inertia of plane laminar body about an axes perpendicular to its plane is equal to the sum of the moments of inertia about two mutually perpendicular axes in the plane of the lamina such that the three mutually perpendicular axes have a common point of intersection.

FORMULA: (1) **for rectangular plate**

(a) Moment of inertia about an axis perpendicular to the plane of the plate $\mathbf{T_Z}$
(b) Moment of inertia about an axis parallel to the breadth of the plate $\mathbf{T_X}$
(c) Moment of inertia about an axis parallel to the length of the plate $\mathbf{T_Y}$
Hence $\mathbf{T_Z^2=T_X^2+T_Y^2}$ since $\mathbf{I \alpha T}$ where **I** is moment of Inertia of a rigid body about the axis of rotation

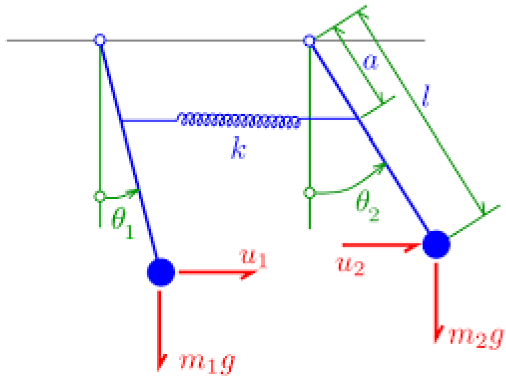
PROCEDURE:

(1) Suspend the Rectangular Plate as shown in figure.
(2) Set into torsional oscillations and determine the period of oscillations.
(3) Repeat steps 1,2 for different axis and different axis.
(4) Verify $\mathbf{T_Z^2=T_X^2+T_Y^2}$.

RESULT:

Experimentally it is found that $\mathbf{T_Z^2=T_X^2+T_Y^2}$ for a rectangular plate and hence perpendicular axis theorem is verified

DIAGRAM:



OBSERVATIONS:

In phase mode:

Tr no	Coupling distance (cm)	Time for 20 oscillations (s)				$T_1=t/20$ (s)	$f_1=\frac{1}{T_1}$ (Hz)
		t_1	t_2	t_3	t_{mean}		
1							
2							

Out phase mode:

Tr. No	Coupling distance (cm)	Time for 20 oscillations (s)				$T_1=t/20$ (s)	$f_1=\frac{1}{T_1}$ (Hz)	$f_b=f_1 \sim f_2$ (Hz)
		t_1	t_2	t_3	t_{mean}			
1								
2								

Time for one cycle of energy transfer t (s)	Period of energy transfer t (s)	Frequency $f_s=1/t$ (Hz)

EXPERIMENT NO:06

EXPERIMENT NAME: COUPLED OSCILLATOR

AIM: 1) To demonstrated the effect of coupling in the behavior of individual oscillators.

2) To find the frequency of normal modes (both in and out of phase).

3) To find the frequency of energy transfer.

APPARATUS: Two identical bobs, inexentensible threads, digital stop watch, scale etc.

PRINCIPLE: If two oscillators A and B have an interaction between them, they are said to form a coupled system. In this coupled system neither of them oscillates harmonically, except in two situations. These situations are called normal modes viz "in phase (zero phase difference)" and "out of phase (phase difference of π)" modes.

The common frequency of oscillation when the two oscillators oscillate in phase is f_1. The common frequency of oscillation when the two oscillators oscillate in out of phase is f_2. The difference in the frequencies of two modes is called beat frequency ($f_b = f_1 \sim f_2$). It is very important to study oscillations of coupled system because coupling leads to phenomenon of wave motion.

FORMULA:

1. Frequency of oscillation when the bobs are in phase:

$$\mathbf{f_1} = \frac{1}{T1} \quad \text{Hz}$$

where T1= period of oscillations of the coupled oscillators which are in phase(s)

2. Frequency of oscillation when the bobs are out of phase:

$$\mathbf{f_2} = \frac{1}{T2} \quad \text{Hz}$$

where T2= period of oscillations of the coupled oscillators which are out of phase(s)

3. Beat frequency $\mathbf{f_b = f_1 \sim f_2}$ Hz
4. Frequency of energy transfer

$$\mathbf{f_3} = \frac{1}{T3} \quad \text{Hz}$$

where T3= energy transfer time for one cycle(s)

PROCEDURE:

1. The experimental arrangement is made as shown in the figure.
2. Chose a certain length 'L' of the pendulum and coupling distance 'x'.

Part-01: for 'in phase' normal mode

3. Displace the bobs equally in the same direction and release them simultaneously such that they oscillate in a plane.
   [Take care that both pendulums should maintain same frequency and amplitude ratio]

4. Record the time for 20oscillations thrice and calculated the mean value. Calculate the period (T1) and hence the frequency f_1.

Part-02: for 'out of phase' normal mode

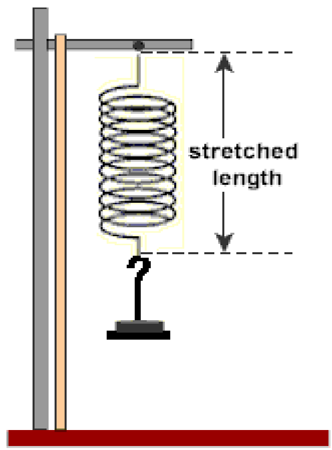
5. Without changing the coupling distance and the length of the coupling system, displace the bobs equally in the opposite direction and release them simultaneously such that they oscillate in a plane.
6. Record the time for 20 oscillations thrice and calculated the mean value. Calculate period (T2) and hence the frequency f_2.
7. Calculate the beat frequency corresponding to normal mode: $f_b=f_1 \sim f_2$

Part-03:for energy transfer

8. place the bob 'A' at rest. Displace the bob 'B' and release.[the amplitude of the bob 'B' slowly decreases and comes to rest momentarily. In the mean time the energy transfer will takes from bob 'B' to the bob 'A'. Hence the bob 'A' will pick up oscillations. The oscillations of the b0b 'A' increases-becomes maximum-decreases and becomes zero momentarily. Next the bob 'B' picks up the oscillations and the process goes on. The event between any two conclusive zero amplitudes of a bob is equal to one cycle of energy transfer for the bob].
9. Note down the energy transfer time for the bob (say B) for 5 consecutive cycles of energy transfer thrice and fine the mean time. Calculate the beat period T3 (I.e time for one cycle) and hence the frequency of energy transfer (f_3) using the formula (4).
10. Repeat the experiment for two lengths (L) and two coupling distances(x).

RESULT: The beat frequency f_b corresponding to the normal modes is found equal to the frequency of energy transfer within the experimental limits.

DIAGRAM:



EXPERIMENT:07

EXPERIMENT NAME: g BY SPIRAL SPRING

AIM: To determine the acceleration due to gravity by using a spiral spring.

APPARATUS: spiral spring, scale pan, stop watch, meter scale, weights, stand.

PRINCIPLE: The **helical spring**, is the most commonly used mechanical **spring** in which a wire is wrapped in a **coil** that resembles a screw thread. ... **Helical spring** works on the **principle** of Hooke's Law. Hooke's Law states that within the limit of elasticity, stress applied is directly proportional to the strain produced.

FORMULA:

1) $\mathbf{g} = 4\Pi^2(x/T^2)$ cm/sec^2

   g is acceleration due to gravity
   x is Extension in spring
   T is Time period for 20 vibrations

2) Extension $\mathbf{x} = x_2 - x_1$ (cm)
   $\mathbf{x_1}$= initial pointer reading

   $\mathbf{x_2}$ = final pointer reading

3) Percentage Error = Differenc/Original X 100
   = (980-$\mathbf{g_{mean}}$ **/** 980) X 100

PROCEDURE:

- Make the experimental set up
- Add load in steps of 50 gms for each trial
- Determine the initial (x_1) cm and final (x_2) cm pointer reading
- Find the extension in the spring by using the formula $\mathbf{x} = x_2 - x_1$ (cm)
- Determine the time period (T) for 20 vibrations
- Finally find the value of **'g'**

RESULT: Acceleration due to gravity by spiral spring is g = ………ms^{-2}

Tabular Column :

Trial no.	Load Suspended in **M (gm)**	Pointer reading		Extension in spring $X = X_2 - X_1$ (cm)	Time for 20 vibrations			Time Period $T=t/20$ (secs)	T^2 (sec^2)	$g=4\Pi^2(x/T^2)$ (cm/sec^2)
		X_1(cm)	**X_2(cm)**		t_1 (secs)	t_2 (secs)	$t=t_1+t_2/2$ (secs)			

g_{mean} =

||JAI SRI GURUDEV||

BGS SCIENCE ACADEMY

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LABORATORY MANUAL

B.Sc. PHYSICS

For III – SEMESTER

Volume – 3

Paper - 302

PREPARED BY TEAM OF PHYSICS DEPARTMENT

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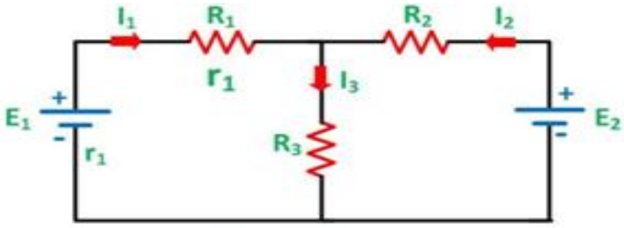
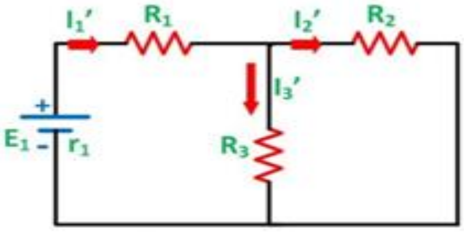
CONTENTS

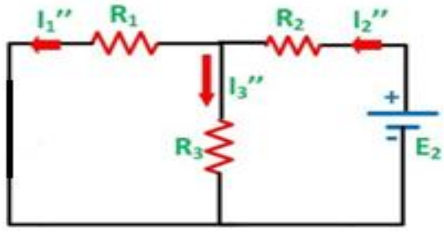
CIRCUIT DIAGRAM:



Circuit Diagram A



Circuit Diagram B



Circuit Diagram C

TABULAR COLUMN:

		Current through R_3 in (mA)				Voltage across R_3 in (V)			
V_1 in(v)	V_2 in(v)	V_1 alone I_1' in (mA)	V_2 alone I_2' in (mA)	V_1&V_2 together I in (mA)	$I=I_1'+I_2'$ in (mA)	V_1 alone V_1' in (mA)	V_2 alone V_2' in (mA)	V_1&V_2 together V in (v)	$V=V_1+V_2$ in (v)
1	2								
2	4								
3	6								

CALCULATIONS:

EXPERIMENT NO: **01** DATE:

EXPERIMENT NAME: **SUPERPOSITON THEOREM**

AIM: Verification of the superposition theorem

APPARATUS: Dual DC power supply (0-30V), Multi meter, DC Milli ammeter (0-50mA),Resistor and connecting wires.

PRINCIPLE: The theorem states that " The current through or voltage across an element in a linear bilateral network is equal to the algebraic sum of the currents or voltage produced independently by each source .This theorem is not applicable to power effects.

PROCEDURE:

1. The resistors are checked for open or short and their values are found using multimeter and colour code method.

2. Construct the circuit as shown in the figure using the given values of computer.

3. The values of current I_1 through R_3 and voltage across it are found by varying the voltage V_1 in steps of 2V set V_2 =0v.

4. Set V_1=0v, Vary V_2 in steps of 2v and note down the current I_2 through R_3 and voltage across it.

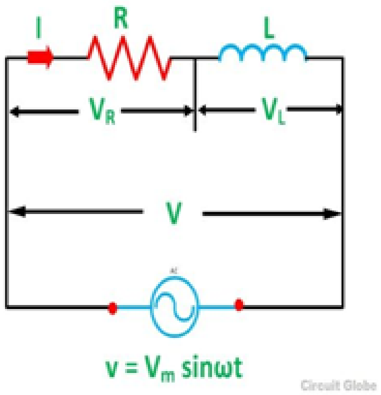
5. By adjusting the values of $V_1 = V_2$ in steps of 2v, the current I through R_3 and voltage across it are noted down. The experiments repeated for different values of voltage

6. The experiment is repeated by reversing the polarity of one of the power supplies.

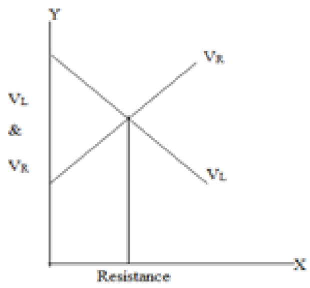
RESULT: It is found that in each case $I = I_1 + I_2$ and $V = V_1 + V_2$

Hence superposition theorem is verified

DIAGRAM:



EXPECTED GRAPH :



TABULAR COLUMN:

R' in (Ω)	V_R in (v)	V_L in (v)
10		
20		
30		
40		
50		

CALCULATIONS:

EXPERIMENT NO: **02** DATE:

EXPERIMENT NAME: **MEASUREMENT OF INDUCTANCE 'L' & BY EQUAL VOLTAGE METHOD**

AIM: Determination of the capacitance of the given capacitor the inductance of the given inductor.

APPARATUS: Capacitor (0.22 MF or 0.33 MF or 0.47MF), resistance box, step down transformer, millimetre, choke and connecting wires.

PRINCIPLE: Similarly when a inductor is connected in series with a resistance box on AC source the current through L&R are the same then the total impedance of the inductor equals the resistance R. When the voltage across them are the same then the total impedance of the choke is $\sqrt{R^2 + \omega^2 L^2}$ = r^2

Where r= resistance of the choke

L= inductance of the choke

R= resistance value on the resistance box

FORMULA: $L^2 = R^2 - r^2 / \omega$

$\omega = 2\Pi f$

$$\boxed{L = \sqrt{\frac{R^2 - r^2}{2\Pi f}}}$$

Where R - resistance unplugged from the resistance box for equal voltage across L&F the resistance box in Ω

PROCEDURE:

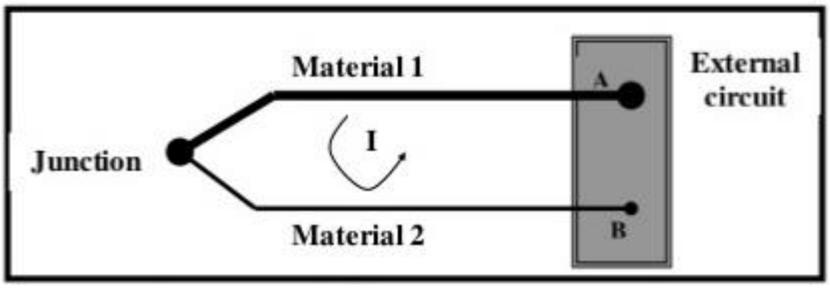
To determine L

- Connection is made as shown in the figure.
- The resistance is varied in suitable steps (10 to 50) in the resistance box and in each case the voltage across the resistance box (V_R') and the inductance (V_L) are recorded using a multimeter.
- It is found that V_R gradually increased and V_L gradually decreased when R is increased.

- Graph of V_R & V_L versus R is plotted in the same graph.
- The value of R corresponding to intersection of two straight lines is noted.
- The value of choke is disconnected from the circuit and its resistance is measured using multimeter.
- Using the values of R and r the inductance is calculated using the formula.

RESULT: The value of given inductance L =- -------------mH

DIAGRAM:



TABULAR COLUMN:

Sl No	Temperature in (^{0}c)	Milli volts
01		
02		
03		
04		
05		
06		
07		

CALCULATIONS:

EXPERIMENT NO: **03** DATE:

EXPERIMENT NAME: **STUDY OF THERMOCOUPLE**

AIM: To study and used of thermocouple for measurement of temperature

APPARATUS: Thermocouple, thermometer, milli voltmeter.

PRINCIPLE: When a pair of electrical conductors is joined together, a thermal emf is generated when the junction are at different temperature this phenomenon is known as seeback effect. Such device is called as thermocouple. To find resultant emf developed by the thermocouple the temperature difference between the junctions is maintained at 100^0c.

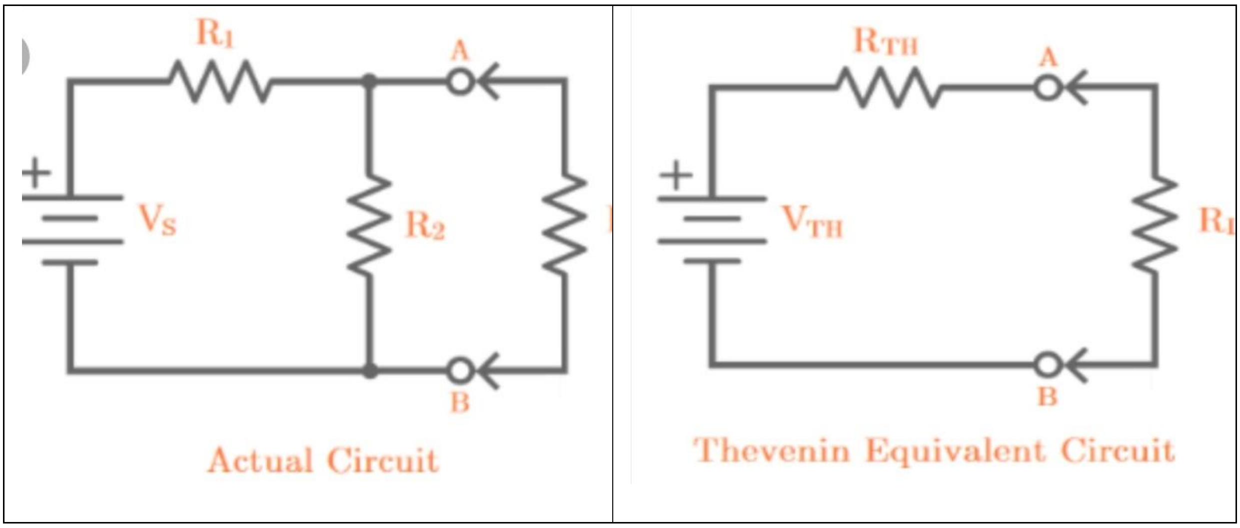
To determine the emf of thermocouple as function of temperature, one junction is maintained at constant temperature (ice water mixture at temperature of 0^0c) and other junction temperature is varied.

PROCEDURE:

- Place the thermocouple carefully so that the junction of the thermocouple should go inside the hole properly and also place the thermometer inside the hole of the oven properly as shown in the figure.
- Connect the led's of the thermocouple with the sockets of milli voltmeter by taking care of proper polarity.
- Switch on the instrument and oven.
- Wait for some time until the reading in the meter reaches maximum value and stops increasing.
- Now switch of the oven and record the values with decrease in the temperature in the thermometer.
- Plot the graph of milli volts vs temperature.

RESULT:

DIAGRAM:



TABULAR COLUMN:

Trial No.	E (volt)	I_L (mA)
01		
02		
03		
04		
05		

V_{TH} (volt)	I_L' (mA)

CALCULATION:

1. Calculation for R_{TH} =

2. Calculation for V_{TH}=

EXPERIMENT NO: **04** DATE:

EXPERIMENT NAME: **THEVENIN'S THEOREM**

AIM: To verify thevenin's theorem

APPARATUS: DC power supply, resistance box, milli ammeter, connecting wires.

PRINCIPLE: According to thevenin's theorem, "any complex network can be replaced by a equivalent network consisting of voltage source (V_{th}) and a resistance (R_{th}) in series".

The thevenin's voltage (V_{th}) is the open circuit voltage at the output terminals and the thevenin's resistance (R_{th}) is equal to the resistance between the output terminals when the voltage sources in the network are replaced by their terminal resistances.

FORMULA:

1. Thevenin's voltage : $V_{th} = \frac{ER_3}{R_3+R_1}$ in volts

Where E= applied voltage in DC regulated power supply (in volt)
R_1, R2 and R_3 are the resistances in the complex network (inohm).

2. Thevenin's resistance : $R_{TH} = R_2 + (\frac{R_3 R_1}{R_3+R_1})$

PROCEDURE:

PART –A

- Circuit connections are made as shown in the figure 1
- Suitable resistances R_1, R2, R3 and R_L are unplugged in resistance boxes.
- The emf of the source E is set for a suitable value (say 1 volt)
- The current in the circuit I_L is noted from the ammeter.
- The experiment is repeated for various values of E
- In each case corresponding current I_L in the circuit is noted.

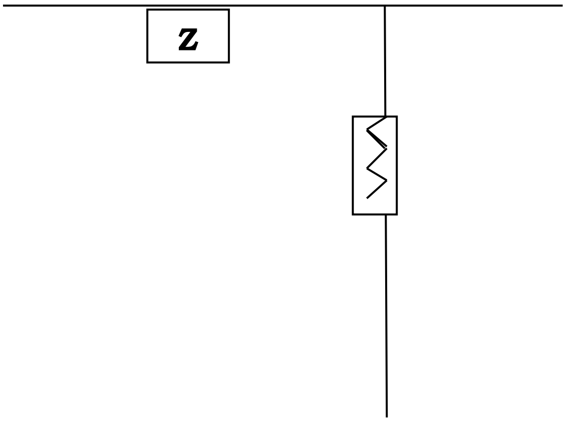
PART-B

- Thevenin's resistance (R_{th}) is calculated using the formula (2)

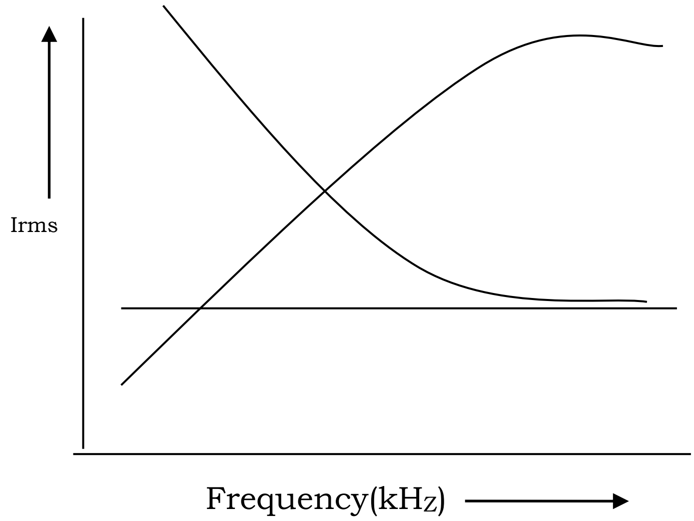
- Thevenin's voltage (V_{TH}) for the value of emf E of the source in trial no (1) is calculated.
- Thevenin's equivalent circuit connections are made as shown in the figure (2).
- The current in the Thevenin's circuit I_L' is noted from the ammeter.
- The experiment is repeated for different values of E included in other trials.

<u>RESULT</u>: It is found that in each trial $I_L = I_L'$.
The complex dc network constructed is equivalent to the Thevenin's circuit
Hence Thevenin's theorem is correct.

DIAGRAM:



EXPECTED GRAPH :



TABULAR COLUMN:

Terminal frequency (KHz)	0 & 1 I_{rms} (mA)	Terminals frequencies KHz	0 & 2 I_{rms} (mA)	Terminals frequency (kHz)	0 & 3 I_{rms} (mA)
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					

CALCULATIONS:

f=

A_v=

$$Z=\frac{R}{A_V}$$

$$L^2=\frac{Z^2+R^2}{\omega^2}$$

$$C=\frac{1}{\sqrt{\omega^2\,(Z^2-R^2)}}$$

EXPERIMENT NO: **05** DATE:

EXPERIMENT NAME: **BLACK BOX**

AIM: To identify and measure the values of the circuit element connected in a box with terminals provided outside the box.

APPARATUS: Black box, digital AC voltmeter, function generator and resistor.

PRINCIPLE: Black box experiment is to identify the passive circuit elements and also determine their values. Passive circuit elements are the elements which work only when they are connected. The passive circuit elements are resistors, capacitors and inductance. The basic idea is to study the response of each element with respect to applied AC frequency. The capacity reactance of capacitor decreases with increase in the frequency where as inductor reactance of the inductor increases with increase in the frequency but response of resistor is independent of applied frequency. This fact is used here to identify the passive circuit elements. The passive circuit elements are connected in series to study the resonance frequency.

FORMULA:

1. $R=ZA_V$

Where Z= Impedance

A_v= Transfers ratio $(\frac{V_0}{V_i})$

2. INDUCTANCE : $L^2= \frac{Z^2+R^2}{\omega^2}$

3. CAPACITANCE : $C=\frac{1}{\sqrt{\omega^2\,(Z^2-R^2\,)}}$

ω= Frequency

R= Resistor

PROCEDURE:

- The voltage divider circuit is rigged with Z_1
- By seeing one of the unknown impedance Z and a voltage divider circuit is rigged R as shown in the figure.
- A sine wave oscillator or function generator is connected to the input of the voltage divider network and the frequency is set to 100H_z and amplitude 1v.

- The AC voltmeter provided in the setup is used to measure input and output by connecting it to input and output respectively. The input voltage is set 1v and amplitude knob should not disturb further.
- The trial is repeated by increasing the frequency in steps 1 kHz up to a maximum of 10 kHz. In each case the output is noted and transfer gain is calculated using formula A_v.
- A graph is plotted transfer ratio v/s frequency.
- The experiment is repeated by taking different values of impedance.

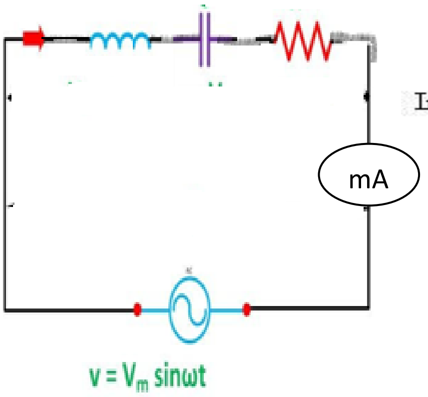
RESULT: The values of passive components are determined from the black box are

R=

L=

C=

CIRCUIT DIAGRAM:



EXPECTED GRAPH:

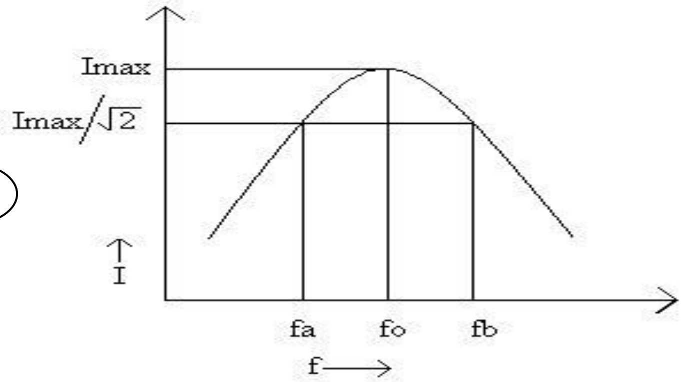


figure 2

TABULAR COLUMN:

Frequency f in H_z	Current I in (mA)

CALCULATIONS:

$$L = \frac{1}{4\pi^2 f^2 c}$$

EXPERIMENT NO: **06** DATE:

EXPERIMENT NAME: **LCR- SERIES RESONANCE**

AIM: To study the frequency response of series resonance of LCR circuit.

APPARATUS: Inductance coil, decode capacitance box, resistance box, audio oscillation AC ammeter etc.

PRINCIPLE: Electrical resonance occurs when the frequency of the input is equal to the natural frequency of the circuit. Then the emf and current are in phase and the impedance of the circuit is minimum.

With the increase in the frequency, inductance reactance (X_L) increases and capacitance reactance decreases. At resonance $X_L=X_C$ output voltage and current are in phase. Hence impedance of the circuit is maximum .

FORMULA:

1. Self inductance of the given inductor:

$$\boxed{L=\frac{1}{4\pi^2 {f_0}^2 C}}$$

Where

f_0=resonant frequency (in H_z)
C=capacitance of the capacitor (in farady)

2. $\boxed{\text{Band width}=f_a \sim f_b}$

Where f_a and f_b are half power frequencies (in H_z)

3. Quality factor:

$$\boxed{Q=\frac{Resonant\ frequency}{Band\ width}=\frac{f_0}{f_a \sim f_b}}$$

PROCEDURE:

- The circuit connections are made as shown in the figure.
- The resistance is unplugged in the resistance box and capacitance is set in the standard decade capacitance box.

- The frequency of the electrical oscillator is varied in suitable steps and the corresponding currents are noted.
- As the frequency increases the current reaches to maximum value and start decreasing.
- A graph is plotted taking frequency on x-axis and current on y-axis.
- The resonance frequency (f_0) and the maximum value of current (I_0) are noted from the graph. The self inductance of the inductor is calculated.
- A horizontal line is drawn at the value of $I = \frac{I_0}{\sqrt{2}}$.
- The line cuts the curve at two different frequencies (f_a) and (f_b). These are called half power frequencies. The band width and quality factor of the circuit is calculated.
- The experimental results are noted down.

RESULT: The frequency response of a LCR series resonance circuit is studied.

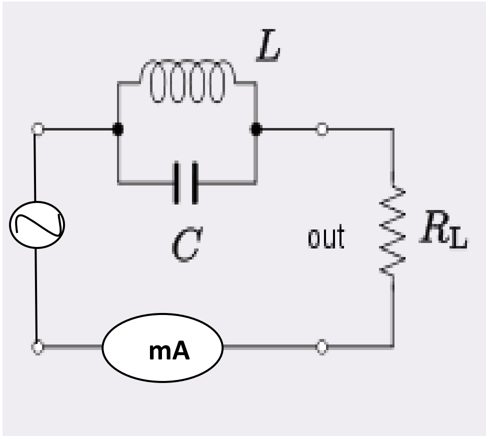
C=

L=

B.W=

Q=

CIRCUIT DIAGRAM:



EXPECTED GRAPH:

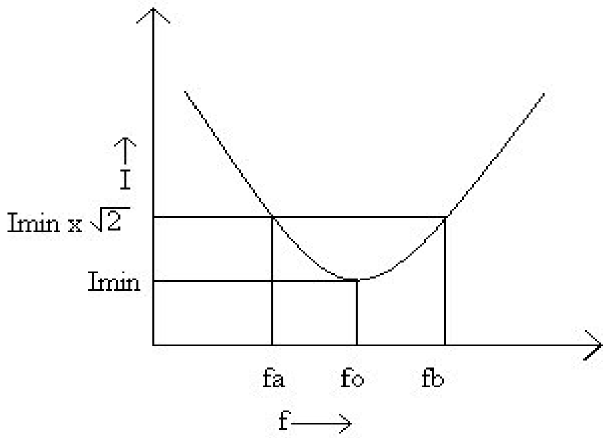


figure 4

TABULAR COLUMN:

Frequency in (H_z)	Current in (mA)

CALCULATION:

$$L=\frac{1}{4\pi^2 {f_0}^2 c}$$

EXPERIMENT NO: **07** DATE:

EXPERIMENT NAME: **LCR-PARALLEL RESONANCE**

AIM: To study the frequency response of a parallel resonance LCR circuit.

APPARATUS: Inductance coil, decode capacitance box, resistance box, audio oscillation AC ammeter etc.

PRICIPLE: Electrical resonance occurs when the frequency of the input is equal to the natural frequency of the circuit. Then the emf and current are in phase and the impedance of the circuit is maximum.

With the increase in the frequency, inductance reactance (X_L) decreases and the capacitive reactance (X_C) increase. At resonance X_L=X_C. No current will flow in the circuit. The impedance of the parallel LCR circuit is infinite at resonant frequency.

FORMULA:

1. Self inductance of the given inductor:

$$\boxed{L=\frac{1}{4\pi^2 {f_0}^2 C}}$$

Where

f_0=resonant frequency (in H_z)
C=capacitance of the capacitor (in farady)

2. $\boxed{\text{Band width}=f_a \sim f_b}$

Where f_a and f_b are half power frequencies (in H_z)

3. Quality factor:

$$\boxed{Q = \frac{Resonant\ frequency}{Band\ width} = \frac{f_0}{f_a \sim f_b}}$$

PROCEDURE:

- The circuit connections are made as shown in the figure.
- The resistance is unplugged in the resistance box and capacitance is set in the standard decade capacitance box.

- The frequency of the electrical oscillator is varied in suitable steps and the corresponding currents are noted.
- As the frequency increases, the current deceases and reaches to maximum value and start increasing.
- A graph is plotted taking frequency on x-axis and current on y-axis.
- The resonance frequency (f_0) and the minimum value of current (I_0) are noted from the graph. The self inductance of the inductor is calculated.
- A horizontal line is drawn at the value of $I = I_0\sqrt{2}$
- The line cuts the curve at two different frequencies (f_a) and (f_b). These are called half power frequencies. The band width and quality factor of the circuit is calculated.
- The experimental results are noted down.

RESULT: The frequency response of a LCR series resonance circuit is studied.

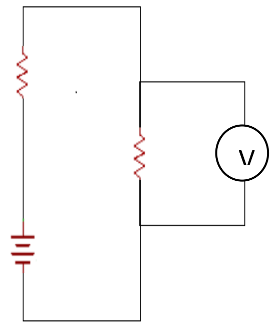
C=

L=

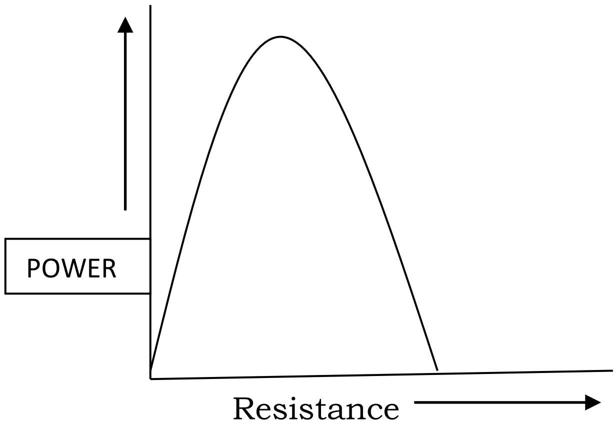
B.W=

Q=

DIAGRAM:



EXPECTED GRAPH:



TABULAR COLUMN:

For R_i=50Ω

Trial no.	Resistance R_L In (Ω)	Voltage across R_L In (volts)	$P=\frac{V^2}{R_L}$ In (w)
01	10		
02	20		
03	30		
04	40		
05	50		
06	60		
07	70		
08	80		
09	90		
10	100		
11	110		
12	120		

For R_i=100Ω

Trial no.	Resistance R_L In (Ω)	Voltage across R_L In (volts)	$P=\frac{V^2}{R_L}$ In (w)
01	10		
02	20		
03	30		
04	40		
05	50		
06	60		
07	70		
08	80		
09	90		
10	100		
11	110		
12	120		

CALCULATIONS:

EXPERIMENT NO: **08** DATE:

EXPERIMENT NAME: **MAXIMUM POWER TRANSFER THEOREM**

AIM: TO VERIFY THE MAXIMUM POWER TRANSFER THEOREM.

APPARATUS: Two resistance boxes, power supply, digital DC voltmeter.

PRINCIPLE: Maximum power transfer theorem states that maximum power will be delivered to the load. When the load resistance becomes equal to the internal resistance of the source delivering the power .

FORMULA: The power delivered to the load is given by

$$\boxed{P=\frac{V^2}{R_L}} \quad W$$

Where V= voltage across the load

R= load resistance (Ω)

PROCEDURE:

- Circuit connections are made as shown in the figure.
- A resistance of R_i is unplugged in the resistance and kept constant throughout the experiment. The load resistance R_L is unplugged (in steps of 10Ω) and voltage across the load resistance V_L is recorded.
- Power delivered to the load in each case is calculated using the formula.
- Graph is plotted by taking load resistance on x-axis and power on y-axis. From the obtained graph $R_i = R_L$ corresponding to maximum power is determined.
- The experiment is repeated for different value of R_i, and values are tabulated.

RESULT:

The maximum power transfer theorem is verified.
i.e $R_i=R_L$

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LABORATORY MANUAL

B.Sc. PHYSICS

For IV – SEMESTER

Paper - 402

PREPARED BY TEAM OF PHYSICS DEPARTMENT

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CONTENTS

Experiment : 01

DETERMINATION OF THICKNESS OF A THIN WIRE USING AIR WEDGE METHOD

Aim: To determine the thickness of a thin wire using air wedge method

Apparatus required: Two optically plane rectangular glass plates, thin wire, travelling microscope, reading lens, sodium vapour lamp, condensing lens with stand, wooden box with glass plate inclined at 45^0 .

Formula: 1.$\boldsymbol{The\ thickness\ of\ the\ wire,\ t = l\lambda/\ 2\beta\ m}$

2.$\boldsymbol{Wedge\ angle, \theta = t/\ l\ radians}$

Where $\boldsymbol{\lambda}$ is the wavelength of sodium light in m

is the distance of the wire from the edge of contact in m

β is the width of one fringe in m

Procedure :

The experimental arrangement and ray diagram are shown in Fig. 1. Two optically plane glass

plates are placed one over other and tied together by means of a rubber band at one end.

A thin wire is inserted between the plates at the other end. Now 27 a wedge shaped air film is formed between the two glass plates.

The slide system is kept on the platform of a travelling microscope. The light from a sodium

vapour lamp is rendered parallel with a condensing lens and is made to incident on a plane

glass sheet held over the wedge at an angle of 45o with the vertical. The light falling on the

sheet is partially reflected which is in turn incident normally on the air wedge.

Adjusting the arrangement properly, the microscope field of view is made bright to the maximum

extent. The microscope is moved vertically up and down till parallel fringes are visible which are

located on the surface of the air film (Fig.2). By moving the microscope in a horizontal direction,

the cross-wires of the microscope are set on one of the dark (nth) fringes in the pattern. Its position is noted down in the horizontal scale.

The microscope is moved further using the tangential screw along the length of the air film

counting the number of dark fringes. After counting 2 dark fringes, the cross wire is coincided

with the (n+2)nd fringe and its position is noted. The measurements are repeated similarly for

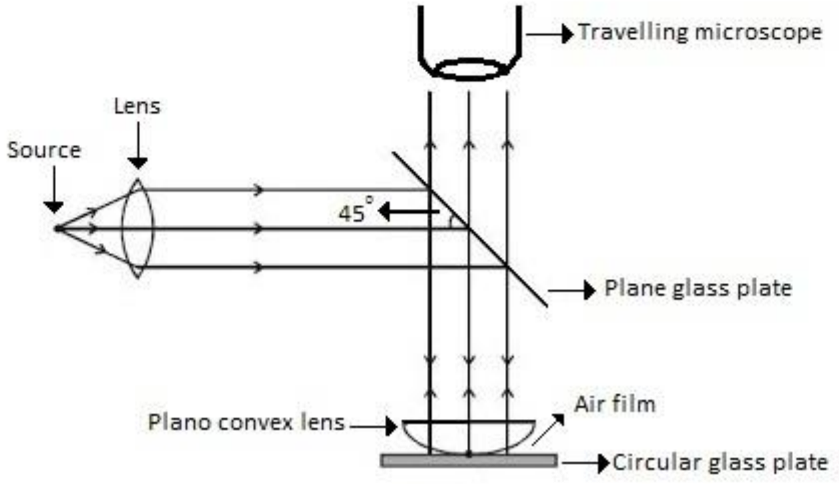
every alternate dark fringe and are noted. The width of 10 dark fringes is calculated from the

table and the mean width of 10 fringes is averaged out. is calculated. The length of the air film

is measured as theβFrom this, the fringe width distance between the line of contact and the

inner edge of the wire. The measurement can be done using the travelling microscope or withthe calibrated scale.

Diagram :



Observation :

Valuof of 1 MSD on the T.M = S=1/20 cm

Total no. Of divisions on the vernier scale =N= 50

Least count of the T.M scale : $LC=S/N=\frac{1/20}{50}$

$= 0.001$ km

TR = MSR + [CVDXLC]

Wave length of the monochromatic light used = λ = 589.3 X 10^{-9} m

Tabular column :

Order of fringe	TM reading X_1(cm)	Order of fringe	TM reading X_2(cm)	Width of 25 Fringes (X_1 - X_2) cm	Width of 1 Fringe β (cm)
n		n + 25			
n + 5		n + 30			
n + 10		n + 35			
n + 15		n + 40			
n + 20		n + 45			

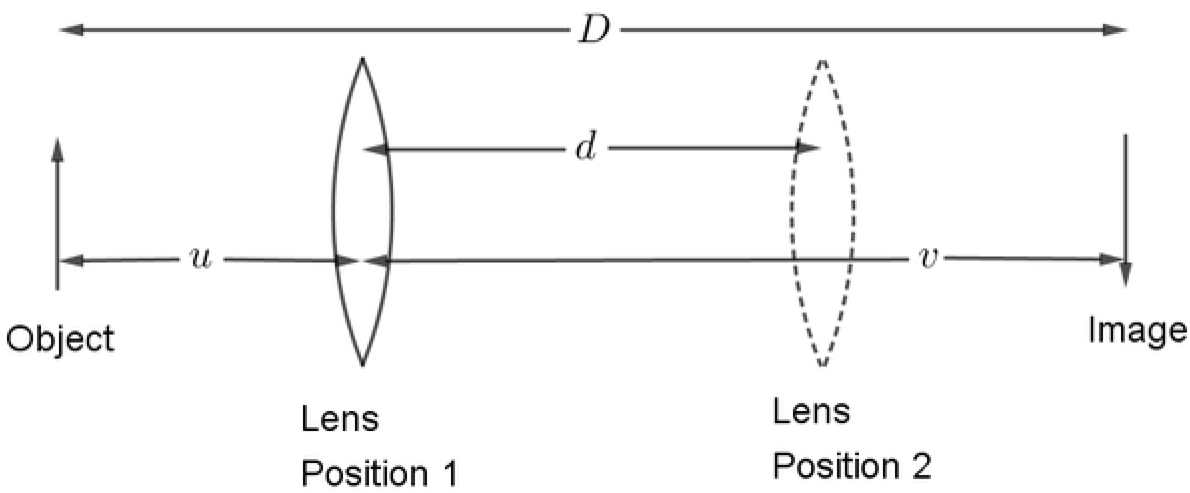
Mean Width of 1 Fringe β (cm)= ___________m

Length of the air wedge (L) =______________m

Experiment : 02

FOCAL LENGTH BY COMBINATION OF TWO LENSES SEPERATED BY A DISTANCE

DIAGRAM:



OBSERVATION:

1) Magnification method :

Distance between two covex lens d=___ cm

Size of the object =____cm

Tabular column 1:

Trial no	Distance between object & screen 'D' in cm	Size of image in cm	Magnification m= Size of image / Size of object	Focal length $F = \frac{Dm}{(m+1)^2}$ in cm
1				
2				
3				
4				
5				

Mean= cm

= m

2) Shift Method : To find focal length (f_1):

Tabular column 2:

z

Trial no	Distance between object & screen 'D' in cm	Shift S in cm			Focal length $f1 = \frac{D^2-S^2}{4D}$
		S1	S2	S = S1- S2	
1					
2					
3					
4					
5					

Mean= cm

= m

Tabular column 3: **To find focal length (f_2):**

Trial no	Distance between object & screen 'D' in cm	Shift S in cm			Focal length $f1 = \frac{D^2-S^2}{4D}$
		S1	S2	S = S1- S2	
1					
2					
3					
4					
5					

Mean= cm

= m

Aim: To determine the focal length of the combination of two convex lenses separated by a distance

Using 1) Magnification method. 2) Shift method 3) Newtons formula method

Apparatus : two convex lenses , object (cross wire), transluscent meter scale , screen plane mirror, illuminated source etc...

Principle : when two thin convex lenses of focal lengths f1 & f2 seperated by a distance the combination behaves as converging lens the magnification varies with the distance D between the object & the screen & by measuring m for various values of D, the focal length of the combination is determined

Formula:

1) Focal length $F = Dm/(m+1)^2$ in m
   Where F= focal length of the combination of two thin lenses in m
   D= distance between the object & the screen
   m=magnification

2) $1/F=1/f1+1/f2-d/f1f2=$ m

   Where f1 & f2 is the focal length of the individual thin convex lenses & d is the distance of separation between the lenses

Procedure:

A transluscent meter scale is held vertically using a retard scale & illuminated by an electric bulb.The system of two convex lenses mounted on lense holders & separated by a short distance d (5 cm)is placed in front of the scale at a suitable distance, the screen is placed on the other side & its position is adjusted till a clear image of the object is obtainedon on it.

The distance between the scale (object) & the screen (image) gives D, the magnification m is determined by measuring the length of the image corresponding to 1 cm on the scale.

Magnification m= size of the image & size of the object.The experiment is repeated by changing D values & measuring m in each case.The focal length of the combination of lenses is caluculated using the formula.

Shift Method : Verification to find focal length f1 & f2 : The distance D between the object & the screen is adjusted to be greather than 4f where f is the focal length of the convex lense . The lense introduced between the object and the screen and its position is adjusted till a sharp and magnified image of the object is formed on the screen ,the position (S1) of the lense is marked on the table.The distance of lense is now marked towards the screen so that a sharp diminished image is formed on the screen . The position (S2) of the lens is marked on the table.The distance S (Shift) between the two positions of the lens is measured. The focal length of the lens is measured , the focal length of the lens is given by

$$f1=D^2 - S^2/4D$$

The experiment is repeated for another convex lens of focal length f2 knowing the values of f1 , f2 & d the focal length of the combination F is caluculated . This value is compared with that obtained by the magnification method.

Result:

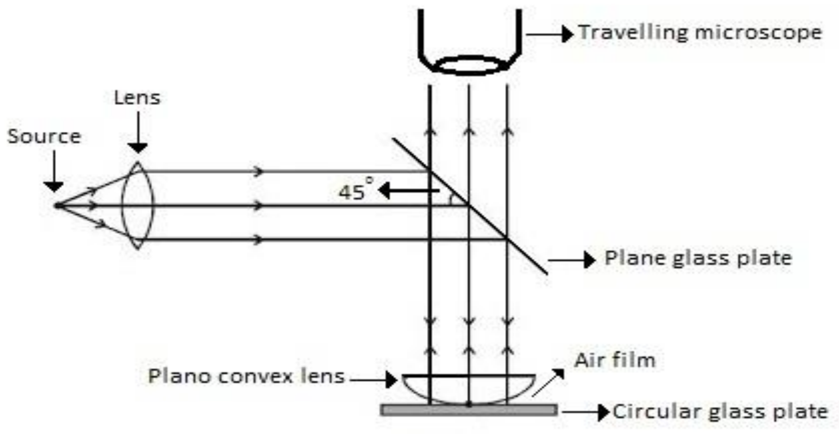
The focal length of the combination of two convex lenses

1. By magnification method F= _____m
2. By using the formula F = ________ m
3. Mean focal length f1=_______m
4. Mean focal length f2=________m

Experiment : 03

NEWTON'S RINGS

Diagram:



Observation :

Value of 1 main scale division on the T.M = S= 1/20 cm

Total number of divisions on the vernier scale = N = 50

L.C. of the T.M.scale : Lc=S/N=0.001 cm

TR=MSR+CVDXLC

Wave length of the monochromatic light used is $\lambda=589.3X10^{-9}$m

Tabular column

Ring no.	TM reading (D_m)			D^2m Cm^2		TM reading (D_n)			D^2n Cm^2	D^2m-D^2n Cm^2
	Left X1 (cm)	Right X2 (cm)	D_m=x1-x2 (cm)			Left X1 (cm)	Right X2 (cm)	D_n=x1-x2 (cm)		

Mean D^2m-D^2n=_______m^2

Radius of curvature of the surface of the convex lens:

R= $D^2m-D^2n/4\ \lambda(m-n)$ m

Aim : To determine the radius of curvature of the convex surface of the given convex lens

Apparatus : Newtons rings apparatus ,sodium vapour lamp, bridge type travelling Microscope , reading lens, etc.....

Principle :

when convex surface of a lens is in contact with a plane glass plate ,thin circular air film is formed between the two surfaces.When this film is illuminated by a monochromatic light & viewed in reflected light , alternate dark & bright circular rings called Newtons rings are formed due to interference, concentric rings formed around the point of contact, as the locus of points having the same thickness of air is a circle.

Formula : Radius of curvature of the surface of the convex lens:

$$R = D^2m - D^2n / 4\,\lambda(m-n) \quad m$$

D_m-D_n= diameter of the m^{th} & n^{th} dark rings respectively

λ= Wave length of the monochromatic light

Procedure :

The given convex lens (L) is kept with its convex lens surface on a plane glass plate plate (G) below the travelling microscope (T.M)

A parallel beam of monochromatic light is made to fall on the lens L with the help of another glass plate P inclined at an angle of 45^0 to the incident beam.The microscope is focused so that the Newton's rings are seen clearly.

The ring system is adjusted to make the horizontal cross wire of the T.M a common diameter for all the rings ,with the centre of the pattern being dark.

The vertical cross wire is shifted in steps of ringes from left to right and the readings of the microscope are noted.

The diameter of the rings (D) is caluculated

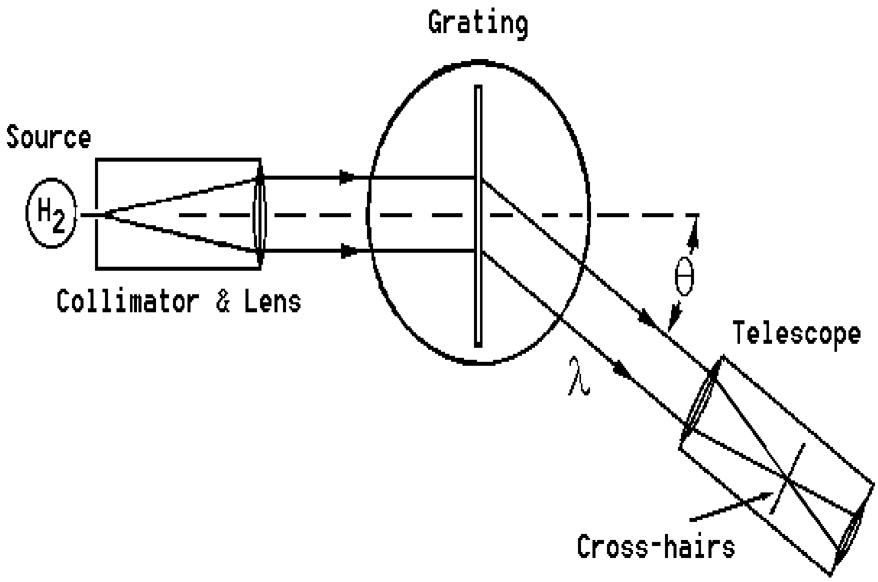
Assuming **λ** the radius of curvature of the given lens surface is caluculated

Result : The radius of curvature of the convex surface of the given lens is____**m**

Experiment : 04

DIFFRACTION GRATING

Diagram:



No. Of lines on the grating = 15000 lines per inch

= $15000/2.54X10^{-2}$ per meter

Grating constant :

[Distance b/w any two consecutive lines on the grating]

C= $2.54X10^{-2}/15000$ m

C =_______________m

Least count of the spectrometer scale :

Value of 1 MSD = S= $½^0$ =30 minutes

Total number of divisions on the vernier scale =N= 30

Least count of spectrometer microscope = S/N= 30/30min=1 min

Tabular column:

Spectral line	R	$D=R-R_0$	$\lambda = \frac{2c\sin(D/2)}{n}$ (m)
Blue			
Green			
Yellow-1			
Yellow-2			

Direct Reading : $R_0 = 145^0 + (5X1')$

$R_0 = 145^0\,5'$

Aim: To determine the wavelength of the mercury spectral lines using a diffraction Grating adjusted for minimam deviation

Apparatus : Spectrometer, diffraction grating , mercury lamp etc….

Principle: When a parallel beam of white light is incident normally on a grating , Fraunhoffer diffraction takes place and the spectra of different orders Are observed symmetrically on either side of the minimam deviation for Different specral lines can be measured.

Formula : Wave length of the spectral line $\lambda = 2c \sin(D/2)/n$ (m)

Where n= order of the spectrum

D = angle of minimam deviation of the spectral lines

C= grating constant

Procedure :

1. The preliminary adjustments of the spectrometer are made by
   - Focusing the telescope on a distant object
   - Focusing the collimator until clear image of the slit is seen in telescope
   - Levelling the prism table with the help of a spirit level
2. The grating is mounted on the prism table so that the light coming falls normally on the grating .The first order spectrum is observed through the telescope
3. Connecting the yellow 1 line the prism table is rotated so that the lines moves towards the position of the direct reading [angle of diffraction decreases].The rotation is continued till the line goes to an extreme position and turns black gives minimam deviation position
4. The vertical cross wire is made to coincide with the line and the reading are taken in the minimam deviation position for other spectral lines on the same vernier.
5. Grating is removed and the telescope is now brought in alignment with the collimator .Direct reading corresponding the slit (R_0) is taken on the same vernier.
6. For each colour the difference between the minimam deviation reading and the direct reading gives angle of minimam deviation (D)for the spectral line .
7. Knowing the value the grating constant C wavelength (λ) of the spectral lines are caluculated

Result:

The wavelength of the various spectral lines of the mercury spectrum are found to be as follows:

Spectral line	Standard values	Detrmined value
Blue	4358.8 nm	
Green	546.1 nm	
Yellow 1	577.0 nm	
Yellow 2	579.0 nm	

Experiment : 05

REFRACTIVE INDEX OF A LIQUID BY PARALLAX METHOD

Diagram :

1. **Focal length of the covex lens (f):**

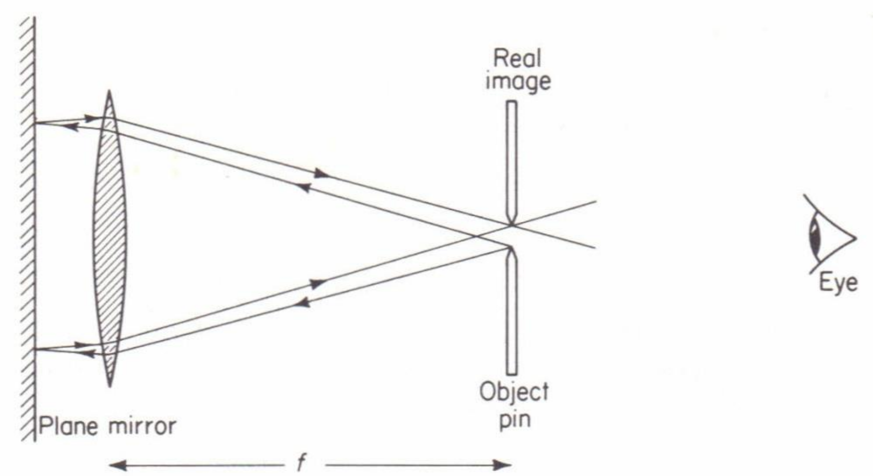
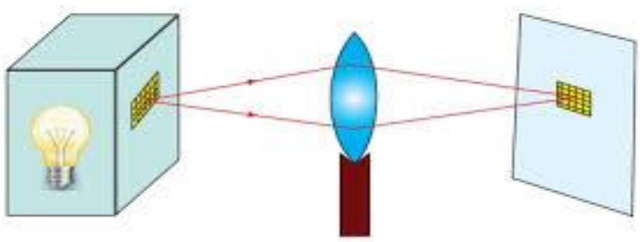


Fig. 24.13. Focal length of a converging lens by pin method

2. **Focal length of the covex lens (f) by u-v method**



3.Focal length of the combination of covex lens and liquid lens (F) [by parallax method]:

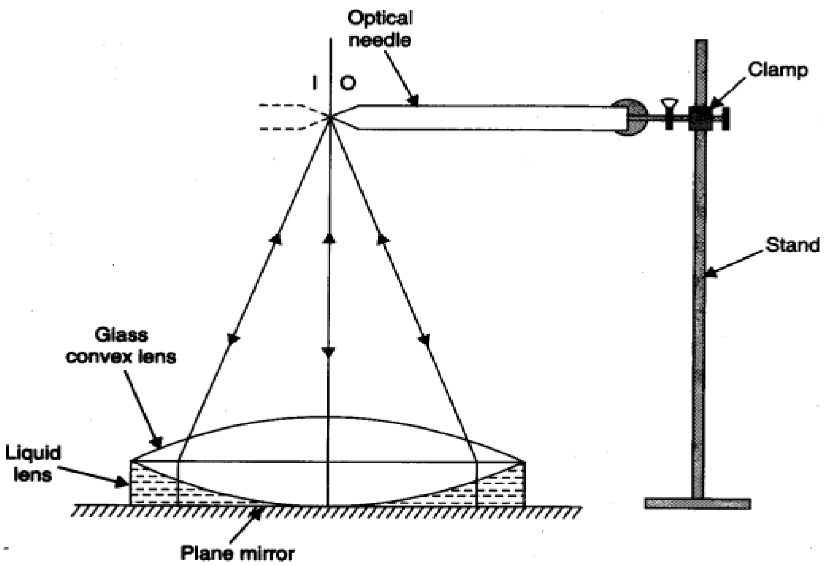


Fig. Focal length of glass convex lens and liquid lens combination.

4. Boy's method :

Determine the distance between the object & convex lens x =____m

5.Refractive index of the liquid:

$$\mathbf{n = 1 + r/f_L}$$

$$\mathbf{r = fx/f - x}$$

Aim : To determine the refractive index of the liquid water by parallax method

Apparatus : Plane mirror , a pin held in a stand , water, convex lens , scale , Illuminated cross wire screen , white paper screen , etc.....

Principle : When a parallel beam of light is incident on a converging lens, the rays Are brought to focus at its focal point .Conversily a point object kept at the focus would have the refracted rays parallel to one another .An object kept at the principle focus of a converging lens which is kept in contact with a plane mirror would form its image at the same point,as the rays would be incident normally on the mirror

Formula :

1. Focal length of the liquid (water) lens :

   $f_L = Ff/F\text{-}f$

   where , f= focal length of the convex lens (m)

   F = focal length of the combination of water lens & convex lens (m)

Tabular column :

Trial no.	u (m)	v (m)	f = uv/u+v (m)
1.			
2.			
3.			
4.			
5.			

Mean f = ______m

2.Radius of cuvature of the surface of lens in contact with the liquid [Boy's formula] :

$r = fx/f\text{-}x$

where x = distance of the lens from the object where image is formed by its side (m)

3.The refractive index of the liquid :

$$n = 1 + r/f_L$$

Procedure :

1. **To find focal length of convex lens by parallax method:**

   A plane mirror is kept horizontally on a base. A convex lens is placed on the mirror.A needle fixed to a stand horizontally is placed along the axis of the lens.

   The position of the needle is adjusted until the virtual image coincides with the needle without parallax.

   The height of the needle above the lens is measured to give the focal length Of the convex lens (f)

2. The focal length of the convex lens thus obtained (f) can be verified by u-v method

3. **To find focal length of the plano- concave lens:**

   The plane mirror is kept horizontally on the base once again . A few drops Of water is placed on the mirror and the concave water lens is formed

   The needle is placed over the lens as before .The position of the needle is adjusted until the virtual image coincides with the needle without parallax. The height of the needle from the mirror gives the focal length of the combination (F).

   Focal length of the liquid lens (f_L) is caluculated using the formula (1)

4. **To find radius of curvature of the curved surface of the lens in contact with liquid [Boy's method]**

   The given convex lens is mounted on a lens stand .It is kept in front of an illuminated object with the surface of the lens in contact with liquid facing the object.

   The position of the lens is mounted so that its image is formed by side of the object.

   The distance [x] between the lens and the object is measured . The radius of curvature with water (r) is caluculated using the formula (2)

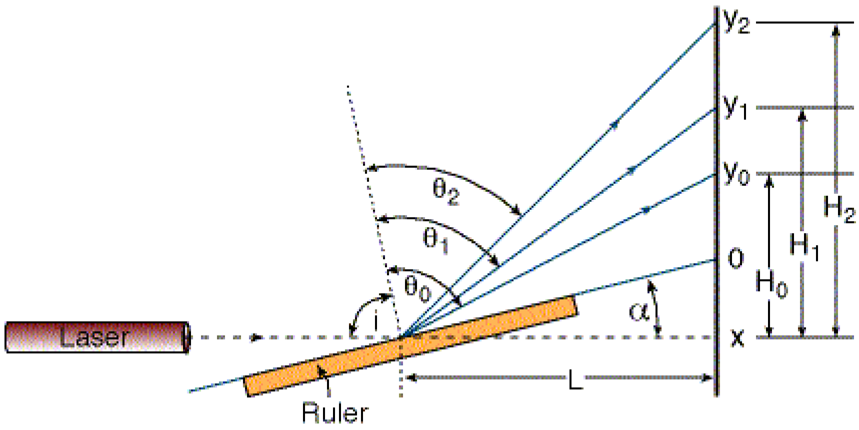
5. **Refractive index of liquid (n) is caluculated using the formula (3)**

Result: The refractive index of the given liquid is ....

Experiment : 06

TO DETERMINE THE WAVELENGTH OF LASER LIGHT BY STUDYING THE DIFFRACTION PATTERN USING THE METAL SCALE

Diagram :



Tabular column :

Diffraction spot no.	y_m	y^2m	$y^2m-y^2_0$	$y^2m-y^2_0/2$
0				
1				
2				
3				
4				
5				

Mean $y^2m-y^2_0/2$ = ____________ m^2

Distance between the point of incidence of light on the metal scale to the

Screen (D) =_____m

y_0 = position of the zeroth [central principal maximum] diffracted spot]

y_m = position of the m^{th} diffracted spot

Aim : To determine the wavelength of laser light by studying the diffraction pattern

Apparatus : Laser source , metal vernier scale , meter scale , etc.....

Principle : Diffraction of light occurs when the width of the obstacle is comparable to The wavelength of the source. The light from a laser source is allowed to Fall on a metal vernier at a suitable angle [grazing incidence] and measuring the distance between the diffracted spots the wavelength of laser light is determined .

Formula : Wavelength of the monochromatic light $\lambda = \frac{1}{2}\, d/D^2\, (y^2m - y^2{}_0)/2$ m

Where d= value of 1 scale division on the metal scale [in meter]

D= distance between the point of incidence of light on the metal Scale to the screen

Procedure :

A metal rulers is placed on a table and the laser beam is aligned such that the laser

Beam is incident at a suitable angle on the metal ruler , as shown in the figure.

A screen is placed at a distance D to observe the diffraction pattern . The laser beam can be gently aligned to get a well resolved diffraction pattern, further , the principal maxima should be obtained symmetrically on either side of the central maximam.

The position of the diffraction spots on the screen are marked as y_0, y_1, y_2,............... y_m

The scale is removed and the position of the direct beam is marked on screen. The direct beam is marked on screen . The distance of the various diffracted spots are measured from the position of the directed beam.

The values of $y_m = y_1 - y_0,\ y_2 - y_0$.............are caluculated .

λ is caluculated using the formula.

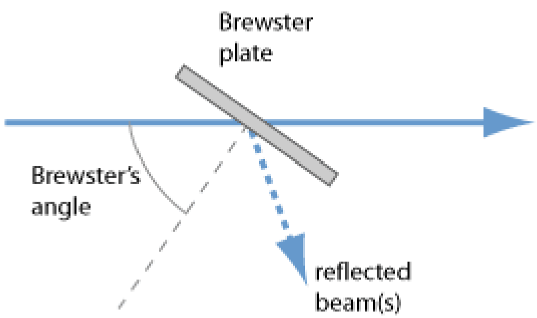
Result:

The wavelength of the laser light is ....nm

Experiment : 07

BREWSTER'S LAW

Diagram:



Least count of spectrometer scale :

Value of 1 MSD = S= 0.05 cm

Total number of divisions on the vernier scale = N= 50

LC of the travelling microscope = S/N=0.001 cm

TR=MSR+(CVDXLC)

Tabular column :

Trial no.	Telescope reading		$\theta_B = \frac{180^0 - (R - R_0)}{2}$	$n = \tan\theta_B$
	Reflected slit (R)	Direct slit (R_0)		
01				
02				

Mean n =

Aim : To determine the Brewster's angle and hence the refractive index of the Transparent material

Apparatus : spectrometer , glass (or glass prism), sodium lamp etc...

Principle : If a beam of natural light is incident at an angle θ on a transparent Material , the reflected light is partially plane polarized . this angle of Incidence , the reflected light is completely plane polarized .This angle Of incidence is called the polarizing angle or Brewster's angle (θ_n), by Brewster's law $n = \tan\theta_n$

Formula :

1. **Brewster angle is given by**

$$\theta_B = \frac{180^0 - (R - R_0)}{2}$$

Where R= reading of the spectrometer with the medium when the Reflected image of slit just vanishes

R_0 = reading of the spectrometer with the direct image of The slit.

2. **Refractive index: $n = \tan\theta_B$**

Procedure :

1. The preliminary adjustments of the spectrometer are made
2. The polarizer is fixed to the telescope .The given glass plate (or glass prism)is placed on the prism table so that light from the collimator is incident on the glass plate (or one of the refracting surfaces of the prism). The telescope is rotated to receive the reflected light . The slit is obtained at the intersection of the cross wire.
3. The polarizer is now rotated so that intensity of light becomes minimam.
4. The prism table and the telescope are gradually rotated [with the slit always at the cross wire] so that light gradually is extinguished .The reading R of the telescope is noted.

5. The glass plate(or the prism) is removed The telescope is rotated to get the Direct image of the slit , when the slit is at the intersection of the cross wire, the reading R_0 of the telescope is noted .

6. The Brewster's angle θ_B is caluculated using the formula

7. The experiment is repeated to get the reflected image on the other side of the collimator axis.Mean refractive index is caluculated.

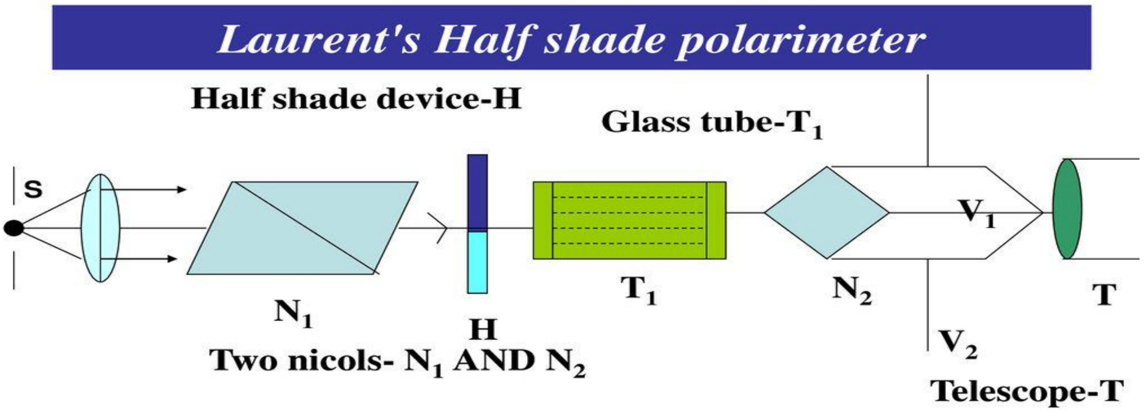
Result:

Refractive index of the material of the given glass n =

Experiment : 08

POLARIMETER – DETERMINATION OF SPECIFIC ROTATION OF A SOLUTION

DIAGRAM :



Nicol N_2 can be rotated and its position can be noted on a circular scale with verniers V_1 and V_2

Monochromatic light after passing through N_1 become plane polarized with its vibrations in principal plane of nicol.

Observation : Length of the polarimeter tube (l) =_________m

Least count of the polarimeter scale (LC)= $\dfrac{\text{value of one main scale division}}{\text{Total number of vernier scale division}}$

= 1/10 = 0.1 m

TR= MSR +(CVDXLC)

Reading of the polarimeter with distilled water (R_0)=

Tabular column :

Trial no.	C (kg m^{-3})	R	$\theta = R_0 - R$ (degree)	θ (radian)	$S = \theta / lc$ (radian $kg^{1}m^{2}$)
1					
2					
3					

Mean S =__radian $kg^{1}m^{2}$

Aim : To determine specific rotation of sugar solution using a polarimeter

Apparatus : polarimeter, sodium vapour lamp, sugar , distilled water , balance etc..

Priciple : Sugar solution being optically active rotates the plane of vibration of Polarized light . The angle of rotation θ is directly proportional to the Length (l) and concentration (c) of the solution .For a given wavelength at a particular temperature specific rotation 'S' of the solution of numerically equal to the amount of rotation produced by unit length and unit concentration of the solution.

Formula : S= θ / lc radian kg^1m^2

S = specific rotation of the sugar solution

θ = angle of rotation of the plane of vibration (radian)

l = length of the sugar solution

c = concentration of the sugar solution (kg m^{-3})

Procedure:

1. The length of the polarimeter tube (l) is measured using a meter scale.
2. Polarimeter tube is filled with distilled water. Analyzer is rotated till the two Halves of the field of view being of uniform intensity of same colour is obtained .The reading R_0 of the analyzer is noted .
3. Sugar solution of known concentration (C) is prepared and the solution is Filtered (ex: 1000 kg m^{-3} concentration sugar solution is made by dissolving 10 gm of sugar in 100 cc of distilled water)
4. Polarimeter tube is filled with sugar solution the analyzer is rotated till the Two halves of the field of view being of uniform intensity of same colour Is rotated once again .The reading R of the analyzer is noted
5. The angle of rotation of plane of polarization [$\theta = R_0 - R$] is caluculated .
6. Specific rotation (S) of the sugar solution is caluculated using the formula.
7. The experiment is repeated for different concentration of sugar solution the mean value of S is caluculated.

Result :

Specific rotation of sugar solution is found to be_______radian kg^1m^2

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LABORATORY MANUAL

B.Sc. PHYSICS

For V – SEMESTER

Paper -502

PREPARED BY TEAM OF PHYSICS DEPARTMENT

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CONTENTS

EXPERIMENT – 01

ZENER DIODE AS VOLTAGE REGULATOR

Aim: To study the voltage regulation for different input voltage and for different loads.

Apparatus: Zener diode, resistance box, voltmeter, milliammeter, power supply.

Principle:

Circuit Diagram:

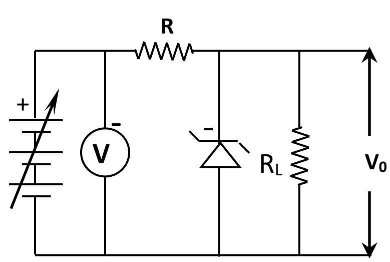


Fig1

Nature of Graph:

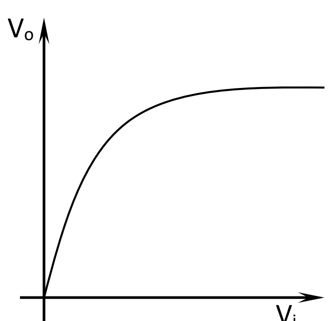


Fig2

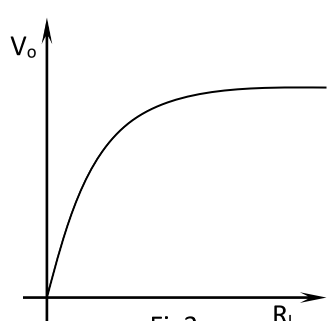


Fig3

Procedure:

Connections are made as shown in the Fig 1. Keeping load resistance R_L constant, input voltage V_i is increased from 0 to 15 volts in steps of 1volt and corresponding output voltage V_0 is noted. A graph of V_0 against V_i is plotted as shown in the Fig2.Keeping input voltage V_i constant (higher than breakdown voltage V_Z of zener diode), load resistance R_L is varied and output voltage V_0 is noted. A graph of V_0 against R_L is plotted as shown in the fig3.

Observations:

(i) R_L = 3000 Ω:

Vi (V)	V_0 (V)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	

(ii) **Vi = ----------- V**

R_L (Ω)	**V_0 (V)**
10	
50	
100	
200	
300	
400	
500	
600	
700	
800	
900	
1000	

Result: Graphs 1 and 2 show voltage regulation for varying input voltage and load resistance.

EXPERIMENT – 02

SCHERRER'S FORMULA

Aim: Determination of Particle Size using Scherer's formula.

Apparatus: Scherer formula data sheet,

Principle: The Scherer equation , in X-ray diffraction and crystallography, is a formula that relates the size of sub-micrometer particles, or crystallites , in a solid to the broadening of a peak in a diffraction pattern . X- ray diffraction in nano crystalline bulk materials.

The Scherer equation can be written as : $\delta = K\lambda / \beta \cos\theta$

δ is the mean size or particle size of the ordered crystalline sample.

K is the dimensionless shape factor, with a value close to unity. The shape factor has a typical value of about 0.9

λ is the X-ray wavelength for cu K α radiation = 0.154 nm.

β is the full width at half the maximum intensity (FWHM) , in radians.

θ is the Bragg angle .

Procedure:

1. Tabulate the 2θ values and intensity for the given sample.
2. Plot a graph by taking 2θ along X-axis and intensity along y-axes .
3. Identify the standard peak
4. Measure the peak value of intensity
5. Caluculate the full width at half the maximum intensity (FWHM), in radians.
6. Corresponding Bragg angle is noted.
7. Caluculate the particle size using the scherer's formula.

Result: particle size of the crystallite is ……………nm

Scherer formula data sheet

2θ	Intensity
15.0	626
15.1	595
15.2	553
15.3	588
15.4	536
15.5	590
15.6	585
15.7	583
15.8	526
15.9	553
16.0	615
16.1	593
16.2	666
16.3	703
16.4	763
16.5	741
16.6	825
16.7	895
16.8	950
16.9	1015
17.0	1151
17.1	1056
17.2	978
17.3	940
17.4	848
17.5	830
17.6	768
17.7	695
17.8	658
17.9	598
18.0	616
18.1	601
18.2	590
18.3	530
18.4	525

Given: K = Shape factor = 0.9

λ = X-ray Wavelength (1.54 A^{o})

EXPERIMENT NO: 03
CHARACTERISTICS OF A SELENIUM PHOTOCELL

AIM: Verification of inverse square law of light using selenium photo cell.

APPARATUS: selenium photocell mounted in the box and connections brought out at sockets, lamp holder with bulb, one analog galvanometer (30-30)

PRINCIPLE: Photo-conductive cell is also based on the principle of inner photoelectric effect. It consists of a thin film of semi-conductor like Selenium or thallus sulphide place below a thin film of semi-transparent metal. This combination is placed over the block of iron.

The Iron base and the transparent metal film is connected through battery and resistance. When light falls on the cells its resistance decreases and hence the current starts flowing in the external circuit.

If 'I' be luminous intensity of an electric lamp and 'E' be the illuminance at a point distance'd' from it. Then according to the inverse square law. $E=\frac{I}{d^2}$

If light from the lamp be incident on the photovoltaic cell placed at a distance 'd' from it. If q be the corresponding deflection shown by the microammeter , then qxd^2=constant.

PROCEDURE:

The experiment can be performed in the laboratory but it is always good to conduct in dark room. Where sun light falling on the photocell can be avoided. In the dark room mount the various parts of the apparatus on the optical bench. Provided with a ½ meter scale. Make the other connections As shown in the figure.

Light up the lamp and adjust it at a suitable distance from the photocell so that the galvanometer indicate a reasonable deflection.

Change the distance of the lamp from the voltaic cell and take a series of observations for the corresponding values of d & q.

RESULT: I/d^2 v/s θ gives straight line which verifies inverse square law of light.

OBSERVATIONS:

Sl no.	Position of the lamp	Deflection (θ)	Distance from photocell(d)	I (μA)	E=$\frac{I}{d^2}$
1					
2					
3					
4					
5					
6					

CALCULATIONS:

EXPERIMENT NO: 04

H- PARAMETER OF A TRANSISTOR

AIM: To determine the H-parameter of given npn transistors by drawing input and output characteristic in CE mode.

APPARATUS: 2v and 9v battery, BC107 [npn transistor], micro-ammeter, milliammeter, voltmeter etc.

PRINCIPLE: A Transistor is a current amplifying device. In a transistor the emitter base junction is reverse biased and this result in low input impedance at E-B junction and high output impedence at the common base junction. The emitter current equal to the sum of base current and collector current.

i,e $I_E=I_B+I_C$

FORMULA:

Input impedence : $\frac{\Delta V_{BE}}{\Delta I_B}$

Reverse voltage ratio: $\frac{\Delta V_{BE}}{\Delta V_{CE}}$

Output admittance: $\frac{\Delta I_C}{\Delta V_{CE}}$

PROCEDURE:

- A circuit for CE mode characteristics of a transistor is as shown in the figure.
- To draw a common emitter input characteristics keep V_{CE} =1V,V_{BE} the base emitter voltage is varied in small sets and in each case I_B be the base current is recorded.
- The experiment is recorded for V_{CE} = 4V.
- A graph is drawn by plotting I_B along y axis and V_{BE} along x axis for two values of V_{CE}.
- Using input characteristics R_{in} = h_{ie} is determined. By using slope for a particular input curve V_{CE}.

$1/\text{slope} = R_{in} = h_{ie} = \frac{\Delta V_{BE}}{\Delta I_B}$

- For a particular value of I_B using input characteristics h_{re} [reverse voltage ratio] is determined.

  $h_{re} = \frac{\Delta V_{BE}}{\Delta V_{CE}}$
- To draw input characteristics I_B = 10μA, V_{CE} is varied in steps of 0.5V and h_e corresponding I_C is recorded.
- Experiment is repeated for I_B = 20 μA , output characteristics are drawn by plotting I_C along y axis and V_{CE} along x axis.
- Using output characteristics h_{oe} is determined.

  $h_{oe} = \text{slope} = \frac{AB}{BC} = h_{oe} = \frac{\Delta I_C}{\Delta V_{CE}}$
- During output characteristics h_{oe} is determined for a particular value of V_{CE}. $h_{fe} = \frac{\Delta I_C}{\Delta I_B}$

RESULT:

H –Parameter of the given npn transistor determined.

Found to be

h_{ie}=

h_{rc}=

h_{oe}=

h_{fc}=

TABULAR COLUMN:

INPUT CHARACTERISTICS:

V_{CE}=1V		V_{CE}=4V	
V_{BE} (V)	I_B (µA)	V_{BE} (V)	I_B (µA)

OUTPUT CHARACTERISTICS:

I_B=10μA		I_B=20 μA	
V_{CE} (V)	I_B(mA)	V_{CE} (V)	I_B(mA)

CALCULATIONS:

Input characteristics

Slope=AB/BC

1/slope= R_{in} = h_{ie}= $\frac{\Delta V_{BE}}{\Delta I_B}$=

ΔV_{CE}=

ΔV_{CE}=

h_{re}=$\frac{\Delta V_{BE}}{\Delta V_{CE}}$

Output characteristics

slope=AB/BC

h_{oe}=

ΔI_C=

ΔI_B=

h_{fe}=$\frac{\Delta I_c}{\Delta I_B}$

EXPERIMENT NO: 05

THE GALTON BOARD EXPERIMENT

AIM: Verification of gauss distribution using Galton board.

APPARATUS: Galton board with parcal triangle and marbles.

PRINCIPLE: The Galton board[also known as a been machine or a quincusx] is a device invented by Franc's galton to demonstrated the central limit theorem(CLT) in statistics.

Galton board is an inclined board consisting of three sectors. The top section is meant for dropping the marbles of suitable size. The middle part of the board consists nails that are arranged in the form of parcal triangle.these nails are binomial coefficient and form lattices of walks of marbles falling from top to bottom in different columns .

The CLT explains the common appearance of the "bell curve" in density estimates applied to real world data. In general one can often regard a single measured value as the weighted average of a large number of small effects. Since the simulations are used in a nuclear physics, the fundamental aspect a particle distribution during interactions is similar to galton board distribution. this fundamental aspects of statistics is studied in physics .

We come across in our daily lives with many examples of normal (or) Gaussian distribution such as water droplets bursting out, of a hole in a leaking pipe, or a heap of sand that forms when sand is poured from a certain height which have normal distribution in three dimensions.

FORMULA :

Probability p= $\frac{no\ of\ balls\ collected\ in\ the\ nth\ column}{total\ number\ of\ balls\ used}$

PROCEDURE:

- The galton board is placed on the table. The different rows and columns from nails are determined.
- Balls are dropped by one by one from the dropping hole into the parcal triangle formed by nails are indentified; care is taken to see that balls hits the first nail.

- The ball the first nail, moves either to left or right and bounces on to nails of n=1 row. This action is verified the ball travels through all the rows and is finally collected by the bins under each column.
- Sufficient numbers of balls are dropped until anyone of the collecting bins appeared to be full with balls, at this point further dropping of balls is halved and balls collected in each bin are counted and noted.
- The experiment is repeated 10 to 15 times in each case the balls collecting after each round of dropping are collected and noted.
- Experimental value of probability is calculated by knowing the total number balls used in the experiment.

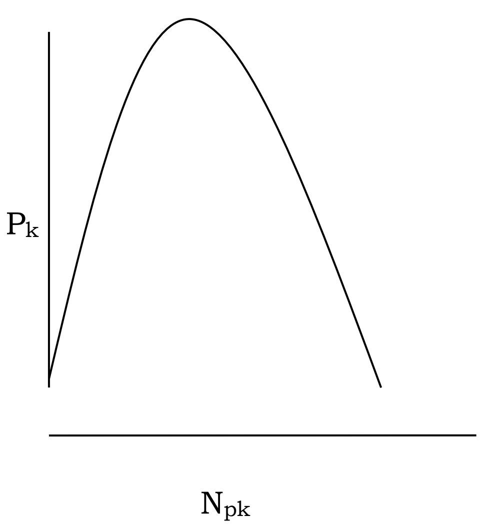
Probability p= $\frac{no\ of\ balls\ collected\ in\ the\ nth\ column}{total\ number\ of\ balls\ used}$

- A graph is drawn by taking number of columns(k) on the x axis and probability of balls collected in different bins on the y axis.
- The resulting graph is bell shaped curve. The area under the experimental value is determined by counting the squares.

RESULT:

Area under the probability curve =

EXPECTED GRAPH:



OBSERVATIONS:

Trial No.	Balls collected Number of the collecting bin or column(k)															Tota l
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
Total																

Column(k)	Probability(P_k)	No. of balls (N_{pk})
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

CALCULATION:

EXPERIMENT NO: 06

TRANSISTOR AS AN ACTIVE DEVICE & AN ACTIVE MEDIUM

Aim : To study the operation of a transistor as a switch and an active medium

Apparatus: A transistor(BC-107) , Resistor (2.2 kΩ) & (100 kΩ), 5v battery, a variable 5v battery (ac), dc voltmeter.

Principle: **Transistor** will become ON (saturation) when a sufficient voltage V is given to input. During this condition the Collector Emitter Voltage Vce will be approximately equal to zero,
ie the **transistor** acts as short circuit.

PROCEDURE :

1. Connect the ckt as shown in fig.
2. Vary the voltage (v_i) of the base supply from 0 to 5 v and observe the The corresponding(v_0) at the collectors of the transistor.
3. Plot the graph of v_0 against v_i

Result : voltage against given transistor in the amplification is ---- v

Tabular column :

v_{in}	V_{out}

CIRCUIT:

Expected graph :

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||JAI SRI GURUDEV||

BGS SCIENCE ACADEMY

Agalagurki, Chickballapur – 562 101

LABORATORY MANUAL

B.Sc. PHYSICS

For V – SEMESTER

Paper -504

PREPARED BY TEAM OF PHYSICS DEPARTMENT

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CONTENTS

Experiment No:1

Analysis of X-Ray Powder Method

Aim: To determine the lattice constants, inter planar distance and density of the material by analysing the photograph of x-ray by x-ray powder method.

Apparatus: X-ray photograph, scale, etc,..

Principle: The x-ray powder method is used for a crystal planes having random orientation of the gains with respect to monochromatic x-ray beam, suggest that some of them will be in a position to reflect the radiation from important set of planes. The diffracted x-ray going out from individual crystallines which gets oriented with the planes making a glancing angle θ satisfying Bragg's equation 2dsinθ=nλ gets reflected rays from the concentric with the original beam of semi-vertical angle 2θ for each set planes, the cones intercept the film is in between a pair of arcs 2θ and the spacing of the planes can be determined.

Formula:

- The glancing angle θ= S/4R=________Rad.

  $\theta = \frac{S}{4R} \times \frac{180}{\pi}$ deg.

  Where S= Distance between a pair of arcs in m.

  R= Radius of the powder camera=5.73 cm.

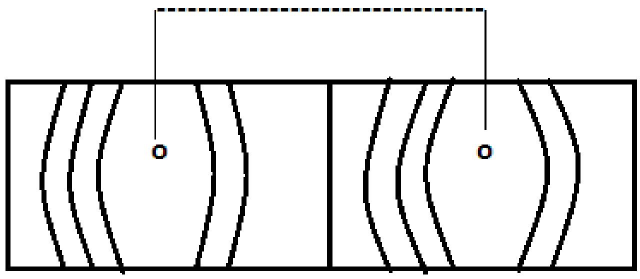
- The lattice constant (edge of a unit cell) a= $\frac{\pi}{2\sqrt{CF}}$=________m
  Where λ=wavelength of x-ray in m.
  CF= Common factor of successive difference in $\sin^2\theta$
- Inter planar distance between set of crystal of crystal planes
  $d = \frac{a}{\sqrt{h^2+k^2+l^2}}$ =________m
  Where h,k and l =miller indices of a given set of crystal planes.
- Density of material of a given crystal $\rho = \frac{nm}{v \times N_A}$ =________Kgm^{-3}

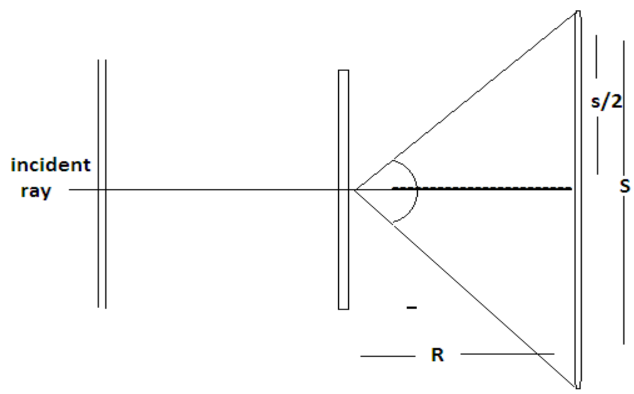
  where n= number of lattice points per unit cell for face centred cubic lattice (FCc), copper crystal n=4, m=63.55 $x10^{-3}$ Kg
  Atomic weight of copper, N_A=6.023 x 10^{23}
  V= a^3 volume of unit cell in m^3

Procedure:

- The given x-ray photograph is illuminated using cm scale reading corresponding to the arcs.
- On either side of the punched hole are recorded.
- The distance between the pair of arcs 1,2,3,4 are measured.
- The glancing angle θ is calculated using the formula $\theta = \frac{S}{4R} \times \frac{180}{\pi}$ deg.
- The value sinθ, $\sin^2\theta$ and successive differences are computed and minimum value of successive difference CF is identified.
- Using CF, $\frac{\sin^2\theta}{CF} = h^2+k^2+l^2$ is calculated.
- The values are rounded off to the nearest integral values are assigned taking care to see that either odd or even.
- The lattice constant and density of the materials of the crystal are determined using the relations.

Diagram:





Tabular Column:

Arc No	Scale reading	S in Cm	$\theta=\frac{S}{4R}$	$\theta=\frac{S}{4R} \times \frac{180}{\pi}$ in deg	$\sin\theta$	$\sin^2\theta$	Successive difference	$h^2+k^2+l^2 = \frac{\sin^2\theta}{CF}$	h k l	$d=\frac{a}{\sqrt{h^2+k^2+l^2}}$
1										
2										
3										
4										

Calculation:

Result: The lattice constant(edge of the unit cell) a=______A^0

The density of the material of the crystal ρ =______kgm^{-3}

Inter planar distance for different set of crystal plane d_1=_____A^0

d_2=_____A^0

d_3=_____A^0

d_4=_____A^0

Experiment No:2

SOLAR CELL CHARACTERISTICS

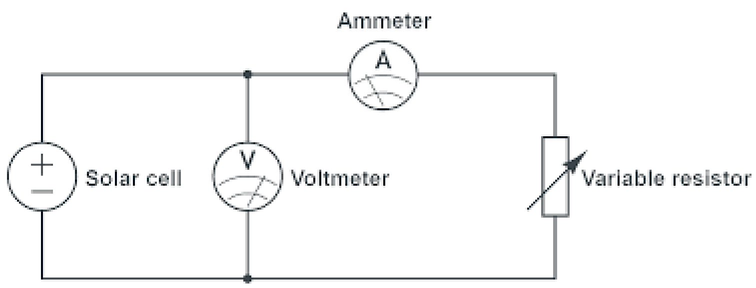
Aim: To study the characteristics of a solar cell and to complete the efficiency of the cell.
Apparatus: Calculator, solar cell, multi meter, micro ammeter, Dut40w, lamp, connecting wires.
Formula: Efficiency of a solar cell given by $\eta = \frac{Area\ of\ the\ rectangle\ at\ knee\ point}{Total\ area\ under\ the\ current\ curve}$

$$\eta = \frac{I_m \times V_m}{I_{sc} \times V_{oc}}$$

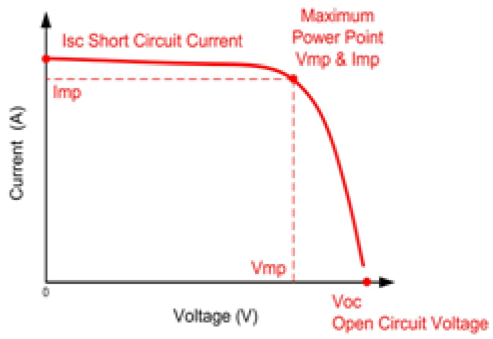
Procedure:

- Connect the solar cell according to the circuit diagram.
- Place the 40W close to the cell so that light from the lamp falls normally on the cell.
- Put in the key K_1, keeping K_2 open note the reading of the voltmeter for open circuit V_0.
- Keeping the pot in, mini position key K_2 is closed, by keeping K_1 open and adjust the position of the lamp.
- The graph of current through the photocell V/S voltage across the photocell is plotted.
- The efficiency of the solar cell is calculated using the formula.

Diagram:



Expected Graph:



Observation:

open circuit voltage V_{oc}= _______V

Open circuit current I_0 = _______A

Short circuit voltage V_{sc} = _______V

Short circuit current I_{sc} =_______x10^{-3}A

Tabular column:

Load resistance R_L	V in (V)	I in (mA)
100		
200		
s300		
400		
500		
600		
700		
800		
900		
1000		
2000		
3000		
4000		
5000		
6000		

Calculation:

Result: The characteristics of the solar cell drawn and shown in the graph.

1. Open circuit voltage of the solar cell V_{oc}=_______V
2. Short circuit current of the solar cell I_{sc} =______x10^{-3}A
3. Efficiency of the solar is found to be η = ________%

Experiment no:3

Temperature co-efficient of Thermistor

Aim: Determination of energy gap of an intrinsic semiconductor thermistor.
Apparatus: Meter bridge, power supply, resistance box, plug key, galvanometer, thermometer, sliding contact.
Formula: $\boldsymbol{\rho = \rho_0 exp\left(\frac{E_g}{2KT}\right)}$

where E_g= energy of semiconductor (eV)
T= Absolute temperature (K)
K= Boltzman's constant (Jk^{-1})
$\ln\rho - ln\rho_0 + \left(\frac{E_g}{2KT}\right) = \mathbf{0}$

A graph of $\ln \rho$ varius $\frac{1}{T}$ is a straight line where slope = $\left(\frac{E_g}{2K}\right)$
where k=1.381x10^{-23} Jk^{-1}

slope m= $\frac{E_g}{2K}$

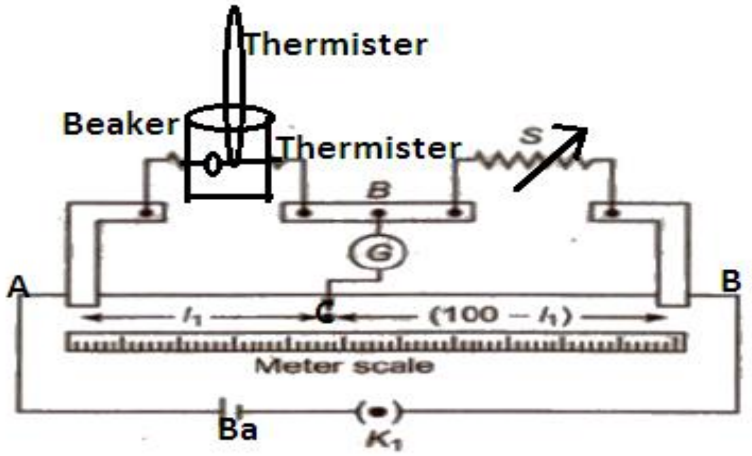
E_g=2km=$\frac{2.302\times2\times k\times m}{1.602\times10^{-19}}$=_______V

$$\alpha = \frac{2.303\left(\omega_g R_1 - \log R_2\right)}{\left(T_1 - T_2\right)} = \_\_\_\_\_\_ k^{-1}$$

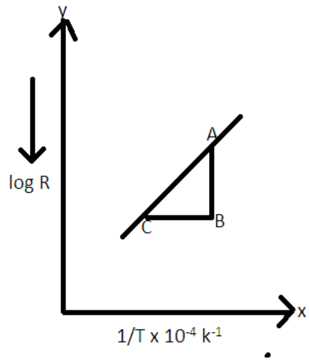
Procedure:

- ❖ Circuit connections are made in figure.
- ❖ Thermometer is connected to edge and dipped in cold water at room temperature .
- ❖ Suitable resistance is unplugged such that balancing length middle of meter bridge wire
- ❖ Balancing length of room temperature is measured and resistance calculated $R = \frac{sl}{1-l}$
- ❖ Cold water in the beaker is replaced the hot water (90^0) and thermometer dipped in hot water.
- ❖ Balancing length is measured for every 5^0 is temperature resistance of thermistor.
- ❖ A graph of log R versus $\frac{1}{T}$ is drawn and its slope 'm' is determined.
- ❖ Using the slope energy gap of semiconductor calculated.

Diagram:



Expected graph:



Observation: (S = 400 or 500 unplugged for trials.**)**

Tabular column:

Trial No	Temperature	T=t+273 K	Balancing length	Resistance $R=\frac{Sl}{1-l}\ \Omega$	Log R Ω	$\frac{1}{T}\times10^{-4}\ k^{-1}$
1						
2						
3						
4						
5						
6						
7						
8						
9						

Calculation:

Result: Energy gap of the given semiconductor

E_g= ________eV

α =________k^{-1}

Temperature co-efficient of resistance of given semiconductor, α =________k^{-1}

Experiment No: 4

Distance of Distant Object By Parallax Method

Aim: To determine the distance of a distant object by parallax method.

Apparatus: 2-Spectrometer, meter scale, metal pointer.

Principle: The viewing angles θ_1 and θ_2 of a distant object from two positions separated by a distance b are measured. The angle subtended by the base line at the distant object is

$$\alpha = \left[180^0 - (\theta_1 + \theta_2)\right]\frac{\pi}{180^0}\ radian$$

The distance d of the distant object and $d = \frac{b}{\alpha}$ d and b are measured meters.

Formula:

$$\alpha = \left[180^0 - (\theta_1 + \theta_2)\right]\frac{\pi}{180^0}\ radian$$

$$d = \frac{b}{\alpha}$$

Procedure:

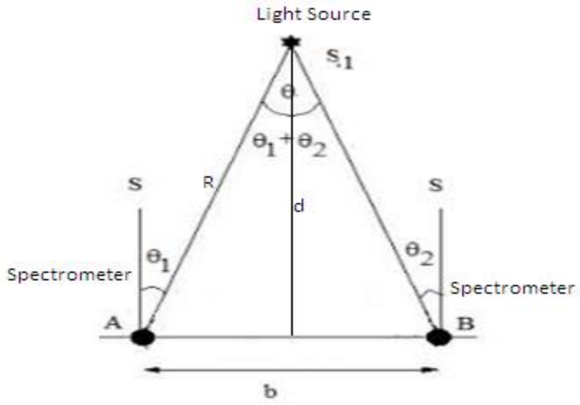
- A distant object is identified or marked. From this distant object a base line AB of length b is drawn. d and the distance between the distant object from the centre of the base line.
- The centre of the protractor and placed at the point A on the base line. With one end of the metal pointer at A, The other end is rotated to view the distant object along the pointer.
- The angle subtended by the pointer with the base line AB is noted.
- Now the centre of the protractor is placed at B again keeping one end of the pointer fixed at B the other end is rotated to view the distant object along the pointer. The angle θ_1 subtended by pointer with the base line AB is measured. The angle θ_2 subtended by the base line AB at the distant object is calculated in radian using the formula

  $$\alpha = \left[180^0 - (\theta_1 + \theta_2)\right]\frac{\pi}{180^0}\ radian$$
- The length b of the base line AB is in meters. The distance d of the distant object of the base line is calculated using the formula

  $$d = \frac{b}{\alpha}$$

- The experiment is repeated for the different base lengths.

Diagram:



Tabular column:

Sl. No	Base line length b in m	Viewing angle at A θ_1 in deg	Viewing angle at B θ_2 in deg	Angle subtended by base line at distant object in radian	Distance of distant object d in m
1					
2					
3					

Calculation:

Result: The distance of the distant object is d=_______m.
Distance from direct measurement _______m.

Experiment No.:5

I- V Characteristics Of Photodiode

Aim: To study V-I Characteristics of Photodiode in reverse bios.

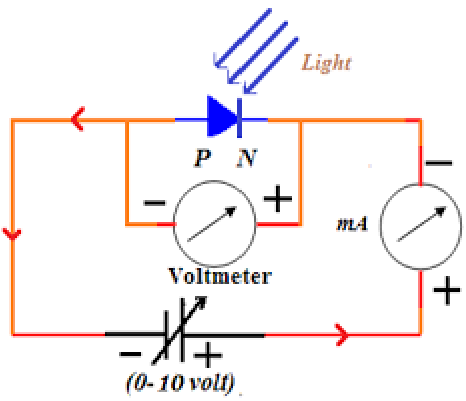
Apparatus: Fiber optics LED model , photodiode, dc regulated power supply, resistor , connecting wires multimeter and ammeter.

Principle: Device with in intrinsic layer are called P=I-N or PIN photodiodes. Light absorbed in the depletion region or the intrinsic region generates electron hole pains , most of which contribute to a photocurrent. This photocurrent is directly proportional to the incident light intensity.

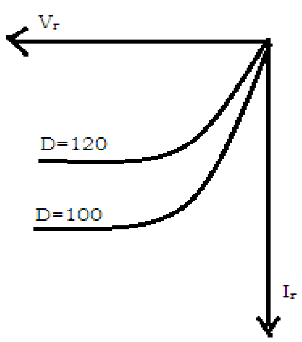
Procedure:

- The circuit connect of reserve biased , photo diode are as shown below.
- The +12V dc power supply is connected to LED module & photodiode module.
- The DC source is varied in steps of 1V or 2V.
- The filter cable is connected b/w LED & photodiode.
- The photodiode module is switched on.
- The multimeter probe is connected b/w P5 (+ve) & P6 (ground or -ve).
- The dc output voltage is noted & the potentiometer is varied in steps of 0.5V (0V to 5V).
- The values of voltage across resistor (V_{RS})& voltage across diode (V_P) are noted & the readings are tabulated.
- A graph of V_{Pd} & I_{Pd} is plotted.
- The experiment is repeated for different intensities of light.

Diagram:



Expected Graph:



Observation:

Tabular Column:

Reverse voltage(v)	**Reverse current I_R in μA**	
	D=100cm	D=120cm

Calculation:

Result:

The reverse V-I characteristics of photodiode is studies.

Experiment No:6

LED Characteristics

Aim: To study the characteristics of LED.

Apparatus: DC power supply , milli ammeter, voltmeter, experiment board.

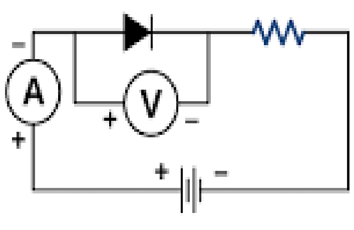
Procedure:

Forward Bios: Electrical connections are made as shown in the figure. The forward voltage Vr is increased in steps of 0.2volts till the LED starts glowing. At each value of Vf, forward current If is noted. Plot a graph of If against Vf as shown in the figure. The knee voltage Vk is determined from the forward characteristics.

Reverse Bios: Electrical connections as shown in the figure. The reverse voltage Vr is increased in steps of 1 volts. At each value of Vr, reverse current Ir is noted. Plot a graph of Ir against Vr as shown in the figure.

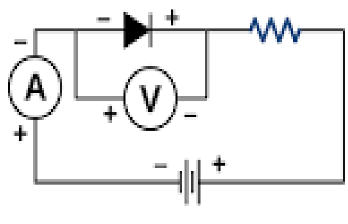
Circuit Diagram:

Forward bias:



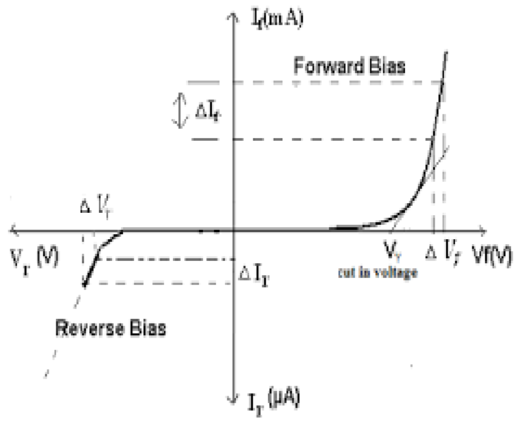
(b) Forward bias

Reverse Bios:



(a) Reverse bias

Model Graph:



Tabular Column:

Forward voltage (Vf)	**Forward current (mA) I_f**

Reverse voltage (V_r)	**Reverse current (mA) I_r**

Result: The knee voltage for LED -------V

Experiment No: 7

HR Diagram

Aim: To determine some of the physical properties of stars and to draw the Hertz sprung Russel Diagram.
Apparatus: Data tables of apparent and absolute magnitudes and effective surface temperatures of the stars.
Principle: Knowing the luminosity, absolute magnitude and radius of the sun the physical properties of the main sequence stars and white dwarfs can be calculated from the data table provided.
A graph plotted with the absolute magnitude (or luminosity) of the star against their surface temperature (or B-V value) is called Hertz sprung Russell diagram. Most of the stars are found to be located on a diagonal band that goes from the upper left to the lower right called main sequence stars on the HR diagram.

A smaller populations of brighter but cooler stars known as super giants occupies the uppermost right region of the diagram.

Some stars, which are difficult to discover because they are so intrinsically faint, lie near the left bottom the HR diagram and are called as white dwarfs.

Formula:

1. $d = \frac{1}{P}$
2. $M = m - 5 \log d + 5$

Where, d = distance of the star (in per sec)
[1persec = 3.26LY]
p = parallax of the star (in arc sec)
M = absolute magnitude of the star

Procedure:

1. (a) Knowing the parallax (p) of the star, determine its distance (d) using the formula(1)
   (b) Knowing the apparent magnitude (m) and the star, calculate its absolute magnitude (M) using the formula.
   (c) Knowing the B-V value of the star and knowing its M value, locate its position in the graph of m vs B-V value.

2. (a) Using the data table -2 draw the calibration curve (B-V) vs. T.
   (b) Using the above calibration curve, knowing the B-V value of the star determine its surface temperature (T).
3. Identify the spectral class of the star using the tables.
4. All the above calculations are done for all the given stars, and the results are tabulated.

Data to Study Stellar Spectra

Table -1

Temperature of the star in K	B-V
4000	
5000	
6000	
7000	
8000	
9000	
10000	
15000	
20000	
25000	
30000	
35000	
40000	

Table -2

Spectral sequence based on temperature

Spectral Class	Temperature (K)	Colour
O	26000 - 50000	Blue - Violet
B	10000 - 28000	Blue - white
A	7500 - 10000	White
F	6000 - 7500	Yellow - white
G	5000 - 6000	Yellow
K	3500 - 5000	Orange
M	2500 - 3500	Red - Orange

OBSERVATIONS

Name of the star	P (arc sec)	M	B-V	d (in pc)	M	T (in k)	Spectral class
Alpha Cen A	0.752	-0.01	0.72				
Alpha Cen B	0.752	1.40	0.79				
Bernard's star	0.552	9.54	1.74				
Betelgeuse	0.005	0.5	1.85				
Sirius A	0.375	-1.46	0.00				
Sirius B	0.375	8.7	-0.35				
Sun	206 265.000	-26.76	0.60				
Vega	0.124	0.04	-0.27				

Calibration graph of B-V vs. T

Experiment No: 8
Analysis of Stellar Spectra

Aim: To analyse the given stellar spectra and to determine the temperature of the star.

Apparatus: Given stellar spectra (spectral plot of luminous flux vs temperature), comparator (or a measuring scale),etc..

Principle: A star can be treated as a black body. Using the Plank's black body radiation formula, temperature of the star can be determined from the luminous flux vs. temperature plot.

Formula:

1. $F_\lambda \propto \frac{1}{\lambda^5}\left[\frac{1}{e^{\frac{hc}{\lambda kT-1}}}\right]$

$$\approx \frac{\left(\frac{F_{\lambda_1}}{F_{\lambda_2}}\right)}{\left(\frac{\lambda_2}{\lambda_1}\right)^5} = \frac{e^{\frac{hc}{\lambda_2 kT}}}{e^{\frac{hc}{\lambda_1 kT}}}$$

Where F_λ=luminous flux for wavelength λ (in $Wm^{-2}A^{-1}$)

h=Plank's constant=6.625×10^{-34} Js

c= Velocity of light in vaccum =3×10^{8} ms^{-1}

k= Boltzmann constant = 1.38×10^{-23} Jk^{-1}

T= Temperature of the star in K

Observation:

Slno.	T	$X = \frac{e^{\frac{hc}{\lambda_2 kT}}}{e^{\frac{hc}{\lambda_1 kT}}}$
1	5000 K	
2	6000 K	
3	7000 K	
4	8000 K	
5	9000 K	
6	10000 K	

Expected Graph:

Procedure:

1. (a) For different temperatures T (5000K, 6000K,...), calculate the ratio $\frac{e^{\frac{hc}{\lambda_2 kT}}}{e^{\frac{hc}{\lambda_1 kT}}}$
   (b) A calibration
2. (a) In the given stellar spectra , using a meter scale note down the flux (F_λ) values for any two wavelength λ in the smooth part of the curve .
   (b) Calculate the ratio $\frac{\left(\frac{F_{\lambda_1}}{F_{\lambda_2}}\right)}{\left(\frac{\lambda_2}{\lambda_1}\right)^5}$
3. The temperature of the star (T) corresponding to the ratio $\frac{\left(\frac{F_{\lambda_1}}{F_{\lambda_2}}\right)}{\left(\frac{\lambda_2}{\lambda_1}\right)^5}$ is determined from the calibration curve.

From the stellar spectra:

Sl no.	Standard Wavelength λ (A^0)	Luminous flux F_λ ($erg\ cm^{-2} s^{-1} A^{-1}$)
1		
2		

Calculation:

$$X = \frac{\left(\frac{F_{\lambda_1}}{F_{\lambda_2}}\right)}{\left(\frac{\lambda_2}{\lambda_1}\right)^5} = \frac{e^{\frac{hc}{\lambda_2 kT}}}{e^{\frac{hc}{\lambda_1 kT}}}$$

Corresponding to the ratio (x)_____ the value of T from the calibration curve is _______

Thus the temperature of the star (T) _______ K

RESULT: Temperature of the star is found to be _______K

Experiment No: 9

Solar Rotation Period

Aim: To determine the solar rotation period from sun spot positions.

Apparatus: Sun spot photographs observed by SOHO spacecraft by NASA by a period of a week, scale, etc..

Principle: The rotation of the sun was first recognised from the movement of sun spots across its disk. The time interval between two successive appearances of a spot on the central meridian is the period of rotation of the sun. The period as observed from the earth is called synodic period. By determining the positions a sun spot at different times as seen on the sun's disk of radius R, the synodic period of the sun at a latitude can be calculated.

Formula:

1. $\sin\theta = \frac{x}{\sqrt{R^2-y^2}}$ where
   θ=longitude of the sunspot
   R=radius of the sun's disk in the photograph

2. $sin\emptyset = \left(\frac{y}{R}\right)$ x and y are co-ordinates of the sunspot along the x-and y- direction
   $\emptyset$= latitude of the sunspot

3. $T = \frac{360^0}{\left(\frac{d\theta}{dt}\right)}$ T= sidereal period of the sun at the latitude $\emptyset$
   $\frac{d\theta}{dt}$=rate of change of longitude of the sunspot

Procedure:

1. Measure the diameter of sun's disk in the given photograph, and hence calculated its radius R.
2. Note down the x and y co-ordinates of a sun spot in the given photographs.
3. Calculate the angle(θ) between each spot and the line of sight using the formula no.1.
4. Calculate the latitude ($\emptyset$) of the sun spots using the formula No.2
5. Plot a graph of θ against time t of accurance, determine the slope=$\frac{d\theta}{dt}$

6. Calculate the synodic period of rotation of the sun using the formula No.3.
7. Repeat the calculations for 2 more sun spots.

Observations:

Sun spot No:

Diameter of the Sun's image:

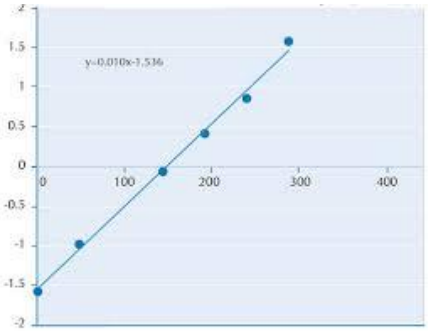
Radius of the Sun's image:

Tabular Column:

Day	x	y	$\sin\theta = \frac{x}{\sqrt{R^2-y^2}}$	θ	$\emptyset = sin^{-1}\left(\frac{y}{R}\right)$

Mean latitude=________

Graph:



Result: Synodic period of the sun is____ days at the latitude ____

First Print: **JULY 2019**

ENERGY DIAGRAM OF HBr MOLECULE

OBSERVATIONS:

Analysis of rotational-vibrational spectra of HBr molecule

$\bar{\upsilon}$ ($\times 10^2$ m^{-1})	Scale reading ($\times 10^{-2}$m)
2700	
2600	
2500	
2400	

R-branch

J	Scale reading (cm)	$\bar{\upsilon}_R$ (cm^{-1})
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

P-branch

J	Scale reading (cm)	$\bar{\upsilon}_P$ (cm^{-1})
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

EXPERIMENT NO: 01

EXPERIMENT NAME: ANALYSIS OF ROTATIONAL-VIBRATIONALSPECTRA OF HBr MOLECULE.

AIM: To analyze rotational-vibrational spectra of HBr molecule and hence to find the rotational constant, reduced mass, moment of inertia and mean bond length.

PRINCIPLE: A large number of rotational energy levels are between the vibrational energy levels of a molecule. The IR absorption spectrum of HBr molecule consist of a series of almost equidistant absorption peaks in distinct branches. These peaks are due to the transitions from the vibrational ground level $\vartheta = 0$ to the next higher energy level $\vartheta = 1$.

The P branch consists of peaks on the higher wave number side corresponding to $\Delta \mathbf{J} = j_i = -1$.

The R branch consists of peaks on the higher wave number side corresponding to $\Delta \mathbf{J} = j_0 - j_i = +1$.

FORMULA:

1. Rotational constant $\mathbf{B} = \frac{\text{slope}}{2}$ m^{-1}
2. Moment of inertia of HBr molecule : $\mathbf{I} = \frac{h}{8\pi^2 Bc}$ kgm^2
   B= rotational constant (m^{-1})
   C= velocity of light ($3\times10^8 ms^{-1}$)
3. Reduced mass of HBr molecule : $\mu = \frac{m1m2}{m1+m2}$
   Where m1= mass of the hydrogen atom = 1.00784 amu
   m2= mass of bromine atom = 79.916 amu
   1amu = 1.67×10^{-27} kg
4. Mean bond length or inter atomic distance of HBr molecule $\mathbf{r} = \sqrt{\frac{I}{\mu}}$ m

PROCEDURE:

- Using meter scale note down the scale reading for standard wave numbers in the given chart.
- Draw a calibration graph of standard wave number v/s scale reading.
- Using scale note down the scale readings of the spectral lines in the R branch and P branches of the spectra.
- Wave numbers of spectral lines in R&P branches are determined using calibration graph by interpolation method.
- The difference in the wave number $\bar{\upsilon}_R - \bar{\upsilon}_P$ are determined for for different values of J.
- A graph of $\bar{\upsilon}_R - \bar{\upsilon}_P$ v/s 2J+1 is drawn and the slope of the straight line is determined, which gives 2B where B is rotational constant.
- Rotational constant B=$\frac{\text{slope}}{2}$ is determined.

- Moment of inertia of HBr molecule is determined by using formula.
- Mean bond length of HBr molecule is determined

To draw $\bar{\upsilon}_R - \bar{\upsilon}_P$ vs 2J+1

J	**2J+1**	$\bar{\upsilon}_R - \bar{\upsilon}_P$ **(cm^{-1})**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

CALCULATIONS:

RESULT:

1. B=
2. I=
3. μ=
4. r =

DIAGRAM:

OBSERVATION:

$\Delta\bar{\upsilon}$ (cm^{-1})	scale reading (cm)
150	
100	
50	
0	

ANTI –STOKE LINES

J	Scale reading (cm)	$\Delta\bar{\upsilon}$ ($\times 10^2 m^{-1}$)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

EXPERIMENT NO: 02

EXPERIMENT NAME: ANALYSIS OF ROTATIONAL RAMAN SPECTRUM OF NITROGRN MOLECULE

AIM: To determine the rotational constant and bond length of nitrogen molecule by studying anti-stokes lines in the rotational Raman spectrum.

PRINCIPLE: When light from monochromatic source is passed through a gas, liquid or a transparent crystal it gets scattered in all directions. The transversely scattered light consists of lines having shortest and longest lines besides the line with the original line. These lines are called **Raman lines**. The original line is called the **Rayleigh line**.

The energy that is absorbed or emitted by the molecules may be electronic, vibrational or rotational. Thus there may be electronic, vibrational or rotational Raman Effect. The rotational Raman spectrum arises from transition involving $\Delta J = 0, \pm 2$

Where $\Delta J=0$ gives the Rayleigh line

$\Delta J=+2$ gives a series of longer wavelength(stokes lines), the S-branch lines.

$\Delta J=-2$ gives the series of shorter wavelength (anti stokes lines), the O- branch lines.

FORMULA:

1. $4B=\frac{\Delta\bar{\upsilon}_{as}}{\Delta J}$ m^{-1} (slope of the graph of anti stokes lines)
2. Moment of inertia of N_2 molecule $I=\frac{h}{8\pi^2 Bc}$ Kgm^2
   Where h=Planck's constant (6.625×10^{-34} kgm^2/s)
   C= velocity of light
   B=rotational constant
3. Reduced mass of nitrogen molecule : $\mu = \frac{m1m2}{m1+m2}$
   Where m1=m2= mass of the nitrogen atom = 14.00308 amu
   1amu = 1.67×10^{-27} kg
4. Mean bond length of the molecule: $r_0=\sqrt{\frac{I}{\mu}}$

PROCEDURE:

- The positions of the peaks O branches corresponding to different J values are noted with respect to the reference line using an ordinary value.
- The calibration graph of wave number shift $\Delta\bar{\upsilon}$ against scale reading is plotted. The wave number shift ($\Delta\bar{\upsilon}_{as}$) of the different anti stokes lines are obtained from the calibration graph, the readings are tabulated.
- A graph of $\Delta\bar{\upsilon}_{as}$ against J is plotted.
  The slope of the straight line obtained gives the value of 4B.
  The magnitude of B value is calculated.
- The moment of inertia and bond length are calculated using the formulae.

RESULT:

- The rotational constant of nitrogen molecule B= m^{-1}
- Mean bond length of nitrogen molecule r_0= m
- Moment of inertia of nitrogen molecule I= kgm^2

DIAGRAM:

OBSERVATION:

$\Delta\bar{\upsilon}$ (cm^{-1})	**scale reading (cm)**
0	
-50	
-100	
-150	

STOKE LINES

J	Scale reading (cm)	$\Delta\bar{\upsilon}$ ($\times 10^2 m^{-1}$)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

14		
15		
16		
17		
18		
19		
20		

EXPERIMENT NO: 03

EXPERIMENT NAME: ANALYSIS OF ROTATIONAL RAMAN SPECTRUM OF NITROGRN MOLECULE

AIM: To determine the rotational constant and bond length of nitrogen molecule by studying stokes lines in the rotational Raman spectrum.

PRINCIPLE: When light from monochromatic source is passed through a gas, liquid or a transparent crystal it gets scattered in all directions. The transversely scattered light consists of lines having shortest and longest lines besides the line with the original line. These lines are called **Raman lines**. The original line is called the **Rayleigh line**.

The energy that is absorbed or emitted by the molecules may be electronic, vibrational or rotational. Thus there may be electronic, vibrational or rotational Raman Effect. The rotational Raman spectrum arises from transition involving $\Delta \mathbf{J}=\mathbf{0},\pm\mathbf{2}$

Where $\Delta J=0$ gives the Rayleigh line

$\Delta J=+2$ gives a series of longer wavelength(stokes lines), the S-branch lines.

$\Delta J=-2$ gives the series of shorter wavelength (anti stokes lines), the O- branch lines.

FORMULA:

5. $4B=\frac{\Delta \bar{\upsilon}_s}{\Delta J}$ m^{-1} (slope of the graph of stokes lines)
6. Moment of inertia of N_2 molecule $I=\frac{h}{8\pi^2 Bc}$ Kgm^2
   Where h=Planck's constant (6.625×10^{-34} kgm^2/s)
   C= velocity of light
   B=rotational constant
7. Reduced mass of nitrogen molecule : $\mu = \frac{m1m2}{m1+m2}$
   Where m1=m2= mass of the nitrogen atom = 14.00308 amu
   1amu = 1.67×10^{-27} kg
8. Mean bond length of the molecule: $r_0=\sqrt{\frac{I}{\mu}}$

PROCEDURE:

- The positions of the peaks S branches corresponding to different J values are noted with respect to the reference line using an ordinary value.
- The calibration graph of wave number shift $\Delta\bar{\upsilon}$ against scale reading is plotted. The wave number shift ($\Delta\bar{\upsilon}_s$) of the different anti stokes lines are obtained from the calibration graph, the readings are tabulated.
- A graph of $\Delta\bar{\upsilon}_s$ against J is plotted.
  The slope of the straight line obtained gives the value of 4B.

The magnitude of B value is calculated.

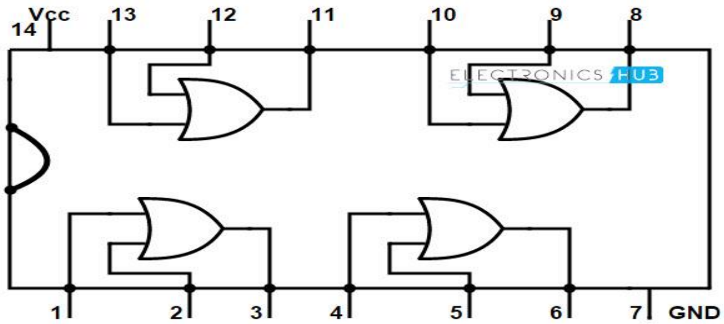
- The moment of inertia and bond length are calculated using the formulae.

RESULT:

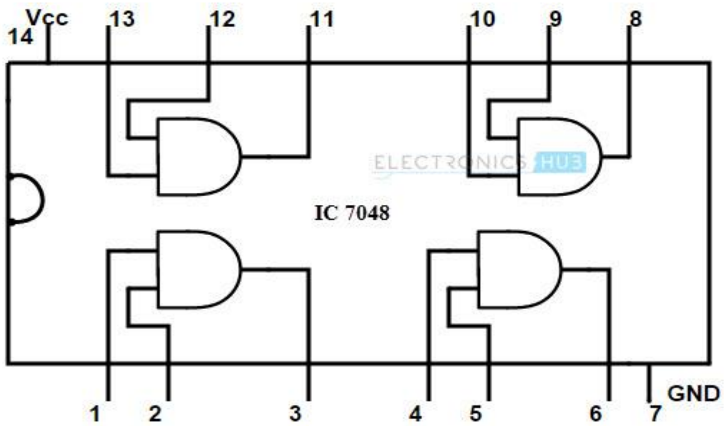
- The rotational constant of nitrogen molecule B= m^{-1}
- Mean bond length of nitrogen molecule r_0= m
- Moment of inertia of nitrogen molecule I= kgm^2

PIN DIAGRAMS OF LOGIC GATES:

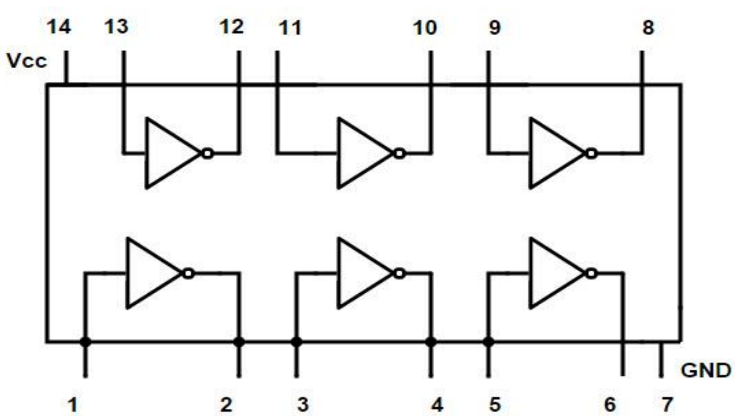
1) **OR-GATE [7432]**



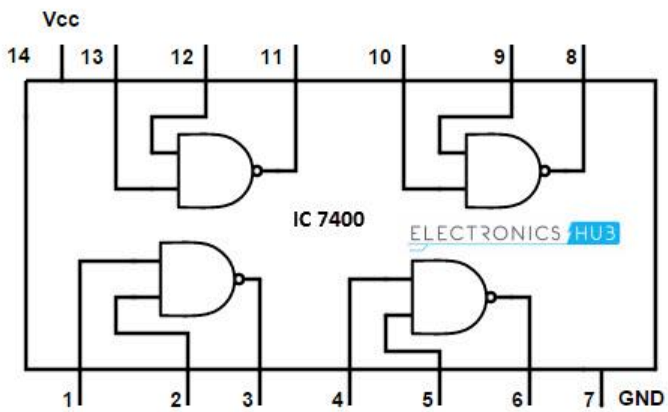
2) **AND-GATE[7408]**



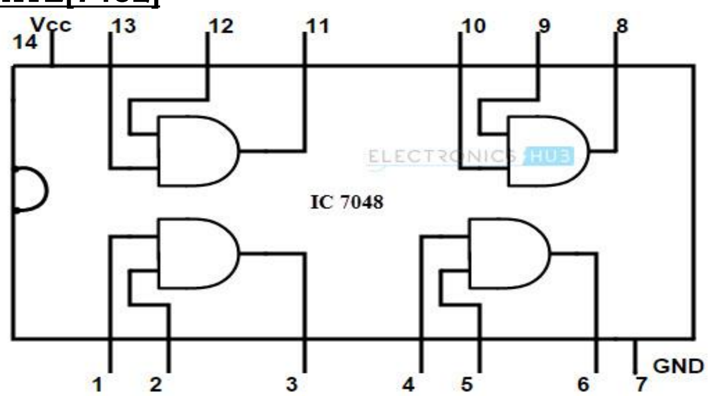
3) **NOT-GATE[7404]**



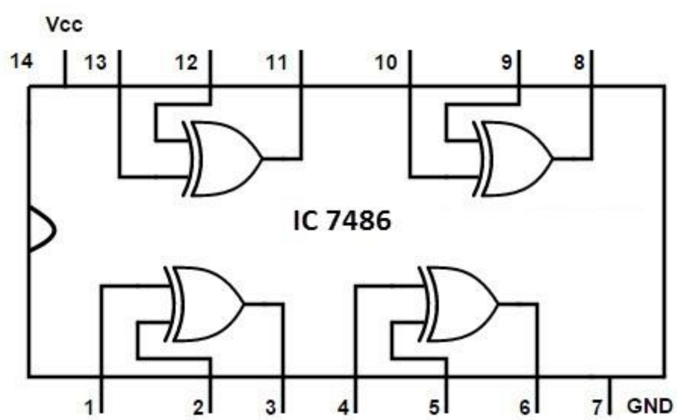
4) NAND-GATE[7400]



5) NOR-GATE[7402]



6) XOR-GATE[7486]



EXPERIMENT NO: 04

EXPERIMENT NAME: LOGIC GATES

AIM: To design and setup a logic gates of OR-gate, AND-gate, NOT-gate, NAND-gate, NOR-gate and EX-OR gate.

PRINCIPLE: In digital electronics, a gate is a logic circuit with one output and one or more inputs. An output signal occurs for certain combination of input signals. The action of logic circuit is summarized in the form of truth tables the basic gates such as OR, AND, NOT and XOR gates can be realized only by using NAND gates. Therefore NAND gate is called the universal gate.

FORMULAE:

1. The Boolean equation for AND gate is $Y=A\cdot B$
2. The Boolean equation for OR gate is $Y=A+B$
3. The Boolean equation for NOT gate is $Y=\bar{A}$
4. The Boolean equation for XOR gate is $Y=\bar{A}B+AB$
5. The Boolean equation for NAND gate is Y=
6. The Boolean equation for NOR gate is Y=

TRUTH TABLES:

1) **OR GATE**

A	B	**Y**
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

2) **AND GATE**

A	B	**Y**
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

3) **NOT GATE**

A	**Y**
0	**1**
1	**0**

4) **NAND GATE**

A	B	**Y**
0	0	**1**
0	1	**1**
1	0	**1**
1	1	**0**

5) **NOR GATE**

A	B	**Y**
0	0	**1**
0	1	**0**
1	0	**0**
1	1	**0**

6) **XOR GATE**

A	B	**Y**
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**

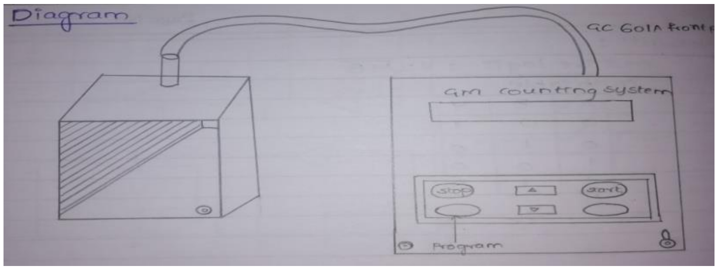
PROCEDURE:

- Verify all the components and connecting wires.
- Make circuit connections as shown in the diagram.
- Give supply to IC's
- Provide a input data to the circuit.
- Verify the truth table sequence and outputs.

RESULT:

All the truth tables are verified.

DIAGRAM:



OBSERVATION: Reading from Geiger counting system

Applied voltage V (in volts)	Counts for 60 seconds N	Background counts for 60 seconds (N_B)	Corrected counts for 60 seconds ($N-N_B$)	Count rate $\frac{N-N_B}{60}$
0				
25				
50				
75				
100				
125				
150				
175				
200				
225				
250				
275				
300				
325				
350				
375				
400				
425				
450				
475				
500				
525				
550				
575				
600				
625				
650				
675				
700				
725				
750				
775				
800				

EXPERIMENT NO:05

EXPERIMENT NAME: CHARACTERISTICS OF GM COUNTER

AIM: To study the characteristics of GM counter and hence determine the operating voltage.

PRINCIPLE: When a radiation (**α**-particle or β-particle or Γ-particle) enters the G.M.tube, it ionizes the gas inside it. The voltage applied between the electrodes inside the tube drifts the electrons towards the anode. These electrons are counted using a Geiger counting system (GCS).

For different voltages the count rate is recorded and the characteristics are drawn.

FORMULAE:

1. Corrected count rate: $\mathbf{C=\frac{N-N_B}{t}}$
   Where N is count for't' sec with the radioactive source.
   N_B is background counts for't' sec without source.
2. Operating voltage $\mathbf{V_0=\frac{V1+V2}{2}}$
3. Plateau voltage $\mathbf{V_p=V2\text{-}V1}$
4. Slope of the plateau= $\mathbf{\frac{(c2-c1)\times 100}{c1\times(V_L-V_m)}}$
   Where c1 and c2 are count of rate at the lower and upper limits of the plateau V_L and V_m are the corresponding voltages [if the slope is less than 10%, then the tube is good]

PROCEDURE:

- Connect the Geiger counting system to the GM tube.
- The radioactive source is placed in the tray at a distance above 2cm from the tube.
- The system is switched on
  The preset time is set to be 60 sec
- Increase the voltage (ETH) gradually in steps of 25V till the counting just starts. The threshold voltage (starting voltage) is noted.
- Increase the voltage (V) further in steps of 25V up to 800V and the number of counts (N_s) is recorded each time. Increasing of the voltage is stopped when the count rate suddenly increases.
- The radioactive source is removed. The background counts (N_B) are recorded for each voltage (from starting voltage) for 60 seconds. The corrected count rate (N) is calculated.
- Plot a graph of applied voltage vs corrected count rate.
  The knee voltage (initial steep rise after starting voltage V_K).
  The plateau region (appox. Constant region) and
  The discharge region (steep rise after the plateau) is marked.
- The midpoint of the plateau region gives the operating voltage (V_0) of the tube. The tube must always be operated with this voltage whenever it is used.

RESULT:

1. Operating voltage =
2. Plateau length=
3. Slope of the plateau=

DIAGRAM:

OBSERVATION:

Least count=$\frac{\textbf{Value of 1 MSD}}{\textbf{total no of divisions on VSD}}=\frac{30}{30}=\mathbf{1}$

No of lines per inch N=

Grating constant C=$\frac{2\times10^{-2}}{N}=$

Order of spectrum n=1

Direct reading=R_0=

TABULAR COLUMN:

Colour of spectrum	Reading (R) deg			Angle of deviation $\theta = (R - R_0)$ deg	Wavelength $\boldsymbol{\lambda}=\frac{c\sin\theta}{n}$	$\Delta\lambda$	Wave shift $\Delta\bar{\upsilon}=\frac{\Delta\lambda}{\lambda1\lambda2}$
	MSR	CVD	TR				
Yellow-1							
Yellow-2							

CALCULATIONS:

EXPERIMENT NO:06

EXPERIMENT NAME: SUMMER FIELD'S FINE STRUCTURE CONSTANT

AIM: To determine the fine structure constant (d) from the fine structure separation of sodium doublets using a plane transmission diffraction grating.

APPARATUS: spectrometer, grating, sodium lamp, spirit level and reading lines.

FORMULA:

Fine structure constant

$$\alpha = \sqrt{\frac{n^3 l(l+1)\Delta\bar{\upsilon}}{R(z-\sigma)^4}}$$

Where,

For sodium lines

l= orbital quantum number of the first excited state=1

n= principle quantum number of first excited state=1

Z= atomic number=11

$\Delta\bar{\upsilon}$=wave number separation between R_1 and R_2lines in number

σ= screening constant = 7.45

R=Rydberg's constant=$1.097\times10^7 m^{-1}$

PROCEDURE:

- The following initial adjustment is made as shown in the figure.
  The telescope is found for a distance object.
  The slit should be made narrow and vertical in the coli meter and it is adjusted for parallel rays through the coli meter.
- The sodium lamp is switched on.
- The grating is placed on the prison table and normal to the incident rays.
- The least count of the spectrometer is determined.
- Direct reading R_0 is noted.
- First order spectrum which consists of yellow, green and red doublet is observed.
- Since the measurements are not very accurate in the first order, second order spectrum is observed.
- The positions of G_1, G_2, y_1, y_2 and R_1, R_2 are noted and reading R is calculated.
- Diffraction angle, $\theta=R_nR_0$ is calculated for all 6 colours.
- Wavelength of the doublets is calculated using relation
  $\lambda=\frac{c\sin\theta}{n}$ where $c=\frac{2.54\times10^{-2}}{N}$ where N= number of lines per inch on the grating.

- Wavelength shift $\Delta\bar{\upsilon}=\frac{\Delta\lambda}{\lambda 1\lambda 2}$ is calculated.
- Fine structure constant is calculated.

RESULT:

The fine structure constant =

EXPERIMENT NO: 07

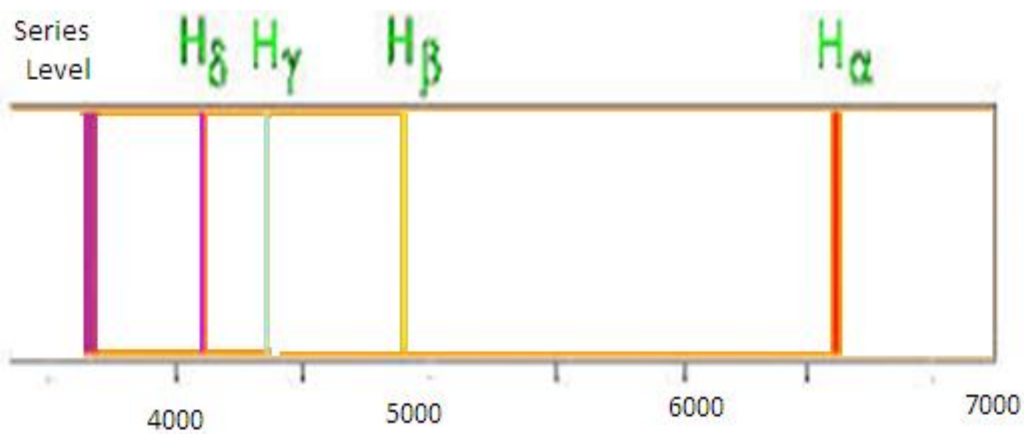
EXPERIMENT NAME: HYDROGEN SPECTRUM

Aim : Determination of the Rydberg constant by analysing hydrogen spectrum .

Apparatus : Hydrogen spectrum

Principle : Exited hydrogen atoms in the lamp when jump from higher energy levels to second energy level , emit spectral llines which are visible . This series of visible spectral lines is called Balmer series . By determining the wavelength of any one of the line in Balmer series , the Rydberg constant can be determined .

Diagram:



Formulas :

1) Rydberg constant : [experimental]

* $R_H = \frac{1}{\lambda_\alpha}\left[\frac{n_1^2\ n_2^2}{n_2^2 - n_1^2}\right]$

Where , λ_α is the wavelength of H_α line (Red line)

$n_1=2$ $n_2=3$

* $R_H = \frac{1}{\lambda_\beta}\left[\frac{n_1^2\ n_2^2}{n_2^2 - n_1^2}\right]$

Where , λ_β is the wavelength of H_β line

$n_1=2$ $n_2=4$

* $R_H = \frac{1}{\lambda_\gamma}\left[\frac{n_1^2\ n_2^2}{n_2^2 - n_1^2}\right]$

Where , λ_β is the wavelength of the H_γ line (blue line)

$n_1=2$ $n_2=5$

2) Rydberg constant [Theoretical]

$$R_H = \frac{me^4}{8\epsilon_0 h^3 c}10$$

Where , m = mass of electron = 9.1×10^{-31} kg

e = charge of electron = 1.6×10^{-19} C

ϵ_0 = Permeability of free space = $8.854\times 10^{-12}C^2N^{-1}m^{-2}$

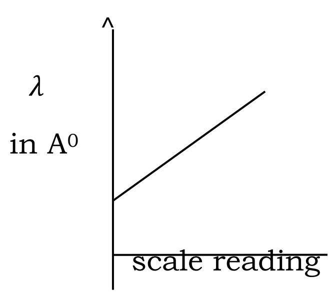
C = Velocity of light in free space = 3×10^8Jms^{-1}

h = planks constant

Procedure :

- ❖ A reference line is drawn on the left margin of the given spectral photograph , parallel to the spectral lines . The horizontal positions of the known wavelength (λ) and the spectral line in the spectrum with respect to the reference line in the spectrum with respect to the reference line are determined using a meter scale.
- ❖ The Caliberation graph of the given standard markings (λ) against the scale reading is plotted.The Wavelength (λ) of the $H_\alpha, H_\beta, H_\gamma$, lines from the formula (1) . Mean value of the constant is also caluculated.
- ❖ Rydberg constant is also caluculated using the formula (2).

Expected Graph :



Tabular Column :

λ in A^0	scale reading (cm)
4000	
5000	
6000	
7000	
H_α	
H_β	
H_γ	
H_δ	

From Calibration Graph:

spectra lines	λ in A^0	$R_H \times 10^7 m^{-1}$ (caluculating the experimental value)
H_α line	6500	
H_β line	5000	
H_γ line	4400	
H_δ line	4100	

Concordant Value = ---------$\times 10^7 m^{-1}$

Calculation :

Result : Rydberg Constant for H-Spectrum is found to be

- Theoritical R_H = ---------$\times 10^7 m^{-1}$
- Practical R_H = ---------$\times 10^7 m^{-1}$

||JAI SRI GURUDEV||

BGS SCIENCE ACADEMY

Agalagurki, Chickballapur – 562 101

LABORATORY MANUAL

B.Sc. PHYSICS

For VI – SEMESTER

Paper -604

PREPARED BY TEAM OF PHYSICS DEPARTMENT

Mr.SRINIVASA MURTHY P R
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Ms.LAVANYA S V
ASSISTANT PROFESSOR

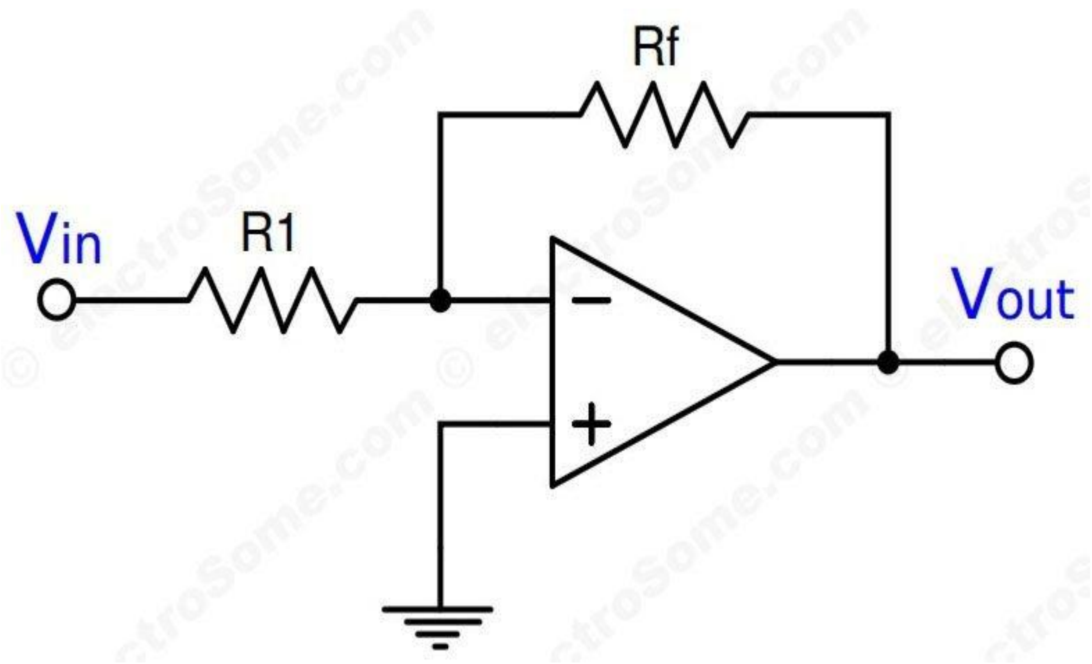
Ms.NAGALAKSHMI L
LAB INSTRUCTOR

CONTENTS

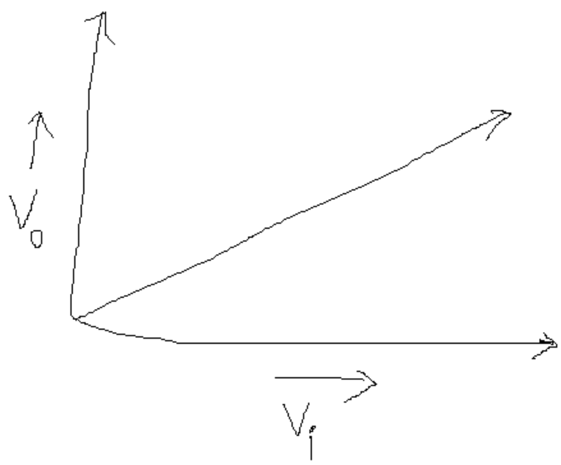
EXPERIMENT-01

INVERTING AMPLIFIER

DIAGRAM:



Expected graph :



Tabular column:

Set	Sl.no.	R_s (Ω)	R_f(Ω)	V_1 (volts)	V_2(volts)	Experimental gain = $-(v_0/v_1)$	Theoritical gain $A_v = -(R_f /R_s)$
1	1	10 k	10 k				
	2	10 k	10 k				
	3	10 k	10 k				
	4	10 k	10 k				
2	1	10 k	10 k				
	2	10 k	22 k				
	3	10 k	33 k				
	4	10 k	47 k				

Aim : To construct Inverting amplifier using IC-741 & to verify its gain

Apparatus : op-amp (IC-741), power supply, resistor

Principle : Inverting Amplifier is a normal OP-**Amp** in which the output is given as feedback to the **inverted** terminal of input by means of a feedback resistor. ... Now the Op-**Amp** becomes Closed Loop **Inverting Amplifier** which uses negative feedback to control the overall gain of the **amplifier**.

Formula : The voltage gain of the inverting amplifier is $A_v = -(v_0/v_1) = -(R_f / R_s)$

Where v_0=output voltage

$v_1 =$ input voltage

$R_f =$ feedback resistance

R_s = external resistance

Procedure:

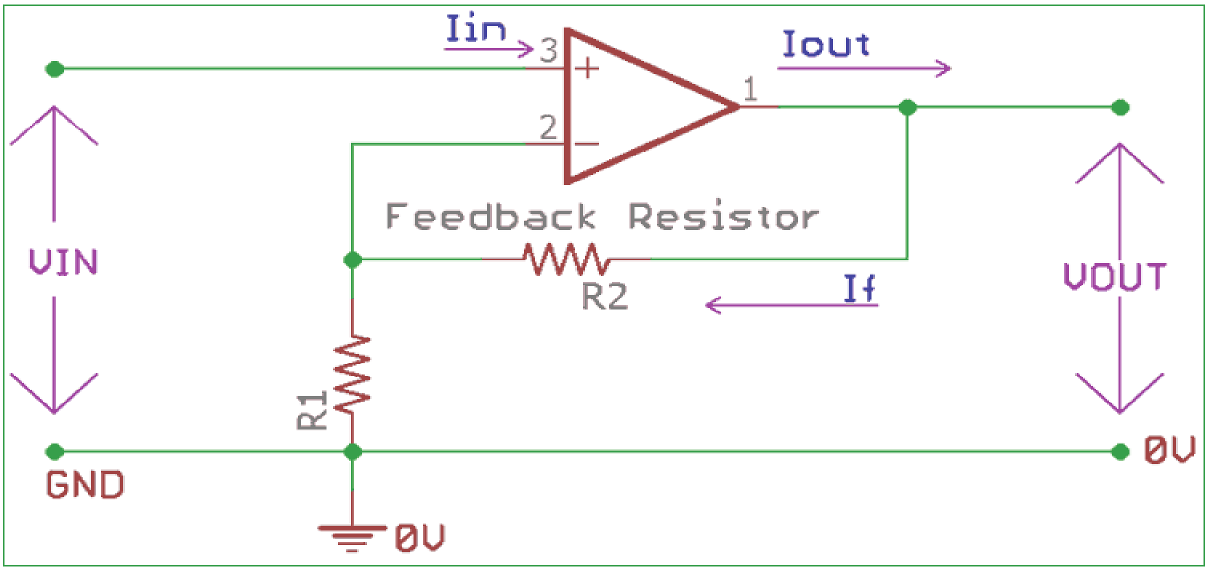
- Connect the circuit as shown in fig.
- Keep R_s = 10 kΩ & R_f =10 kΩ for making two connections at a single point using patch card with the holes in it
- Set voltmeter selector switcher towards v_1
- The voltage of DC source v_1 is set to 1v which can be measured with the help of digital voltmeter
- Now this input voltage is connected at the terminal as shown in the diagram and the output voltage v_0 is measured along with polarity shown by keeping the meter selector switch towards v_0
- Repeat the steps for various values of v_i = 1.5v, 2v,etc..
- Take the second set of readings by repeating the above steps keeping v_i = 1v & R_s = 10,22,33,47 kΩ
- Compare and verify experimental values with the theoretical values

Result : The inverting amplifier is constructed and its gain is verified with experimental theory

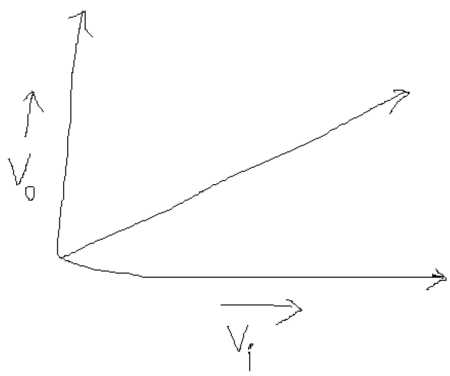
EXPERIMENT-02

NON-INVERTING AMPLIFIER

Diagram:



Expected graph:



Aim : To construct Non-inverting amplifier using IC-741 and Verify its gain

Apparatus: op-amp(IC-741), Dual power supply, Resistor

Principle: A **non-inverting amplifier** is an op-**amp** circuit configuration which produces an amplified output signal. This output signal of **non-inverting** op **amp** is in-phase with the input signal applied. In other words a **non-inverting amplifier** behaves like a voltage follower circuit

Formula :

The voltage gain of non-inverting amplifier is $A_v = -V_0/\ V_{in}=1+R_f/R_s$

Where V_0 = output voltage

V_{in} = input voltage

R_f = feedback resistance

R_s = external resistance

Procedure :

- ❖ Connect the circuit as shown in figure
- ❖ Keep R_s = 10 kΩ & R_f = kΩ for making two connections at a single point using patch card with holes in it
- ❖ Set voltmeter selector switch towards V
- ❖ The voltage of DC source is set to 1 V which can be measured with the help of digital voltmeter
- ❖ Now the input voltage (V_{in}) is connected at the terminal as shown in the diagram and the output voltage (V_0) is measured along with polarity shown by keeping the meter selector switch towards V_0
- ❖ Repeat the steps for various values of V_{in} = 1.5,2.0,2.5v etc
- ❖ Entering the readings in the tabular column
- ❖ Take the second set of readings by repeating the above steps keeping v_i = 1v & R_s = 10,22,33,47 kΩ
- ❖ Compare and verify experimental values with the theoretical values

Result : The inverting amplifier is constructed and its gain is verified with experimental theory

EXPERIMENT-03

DIELECTRIC CONSTANT

Diagram:

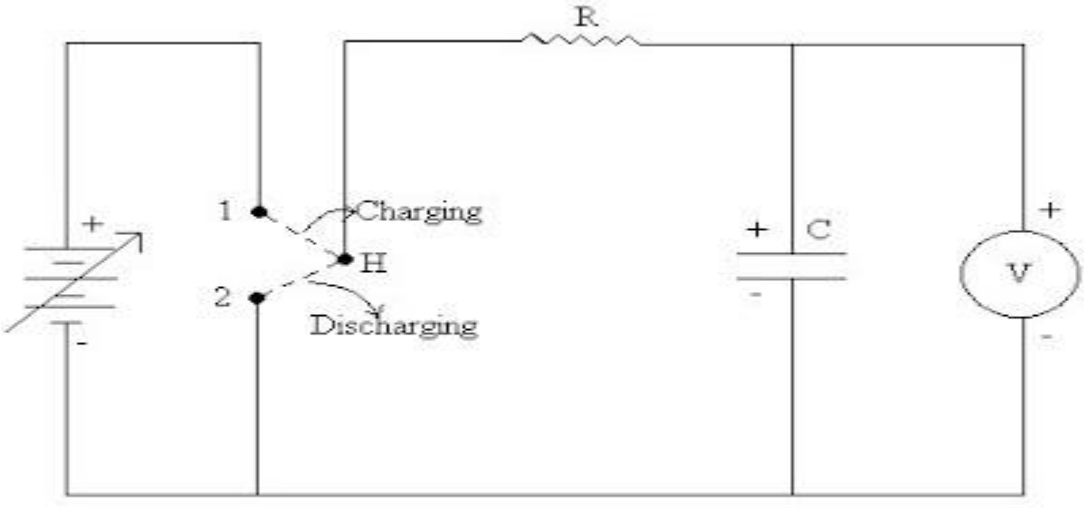
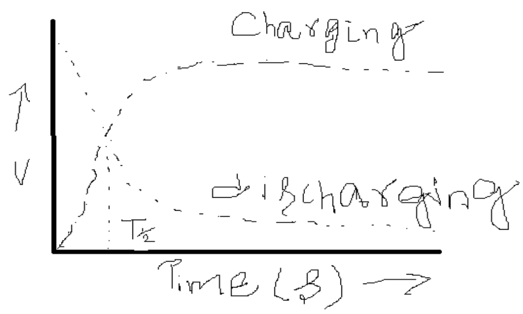


Figure 1

Expected graph:



Length of the dielectric l =_______mm

Breadth of the dielectric b =_______mm

Area of the dielectric A = $l \times$ b = _______m^2

Thickness of the dielectric d =_________m

Resistance of the Resistor used in the circuit R =_______ kΩ

ε_0 = ____________Fm^{-1}

Tabular column:

Time (secs)	Charging	Discharging

Physical dimensions of capacitors:

Capacitor	C_1	C_2	C_3
Length (mm)	47	114	183
Breadth(mm)	5	5	6
Separation (mm)	0.075	0.075	0.075

Aim: To determine the dielectric constant of a material of a capacitor by charging and discharging the capacitor

Principle: Dielectric constant (ϵr) is defined as the ratio of the electric permeability of the material to the electric permeability of free space (i.e., vacuum) and its value can derived from a simplified capacitor model.

Formula :

$$\varepsilon_r = \frac{d\, T_{1/2}}{0.693\, \varepsilon_0\, AR \times 10^{-6}}$$

$$C = \frac{T_{1/2}}{0.693\, R}$$

Where

d= thickness of dielectric material (m)

$T_{1/2}$ = time required for charging and discharging to half of the Maximam potential (S)

A = area of the dielectric material (m^2)

R = resistance (Ω)

10^{-6} = correction factor

Procedure :

- ❖ A capacitor and a resistor of known values are connected as shown in the circuit diagram
- ❖ A multimeter is connected across the capacitor with plug keys k_1 & k_2 open
- ❖ A voltage of 5v is applied from the battery ,the capacitor is the charged by closing the key k_1 and simultaneosely starting the stop clock

- ❖ During charging of the capacitor the plug key k_2 is open.The voltage in the multimeter connected across the capacitor is noted
- ❖ For every 10 s till voltage reaches 5v.After charging to 5v,the plug key k_1 is opened .The capacitor is discharged by closing the plug key k_2 and simultaneously starting the stopclock,the voltage in the multimeter is noted for every 10 secs till the voltage reches to minimam voltage of the order of 0.1 v
- ❖ The readings are tabulated , a graph of voltage versus charging time is ploted for both charging and discharging process of the capacitor
- ❖ From the plot it is observed that the curves for charging and discharging intersect at a point responding to their point of intersection , a normal is drawn on to the time axis and the time $T_{1/2}$ required for the charging and discharging to half of the maximam
- ❖ Note from the graph by substituting the value of $T_{1/2}$ A and R in the formula given below.The value of dielectric constant of the material in the capacitor is caluculated.

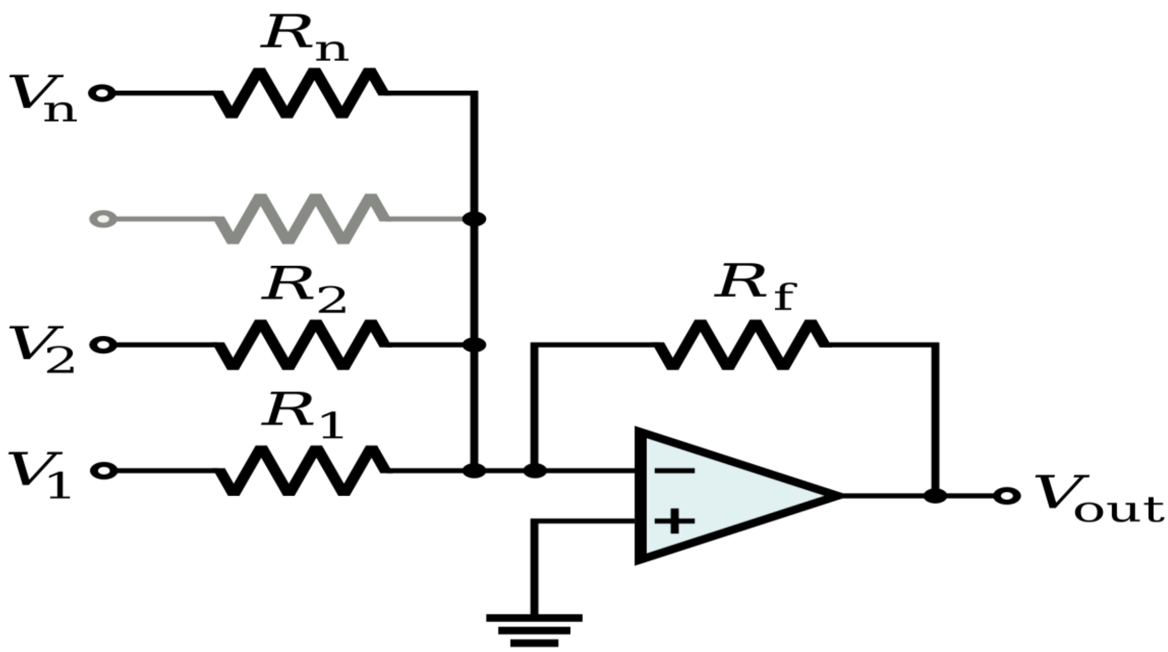
Result:

Dielectric constant of the dielectric medium of the given capacitor is …………

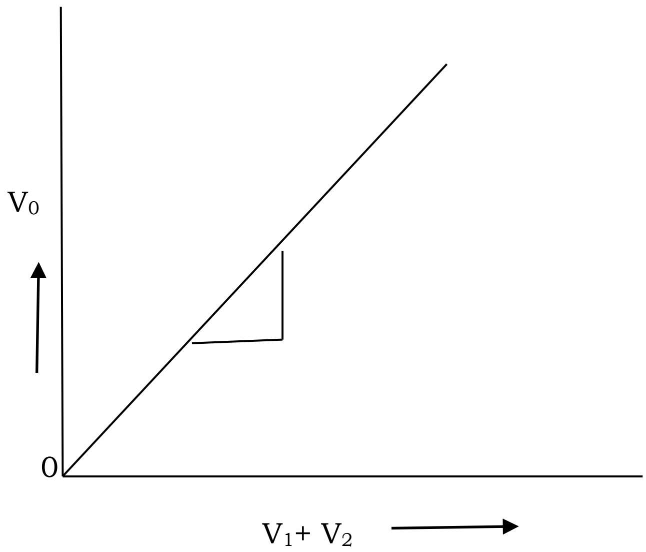
EXPERIMENT-04

OP-AMP AS SUMMING AMPLIFIER

Diagram :



Expected graph :



Observation :

Tabular column :

Sl.no.	V_1(v)	V_2(v)	Experimental output V_0 (v)	Theoritical $V_0 = -(V_1 + V_2)$
1	1	2		
2	0.5	1.5		
3	2	1.5		
4	2.5	2		

Aim : To study the performance of a summing (Adder) using an op-amp

Principle : An **op amp** is an **amplifier**. ... We can design an **op amp circuit** to combine number of input signals and to produce single output as a weighted **sum** of input signals. **Summing amplifier** is basically an **op amp circuit** that can combine numbers of input signal to a single output that is the weighted **sum** of the applied inputs.

Formula :

$$V_0 = -(V_1 + V_2) \text{ ---------v}$$

Where V_1 & V_2 are input voltages

V_0 is the out put voltage

Procedure :

- Circuit connections are made as shown in the figure
- The non-inverting terminal is grounded
- The two input voltages to be added are applied to input inverting resistor ie $R_1 = R_2 = 10\ k\Omega$
- V_1 is varied in steps of 0.5 v to 5 v and V_2 is varied in steps of 0.5 v to 5 v
- The output voltage is measured and the values are noted
- The theoretical output $V_0 = -(V_1 + V_2)$ in each case and compared with experimentally measured output
- A graph of output voltage versus input voltage $(V_1 + V_2)$ drawn and the slope of straight line is determined

Result :

Experimentally it is found that for differegnt values of V_1& V_2 , output voltage is equal to the algebraic sum of input voltage

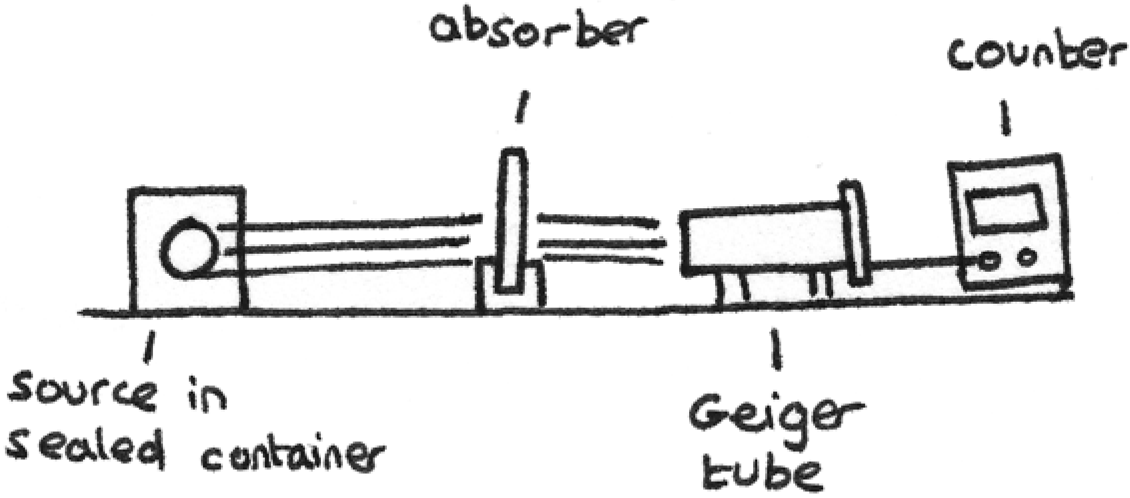
Slope of the graph is determined m= ....

$$m = R_f / R_1 = R_f / R_2 = 1$$

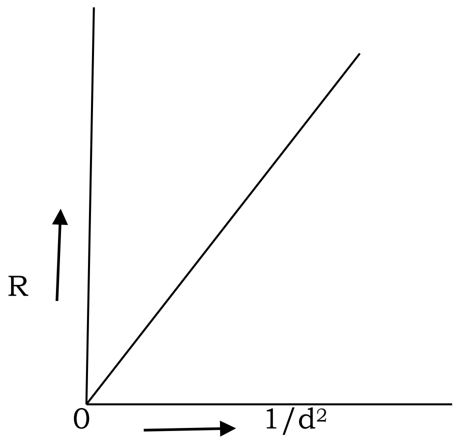
EXPERIMENT-05

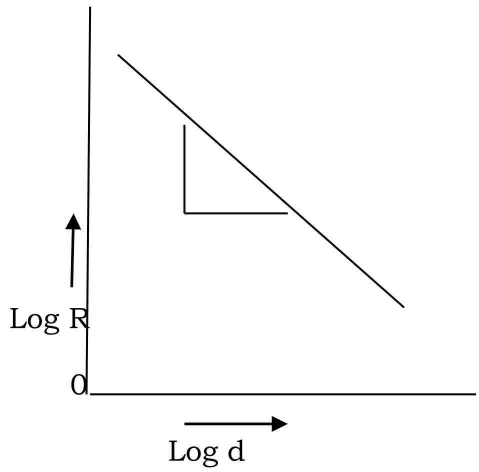
INVERSE SQUARE LAW BY USING GM COUNTER

Diagram:



Expeted graph :





Tabular column 1:

Sl.no	Distance d (cm)	Counts for 60 (secs)	Corrected counts $C=N-N_B/t$	Net count rate = C/60	Product $P=R\ d^2$	Transformation $1/d^2$ in $1/\ m^2$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Tabular column 2:

Sl.no	R	Log R	d	Log d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Aim : To show that the intensity of ray emitted isotopically from a point sourse

Varies inversely as the square of the distance from the source

Principle : the intensity of ray emitted isotopically from a point sourse Varies inversely as the square of the distance from the source

Formula :

$$C \propto 1/R^2$$

$$1/\sqrt{C} \propto R$$

$$\ln c \propto -2 \ln d$$

C is the count rate

R is the distance from the source

D is the corrected distance

Procedure :

- Gcs is connecte d to GM tube mounted on the stand
- Set the EHT(Extra high tension) to operating voltage 460v and present time to 60 secs
- Note the background count N for 60 secs
- Place the radioactive source in the source holder at the second slot and note the count
- Repeat for different slots and note the corresponding counts
- Caluculate the corrected count rate $C = N-N_B/t$
- Plot $1/\sqrt{C}$ versus R find the intercept (R_0) on the x-axis
- Caluculate the corrected distance $d= R + R_0$
- Plot another graph $\ln c$ versus $\ln d$ and determine its slope

Result :

The slope of graph of $\ln c$ versus $\ln d$ is found to be nearly equal to 2.

Hence inverse square law is said to be verified

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