K L University

Department Of Physics

List of experiments conducted in Physics Lab during INSPIRE CAMP held during 29th June to 3rd July 2015

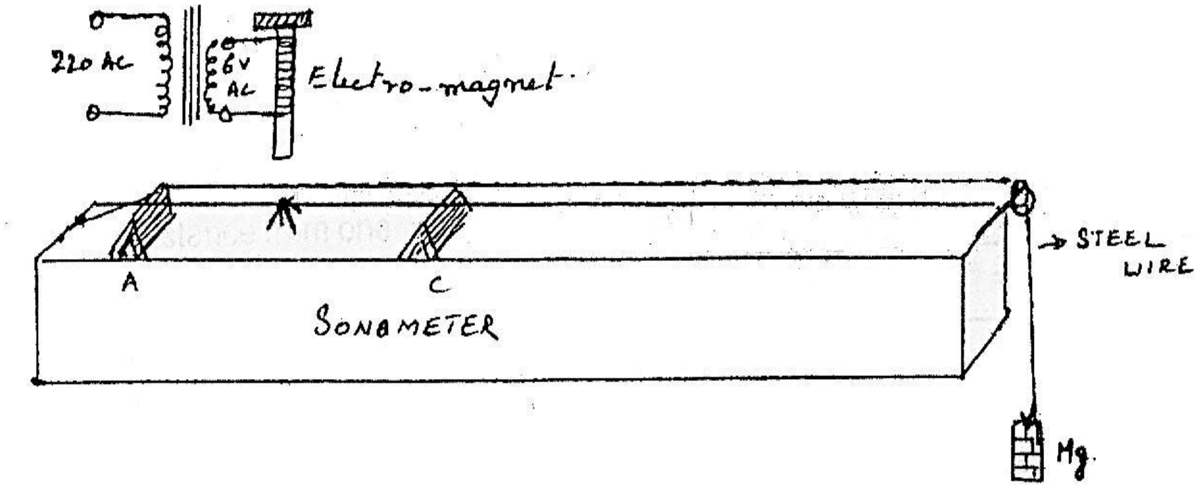
- Frequency of A.C Supply Using Sonometer
- Haidinger Fringers
- Plank's Constant
- Solar Cell
- Magnetic Field Along the axis of Circular Coil
- Laser Difraction Grating

FREQUENCY OF AC SUPPLY USING SONOMETER

AIM: To determine the frequency of an **A.C.** supply using Sonometer.

APPARATUS: Sonometer with a steel wire, Weight hanger, Slotted weights, Step down transformer, Weights, Electromagnet.

DIAGRAM:



FORMULA:

Frequency of **A.C.** power supply, $n^1 = \frac{n}{2} = \frac{1}{4l}\sqrt{\frac{T}{m}}$ Hz

Where

n = Frequency of sonometer in Hz

T = Tension = Mg dyne (M = Mass suspended in gm);

m = Linear mass density of string (X/L) in gm/cm;

X = Mass of the specimen string in gm

L = Length of the suspension string in cm

l = Resonating length in cm (AC, see Figure)

PROCEDURE:

1. The frequency of the given wire in the experiment is found by using the rider method.

2. The apparatus is arranged as shown in the figure. The primary winding of step down transformer is connected to A.C. mains and secondary to the electromagnet. The given steel wire is stretched tightly on the hollow wooden box over the bridges A & C through the pulley.

3. A weight 'M' (say 250 gm) is added to the weight hanger. Initially minimum distance between bridges A & C is maintained and a paper rider is kept on the wire.

4. Now the electromagnet is brought near the center of the stretched wire. Distance between A & C is adjusted till the paper rider falls down. Now the wire segment is in resonance

5. Distance 'AC' is measured. The experiment is repeated by changing the tension of wire and the results are tabulated.

OBSERVATIONS:

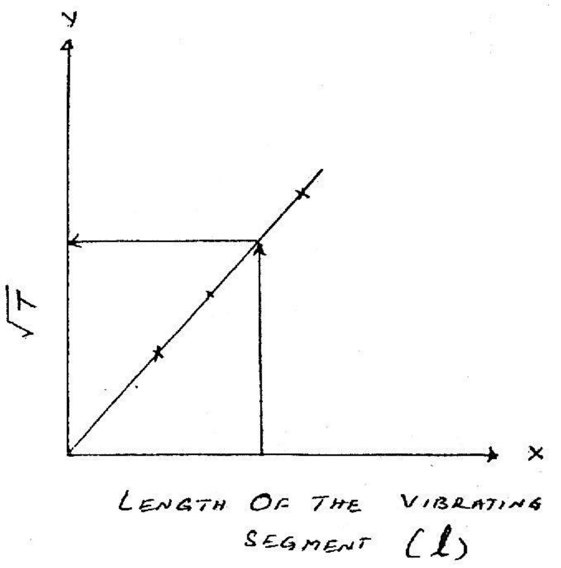
S. No	**Tension (T) = Mg**		**Resonating length l (cm)**			**√T / l (√dyne / cm)**
	T (dyne)	**√T (√dyne)**	**Trail 1**	**Trail 2**	**Mean**	

Average = √T / l =

$$n = \frac{1}{2\sqrt{m}} x \frac{\sqrt{T}}{l} =$$

$$n^1 = \frac{n}{2} =$$

GRAPH: The graph is drawn between √T versus l, taking l on x-axis and √T on y-axis. The graph is straight line passing through origin. n^1 is calculated using the values of √T and l obtained from graph.



PRECAUTIONS:

1. Vibrator should not touch the sonometer wire.
2. Carefully measure the resonating length.
3. Switch off the power supply immediately after taking the readings.

RESULT:

Frequency of the given **A.C.** supply = …………. Hz.

REVIEW QUESTIONS:

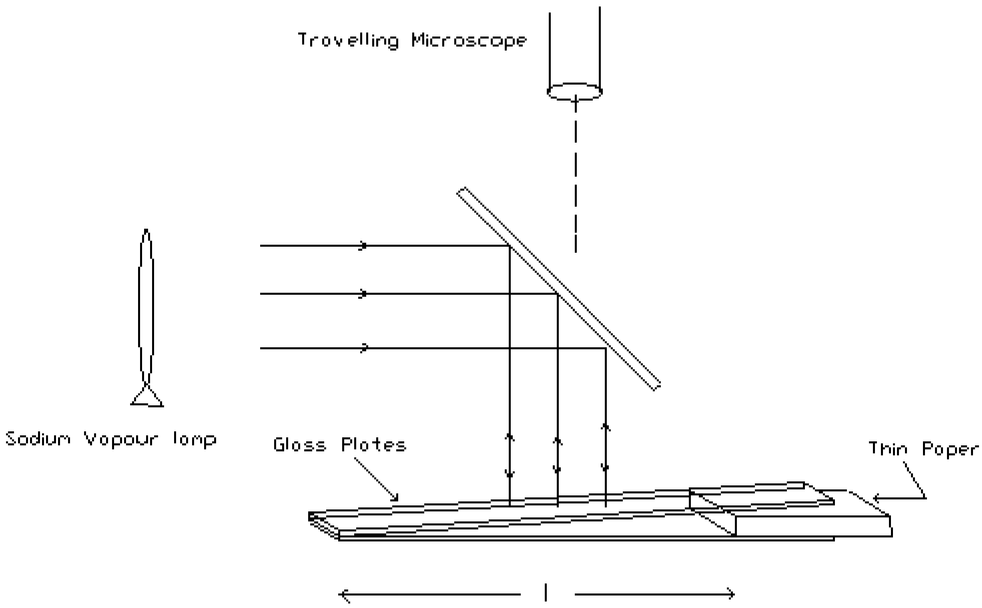
1. What is sonometer?
2. What is resonance?
3. What is law of length?
4. What is law of tension?
5. What is law of mass?
6. Define node and antinode.
7. How transverse stationary waves are produced in a stretched string?
8. How does velocity of a sound vary with humidity?
9. What is the difference between stationary and progressive waves?
10. What kind waves are produced in a stretched string?
11. Define tension.
12. Define sound and in which medium sound travels faster?
13. What are the uses of sonometer?
14. What kind of waves are produced in sonometer wire?

2. HAIDINGERS FRINGES

AIM: To determine the thickness of the paper using wedge method.

APPARATUS: Traveling microscope, Glass slides- 2 No., Thin paper, Table lamp, Reading lens, Reflector, Retard stand, Sodium vapor lamp.

DIAGRAM:



FORMULA:

Thickness of the paper (in cm) $T = \frac{\lambda l}{2\beta}$

Where λ = wavelength of the incident light (in Å)

B = fringe width (in cm)

l = length of the air wedge (in cm)

PROCEDURE:

1. A thin paper is inserted in between the two glass slides and is placed under traveling microscope so that the air wedge between the slides lie under the objective of the microscope.

2. Fix the reflector to a retort stand and change the position of the reflector until the light beam intensity is maximum. In this position the reflector will interrupt the light beam from sodium lamp at 45^0 and the beam falls normally on to the glass slides.

3. Microscope is focused on the wedge, such that alternate dark and bright bands are observed.

4. Screw attached to the microscope is rotated in such a way that it causes displacement. The displacement (either to right or left side) is parallel to the scale (in cm) attached on travelling microscope.

5. Because of this displacement it appears as bright and dark fringes are moving. Now the cross wire is made to coincide with one bright (dark) fringe in the pattern. Initial reading S_1 of the microscope is noted.

6. Microscope is moved and number of fringes crossed by cross wire is counted. Suppose cross wire is made to coincide with 5^{th} fringe than final microscope reading is noted down as S_2. The bandwidth is determined using the following formula.

$$\beta = \frac{S_2 - S_1}{N}$$

7. This process is repeated for 5 to 6 times (for equal interval of fringes) and average value of β is determined.

OBSERVATIONS:

Least count of Travelling Microscope:

1 Main Scale Division (MSD) = 0.05 cm

No. of divisions on vernier scale = 50

Least count = Value of 1MSD / No. of vernier scale divisions

= 0.05cm/50 = 0.001cm

S. No.	No. of the Fringe	MSR (a) (cm)	VC	VC x LC (b) (cm)	Total (a + b) (cm)

Determination of band width:

S. No.	No. of Fringes (N)	Microscope Reading (cm)		$\beta = \frac{S_2 - S_1}{N}$ (cm)
		Initial (S_1)	Final (S_2)	
				Avg. β =

CALCULATION:

Substituting the value of β in the given formula $T = \frac{\lambda l}{2\beta}$ the thickness of the paper is calculated.

PRECAUTIONS:

1. While taking reading move in one direction (either to right or left side).
2. Take readings without parallax error.
3. Do not disturb the setup until all the readings have been noted down.

RESULT:

The thickness of the given paper = ………………. cm.

REVIEW QUESTIONS:

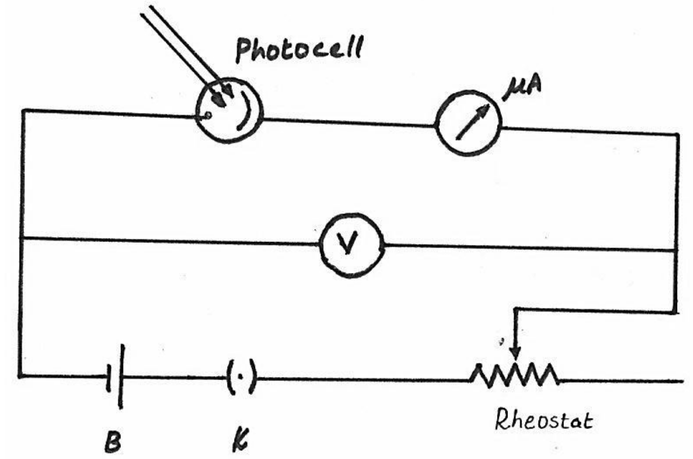
1. What is interference?
2. Why bright and dark fringes are appeared in the experiment?
3. How wedge is formed?
4. What is a fringe width?
5. What is the relation between path difference and phase difference?
6. If light travels from denser medium to rarer medium how much phase difference it exhibits?
7. What are the conditions for getting bright and dark fringes?
8. If we take mercury lamp instead sodium lamp, how the fringes will appear?
9. If the thickness of the paper increases how the fringe will appear?
10. What is coherence?
11. Explain constructive and destructive interferences.
12. Give the relation between intensity and amplitude of the wave.
13. What is the nature of light?
14. State Stokes theorem.
15. What is the principle of superposition?
16. What happens to the fringes when sodium vapour lamp is replaced with laser?
17. How the fringe width varies with wavelength (if t and l are constant).
18. Why normal incidence is preferred?

3. PLANCK'S CONSTANT

AIM: To determine the value of Planck's constant "h".

APPARATUS: Photo cell, Power supply, Light source, Filters, Planck's constant kit and Connecting wires.

DIAGRAM:



THEORY:

From Einstein theory of Photo-electric effect

$$h\nu = {}^{1}\!/_{2}\, mv^2 + w$$

Where $h\nu$ is the energy of incident light photon,

$\frac{1}{2} mv^2$ is kinetic energy gained by electrons.

W is the work function.

If ν_o is threshold frequency, then work function $W = h\nu_o$. If V_o is stopping potential, then $(\frac{1}{2}) mv^2 = eV_o$, where 'e' is the charge of electron. Now

$$h\nu = h\nu_o + eV_o$$

$$eV_o = h\,\nu - h\,\nu_o$$

$$V_o = (h/e)\nu - (h/e)\,\nu_o$$

The above equation can be compared with a straight line Y = mx+c

PROCEDURE:

1. The connections are made as per the circuit diagram. Light of fixed wavelength (red light) is made to fall photocell by placing the red filter in the path of light.
2. The potentiometer is varied until the photo current becomes zero and the value of stopping potential is noted.
3. Following the same procedure, for different filters (orange and yellow etc.) the values of stopping potential are noted. The observations are noted in the following table.

OBSERVATIONS:

For high intensity:

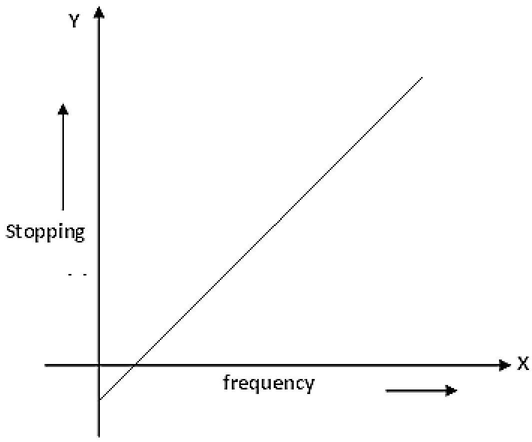
S. No	Filter	Wave length (A^0)	Frequency (Hz)	Stopping potential V_0 (volt)
1.	Blue	$4602A^0$	$6.52x10^{14}$	
2.	Green	$5500\ A^0$	$5.89\ x10^{14}$	
3.	Yellow	$5790\ A^0$	$5.18\ x10^{14}$	
4.	Orange	$6234\ A^0$	$4.81\ x10^{14}$	
5.	Red	$6907\ A^0$	$4.35\ x10^{14}$	

For medium intensity:

S. No	Filter	Wave length (A^0)	Frequency (Hz)	Stopping potential V_0 (volt)
1.	Blue	$4602A^0$	$6.52x10^{14}$	
2.	Green	$5500\ A^0$	$5.89\ x10^{14}$	
3.	Yellow	$5790\ A^0$	$5.18\ x10^{14}$	
4.	Orange	$6234\ A^0$	$4.81\ x10^{14}$	
5.	Red	$6907\ A^0$	$4.35\ x10^{14}$	

GRAPH:

A graph is drawn by taking frequency values on X - axis and stopping potential value on Y- axis. The graph is a straight line not passing through origin. We can equate the slope of the above straight line with (h/e) value obtained from the formula shown above.



PRECAUTIONS:

1. Do not set the lamp very close to the photo cell.
2. Take the readings without parallax error.

RESULT:

The value of Planck's constant, h = …………….. J – Sec.

REVIEW QUESTIONS:

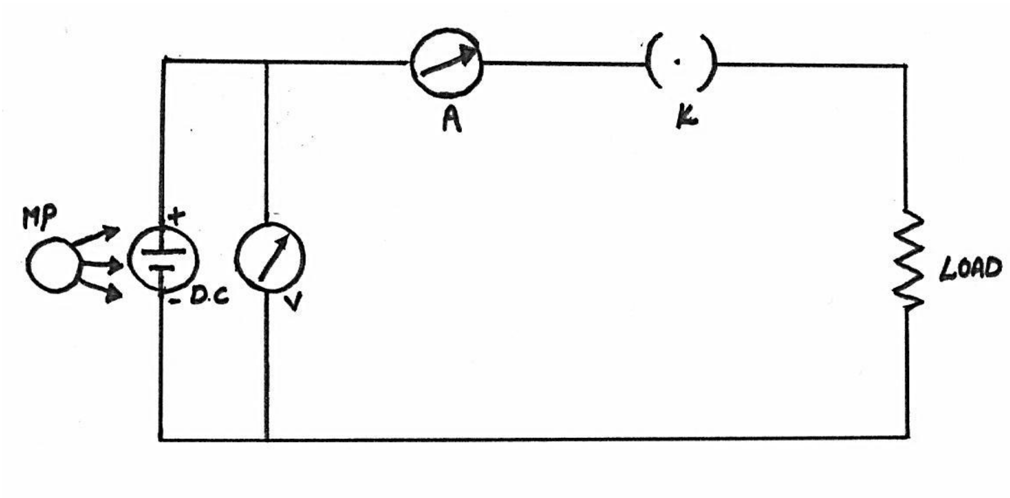
1. What is photo electric effect
2. What is the value of Planks constant
3. What are the units of Planks constant
4. Who discovered the photoelectric effect
5. Does the planks constant depend on the metal of cathode of the frequency of light Incident
6. What is work function
7. Does the work function depend on incident light and the cathode metal?
8. What is threshold frequency
9. What is stopping potential
10. What is photo cell
11. Are all the metals useful for photoelectric effect?
12. Photo electric affect which nature of light.
13. What is a proton
14. What are the laws of photoelectric emission
15. What is the charge of electron in esu?
16. What is an electromagnetic wave?
17. Who discovered photoelectric effect?
18. Who explained photoelectric effect?
19. What are photo metals?
20. How does photo current vary with respect to intensity?
21. Work function depends on what factors?
22. Write Einstein Photo electric equation.
23. How does Kinetic energy of electron vary with frequency?
24. Photoelectric effect supports which theory of light?

4. SOLAR CELL

AIM: To draw solar cell characteristics and to determine the fill factor of the cell.

APPARATUS: Solar cell, Ammeter, Voltmeter, Variable load, key, lamp.

DIAGRAM:



FORMULA: The fill factor (η) of the solar cell is given by

$$\eta = \frac{I_{mp}}{I_{sc}} x \frac{V_{mp}}{V_{oc}} = \frac{\text{max. } useful\ \ power}{ideal\ \ power}$$

Where	I_{mp}	:	Current at max. Power amp
	V_{mp}	:	Voltage at max. Power Volts
	I_{sc}	:	Short circuit current amp
	V_{oc}	:	Open circuit voltage Volts

PROCEDURE:

1. Connect the circuit as shown in the diagram
2. Switch on the lamp. Keep the lamp close to the solar cell and set it so that the incident light falls normally on the cell.
3. Set the load resistance max (say 1000 Ω) measure the open circuit voltage V_{oc}.
4. Close the key. Keep zero resistance in the load. Note down the short circuit current I_{sc}.

5. Vary the load in equal steps. For each load, note down the output current, I, and voltage, V.

6. Enter the readings in a tabular form.

OBSERVATIONS:

S. No.	Load, R (Ω)	Voltage V (mV)	Current I, (mA)	Power P = VI (watt)

Open circuit voltage, V_{oc} = mV.

Short circuit current, I_{sc} = mA.

Voltage at Max.power, V_{mp} = mV

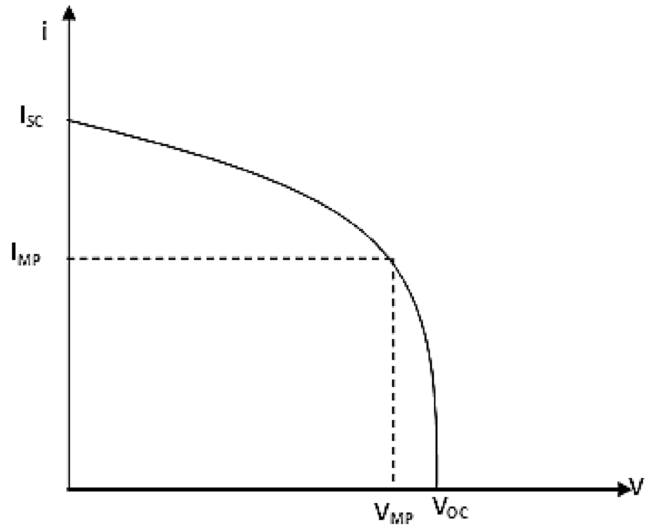
Current at max.power, I_{mp} = mA.

Fill factor,

$$\eta = \frac{I_{mp}}{I_{sc}} x \frac{V_{mp}}{V_{oc}} = \frac{\max. \, useful \;\; power}{ideal \;\; power}$$

MODEL GRAPH:

A graph is plotted by taking values of voltage along X-axis and the corresponding values of current on the Y-axis.



PRECAUTIONS:

1. Do not set the lamp very close to the cell. Otherwise the solar cell will be heated up and the characteristics may change.
2. Keep the intensity of the light constant throughout the experiment.
3. Change the load at equal steps slowly.

RESULT:

The fill factor of the cell, η, is ………………..

REVIEW QUESTIONS:

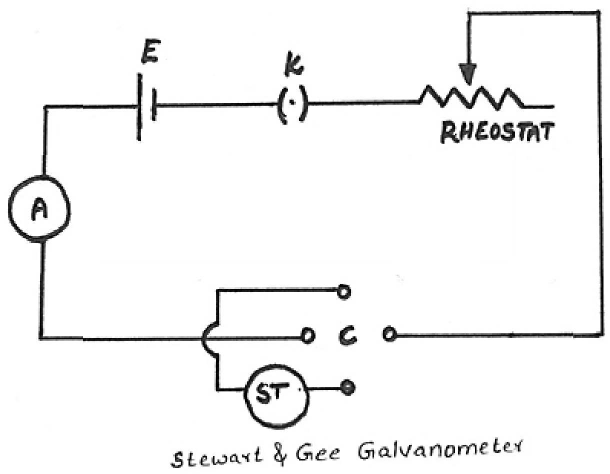
1. What is the principle behind working of a solar cell?
2. What is the formula for fill factor?
3. What are the units of fill factor?
4. What is the physical significance of a fill factor?
5. What is work function?
6. What happens to the current when voltage increases?
7. What is short circuit current?
8. What is open circuit voltage?
9. What is the material with which solar cell is prepared?
10. Why should we maintain certain distance between the solar cell and the bulb?
11. What is a junction diode?
12. What is a depletion layer?
13. What is Fermi level?
14. Define efficiency of a solar cell.
15. Write the formula for efficiency.
16. What are the units of efficiency?
17. What is ideal power?
18. What is maximum useful power?
19. Define V_{mp} and I_{mp}.
20. Which type of current is generated in solar cell?
21. Which wavelength is preferred for solar power generation and why?
22. What are the advantages of solar energy?

5. FIELD ALONG THE AXIS OF THE COIL

AIM: To study the variation of magnetic field along the axis of a circular coil carrying current.

APPARATUS: Stewart & Gee type galvanometer, Power supply, Plug key, Commutator, Rheostat and Ammeter.

DIAGRAM:



FORMULA: The magnetic field 'B' at a point on the axis of a circular coil of 'n' turns and radius 'a' is given by the equation.

$$B = \frac{2\pi n i a^2}{10\left(x^2 + a^2\right)^{3/2}}$$

Where

i = Current passing through the coil in mA,

x = Distance of the point from the center of the coil in cm

n = Number of turns,   a = Radius of the circular coil in cm.

PROCEDURE:

1. The circuit is connected as shown in the figure. The primary adjustments of the instrument are made.
2. The coil of the instrument is set along the magnetic meridian (Tan A) position. The Al pointer is made to read 0 - 0 readings with no current.
3. The ends of the coil are connected to the Commutator and through it to battery rheostat and ammeter.

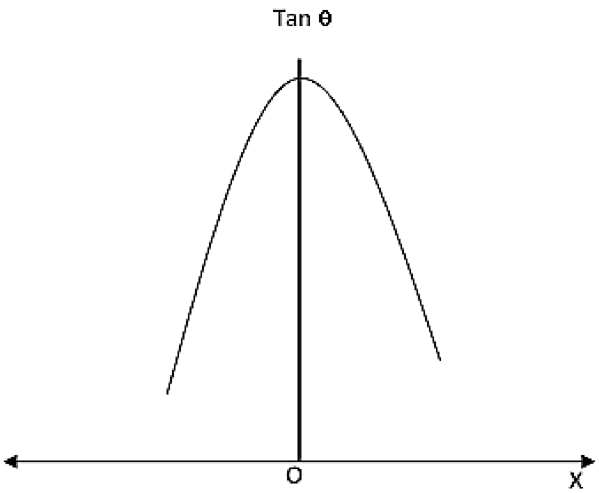
4. When the circuit is closed with the plug key current flows through the circular coil. A magnetic field is produced on the axis of the coil.
5. The magnetic needle is deflected through an angle θ from the direction of horizontal component of earth's magnetic field, H. Thus we get the equation $B = B_H \tan\theta$
6. The current in the circuit is adjusted such that the deflection lies between $30^o - 60^o$ using the rheostat.
7. The compass box is placed 5cm away from the center of the coil on its axis. The deflection θ_1 and θ_2 of the Al pointer are noted. The deflections θ_3 and θ_4 were also noted after reversing the current in the coil.
8. The experiment is repeated in steps of 5cm, on the same side and other side of the coil. For each distance mean deflection θ is calculated.

OBSERVATIONS:

S. No	**Position of the magneto-meter**	**Distance (x) (cm)**	**Deflections (deg.)**					**Tan θ**	**B = B_H Tan θ (amp/cm)**	$B = \frac{2\pi nia^2}{10(x^2+a^2)^{3/2}}$ (amp/cm)
			θ_1	**θ_2**	**θ_3**	**θ_4**	**Mean θ**			
1.	Center	0								
2.	Left	5								
		10								
		15								
3.	Right	5								
		10								
		15								

MODEL GRAPH:

A graph is plotted by taking distance on x axis and main deflection on y axis. The graph shows the variation of magnetic field along the axis of the circular coil with distance. It is symmetrical about y axis and magnetic field is maximum at the center of the coil.



PRECAUTIONS:

1. The Galvanometer should not be disturbed after making preliminary adjustments.
2. The deflection should be observed without any parallax error.

RESULT:

The variation of magnetic field along the axis of the coil is studied.

REVIEW QUESTIONS:

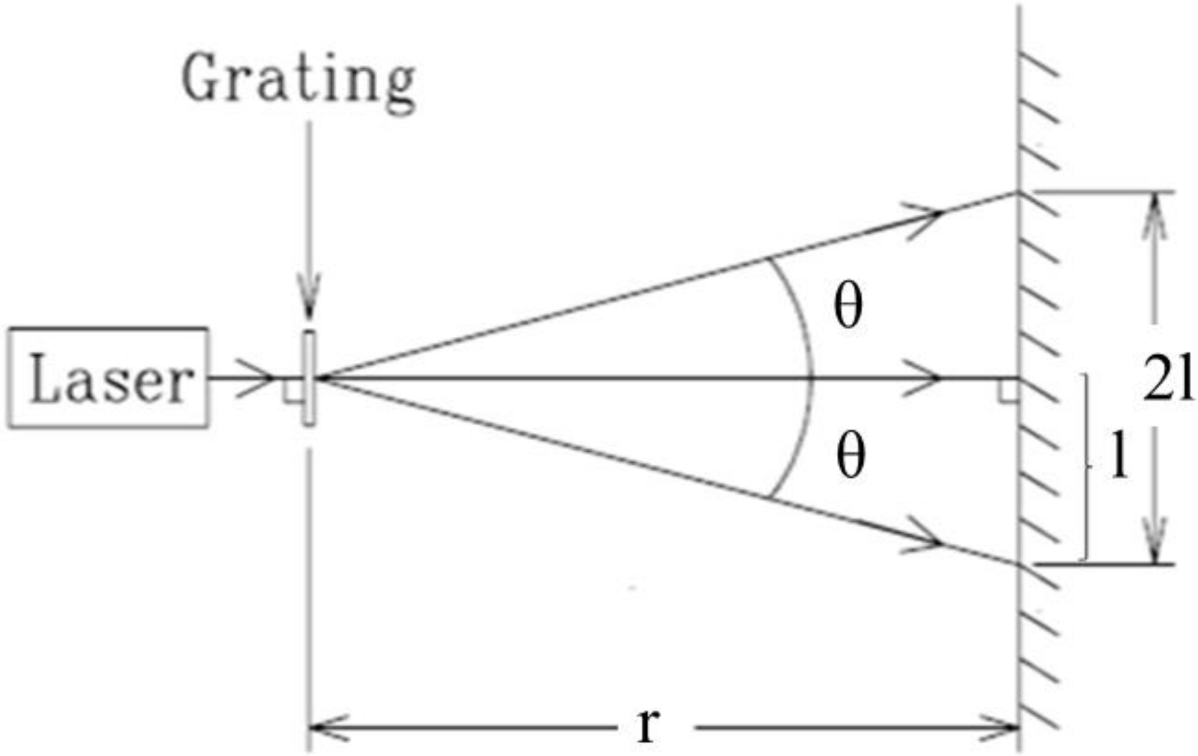
1. State Ampere's law.
2. State Biot Savart's law.
3. What is TAN A position?
4. What is TAN B position?
5. What is the use of Commutator?
6. Explain the use of Rheostat.
7. How field varies with respect to no. of turns?
8. What is the difference between a magnet and magnetic material?
9. Is current carrying conductor electrically neutral?
10. What is tangent law?
11. Define Faraday and Lenz's law.

6. LASER DIFFRACTION GRATING

AIM: To determine the wavelength of laser beam using diffraction grating.

APPRATUS: Diode laser, transmission grating, screen, meter scale.

DIAGRAM:



FORMULA:

$$\text{Wavelength } (\lambda) = \frac{\text{Sin } \theta}{nN}$$

where 'θ' is the angle of diffraction.

$$\theta = \frac{l}{r} x \frac{180}{\Pi} \text{ degree}$$

n: is the order of the spectrum; N: is the number of lines per cm of the grating.

l: is the distance of n^{th} principal maxima from the central maxima.

r: is the distance of the screen from the grating.

PROCEDURE:

1. Mount the grating on the stand. Illuminate the grating with laser beam.
2. The beam on the grating produces several spots due to diffraction.
3. The bright spot is central maximum. The other spots on both sides of central maximum are principal maxima.
4. Measure the distance (l) of the n^{th} principal maxima from the central maxima. Also measure the distance (r) of screen from the grating.
5. Note the number of lines per cm given on the grating plate. Calculate wavelength using the formula given below.

$$\lambda = \frac{\sin\theta}{nN}$$

OBSERVATIONS:

Order of the spectrum, n =

S. No.	**No. of lines per cm of the grating (N)**	**Distance of spot from central maxima (l) (cm)**	**Distance of screen from grating (r) (cm)**	$\theta = \frac{l}{r} x \frac{180}{\pi}$ **(degree)**	$\lambda = \frac{\text{Sin } \theta}{nN}$ **Å**

PRECAUTIONS:

1. Light should fall normally on the grating.
2. Do not see the straight towards the LASER light.

RESULT:

The wavelength of the laser is obtained as …............ Å

REVIEW QUESTIONS:

1. What a LASER.
2. What are the special characteristics of LASER light?
3. What are monochromatic and polychromatic lights?
4. Is LASER light monochromatic or polychromatic?
5. Define coherence
6. What are different methods to get coherent beam of light?
7. What is ground state?
8. What is stimulated absorption?
9. Define mean life of an energy level in a system?
10. What is meta stable state?
11. What is population inversion?
12. What is meant by pumping?
13. Define spontaneous emission.
14. Define stimulated emission.
15. Write the condition to get lasing action in a system.
16. What are the different types of lasers based on active medium?
17. Define diffraction.
18. What are the conditions for obtaining diffraction of light?
19. Distinguish Fresnel and Fraunhoffer's diffraction.
20. Which atoms are responsible for lasing action in Ruby laser?
21. What are the lasing atoms in He-Ne laser?
22. Which method is used to pump the atoms in Ruby laser?
23. What is the technique used to promote Neon atoms in He-Ne laser?
24. What is the fundamental difference between interference and diffraction?
25. What are the applications of laser light?