1. Determination of dielectric constant of the sample

AIM

To determine the dielectric constant of the given sample at different temperatures.

Theory

Dielectrics are the insulating materials having electric dipole moment permanently or temporarily by applying the electric field. These are mainly used to store electrical energy and used as electrical insulators. All dielectrics are electrical insulators. But all electrical insulators need not to be dielectrics. Dielectrics are non-metallic materials of high specific resistance and have negative temperature coefficient of resistance.

The capacitance of a capacitor increases when it is filled with an insulating medium. The increase in the capacitance depends on the property of the medium, called dielectric constant (ε). It can be measured using either static or alternating electric fields. The static dielectric constant is measured with static fields or with low frequency ac fields. At higher frequencies, values of dielectric constant become frequency dependent. The dielectric constant varies with temperature also.

This is a prime parameter to characterize a capacitor. A capacitor is an electronic component designed to store electric charge. This is widely built by sandwiching a dielectric insulating plate in between the metal conducting plates. The dielectric property plays a major role in the functioning of a capacitor.

When a dielectric material loses its property and permits the flow of a large current, it is known a dielectric breakdown.

PROCEDURE

APPARATUS

The given sample, capacitance meter, dielectric sample cell, digital temperature indicator etc.

Determination of dielectric constant

1. The given dielectric sample inside the dielectric cell in its position without forming air gap between the plates of the sample holder.
2. Connect the thermocouple leads to a digital temperature indicator to measure the temperature of the dielectric cell
3. Also, connect the capacitance meter to the dielectric cell
4. Connect the heater terminals of the dielectric cell to ac mains through a dimmerstat.
5. At room temperature, measure the capacitance of the sample using capacitances meter.
6. Now switch on the heater and measure the capacitance of the sample at different temperature (in steps of 10°C starting from room temperature).
7. The given dielectric sample inside the dielectric cell in its position without forming air gap between the plates of the sample holder.
8. Connect the thermocouple leads to a digital temperature indicator to measure the temperature of the dielectric cell
9. Also, connect the capacitance meter to the dielectric cell
10. Connect the heater terminals of the dielectric cell to ac mains through a dimmerstat.
11. At room temperature, measure the capacitance of the sample using capacitances meter.
12. Now switch on the heater and measure the capacitance of the sample at different temperature (in steps of 10°C starting from room temperature).
13. Measure the thickness of the sample (*d*) using the micrometer screw attached in the sample cell
14. Measure the diameter of the sample using a vernier caliper and determine the radius of the sample
15. Calculate the capacitance of the air capacitor using, the relation

$$C_0 = \frac{\varepsilon_0 (\pi r^2)}{d}$$

16. Calculate the dielectric constant of the sample at different temperatures using the relation.

$$\varepsilon_r = \frac{C}{C_0}$$

    and tabulate the readings in the table

17. Plot a graph by taking temperature along X axis and dielectric constant along Y axis.

18. The dielectric constant of the sample is given by,

ε_r = C / C_0 (No unit)

where C = capacitance of the sample (farad)

C_0 = Capacitance of the air capacitor having the same area and thickness as the sample (farad)

19. The capacitance of air capacitor is given by,

$$C_0 = \frac{\varepsilon_0 A}{d} \text{(farad)}$$

where ε_0 = permittivity of free space

= 8.854×10^{-12} farad / metre

A = area of the plates of the capacitor

(A = πr^2 : r = radius of the sample)

d = thickness of the sample (or) distance between the plates (m)

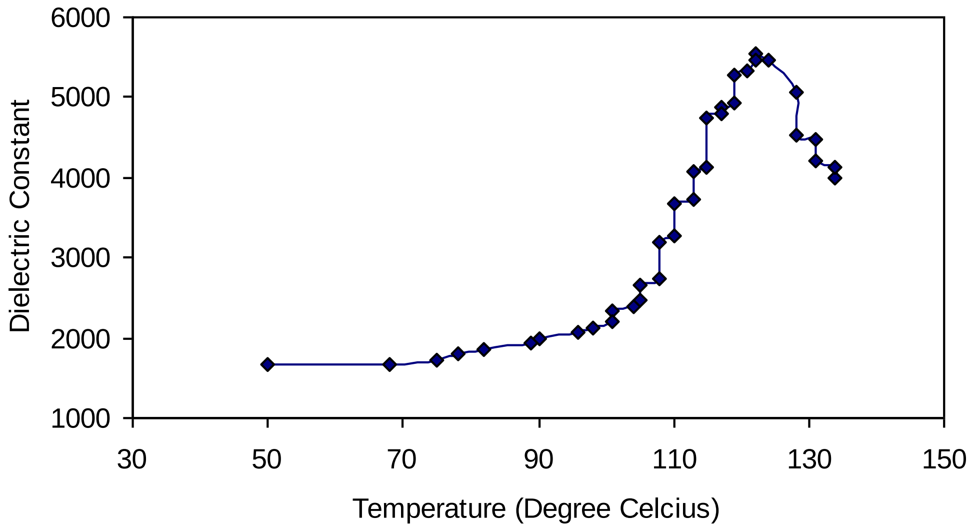


Fig. 1.1. Dielectric Constant versus Temperature for barium titanate

Determination of dielectric constant of the sample:

Sl.No.	Temperature (°C)	Capacitance (Farad)	Dielectric constant $\left(\varepsilon_r = \frac{C}{C_0}\right)$

Observation

The radius of the sample (r) = ………………….m

The thickness of the sample (d) =…………………..m

Calculation

The area of the plates of the capacitor = πr^2 =…….. m^2

The capacitance of the air capacitor,

$$C = \frac{\varepsilon_0 A}{d} = \text{.........} \; farad$$ The dielectric constant of the sample

$$\varepsilon_n = \frac{C}{C_0}$$

RESULT

The dielectric constants of the given sample at different temperature are measured and a graph is plotted between the temperature and dielectric constant.

Assignment Questions (Self-Evaluation):

1. Define dielectric constant
2. On what factors dielectric constant depends?
3. What is dielectric constant formula?
4. Does dielectric constant depend on temperature?
5. What are requirements of good insulating materials?
6. What is dielectric break down?
7. What is the effect of dielectric when it is placed in an electric field?

References:

1. 18PYB101J Instructional manual
2. https://vlab.amrita.edu/?sub=1&brch=282 -Solid State Physics virtual lab
3. Introduction to Solid State Physics – C. Kittel, Wiley Eastern Limited (5th Edition).

2.Calibration of ammeter using potentiometer

AIM

To calibrate the given ammeter by potentiometer. (i.e. To check the graduations of ammeter and to determine the corrections, if any).

Theory:

The calibration is the process of checking the accuracy of the result by comparing it with the standard value. In other words, calibration checks the correctness of the instrument by comparing it with the reference standard. It helps us in determining the error occurs in the reading and adjusts the voltages for getting the ideal reading.

Ammeters work to measure electrical current by measuring the current through a set of coils with a very low resistance and inductive reactance. This allows for a very low impedance, the force that opposes electric current, that lets the ammeter accurately measure the current in a circuit without interference or change due to the ammeter itself.

In moving-coil ammeters, movement results from the fixed magnets that are set to oppose the current. The movement then turns a centrally located armature that is attached to an indicator dial. This dial is set above a graduated scale that lets the operator know how much current is moving through a closed circuit.

The fundamental requirement of any measuring instrument is that it should not change the physical quantity to be measured. For example, an ammeter should not change the original current. But this is not possible in practice. In an electric circuit, the initial current is $I_1 = E/R$ before connecting the ammeter. Assume that the internal resistance of the cell is zero.

Galvanometers detect the strength and direction of minuscule currents in circuits. A pointer attached to the coil moves over a scale. The scale is then calibrated to read the current in ampere.

Galvanometers require a magnetic field while ammeters can work without one. While a galvanometer has much more precision than an ammeter does, it isn't as accurate. This means galvanometers can be very sensitive to small changes in current, but this current could still be far from the actual value.

Galvanometers can only measure DC because they require the force of the electric current in a magnetic field while ammeters can measure both DC and AC. DC ammeters use the moving-coil principle while AC ammeters measure changes in how a piece of iron moves in the presence of the electromagnetic force of a fixed coil wire.

PROCEDURE

APPARATUS REQUIRED

Potentiometer, rheostat, batteries (2V and 6V) (or) accumulators, keys, Daniel cell, high resistance, sensitive table galvanometer, the given ammeter, a standard resistance (1 Ω) (or) a dial type resistance box (1–10 ohm) connecting wires etc.

Part 1 : To standardize the potentiometer (or) To find the potential fall across one metre length of the potentiometer

1. The circuit connections are made as shown in fig. (6.14) and is described below.
2. A primary circuit is made by connecting the positive terminal of a battery to the end A of the potentiometer and its negative terminal to the end B through a key (K_1).
3. A secondary circuit is made by connecting the positive terminal of the Daniel cell to A and its negative to the jockey through a high resistance (HR) and a sensitive galvanometer.
4. The rheostat is adjusted to send a suitable current through the circuit.
5. Since the accumulator has a constant e.m.f. the potential drop across the potentiometer wire remains steady.
6. Next the jockey is moved along and pressed along the 10-metre potentiometer wire, till the position for the null deflection is found in the galvanometer.
7. Calibrated current passing through standard resistance

$$i' = \frac{1.08}{R\ell_0}\ell \ (amp)$$

where R= Standard resistance (1 Ω)

l = Balancing length for different ammeter readings (m)

l_0 = Balancing length corresponding to e.m.f. of Daniel cell (m)

8. Let the balancing length be l_0 meter (AJ). Then, the potential drop per unit length of the potentiometer $\frac{1.08}{l_0}$ is calculated. The rheostat should not be disturbed hereafter.

Circuit Diagrams

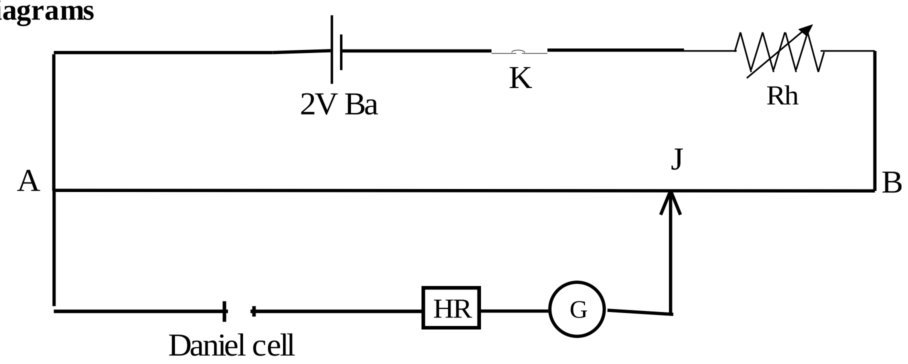


Fig. 2.1. Standardization of Potentiometer

Part 2 : To calibrate the given ammeter

1. In order to calibrate the given ammeter, the primary circuit of the potentiometer is left undisturbed.
2. In the secondary circuit the voltmeter is replaced by a standard one-ohm resistance (or a dial resistance box).
3. One end of one ohm resistance is connected to A and the other end is connected to jockey through a high resistance (HR) and galvanometer [figure (6.15)].
4. In addition an ammeter, plug key (K_2), a rheostat and a 6V battery are connected in series to ends of one ohm standard resistance.
5. The rheostat of the ammeter is adjusted to read 0.1 A and the jockey is moved and pressed to get null deflection in the galvanometer. The second balancing length l m is determined, and i' is calculated using the given formula.
6. The experiment is repeated by adjusting the rheostat in the secondary circuit, so that the ammeter readings are successively 0.2, 0.3, …..1 ampere.
7. The current flowing through the circuit is calculated in each case and the corrections to the readings of the ammeter (i' – i) are tabulated.

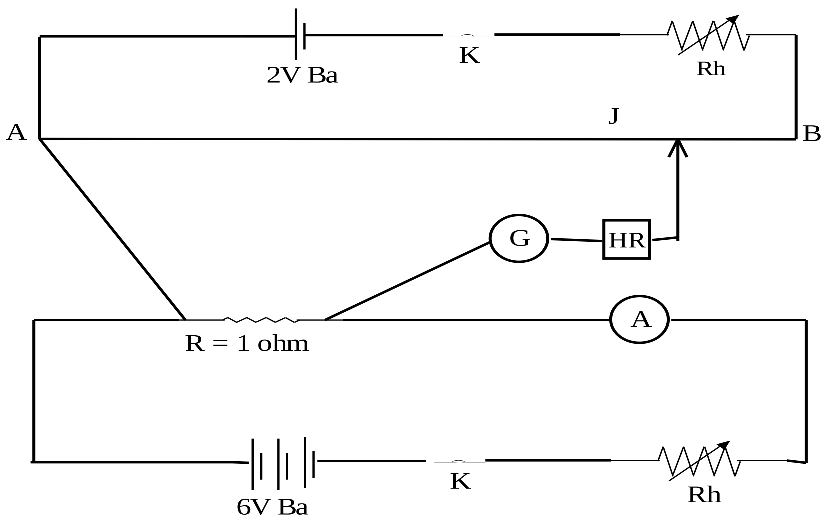


Fig. 2.2. Calibration of Ammeter

Observations

To calibrate the given ammeter

Balancing length l_0 = ……… $\times 10^{-2}$ m

(Length of the wire balancing the emf of the Daniel cell)

S.No.	Ammeter reading i (A)	Length balancing the p.d across l ohm coil l m	Calculated ammeter reading $i' = \frac{1.08}{l_0} \times l$ (A)	Correction (I′– i) (A)

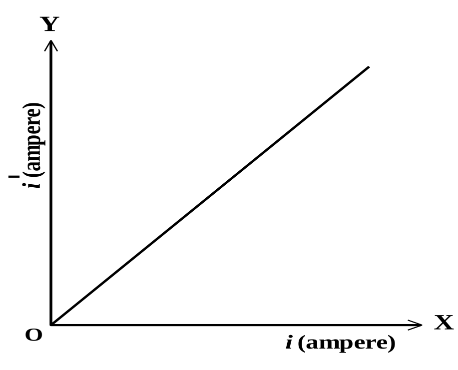


Fig. 2.3. Model Graph (*i vs i′*)

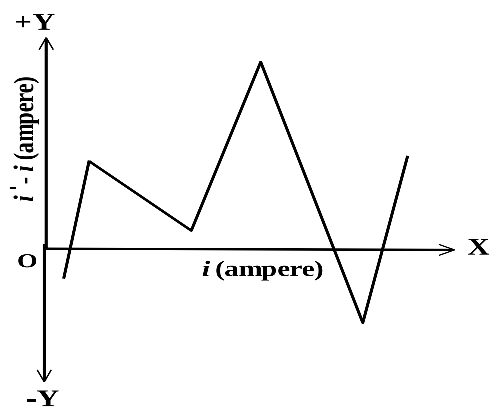


Fig. 2.4. Model Graph *i* vs (*i′ – i*)

Graph

1. A graph between ammeter reading (*i*) along the X-axis and the correction (*i'* – *i*) along the y – axis is drawn.
2. A graph between ammeter reading (*i*) and calculated ammeter reading *i'* is also drawn.

RESULT

The given ammeter is calibrated.

Assignment Questions (Self-Evaluation):

1. What is calibration of ammeter?

2. What is usually used to calibrate a potentiometer?

3. How is the voltmeter be calibrated with DC potentiometer?

4. Do voltmeters need calibration?

5. Why calibration of instrument is important?

6. Explain the calibration procedure.

7. Define Calibration

References:

1. 18PYB101J Instructional manual
2. https://vlab.amrita.edu/?sub=1&brch=282 -Solid State Physics virtual lab
3. Introduction to Solid State Physics – C. Kittel, Wiley Eastern Limited (5th Edition).

3. Calibration of voltmeter using potentiometer

AIM

To calibrate the given voltmeter by potentiometer. (i.e. To check the graduations of voltmeter and to determine the corrections, if any).

Theory:

A potentiometer instrument for measuring the potential (or voltage) in a circuit taps off a fraction of a known voltage from a resistive slide wire and compares it with the unknown voltage by means of a galvanometer. The potentiometer method is the usual basis for the calibration of voltmeters. Since the potentiometer is a DC measurement device, the instrument to be calibrated must be of the DC or electrodynamometer type. One of the first requirements in this calibration procedure is that a suitable, stable DC supply be available, since any variation in the supply voltage causes a corresponding change in the voltmeter calibration voltage.

Calibrated voltage $V' = \frac{1.08}{l_0} l \ (volt)$

where l_0 = Balancing length corresponding to e.m.f. of Daniel cell (m)

l =Balancing length for different voltmeter reading (m)

PROCEDURE

APPARATUS REQUIRED

Potentiometer, rheostat, battery (2V) (or) accumulators, keys, Daniel cell, high resistance, sensitive table galvanometer, given voltmeter, connecting wires etc.

Part 1 : To standardize the potentiometer (or) To find the potential fall across one metre length of the potentiometer

1. The circuit connections are made as shown in fig. (6.10) and is described below.
2. A primary circuit is made by connecting the positive terminal of a battery to the end A of the potentiometer and its negative terminal to the end B through a key (K_1).
3. A secondary circuit is made by connecting the positive terminal of the Daniel cell to A and its negative to the jockey through a high resistance (HR) and a sensitive galvanometer.
4. The rheostat is adjusted to send a suitable current through the circuit.
5. Since the accumulator has a constant e.m.f. the potential drop across the potentiometer wire remains steady.
6. Next the jockey is moved along and pressed along the 10-metre potentiometer wire, till the position for the null deflection is found in the galvanometer.

Circuit Diagrams

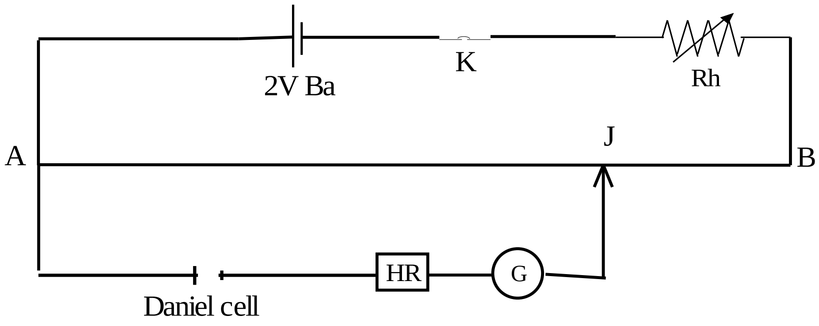


Fig. 3.1. Standardization of Potentiometer

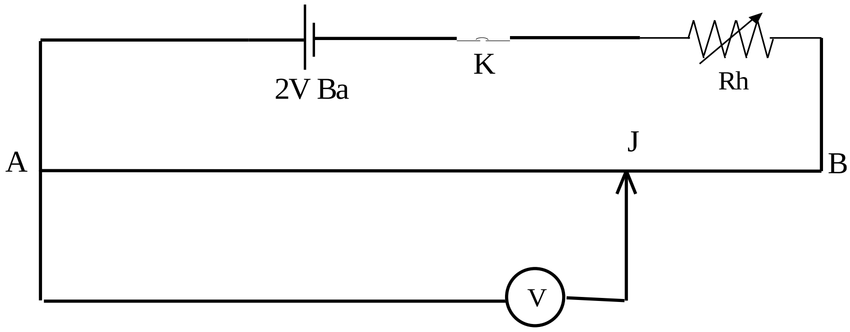


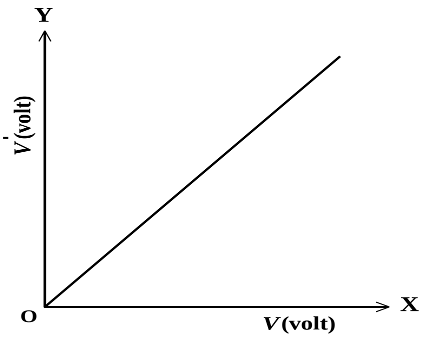
Fig. 3.2. Calibration of Voltmeter

Observations

Table 6.1a: To calibrate the given voltmeter

Length of the wire balancing the e.m.f. of the Daniel cell (l_0) = …… $\times 10^{-2}$ m

S. No.	Voltmeter reading (V) volt	Balancing Length (l) m	Calculated voltmeter reading $V' = \frac{1.08}{l_0} \times l\ (volt)$	Correction (V′ – V) Volt



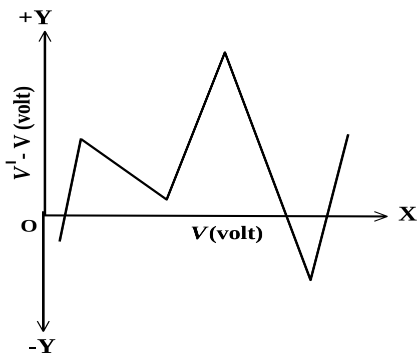


Fig. 3.3. Model Graph (*V vs V'*)

Fig. 3.4. Model Graph V vs (*V' – V*)

7. Let the balancing length be l_0 meter (AJ). Then, the potential drop per unit length of the potentiometer $\frac{1.08}{l_0}$ is calculated. The rheostat should not be disturbed hereafter.

Part 2: To calibrate the given voltmeter

1. The Daniel cell, high resistance (HR) and the galvanometer are replaced by the given low range voltmeter which is to be calibrated. The positive terminal of the voltmeter is connected to A and its negative terminal to the jockey[figure (6.11)]
2. By trial, the jockey is moved along the wire, and by pressing at different points, the length *l* m of the potentiometer wire which gives a reading of 0.1 volt in the voltmeter is determined.
3. The experiment is repeated by finding similar balancing lengths for voltmeter readings of 0.2, 0.3, ……1 V. Knowing the p.d meter length of the wire (l_0), the actual p.d. V' corresponding to these reading are calculated and the corrections in these readings are determined.

Graph

1. A graph between the voltmeter reading (V) along the X-axis and the correction (V'-V) along the Y-axis is drawn.
2. A graph of observed voltmeter reading (V) along the X-axis and calculated voltages (V') along the Y-axis may also be drawn.

RESULT

The given voltmeter is calibrated.

Self Assignment.

1. What do you mean by a potentiometer?
2. What is the working principle of a potentiometer?
3. What is standardization of potentiometer?
4. What is the purpose of connecting a standard battery in the circuit?

Reference:

1. 18PYB101J Instructional manual

4. Determination of Paramagnetic Susceptibility – Quincke's Method

AIM

To measure the susceptibility of paramagnetic solution by Quincke's tube method.

Theory:

When a material is placed within a magnetic field, the magnetic forces of the material's electrons will be affected. This effect is known as Faraday's Law of Magnetic Induction. However, materials can react quite differently to the presence of an external magnetic field. This reaction is dependent on a number of factors, such as the atomic and molecular structure of the material, and the net magnetic field associated with the atoms. The magnetic moments associated with atoms have three origins. These are the electron motion, the change in motion caused by an external magnetic field, and the spin of the electrons. In most atoms, electrons occur in pairs with spins in opposite directions. These opposite spins cause their magnetic fields to cancel each other. Therefore, no net magnetic field exists. Alternately, materials with some unpaired electrons will have a net magnetic field and will react more to an external field. Most materials can be classified as diamagnetic, paramagnetic or ferromagnetic. Although you might expect the determination of electromagnetic quantities such as susceptibility to involve only electrical and magnetic measurements, this practical shows how very simple measurements of mechanical phenomena, such as the displacement of a liquid column can be used instead. Quincke devised a simple method to determine the magnetic susceptibility, χ, of a paramagnetic solution by observing how the liquid rises up between the two pole pieces of an electromagnet, when a direct current is passed through the electromagnet coil windings. A material's magnetic susceptibility tells us how "susceptible" it is to becoming temporarily magnetized by an applied magnetic field and defined as the magnetization (M) produced per unit magnetic field (H). $\chi = M/H$

Based on molecular currents to explain Para and diamagnetic properties magnetic moment to the molecule and such substances are attracted in a magnetic field are called paramagnetic. The repulsion of diamagnetic is assigned to the induced molecular current and its respective reverse magnetic moment.

The force acting on a substance, of either repulsion or attraction, can be measured with the help of an accurate balance in case of solids or with the measurement of rise in level in narrow capillary in case of liquids.

The force depends on the susceptibility χ, of the material, i.e., on ratio of intensity of magnetization to magnetizing field I/H. If the force on the substance and field are measured the value of susceptibility can be calculated.

Formula

The susceptibility of the given sample is found by the formula

$$\chi = \frac{2(\rho - \sigma)gh}{H^2} \text{ kg m}^{-1}\text{ s}^{-2}\text{ gauss}^{-2}$$

Where ρ is the density of the liquid or solution (kg/m^3)

σ is the density of air (kg/ m^3)

g is the acceleration due to gravity (ms^{-2})

h is the height through which the column rises (m)

H is the magnetic field at the centre of pole pieces (Gauss)

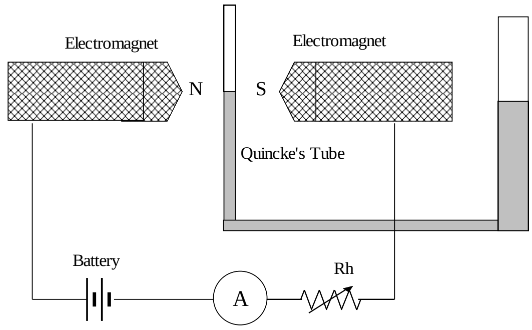


Fig. 4.1. Quincke's Setup

PROCEDURE

1. The apparatus consists of U-shaped tube known as Quincke's tube. One of the limbs of the tube is wide and the other one is narrow.
2. The experimental liquid or the solution ($FeCl_3$) is filled in the tube in such a way that the meniscus of the liquid in the narrow limb is at the centre of the magnetic field as shown in the figure.
3. The level of the liquid in the narrow tube is read by a traveling microscope when the magnetic field is off (h_1).
4. The magnetic field is switched on by switching on the electromagnet. Adjust the regulator knob available with the power supply to the electromagnet and fix the current to be 0.3A. The raised level of the column is read with the traveling microscope and noted in the table as (h_2).
5. The experiment is repeated by varying the field by changing the current insteps of 0.3 A upto the maximum and each reading is noted.
6. To determine the magnetic field (H), the hall probe flux meter (Gauss meter) is used.
7. The flat portion of the hall probe is placed perpendicular to the magnetic field i.e. between the pole pieces at the center parallel to the poles.
8. Switch off the electromagnet power supply. By adjusting, the gauss meter knob and fix the field to be zero.
9. Switch on the electromagnet and adjust the current to be 0.3A. Note the field value from the gauss meter. Repeat the same as before till attaining the maximum current and note the reading in the table.
10. Calculate the magnetic susceptibility using the above formula.

Microscopic reading without field (h_1) = ….. cm

LC = … cm   TR = MSR + (VSC $\times$ LC)

S.No.	Current (i)	Field (H)	Travelling microscope reading (h_2)			Difference $h = h_1 \sim h_2$	h / H^2
	Ampere	Gauss	MSR (cm)	VSC (div)	TR (cm)	$\times 10^{-2}$ m	(m^{-1})

Mean h/H^2 = …………….

Observation:

ρ = density of the liquid or solution = …..kg/m^3

σ = density of air = … kg/ m^3

Calculation:

The magnetic susceptibility of the given solution $\chi = \dfrac{2(\rho - \sigma)gh}{H^2}$

RESULT

The magnetic susceptibility of the given sample = …………… kg m^{-1} s^{-2} $gauss^{-2}$

Self Assignment

1. What is magnetic field?
2. Explain magnetization?
3. What is meant by susceptibility?
4. Explain the properties of paramagnetic materials?

Reference:

1. 18PYB101J Instructional manual

5. Determination of Planck's Constant

AIM: To determine Planck's constant by measuring the turn-on voltage of several LEDs

Theory:

Light Emitting Diodes (LEDs) are semiconductor devices characteristically defined by their ability to emit electromagnetic radiation in the visible spectrum when a potential is applied to the semiconductor materials. LEDs are composed of p-type (electron acceptor) and n-type (electron donor) materials that form a physical connection referred to as the p-n junction. Excited electrons transitioning from the conducting band down to the valence band (hole-electron recombination) releases a quanta of energy equal to that of the quanta required to create the electron hole pair as a photon of discrete energy

The packet of energy is given by

$$E=h\upsilon \qquad \ldots 1$$

Where "h" is a constant now called as Planck's constant in honor of the inventor. The relationship between the wavelength of the emitted photon, the applied potential and discrete quanta of energy E is given by

$$E = hc/\lambda \qquad \ldots 2$$

Where c is the velocity of the light, λ is the wavelength of the light emitted and $1/\lambda$ is the wave number and h is Planck's constant

If V is the forward knee voltage applied across the LED terminals that makes it emit then the energy given to the LED is given by

$$E = eV \qquad \ldots 3$$

Where e is electronic charge.

LEDs are very high efficiency diodes and hence this entire electrical energy is converted into light energy, then equating equations 2 and 3,

$$eV = hc/\lambda \qquad \ldots 4$$

From which Planck's constant is given by

$$h = eV\lambda / c \qquad \ldots 5$$

ie for different values of λ, the V is determined and the corresponding h is calculated. We know that e/c is a constant and hence the product λV must also be a constant. This enables the determination of Plank's constant.

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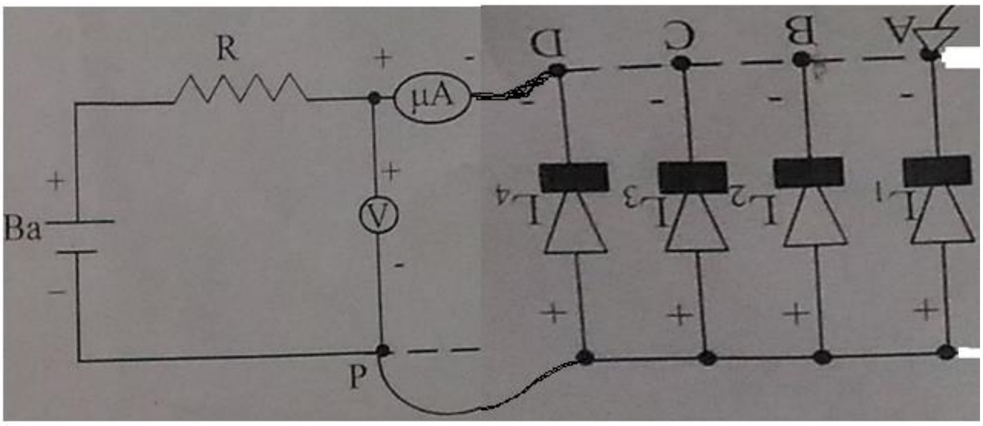


Fig:5.1 Plank's constant set up

Procedure:

APPARATUS: Planck's constant kit

PRINCIPLE: The height of potential barrier across the p-n junction is reduced when it is connected to forward bias. At a particular input voltage, the height of potential barrier becomes very low and the LED starts glowing. This is called turn-on voltage.

FORMULA:

$h = E\lambda / C$ Js

E-Energy of light, λ-Wavelength of light emitted by LED and C-Velocity of light

DETERMINATION OF PLANK'S CONSTANT

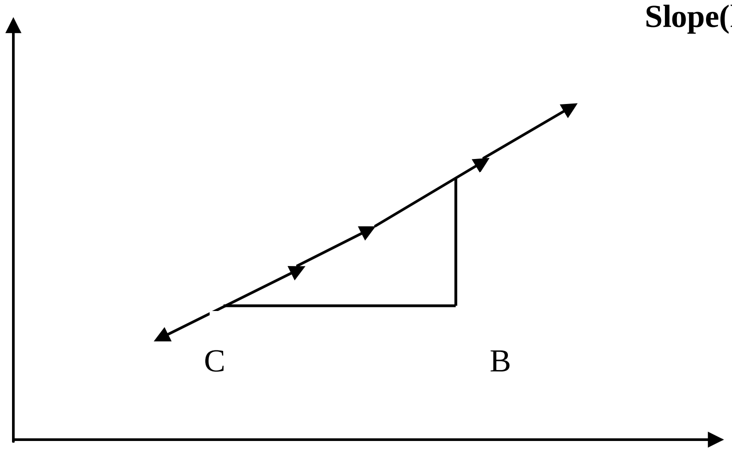
1. The circuit connections are made as shown in the circuit diagram as on panel
2. The wavelength of the given LEDS are noted in the tabular column.
3. The Terminal P is connected to LED L_1. The supply voltage is varied slowly by varying the fine voltage knob of the regulated power supply.
4. The voltmeter reading is noted down when the LED just glows this is the turn on voltage (V_0) for the LED L_1.
5. The same procedures are repeated for other LED's L_2, L_3 and L_4 by connecting the respective terminals.
6. In each case the turn in voltage V_0 is noted. A graph of energy ($E=eV_0$) along Y – axis and frequency ($\nu = c/\lambda$) along X-axis is plotted.
7. The slope of the graph gives the plank's constant.

LED	**Wavelength (λ) nm**	**Turn on voltage V_o Volt**	**Energy $E = eV_o$**	**$h = E\lambda/c$ Js**
Blue	450			
Green	525			
Orange	610			
Red	660			

Slope(h) = (AB/BC)

$E=eV_0J$

A



$\nu=c/\lambda$

Fig.5.2. Model Graph

Observation:

$$E_g = eV_o = h\nu = hc/\lambda$$

$$h = eV_o\lambda/c \quad \text{Js}$$

RESULT: Planck’s constant (i) By Theory ………………. Js

(ii) By Graph ……………….Js

Assignment Questions (Self-Evaluation):

1. What is the value of Planck’s constant?
2. What is the relation between E, h and f?
3. What are LED‟s
4. What produces light from the junction?
5. What is the advantage of this method of finding value of h?
6. Who proposed discrete behavior for an object of subatomic dimensions?

References:

4. 18PYB101J Instructional manual
5. Raymond A. Serway and Jr. John W. Jewett. Principles of Physics. Brooks/Cole, Belmont, CA, fourth edition, 2006.SS

6. V-I Characteristics of a Light Dependent Resistor (LDR)

AIM: To study the photoconductive nature of the given light dependent resistor (LDR) and to plot the V-I characteristics of the LDR.

THEORY:

Light dependent resistor, LDRs or Photoresistoris a device, which is often used to detect the presence or the level of light.A LDR is a device component that is sensitive to light. The resistance decreases as the intensity of incident light increases, and vice versa. In the absence of light, LDR exhibits a resistance of the order of mega-ohms which decreases to few hundred ohms in the presence of lightWhen light falls upon it then the resistance changes.

Principle:

An LDR is made using semiconductor material with a high resistance. When light is incident on LDR, a photon is absorbed and thereby it excites an electron from valence band into conduction band. Due to such new electrons coming up in conduction band area, the electrical resistance of the device decreases. Thus the LDR or photo-conductive transducer has the resistance which is the inverse function of radiation intensity.

$$\lambda_0 = \frac{hc}{eE_\omega}$$

where λ_0 = threshold wavelength in meters, e = charge on one electron in Coulombs,E_ω = work function of the metal in eV.

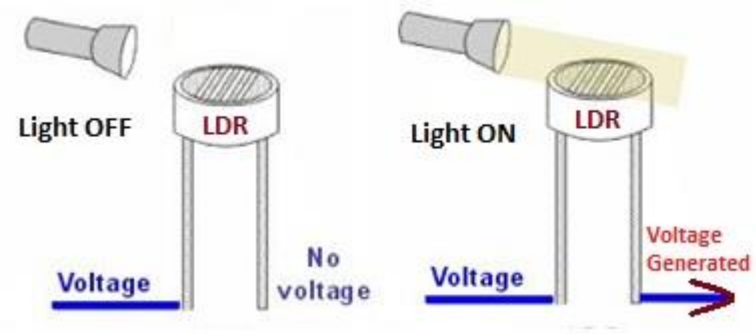


Fig. 6.1. Working of LDR

Any radiation with wavelength λgreater than threshold wavelength(λ_0), will not produceany change in the resistance of this device. Due to large energy gaps, the LDR materials have extremely high resistivity at room temperature. So when the device is kept in darkness, its resistance is called as dark resistance.

The materials used for photoresists are semiconductors and include materials such as CdSe, CdS, CdTe, InSb, InP, PbS, PbSe, Ge, Is, GaAs. Each material gives different properties in terms of the wavelength of sensitivity, etc.

PROCEDURE:

Apparatus Required:

LDR, Resistor (1 kΩ), Ammeter (0 – 10 mA), Voltmeter (0 – 10 V), Light source, Regulated power supply, Measuring Scale.

Formula:

By ohm's law, $V = IR$ (or) $R = \frac{V}{I}$ ohm

where R is the resistance of the LDR (i.e.) the resistance when the LDR is closed. V and I represents the corresponding voltage and current respectively.

Determination of Photoresistance:

1. Circuit connections are given in as shown in Fig. 6.2
2. Light source is turnedON and made to fall on the LDR.
3. Corresponding Voltmeter and Ammeter readings are noted.The value of the resistance can be calculated by Ohm's law.
4. The procedure is repeated by keeping the light source at different distances away from the LDR.
5. A graph is plotted between resistance and distance of LDR from the light source.
6. The value of the dark resistance is determined using Voltmeter and Ammeter readings when the Light source is turnedOFF.

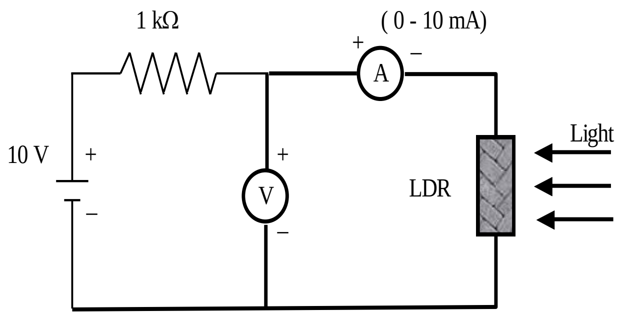


Fig. 6.2. Circuit diagram

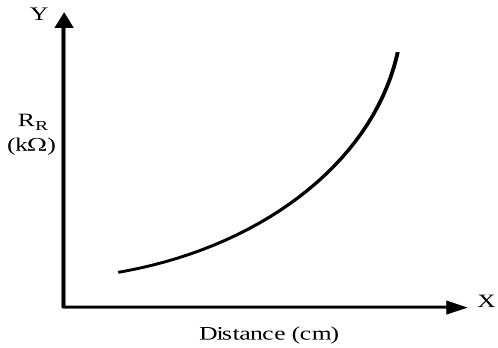


Fig. 6.3. Model graph

OBSERVATION:

Voltmeter reading when the LDR is closed = …… V

Ammeter reading when the LDR is closed = ……. A

Dark resistance = $R = \frac{V}{I}$ = ……. ohm

To determine the resistances of LDR at different distances

S.No	Distance (cm)	Voltmeter reading (V) volt	Ammeter reading (I) mA	R_R kΩ
1 2 3 4 5	A (Long Distance)			
1 2 3 4 5	B (Mid Distance)			
1 2 3 4 5	C (Short Distance)			

RESULT:

1. The V-I characteristics of LDR were studied and plotted.
2. The dark resistance of the given LDR is found out to be = …….. ohm

Assignment Questions (Self-Evaluation):

1. What is Dark Resistance?
2. Define Work Function of metal
3. Write down four applications of LDR?
4. Describe how the resistance of an LDR changes in light and dark conditions?
5. Why the resistance of the LDR varies as the distance between the light source and LDR gets varied?
6. Determine the resistance of the LDR component at 10 cm.
7. Evaluate the dark resistance of the LDR component at room temperature.

References:

6. 18PYB101J Instructional manual
7. U.A Bakshi, A.P Godse, "Electronic Devices. Technical Publications", India, 2008.
8. Robert Diffenderfer,"Electronic Devices: Systems and Applications", Thomas Delmer Learning, USA, 2005.

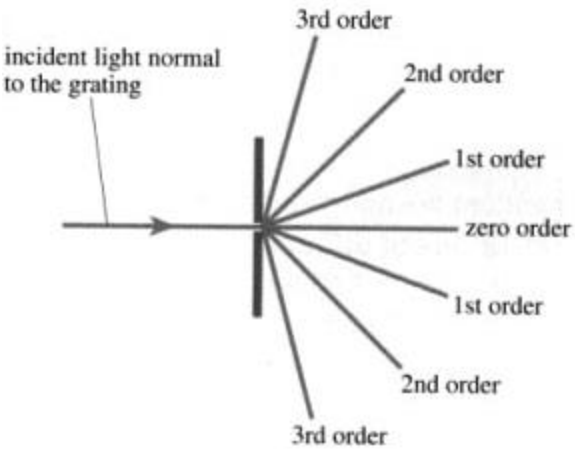
7. Determination of wave length of mercury spectrum-Diffraction spectrometer

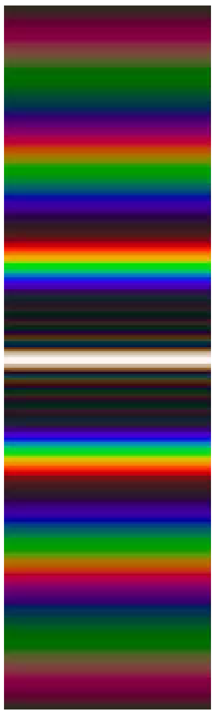
AIM:

To determine the wave length of the mercury spectrum using diffraction grating.

Theory:

Diffraction grating is a thin film of clear glass or plastic that has a large number of lines per (mm) drawn on it. A typical grating has density of 250 lines/mm. Using more expensive laser techniques, it is possible to create line densities of 3000 lines/mm or higher. When light from a bright and small source passes through a diffraction grating, it generates a large number of sources at the grating. The very thin space between every two adjacent lines of the grating becomes an independent source. These sources are coherent sources meaning that they emit in phase waves with the same wavelength. These sources act independently such that each source sends out waves in all directions. On a screen at a distance D away from the gratting, points can be found whose distance differences from these sources are different multiples of λ causing bright fringes. One difference between the interference of many slits (diffraction grating) and double slit experiment is that a diffraction grating makes a number of principle maxima along with lower intensity maxima in between. The principal maxima occur on both sides of the central maximum for which a formula similar to double slit interference holds true which is given by $d \sin\theta n = \lambda n$, where n = 1, 2, 3, ... In this equation, d is the spacing between every two lines (same as every two sources). If there are N lines per mm of the grating, then d, the space between every two adjacent lines or (every two adjacent sources) is $d=1/N$ (mm). If the light source has different colors (different wavelengths), shorter wavelength color will have smaller diffraction angle compared to longer wavelength for the same order of principle maximum. Thus we will see a spectrum in such case. The angular spacing for different colors will increase for higher order maxima.





APPARATUS:

A spectrometer, mercury vapour lamp, grating, spirit level, reading lens etc.

FORMULAE:

Wave length $\lambda = \text{Sin}\theta/mN$

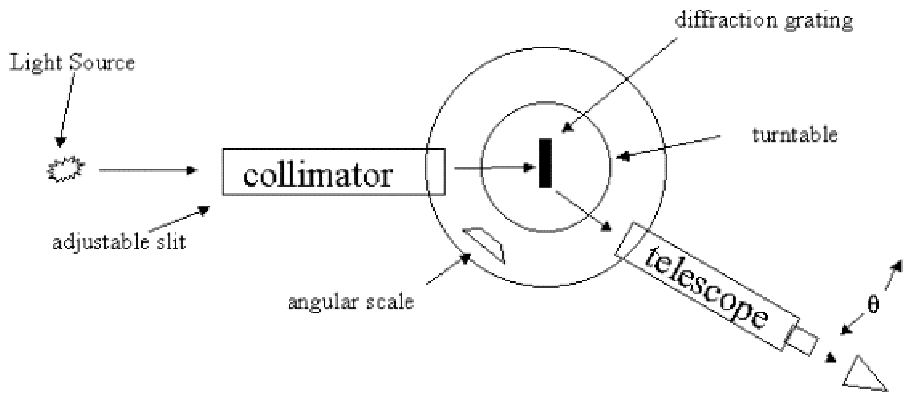


Fig. 8.1. Spectrometer Grating Normal Incidence position

Observations

$$LC = \frac{\text{Value of one MSD}}{\text{No. of div on VS}} = \frac{30'}{30} = 1'$$

PROCEDURE:

Adjustments of telescope to receive parallel rays:

Turn the telescope towards a distant object (e.g. a far off building) and adjust the telescope to see a clear well-defined image of the distant object. If the initial adjustment of the cross hairs was good, the image of the distant object will remain fixed against the image of cross hairs as the eye is moved slightly from side to side. That is, there is no parallax between the images of the cross hairs and the distant object, and thus the two coincide with the focal plane of the telescope. Otherwise there is relative motion between the image of the cross hairs and that of the distant object and the adjustments must be repeated. This method of focusing by the elimination of parallax is universal in the use of optical instruments.

Adjustments of the collimator to provide parallel incident rays:

Swing the telescope so that it is aligned with the collimator. There are two knobs under the telescope. One of these is to fix the telescope relative to the collimator and the other for fine alignment of the telescope with respect to the collimator. Note that there is another set of knobs for the prism table. One of them is to fix the prism table at any position and the other is used for finer adjustments. The slit side of the collimator should face the light source. Illuminate the collimator slit with the mercury light source. Make the slit width narrow and bring the slit into sharp focus while viewing through the eyepiece side of the telescope and by adjusting the collimator only. Again use the absence of parallax between the slit image and the cross hairs.

Determination of the precision of angular measurement in the spectrometer:

1) The circular main scale on the spectrometer is graduated from zero to 360°; each division on this scale is equal to one half of a degree (i.e., 30 minutes). There are 30 divisions on each of the venires scales (1) and (2).

2). When the zero of either of the vernier scales matches with a division on the main scale, the 30th division on that vernier coincides with another main scale division. Careful observation indicates that there are 29 main scale divisions between these zero and 30th divisions of the vernier scale. This implies that each vernier division corresponds to (29/30) of a main scale division and that the angular measurements can be made to a precision of one minute (i.e. the difference between the values of one main scale division and one vernier scale division). Remember that one minute equals 1/60 th of a degree.

3. Mounting the grating CAUTION: do not touch the grating surface. Handle the grating by means of the frame supporting it. The grating and holder are used with the side marked "FRONT" or the printed data turned toward the collimator. The height of the grating is adjusted until its center coincides with the axis of the collimator. The grating spacing, d, is the reciprocal of the number of lines per unit length of the grating.

4. Adjustment of the position of the grating the plane of the grating must be normal to the light beam as it emerges from the collimator. To make this adjustment, we will make use of the law of reflection. a) Lock the table and take a reading with the cross-hairs aligned with the slit image. b) Move the telescope 90° 0' and lock the telescope. c) Insert the grating and rotate the grating until the slit image reflected from the grating surface (a plane mirror) is aligned with the crosshairs. d) Unlock the table and rotate it 45° 0' in a direction that places the grating perpendicular to the light beam. e) Lock the table and unlock the telescope for further readings.

5. Zeroth-order reading Read the angle for straight-through light from the collimator and record this reading as a. In general, the zero for the vernier division is between two main scale divisions. Note the main scale reading to the left of the zero of the vernier. Find the number (n) of the vernier division that coincides with a main scale division. Thus a = main scale reading + n(1 minute). Enter a in Data Table 1.

6. Measurement of angles of diffraction (a) Move the head to the left or right of the normal position until the first order of the spectrum is observed with the unaided eye. [Note: some gratings, due to minor variations in manufacture, give brighter spectra on one side than the other. This is the side to use for readings. In the gratings supplied, motion to the left usually gives the best results.] Swing the telescope into position to locate this first order. Take angular readings on the blue, green and two yellow lines in the spectrum, calling the reading b for each color. Continue to move the telescope, locating the second and, possibly, third order. Read the angles of each line for each order. (c) The angle of diffraction q is thus the difference between the straight-through reading a and the reading taken for each line b.

Result

The wave lengths of colors of mercury spectrum -------------

Assignment Questions (Self-Evaluation):

8. Define Diffraction in light?
9. What is Diffraction Grating?
10. What are the major differences between interference and diffraction pattern?
11. Why the intensity of the higher diffraction order are reduced?
12. In diffraction grating experiment, what are all the changes will be observed if white light is replaced by a monochromatic light?
13. What is meant by grating element?

Number of lies per meter of grating N = Order of Diffraction m = 1

Colours	**Spectrometer Reading (Right)**		**Spectrometer Reading (Left)**		**2θ**		**Mean 2θ**	**θ**	**$\lambda = \sin\theta / mN$**
	V_A	V_B	V_A	V_B	V_A	V_B			
Violet									
Blue									
Green									
Yellow I									
Yellow II									
Orange									
Red I									
Red II									

8. Study of attenuation and propagation characteristics of optical fiber cable

AIM

AIM

(i) To determine the attenuation for the given optical fiber.

(ii) To measure the numerical aperture and hence the acceptance angle of the given fiber cables.

THEORY:

Optical fibers are the light equivalent of microwave waveguides with the additional advantage of wide bandwidth. Physically an optical fiber is a very thin and flexible medium, having a cylindrical shape consisting of 3sections: Core, Cladding, Jacket. Optical fibers are having lower attenuation, smaller size, electromagnetic isolations, no crosstalk, greater bandwidth, greater repeater spacing. The exchange of information between any 2 devices across a communication channel using optical signal is called optical communication. Key components of optical communication link are light sources, optical fiber, photo detectors and optical amplifiers.

ATTENUATION: Attenuation in an optical fiber is caused by absorption, scattering, and bending losses. Attenuation is the loss of optical power as light travels along the fiber.

PROPAGATION LOSS: Attenuation is loss of power. During transit light pulse lose some of their photons thus reducing their amplitude. Attenuation for a fiber is usually specified in decibels per kilometer. For commercially available fibers attenuation ranges from 1–2000 decibels per kilometer. The basic measurement for loss in a fiber is made by taking logarithmic ratio of the input power to the output power. α (dB) = 10 log10Pi/ P0

BENDING LOSS: Whenever the condition for angle of incidence of the incident light violated the losses are introduced due to refraction of light. This occurs when fiber is subjected to bending. Lower the radius of curvature more is the loss.

NUMERICAL APERTURE: The numerical aperture (NA) of an optical system is a dimensionless number that characterizes the range of angles over which the system can accept or emit light. The cone formed by the rotation of this angle along the axis of the fiber is the cone of acceptance of the fiber. The light ray should strike the fiber end within its cone of acceptance else it is refracted out of the fiber.NA = $\sin \theta_{max} = W/\sqrt{(4L^2 + W^2)}$

I . ATTENUATION IN FIBERS

APPARATUS REQUIRED

Fiber optic light source, optic power meter and fiber cables (1m and 5m), Numerical aperture measurement JIG, optical fiber cable with source, screen.

PRINCIPLE

The propagation of light down dielectric waveguides bears some similarity to the propagation of microwaves down metal waveguides. If a beam of power P_i is launched into one end of an optical fiber and if P_f is the power remaining after a length L km has been traversed , then the attenuation is given by,

$$\text{Attenuation} = \frac{10\log\left(P_i/P_f\right)}{L}\ \text{dB / km}$$

FORMULA

$$\text{Attenuation (dB / km)} = \frac{10\log\left(P_i/P_f\right)}{L}$$

PROCEDURE

1. One end of the one metre fiber cable is connected to source and other end to the optical power metre.
2. Digital power meter is set to 200mV range (- 200 dB) and the power meter is switched on
3. The ac main of the optic source is switched on and the fiber patch cord knob in the source is set at one level (A).
4. The digital power meter reading is noted (P_i)
5. The procedure is repeated for 5m cable (P_f).
6. The experiment is repeated for different source levels.

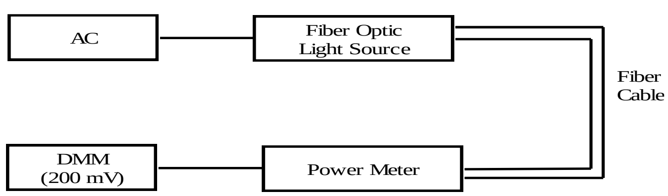


Fig. 12.1. Setup for loss measurement

Determination of Attenuation for optical fiber cables

$L = 4\text{ m} = 4 \times 10^{-3}\text{ km}$

Source Level	Power output for 1m cable (P_i)	Power output for 5m cable (P_f)	Attenuation = $\frac{10\log\left(P_i/P_f\right)}{L}$ dB / km

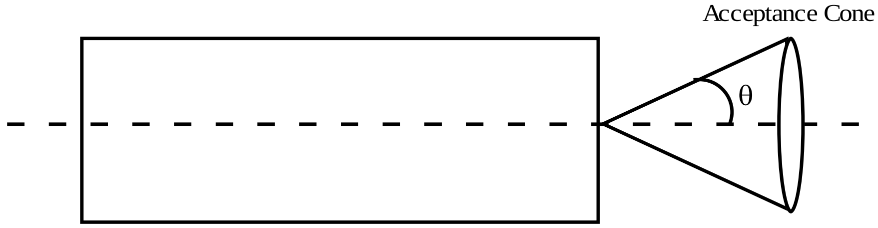


Fig. 12.2. Numerical Aperture

Measurement of Numerical Aperture

Circle	Distance between source and screen (L) (mm)	Diameter of the spot W (mm)	NA = $\frac{W}{\sqrt{4L^2+W^2}}$	θ

RESULT

1. Attenuation at source level A = ----------- (dB/km)
2. Attenuation at source level B = ----------- (dB/km)
3. Attenuation at source level C = ----------- (dB/km)

II. Numerical Aperture

PRINCIPLE

Numerical aperture refers to the maximum angle at which the light incident on the fiber end is totally internally reflected and transmitted properly along the fiber. The cone formed by the rotation of this angle along the axis of the fiber is the cone of acceptance of the fiber.

FORMULA

Numerical aperture (NA)= $\dfrac{W}{\sqrt{4L^2 + W^2}} = \sin\theta_{max}$

Acceptance angle = 2 θ_{max} (deg)

where L = distance of the screen from the fiber end in metre

W =diameter of the spot in metre.

PROCEDURE

1. One end of the 1 metre fiber cable is connected to the source and the other end to the NA jig.
2. The AC mains are plugged. Light must appear at the end of the fiber on the NA jig. The set knob in source is turned clockwise to set to a maximum output.
3. The white screen with the four concentric circles (10, 15, 20 and 25mm diameters) is held vertically at a suitable distance to make the red spot from the emitting fiber coincide with the 10mm circle.
4. The distance of the screen from the fiber end L is recorded and the diameter of the spot W is noted. The diameter of the circle can be accurately measured with the scale. The procedure is repeated for 15mm, 20mm and 25mm diameter circles.
5. The readings are tabulated and the mean numerical aperture and acceptance angle are determined.

RESULT

i) The numerical aperture of fiber is measured as ....

ii) The acceptance angle is calculated as .... (deg).

Assignment Questions (Self-Evaluation):

1. What is an optical fiber?
2. List some advantages of optical fiber over the conventional metallic wave guides.
3. What are the different types of losses in optical fiber?
4. What causes the losses in the optical fiber?
5. Define acceptance angle and cone in optical fiber?
6. Define Numerical Aperture?

9. Determination of wavelength of monochromatic light Newton's ring

AIM: To determine the wavelength of monochromatic light using Newton's ring method.

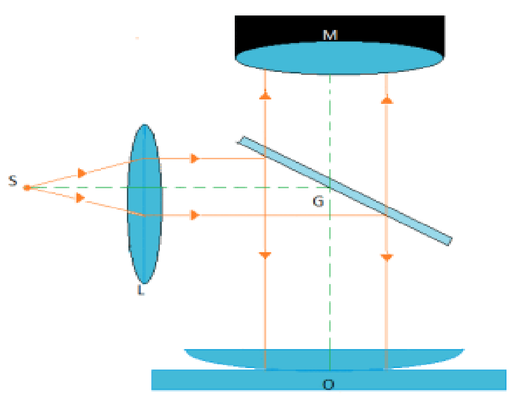
Theory

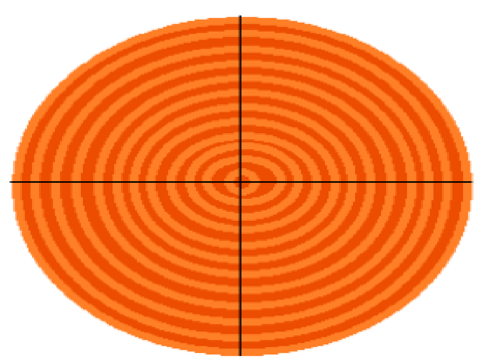
Newton's rings is a phenomenon in which an interference pattern (the superposition of light waves leading to redistribution of energy and hence resulting in the modification of intensity distribution at the region of superposition) is created by the reflection of light between two surfaces: a spherical surface and an adjacent touching flat surface. The formation of Newton's rings can be explained on the basis of interference between waves which are partially reflected from the top and bottom surfaces of the air film. If t is the thickness of the air film at a point on the film, the refracted wavelet from the lens has to travel a distance t into the film and after reflection from the top surface of the glass plate, has to travel the same distance back to reach the point again. Thus, it travels a total path 2t. One of the two reflections takes place at the surface of the denser medium and hence it introduces an additional phase change of π or an equivalent path difference λ/2 between two wavelets. The centre of the ring dark in Newton's Rings experiment with reflected light is dark because at the point of contact the path difference is zero but one of the interfering ray is reflected so the effective path difference becomes λ/2 thus the condition of minimum intensity is created hence centre of ring pattern is dark.

The wavelength of the light can be calculated using the formula

$$\lambda = (r_{n+m}{}^2 - r_n{}^2)/mR \quad \text{meter}$$

r_n-Radius of the dark n^{th} ring, m-Order of the ring and R-Radius of curvature of the ring





R

Newton's Ring Set up

Newton's Rings

PROCEDURE:

APPARATUS: Travelling microscope, glass plate, convex lens, monochromatic light.

1. Place the lens L at a distance equal to its focal length from the sodium lamp to get a parallel beam of light.
2. Adjust the microscope vertically above the center of the lens. Focus the microscope so that alternate dark and bright rings are clearly visible.
3. The first few rings are usually not clear so slide the microscope to the left or right and set it tangentially at the center of the N^{th} dark ring.
4. Move the cross wire towards right by turning the horizontal tangential screw in clock wise direction and count the number of rings till 21^{st} and set it tangentially at the corner of the 21^{st} dark ring. This is the $N+21^{st}$ dark ring on right hand side. Now take the microscope reading.
5. After that rotate the horizontal tangential screw in anti clock wise direction and catch $N+18^{th}$ dark ring on same right side and take the microscope reading.
6. Repeat the procedure no. 5 for N+15, N+12….. up to Nth dark ring. The readings are tabulated.
7. Then rotate the horizontal tangential screw in same anti clock wise direction and catch the N^{th} dark ring on left side and note down microscope reading. Continue the same for N+3, N+6…… up to N+21. The values are tabulated.
8. From the readings calculate the difference between $N+21^{st}$ dark ring on right and left hand side, which gives the diameter of the 21^{st} ring. Similarly calculate the diameter of 18, 15…….nth dark rings.
9. From the diameter calculate radius and square of radius and the values are tabulated.
9. Now, calculate the difference between first reading and fifth reading in square of radius which is called $r_{n+m}{}^2 - r_n^2$ (Order 12 rings). Similarly calculate the same for 2^{nd} and 6^{th}, 3^{rd} and 7^{th} and 4^{th} and 8^{th} readings and the values are tabulated.
10. Then take the mean value of $r_{n+m}{}^2 - r_n^2$
11. By using the above formula calculate the wavelength of monochromatic light.

OBSERVATIONS

Order of the Ring	Microscope Reading		Diameter of the Ring	Radius of the Ring	r^2	$r_{n+m}{}^2 - r_n^2$	Mean of
	Left	Right					
N+21							
N+18							
N+15							
N+12							
N+9							
N+6							
N+3							
N							

Order of the ring (m) =12

Radius of curvature of lens (R) = 20 cm

RESULT:

Wave length of the monochromatic light = …………… m

Assignment Questions (Self-Evaluation):

1. What is interference?
2. Why the centre of the ring in Newton's ring is dark?
3. What is the unit of wavelength?
4. Name the surfaces through which reflection of light takes place for the formation of Newton's rings.
5. What is the total path travelled by the refracted wavelet through the air film in the formation of Newton's rings?

References:

1. Engineering Physics by R. K. Gaur and S. L. Gupta, Dhanpat Rai Publishing Co Pvt Ltd
2. A Textbook of Engineering Physics by Dr. M.N Avadhanulu and Dr. P.G Kshirsagar, S.Chand Publications

10. (a) Determination of laser parameters–divergence and wavelength for a given laser source using laser grating

AIM

To determine the divergence and wavelength of the given laser source using standard grating.

Theory

Laser is the acronym of Light Amplification by Stimulated Emission of Radiation. Laser is light of special properties. Einstein predicted in 1917 that when there exist the population inversion between the upper and lower energy levels among the atom systems, it was possible to realize amplified stimulated radiation, i.e., laser light. The purity of the spectral line is expressed in terms of coherence. Coherence is expressed in terms of ordering of light field. Temporal coherence refers to correlation in phase at a given point in a space over a length of time. Spatial coherence refers to correlation in phase at different points at the same time. The high degree of temporal coherence arises from the lasers monochromaticity. The high degree of spatial coherence results, since the wave fronts in a laser beam are in effect similar to those emanating from a single point source.

Directionality and Divergence

The directionality of a laser beam is expressed in terms of the full angle beam divergence which is twice the angle that the outer edge of the beam makes with the axis of the beam. The outer edge of the beam is defined as a point at which the strength of the beam has dropped to 1/e times its value at the centre. At d_1 and d_2 distances from the laser window, if the diameter of the spots are measured to be a_1 and a_2 respectively, then the angle of divergence (in degrees) can be expressed as

$$\Phi = \frac{(a_2 - a_1)}{2(d_2 - d_1)}$$

where a_1 = Diameter of the laser spot at distance d_1 from the laser source

a_2 = Diameter of the laser spot at distance d_2 from the laser source

For a typical laser, the beam divergence is about 1 milli radian.

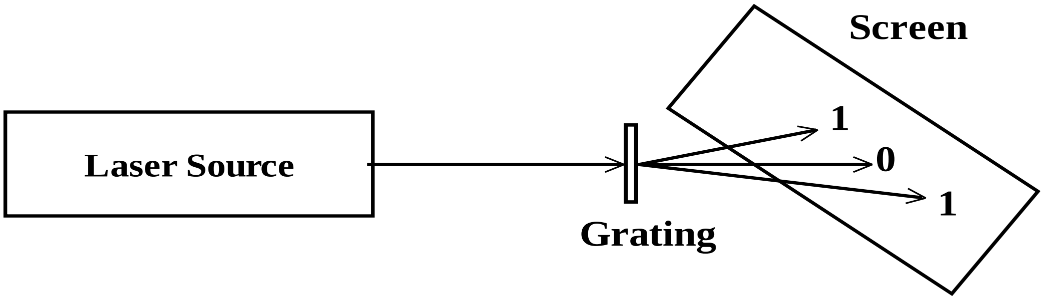
Wavelength

When a composite beam of laser light is incident normally on a plane diffraction grating, the different components are diffracted in different directions. The m^{th} order maxima of the wavelength λ, will be formed in a direction θ if $d \sin \theta = m\lambda$, where d is the distance between two lines in the grating.

The wavelength of the laser light is given by

$$\lambda = \frac{\sin \theta_m}{Nm} \quad \text{m}$$

where	m	=	Order of diffraction
	θ_n	=	Angle of diffraction corresponding to the order m
	N	=	number of lines per metre length of the grating
	θ	=	$\tan^{-1}$ (x/D)
	x	=	Distance from the central spot to the diffracted spot (m)
	D	=	Distance between grating and screen(m)



Experimental Setup for Laser Grating

PROCEDURE

APPARATUS REQUIRED

Laser source, grating, a screen etc.,

Part 1: Determination of angle of divergence

1. Laser source is kept horizontally.
2. A screen is placed at a distance d_1 from the source and the diameter of the spot (a_1) is measured.
3. The screen is moved to a distance d_2 from the source and at this distance, the diameter of the spot (a_2) is measured.

Part 2: Determination of wavelength

1. A plane transmission grating is placed normal to the laser beam.
2. This is done by adjusting the grating in such a way that the reflected laser beam coincides with beam coming out of the laser source.
3. The laser is switched on. The source is exposed to grating and it is diffracted by it.
4. The other sides of the grating on the screen, the diffracted images (spots) are seen.
5. The distances of different orders from the central spot are measured.
6. The distance from the grating to the screen (D) is measured.
7. θ is calculated by the formula $\theta = \tan^{-1}(x/d)$.
8. Substituting the value of θ, N and m in the above formula, the wavelength of the given monochromatic beam can be calculated.

Determination of wave length of Laser Light:

Distance between grating and screen (D) = ----------- m
Number of lines per metre length of the grating = N = --------------

OBSERVATIONS

S.No	Order of Diffraction (m)	Distance of Different orders from the Central Spot (x) m		Mean (x) m	Angle of diffraction $\theta = \tan^{-1}[x / D]$	$\lambda = \frac{\sin \theta_m}{Nm}$ Å
		Left	Right			

Result

1. The angle of divergence is = -----------.
2. The wavelength of the given monochromatic source is = ----------- Å

Assignment Questions (Self-Evaluation):

1. What is the acronym of LASER?
2. Explain about coherence?
3. What is the unit of divergence?
4. The diffraction phenomenon observed in a grating is Linear or Circular?
5. A three level laser system produces continuous wave laser or pulsed laser?

References:

1. Koechner, Walter. Solid-State Laser Engineering. Berlin: Springer, 2006.
2. Ion, John. Laser Processing of Engineering Materials. Amsterdam: Elsevier/Butterworth-Heinemann, 2005.
3. Laser Surveying. London: Van Nostrand Reinhold (International), 1989.

10 (b) Particle size determination using laser

AIM

To determine the size of micro particles using laser.

Theory

When laser is passed through a glass plate on which fine particles of nearly uniform size are spread, due to diffraction circular rings are observed. From the measurement of radii of the observed rings, we can calculate the size of the particles. Since for diffraction to occur size of the obstacle must be comparable with wavelength, only for extremely fine particles of micron or still lesser dimension, diffraction pattern can be obtained.

Diffraction is very often referred to as the bending of the waves around an obstacle. When a circular obstacle is illuminated by a coherent collimated beam such as laser light, due to diffraction circular rings are obtained as shown in the Figure.. If "r" is the radius of the first dark ring and "D" is the distance between the obstacle and screen on which the diffraction pattern is obtained, then.

$$\tan\theta = \frac{r}{D}$$

Since θ is very small in this experiment

$$\tan\theta = \theta = \frac{r}{D}$$

According to the theory, the diameter 2a' of the circular obstacle is given by

$$2a = \frac{1.22 n \lambda D}{r_n}$$

where

r_n	=	radius of the n^{th} order dark ring (m)
D	=	distance between the obstacle and the screen (m)
λ	=	wavelength of the laser light (Å)

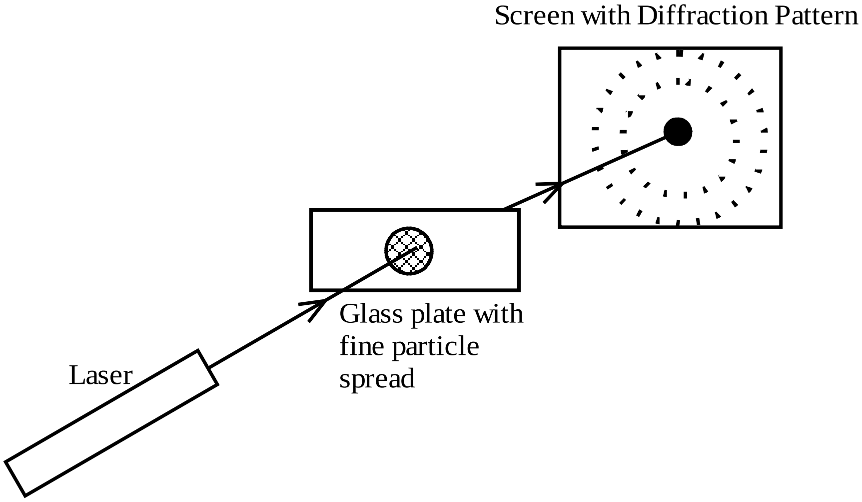
PROCEDURE

APPARATUS REQUIRED

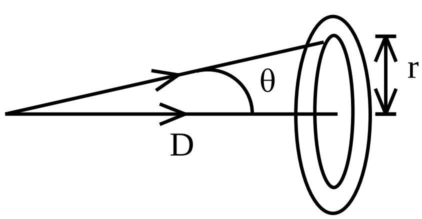
Fine micro particles having nearly same size (say lycopodium powder), a glass plate (say microscopic slide), diode laser, and a screen.

1. Fine powder of particles is sprayed/spread on the glass plate.
2. Laser is held horizontally and the glass plate is inserted in its path.

3. Position of the glass plate is adjusted to get maximum contrast rings on the screen which is at a distance more than 0.5 m.
4. A white paper is placed on the screen and the positions of the dark rings are marked. The radii of different order dark rings (r_n) are measured using a scale.
5. The distance between the screen and the glass plate (D) is also measured. Using the given formula, the average diameter of the particles is calculated. $2a = \frac{1.22n\lambda D}{r_n}$
6. The experiment is repeated for different D values.
7. Determination of particle size



Particle size determination using Laser



OBSERVATIONS

Sl.No.	Distance (D)	Diffraction order (n)	Radius of dark ring (r_n)	Particle size (2a)
Unit	m		m	m
1		1 2		
2		1 2		
3		1 2		
			Mean	

RESULT

The average size of the particles measured using laser = ...μm

Assignment Questions (Self-Evaluation):

1. What is the unit of particle size?
2. The diffraction phenomenon observed in a particle size experiment is Linear or Circular?
3. Define diffraction phenomenon.
4. What is the condition for diffraction?
5. Name the theory on which the laser diffraction analysis relies on?

References:

1. Xu, R. (2002). Particle Characterization: Light Scattering Methods. Dordrecht: Springer Netherlands, 111-181
2. Merkus, H. (2009). Particle Size Measurements. Dordrecht: Springer Netherlands, 259-285

3. ISO 13320:2009, Particle size analysis - Laser diffraction methods