SEMESTER – II

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ANY TEN EXPERIMENTS

1. Fabry – Perot interferometer – Determination of wavelength.
2. Arc spectra – Copper and Iron
3. Determination of V-I characteristics of a solar cell.
4. Susceptibility – Quinke's method
5. Susceptibility – Gouy method
6. Hall Effect
7. Measurement of resistivity and conductivity of dielectric using Four-probe apparatus.
8. Compressibility of a liquid – Ultrasonic Interferometer, and verify with Ultrasonic Diffractometer
9. Determination of Stefan's constant.
10. Laser Diffraction at sharp edge – Determination of wavelength.
11. Series LCR circuit: (i) Determination of the resonance frequency using variable frequency source, (ii) To study the resonance of LCR using AC mains.
12. Kelvin's double bridge – To measure low resistance.

RERERENCES

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2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut
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4. Gupta S.L. and V.Kumar, 2002, Practical Physics, 25th Edition, Pragathi Prakashan, Meerut
5. B.L Worsnop & H T Flint,1951,Advanced Practical Physics For Students ,9th revised Edition ,Littlehampton Book Services Ltd

List of Experiments

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SUSCEPTIBILITY OF A LIQUID -QUINCKE'S METHOD

Aim

To determine the magnetic susceptibility of given solution by Quincke's method.

Apparatus required

Electromagnet, power supply, U shaped glass tube, traveling microscope and Gauss meter.

Formula used

Susceptibility is given by $\chi = 2g\,(\sigma-\rho)\,h/H_1^2$ N/wb

$$\sigma = (w_3-w_2)/(w_2-w_1)$$

Where w_1- weight of empty tube (gm)

w_2 - weight of given liquid (gm)

w_3- weight of water (gm)

Experimental Procedure

The U-shaped tube consists of one narrow and one wide end which has to be filled (3/4) with the experimental liquid. The narrow end of the tube has to keep at the center of the magnetic field where strong magnetic field is developed by an electromagnet. It is fed by suitable dc power supply. The height of the liquid in the tube is viewed through a microscope. While switch ON the power supply the level of the liquid will change in the narrow limb. The difference in the height (with and without field) will give h. Repeat the experiment for different current value.

The magnetic field strength is measured with the help of Gauss meter. Place the Gauss probe vertically in between the electromagnet. By varying the current from 0 A to 4 A the magnetic field can be obtained.

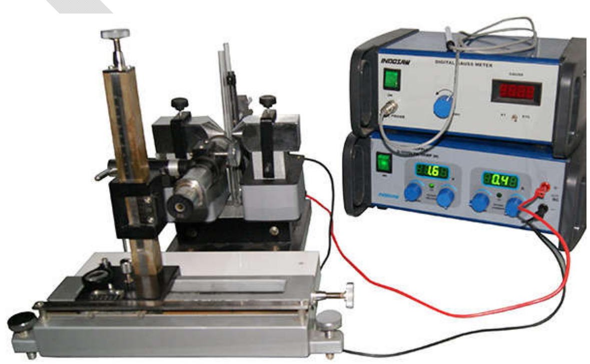


Fig. 1

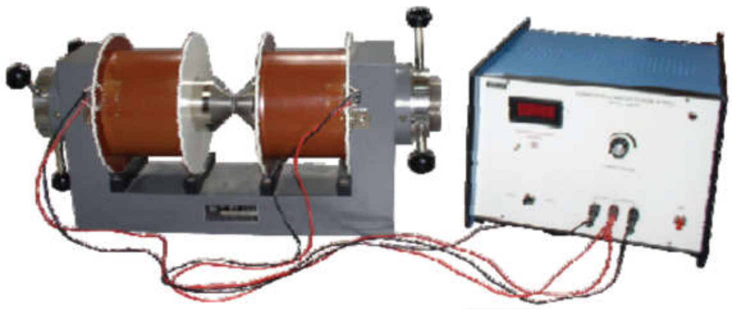


Fig. 2

Tabulation

Magnetic field strength

Current (A)	H_1(oestered)
0.5	
1	
1.5	
2	
2.5	
3	
3.5	
4	

Current (A)	Height without field (h_1) cm	with field (h_2) cm	$h = h_1 - h_2$ cm	h/H_1^2 x cm
0.5				
1				
1.5				
2				
2.5				

3				
3.5				
4				

Observations

Density of the liquid = ---------- kg/m^3

Acceleration due to gravity = ----------- m/s^2

Weight of the empty tube = ------------ gm

Weight of the tube with liquid = ------------ gm

Weight of the tube with water = ------------ gm

Calculations

$$\sigma = (w_3-w_2)/(w_2-w_1)$$

$$\sigma = \text{------------}$$

$$\chi = 2g\,(\sigma-\rho)\,h/(H_1^2)\ \text{N/wb}$$

Result

The susceptibility of the given liquid is _______ by Quincke's method

Viva Voce

1. What is called susceptibility?
2. Define magnetic field?
3. Is this method applicable for all liquids?
4. What is the relation between susceptibility and permeability?

SUSCEPTIBILITY OF A LIQUID –GOUY'S METHOD

Aim

To determine the magnetic susceptibility of a given liquid by a Gouy's method

Apparatus Required

Gouy set up, experimental liquid, Gauss meter, Gouy tube, Electromagnet and power supply.

Formula Used

The magnetic susceptibility of the liquid is given by, $\chi_m = \frac{2Mg}{A\rho H_1^2}$ Nm^2/wb^2

where, H_1 – magnetic field measured from gauss meter

ρ – density of the liquid (kg/m^3)

A- Area of cross section of the Gouy tube (m)

M- mass of the liquid (gm)

g- acceleration due to gravity (m/s^2)

Theory

Gouy balance measures the apparent change in the mass of the sample as it is repelled or attracted by the region of high magnetic field between the poles.

Experimental Procedure

The electromagnet is energized by a DC power supply. The variable magnetic field is provided by the wedge shaped pole pieces. The distance between the pole pieces can be adjusted with the help of handle provided on both sides of the pole pieces. A hook is provided at the bottom of the digital balance of Gouy set up; which can be used to suspend the Gouys tube. An experimental liquid is filled 3/4th of a tube and placed between the poles. Before switch ON the power supply, the digital balance must be zero and then hang the liquid on the hook. The mass of the liquid is noted from the digital balance.

Switch ON the power supply and vary the current from 0 to 4A in steps of 0.5 A and note the mass of the liquid in each case. The magnetic field strength is measured with the help of Gauss meter. Place the Gauss probe vertically in between the electromagnet. By varying the current from 0 A to 4 A the magnetic field can be obtained.

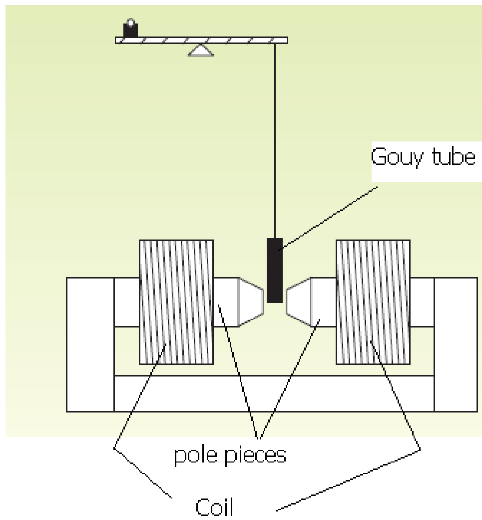


Fig. 1

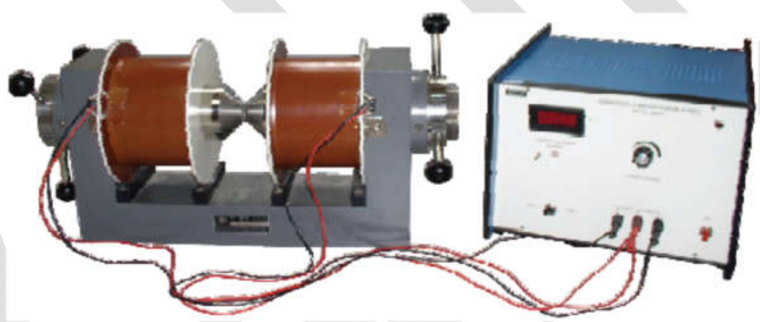


Fig. 2

Tabulation

Current (A)	Mass of the liquid (M) (gm)		M (gm)	Magnetic field (H_1^2)	M/H_1^2 gm
	without field	with field			
0.5					
1					
1.5					
2					
2.5					

3					
3.5					
4					

Observations

Acceleration due to gravity = --------- m/s^2

Density of the liquid = --------------- kg/m^3

Area of cross section of Gouy tube = ---------- (m)

Calculation

$$\chi_m = \frac{2Mg}{A\rho H_1^2} \ Nm^2/wb^2$$

Result

The susceptibility of the liquid by Gouy method is _________ Nm^2/wb^2

Note:

1. Reduce the current through the coil to zero slowly and then switch off the power supply.
2. Don't change the distance between the pole-pieces in between the experiment.
3. Switch off the digital balance after completing the experiment.

Viva voce

1. What is called magnetic susceptibility?
2. Define magnetic field?
3. Is this method applicable for all liquids?s
4. What is the principle behind this method?

KELVIN'S DOUBLE BRIDGE-TO MEASURE LOW RESISTANCE

Aim

To determine the very low resistance and specific resistance by Kelvin's double bridge method.

Apparatus Required

Kelvin's double bridge apparatus, ballistic galvanometer, copper wire.

Formula used

The unknown resistance is given by y = $R_3 \frac{R_2}{R_1}$ Ω

where, Rs-standard known resistance

Specific resistance is given by ρ=$\frac{\pi r^2}{l}\ y$ (Ωm)

Where, r- radius of the wire (m)

l- length of the wire (m)

Experimental Procedure

To find the resistance of the specimen, the wire is stretched between plates; so that it makes a contact with the knife edges. The battery connected should be capable of providing a steady DC of 25 A. Galvanometer shoul be sensitive and provided with a universal shunt.

The standard resistance R3 and the ratio R2/R1 are set to give an appropriate value os unknown resistance. The galvanometer is shunted and the key is pressed to obtain the deflection. The value of R3 and slide wire resistance is given by equation y = $R_3 \frac{R_2}{R_1}$.

By knowing R3 and the ratio of R2/R1, the value of y can be calculated. R3 includes the resistance of lead as well as wire. In order to find the actual resistance either the resistance of load is subtracted from the observed value or a preliminary experiment is made to do away with the resistance of loads. This part is known as the setting of the zero of the bridge i.e the bridge is initially set at zero with respect to the resistance of the loads.

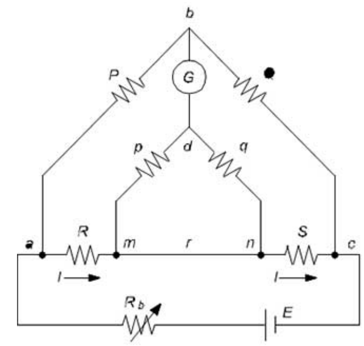


Fig.1

Tabulation

To find the load resistance

R2/R1 Ω	R3 Ω	R3(R2/R1) Ω

Calculations

$$\rho = \frac{\pi r^2}{l}\, y \ (\Omega m)$$

Radius of the wire = --------

Length of the wire = --------

$$\rho =$$

Result

The unknown resistance is found to be = ------- (Ω)

The specific resistance of a given wire is = -------

Viva voce

1. What is the principle of Kelvin double bridge?

2. What is Wheatstone's bridge?

3. What is specific resistance?

4. Which galvanometer is used in this method?

ARC SPECTRA-COPPER AND IRON

Aim

To photograph the brass and mercury arc spectra & to calculate the wavelength of each spectral lines using Hartmann's formula.

Apparatus Required

Arc spectra apparatus, mercury lamp, photographic film, developer, fixer and brass rod.

Formula

The wavelength of the prominent lines is calculated by using the Hartmann's formula

$$\lambda = \lambda_0 + \frac{c}{(d - d_0)} \text{ Å}$$

Where, c- velocity of light (m)

d- corresponding comparator reading of the spectral lines.

Description

The constant deviation spectrometer consists of an iron stand with two arms at a right angle on the axis which is held rigidly between the telescope. The eyepiece can be adjusted to cut out any point of the field adjustable metal pointer.

The apparatus consists of a constant deviation prism which is mounted on a table. The mean deviation of the rays passing through the prism table is turned by means of a screw to which a drum is attached provided with a middle node.

Procedure

The slit of the spectrometer is illustrated by radiation from the brass arc for lighter and intensive illumination a condenser lens is used. Proper adjustments are made to obtain a well designed spectrum falls on the ground plate fixed to the camera. After preliminary adjustment the photograph of the spectrum is taken by giving a proper exposure. Now the brass arc is removed and the slit is illuminated by the mercury vapor lamp. A proper spectrum is superimposed. The wavelength corresponding to each spectral line is calculated using the Hartmann's formula.

Tabulation

Color	**Comparator reading (cm)**	**Calculated wavelength x 10^{-10} m**	**Standard wavelength x 10^{-10} m**
Violet			
Green			
Yellow			

Comparator reading (cm)	**Calculated wavelength x 10^{-10} m**	**Standard wavelength x 10^{-10} m**		
		Iron	**Copper**	**Zinc**

Calculations

$\lambda 1$ – 4047 Å

$\lambda 2$ – 5421 Å

$\lambda 3$ – 5790 Å

$$x = \frac{(\lambda_1 - \lambda_2)(d_3 - d_2)}{(\lambda_2 - \lambda_3)(d_2 - d_1)}$$

$$d_0 = d_1 - \frac{d_3 - d_1}{x - 1}$$

$$c = \frac{(\lambda_1 - \lambda_2)(d_1 - d_0)(d_2 - d_0)}{d_2 - d_1}$$

$$\lambda = \lambda_0 + \frac{c}{(d - d_0)} \text{ Å}$$

RESULT

The wavelength of spectral lines is determined by Hartmann's formula.

COMPRESSIBILITY OF A LIQUID - ULTRASONIC INTERFEROMETER

Aim

To calculate the adiabatic compressibility of the given liquid.

Apparatus

Ultrasonic interferometer, sample liquids, high frequency generator.

Formula used

$$\text{Compressibility, } \beta = \frac{1}{\rho v^2}$$

$$\text{where, } v = \lambda \times F$$

$$\lambda = 2d/N$$

ρ – density of the liquid (kg/m^3)

v- velocity of the liquid (m/s)

F- frequency of the wave (Hz)

d- total distance of micrometer (m)

Theory

Ultrasonic interferometer is a simple device which yields accurate and consistent data, from which one can determine the velocity of ultrasonic sound in a liquid medium.

Experimental Procedure

- Insert the quartz crystal in the socket at the base and clamp it tightly with the help of a screw provided on one side of the instrument.
- Unscrew the knurled cap of the cell and lift it away. Fill the middle portion with the experimental liquid and screw the knurled cap tightly.
- Then connect the high frequency generator with the cell.
- There are two knobs on the instrument- “Adj” and “Gain”. With “Adj”, the position of the needle on the ammeter is adjusted. The knob “Gain” is used to increase the sensitivity of the instrument.
- Increase the micrometer setting till the anode current in the ammeter shows a maximum.
- Note down the micrometer reading.

- Continue to increase the micrometer setting, noting the reading at each maximum. Count any number of maxima and call it as *n*. Subtract the reading at the first maximum from the reading at the last maximum.
- Then calculate the velocity of the wave through the medium.
- Knowing the density of the medium, the adiabatic compressibility can be calculated using the equation.

Fig.1

Tabulation

Deflection	**Micrometer reading (m)**	**D**	**Wavelength (Å)**

Calculation

Result

The velocity of the liquid = ------ m/s

Compressibility of liquid = ------ N/m^2

LASER DIFFRACTION AT SHARP EDGE

Aim

To determine the wavelength of the light using He-Ne laser and scale.

Apparatus Required

He-Ne laser, white screen, meter scale, engraved foot scale.

Formula used

$$\lambda = \frac{d}{2D^2}\left(\frac{y_m^2 - y_0^2}{m}\right)\text{Å}$$

where, λ- wavelength of the laser Å

m-order

d- distance between the engraved screen and the laser beam (m)

Experimental Procedure

(i) Laser is placed on a magnetic mount to make a small angle with the ruler.

(ii) Measure the distance (d) between the ruler and the screen.

(iii) By adjusting the position of the ruler, the laser beam is focused on the engraved scale.

(iv) Various spot is viewed on the screen and noted as y0, y1, ……

(v) The ruler is removed and the position of the direct beam is alos noted and the distance is measure.

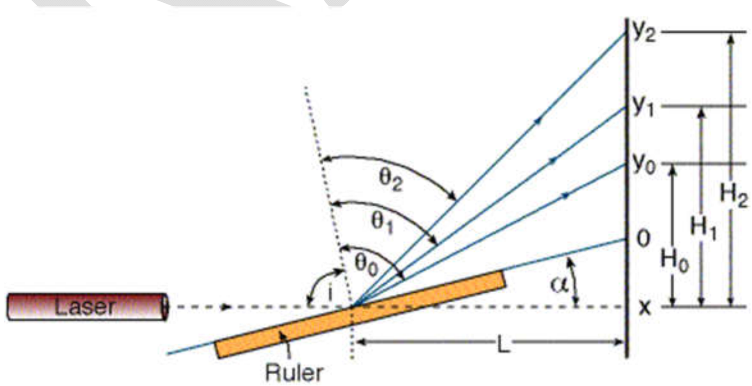


Fig.1

Tabulation

Order	Distance in cm	Wavelength Å
Y		
y+1		
y+2		
y+3		
y+4		
y+5		

Calculation

$$\lambda = \frac{d}{2D^2}\left(\frac{y_m^2 - y_0^2}{m}\right)Å$$

Result

The wavelength of the light using He-Ne laser is tabulated.

Viva voce

1. What is LASER?

2. What is the wavelength of He-Ne laser?

3. What is called diffraction?

4. How the fringes are formed?

HALL EFFECT

Aim

To study the Hall Effect and to determine the hall coefficient and number of charge carrier per unit volume.

Apparatus Required

Hall Effect kit, Gauss meter and electromagnet.

Formula Used

Hall coefficient is given by, $R_H=(V_H/Ic)(t/B)$ ohm^{2}Wmb

where, V_H – Hall voltage (V)

B – magnetic field

t- thickness of the specimen (m)

Ic – current (mA)

Number of charge carriers per unit volume, $n = \frac{1}{R_H e}$

e- charge of an electron

$$\text{Hall angle, } \tan \theta_H = \mu_H B$$

A- Magnetic field

$$\text{Hall Mobility, } \mu_H = \frac{R_H}{\rho}$$

ρ –density of the material (kg/m^3)

Experimental Procedure

(i) Place the specimen in the magnetic field.

(ii) With the help of rheostat allow the current to the semiconductor and measure the hall voltage (V_H) and Hall current Vx.

(iii) Increase the current (Ix) and measure Vx and V_H. Plot a graph between V_H and Ix.

(iv) Using the Gauss meter, measure the magnetic field.

Tabulation

Dimmer state current (A)	Hall probe current (mA)	Hall probe voltage (mV)
0.5	1.0 2.0 3.0	
1	1.0 2.0 3.0	
1.5	1.0 2.0 3.0	

Dimmer state current (A)	Hall probe current (mA)	Hall probe voltage (mV)
0.5 1.0 1.5 2.0 2.5	1.0	
0.5 1.0 1.5 2.0 2.5	2.0	
0.5 1.0 1.5 2.0 2.5	3.0	

current (A)	Magnetic field (B)
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	

Calculation

Result

Hall coefficient = ----------
No. of charge carriers, = --------
Hall angle = ---------
Mobility = ------------

Viva Voce

1. What is called Hall effect?
2. What is called mobility?
3. What is called Hall coefficient?

DETERMINATION OF STEFAN'S CONSTANT

Aim

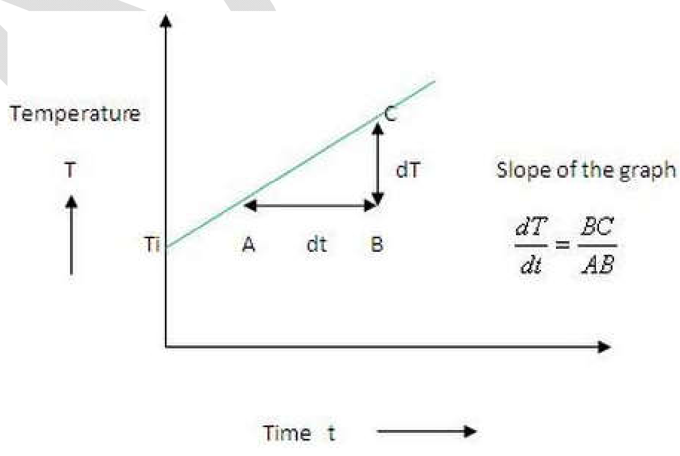
To determination of Stefan- Boltzmann constant σ.

Apparatus

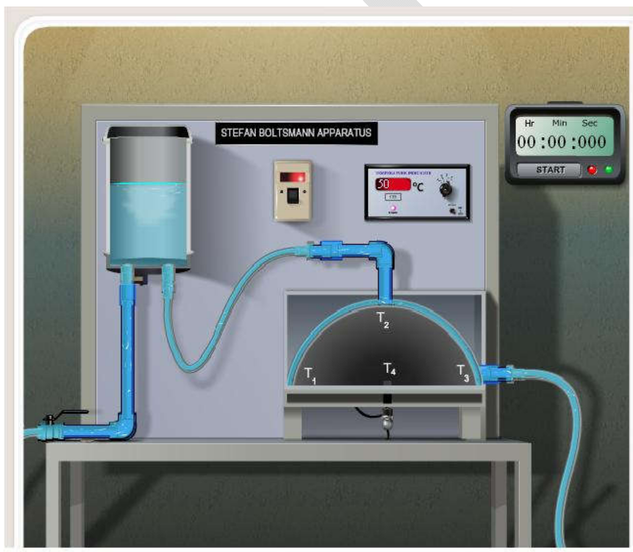
Heater, temperature-indicators, box containing metallic hemisphere with provision for water-flow through its annulus, a suitable black body which can be connected at the bottom of this metallic hemisphere.

Experimental Procedure

1. Remove the disc from the bottom of the hemisphere and switch on the heater and allow the water to flow through it.
2. Allow the hemisphere to reach the steady state and note down the temperature T_1, T_2, T_3.
3. Fit the disc (black body) at the bottom of the hemisphere and note down its rise in temperature with respect to time till steady state is reached.
4. A graph is plotted with temperature of disc along Y-axis and time along X-axis as shown.
5. Find out the slope dT/dt from the graph
6. Choose desirable values of water temperature, surrounding temperature, mass and radius of the disc using the sliders.



1. Click the "Power ON" button and wait till T_1, T_2 ,T_3 reach steady state. Note down its values.
2. Putting T_4 button, click "Fit the disc" option.
3. Note down T_4 at different intervals of time till it reaches steady state.
4. Plot Temperature-Time graph and determine its slope $\frac{dT}{dt}$.
5. Determine Stefan's constant 'σ' using the given formula.



Observations:

trial number	temperature of the hemisphere			Average Temp T_h= (T1+T2+T3)/3	Temperature of the disc in Kelvin T_4	Time **T** in sec	steady state temperature of the disc in Kelvin T_d
	T_1	T_2	T_3				
1.							
2.							
3.							

Calculations:

Mass of the copper disc = ... kg

Specific heat of copper = ... Jkg^{-1}

Radius of the disc = ... m

Area of the disc = ...m^2

Slope of the graph $\frac{dT}{dt}$ = ……Ks^{-1}

Substituting the values in the given expression,

$$\sigma = \frac{mC_p \frac{dT}{dt}}{A\left(T_h^{\,4} - T_d^{\,4}\right)}$$

= …………………………… $Wm^{-2}K^{-4}$

Result:

Stefan-Boltzmann's constant σ =…………… $Wm^{-2}K^{-4}$