Experiment-2

Aim:- Determine the dispersive power of sodium D-lines using a diffraction grating

Apparatus:-
- Spectrometre
- Diffraction Grating
- Sodium Lamps with power supply

Formula Used:-

* $(a+b)\sin\theta = n\lambda$

  n = order of spectrometre

  θ = angle of diffraction

* $\frac{d\theta}{d\lambda} = \frac{n}{(a+b)\cos\theta}$ → $(a+b)$ = grating element

  a = width of Transparency.

  b = width of opacity

Experiment-7.

Aim:- Determine the dispersive power of sodium D-lines using a diffraction grating.

Apparatus: Spectrometer, Diffraction grating, Sodium lamp with power supply.

Formula Used:- for Polychromatic Incident light falling normally on a plane transmission grating principle maxima for each spectral colour is given by,

$$(a+b)\sin\theta = n\lambda$$

where n = order of principal maximum
θ = angle of Diffraction

Also, Angular Dispersive power.

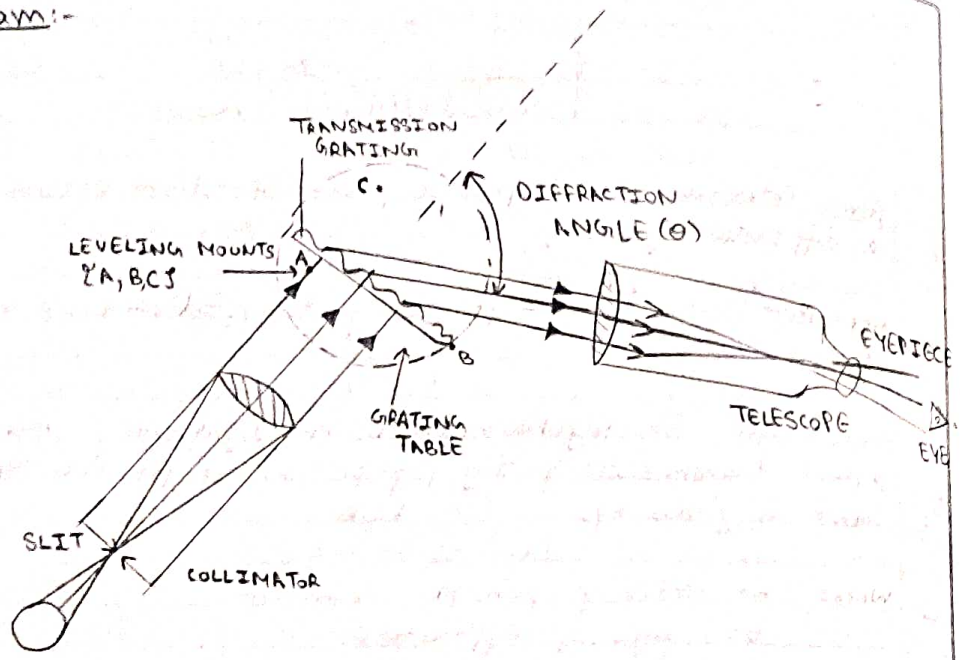
$$\frac{d\theta}{d\lambda} = \frac{n}{(a+b)\cos\theta}$$

where, $(a+b)$ = grating Element
a = width of Transparency
b = width of opacity
n = order of Spectrum
θ = angle of diffraction

Theory:- The sodium spectrum is dominated by bright doublet known as the sodium D-lines 589.0 and 589.6 nm. Using an appropriate diffraction grating and wavelength separation can be determined

- DIFFRACTION GRATING: An arrangement consisting of a layer number of parallel slits of the same width and separated

Diagram:-



LEAST COUNT CALCULATION:

20 Main Scale Divions = 10

1MSD = 0.5

⇒ No. of Lines on Vernier Scale = 30

Least Count = $\frac{0.5}{30}$

⇒ $\boxed{L.C = 0.0166}$

by an opaque space of width b. The diffraction pattern consists of diffraction modulated interference fringes. The quatity (a+b) is called the grating element and $N = [1/(a+b)]$ is the number of slits per unit length, which could typically be 300 to 12000 lines per inch. For a large number of slits, the diffraction pattern consists of extremely sharp principal maxima, together with weak secondary maxima. They are called orders.

- ANGULAR DISPERSIVE POWER: It is defined as the rate of change of angle of diffraction with the change in wavelength.

Procedure:-

(a) Adjustment of collimator and the Telescope:

1. Level the prism table, telescope and collimator with spirit level such that telescope and collimate axis intersect the in principal vertical axis of the spectrometer. A prism may be used for this purpose.
2. Focus the Eye-piece of the Telescope tube cross by drawing it in or out of the Telescope tube and untill the cross-wire is seen clearly.
3. Use schuster's method for focusing telescope and collimator for parallel Rays.

(b) Adjustment of the grating:- The grating is to be adjusted on the prism table such that light from the collimator falls normally on it.

4. First the collimator falls and Telescope are brought in one line and the image of the slit is focused on the vertical cross-wire. The corresponding reading on the Vernier

Observation Table:-

	n	MSR	VSR	Total	θ
Central	0	157	5	157.083	–
1st Right	1	167	3	167.0498	9.9668
1st Left	-1	148	3	148.0498	9.0332
2nd Right	2	179	2	179.0332	21.9502
2nd Left	-2	136	3	136.0498	21.0332

* $n=1$, $\theta_1 = \frac{9.9668+9.0332}{2} = 9.5$

* $n=2$, $\theta_2 = \frac{21.9502+21.0332}{2} = 21.4917$

Wavelength $\lambda_{n=1} = \frac{(a+b)\sin\theta_1}{n} = \frac{(\frac{1}{300})\sin(9.5)}{1} = 550.16\,nm$

$\lambda_{n=2} = \frac{(a+b)\sin\theta_2}{n} = \frac{(\frac{1}{300})\sin(21.4917)}{2} = 610.61\,nm$

Dispersive Power.

$\left[\frac{d\theta}{d\lambda}\right]_{n=1} = \frac{n}{(a+b)\cos\theta} = \frac{1}{(\frac{1}{300})\times\cos(9.5)} = 304.17$ rad/mm

$\left[\frac{d\theta}{d\lambda}\right]_{n=2} = \frac{n}{(a+b)\cos\theta} = \frac{2}{(\frac{1}{300})\cos(21.4917)} = 644.83$ rad/mm.

is noted.

5. The Telescope is rotated through 90°
6. Mount the grating on the prism table and rotate the prism table so that the Reflected image is seen on the vertical cross wire in the Telescope. Take the vernier reading.
7. Turn the prism table from this position through 45° or 135° so that 'writing' on the grating is away from the collimator. In this position, getting is normal to incident beam.
8. The slit is rotated in its place till the spectral lines are very sharp and bright. This brights the slit parallel to the lines of grating.

(c) Measuring the Diffraction Angles:-

9. Rotate the telescope to the left side of the direct image and Adjust it on diffrent spectral lines turn by turn It should be taken care that the movement of telescope is in one direction.
10. Note the vernier ~~as~~ readings V_1 and V_2.
11. Now rotate the telescope to the right side of the direct image and repeat steps 9 and 10. The difference of corresponding vernier readings will give twice the angle of Diffraction.
12. Find the angles of diffraction for Prominent lines in the first and second order spectra.

Result:- The Dispersive power of the Sodium D-lines is ~~274.55~~ 304.17 rad/mm.

Teacher's Signature

ERROR:

$$P = \frac{d\theta}{d\lambda} \Rightarrow P = \frac{n}{(a+b)\cos\theta}$$

Taking log on both sides and differentiating

$$\frac{dP}{P} = \left(\frac{\sin\theta}{\cos\theta}\right) d\theta$$

n and (a+b) are constants, There fore, turn zero on differentiating.

$$\frac{dP}{P} = \tan\theta \; d\theta$$

$\Rightarrow d\theta$ is least count

RESULT:-

The Dispersive Power of Sodium D-lines is 304.17 rad/mm.

$$\left[\frac{dD}{P}\right]_1 = \tan(9.5)\frac{1}{60} = 0.167 \times \frac{1}{60} = 0.00278$$

$$\left[\frac{dD}{P}\right]_2 = \tan(21.49)\frac{1}{60} = 0.393 \times \frac{1}{60} = 0.00656$$

Date

Expt. No.

Precautions:-

1. Once the collimator and Telescope and adjusted for ~~parall~~ parallel rays, their rays focusing should be not disturbed throughout the Experiment.
2. Once the grating is properly adjusted on the turn-table it should be locked.
3. While taking measurments at different positions of the Telescope. It must always be in locked position.
4. While rotating the Telescope arm if the vernier crosses over 0° [360°] on the circular scale, take the Angular difference appropriately.

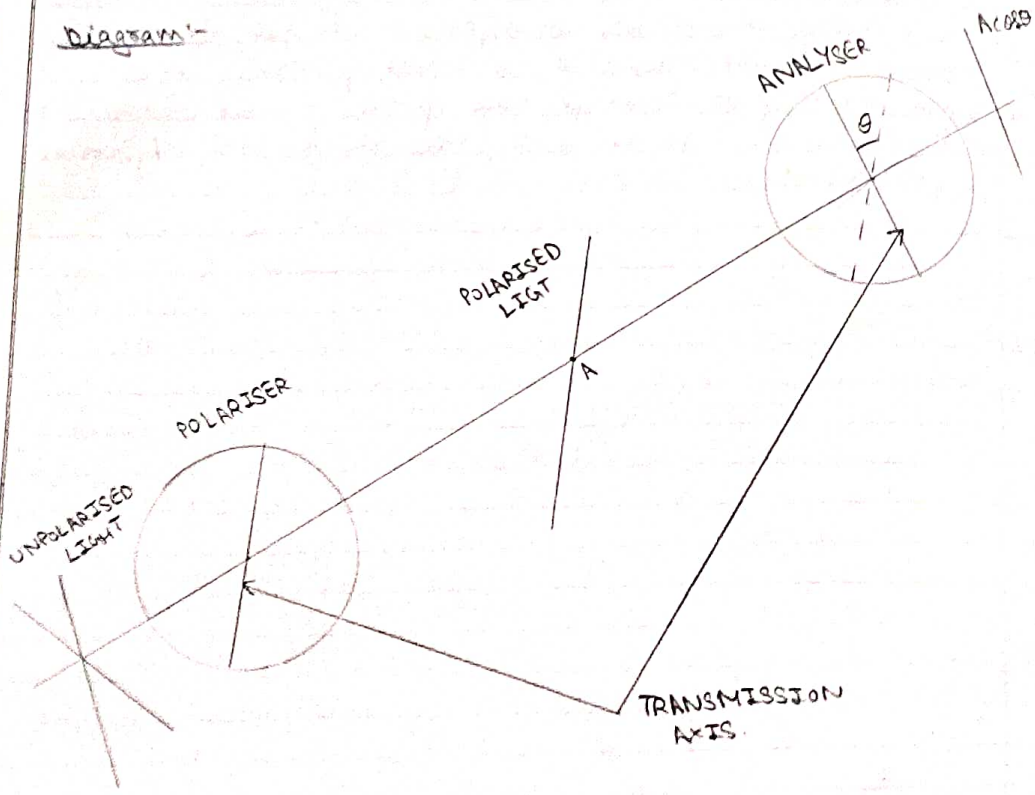
Teacher's Signature

Experiment-3

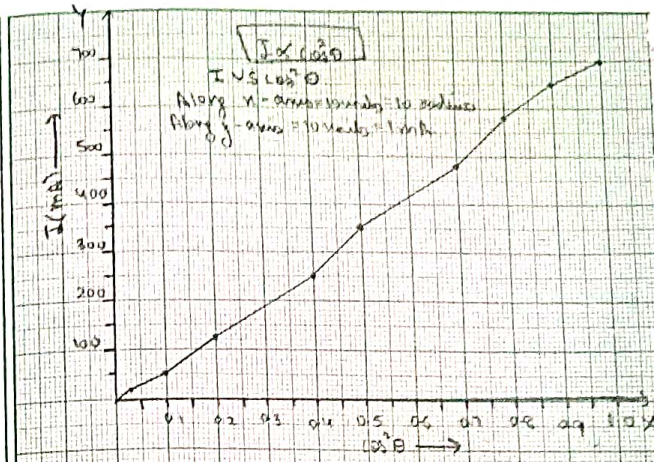
Aim:- To study and verify the Malus Law.

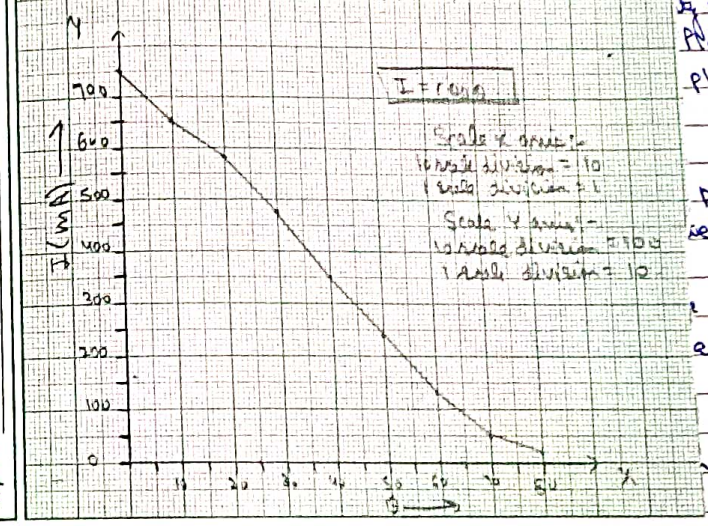
Apparatus:- optical bench with polariser. Analyzer, LDR sensor, Multimetre, Voltage. Stablizer.

Diagram:-



MALUS LAW SET-UP





alyser, lens and
voltage stablizer,

ty of Emergent light
Plain Polarised light
planes of Transmission.

polarised light is
ensity (I) of the
directly proportional
Angle between the
and the Polarizer.

lamp intensity.
and the detector

in one line.

3. Set Polarizer, Analyser, at zero position and for current value. It should be maximum.

4. Change Analyser position, in steps of 15° and note down the value of current.

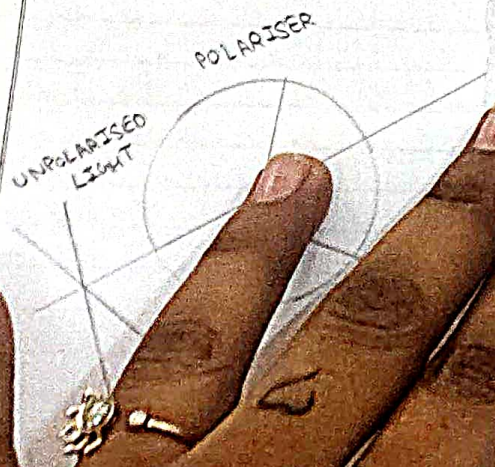
Teacher's Signature

Ex

Aim:- To study and verify

Apparatus:- optical bench
Multimetre, Voltage. St

Diagram:-



Malus

Malus

AXIS

LUS LAW SET-UP

Date 13/11/21

Expt. No.

Experiment-3

Aim:- To study and verify Malus Law.

Apparatus: Optical bench with Polarizer, Analyser, lens and Detector along with lamp, Multimeter, voltage stabilizer, etc.

Formula Used:- $I = I_0 \cos^2\theta$ where I = Intensity of Emergent light
I_0 = Intensity of Plain Polarised light
θ = Angle between planes of Transmission.

Theory:-
Acc to Malus's Law, when completly plane polarised light is incident on the Angular Analyser, the Intensity (I) of the light transmitted by the Analyser is directly proportional to the square of the cosine of the Angle between the Transmission axis of the Analyzer and the Polarizer.

Procedure:
1. Set voltage at 16V to achieve maximum lamp intensity.
2. Set the lamp, Polarizer, Analyzer, lens and the detector in one line.
3. Set Polarizer, Analyser, at zero position and for current value. It should be maximum.
4. Change Analyser position, in steps of 15° and note down the value of current.

Teacher's Signature

OBSERVATION TABLE:-

POSITIONS		θ (degree)	I (mA)	cos θ	$\cos^2\theta$	$I_0\cos^2\theta$
POLARISER	ANALYSER		$= I_0$			
0	0	0	7.01	1	1	7.01
0	10	10	6.52	0.984	0.969	6.79
0	20	20	5.83	0.939	0.883	6.18
0	30	30	4.82	0.866	0.75	5.25
0	40	40	3.65	0.766	0.586	4.10
0	50	50	2.46	0.642	0.413	2.89
0	60	60	1.36	0.5	0.25	1.75
0	70	70	0.55	0.342	0.116	0.81
0	80	80	0.24	0.173	0.030	0.2103
			$\Sigma I = 32.44$			$\Sigma I_0\cos^2\theta = 34.99$

ERROR CALCULATION:-

$$\% \text{ Error} = \left| \frac{\Sigma I_0 \cos^2\theta - \Sigma I}{\Sigma I_0 \cos^2\theta} \right| \times 100$$

$$\% \text{ Error} = \left| \frac{34.99 - 32.44}{34.99} \right| \times 100 \Rightarrow \boxed{\% \text{ Error} = 7.287\%}$$

Result:-

- Malus Law is thus verified as
  $\Rightarrow I = I_0 \cos^2\theta$

5. Current values will correspond to I and position difference between Polarizer and Analyzer as θ.
6. Record your observations in a suitable Table.
7. Draw a curve between I and $\cos^2\theta$ and I and θ.

Result:-

- Malus law is thus verified as $I = I_0\cos^2\theta$ where $\boxed{I \propto \cos^2\theta}$.
- Error is ~~2.784%~~. 7.287%.

Precautions:-

1. The position of the Polarizer should not be disturbed throughout the experiment.
2. The source of light, lens, Polarizer and solar cell should be adjusted to the same height.
3. The voltage applied to the light source should be constant throughout the experiment.
4. The Experiment should be performed in a dark room to avoid any external light inside the photovoltaic cell.

Sources of Error:

1. The position of polarizer may be get disturbed.
2. Polarizer and Analyzer may not be at the Same height
3. Changing the values of Analyzer abruptly may cause Errors.

Experiment-4

Aim:- To determine the wavelength of Sodium light by newton's ring

Apparatus:- A plano-convex lens of large radius of curvature, optical arrangement for newton's rings, plane glass, sodium lamp and travelling microscope.

Formula used:-

$$\boxed{\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}}$$

Where

D_{n+p} = diameter of $(n+p)$th ring.

D_n = diameter of nth ring

p = an integer number. (of the ring)

R = radius of curvature of the curved face of the plano-convex lens.

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Experiment-4

Aim:- To determine the wavelength of Sodium light using Newton's rings method.

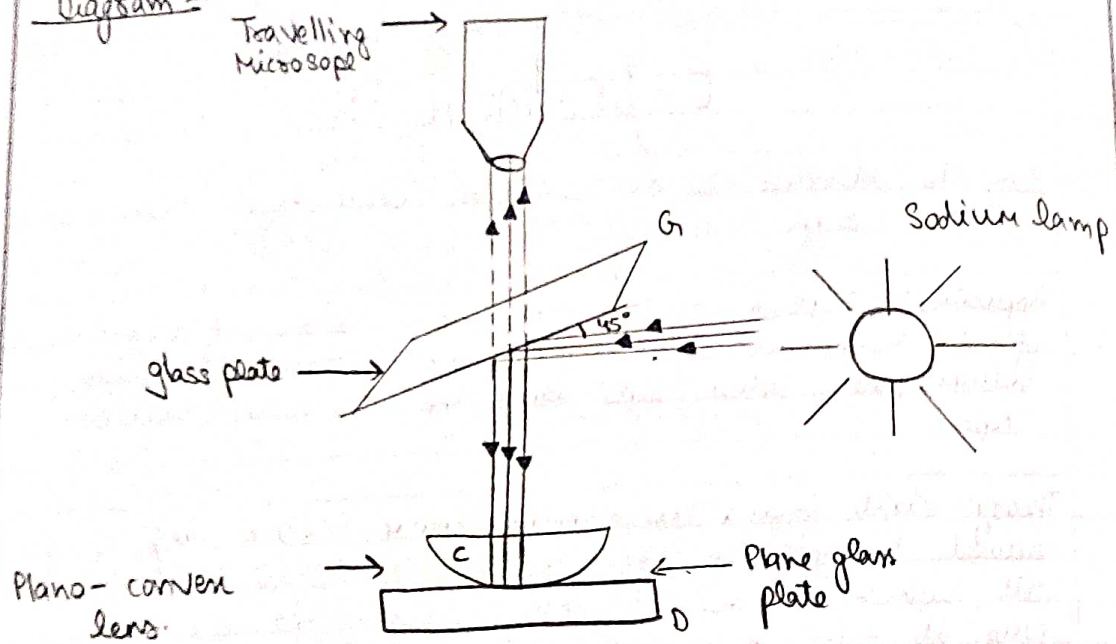
Apparatus:- A plano-convex lens of large radius of curvature, optical arrangement for Newton's rings, plane glass plate, Sodium plate, Sodium plate lamp and travelling micro-scope.

Theory:- Light from a monochromatic source (sodium lamp) is allowed to fall on the convex lens through a broad slit which renders it into a nearly parallel beam. Now it falls on a glass plate inclined at an angle 45° to the vertical, thus the parallel beam is reflected from the lower surface. Due to the air film formed by a glass plate and a plano convex lens of large radius of curvature, interference fringe are formed which are observed directly through a travelling microscope. The rings are concentric circles.

Newton Rings:- Newton Rings are circular interference fringes of equal thickness which are produced in the air between a convex surface and an optical flat / plane glass.

Teacher's Signature

Diagram:-



Observation Table:-

Left side reading of ring

S.No.	M.S.R	C.S.R	L.C	M.S.R + CSR × LC(L)
1	9	82	0.01	9.82
2	9	40	0.01	9.40
3	9	14	0.01	9.14
4	8	93	0.01	8.93
5	8	63	0.01	8.63

Procedure:-

(i) Initially, in the newton's ring apparatus, it is checked that the centre of the lens is well illuminated by adjusting the inclination of glass plate at 45°.

(ii) Now, we focus the eyepiece on the cross wire and move the microscope in the vertical plane by means of rack and pinion arrangement till the rings are quite distinct. clamp the microscope in the vertical side.

(iii) According to the theory the center of the interference fringes called should be dark so it should be checked throughly.

(iv) Move the microscopic in a horizontal direction to one side of the fringes. For fix up the cross wire tangential to the ring and note the reading. Again the microscope is moved in the horizontal plane and the cross wire is fixed tangentially to the successive bright fringes. noting the vernier readings till the other sides is reached.

This means that first we move the microscope horizontally in right direction and then we repeat the same procedure by moving it to the left direction and taking proper readings.

Right Side reading of ring

S.No.	M.S.R	C.S.R	L.C	MSR+CSR × LC(R)
1	10	81	0.01	10.81
2	11	23	0.01	11.23
3	11	49	0.01	11.49
4	11	86	0.01	11.86
5	12	4	0.01	12.04

Difference
10.81 − 9.82 = 0.99
11.23 − 9.4 = 1.83
11.49 − 9.14 = 2.35
11.86 − 8.93 = 2.93
12.04 − 8.63 = 3.41

Calculations:-

(i) $p = m - n$; $R = 1100$ mm, $n = 1$ [$m = 2$, $n = 1$]

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR} = \frac{D_2^2 - D_1^2}{4 \times 1 \times 1100} = 53.83 \times 10^{-9} m$$

(ii) $p = 3$, $R = 1100$ mm, $n = 1$ [$m = 4$, $n = 1$]

$$\lambda = \frac{D_4^2 - D_1^2}{4 \times 3 \times 1100} = 576.12 \times 10^{-9} m$$

(iii) $p = 2$; $R = 1100$ mm; $n = 2$ [$m = 4$, $n = 2$]

$$\lambda = \frac{D_4^2 - D_2^2}{4 \times 2 \times 1100} = 592 \times 10^{-9} m$$

(iv) $p = 2$; $R = 1100$ mm; $n = 1$ [$m = 3$, $n = 1$] $\lambda = \frac{D_3^2 - D_1^2}{4 \times 2 \times 1100} = 516.18 \times 10^{-9} m$

$$\lambda_{mean} = \frac{[53.83 + 576.12 + 592 + 516.18] \times 10^{-9}}{4}$$

$$\lambda_{mean} = 556.39 \times 10^{-9} m$$

Result:- % Error $= \frac{|\text{std.} - \text{observed}|}{\text{std. value}} \times 100$

$\Rightarrow \frac{|5893 Å - 5563 Å|}{5893 Å} \times 100$ $\Rightarrow$ **5.6%**

Date

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Result:- % error in wavelength of sodium light = 5.6%.

Precautions:-

(i) The lens used should be of large radius of curvature.
(ii) The source of light used should be an extended one.
(iii) Before measuring the diameter of rings, the range of the microscope should be properly adjusted.
(iv) Cross wire, should be focused on a bright ring tangentially.

Teacher's Signature

Experiment - 5.

Aim:- To determine the value of Plank's constant.

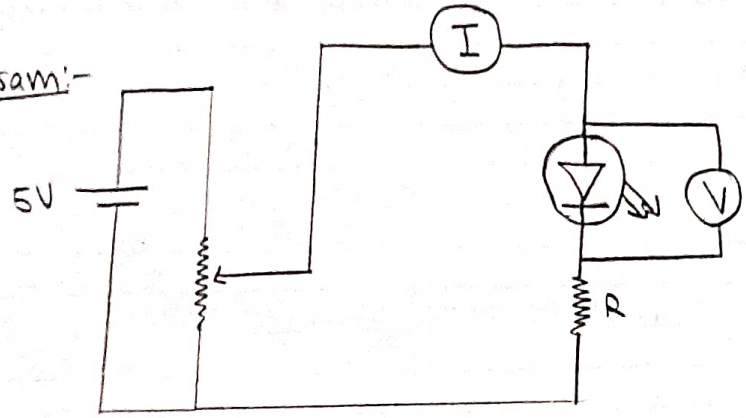
Apparatus:- Plank's constant pit and LED's

Formula used:- Plank's constant $= \frac{eV\lambda}{c}$

e: electronic charge.

V: Voltage applied ; λ: wavelength of light ; c: Speed of light

Diagram:-



Observation Table:- Theoretical value of $h = 6.626 \times 10^{-34}$ Js

Breakdown.

S.No.	Colours	Voltage (V)	1/wavelength (λ^{-1})
1.	Red	1.2 V	15.94×10^5
2.	Yellow	1.3 V	17.69×10^5
3.	Green	1.4 V	16.94×10^5
4.	Blue	2.0V	20.83×10^5

After
wards.

Date 9/11/21.

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Experiment-5.

Aim:- To determine the value of Plank's constant.

Apparatus:- Plank's constant kit and LED's.

Plank's constant:-
The Plank's constant or Plank's constant, is the quantum electromagnetic action that relates a photon energy to its frequency.

The value of Plank's constant, say h
$h = 6.626 \times 10^{-34}$ JS or m^2 Kg/S.

Acc. to the defination of Plank's constant,
$E = h\nu = hc/\lambda$
where E is energy of photon, h is plank's constant, ν is frequency, c is the speed of light, λ is the wavelength.

How to determine value of 'h':-
Photoelectric Effect:- The photoelectric effect is the emission of electrons when electromagnetic radiation, such as light, hits a material. The minimum energy required to remove (-ve) an electron from the surface of material is

$$\boxed{W = h\nu_0}$$

Teacher's Signature

Observation Table:-

(1)

Green		Blue		Red		Yellow	
Voltage (V)	Current (n)	Voltage (V)	Current (n)	Voltage (V)	Current (n)	Voltage (V)	Current (n)
0	0	0	0	0	0	0	0
0.53	5	0.5	5	0.51	5	0.5	5
1.02	10	1.02	10	1.01	10	1.01	10
1.48	15	1.51	15	1.40	15	1.43	15
1.63	20	2.01	20	1.46	20	1.52	20
1.68	30	2.38	30	1.49	30	1.58	30
1.71	50	2.43	50	1.52	50	1.62	50
1.75	100	2.47	100	1.56	100	1.66	100
1.77	150	2.48	150	1.58	150	1.68	150
1.78	200	2.50	200	1.59	200	1.70	200

Calculations:-

$$\text{Slope} = \frac{y_0 - y_1}{x_2 - x_1}$$

we consider 2 points red and blue

For red

$V_R = 10^2$

$\lambda^{-1} = 15.94 \times 10^5$

$V_B = 2.0$

$\lambda^{-1}_B = 20.83 \times 10^5 m^{-1}$

$$\text{Slope} = \frac{2.0 - 1.2}{(20.83 - 15.94) \times 10^5} = \frac{0.8}{4.89} \times 10^{-5} = 0.16 \times 10^{-5}$$

Planck's Constant (h) $= \frac{eV\lambda}{c}$

$V\lambda$ is the slope.

$$h = \frac{1.6 \times 10^{-19} \times 0.16 \times 10^{-5}}{3 \times 10^8} = 8.53 \times 10^{-34}$$

The formula for the maximum K.E of the ejected electrons becomes.

$$K_{max} + W = h\nu$$

Reverse Photoelectric effect:- In this process a voltage is applied to a forward -biased diode. Such diode emits the light due to recombination of e's and holes. The emitted light voltage is recorded in the voltmetre.

Procedure:-

(i) Make the connection measurement in the pit.
(ii) Take the current measurement of each LED by varying the voltage as given in the table.
(iii) Plot the curve on the graph pap (-e) ve b/t voltage on x axis and current on Y axis.
(iv) Take voltages corresponding to a current by a drawing the line parallel to Y-axis and note down values of voltages corresponding to different LED's
(v) The intercept is the point at which the voltage equals to the barrier potential. Put this value in table 2.
(vi) Now, plot a graph between voltage V and $1/\lambda$ and determine the slope of the line. It will give the value of hc/e. Put the value of c (3×10^8 m/s) and e (1.6×10^{-19} C). Reduce the value of Plank constant h.

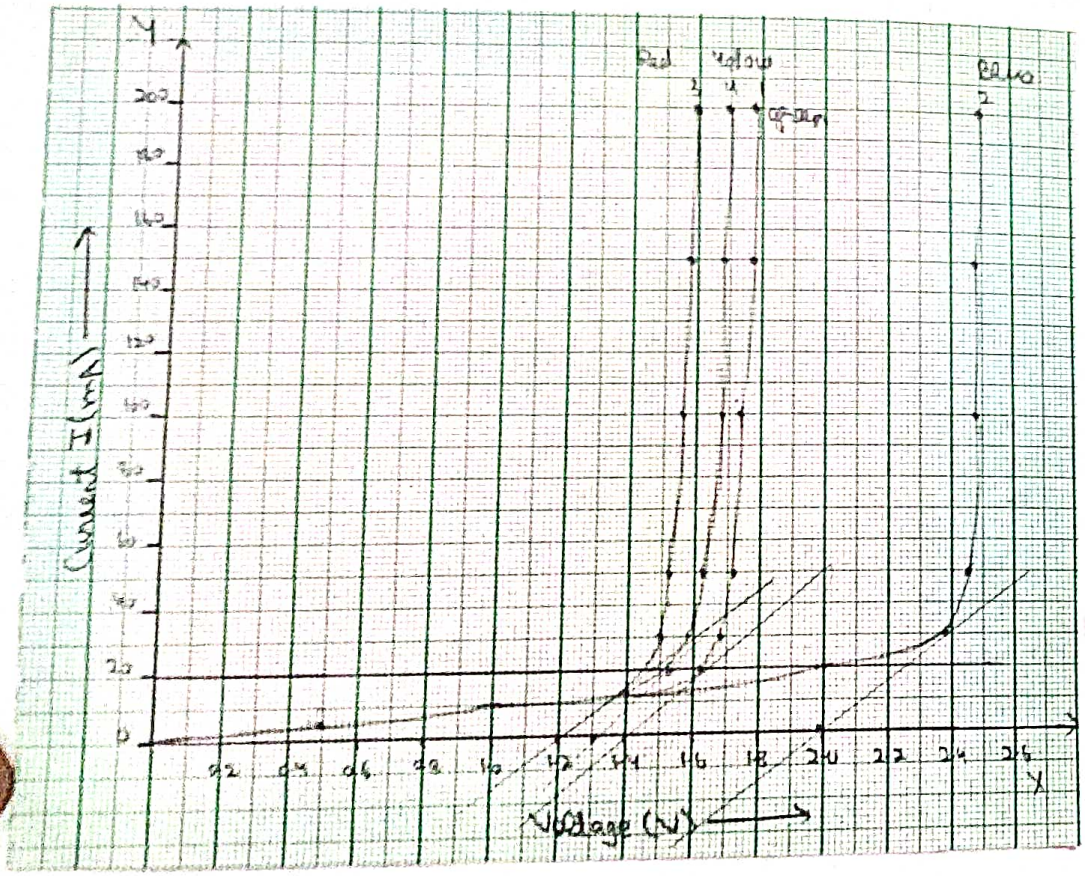
Result:- % error in Plank's constant = 4.1%.

$$\% \text{ Error} = \frac{|\text{Calculated} - \text{Observed}|}{\text{Calculated}} \times 100$$

$$= \frac{|6.626 - 8.531|}{6.626} \times 100$$

$$= 28.73\%$$

<u>Result:-</u> % Error in plank's constant = 28.73%.

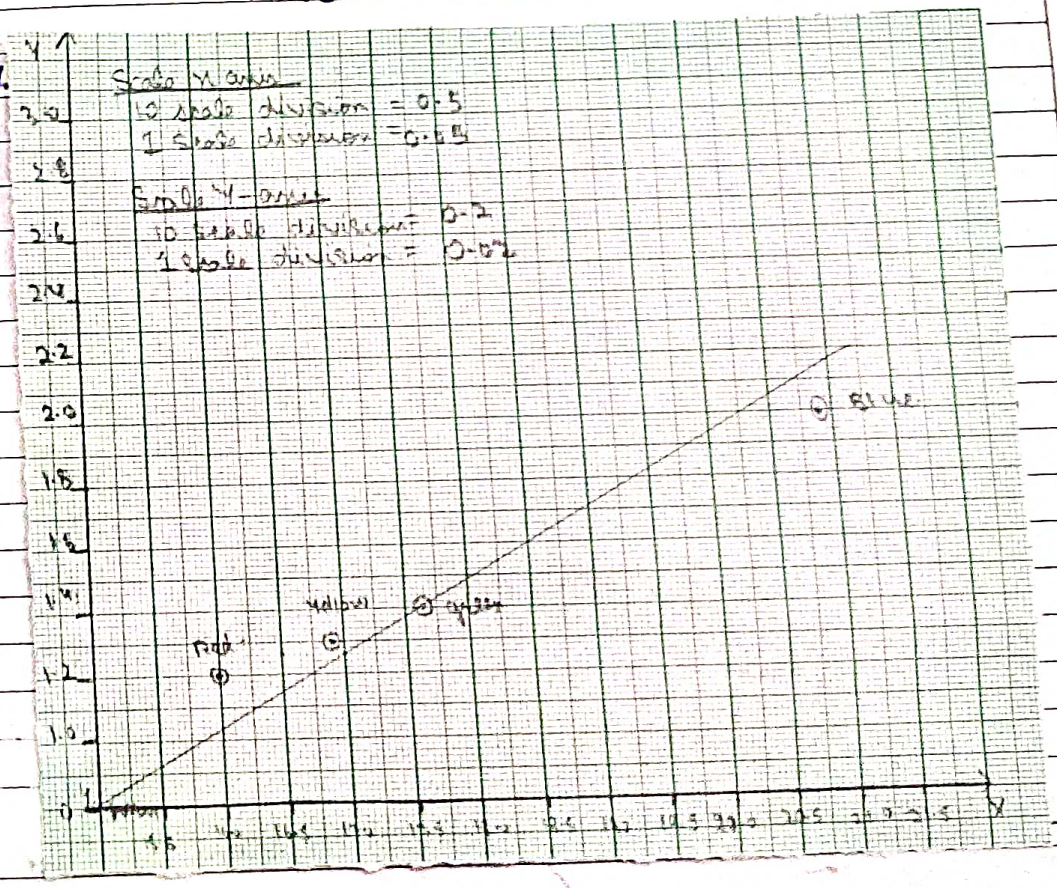


Precautions

- Rotate Rotate all the knobs very slowly.
- After completing the experiment turn off the switch.
- Don't use approximations while calculating the 'h' otherwise there will be larger error.
- Note all the readings very carefully.

Percentage Error:-

$$\% \text{ Error} = \frac{\left| \text{Experimental Value} - \text{Theoretical Value} \right|}{\text{Theoretical Value}} \times 100\%$$



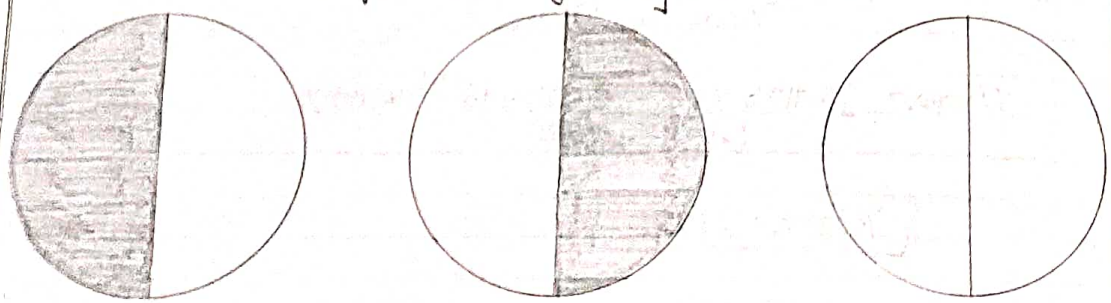
Experiment 6

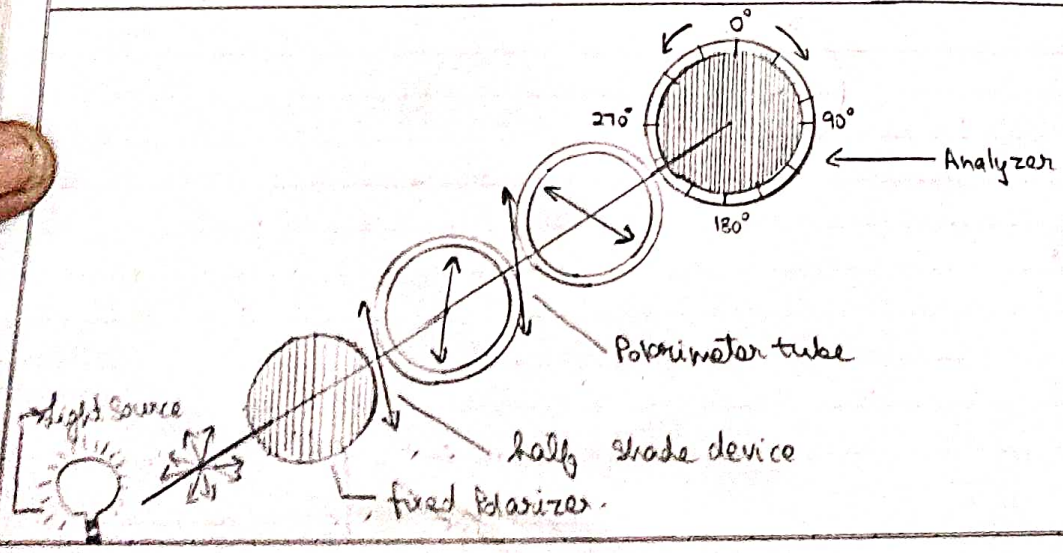
Aim:- To determine the specific rotation of cane sugar dissolved in water

Apparatus required:-
- Polarimeter
- 100cc flask
- Polarimeter tube [2dm]
- Sugar [20gm]

Diagram:-

Field of views through analyzer





Experiment 6.

Aim of the Experiment:-

To determine the specific rotation of cane sugar dissolved in water.

Apparatus Required:-

- Polarimeter
- 100cc flask.
- Polarimeter tube (2dm)
- Sugar (80gm)

Theory.

The rotation produced by an optically active substance depends upon.

1. The wavelength of light used.
2. The temperature
3. The path travelled by ray of light. (length of polarimeter tube)
4. The density or concentration of the solution.

Suppose the length of the polarimeter tube = 1 unit
concentration of solution used = gm/cc.

The angular rotation produced (corresponding to given wavelength and temperature) $\theta = \alpha l c$.

Where α is the specific rotation.

$\alpha = \frac{\theta}{lc}$ = rotation in degree / length in decimetre × concentration (gm/cc).

Observation Table :-

Room Temp = 35°C, Length of Polarimetre = 2 decimetre

Mass of sugar dissolved = 20gm

Vol. of solution = 100cc

With Water.			With Cane Sugar Solution			Angle of rotation θ
Anglear Reading			Analyzer's Readings			$\theta = \theta_s - \theta_w$
Main Scale (MS)	Vernier Scale (V.S)	θ_w T=MS+VS	Main Scale [MS]	Vernier Scale [VS]	θ_s T=MS+VS	
154	0.5	154.5	180	0.1	180.1	$\theta_1 = 25.6°$
27	0.3	27.3	51	0.8	51.8	$\theta_2 = 24.5°$
86	0.1	86.1	110	0.4	110.4	$\theta_3 = 24.3°$

$$\text{Average} = \frac{\theta_1+\theta_2+\theta_3}{3} = \frac{25.6+24.5+24.3}{3} \Rightarrow \boxed{\text{Average } \theta = 24.8°}$$

Results :-

$$\alpha = \frac{\theta}{l} \times \frac{V}{x} = \frac{24.8}{2} \times \frac{100}{20} = 62° \, dm^{-1} [g/cc]^{-1}$$

$$\boxed{\alpha = 62° \, dm^{-1} (g/cc)^{-1}}$$

Where α is specific rotation

θ = Rotation in degree

l = length of solution tube in dm

v = volume of solution in cc

x = weight of dissolved sugar in gm

where $l = 1$ decimetre ; $c = 1 gm/cc$; then $\alpha = \theta$.

So we can define specific rotation as the rotation produced by one decimetre length of solution of a unit concentration for a given wavelength and at the given temperature.

Procedure:-

1. Clean polarimeter tube and fill it with distilled water, place the tube inside the apparatus at its given position. So the field of view at equal intensity and note the readings of the position of angle from both the scales. Mark them as θ_w and θ'_w.

2. Now pour out of water from the tube and fill it with the given sugar solution. Again set the field of view at same position as before. Note down the readings of the position of angle from both the scales. Mark them as θ_s and θ'_s.

3. The angle of rotation $\theta_1 = \theta_s - \theta_w$, $\theta_2 = \theta'_s - \theta_w$

$$\text{Angular rotation } \theta = \frac{\theta_1 + \theta_2}{2}$$

4. Calculate specific rotation of given salt solution by

$$\alpha = \frac{\theta}{lc}.$$

Percentage Error:- $\alpha = \frac{\theta}{l \times c}$

taking log on both sides $\log \alpha = \log \theta - \log l - \log c$

differentiating both sides $\frac{d\alpha}{\alpha} = \frac{d\theta}{\theta} - \frac{dl}{l} - \frac{dc}{c}$

Since l and c are constants, dl and $dc = 0$

$$\therefore \frac{d\alpha}{\alpha} = \frac{d\theta}{\theta}$$

% Error $= \frac{d\theta}{\theta} \times 100$ $\quad d\theta =$ least count

$\theta =$ average value of angle of rotation

% Error $= \frac{0.1}{24.8} \times 100 \Rightarrow 0.403\%$

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Result:-

The specific rotation of given cane sugar solution is $\alpha = 62$ deg dm^{-1} $[g/cc]^{-1}$.

Precautions:-

1. The Polarimeter should be cleaned properly.
2. There should not be any air bubble in the tube filled with water/solution.
3. Solution should be clear and dust free.
4. Equally bright positions should be used for taking readings.
5. The position of the analyzer should be set accurately.
6. The temperature and wavelength of light must be stated.
7. Switch off the lamp after completing the experiment.

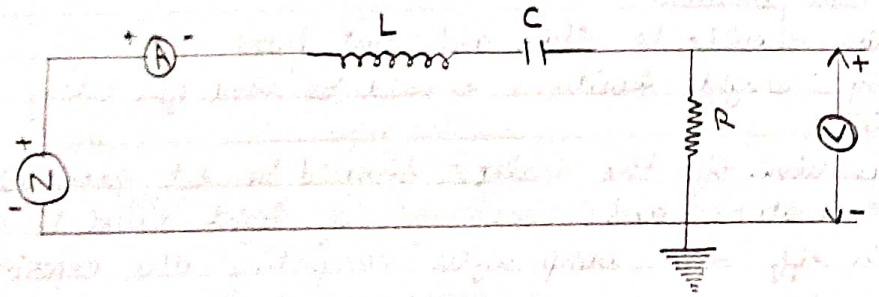
Teacher's Signature _____

Experiment-8

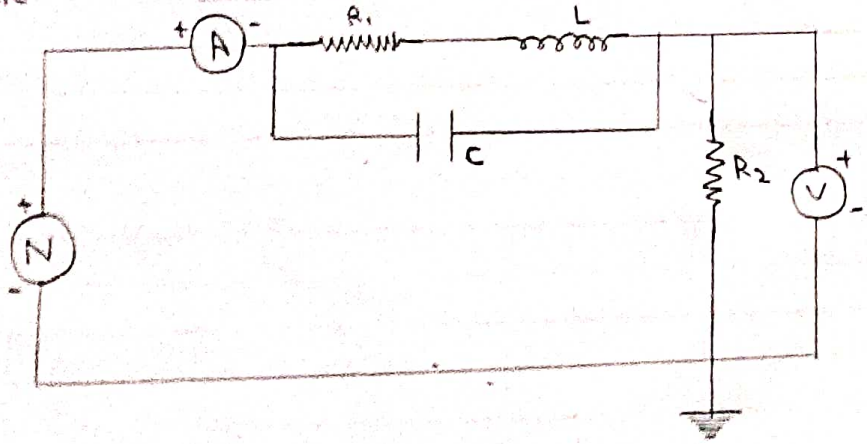
Aim of the experiment:-
To determine resonance in series and parallel LCR circuit.

Apparatus Required:- Sine wave generator [Signal generator], AC ammeter, AC Voltmeter

Circuit Diagram:-



Parallel LCR circuit



Experiment-8

Aim of the Experiment:-
To determine the resonance in series and parallel ~~RLC~~ LCR circuit.

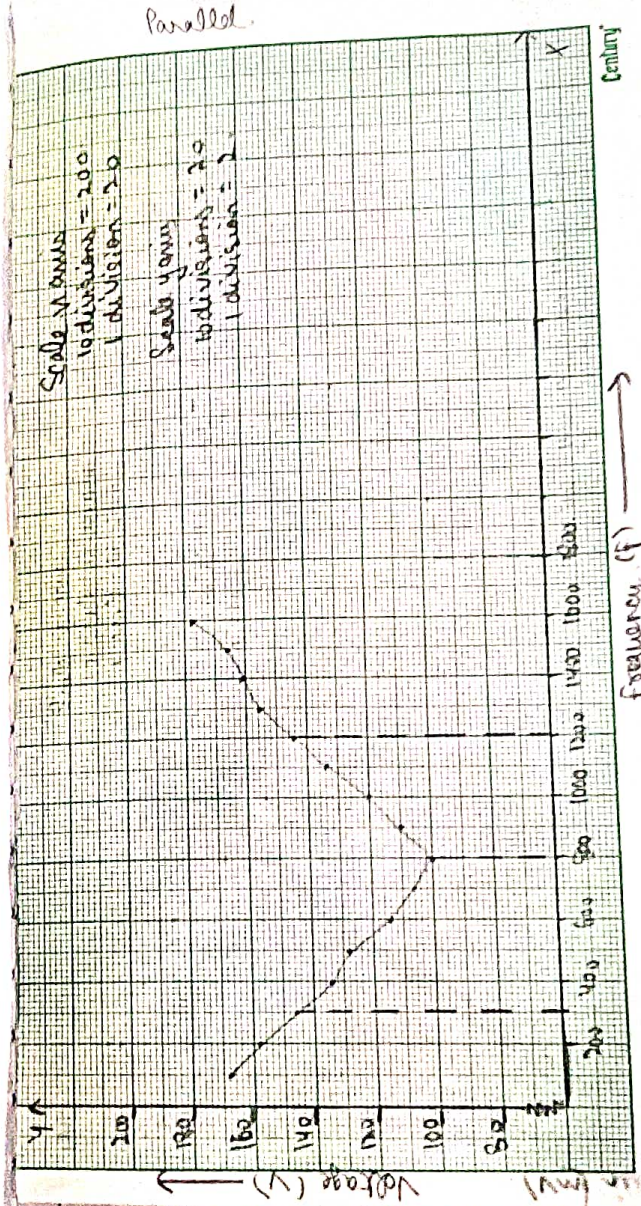
Apparatus required:- Sine wave generator (signal generator), AC ammeter, AC Voltmeter

Theory:-
Series LCR circuit:-
When the resistor R, inductor L, and capacitor C are connected in a series with a source of emf V, the circuit is called as the series LCR. This is an acceptor circuit, that mean it allows maximum current to flow through it a particular (resonant frequency) and at all other frequencies it allows less current. In AC circuit voltage and current are usually out of phase. Across the inductor, the current lags behind the voltage by an angle of $\pi/2$ whereas across the capacitor, the current leads the voltage by 90°. But across the resistor the voltage and current both are in phase. Under certain conditions, the voltage and current are in phase even through the circuit consists of a L, C and R, the circuit behaves as a pure resistor. This phenomena is called resonance. This occurs at a single frequency known as a resonant frequency. At this frequency the capacitive reactance ($X_C = 1/\omega C$) and the inductive reactance ($X_L = \omega L$) are equal. So they cancel each other

Observation Table:-

Circuit in Series		Circuit in Parallel	
Frequency (Hz)	Voltage (mV)	Frequency (Hz)	Voltage (mV)
100	30	100	168
200	53	200	158
300	75	300	143
400	101	400	135
500	128	500	127
600	153	600	115
700	165	700	105
800	175	800	100
900	180	900	110
1000	176	1000	120
1100	166	1100	135
1200	154	1200	145
1300	140	1300	156
1400	124	1400	160
1500	110	1500	165
1600	100	1600	169
1700	84		
1800	66		
1900	45		
2000	35		

Parallel



dependence impedence of the

> $\omega L - Y\omega C = 0$

imum $I = V/R$.

is maximum and this frequency f_0
. The circuit has selective
ity or sharpness of resonance,
chosen at which the current
wer points) of its maximum.
$(f_2 - f_1)$ between the half
t width.

in which one branch consists
oiated resistor R and the other
t C. This is a rejector circuit
current or allows minimum
it, at a particular (anti-resonant)
frequency and it allows more current at all other
frequencies. So the circuit is not selective. But it is
highly selective when energised from a high impedence
generator.

Observation Table:-

Circuit in Series		Circuit in Parallel	
Frequency (Hz)	Voltage (mV)	Frequency (Hz)	Vol (V
100	30	100	16
200	53	200	15
300	75	300	14
400	101	400	13
500	128	500	12
600	153	600	11
700	165	700	1
800	175	800	1
900	180	900	1
1000	176	1000	1
1100	166	1100	1
1200	154	1200	1
1300	140	1300	1
1400	124	1400	1
1500	110	1500	1
1600	100	1600	1
1700	84		
1800	66		
1900	45		
2000	35		

Parallel.

and only resistance acts. the independence impedence of the circuit is given by.

$$Z = R + j(\omega L - 1/\omega C)$$

at resonence

$$X_L = X_C \Rightarrow \omega L = 1/\omega C \Rightarrow \omega L - 1/\omega C = 0$$

$\therefore$ imperdence $Z = R$

The current is maximum $I = V/R$.

So $\omega L = 1/\omega C$

$\omega_0 = \omega = 2\pi f_0 = 1/\sqrt{LC}$

At this frequency the current is maximum and this frequency f_0 is called resonent frequency. The circuit has selective properties. To compare selectivity or sharpness of resonence, a band of frequencies is chosen at which the current falls to $1/\sqrt{2}$ times (half power points) of its maximum value. The frequency difference $(f_2 - f_1)$ between the half power point is called a band width.

Parallel LCR circuit:-

Parallel resonant circuit is one in which one branch consists of an inductor L with associated resistor R and the other branch consists of a Capacitor C. This is a rejector circuit that means it rejects the current or allows minimum current to flow through it, at a particular (anti-resonent) frequency and it allows more current at all other frequencies. So the circuit is not selective. But it is highly selective when energized from a high impedence generator.

Observations

Series LCR circuit

Peak Voltage = 180V

Resonance Frequency: 900Hz

Half Power freq (lower) = 500Hz

Half Power freq (upper) = 1400Hz

Parallel LCR circuit

Minimum Voltage = 100mV

Resonance Frequency = 800Hz

Half Power freq (lower) 300Hz

Half Power Freq (upper) = 1200Hz

Series LCR circuit

$$\text{Bandwidth} = \frac{f_0}{|f_1 - f_2|}$$

$$\text{Bandwidth} = \frac{500}{|500 - 1400|}$$

Bandwidth = 0.55

Parallel LCR circuit

$$\text{Bandwidth} = \frac{f_0}{|f_1 - f_2|}$$

$$\text{Bandwidth} = \frac{800}{|1200 - 300|}$$

Bandwidth = 0.88

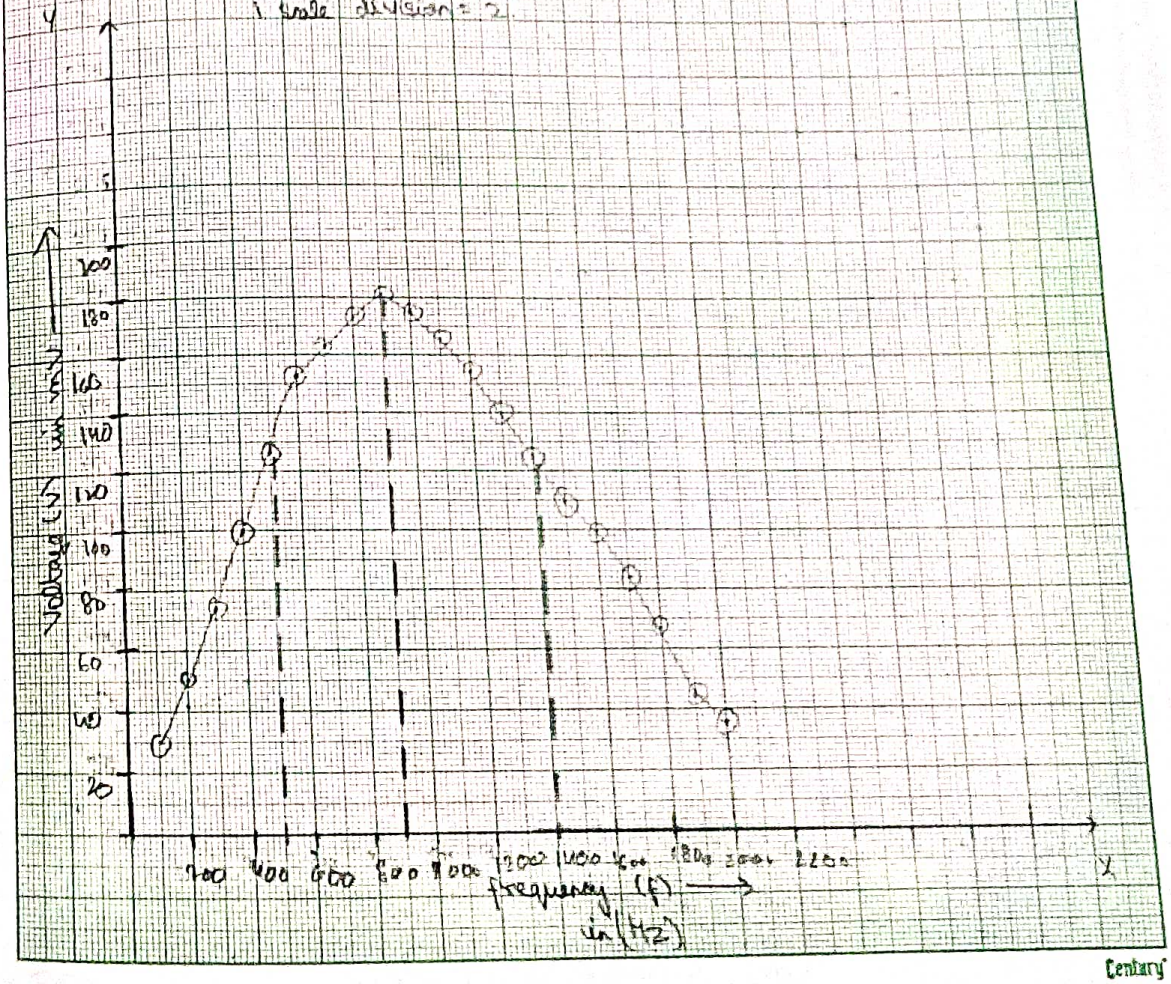
Results:-

	Series LCR circuit	Parallel LCR circuit
Resonant frequency f_0	900Hz	800Hz
Half upper frequency f_2	1400 Hz	1200Hz
Half lower frequency f_1	500 Hz	300 Hz
Bandwidth $\frac{f_0}{\lvert f_1 - f_2 \rvert}$	0.55	0.88

Topic : Series Date :

Scale x-axis :-
10 scale divisions = 200
1 scale division = 20

Scale Y-axis :-
10 scale divisions = 2
1 scale division = 2



Century

LCR

Series

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The impedence of the circuit is given by:-

$$\frac{1}{Z} = \frac{1}{R+jL\omega} + \frac{1}{1/j\omega}.$$

At resonance the impedence is maximum.

The impedence at resonance $Z = L/RC$.

The anti resonant frequency $f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$ Hz.

The R is very small then $f = \frac{1}{2\pi\sqrt{LC}}$ Hz.

Procedure:-

For series LCR circuit:-

1. Connect the current meter in to the circuit across.
2. Adjust the output of function generator starting from 10Hz frequency.
3. Increase the frequency of signal upto 10KHz in small steps and note down the corresponding value of frequency and voltage.

For parallel LCR circuit:-

1. Connect the current meter in to the circuit across.
2. Adjust the output of the function generator starting from 10Hz frequency.
3. Increase the frequency of signal upto 10KHz in small steps and note down the corresponding value of frequency and voltage.

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Precautions :-

1. All the connections should be tight.
2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. Before the circuit connection it should be check out working condition of all the component.

Teacher's Signature