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POLARIMETER

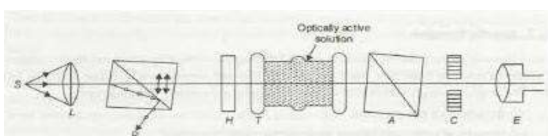
Aim: To find the specific rotation of cane-sugar solution by a polarimeter at room temperature, using Half shade polarimeter.

Apparatus used: Polarimeter set up, polarimeter tube, cane-sugar, physical balance, weight box, measuring cylinder, beaker and source of light.

Formula used: The specific rotation of cane- sugar solution is

$$S = \frac{\theta V}{lm}$$

Where θ = rotation of the plane of polarization (in sugar) produced by the solution
V = volume of the sugar solution in cc
l = length of the polarimeter tube in decimeter
m = mass (in gms.) of sugar dissolved in water



Procedure:

1. The polarimeter tube (T), is cleaned and filled with water such that no air is enclosed in it. If there remains a small air bubble, then the bubble is brought in the bubble trap while placing the tube inside the polarimeter.
2. The tube is placed in its position inside the polarimeter and the polarimeter is illuminated with monochromatic source(S).
3. Switch on the sodium lamp and focus the telescope at the position of equal brightness of both the halves by rotating analyser clockwise. Note down the position of analyzer on the circular scale (C).
4. Rotate the analyzer (A) in anti-clockwise direction for the same position of equal brightness. Note down readings of this position.
5. Now the polarimeter tube (T) is filled with sugar solution and repeat the same procedure as that for water. Note down readings with sugar solution of different concentation.

Observations:

Length of the polarimeter tube = 2 decimeter
Mass of sugar = 2 gms
Volume of the sugar solution = 50 ml

Concentrations of the solution : $C_1 = m/v = 2/50$ gms/ml = ……. gm/cc
$C_2 = m/2v = 2/100$ gms/ml = …… gm/cc

Least count of polarimeter (LC) =...........degree

Observation table for the angle of rotation:

S. No.	Analyzer reading with pure water						Conc. of sugar	Analyzer reading with sugar solution								Mean
	Clockwise			Anticlockwise				Clockwise			Anticlockwise			Θ_1	Θ_2	$\Theta = (\Theta_1 + \Theta_2)/2$
	M.S.	V.S.	TOTAL (a)	M.S.	V.S.	TOTAL (b)	C	M.S.	V.S.	TOTAL (c)	M.S.	V.S.	TOTAL (d)	a-c	b-d	
1																
2																

Calculations: Specific rotation,

$$S_1 = \frac{\theta_1}{lc} \quad \text{and } S_2 = \frac{\theta_2}{lc}$$

The specific rotation of cane sugar solution $S = \frac{S_1+S_2}{2}$

Result: The specific rotation of cane sugar = --------------- degree/dm/gm/cc

Standard Result: The specific rotation of cane sugar= +66.7 degree/dm/gm/cc

Percentage error:

Sources of error and precautions:

(a) The polarimeter tube should be well cleaned.
(b) Water used should be dust free.
(c) There should be no air bubble inside the tube.
(d) The position of analyzer should be set accurately.

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DIFFRACTION GRATING

Aim: To determine the wavelength of prominent spectral lines of mercury light by a plane transmission grating.

Apparatus used: Mercury lamp, Spectrometer, diffraction grating and a reading lens, eye-piece, prism, spirit level, reading lens.

Formula used: The wavelength of any spectral line can be obtained from the formula.

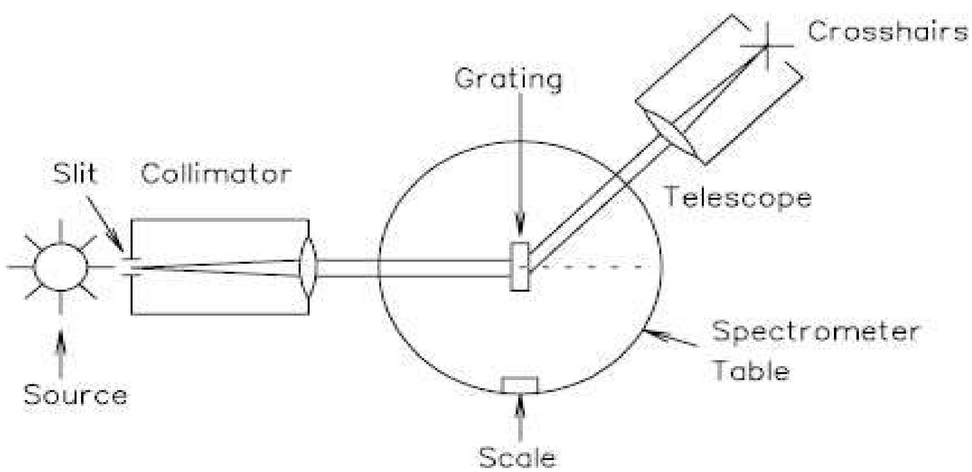
$$(e+d)\sin\theta = n\lambda$$

or, $$\lambda = \frac{(e+d)Sin\theta}{n}$$

Where, $e+d$ = Grating element

θ = Angle of diffraction

n = Order of spectrum



A) Adjustment of Spectrometer

The following adjustments should be done:

I) The optical axes of telescope and collimator should be perpendicular to the axis of rotation of the turn table and should meet at the same point.

This adjustment is done by the manufacturer.

II) Adjustment of the turn table:

1. The prism table is leveled with the help of three screws beneath the prism table. A spirit level is placed along the line joining the screws and the two screws are moved till the air bubble moves in the middle. Now place the spirit level along a line perpendicular to the previous line and adjust the third screw such that again the air bubble appears in the middle. Here one thing should be remembered that first two screws should not be touched this time. The prism table is now leveled.

III) Grating should be normal to the axis of collimator:

1. Collimator and telescope are arranged in a line and the image of the grating is focused on the vertical cross-wire.
2. The telescope is then rotated through 90^0 from this position.
3. The prism table is now rotated till the image of the slit, formed by reflection from the grating is thrown on the cross-wire.
4. The turn table is then rotated through 45^0 or 135^0 from this position. The plane of the grating thus be comes normal to the collimator axis.

After doing all the adjustments view the image of slit through telescope. Now remove the grating keeping eyes on eye-piece. Image of the slit should remain in the same place and should not shift in position.

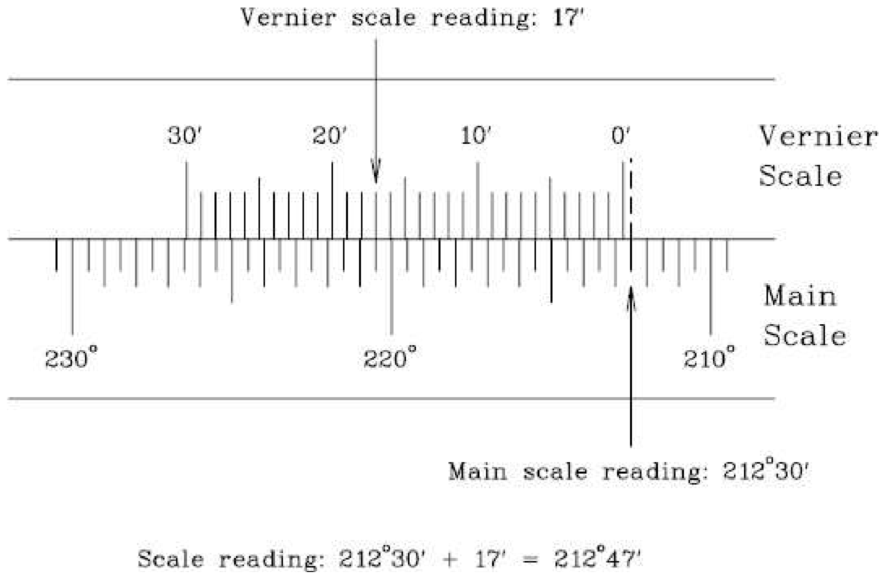
How to read the spectrometer readings:

Read the position of the telescope from the angular scale on the base. This can be done to a precision of 1‟ (±one minute, 60′= 1^0) . To read the scale:

1. Locate the "0" line on the vernier scale, and note which main scale division it is immediately after, e.g. 212^0 30‟ on the main scale. Note that the numbers on the main and vernier scales increase from right to left, and not from left to right as you are used to reading.

2. Scan along the line where the main and vernier scales meet, and note which one vernier scale division is directly in line with a main scale division, e.g. 17 on the vernier scale in Figure 5.

3. Add the main and vernier scale readings to obtain the angular scale reading, e.g. 212^0 30′ +17′= 212^0 47′ in Figure 5.



Procedure:

A. Readings for the angle of diffraction are taken as follows:

1) The telescope is rotated on one side (say left) of the direct image till red line of the first order spectrum comes on the cross wire (fig). The readings of both the verniers (V1 & V2) are recorded. Similarly, readings of both the verniers (V1 & V2) are recorded for other spectral lines (say violet and green).
2) Now rotate the telescope on the other side (say right) of the direct image and repeat the same procedure as above.
3) Find out the difference in readings of the same kind of verniers for each spectral line and calculate angle of diffraction (θ).

Observations:

(1) Observation for adjustment of the grating :
Least Count of the spectrometer = It is defined as the value of one division on main scale divide by total numbers of divisions on venire scale.

(2) Observations for the grating element:.
Grating element $(e+d) = \dfrac{2.54\ cm}{number\ of\ lines\ per\ inch}$

If the number of lines per inch on the grating = 15000.

$$(e + d) = 1.69 \times 10^{-4}\ \text{cm}$$

(3) Observations table for angle of diffraction (θ):

Order of Spectrum	Color of Spectrum	Reading for the Spectrum on				Value of 2θ			Mean Value of θ (deg)
		L.H.S.		R.H.S.		Vernier			
		V_1 (a) = MS+(VS ×LC)(deg)	V_2 (b) = MS+(VS ×LC)(deg)	V_1 (c) = MS+(VS ×LC) (deg)	V_2 (d) = MS+(VS ×LC) (deg)	V'_1 = a~c (deg)	V'_2 = b~d (deg)	Mean of 2θ = $(V'_1+V'_2)/2$ (deg)	
1st	Violet								
	Green								
	Red								

Calculations:

$$\lambda = \frac{(e+d)\sin\theta}{n}$$

Where n = order of spectrum

(e + d) = Grating element

Result: THE CALCULATED WAVELENGTH OF SPECTRAL LINES ARE AS BELOW:

Violet line λ_v =

Green Line λg =

Red Line λ_r =

Standard values:

Violet line λ_v **= 380-450 nm Green line** λg **= 495-570 nm Red Line** λ_r **= 620-750 nm**

Percentage error: $\frac{\text{(Standard value – Observed value)}}{\text{Standard value}} \times 100$

Precautions:

1. The grating should not be touched with hand or rubbed. It should always be held by means of fingers kept on the opposite edges of the grating.
2. Grating should be perfectly normal to the axis of the collimator.
3. The turn – table must be leveled optically.
4. While recording observations the telescope should be rotated in the same direction in order to avoid backlash error.
5. The slit should be as narrow as possible.
6. All the preliminary adjustments of the spectrometer must be made before starting the experiment.
7. While taking observations the turn table must remain clamped.
8. Both verniers should be read.

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AXIAL MAGNETIC FIELD

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

Apparatus: Circular coil, compass box, ammeter, rheostat, commutator, cell, key, connection wires, etc.

The purpose of the commutator is to allow the current to be reversed only in the coil, while flowing in the same direction in the rest of the circuit.

Formula Used: The intensity relation is expressed as

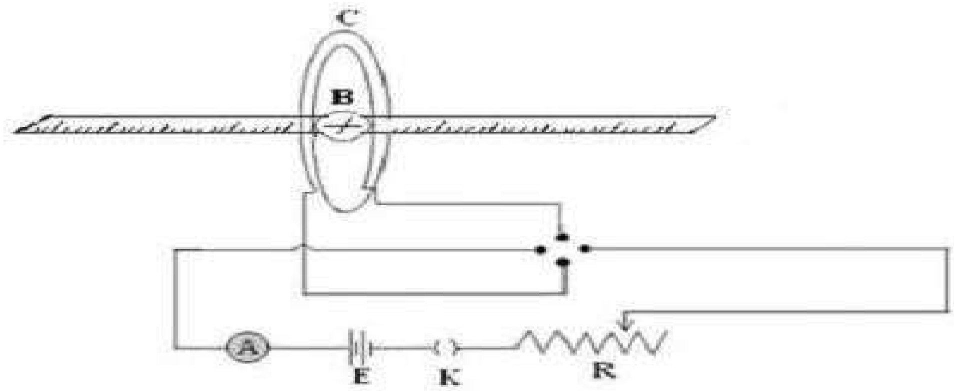
$$F = \frac{2\pi n r^2 i}{10(x^2 + r^2)^{3/2}}$$

Where n = number of turns in the coil
r = radius of the coil
i = current flowing in the coil (in ampere)
x = distance of the point from the center of the coil.

If F is made perpendicular to H, earth‟s horizontal field, the deflection θ of the needle is given by

$$F = H\tan\theta = \frac{2\pi n r^2 i}{10(x^2 + r^2)^{3/2}}$$

Figure: Experimental setup



C – circular coil

A – ammeter

B – Compass box

E - Cell

R - rheostat

Procedure:

The connections are made as shown in the diagram and the initial adjustments of the apparatus are made as follows:

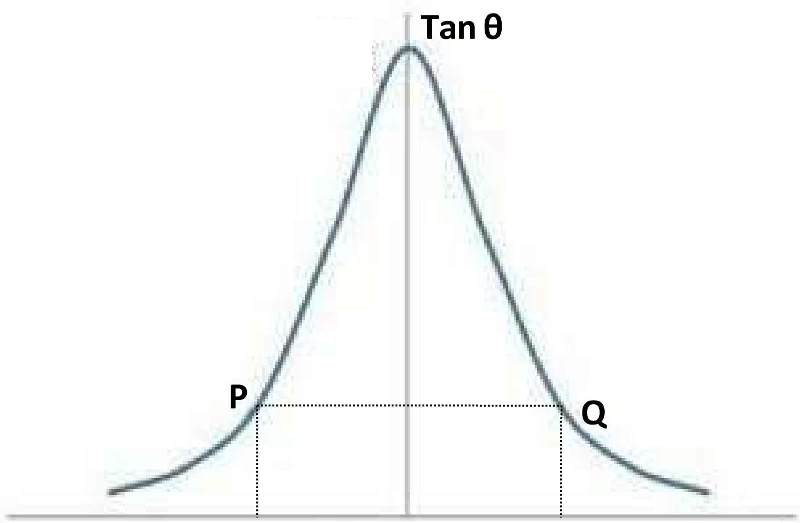
1. First, the coil is fixed at the middle of the platform and the compass box is placed at the center of the coil.
2. The apparatus is rotated such that coil, needle and it's image all lie in same vertical plane.
3. Then the compass box as a whole is rotated till pointer reads 0-0.
4. Close the circuit.
5. Adjust the rheostat until the deflection lies at 75 degrees. Note down the deflection of the compass needle and the current.
6. Then current through the coil is reversed using the commutator and again the deflection and current are noted.
7. Average the magnitude of the two deflections and calculate the magnetic field at the center of the coil from the equation.
8. Without changing the current or the number of turns, place the compass box at a particular distance from the center of the coil. Note the deflection. Again, reverse the current and average the magnitudes of the two deflections. Note the average, and the distance.
9. The same procedure is repeated with the compass box at the same distance on the other side of the arm, keeping number of turns and current constant.
10. Take the average of the two values of θ measured on opposite sides of the coil.
11. Then calculate the magnetic field B_x from the coil using equation (3).
12. Repeat for various distances.
13. Draw graph of B_x on the vertical axis *vs*. distance x on the horizontal axis.

Observation Table:

To plot the graph between distance and magnetic field intensity:

S. No.	Distance of the needle from the center, x (cm)	Deflection on East Arm					Tan θ	Deflection on West Arm					Tan θ
		Current one way		Current reversed		θ (degree)		Current one way		Current reversed		θ (degree)	
		$\theta1$	$\theta2$	$\theta3$	$\theta4$			$\theta1$	$\theta2$	$\theta3$	$\theta4$		
1	0												
2	2												
3	4												
4	6												
5	8												
6	10												
7	12												
8	14												
9	16												

Graph showing variation of magnetic field along the axis of the circular coil.



distance, x (cm)

Result: The graph shows the variation of magnetic field along the axis of a circular coil carrying current. The distance between the points of inflexion P,Q and hence the radius of coil (PQ) = ….cm.

Precautions:

1. The coil should be carefully adjusted in magnetic meridian.
2. There should not be any kind of magnetic or current carrying substance/device nearby experimental setup.
3. Parallax should be removed while reading the position of the pointer and both ends of the pointer should be read.The curve should be drawn smoothly.

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