Experiment No. 3

Object: To find the specific rotation of sugar solution by using a polarimeter.

Apparatus Used: Polarimeter, a balance, measuring cylinder, beaker and a source of light. (Sodium lamp for half shade polarimeter and ordinary bulb or mercury lamp for biquartz polarimeter.)

Formula Used: The specific rotation of the plane of polarization of sugar dissolved in water can be determined by the following formula,

$$S = \frac{\theta}{l.c} = \frac{\theta.V}{l.m}$$

Where, θ = rotation produced in degrees.

l = length of the tube in decimeter.

$c = m/V$ = concentration of sugar solution.

m = mass of sugar in grams dissolved in water.

V = volume of sugar solution.

Procedure: With the half shade a monochromatic source and with biquartz white light can be used.

- Take the polarimeter tube and clean well both the sides such that it is free from dust. Now fill the tube with pure water and see that no air bubble is enclosed in it. Place the tube in its position inside the polarimeter. Switch on the source of light and look through the eyepiece.
- In case of **half shade polarimeter**, two halves of unequal intensity is observed. Left half may be bright and the right half may be dark, or *vice versa*. By rotating the analyzer eyepiece system, the bright-dark pair gets interchanged to dark-bright pair, or *vice versa*. Rotate the analyzer (first in clockwise direction and then in anticlockwise direction) until the intensity of two halves is about to interchanged and circular field of view appears equally bright.
- In case of **biquartz polarimeter** we find two halves of different colours, one red and other blue. By rotating the analyzer eyepiece system, the colour pair gets interchanged. Let us select a pair of different colour, say red and blue. By rotating the analyzer scale, the colour pair can be interchange to blue and red. At the position of interchange, the two colours can be mixed by rotating the analyzer (first in clockwise direction and then in anticlockwise direction), so that circular field of view appears gray instead of two halves of red and blue.
- Take the first reading at equal intensity position (either bright or gray) and also record the second reading at 180° apart from this position, in both the directions (clockwise and anticlockwise). Find the mean of two directions reading separately for both the position.
- Prepare a sugar solution of known strength by dissolving the known amount of sugar (say 10 gm) into 100 ml of water. Take the polarimeter tube and remove the pure water. Fill it with the prepared sugar solution and again place it in the polarimeter.
- Rotate the analyzer eyepiece system to obtain the equal intensity position, first in clockwise direction and then in anticlockwise direction. Note down the first position of the analyzer scale in the two directions. Find the mean reading. Repeat similarly, for second position at 180° apart.
- The difference between water and sugar solution reading gives the specific rotation.
- The experiment can be repeated with sugar solutions of different concentrations.
- Measure the length of the tube in centimeters and change it in decimeters.

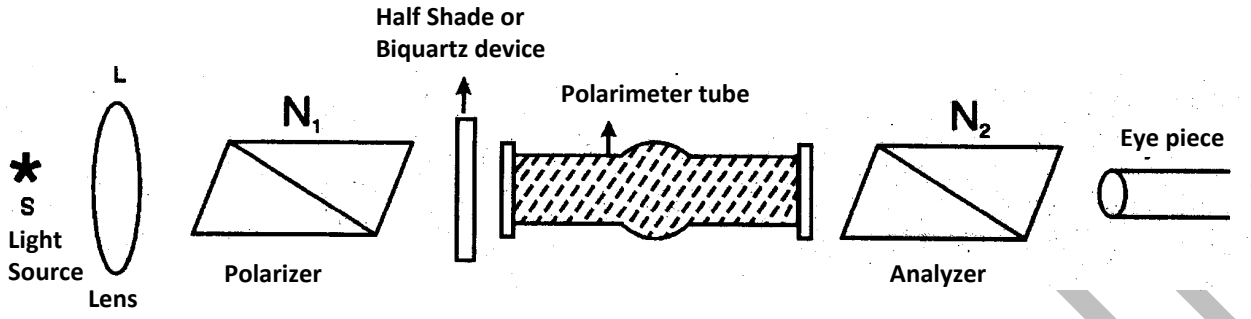

Figure1: Arrangement inside the polarimeter.

Observations: Room temperature = ……..°C

(A) Preparation of sugar solution:

Mass of watch glass = ……gm = …… …kg
Watch glass + sugar = ……gm = ……..kg
Therefore mass of sugar taken, m = ……gm = …… kg
Volume of the solution V = ……..ml = ……c.c.
Concentration of the solution $c = m/V$ = ……gm / c.c. = ……..kg/m^3
Length of the polarimeter tube l = ……cm = ……decimeter

(B) Tables for the determination of specific rotation:

Value of one division of the main scale = ……..
No. of division on vernier scale = ……..
Least count of vernier = ……

With Water

S.No	Analyzer's reading for I position							Analyzer's reading for II position						
	Clockwise			Anticlockwise			Mean	Clockwise			Anticlockwise			Mean
	MS	VS	T (a)	MS	VS	T (a')	$= \frac{a+a'}{2}$	MS	VS	T (b)	MS	VS	T (b')	$= \frac{b+b'}{2}$
1														
2														
3														
						Mean, A							Mean, B	

With Sugar Solution of concentration ……..

S.No	Analyzer's reading for I position							Analyzer's reading for II position						
	Clockwise			Anticlockwise			Mean	Clockwise			Anticlockwise			Mean
	MS	VS	T (c)	MS	VS	T (c')	$= \frac{c+c'}{2}$	MS	VS	T (d)	MS	VS	T (d')	$= \frac{d+d'}{2}$
1														
2														
3														
						Mean, C							Mean, D	

MS = Main Scale Reading, VS = Vernier Scale Reading, T = MS+VS = Total Reading.

Calculation: According to the analyzer's reading;

- For I position, rotation produced by sugar solution, $\theta_1 = C - A$
- For II position, rotation produced by sugar solution, $\theta_2 = D - B$

Thus, the mean rotation produced by cane sugar solution,

$$\theta = \frac{\theta_1 + \theta_2}{2}$$

Then, the specific rotation of the cane sugar solution,

$$S = \frac{\theta}{l.c} =$$

Result: At a temperature ……°C and wavelength …… Å;

The specific rotation for cane sugar solution = …….

Standard Value of specific rotation for cane sugar solution = …….

Percentage Error = …..%.

Sources of error and Precautions:

(i) The polarimeter tube should be well cleaned.
(ii) Water used should be dust free.
(iii) Whenever a solution is changed, rinse the tube with the new solution under examination.
(iv) There should be no air bubble inside the tube.
(v) The position of analyzer should be set accurately.
(vi) The temperature and wavelength of light used should be stated.
(vii) Reading should be taken when halves of the field of view becomes equally illuminated.