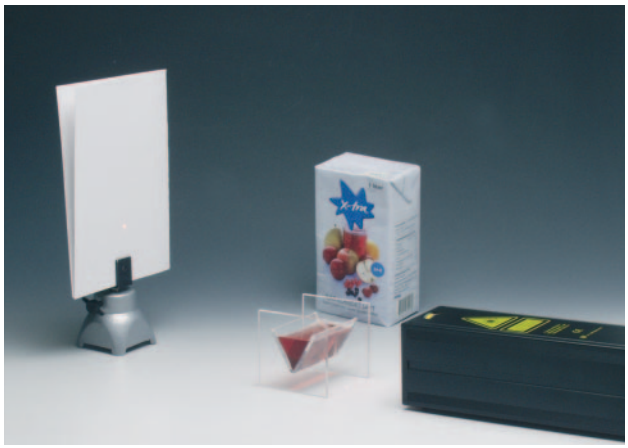
Manual for Sugar solution Prism

03.08.05 Ae 5459.20



The sugar solution prism is designed for experimental determination of the sugar concentration in water-based solutions. The method is based on the measurment of a number of sugar solutions with different concentrations (measured in percentage by mass). The index of refraction for a sugar solution depends upon the concentration. For ordinary cane sugar the relationship between the index of refraction and the concentration is given by the following table:

Sugar concentration (%)	Index of refraction
0	1.3330
5	1.3403
10	1.3479
15	1.3557
20	1.3639
25	1.3723
30	1.3811
35	1.3902
40	1.3997
45	1.4096
50	1.4200
55	1.4307
60	1.4418
65	1.4532
70	1.4651
75	1.4774
80	1.4901
85	1.5033

Source: Handbook of Chemistry & Physics, 64. edition, CRC, 1984.

By sending monochromatic light e.g. from a laser through a number of sugar solutions of known concentrations, one can observe the refraction of the light. Using a horizontal beam of light, one can measure how high the refracted beam strikes a vertical screen placed at a known distance from the prism. This data can be used to prepare a calibration curve. Then solutions of unknown concentration can be studied using the calibration curve to determine their concentrations.

For sugar solutions containing less than 40% sugar one can figure on a linear relationship between the refraction and sugar concentration. I such cases just two points on the calibration curve are sufficient (e.g. at 10% and 25%).

The advantage of using laser light, in addition to its monochromicity (single wavelength), is that it is so intense that it can easily penetrate strongly colored liquids such as undiluted soda pop or juice.

Required accessories:

Laser (2885.00 / 2885.10 / 2885.20), or diode laser (1420.70 / 1420.80). Screen or white cardboard.

Theoretical considerations

Because the angle at the bottom of the sugar prism is 60 degrees it is possible to arrive at the following data using geometry and the law of refraction.

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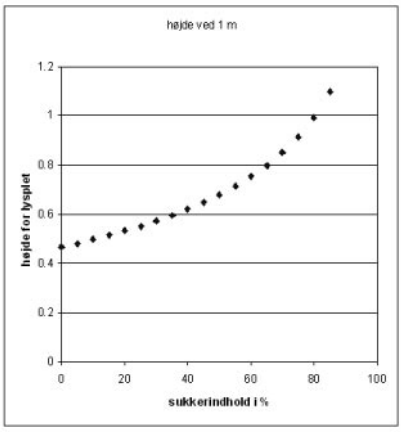
Sugar concentration	Index of refraction horizontal (degrees)	Deviation angle from	Height in mm at 1 m(*
0	1.333	25.0	467
5	1.3403	25.8	482
10	1.3479	26.5	498
15	1.3557	27.2	514
20	1.3639	28.0	532
25	1.3723	28.9	552
30	1.3811	29.8	573
35	1.3902	30.8	596
40	1.3997	31.8	621
45	1.4096	33.0	649
50	1.42	34.2	680
55	1.4307	35.5	715
60	1.4418	37.0	754
65	1.4532	38.6	798
70	1.4651	40.4	851
75	1.4774	42.4	914
80	1.4901	44.8	993
85	1.5033	47.7	100

*) Vertical height over the position of the spot of laser light when the sugar prism is empty

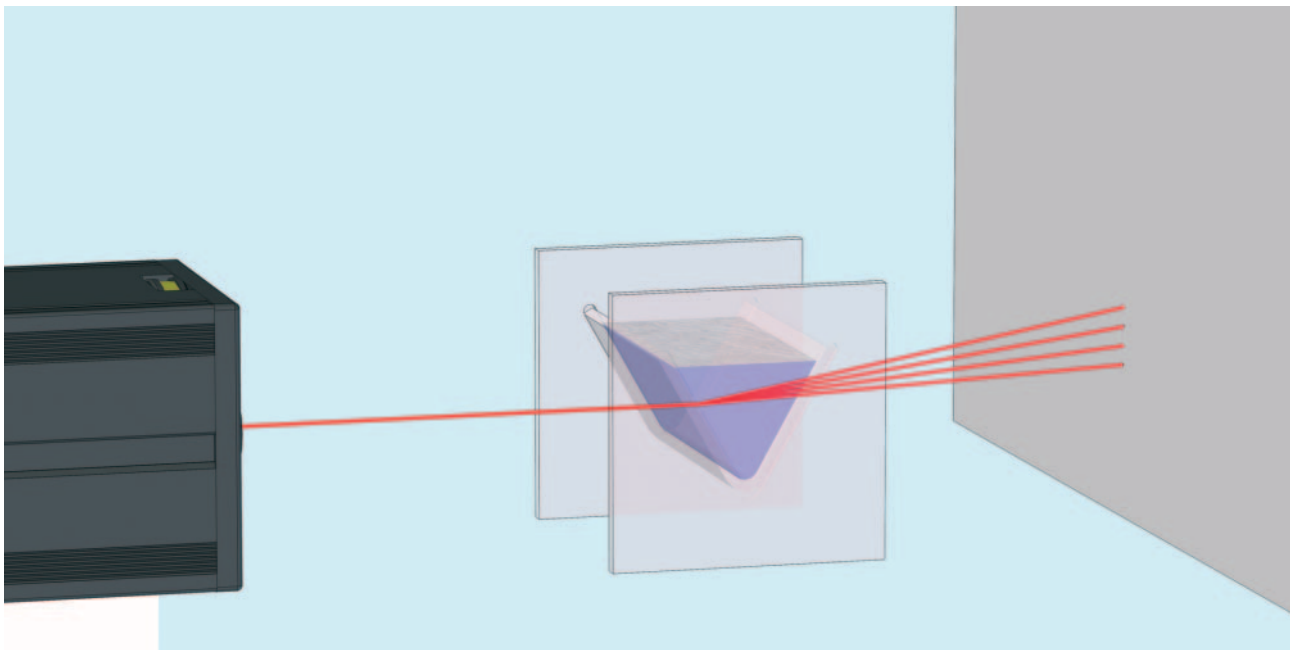
It the last column of the table is graphed vs. the sugar concentation (column 1), the following is obtained:



It can be seen from the graph that the relationship is approximately linear for concentrations up to 40%.

Maintenance:
The sugar prism must not be cleaned with alcohol. Use ordinary soap and water and rinse.

Laboratory exercise – setup:

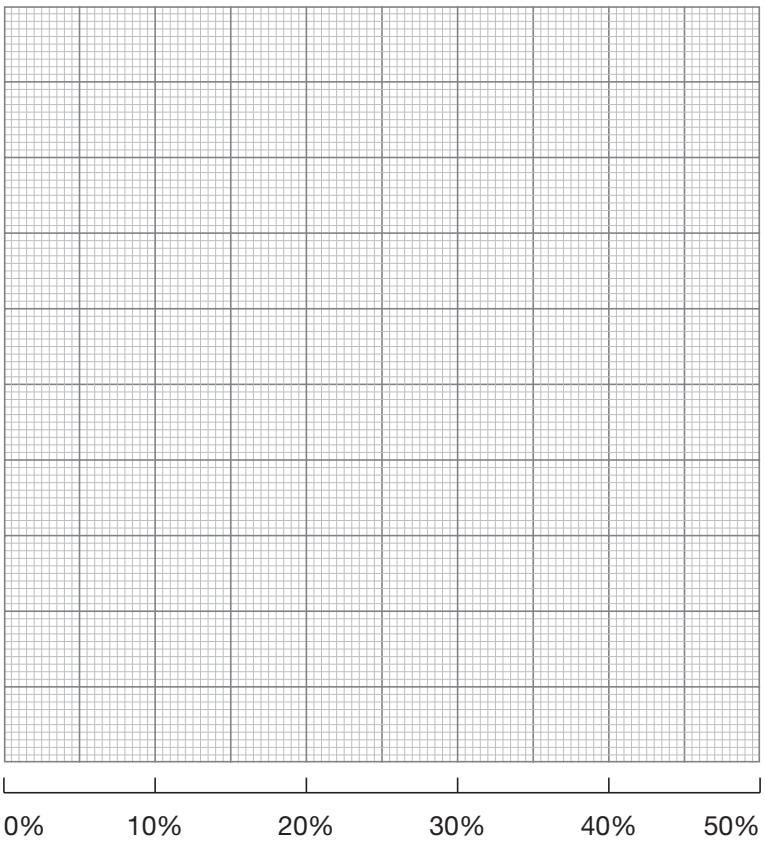


Important!
When the experiment has begun, the distance between the screen and the prism must remain constant.

- Fasten the paper to the wall or screen with tape as shown in the illustration.
- Send a horizontal laser beam through the prism while the prism is empty.
- Make a mark on the paper where the laser beam strikes. This point is considered to be the reference level for measuring the vertical deviations.
- Pour pure water into the prism and repeat the measurement.
- Prepare sugar solutions of e.g. 10% and 25%.
- Perform measurements with these solutions, noting in each case the vertical deviation compared with the reference mark.

Sugar concentration in %	Deviation in mm

- Enter the data for 0%, 10% and 25% in a coordinate system with concentrations on the x-axis and deviations on the y-axis.
- Now measure the deviation distance due to one or more test liquids, e.g. soda pop or other drink containing sugar.
- Use the graph to read off the sugar concentration of each test liquid based on your measurements of the deviation distance.



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