7.4. MEASUREMENT OF THE REFRACTIVE INDEX BY ABBE REFRACTOMETER

Purpose of experiment

To measure the absolute refractive index of the transparent solutions of different concentration.

Tasks of experiment

- To measure the absolute refractive index of a transparent solution and its dependence on the concentration.
- To determine the concentration of a solution.

Theoretical topics

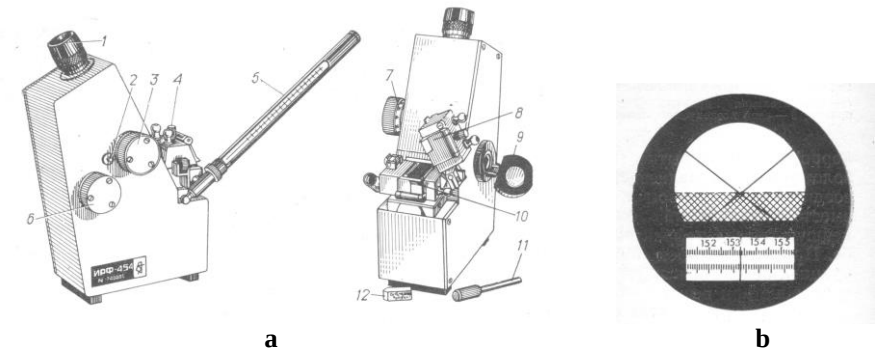
- Light refraction laws.
- Relative and absolute refractive indexes.
- The total internal reflection phenomenon. Critical angle.
- Optical fibers and their applications.
- Optical setup of a refractometer and its application.

Equipment and materials

Refractometer, tubes with distilled water and solutions of various concentrations, pipettes, tissue paper.

Methodology

The refractometer, and the view of the eyepiece field is shown in Fig. 7.4.1. and the optical setup of a refractometer is shown in Fig. 7.4.2.



a **b**

Fig. 7.4.1. Refractometer: (a**)** general view: 1 – eyepiece; 2 – alignment equipment; 3 and 7 – compensator knobs; 4 – handle of illuminant prism chamber; 5 and 11 – thermometer; 6 – refractive index scale knob; 8 – illuminant prism; 9 – mirror, directing beam into measurement prism window; 10 – measurement prism; 12 – alignment plate; (b**)** Refractometer the field of view

The convergive lens (1) collects the light rays from the source (S) into a narrow beam and sends them in the desired direction. The light beam leaves the illuminant prism (2), undergoes refraction in the boundaries of prisms and liquid, and leaves the measuring prism (3) with a refraction angle α_0 from its original position. The light beam then passes through a compensator

(AMICO prism, 4) and propagates through the telescope T. The telescope consists of an objective (5) and eyepiece (9), as well as a plate (8) with a dotted alignment line. This plate is placed in the joint focal plane of lenses (5) and (9). A rectangular prism (6) changes the course of beam by 90° (total internal reflection) for more comfortable usage of the apparatus. The solution refractive index scale is marked on the glass plate (7) attached to the front wall of the inner casing of the apparatus.

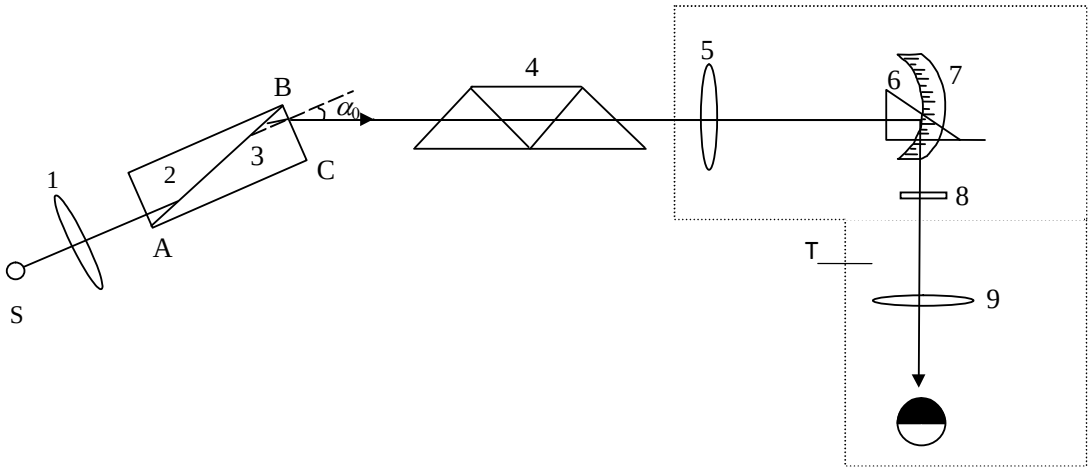


Fig. 7.4.2. Refractometer optical setup.

Procedures

Refractometer and a light source (daylight or 40 W opaque light bulb) set so that the light falls on the illuminant prism (8), the input box or a mirror (9).

1. Open the prisms and thoroughly clean their surfaces.
2. With a pipette drop several drops of distilled water on the prism, then close the prisms (8 and 10, Figure 7.4.1) together.
3. Rotate the eyepiece (1) in order to obtain good visibility of the filament intersection and scale in the eyepiece field of view. If the boundary between the dark and bright fields is unclear or colourful, rotate the compensator knob (3) and obtain a sharp boundary line. Then bring the intersection of the eyepiece threads onto the boundary line between the dark and light fields (Fig. 7.4.1., b) by rotating the knob (6) and obtain the refractive index n_v from the scale. (If the measured n_v value is equal to the refractive index of distilled water at room temperature (1.3330), the refractometer readings do not require any corrections. If the measured value is not equal to 1.3330, then the correction $(1{,}3330 - n_v)$ must be added to the measured absolute refractive indexes of solutions).
4. Clean the prisms with filter paper or a napkin and repeat steps 1-3 for solutions of various concentrations c and for a solution of unknown concentration c_x. (Do not confuse pipettes of distilled water and mixed solutions).
5. Fill in the data in Table 1.

Table 1

c, %	n'	$n = n' + 1{,}3330 - n_v$

6. Plot the graph $n = f(c)$.
7. Find the concentration of the unknown solution from the graph.

References:

1. K. Franklin, P. Muir, T. Scott, L. Wilcocks, P.Yates, Introduction to BIOLOGICAL PHYSICS fot the Health and Life Sciences, Wiley, 455p., 2010, ISBN: 9780470665923.
2. B.H.Brown, P.V. Lawford, R.H. Smallwood, D.R. Hose, D.C.Barber, Medical physics and Biomedical Engineering, Taylor& Francis, 1999, 736 p.