28 - ROTATION OF THE PLANE POLARIZATION OF LIGHT

I. Natural optical activity analysis

1. Turn the sodium lamp on. Wait about **5 minutes** until the full light efficiency is reached. Set the viewfinder of the polarimeter in focus.
2. Put the tubular cuvette with distilled water inside the polarimeter. Make sure that the bottom of the container is directed downwards. Make sure there are no air remnants in water, and both glass windows have to be dry and clean.
3. Find such a setting of the analyzer so that all three sections (middle stripe and two side sections) of the view field were homogenously backlighted (penumbra setting). Even a small rotation of the knob to the left or right should cause a **SIGNIFICANT** change of the image (dark stripe on the bright background or vice versa)
4. Read the angle on the scale and write down the value. The scale is marked with degree units and their decimal parts. Prepare subsequently six aqueous solutions of sugar of a various concentrations.
5. Use the digital scales to prepare 1 g, 2 g, 4 g, 6 g, 8 g, 10 g portions of sugar.
6. Each portion of the sugar has to be dissolved in 50 ml of water. Calculate the concentration *c*.
7. Fill the cuvette with the solution and measure the rotation of the polarization angle α by finding the penumbra.
8. Purge the cuvette twice with clean water and fill it with the next solution. Repeat the procedure for all solutions.
9. Fill the cuvette with the solution of unknown concentration and analyze it.
10. Measure the cuvette length *h*.
11. Draw a graph where x = c · h, y = α **[in radians]**. Using the least squares method, find γ which is called **specific rotation**. ($\alpha = \gamma \cdot c \cdot h$). Calculate the uncertainty type A and B.
12. Based on the calculations above, find the concentration of the „unknown" solution from the point 9.

II. Faraday effect

1. Turn the monochromatic light source on.
2. There is a glass rod in the polarimeter, inside the solenoid. Set the penumbra position when the magnetic field is off. Note down the analyzer angle.
3. Turn the solenoid power supply and, for at least 6 different current I values, measure the analyzer angles corresponding to the new penumbra positions. Calculate the rotation of the polarization angles α.
4. Draw a chart of the rotation of the polarization angle α versus I (**the angle has to be converted into radians!**)
5. Using the formula $B=\mu_0 IN/L$, find the magnetic induction values corresponding to each measurement (N – number of solenoid windings; L – solenoid length). **The solenoid and the glass rod specifications are given on the chassis.**
6. Using the least squares method, find the Verdet constant, assigning $y=\alpha$, x=Bh (use a computer and Origin software). Calculate the uncertainty of the Verdet constant.
7. Based on the formula $V=(e\lambda/2m_e c)(dn/d\lambda)$, using the calculated Verdet constant, calculate the e/m relation value. The dispersion value $dn/d\lambda$ used in the above formula can be evaluated using the formula $(n_1-n_2)/(\lambda_1-\lambda_2)$, where n_1 and n_2 are refractive indexes of waves λ_1 and λ_2, between which is the wavelength of the applied light source λ. The $n(\lambda)$ dependence for glass is given on the plate near to the experimental setup. In this chart, one can read the refraction indexes for two wavelengths located symmetrically with the reference to the sodium wavelength: for example for the wavelength higher and lower by 100 nm.

Caution:

The measurements of the plane polarization rotation for the different current values have to be done without unnecessary delay. It is not allowed to let the current flow through the solenoid for a longer time than 15-20 minutes (this applies especially to the high value currents). The power supply has to be turned off IMMEDIATELY after the measurements have been completed. Before turning the power supply off, make sure to reduce the current down to zero with the control knob. If the solenoid starts to heat up during the operation (check its status by touching the external surface with your hand), the measurement has to be absolutely interrupted!

Note:

The integrated with the DF60SL10A ammeter used in the measurement features a following accuracy (the range is 10 A):

c_1 = 2% c_2 = 0,2%