



evropský
sociální
fond v ČR



EVROPSKÁ UNIE



MINISTERSTVO ŠKOLSTVÍ,
MLÁDEŽE A TĚLOVÝCHOVY



OP Vzdělávání
pro konkurenceschopnost



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

LABORATORY WORK NO. 32

POLARIMETRY

■ PRINCIPLE:

Polarimetry is an optical analytical method based on measurement of the twist of a plane of polarized light, which is twisted by an optically active substance. The light ray can be described as a wave vibrating in all planes. This wave can be changed into a polarized wave eg.. wave which is oscillating only in one plane. Polarized light is produced from normal light in a polarizer, where one ray is split into two rays – so-called **ordinary** and **extraordinary rays**.

The simplest device for measuring the twist of polarized light is called polarimeter. The **twist angle α of polarized light** can be read on the scale of the analyzer in the polarimeter.

The most common substances have tabulated values of the **specific rotation $[\alpha]^t$** .

These values are given for certain temperature t (usually 20° C) and the spectral line of sodium doublet D (589,0/589,6 nm). The relationship between the measured rotation value α and this quantity can be described as :

$$\alpha = [\alpha]^t \cdot b \cdot c ,$$

where b is the length of the optical environment in dm,

c is the concentration in g/ml,

$[\alpha]^t$ is the specific rotation of the particular substance.

It's clear from this relation that the measurement of optical rotation can be used to determine concentration of solutions using the method of a calibration curve.

TASK 1: POLAROMETRIC DETERMINATION OF SUCROSE IN A SAMPLE

■ **CHEMICALS:** sucrose solutions (5, 10, 15, 20, 25 and 30%), sample of unknown concentration of sucrose

■ **AIDS:** polarimeter, 50 ml pycnometer, beakers, volumetric flasks of 100, 250 and 500 ml, thermometer

■ **PROCEDURE:**

Prepare 6 solutions of optically active substances of increasing concentration. For sucrose, dissolve 5, 10, 15, 20, 25 and 30 g of substance in 100 ml of solution. Determine the density of these solutions by pycnometry and construct a graph of the depending of density on concentration (graph 1).

Measure the twist angle for each individual solution on a polarimeter. Perform each measurement 3 times and calculate the arithmetic average.



| | twist angle č.1 | twist angle č.2 | twist angle č.3 | arithmetic average |
|-----------------------|--------------------|--------------------|--------------------|-----------------------|
| Sample 1 | | | | |
| Sample 2 | | | | |
| Sample 3 | | | | |
| Sample 4 | | | | |
| Sample 5 | | | | |
| Sample 6 | | | | |
| Unknown sample | | | | |

Calculate the value of the specific rotation $[\alpha]_t$ of the optically active substance. As a result, indicate the arithmetic average of the values that you have calculated for each solution separately. Connect the temperature data to the resulting specific rotation and compare the calculated value with the tabulated values. Explain any difference.

Construct a graph of the twist angle depending on the concentration (in grams per 100 ml) of the solution (graph 2).

Find out the density of an unknown sample by pycnometry. Determine by polarimetry the concentration (g in 100 ml) from the density curve using a calibration graph.

- **CONCLUSION:** State the substance content in an unknown sample in weight percentage and in moles per 1 dm^3 of a solution. Evaluate the accuracy of the method used.



STUDENT'S SHEET No. 32

POLARIMETRY

1. Complete the crossword. Find the following words: density, specific rotation, polarimetry, calculate, twist, angel, pycnometer

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | Y | C | N | O | M | E | T | E | R | J | P | S |
| O | G | S | B | A | G | M | G | A | P | S | O | P |
| L | U | R | E | T | T | E | A | B | B | A | H | E |
| A | G | D | E | N | S | T | Y | I | L | M | K | C |
| R | U | I | K | H | S | P | H | O | T | P | Z | I |
| I | I | S | E | G | S | P | M | G | R | L | A | F |
| M | L | S | R | L | E | S | T | E | J | E | T | I |
| E | V | O | L | U | M | E | I | N | N | P | V | F |
| T | N | L | U | S | M | T | N | O | M | I | D | A |
| R | E | V | Z | S | I | U | M | U | T | P | G | D |
| Y | D | E | F | O | P | P | U | S | N | E | R | S |
| A | C | L | G | N | L | D | E | L | R | T | N | T |
| N | V | D | H | T | O | E | D | T | F | T | F | W |
| G | R | C | A | L | C | U | L | A | T | E | X | I |
| E | S | U | B | S | T | R | A | C | T | U | E | S |
| L | C | R | O | T | A | T | I | O | N | U | G | T |

2. Fill in the missing letters and translate:

- C-nc-ntr-ti-n
- R-tati-n
- A-e-age
- A-ith-et-c
- Sa-p-e
- Op-icall- a-t-ve
- S-bst-nc-s
- In-re-sing
- R-y
- E-tra-rd-n-r-



3. Vocabulary:

Match the Czech words with their English equivalents:

| | | |
|---------------|---------------|---------|
| 1. polarimetr | A. CURVE | 1..... |
| 2. otáčení | B. AVERAGE | 2..... |
| 3. roztoky | C. CONSTRUCT | 3..... |
| 4. sestroj | D. DENSITY | 4..... |
| 5. pyknometr | E. SOLUTIONS | 5..... |
| 6. křivka | F. VALUE | 6..... |
| 7. průměr | G. SUCROSE | 7..... |
| 8. hustota | H. POLARMETER | 8..... |
| 9. hodnota | I. PYCNOMETER | 9..... |
| 10. sacharóza | J. TWIST | 10..... |

4. Put the words into the right order:

1. six/ solutions/ substances. / Prepare /optically /of /active
2. Construct/ on /angle / a graph/ the / depending /of /concentration./ twist
3. Find /density / by / pycnometry/ the/ unknown/ of / sample.
4. is/ method./ Polarimetry/ optical/ an/ analytical

5. True –false sentences:

1. The length of the optical environment is measured in metres. T / F
2. We can only calculate the density of substances. T / F
3. We need six calibration curves for six samples. T / F
4. Polarimetry is a physical (optical) method? T / F
5. Polarized light is split in many beams in a polarizer. T / F

6. Answer these questions in your own words:

1. What can we determine by polarimetry?
2. What is the unit of measured value?
3. What chemical agents can we measure by this method?