Exercise 1
Index of refraction for solids

Aim

Determination of the refraction index for transparent solids (glass, plexiglass)

Required theoretical knowledge

What is it light?What does the velocity of light depend on? Path of a beam of light at the interface of two media. Law of reflection. Law of refraction. Index of refraction – absolute and relative. Total internal reflection. Chromatic dispersion of white light. Real thickness. Apparent thickness. Uncertainty of average. Logarithmic derivative method of uncertainty calculation. How to use a vernier calipers and a micrometer screw gauge.

Equipment

A microscope with a dial indicator. A micrometer screw. A set of glass and plexiglass plates with red and black lines marked with a sharply pointed marker on the bottom and the top side of the plates.

Problems for discussion:

What is light?
List and interpret the Maxwell's equations.
What determines the speed of light in the material?
What is the relative and absolute refractive index?
What conditions must be met in order to allow for total internal reflection?
Which type of uncertainty should be used for the actual thickness of the plate? Which in the case of apparent?

Measurement plan:

For each plate, indicated by the operator:
1. Measure the actual thickness of plates using micrometer screw in different places of the plate. Repeat measurement several times.
2. Place the plate on the microscope stage.
3. Set the focus on the image of a line on top surface of the plate. Write down the stage height from an indicator.
4. Focus the image on the line on the bottom surface. Write down the stage height from an indicator.
5. Repeat points 3-4 ten times in different places of sample.

Data processing:

1. Calculate the mean value of the actual thickness of the plate and its uncertainty.
2. Calculate the mean value of the value indicated by the microscope stage settings focused on top and bottom surface separately with their uncertainties.
3. Calculate the refractive index and its uncertainty, using the propagation of uncertainties principal.
4. Compare obtained values with Table in the manual and identify the materials they were made of.

Table 1. Example values of refractive indices for different materials.

Material	n [j.u.]
diamond	2,42
water	1,33
ice	1,31
table salt	1,52
air	1,0003
vacuum	1
potassium glass	1,6
Boron- silicate glass	1,45
Sodium calcium glass	1,51
Lead glass	1,8
flint glass	1,66
plexiglass	1,53
quartz	1,46

Literature

1. Halliday, Resnick "Fundamentals of Physics - 8th edition", John Wiley 2007,