# Rotation of the polarisation plane by a sugar solution

## Task and equipment

## Information for teachers

## Additional Information

This experiment makes great demands on the students. The saccharimeter model must not only be meticulously constructed, but the measurements also require painstaking care. This is made even more difficult by the requirement for complete darkness in the physics laboratory.
The obvious solution is a division of labour. For example, the class can be divided into two groups, which perform the measurements with the single or double layer thickness, respectively. Subsequently, the results can be exchanged and recorded.

## Suggestion

To save time the teacher should prepare a concentrated sugar solution beforehand and give the students the required amount at the beginning of the experiment in beakers. The less concentrated solution can either be made before the experiment or prepared during it.


Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

# Rotation of the polarisation plane by a sugar solution

## Task and equipment

## Task

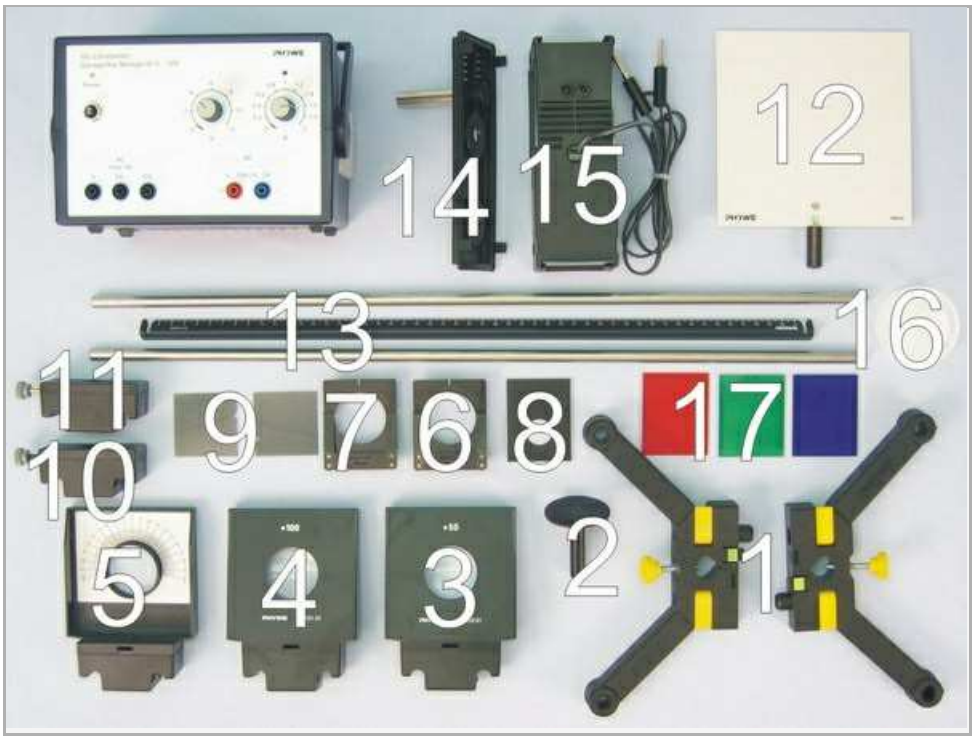
## How does a saccharimeter work?

To construct a model of a saccharimeter and investigate how a sugar solution behaves when polarised light is passed through it.

# Student's Sheet

Printed: 18.04.2017 09:58:21 | P1070000

## Equipment




| Position No. | Material | Order No. | Quantity |
|---|---|---|---|
| 1 | Support base, variable | 02001-00 | 1 |
| 2 | Table with stem | 09824-00 | 1 |
| 3 | Lens on slide mount, f=+50mm | 09820-01 | 1 |
| 4 | Lens on slide mount, f=+100mm | 09820-02 | 1 |
| 5/6 | Mount with scale on slide mount | 09823-00 | 1 |
| 7 | Diaphragm holder, attachable | 11604-09 | 2 |
| 8 | Diaphragm with hole, d=20mm | 09816-01 | 1 |
| 9 | Polarising filter, 50 mm x 50mm | 08613-00 | 2 |
| 10/11 | Slide mount for optical bench | 09822-00 | 2 |
| 12 | Screen, white, 150x150mm | 09826-00 | 1 |
| 13 | Support rod, stainless steel, l = 600 mm, d = 10 mm | 02037-00 | 2 |
| 13 | Meter scale for optical bench | 09800-00 | 1 |
| 14 | Bottom with stem for light box | 09802-10 | 1 |
| 15 | Light box, halogen 12V/20 W | 09801-00 | 1 |
| 16 | Cuvette, double semicircular | 09810-06 | 1 |
| 17 | Colour filter set, additive (red, blue, green) | 09807-00 | 1 |
| | PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |
| Additional material | | | |
| | Beaker, approx. 100 ml | | 1 |
| | Sugar solution, saturated | | 1 |


Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

# Set-up and procedure

Using the two support rods and the variable support base (Fig. 1) assemble the optical bench (Fig. 2); place the meter scale against the front support rod.

Fig. 1

Fig. 2

Place the bottom with stem under the light box (Fig. 3, 4).

Fig. 3

Fig. 4

Clamp it onto the left part of the support base so that the lens end points away from the optical bench (Fig. 5).

Fig. 5

Insert an opaque cover in front of the lens on the light box; place the screen onto the right end of the optical bench and the lens with $f$ = +50 mm about 5 cm from the light box (Fig. 6).

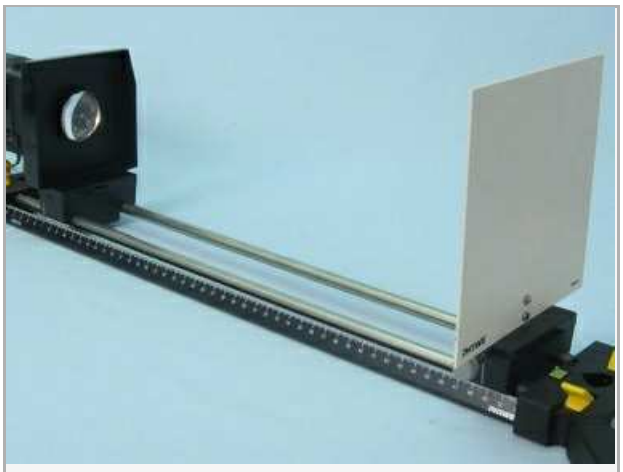


Fig. 6

Insert the diaphragm and a polarising filter into a diaphragm holder and fix it to the frame of the lens (Fig. 7). This polarising filter, which the light passes through first, is called the polariser.

Fig. 7

Connect the light box to the power supply (12 V~) and switch it on (Fig. 8).


Fig. 8

Place the lens with $f$ = +100 mm onto the optical bench about 13 cm away from the first lens (Fig. 9). If necessary, move it slightly: the diaphragm hole is now focused on the screen.

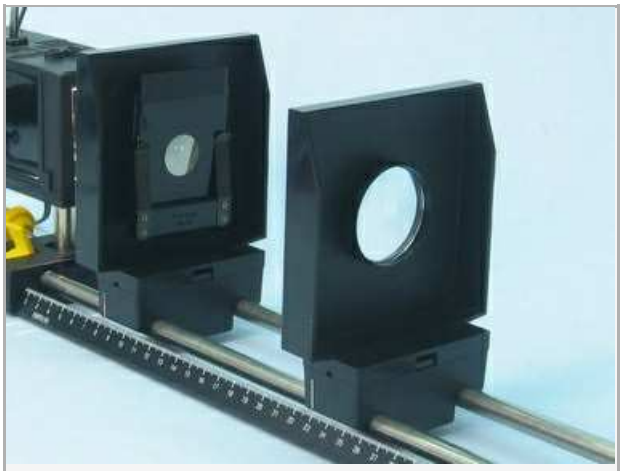


Fig. 9

Insert the second polarising filter into the second diaphragm holder and press it onto the mount with scale so that the mark on the diaphragm holder points exactly at the zero mark on the scale. This polarising filter serves as the analyser.
Position the mount with scale onto the optical bench about 10 cm away from the second lens (Fig. 10).

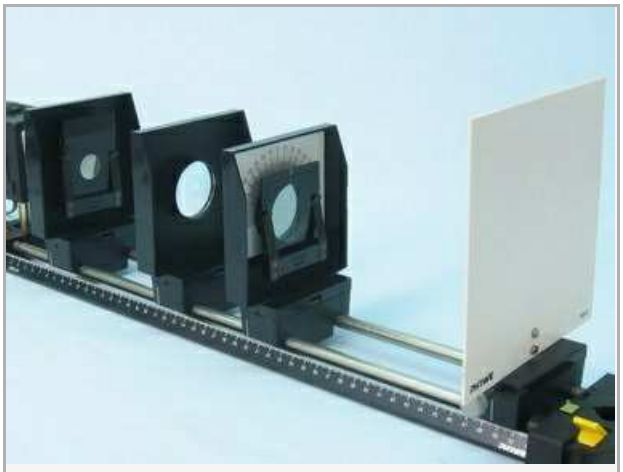


Fig. 10

Turn the polariser until the screen is dark, i.e. until the filters are rotated 90° with respect to each other (Fig. 11).

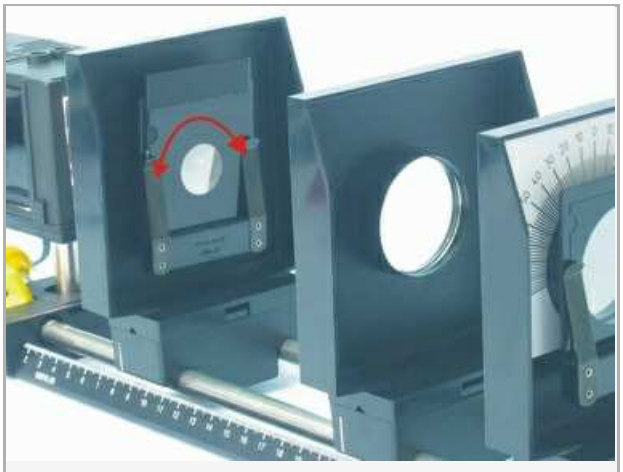


Fig. 11

Place the table with stem onto the second mount and put the cuvette on the platform so that its partition is perpendicular to the optical axis. Change the height of the table until the entire light beam passes through the cuvette (Fig. 12).

Fig. 12

Pour enough sugar solution into one half of the cuvette so that the entire light beam passes through it (Fig. 13). Watch the screen (which has been dark up to now).

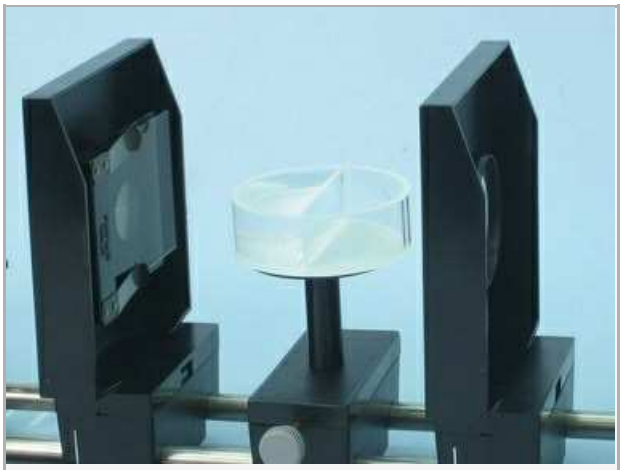


Fig. 13

Turn the analyser slowly to the right and then back to 0° (Fig. 14).

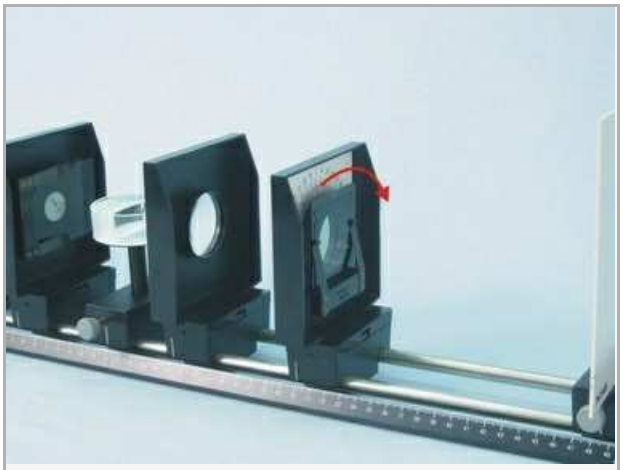


Fig. 14

Continue to turn the diaphragm holder beyond 90° until it has reached its initial position (Fig. 15).

Fig. 15

Describe your observations in the report.

Insert the red filter into the diaphragm slot on the light box and turn the analyser to the right until the screen is dark again (Fig. 16).

Fig. 16

Note the angle required for this, and record it in table 1 in the report.

Replace the red filter with the green and then the blue filter (Fig. 17); in each case determine the angle of rotation necessary to block the light and record it in table 1 in the report.

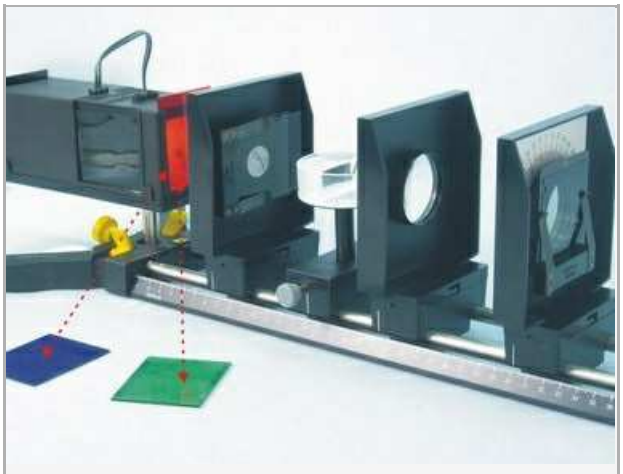


Fig. 17

Suggestion: The light that passes through the filters is not completely monochromatic. Therefore, you will not be able to get an entirely dark screen. Adjust the analyser so that you obtain as dark a screen as possible.

Fill also the other half of the cuvette with sugar solution (Fig. 18).

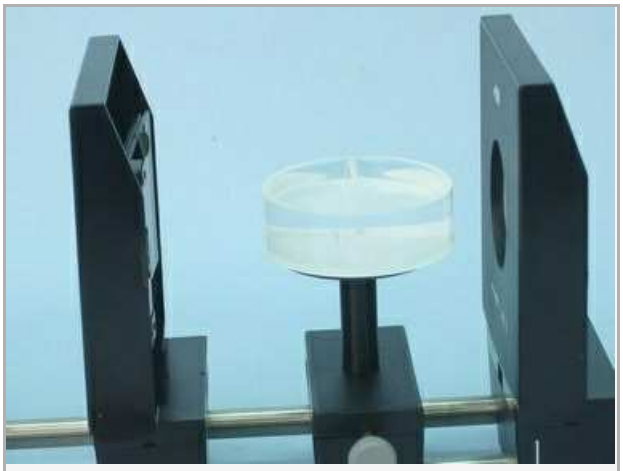


Fig. 18

Determine the necessary angle of rotation for the now 2-fold thicker layer for all three colours (Fig. 19).

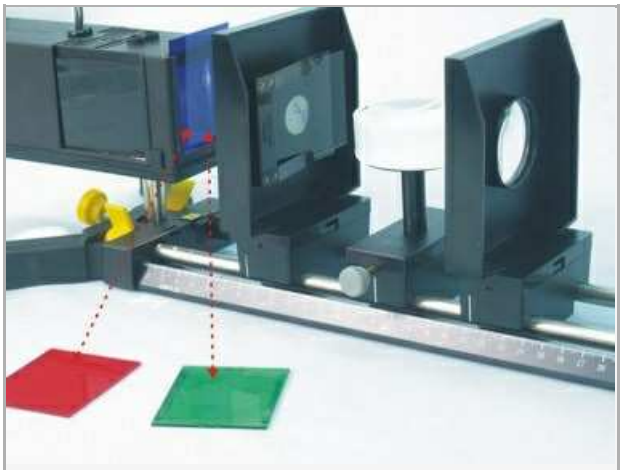


Fig. 19

Record your results in table 1 in the report.

Finally, select a filter, for example the green one, and replace the saturated sugar solution with a less concentrated one. Repeat the measurement and compare the angle of rotation with the one you determined for the saturated sugar solution. Record your observations in the report.

Switch off the power supply.


Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

# Report: Rotation of the polarisation plane by a sugar solution

## Result - Observations 1

What you can observe when the sugar solution is placed between the polariser and the analyser?

.....

.....

.....

.....

## Result - Table 1

Enter your measured values in the table.

| Colour | Layer thickness | Angle of rotation |
|---|---|---|
| Red | single | 1 ±1 |
| Green | single | 1 ±1 |
| Blue | single | 1 ±1 |
| Red | double | 1 ±1 |
| Green | double | 1 ±1 |
| Blue | double | 1 ±1 |

## Result - Observations 2

How is the angle of rotation for less concentrated sugar solution:

.....

.....

.....

.....

## Evaluation - Question 1

Which colour rotates the polarisation plane the most on passing through a sugar solution; which, the least?

.....

.....

.....

.....



Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

# Student's Sheet

Printed: 18.04.2017 09:58:21 | P1070000

## Evaluation - Question 2

What does the angle of rotation of the polarisation plane of a certain colour, passing through an optically active substance (in this case a sugar solution) depend on? Formulate a correlation.

.....

.....

.....

.....

## Evaluation - Question 3

What are the essential parts of a saccharimeter and what can it be used for?

.....

.....

.....

.....


Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com