Pressure exists in a liquid. This is called hydrostatic pressure and can be measured using a pressure element. The hydrostatic pressure is dependent on the depth of the water, but independent of the direction.

Material

1	Support base – PASS -	02005.55
1	Support rod “PASS”, 630 mm	02027.55
1	Right angle clamp -PASS-	02040.55
1	Universal clamp	37718.00
1	Plate holder, opening width 0 – 10 mm	02062.00
1	Table top on rod	08060.00
1	Cursors, 1 pair	02201.00
(1)	Syringe 1 ml, Luer, 10 pcs, 10 pcs, 1 of	02593.03
1	Pressure element, Hartl type	02635.00
1	Scale, l 1200 mm	11200.17
1	Glycerol, 99%, 250 ml	30084.25
1	Microspoon, steel	33393.00
1	Glass beaker DURAN, tall, 1000 ml	36008.00
1	Beaker, low form, 100 ml, plastic	36011.01
1	Patent blue V, 25 g	48376.04

Setup

- Place the scale, support rod and table top on rod in the support base (Fig. 1)
- Fasten the scale on the upper end of the metal tube
- Clamp in the metal tube just above the pressure element in the universal clamp
- Align the pressure box horizontally with the membrane pointing upward

Fig. 1

Fig. 2

Filling the U tube
- Fill the 100ml beaker glass a third with water and dye with a small amount of patent blue V (tip of the microspoon)
- Move the stopper on the U tube until it is located slightly over the glass tube, use glycerol if necessary
- Stick the syringe from this side into the stopper and push the syringe piston completely into the syringe
- Dip the open end into the blue colored water in the beaker glass (Fig. 2)
- Use the syringe to suck water into the U tube until the leg is completely filled with water
- Turn the U tube with the syringe so that the water is halfway in both legs and remove the syringe

Setup
- Fasten the U tube at the scale and move so that the stopper tightly closes the upper opening of the metal tube.
- Open the ventilation screw of the pressure element in order to equalize the low overpressure and to adjust the liquid in the legs again to the same height
  If the liquid cannot be brought to the same height, then there are most likely extra water drops in the U-tube. This can be removed by forcefully blowing it out of the U tube.
- Tightly close the ventilation screw again so that no water can seep in
- Move the scale so that the zero mark is located at the height of the liquid level
- Fill the 1,000 ml beaker glass just below the outflow with water and place on the table top

Implementation

Experiment 1
- Demonstrate the function of the pressure element. To do so press on the membrane with the finger and observe the liquid level in the U-tube
- Place the pressure element in the water up to the attachment piece of the metal tube, change the submerging depth by opening the universal clamp
- Adjust the upper cursor on the scale to the height of the water surface
- Position the lower cursor two centimeters below the upper cursor
- Move the pressure element downward until the membrane is located at the height of the lower cursor (immersion depth h_T)
- Read the difference of height of the liquid in the legs of the tube (measurement value h_M)
- move the lower cursor and the pressure element 2 cm downward, read the difference of height of the liquid in the legs of the tube
- Continue to measure additional values at distances of 2 cm and note them (Table 1)
- Plot the measurement value h_M vs. the immersion depth h_T in a diagram (Fig. 4)

Experiment 2
- Ventilate the pressure element outside of the water via the ventilation screw and seal it again
- Slip the belt over both pulleys
- Submerge the pressure element several centimeters into the water, read the height difference in the U- tube legs
- Turn the pressure element using the belt to different angles,
- e. g.: 45°, 90°, 135°, 180°, 270° and read the height difference of the liquid in the manometer legs (Fig. 3)

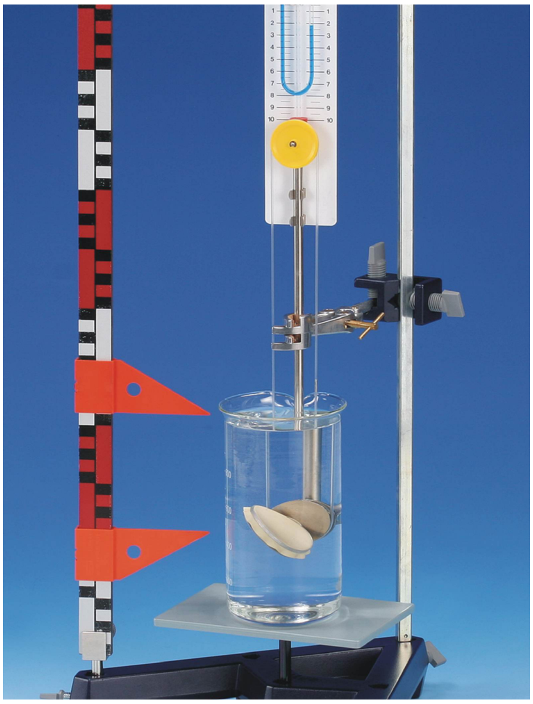

Fig. 3

Observation and measurement results

Experiment 1

The deeper the pressure element is immersed into the beaker glass, the greater the height difference of the liquid in the manometer legs h_M.

Table 1 (Measuring example)

h_T/cm	0	2	4	6	8	10	12
h_M/cm	0	2.1	3.8	5.7	7.4	9.3	10.9

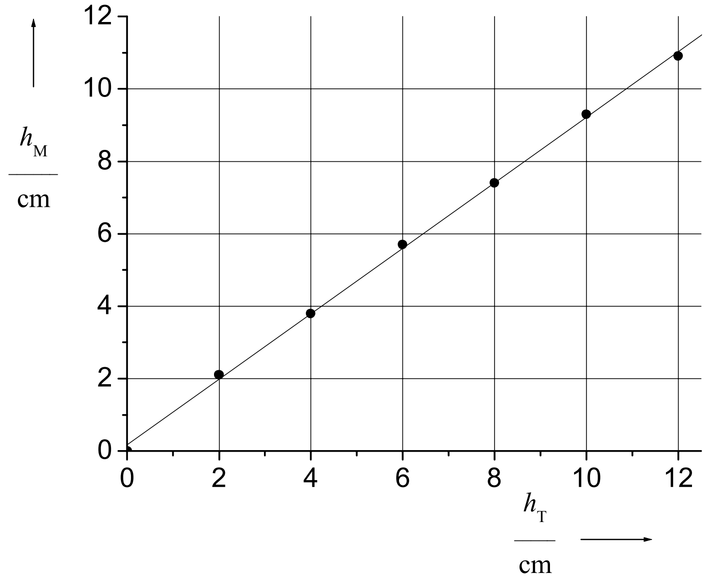

Fig. 4

Experiment 2
If the pressure element is turned at a fixed immersion depth in different angles, then the height difference of the liquid remains the same in the legs at all angles.

Evaluation
Experiment 1
The measuring device is used to measure a pressure and is also called a manometer. It is comprised of an air-filled metal box that is covered with a rubber membrane. If pressure is exerted on the membrane, then the volume of the metal box becomes smaller. The pressure of the locked in air increases. A U-tube is connected to the element. This tube is filled with water and indicates the change of pressure. The difference in height h_M of both liquid levels is a direct measure for the pressure.
If the pressure element is immersed into water, the height of the liquid level in the U-tube changes. The difference in height h_M is proportional to the immersion depth h_T :

$$h_M \sim h_T$$

Pressure exists in a liquid (hydrostatic pressure). The difference in height h_M is proportional to the pressure.

$$h_M \sim p$$

The deeper the pressure element is immersed into water, the greater the pressure. The pressure is proportional to the immersion depth.

$$p \sim h_T$$

Experiment 2
The hydrostatic pressure does not depend on the direction in which the pressure element is pointing. The pressure does not depend on direction.