Hydrostatic pressure with SMARTsense (Item No.: P1001869)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Mechanics
Subtopic: Mechanics of liquids
Experiment: Hydrostatic pressure with SMARTsense

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- Tablet PC with "measure" App

Experiment Variations:

Keywords:

hydrostatic pressure, atmospheric pressure, pascal's law

Information for teachers

Information for teachers

Note:
The students should determine the directional independence of hydrostatic pressure (termed as top, lat-eral and bottom pressure) with the aid of 3 hydrostatic pressure probes.
Additionally, they should measure the hydrostatic pressure as a function of immersion depth and analyse the corresponding graph.
The Sensor-Unit Pressure, to which the probes can be connected via a hose, serves as the measuring device.

- The linear dependency of hydrostatic pressure on immersion depth is measured. At the beginnig of the measurement, the pressure does not equal zero because of air pressure. To only show the proportional dependency of pressure on immersion depth, the pressure has to be set to zero before starting the measurement by selecting “Set to zero” within the app.
- As the hydrostatic pressure p does not only depend on the immersion depth h but also on the density ρ of the used liquid, we obtain $p = \rho g h$ for the tared case.
- To show pascal's law, tare is not needed. The equation is given by $p = \rho g h + p_0$, with the atmospheric pressure p_0 at the water surface.

Introduction

What kind of pressure exists in water?

While studying for a diving license, you learn the importance of knowing which pressure is currently surrounding you. This is the only way of avoiding permanent damage of your body. The problem is caused by the hydrostatic pressure in water which is different than our surrounding pressure of the atmosphere. The pressure increases while going deeper into the water. You might already know this from the pool where you can feel different pressure on the ear depending on the water level of the pool.

Material

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - Pressure, 20 ... 400 kPa	12905-00	1
2	Support base, variable	02001-00	1
3	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
4	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	
5	Boss head	02043-00	1
6	Glass tube holder with tape measure clamp	05961-00	1
7	Probes for hydrostatic pressure	02634-00	1
8	Beaker, low, BORO 3.3, 600 ml	46056-00	1
9	Silicone tubing, ID 8 mm	47531-00	1
Additionally			
10	Tablet PC		
11	PHYWE measureAPP		

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Task

1. Investigate whether the pressure in water depends on the direction.
2. Determine the hydrostic pressure p in water as a function of the depth h.

Setup and procedure

Setup

- Set up the experiment following fig. 1. Screw both parts of the long support rod together. Patch the support base and insert the long support rod. Attach the boss head and jam the short support rod into it. Then secure the glass tube holder to the rod.
- Turn on the Cobra SMARTsense-Pressure. Place the connecting hose on the tube at the bottom of the sensor. Then, tuck the hose through the glass tube holder in such a way that the sensor can not fall down.
- Fill the beaker with water.
- To measure the pressure at different directions use the
  1. Hook-shaped bent probe (bottom pressure)
  2. Straight probe (top pressure)
  3. Right angle bent probe (lateral pressure)
- To connect the probes to the sensor use a piece of a hose with a larger diameter. Insert the top of the probe into one side of the hose and the connecting hose from the sensor into the other side, so that connecting hose and probe touch.

Fig. 1: Experimental Set-up

Procedure

Directional dependence of the hydrostatic pressure:

- Open the "measure" app. Select the pressure sensor and go the the digital displayment of the values 0.0. The shown pressure is the atmospheric pressure.
- Plug the hook-shaped probe into the hose. Immerse the probe 5 cm in the water (use the marks on the probe) and write down the meas-ured value in Table 1. Repeat the measurement so that you have three values in total.
- Now, connect the straigth probe to the pressure sensor. Immerse the probe 5 cm in the water and write down the measured value in Table 1. Repeat the measurement another two times.
- Last, use the right angle probe. Immerse the probe 5 cm in the water and write down the measured value in Table 1 (the water may extend about halfway up the straight side of the manometer). Re-peat the measurement three times.

Dependence of the hydrostatic pressure on the immersion depth:

- For this part of the experiment, use the straight probe and connect it to the pressure sensor.
- Select "Point by point measurement" in the settings of the measureAPP. Start the measurement.
- Immerse the probe centimeter by centimeter (1-10 cm) into the water and take one measurement point for each immersion depth. End the measurement and save it. You can finde the measurement in "My measurements". Copy the values into table 2 in the report.

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Observation and results

Open the report and type in your results. For further evaluation answer the questions.

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Report: Hydrostatic pressure with SMARTsense

Results - Table 1

Write down your results for the measurement for th the lateral pressure, the top pressure and the bottom pressure in table 1.

Table 1: Direction of pressure with immersion depth h = 5 cm

Pressure	p [hPa]	p [hPa]	p [hPa]
Bottom	1 ±3	1 ±3	1 ±3
Top	1 ±3	1 ±3	1 ±3
Lateral	1 ±3	1 ±3	1 ±3

Results - Table 2

Write down the measuremed values for the hydrostatic pressure p in dependence of the immersion depth h.

Table 2: Hydrostatic pressure

h [cm]	p [hPa]
0	
1	1000
2	
3	
4	
5	
6	
7	
8	
9	
10	

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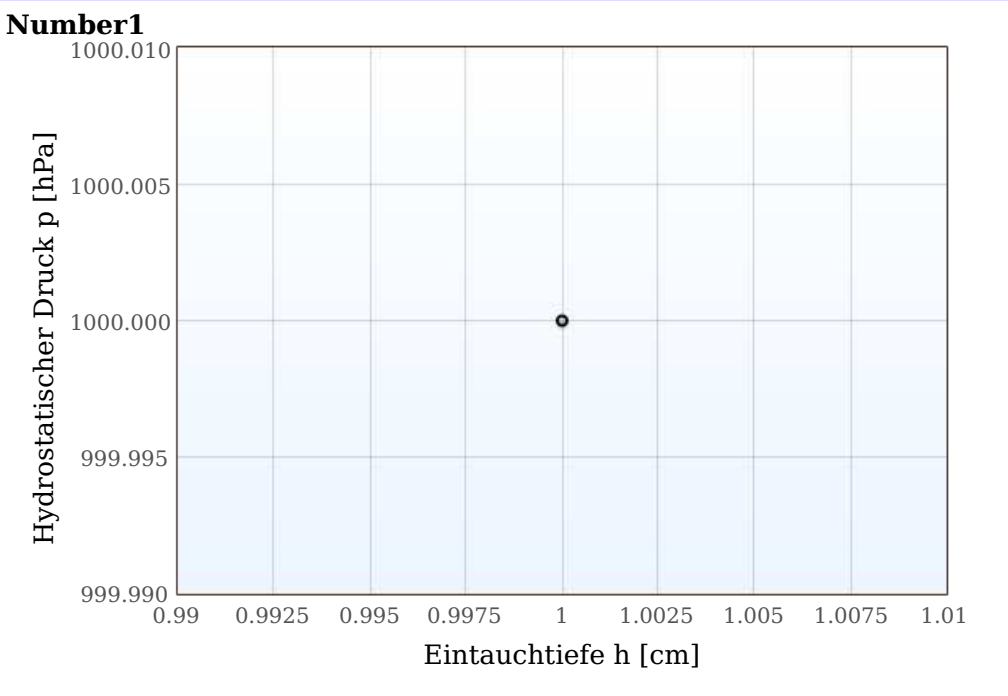

Evaluation - Question 1

Do top, bottom and lateral pressure differ at the same immersion depth (see table 1)?

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Evaluation - Question 2

Look at the graph generated in part 2 of the experiment. What correlation exists between immersion depth h and hydrostatic pressure p?

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Evaluation - Question 3

What can you say about the hydrostatic pressure, now that the measurements have been made?

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