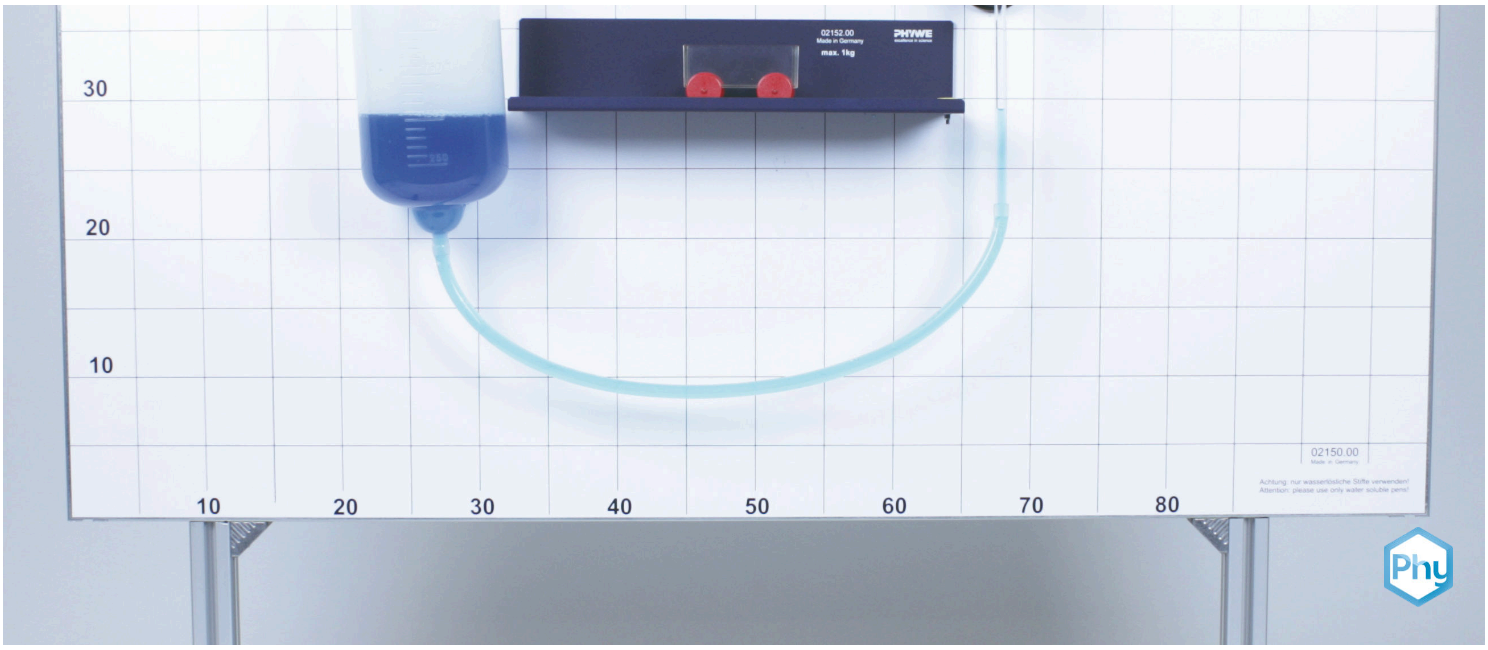
Communicating vessels



P1296900

Physics | Mechanics | Mechanics of liquids & gases

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/66bf13abd158cf00028c8c62

General information

Application

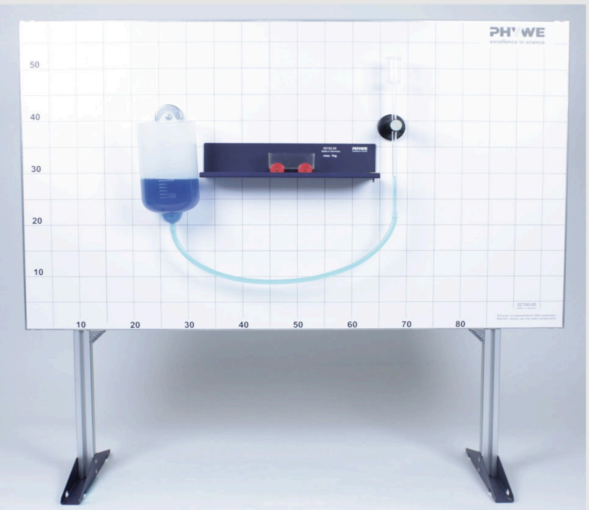


Fig. 1: Experimental setup

Communicating vessels are vessels that are open at the top and connected at the bottom. A homogeneous liquid is at the same height in them because gravity and air pressure are constant.

There are many practical applications of the principle of communicating vessels. With siphons, a form of suction pump, for example, the transfer of liquid is only stopped when the two liquid levels are equal. In nature, if an artesian well with a borehole had a depression below the groundwater level, water would be pressurised and rise to the earth's surface of its own accord.

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Other information (1/2)

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Prior knowledge

Students should have knowledge of communicating vessels and a deeper understanding of the equation $p = \rho \cdot g \cdot h$.

Principle

The aim is to prove that a (homogeneous) liquid is at the same level in connected vessels. The principle of the hose level is then to be demonstrated.

Other information (2/2)

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Learning objective

In this experiment, the students are supposed to be shown and familiarised with the basics of communicating vessels through an example. The students' understanding of the meaning of the equation $p = \rho \cdot g \cdot h$ is to be deepened.

Tasks

The task of this experiment is to observe the position of the liquid levels when the glass tube is placed in different positions.

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Safety instructions

The general safety instructions for experimentation in science lessons apply.

Theory

Communicating vessels are vessels that are open at the top but connected at the bottom. A homogeneous liquid stands at the same height in them.

Why are the liquid columns in them the same height?

This happens because gravitational pressure in liquids is related to the weight of a column of liquid above it. At a certain depth, the pressures must equalise. The gravitational pressure can be calculated using the equation: $p = \rho \cdot g \cdot h$.

When ρ and g are constant, p (pressure) is only dependant on h (height) of the liquid column, but not on the shape of the vessel. In the case of a liquid, the columns must be at the same height in all parts of the connected vessel.

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Equipment

Position	Equipment	Item no.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Pointers f. Demonst.Board, 4 pcs	02154-01	1
3	Rod on fixing magnet	02151-02	1
4	Track holder on holding magnet	02151-05	2
5	Clamping holder, 0-13 mm, fixing magnet	02151-07	2
6	Overflow vessel on fixing magnet	02158-00	1
7	Immersion probe	02632-00	1
8	Cart for measurements and experiments	11060-00	1
9	Track, l 900 mm	11606-00	1
10	Beakers, Boro, high form, various sizes (600 ml)	46029-00	1
11	Silicone tubing, various diameters (7 mm)	39296-00	2
12	Beaker, 100 ml, plastic (PP)	36011-01	1
13	Microspoon, steel	33393-00	1
14	Patent blue-V, 25 ml	48376-05	1
15	Marker, black	46402-01	1
16	Screw clamp	02014-01	2

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Setup and procedure

Setup (1/3)

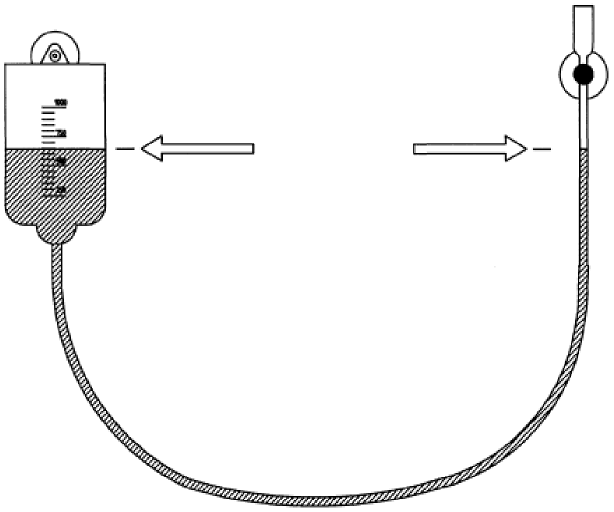

Fig. 2

Structure 1

- Connect a piece of silicone tubing about 110 cm long to the overflow vessel and place the vessel on the top left of the demo board.
- Place the clamping holder with the immersion probe on the top right and connect the end of the hose to the probe (Fig. 2).
- Fill the beaker with water (e.g. 500 ml), colour the water and then pour it into the outlet vessel.

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Setup (2/3)

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- Remove trapped air by repeatedly squeezing the hose if necessary.
- Use the drawing triangle to mark the positions of the liquid levels with a marker and emphasise them clearly with a pointer.

Setup (3/3)

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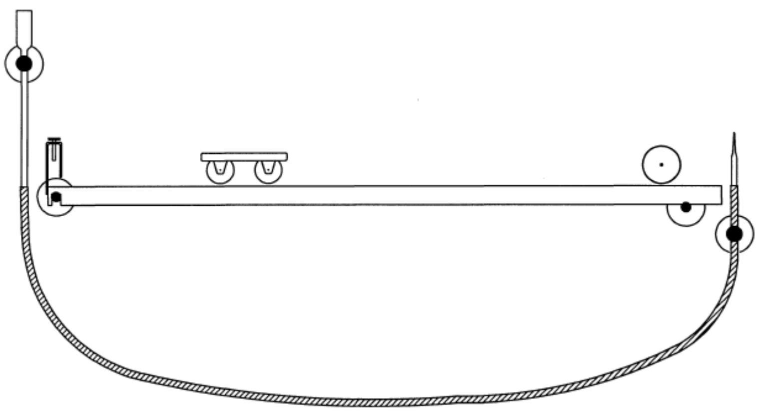

Fig. 3

Setup 2

- Use the track holders to place the track on the demo board.
- Prepare the hose level: Slide one end of the approximately 110 cm long silicone tube onto the tube of the immersion probe and the other onto the glass nozzle of the overflow vessel.
- Place the hose level at the ends of the track with the clamps (Fig. 3).

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Procedure (1/2)

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Procedure 1

- Place the immersion probe in different inclined positions, observe the water level and record the observations (1).
- Remove and empty the immersion probe and the overflow vessel.
- Align the track with the markings for the height of the fluid levels and fix them with the track holders.
- Attach the metal bracket supplied with the track to the left end of the track and place the rod on fixing magnet on the other end as a stopper for the cart.
- Place the cart on the track, then tilt the track slightly to the right or left and record the observations (2).

Procedure (2/2)

Procedure 2

- Carefully pour the coloured water into the immersion probe using the beaker and remove any trapped air bubbles by squeezing the tube.
- Change the position of the track until its upper edge is level with the liquid levels.
- Place the measuring and experiment cart on the track and check that it is level.

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Observations

Observation 1

1. The position of the liquid level remains the same, regardless of whether the glass tube is vertical or inclined.

2 The cart remains stationary on the track. If the latter is tilted, the cart performs an (accelerated) movement.

Observation 2

The track is level when its ends are at the same height as the water level of the hose level.

Evaluation

Evaluation 1

In connected (communicating) vessels, a liquid is at the same level everywhere. The liquid levels are all in the same horizontal plane.

The reason for this is the gravitational pressure. It is the same in all directions at the lowest point of the system of connected vessels and depends on the height of the liquid column, but not on the shape of the vessel.

Evaluation 2

Two points that are at a greater distance from each other can be set to the same height using a hose level. They are then in the same horizontal plane.

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Notes

It is advisable to draw a line through the marking points for the position of the liquid levels on the demo board before attaching the track to improve visualisation if necessary. The liquid levels lie in the same plane if the liquid has the same density everywhere, i.e. if it is homogeneous. If this fact is to be worked out, the experiment can be extended by pouring some ethyl alcohol into the immersion probe, for example. Then, because of $\rho_{water} > \rho_{ethylalcohol}$, the liquid level in the tube of the immersion probe is higher than the left-hand level in the overflow vessel.

The hose level, also known as a water level, is used in practice (construction, landscaping, etc.) to level over large distances. For this purpose, distant points are levelled via the two liquid levels and their height differences to the horizontal plane of the liquid levels are determined using measuring rods.

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