Demo

advanced **PHYWE**

Determining the volume of liquids and solids

(Item No.: P1420500)

Curricular Relevance

Area of Expertise: Physics	Education Level: Age 14-16	Topic: Mechanics	Subtopic: Substance and material properties	Experiment: Determining the volume of liquids and solids
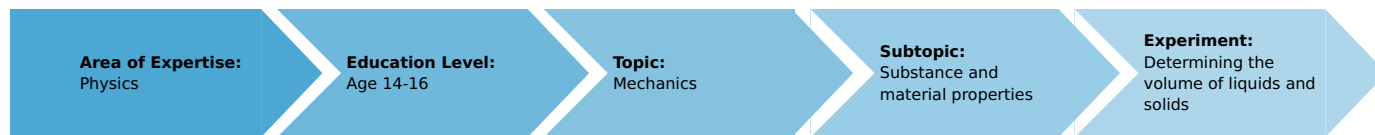
Difficulty	**Preparation Time**	**Execution Time**	**Recommended Group Size**
Easy	10 Minutes	10 Minutes	1 Student

Additional Requirements:

- Water

Experiment Variations:

Keywords:

Volumenbestimmung, Differenzmethode, Volumenmethode

Task and equipment

Introduction

The volume of a liquid can be determined with a graduated cylinder. It is demonstrated that different exact measurements can be made with different graduated cylinders and that the correct choice of graduated cylinder is decisive.
In the second part of the experiment it is examined how the volume of irregular solid bodies can be determined. The difference and overflow method is suitable for this, since solid bodies displace liquid bodies.

Task

Equipment

Position No.	Material	Order No.	Quantity
1	Tripod base PHYWE	02002-55	1
2	Overflow vessel, 600 ml	02213-00	1
3	Table top on rod	08060-00	1
4	Patent Blue V (sodium salt), 25 g	48376-04	1
5	Fish line, l. 100m	02090-00	1
6	Right angle clamp PHYWE	02040-55	1
7	Graduated cylinder 500 ml	36631-00	1
8	Glass beaker DURAN®, short form, 600 ml	36015-00	1
9	Graduated cylinder 10 ml	36625-00	1
10	Graduated cylinder 25 ml	36627-00	1
11	Graduated cylinder 50 ml	36628-00	1
12	Microspoon, steel	33393-00	1

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Set-up and procedure

Experiment 1

- Fill a 10 ml graduated cylinder with a quantity of water, e.g. 9.6 ml (Fig. 1).
- Have a student read the value.
- Pour the water from the 10 ml graduated cylinder into the 25 ml graduated cylinder, and then into the 50 ml graduated cylinder and finally into the 500 ml graduated cylinder.
- Each time, have a student read the value.

Fig.1

Experiment 2

- Remove both screws on the right angle clamp and tie a 30 cm-long thread on it.
- Fill up the 500 ml graduated cylinder more than half full with dyed water (Fig. 2).
- Read the volume of the water V_1 (Results, Table 2).
- Lower the right angle clamp into the cylinder and submerge completely in water.
- Reread the volume V_2.

Fig.2

Experiment 3

- Fasten the table top on rod in the support base, place the overflow vessel on the table top (Fig. 3).
- Place the 50 ml graduated cylinder under the beak-shaped spout.
- Fill the overflow vessel with dyed water until it starts to overflow.
- Completely submerge the right angle clamp on the thread in the water in the overflow vessel.
- Determine the volume V of the liquid collected in the graduated cylinder (Table 2).

Fig.3

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Results and evaluation

Results

Experiment 1

The volume of a liquid can be determined with a graduated cylinder.
Measuring the same amount of liquid with three different graduated cylinders results in different values.
The liquid rises slightly on its edge in the graduated cylinder.

Table 1

Graduated cylinder	10 ml	25 ml	50 ml	500 ml
Measuring tolerance/ ml	± 0,15	± 0,38	± 0,75	± 3,75
Quantity of water/ ml	9,6	9,5	10	approx. 15

Experiment 2 and 3

Table 2

	Difference method	Overflow method
V_1 / ml	250	-
V_2 / ml	290	-
V / ml	40	43

Evaluation

Experiment 1

During the measurement the tolerance range must be observed that indicates the measurement accuracy and is located on the graduated cylinder. To measure a quantity as accurately as possible, the graduated cylinder with the smallest scaling and the smallest tolerance range is best suited.
The right value is read at the lowest spot in the middle of the curved surface of the liquid, which is called the meniscus.

Experiment 2 and 3

The volumes of simple cuboids can be calculated by measuring the lengths of the edges and using the known volume formula:

V = Length · Width · Height

The volume of irregular bodies can be measured by submerging it in water. Rule of thumb: Two bodies cannot occupy the same space at the same time. Whereas the shape of the solid body does not change, liquids adapt to the shape of the space.
With the difference method the volume of the water without the submerged body V_1 is subtracted by the volume of the water with the submerged body V_2. The volume of the right angle clamp is:

$V = V_2 - V_1$

The overflow method provides an immediate result. The volume of the solid body corresponds to the overflowed water in the graduated cylinder.

The accuracy of the measurement depends on the selection of the graduated cylinder. With the overflow method this can be selected irrespective of the shape and size of the solid body. As a result the measurement accuracy here is greater than with the difference method.

Remarks: In the first experiment some water remains in the graduated cylinder each time the water is poured into a different cylinder. This amount is, however, so small that it can be neglected.