Determination of the volume of regular and irregular bodies (Item No.: P0998400)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Mechanik
Subtopic: Stoff- und Materialeigenschaften
Experiment: Volumenbestimmung regelmäßiger und unregelmäßiger Körper

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

Additional Requirements:

- Scissors
- Sliding weight balance

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional Information

The students should determine the volume of 3 solid bodies. In doing this they should know that the cubic meter (m^3) is the unit of volume and also that the term liter (l) is very common.

1. On immersion of a solid body in a graduated cylinder, the difference of the initial and final water levels gives the volume directly. The accuracy of this method increases with increasing narrowness of the graduated cylinder, i.e. with increasing difference in the water levels.
2. Immersion of a body in an overflow vessel and weighing the mass of the overflow volume generally results in more accurate results, since it is possible to read the scales more accurately than the graduated cylinder (meniscus!).
3. For regular bodies the calculation of the volume from the length, width and height, which have been measured with a vernier caliper, is the most accurate measuring method (see Experiment Measurement of length).

The volume tolerances are ±0,2 cm^3 for the two columns and ±0,5 cm^3 for the bosshead.

Suggestions

- Due to the meniscus, the water level should be read in the middle – flat – part of the water surface..
- The small beaker (100 ml) must be dried well before each new measurement.
- Before making the measurements, the bolts should be removed from the bosshead since its volume will later be determined without them.
- Instead of the beam balance another balance with a weighing range of 100 g and an accuracy of 1 g (or better) can be used (see on the Material page).

Remark

In the volume determination with the overflow method, it was assumed that the density of water is equal to 1 g/cm^3 . This fact will be experimentally elaborated in experiment determination of the density of liquids.

In experiment determination of the mass of solid and liquid bodies a quantity of water has already been weighed.

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Task and equipment

Task

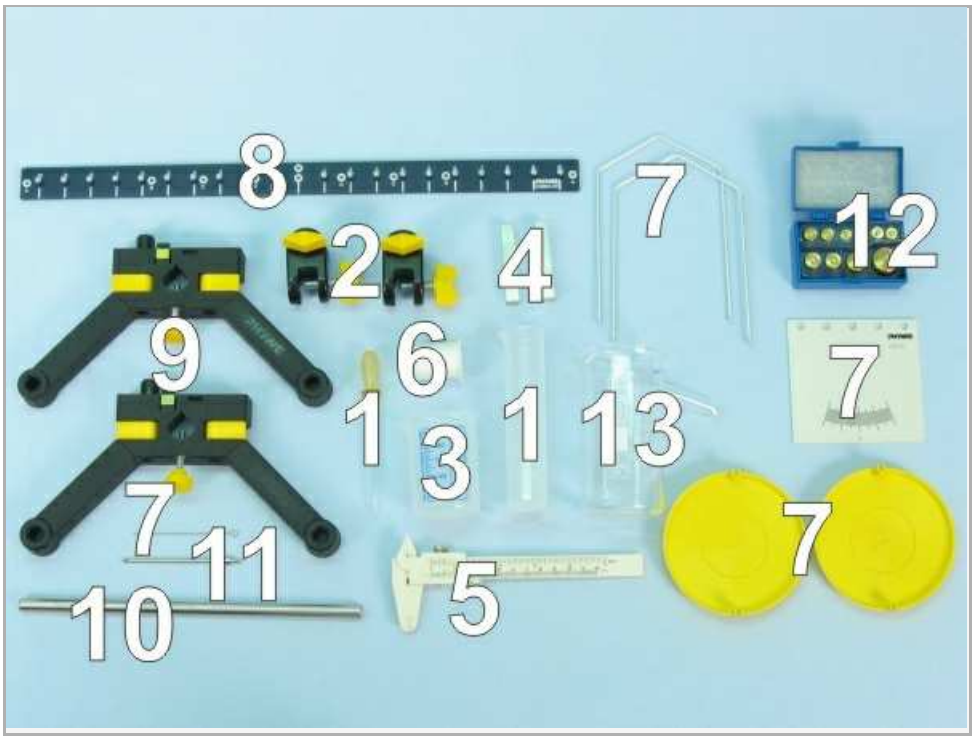
How much water is displaced by a solid body?

Determine the volume of a solid body in 3 different ways.

1. Immerse both metal columns in the water-filled graduated cylinder and determine the volume of the displaced water from the difference of the two water levels.
2. Immerse all 3 solid bodies one after another in the filled overflow vessel and measure the volume of displaced water with the graduated cylinder.
3. Measure the length, width and height of both regularly shaped bodies with the vernier caliper and calculate their volumes from the measured data.

Compare the results obtained and the different measuring methods with each other.

Equipment



Position No.	Material	Order No.	Quantity
1	Graduated cylinder, 50 ml, plastic	36628-01	1
1	Pipette with rubber bulb	64701-00	1
2	Boss head	02043-00	1
3	Beaker, low form, plastic, 100 ml	36011-01	1
4	Steel Column nickel-plated	03913-00	1
4	Aluminium column	03903-00	1
5	Vernier calliper, plastic	03011-00	1
6	Fishing line, l. 20m	02089-00	1
7	Balance pan, plastic	03951-00	2
7	Plate with scale	03962-00	1
7	Pointer for lever	03961-00	1
8	Lever	03960-00	1
9	Support base, variable	02001-00	1
10	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
11	Holding pin	03949-00	1
12	Set of precision weights,1g-50g	44017-00	1
13	Overflow vessel 250 ml	02212-00	1
Additional Material			
	Scissors		
As an alternative	Universal balance, 3000g	46009-00	
	Sliding weight balance, 101g	44012-01	

Set-up and procedure

Set-up

Set up a stand with the support base (Fig. 1), the support rod (Fig. 2) and the bosshead (Fig. 3).

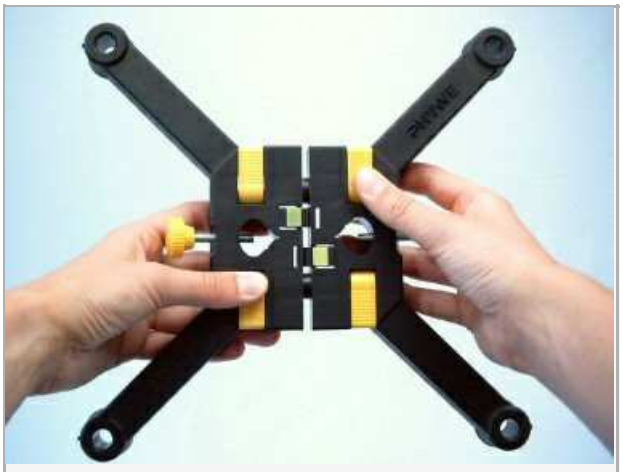


Fig. 1

Fig. 2

Fig. 3

Put the plate with scale in the middle of the lever, then put the holding pin in the hole of the pointer and in the hole of the lever (Fig. 4). Fix the holding pin in the bosshead (Fig. 5).

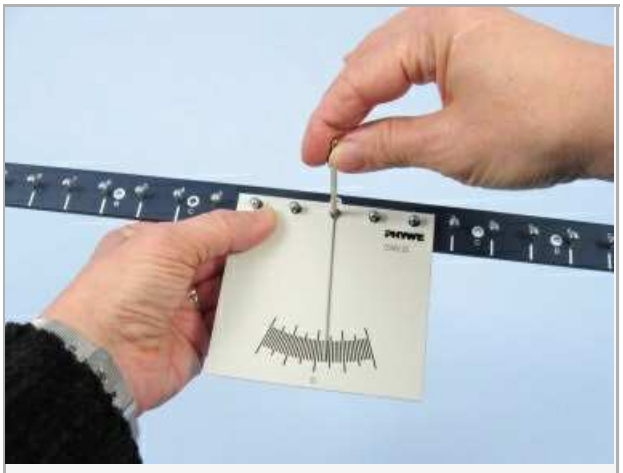


Fig. 4

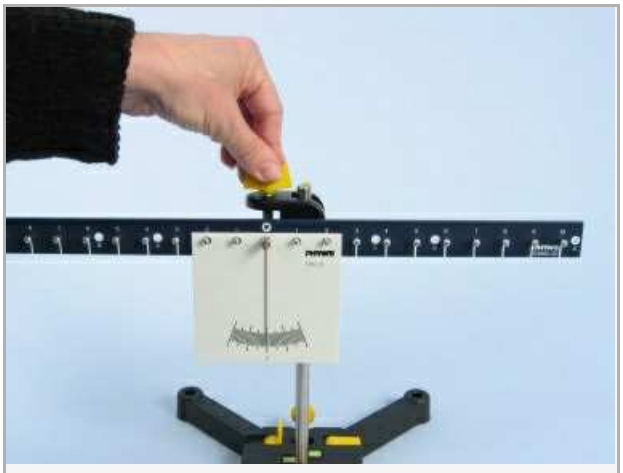


Fig. 5

Assemble the balance pans (Fig. 6) and hang each of them up at the end of the lever (Fig. 7).

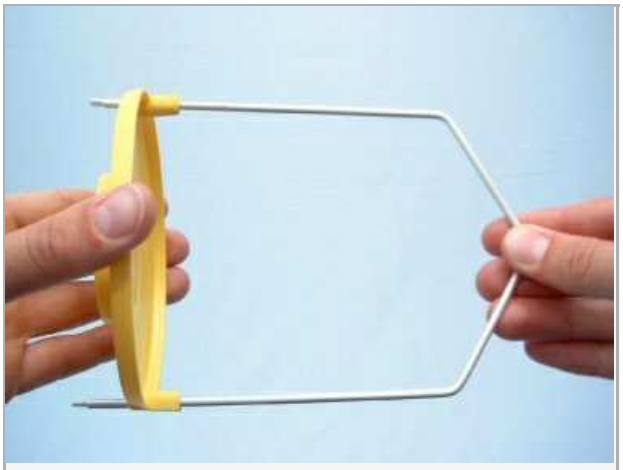


Fig. 6

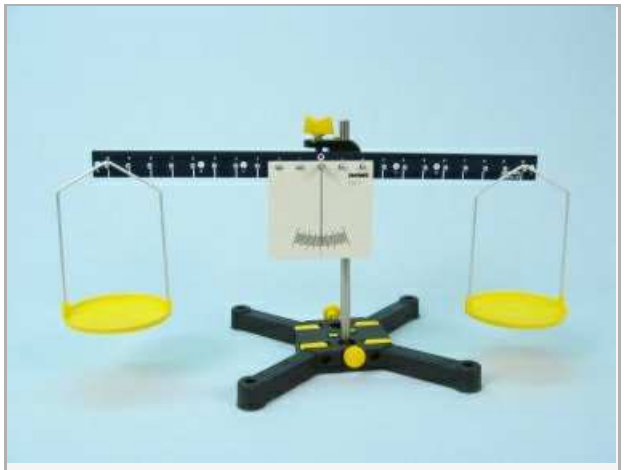


Fig. 7

Place the pointer in such a way that it points exactly to the zero mark (Fig. 8).

Fig. 8

Remove both bolts from the bosshead, fill the large beaker with water and tie a piece of fish line on each metal column and on the bosshead (Fig. 9).

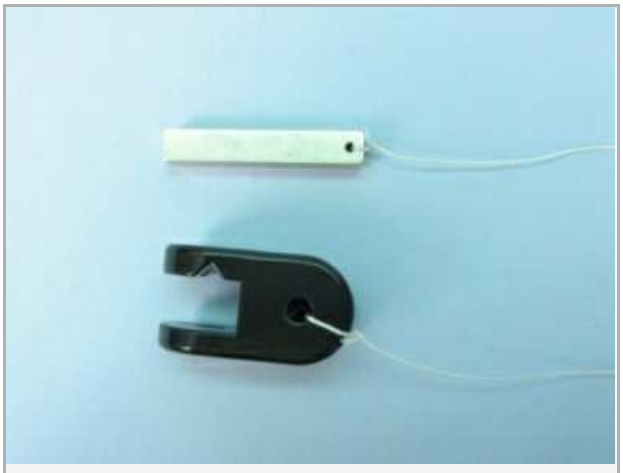


Fig. 9

Procedure

- Fill the graduated cylinder with approx. 35 ml of water (V_0) and record the initial water level. Immerse the iron column in the graduated cylinder so that it is completely covered with water (Fig. 10).

- Determine the new water level (V_1) and enter the value in Table 1 in the report.
- Repeat the experiment with the aluminium column and record this measured value in Table 1 as well.

Fig. 10

- Weigh the small beaker on the balance (Fig. 11) and note the value obtained (m_0).

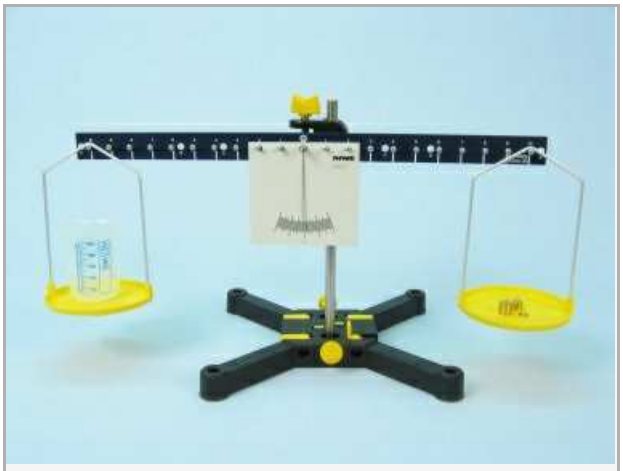


Fig. 11

- Put the small beaker under the spout of the overflow vessel and fill the latter with water until a small amount runs out of the spout. Dry the small beaker carefully and replace it under the overflow spout; immerse one of the 3 objects in the vessel. Ensure that the object is completely immersed (Fig. 12).

Fig. 12

- Wait until the flow from the overflow vessel has stopped and then weigh the small beaker again (m_1). Enter this value in Table 2 in the report.

- Repeat this procedure with the other objects.
- Always ensure that the beaker is well dried before each measurement.
- Measure the length *l*, the width *w* and the height *h* of the two regular objects and enter the measured values in Table 3 in the report.
- In order to disassemble the support base you should press the yellow buttons (Fig. 13).

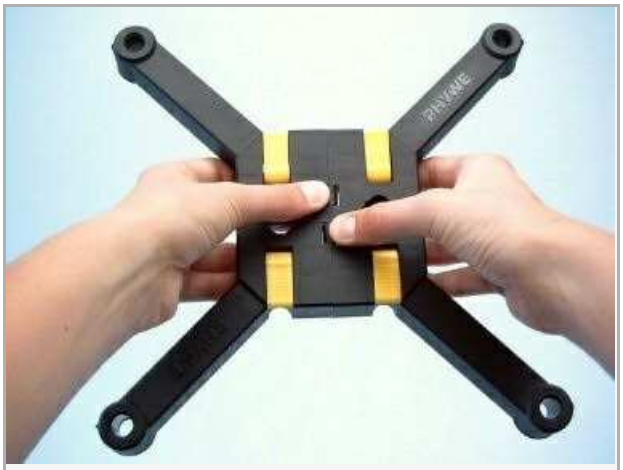


Fig. 13

Report: Determination of the volume of regular and irregular bodies

Results - Table 1

Immersion of a solid body in a graduated cylinder (V_0 = 35 ml): Enter measured value in the Table 1.

Calculate the volume V of both bodies from the difference $V = V_1 - V_0$.

Graduated cylinder	V_1 in ml	V in cm^3
Iron column	1 ±0	0 ±0
Aluminium column	1 ±0	1 ±0

Results - Table 2

Immersion of a body in an overflow vessel: Enter measured value in the Table 2. Calculate here also the volume V from the difference of the two weighings, i.e. from the water mass $m = m_1 - m_0$. (In experiment determination of the mass of solid and liquid bodiesit was determined that 1 ml (= 1 cm^3) of water weighs 1 g.)

Body	m_1 in g	V in cm^3
Iron column	1 ±0	1 ±0
Aluminium column	1 ±0	1 ±0
Bosshead	1 ±0	1 ±0

Results - Table 3

Calculation of the volume from the length, width and height: Enter measured value in the Table 3.

Calculate the volume using $V = l \times w \times h$ and enter these values.

Body	l in cm	b in cm	h in cm	V in cm^3
Iron column	1 ±0	1 ±0	1 ±0	1 ±0
Aluminium column	1 ±0	1 ±0	1 ±0	1 ±0

Evaluation - Question 1

Are there deviations between the measured values which you obtained with the different methods? If there are some, can you give an explanation for them?

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Evaluation - Question 2

How can the volume of a liquid be determined?

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Evaluation - Question 3

Why isn't a volume calculation for the bosshead included?

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