Determination of the density of liquids

Physics | Mechanics | Fabric & material properties

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5ee8b760e73cd9000325e749

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Teacher information

Application

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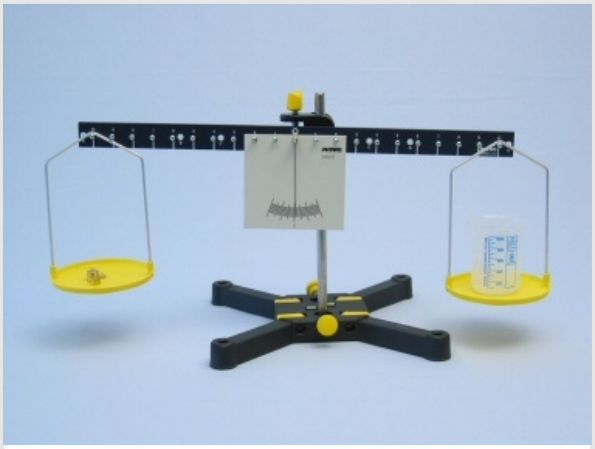
It is generally known that the density ρ of water corresponds to $1,000\ \frac{kg}{m^3}$ and $1\ \frac{g}{cm^3}$ respectively.

The students shall prove this fact in this experiment while learning which method can be used to determine the density of liquid bodies.

The density ρ of a body or material is defined as the quotient of its mass and volume:

$$\rho = \frac{m}{V} V \left[\frac{g}{cm^3}\right]$$



The determination of the mass is part of the density determination

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Other teacher information (1/2)

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Prior knowledge

Students should have a basic understanding of the material properties 'mass' and 'volume' and be able to determine them for solid bodies. Ideally, students should know that density is defined as the quotient of mass and volume.

Principle

For mass determination the beam balance with defined mass pieces is used and the volume is determined with a measuring cylinder.

The small beaker must be dried out well before each new experiment. When pouring liquids from the graduated cylinder into the beaker, care should be taken that all of the liquid is transferred – even the drops!

Other teacher information (2/2)

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Learning objective

The aim of this experiment is to learn and understand the relationship between mass and volume, i.e. the density of a liquid body. Furthermore, the students should investigate the difference in density of a salt solution compared to tap water.

Note: The density differences between tap water and the saline solution are only slightly above the measuring accuracy. For more precise statements, several measurements should be made and the average value should be calculated by the students.

Tasks

To do this, the students proceed experimentally as follows:

1. First of all, they should determine the density of water by measuring the volume in the measuring cylinder and weighing it.
2. The density of a self-prepared saline solution (approx. 20%) is then determined using the same method.

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Safety Instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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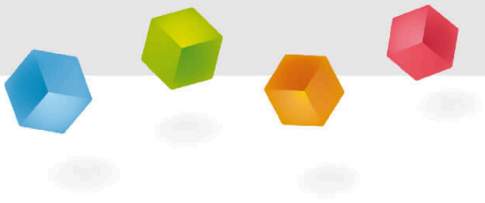

Student Information

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Motivation

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Oil in water

As you know, oil floats on water when you pour these two liquids together.

There are two reasons for this: Firstly, the two liquids do not mix and secondly, they have different densities. In this case, the oil floats on top of the water, because the density of oil is lower than that of water.

In this experiment you learn how to determine the density of liquids by measuring the volume and mass of a certain amount of liquid. Density is a material constant.

Tasks

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In this experiment you will investigate the density of tap water in comparison to a saline solution. Proceed as follows:

1. Determine the mass of the two liquids
2. Determine the volume of the two liquids
3. Calculate the density of the two liquids

The unit of density is $\frac{kg}{m^3}$ or $\frac{g}{cm^3}$ or $\frac{g}{ml} ml$.

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Material

Position	Material	Item No.	Quantity
1	Beaker, 250 ml, plastic (PP)	36013-01	1
2	Beaker, 100 ml, plastic (PP)	36011-01	1
3	Graduated cylinder, 50 ml, plastic	36628-01	1
4	Pipette with rubber bulb	64701-00	1
5	Glass tubes,l.250 mm, pkg.of 10	36701-68	1
6	Sodium chloride 250 g	30155-25	1
7	Balance pan, plastic	03951-00	2
8	Lever	03960-00	1
9	Pointer for lever	03961-00	1
10	Plate with scale	03962-00	1
11	Support base, variable	02001-00	1
12	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
13	Boss head	02043-00	1
14	Holding pin	03949-00	1
15	Set of precision weights,1g-50g	44017-01	1

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Additional material

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Position	Material	Quantity
1	Common salt (sodium chloride)	10 g

Set-up (1/2)

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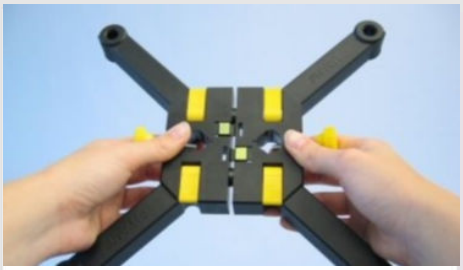
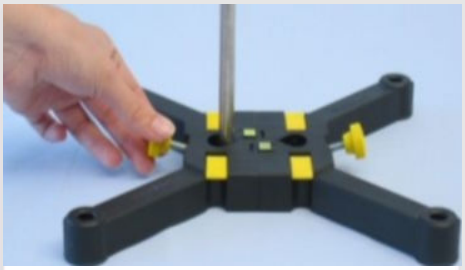
Set up a stand for the balance. Proceed as follows:

1. Set up a stand with the support base and the support rod as shown in the illustrations.

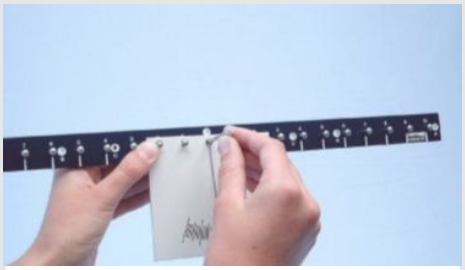
2. Put the holding pin through the hole of the pointer, the plate with scale and the middle of the lever.



Mounting the support base



Screwing the support rod



Mounting the scale

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Set-up (2/2)

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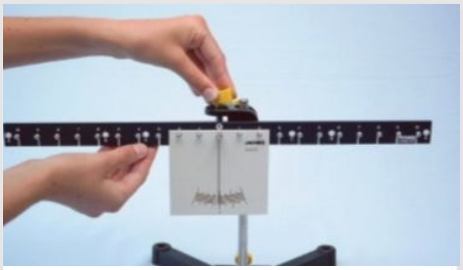
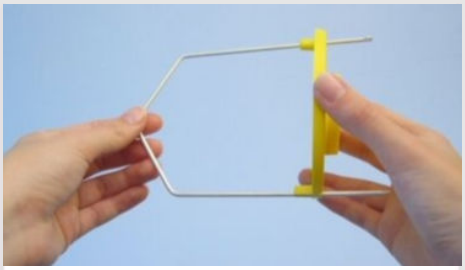
3. Fixx the holding pin to the support with the bosshead.

4. Assemble the balance pans and hang one at each end of the beam.

5. Adjust the pointer by turning it so that it points exactly to the zero mark.



Mounting the balance



Assembly of balance pan

Tare scale

Procedure (1/3)

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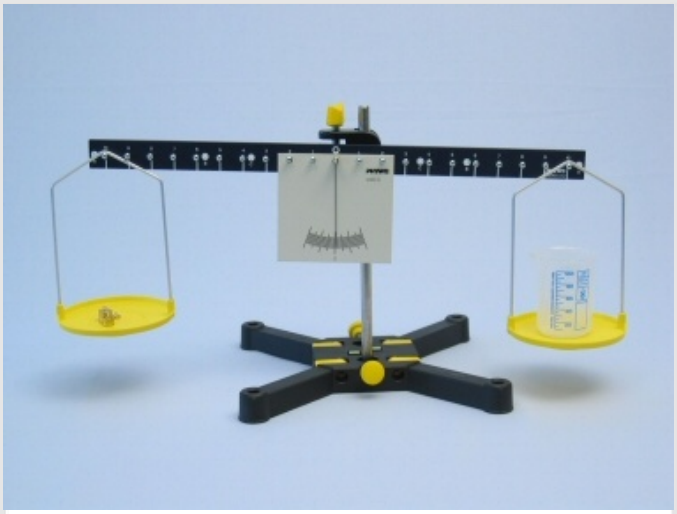
The measurements should be repeated several times. Proceed as follows:

- Fill exactly 50 ml of water into the measuring cylinder, use the pipette.
- Check the volume V on the measuring cylinder carefully, paying attention to the meniscus!
- Determine the mass m_0 of the small beaker with the beam balance, note the result in Table 1 in the report and fill the contents of the measuring cylinder into the small beaker. Make sure that you decant all water, even the drops.



Beam balance for mass determination

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Procedure (2/3)

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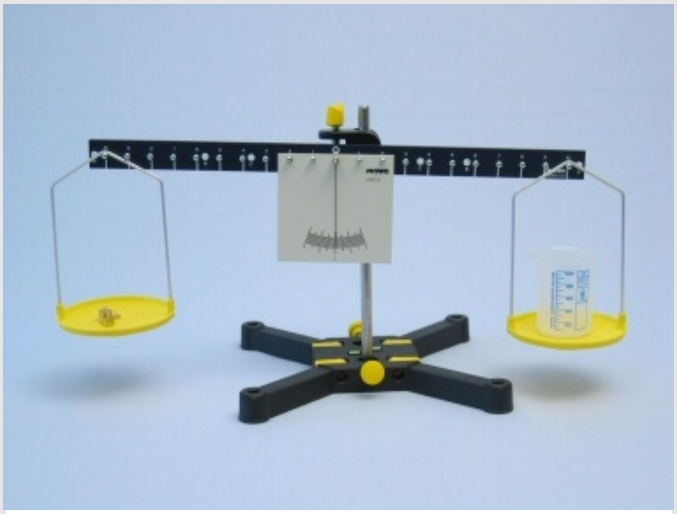
- Determine the mass m_1 of the beaker with water and note the value in Table 1.
- Add 10 g of common salt (NaCl) to the measuring cylinder and fill it up with 40 ml of water.
- Stir the solution well with the glass tube until all the salt is dissolved and fill up to exactly 50 ml with the pipette.
- Pour the solution into the emptied and dried small beaker, determine the mass m_2 of the beaker with saline solution and record this result in Table 1 as well.



Beam balance for mass determination

Procedure (3/3)

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Disassembly of the support base

To disassemble the support base, press the inner yellow buttons to release the locking hooks and pull the halves apart.

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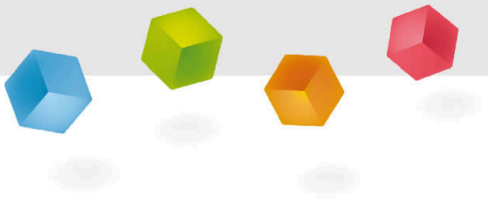

Report

Table 1

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Mass	1. measurement	2. measurement	3. measurement	mean value
$m_0\,[g]$ (empty)				
$m_1\,[g]$ (with 50 ml water)				
$m_2\,[g]$ (with 50 ml saline solution)				

Enter the measured values into the table and calculate the respective mean value.

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Table 2

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	$m\,[g]$	$V\,[cm^3]$	$\rho\,[\frac{g}{cm^3}]$
Water			
Saline solution (20%)			

Calculate from $V = 50\ ml$ and $m = m_1 - m_0$ (water) and $m = m_2 - m_0$ (saline), respectively, the respective densities of the two liquids according to the formula

$$\rho = \frac{m}{V}\left[\frac{g}{cm^3}\right]$$

Complete the table.

Task 1

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Which substance has the greater density?

- ○ The saline solution has the greater density.
- ○ The water has the greater density.

Check

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Task 2

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Can you substantiate this fact?

- ○ The saline solution has the greater density, it was compressed by stirring.
- ○ The saline solution has the greater density because it consists of water and an added mineral, which increases the average density.

Check

Task 3

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Which of these substances have a lower density than water?

- ☐ Aluminium
- ☐ Wood.
- ☐ Frozen water (ice).
- ☐ Saline solution
- ☐ vegetable oil

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Task 4

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What happens if you carefully put oil or spirit on water?

- ○ The liquids mix with the water due to the very similar density.
- ○ The liquids float on the water because they have a lower density.
- ○ The liquids sink because they have a higher density.

Check

Slide	Score / Total
Slide 19: Comparison of densities	0/1
Slide 20: Justification	0/1
Slide 21: Lower density than water	0/3
Slide 22: Oil on water	0/1

Total amount 0 / 6

Solutions | Repeat | Exporting text

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