Determination of the density of solid bodies

Physics | Mechanics | Fabric & material properties

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5ee36f677923e10003f6907c

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Teacher information

Application

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The determination of volume is part of the determination of density

Two bodies of the same size made of different materials have different masses. The reason is the different density of the materials that make up the respective bodies. Reasons for this are the different masses of different elements, as well as the composition of molecules, but also other factors such as the ambient temperature and the surrounding pressure.

Physically, this property is called density. It is defined as the quotient of mass and volume:

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

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Other teacher information (1/2)

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Prior knowledge

In the preliminary experiments for determining the mass and volume, the students learned that the two metal columns have the same volume but different masses. They know that the two bodies consist of iron and aluminium. It is therefore obvious that the mass does not only depend on the volume of an object.

The regular SI unit of density is $[kg/m^3]$.

Principle

To determine the density, the mass and volume of a body are determined one after the other.

Note: The suspension thread may only be attached to the weight after weighing. The 100 ml measuring cup must be dried thoroughly before each new measurement.

Other teacher information (2/2)

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Learning objective

The aim of this experiment is for students to learn and understand the relationship between mass and volume, i.e. the density of a body.

Tasks

The students are to determine the mass of four bodies by weighing.

The volume of the regularly shaped bodies should be determined by measuring them with a calliper and then calculating them according to $V = l \cdot b \cdot h$. The volume of the weight is determined by the immersion 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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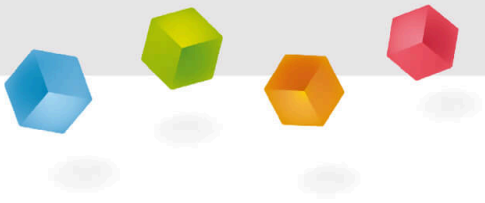

Student Information

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Motivation

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Rings made of metal

How could one determine whether the shiny metallic rings shown here are made of silver, white gold or even platinum? Or perhaps the jeweller has cheated and used chrome-plated iron. All these different materials are of varying degrees of rarity and thus of varying value.

There are only a few non-destructive methods with which one can draw conclusions about the material. The simplest method is the aim of this experiment. For this purpose, both the mass and volume of a solid body are determined and its density is calculated. The density is a material constant.

Tasks

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Determine the density of various solid bodies.

For this purpose, the wooden, aluminium and iron columns and a weight from the weighing set shall be examined as follows:

1. Determine mass
2. Determine volume
3. Calculate density

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Material

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
3	Boss head	02043-00	1
4	Steel Column nickel-plated	03913-00	1
5	Aluminium column	03903-00	1
6	Wood column	05938-00	1
7	Vernier calliper, plastic	03011-00	1
8	Balance pan, plastic	03951-00	2
9	Lever	03960-00	1
10	Pointer for lever	03961-00	1
11	Plate with scale	03962-00	1
12	Holding pin	03949-00	1
13	Set of precision weights,1g-50g	44017-01	1
14	Fishing line, l. 20m	02089-00	1
15	Pipette with rubber bulb	64701-00	1
16	Beaker, 100 ml, plastic (PP)	36011-01	1
17	Graduated cylinder, 50 ml, plastic	36628-01	1

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Additional material

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Position	Material	Quantity
1	Scissors	1

Set-up (1/3)

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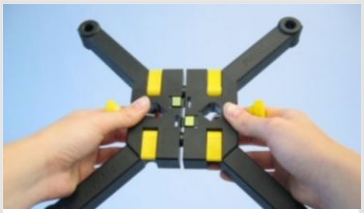
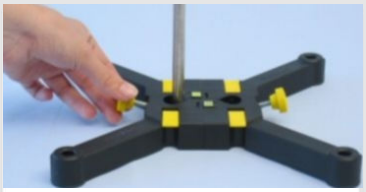


Mounting the support base



Screwing the support rod

Set up a universal support for the scale. When doing so, keep to the following tasks.

1. assemble a universal support with the support base and the support rod as shown in the illustrations.

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Set-up (2/3)

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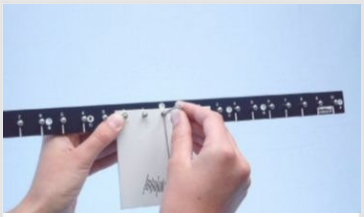
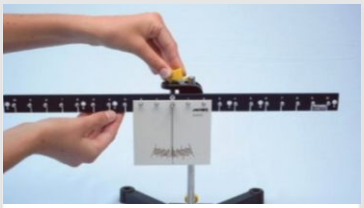


Mounting the scale

2. Hold the plate with the scale in the middle of the lever and then insert the holding pin through the hole of the pointer and through the hole of the lever.



Mounting the balance

3. Fasten the holding bolt to the stand with the boss head.

Set-up (3/3)

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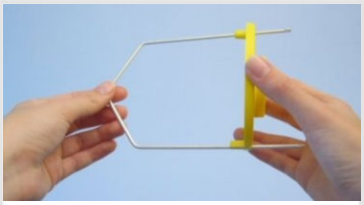

Mounting the weighing pan

4. Put the pans together and hang one at each end of the beam. The distance to the axis of rotation is thus equal and the balance is always balanced when the masses in both pans are of equal weight.

Tare scale

5. Adjust the pointer by turning it so that it points exactly to the zero mark. Now the pointer may no longer be changed manually to avoid falsifying the measurements.

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Procedure (1/4)

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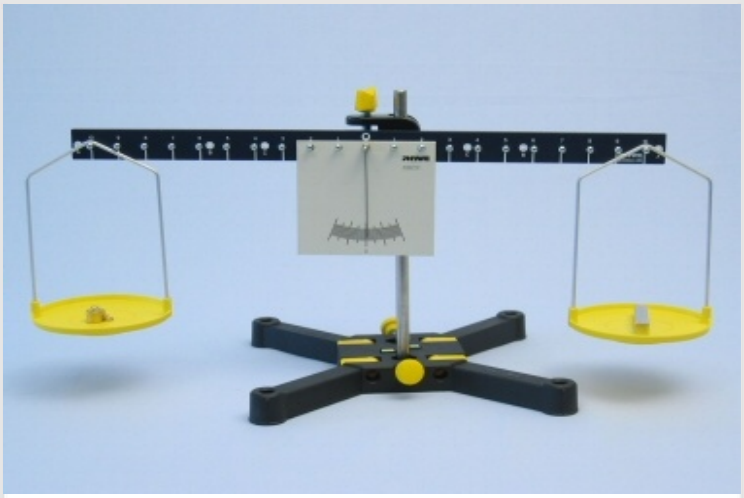

Experiment setup

Determine the mass m of the wooden, iron and aluminium columns and check the mass of the 50 g weight from the weight set with the balance and enter the measured values in Table 1 in the report.

Procedure (2/4)

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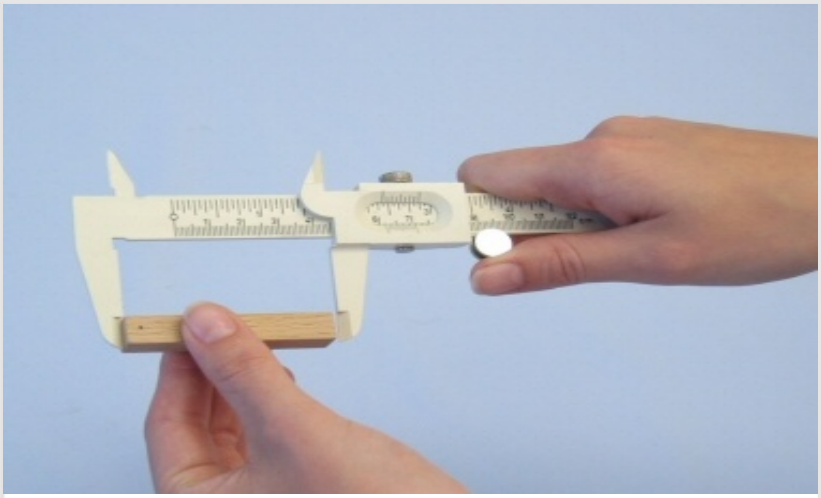
Measure the length *l*, width *b* and height *h* of the 3 regular bodies and calculate their volume from the measured values:

$$V = l \cdot b \cdot h$$

Also enter these values in Table 1.



Measuring the wooden column with the caliper gauge

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Procedure (3/4)

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Overflow vessel with water and immersed irregular body

Determine the volume of the weight using the immersion method:

- Fill the measuring cylinder with 30 ml water (V_0) and check the water level.
- Attach a piece of fishing line to the weight and dip it into the measuring cylinder so that it is completely covered with water. Read the water level again (V_1).
- Calculate the volume of the weight from the difference and enter all values in Table 2 of the report.

Procedure (4/4)

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Disassembling the support base

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

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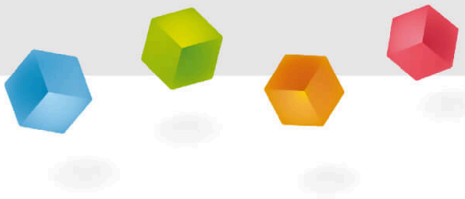

Report

Table 1

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Body	$m\,[g]$	$l\,[cm]$	$b\,[cm]$	$h\,[cm]$	$V\,[cm^3]$	$\rho\,[g/cm^3]$
wooden column						
Aluminium column						
Iron column						

Enter your measured values for the three columns in the table. Then calculate the density of the respective bodies from the values for mass m and volume V according to the following formula:

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

Complete the table.

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Table 2

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	$m\,[g]$	$V_0\,[cm^3]$	$V_1\,[cm^3]$	$V\,[cm^3]$	$\rho\,[g/cm^3]$
Weight					

Enter your measured values for the weight in the table. Then calculate the density of the respective bodies from the values for mass m and volume V according to the following formula:

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

Complete the table.

Task 1

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What do you notice about the density of wood?

- ☐ It is lower than the density of iron.
- ☐ It is greater than the density of iron.
- ☐ This is the lowest density of the examined objects.

Check

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Task 2

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Compare the density of the weight with the density of the metal columns.

Arrange the parts in the order of their densities. For this, order the items in descending order of density, starting with the item with the highest density.

1. ____
2. ____
3. ____.

iron column

weight

Aluminum column

Check

Task 3

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A density greater than iron has...

- ☐ ...water.
- ☐ ...plastic.
- ☐ ...gold.
- ☐ ...lead.

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Slide	Score / Total
Slide 21: Density of wood	0/2
Slide 22: Order of densities	0/3
Slide 23: Greater density than iron	0/2

Total amount 0 / 7

Solutions | Repeat | Exporting text

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