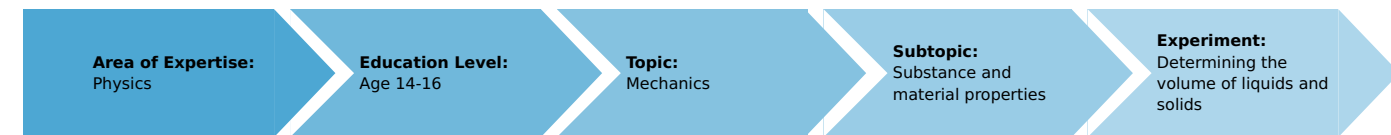# Determination of the density of solid bodies with the same mass and different volumes (Item No.: P1420500)

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:

Experiment Variations:

Keywords:

Density, Volume, Mass

Task and equipment

Introduction

Bodies that have the same mass, but made out of different material have different volumes.

Task

Determination of the density of solid bodies.

Calculation of density, taking into account the mass and the volume.

Equipment

Position No.	Material	Order No.	Quantity
1	Vernier calliper stainless steel 0-160 mm, 1/20	03010-00	1
2	Metal bodies, set of 3	04406-00	1
3	Portable balance, 300 g / 0,05 g	49213-00	1

Set-up and procedure

Set-up

Switch on the balance and wait for it to set to zero.

Fig. 1

Procedure

- Guess which of the three bodies has the smallest and which has the greatest mass and line the bodies up in a row accordingly.

- Determine the mass *m* of the bodies one after the other using the scale (Table 1, Results).

- Measure the length of the bodies *a*, *b* and *c* with the vernier caliper.

Results and evaluation

Results

Observation: All three bodies have the same mass of 60 g.

Table 1

Body	$\dfrac{m}{g}$	$\dfrac{a}{cm}$	$\dfrac{b}{cm}$	$\dfrac{c}{cm}$	$\dfrac{V}{cm^3}$	$\dfrac{\rho}{g\ /\ cm^3}$
Aluminium	60	2	2	5,7	22,8	2,6
Iron	60	2	2	2	8,0	7,5
Copper-zinc	60	2	2	1,8	7,2	8,3

Evaluation

The volume of the cuboids are calculated from:

$$V = a \cdot b \cdot c$$

The following formula is used to calculate the density:

$$\rho = \frac{m}{v}$$

The aluminum cuboid has a density of:

$$\rho_{Al} = \frac{m_{Al}}{V} = \frac{60{,}0\ g}{22{,}8\ cm^3} = 2{,}6\frac{g}{cm^3}$$

For the iron cuboid, the density is calculated as follows:

$$\rho_{Fe} = \frac{m_{Fe}}{V} = \frac{60{,}0\ g}{8{,}0\ cm^3} = 7{,}5\frac{g}{cm^3}$$

The copper-zinc cuboid has a density of:

$$\rho_{CuZn} = \frac{m_{CuZn}}{V} = \frac{60{,}0\ g}{7{,}2\ cm^3} = 8{,}3\frac{g}{cm^3}$$

The three bodies, have the same mass, but are all made of different material. They therefore do not have the same volume. The density is different. The smaller the volume of a body with a certain mass, the greater its density.

Remarks:

1. The density is a material property with which materials can be distinguished from each other. Unknown materials can be identified by determining the density and comparing it with a tabular value.
2. In the experiment the values for the density can deviate slightly from the literature values, since each cuboid has a hole going through it in order to hang it on a string.
3. The SI unit for density is $\frac{kg}{m^3}$.
4. Water has a density of $\rho = 1\frac{g}{cm^3}$. The value of the density of a material therefore indicates how many times larger or smaller the mass of a substance is compared to water.

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