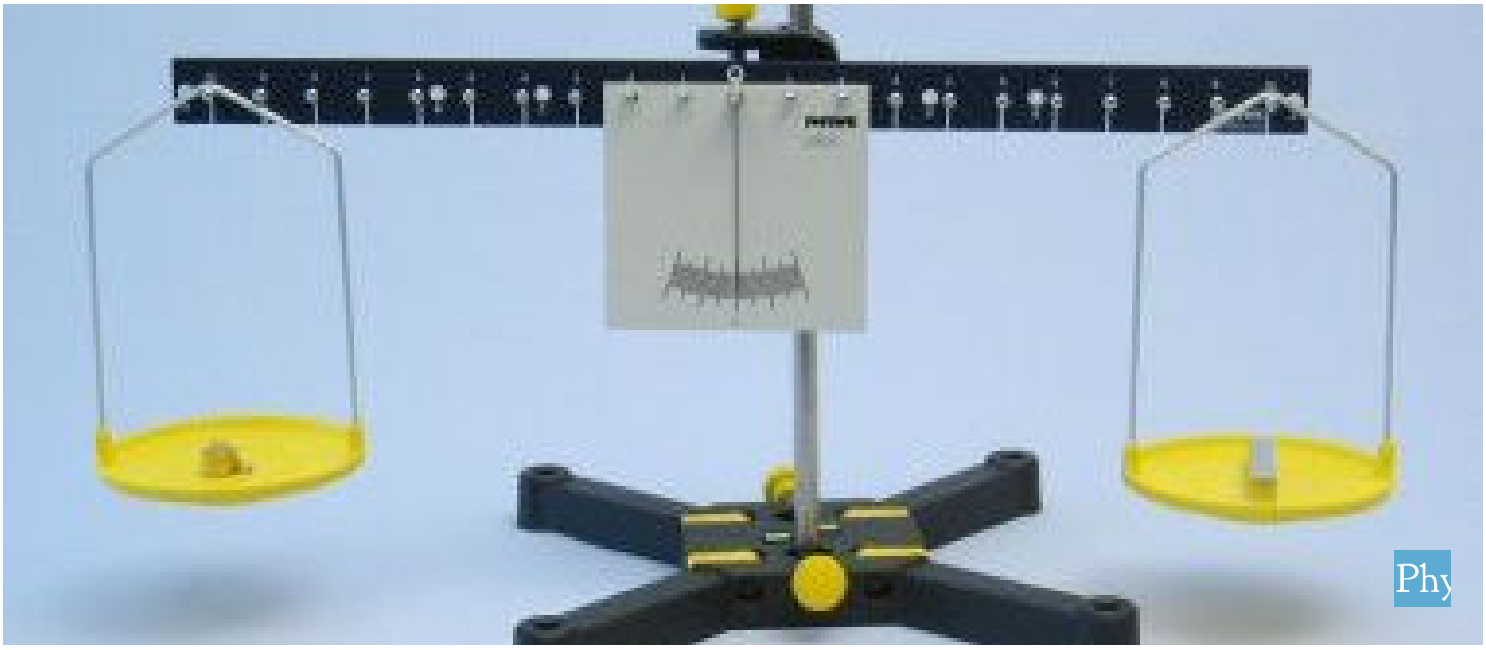
Determination of the mass of solid and liquid bodies



Physics | Mechanics | Fabric & material properties

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

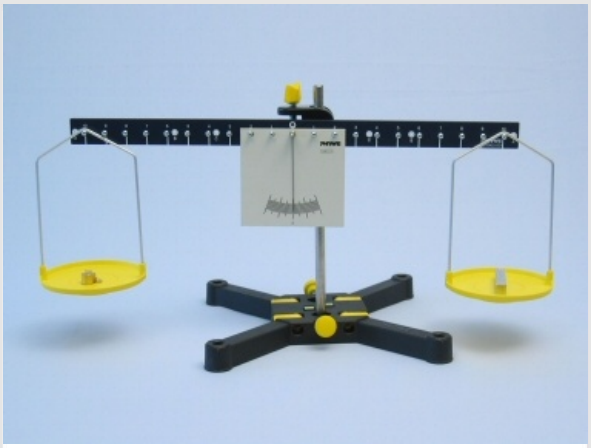
PHYWE excellence in science
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

PHYWE excellence in science

Teacher information

Application

PHYWE excellence in science



Experimental setup

Weighing masses have a wide range of applications in our daily lives.

These range from weighing fruit and vegetables at the market or supermarket to weighing chemicals in the pharmaceutical industry to achieve specific dosages in medicines.

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/2)

PHYWE excellence in science

Prior knowledge

The SI unit of mass is kilogram (kg). It is a basic unit of the SI system. The definition of the kilogram is based on a numerical value of Planck's constant and the definitions of meter and second. Until 2018, the kilogram was defined as the mass of the platinum-iridium prototype kilogram stored in Paris: a cylinder with a height and a diameter of 39 mm each.

Principle

A beam balance is used in this experiment. For this purpose, two pans are fixed equidistant from the axis of rotation. The mass to be measured is placed in one pan balance. The other pan is then filled with weights of known mass until the pans are in balance, i.e. they are level and thus at the same height.

Other teacher information (2/2)

PHYWE excellence in science

Learning objective

In this experiment, the students should determine the mass of liquid or solid substances with the help of a beam balance.

Tasks

For this purpose, an iron, an aluminium and a wooden column will be investigated as solid materials and additionally water as liquid substance.

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Safety Instructions

PHYWE excellence in science

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

PHYWE excellence in science

Student Information

PHYWE excellence in science

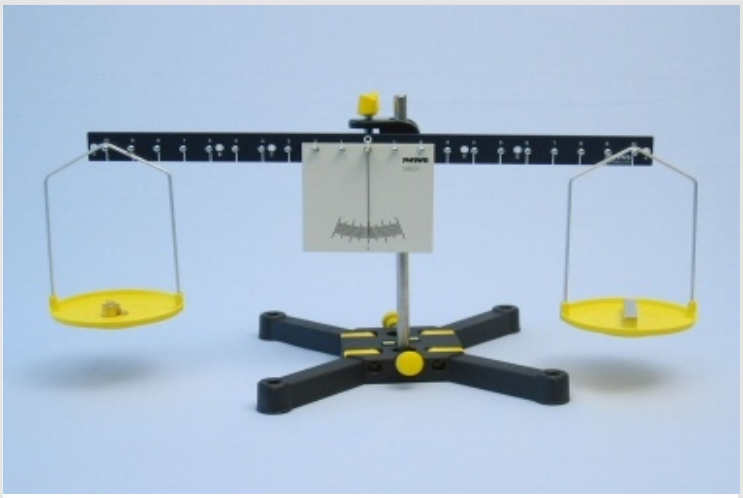
Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Motivation

PHYWE excellence in science



Experimental setup

The knowledge of the mass of given objects is very important in all areas of life:

Weighing fruit and vegetables in the supermarket or packages in mail order, for example, determines the price to be paid.

But how do you determine the mass of solid and also liquid bodies?

This question is to be explained with the help of the upcoming experiment.

Tasks

PHYWE excellence in science

Using a balance, first determine the mass of various solid bodies, and then determine the mass of a liquid body, in this case water.

Bodies/materials to be examined:

- Iron column
- Aluminium column
- Wooden column
- Water

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

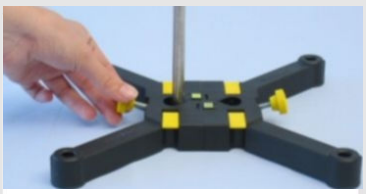
Material

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	Graduated cylinder, borosilicate, 50 ml	36628-00	1
4	Boss head	02043-00	1
5	Steel Column nickel-plated	03913-00	1
6	Aluminium column	03903-00	1
7	Wood column	05938-00	1
8	Balance pan, plastic	03951-00	1
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	Beaker, 100 ml, plastic (PP)	36011-01	1
15	Pipette with rubber bulb	64701-00	1

PHYWE excellence in science
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Set-up (1/3)

Mounting the support base

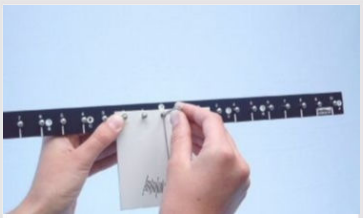


Screwing the support rod

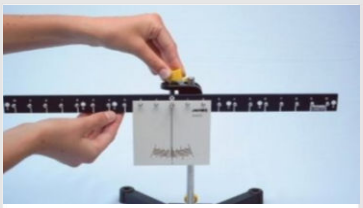
Set up a support for the balance. When doing so, keep to the following tasks.

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

Set-up (2/3)



Mounting the scale



Mounting the balance

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

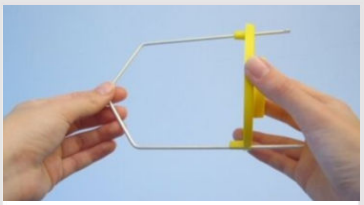
3. Fix the holding pin in the bosshead

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Set-up (3/3)



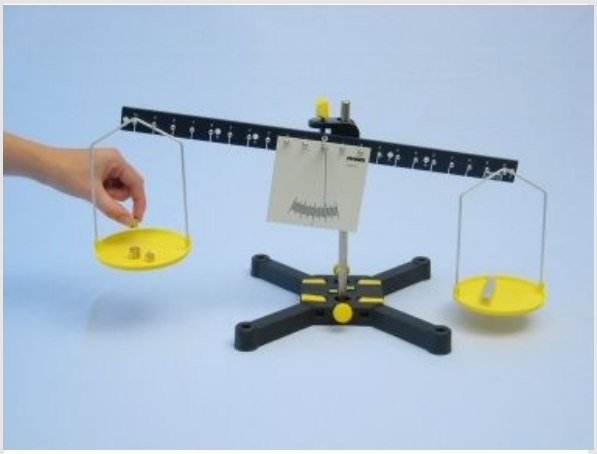
Assembly of pan balance

Tare scale

4. Assemble the balance pan and hang each of them up at the end of the lever. The distance to the axis of rotation is thus equal and the balance is always balanced when the masses in both pans are of same weight.

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.

Procedure (1/3)



Deflected balance

Place the 3 columns (iron, aluminium, wood) one after the other on one pan of the balance and determine their respective mass m by loading the other pan with mass pieces from the weight set until the balance is balanced again.

Enter the measured values in Table 1 in the report.

Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Procedure (2/3)

PHYWE excellence in science

Measuring cylinder with water

Now place the dry beaker on a weighing pan and determine its mass m_0.

Fill the measuring cylinder up to the 30 ml mark with water. Use the pipette for better accuracy. The water level is read in the middle, flat part of the water level.

Transfer the water into the beaker without leaving a drop in the measuring cylinder and determine the mass m_1 of the beaker with water.

Repeat the test with 50 ml water. Make sure that the beaker is well dried before each new weighing, as any additional drop of water would falsify the measurement result.

Enter the measured values in Table 2 in the report.

Procedure (3/3)

PHYWE excellence in science

Do not disassemble the experimental setup yet.

After you have answered question 3 on the evaluation page, you can start to disassemble the experiment.

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

Support base disassembly

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

PHYWE excellence in science

Report

Table 1

PHYWE excellence in science

Body	Mass m [g]
Iron column	
Aluminium column	
Wooden column	

Enter the masses of the solid bodies here.

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Table 2

PHYWE excellence in science

Body	m_0 [g]
Empty beaker	

Enter here the masses of the liquid bodies and determine the mass of the water m from the difference:

$$m = m_1 - m_0$$

Water quantity	m_1 [g]	m [g]
30 ml		
50 ml		

Task 1

PHYWE excellence in science

Order the 3 columns in the order of their masses.
Place the different materials in the right place in the text.

The _____ column has the largest mass.
This is followed by the _____ column.
The lightest is the _____ column.

wooden
aluminum
iron

Check

PHYWE excellence in science
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Task 2

PHYWE excellence in science

The 3 columns have different masses.

What is the reason for this phenomenon?

- ○ They are of different sizes.
- ○ They consist of different materials and have different densities.

Check

Task 3

PHYWE excellence in science

Determine the common mass of two solid bodies with the balance. Compare the result with the sum of the weights in Table 1.

Which sentence is correct?

- ○ The weight of two bodies corresponds to the sum of the two individual masses.
- ○ The weight of two bodies corresponds to the mass of the heavier body.

Check

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Task 4

PHYWE excellence in science

Does the same correlation also apply to liquid bodies?

- ○ Yes, the same correlation applies here.
- ○ No, this correlation is not applicable to liquids.

Check

Task 5

PHYWE excellence in science

Can you give a correlation between the amount of water and the mass of water?

- ○ The smaller the quantity, the greater the mass.
- ○ The mass does not depend on the amount of water, but only on the container
- ○ The greater the quantity, the greater the mass.

Check

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Additional task

PHYWE excellence in science

What form does a liquid body take?

- ○ The shape of the container in which it is located.
- ○ Neither of the other two answers is correct.
- ○ Always a cylindrical shape.

Check

Slide	Score / Total
Slide 19: Order of the solid bodies	0/3
Slide 20: Differences in masses	0/1
Slide 21: Mass of two solid bodies	0/1
Slide 22: Summer liquid body	0/1
Slide 23: Relationship of water quantity to mass	0/1
Slide 24: Form of liquid body	0/1

Total amount 0/8

Solutions Repeat Exporting text

PHYWE excellence in science

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de