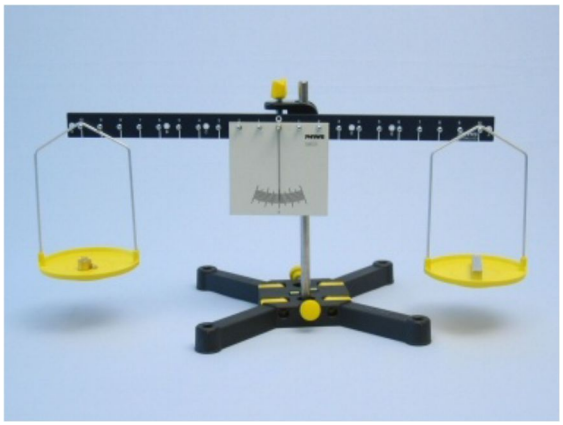
1.3 Determination of the mass of solid and liquid bodies

Task

How does one determine the mass of solids and liquids?

A balance is used to determine the mass of different solid objects. Additionally the weight of a liquid is measured.



Use the space below for your own notes.

Additional Information

1. The students should determine the mass of solid bodies with the aid of a balance.
2. The measurement of the mass of liquids can only be performed using a container. The students should determine the mass from the difference of two measurements.

Suggestion

2. The mass of liquids

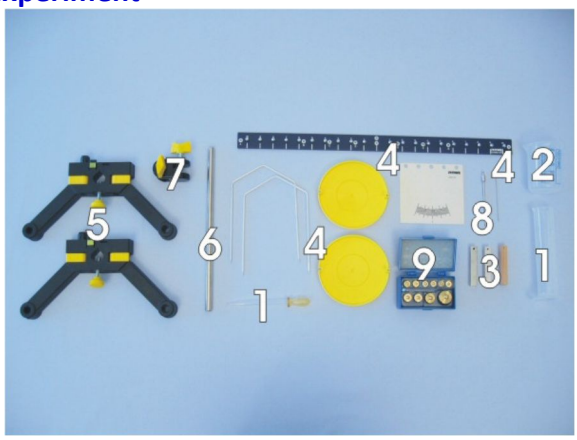
- To adjust the water level to exactly the desired value a pipette can be used. Due to the meniscus, the water level should be read in the middle–flat–part of the water surface.
- To make repeated measurements it is absolutely necessary to dry the beaker completely, since the dhering water drops would otherwise falsify the measurements.

Material

Material from "TESS advanced Physics Set Mechanics 1, ME-1" (Order No.15271-88)

Position No.	Material	Order No.	Quantity
1	Graduated cylinder, 50 ml, plastic	36628-01	1
1	Pipette, with rubber bulb	64701-00	1
2	Beaker, plastic, short form, 100 ml	36011-01	1
3	Iron column, nickel-plated	03913-00	1
3	Aluminium column	03903-00	1
3	Wood column	05938-00	1
4	Balance pan, plastic	03951-00	2
4	Lever	03960-00	1
4	Pointer for lever	03961-00	1
4	Plate with scale	03962-00	1
5	Support base, variable	02001-00	1
6	Support rod, stainless steel 18/8, *l* = 250 mm, *d* = 10 mm	02031-00	1
7	Bosshead	02043-00	1
8	Holding pin	03949-00	1
9	Set of precision weights, 1g...50g, in case	44017-00	1

Material required for the experiment



Setup

Set up a stand with the support base and the support rod as you can see in Fig. 1 and Fig. 2.

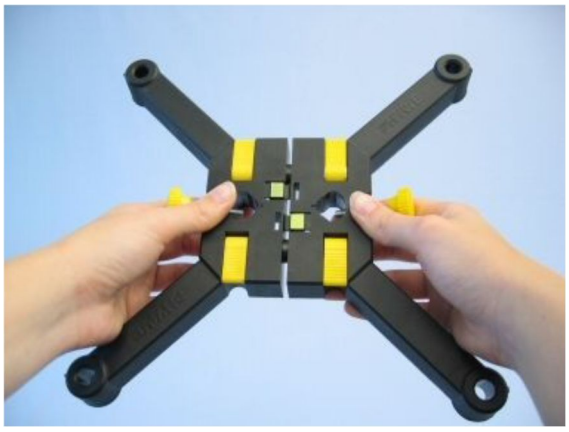


Fig. 1

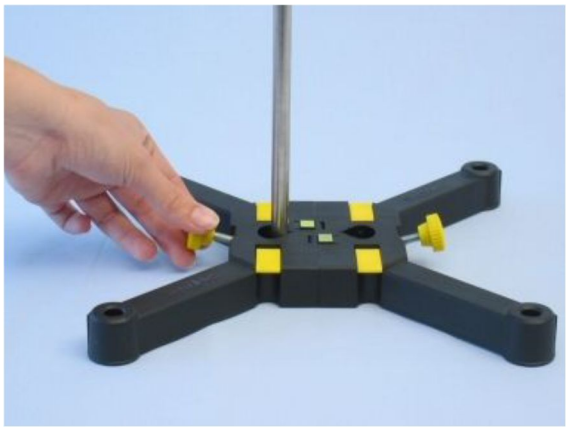


Fig. 2

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. 3). Fix the holding pin in the bosshead (Fig. 4).

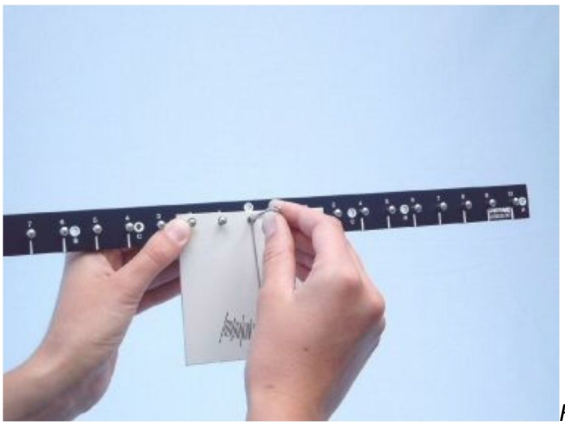


Fig. 3

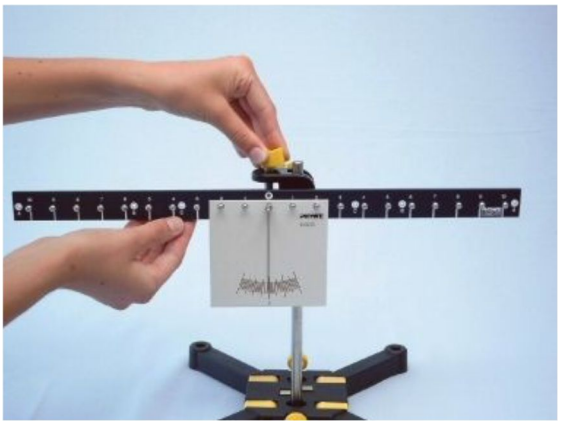


Fig. 4

Assemble the balance pan (Fig. 5) and hang each of them up at the end of the lever (Fig. 6).

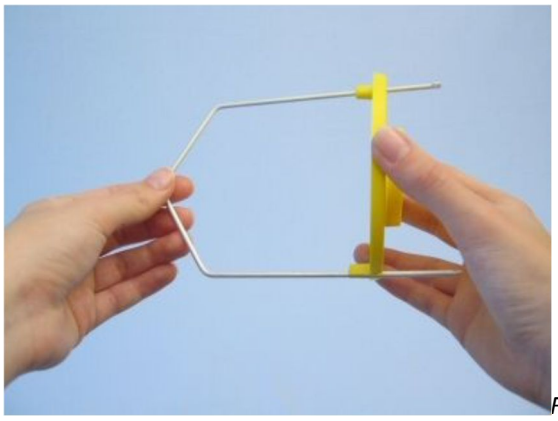


Fig. 5

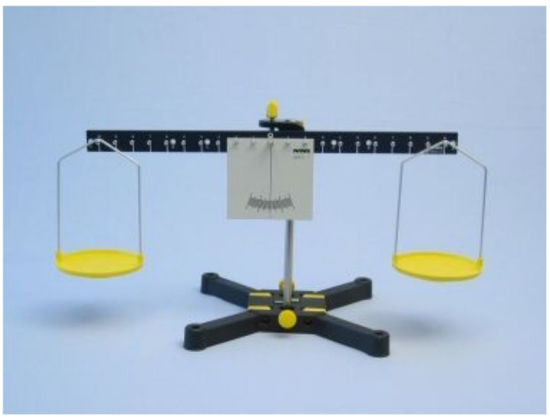


Fig. 6

Place the pointer in such a way, that it points exactly to the zero mark (Fig. 7).

Fig. 7

Action

- Place the 3 columns one after another in the balance pan and determine each of their masses *m* by placing mass pieces from the weight set on the other balance pan until the balance is in equilibrium (Fig. 8).
- Enter the measured values in Table 1 on the Results page.

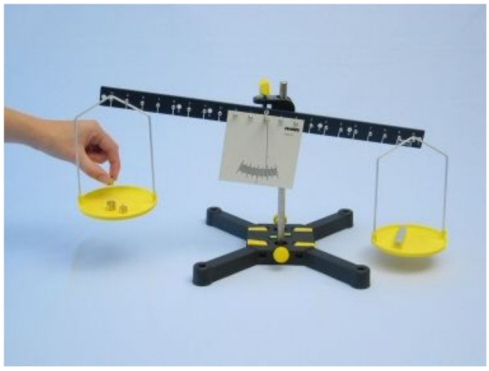


Fig. 8

- Place the dry beaker on one balance pan and determine its mass m_0.
- Fill the graduated cylinder up to the 30 ml mark with water. Use the pipette to bring the water level to exactly this mark (Fig. 9). The water level should be read in the middle-flat-part of the water surface.

Fig. 9

- Pour the water into the beaker, ensure that not even a single drop remains in the graduated cylinder and determine the mass m_1 of the beaker with water.
- Repeat the experiment with 50 ml of water. Be sure that the beaker is completely dry before each new weighing, since the adhering water drops would otherwise falsify the measurements.
- Enter the measured values in Table 2 on the Results page.

After you answered the question 3 on the evaluation tab, you may start disassembling the experiment.
In order to disassemble the support base you should press the yellow buttons (Fig. 10).

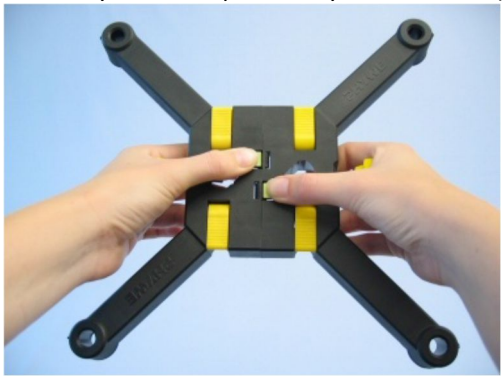


Fig. 10

Results

Table 1
Mass of solid bodies

Object	mass in g
iron column	
aluminium column	
wood column	

Table 2
Mass of liquid bodies

Empty beaker m_0 = g		
Quantity of water	Filled beaker m_1 in g	Mass of water m in g
30 ml		
50 ml		

Evaluation

Question 1:
Arrange the 3 columns according to their masses.

Question 2:
The 3 columns have different masses. What do you notice about them?

Question 3:
Determine the combined weight of 2 solid bodies with the balance. Compare the result with the sum of their weights from Table 1. Do you obtain the same values?

Question 4:
Is the same correlation valid for liquids?

Question 5:
Determine the mass of water m from the difference $m = m_1 - m_0$ and enter the result in Table 2 (See Results page).

Question 6:
Can you state a correlation between the quantity of water and its mass?

Question 7:
What shape does a liquid take?

Additional Tasks

Question 1:
How accurately can masses be determined with this balance?

Question 2:
How could you increase the reading accuracy of the balance?

Question 3:
Can you think of any possible way for the balance to automatically take the weight of the beaker into account?