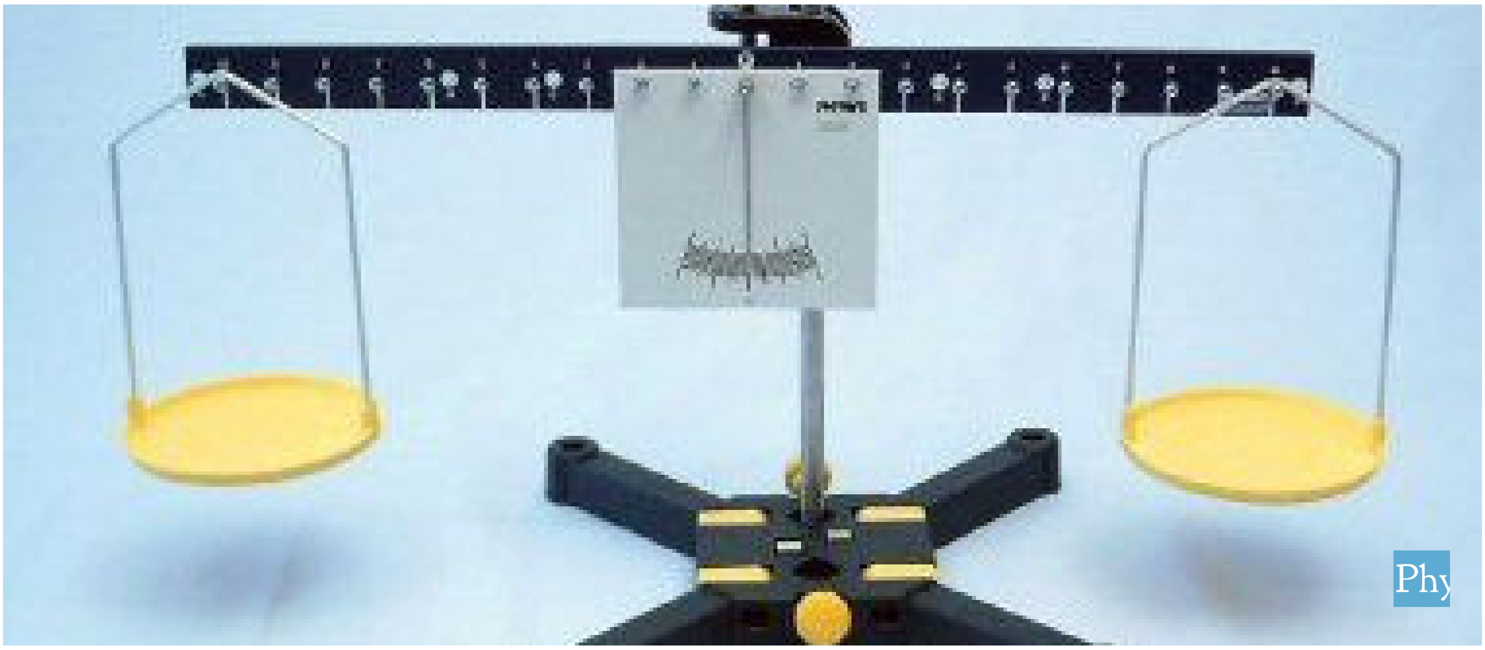
Beam balance



Physics | Mechanics | Forces, work, power & energy

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

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Teacher information

Application

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Beam balance

In the weight force experiment (P0999000), the mass of various bodies was determined using a spring force meter. Here, however, the locally varying attraction force has an effect on the result: the acceleration due to gravity at the poles is minimally greater than at the equator.

This influence can be eliminated by using a Balkan balance to determine the dimensions. Thus, for example, it would be possible to determine the correct mass of a body on the moon without knowing the local gravitational acceleration.

The only requirement is that you have a set of well-defined masses available.

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Other teacher information (1/2)

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Prior

Students should have a basic understanding of the difference in the mass of a body and the resulting weight force. Ideally, the students have already carried out the experiment of mass determination with the beam balance (P0998300).

Scientific

If the two plates of the beam scales are covered with masses of the same size, the scale is in a balanced condition.

In order to avoid parallax errors when reading the pointer on the scale, the students should make sure that they take the reading as perpendicular to the scale as possible.

Other teacher information (2/2)

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Learning

The students should determine different masses with the help of the beam balance. In addition, they should learn other important aspects of using the beam balance, such as balancing measuring vessels, improving the accuracy of determining masses beyond the smallest piece of mass, and changing the measurement accuracy in connection with the law of leverage.

Tasks

- Determine the mass of different bodies with a beam balance.
- Perform a tare measurement.
- Improvement of the reading accuracy by interpolation of the display.
- Additionally, determine the sensitivity of a beam balance and its dependence on various loads.

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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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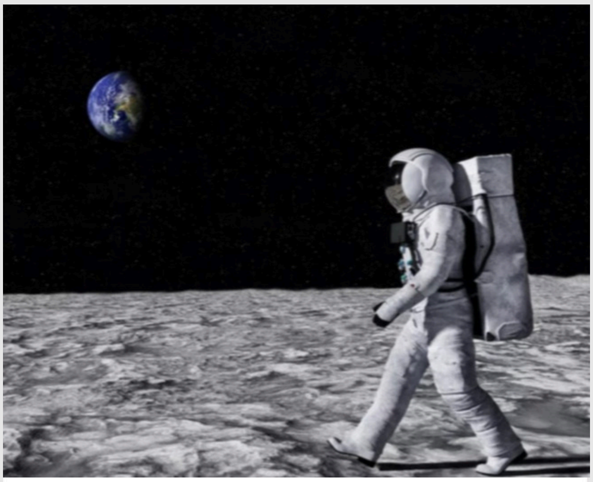
Motivation



Astronaut on the moon

As you know, you can determine the weight force of various objects with the help of a force gauge and conclude the mass from the acceleration of gravity. However, the local acceleration of gravity had a significant influence on this measurement result.

When using a beam balance, however, the local gravitational acceleration is not important and thus, for example, astronauts on the moon could also determine the masses very accurately.

In this experiment, you will learn many important aspects of using a beam balance, such as the balancing of measuring vessels.

Tasks

Using the beam balance

1. Determination of the mass of different solid bodies by comparison with the masses of a set of weights.
2. Determination of the mass of a liquid body after prior compensation of the tare weight of the vessel.
3. Improvement of the reading accuracy by interpolation of the scale display.

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Equipment

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	Holding pin	03949-00	1
5	Balance pan, plastic	03951-00	2
6	Lever	03960-00	1
7	Pointer for lever	03961-00	1
8	Plate with scale	03962-00	1
9	Slotted weight, black, 50 g	02206-01	2
10	Set of precision weights,1g-50g	44017-01	1
11	Steel pellets, d = 2 mm, 120 g	03990-00	1
12	Beaker, 100 ml, plastic (PP)	36011-01	1
13	Beaker, 250 ml, plastic (PP)	36013-01	1
14	Steel Column nickel-plated	03913-00	1
15	Aluminium column	03903-00	1
16	Wood column	05938-00	1
17	Support rod with hole, stainless steel, 10 cm	02036-01	1
18	Helical spring, 3 N/m	02220-00	1

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Set-up (1/3)

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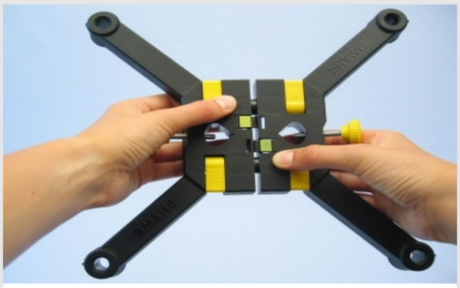
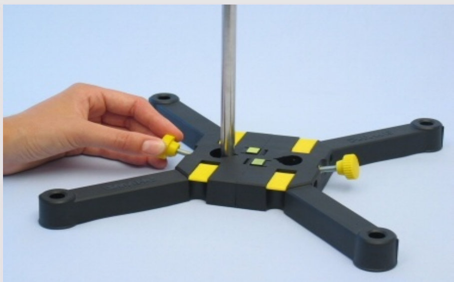
Build a tripod with the tripod base and the tripod rod.

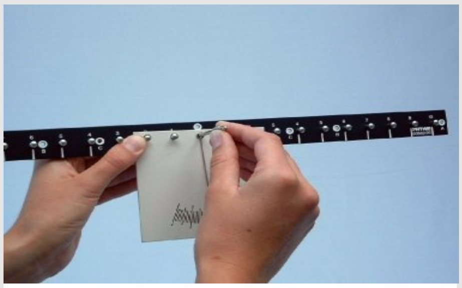
Hang the plate with the scale in the middle of the lever, then insert the retaining bolt through the pointer and lever hole.



Mounting the foot



Tripod foot with tripod rod



Attachment of scale and pointer to the lever of the beam balance

Set-up (2/3)

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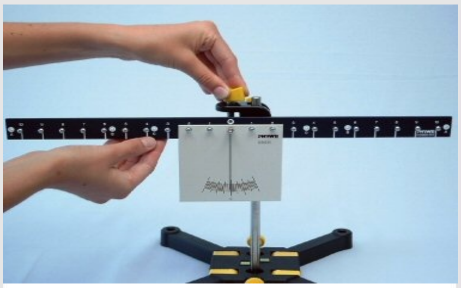
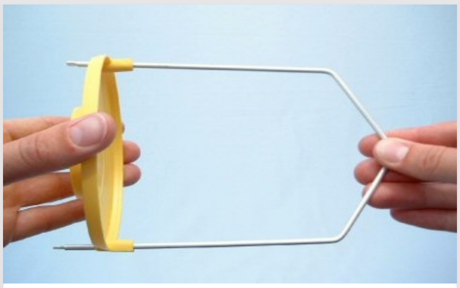
Attach the double socket to the stand rod and fix the holding bolt in the double socket.

Put the weighing pans together and hang one at each end of the lever.



Fastening the double socket to the stand rod



Assembling the weighing pan

Assembled beam balance

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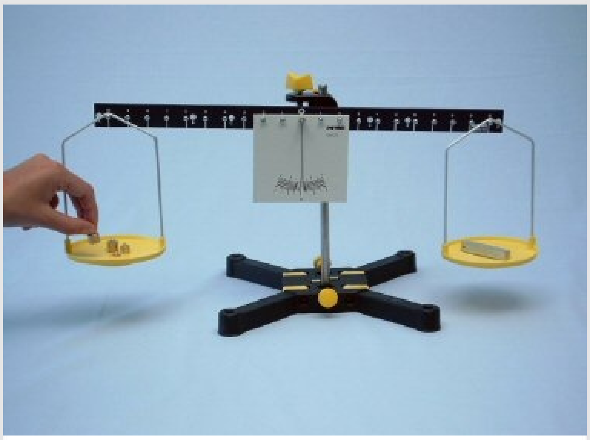
Structure (3/3)

Taring the pointer

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

Procedure (1/4)



Mass determination of various objects with the aid of the beam balance

- Place the following objects one after the other on one pan of the beam balance and balance them by loading the other pan with the weights from the weight set:
    - Coil spring
    - Iron, aluminium and wooden column
    - 250ml beaker
    - 100mm support rod
- Note the measured values in Table 1.

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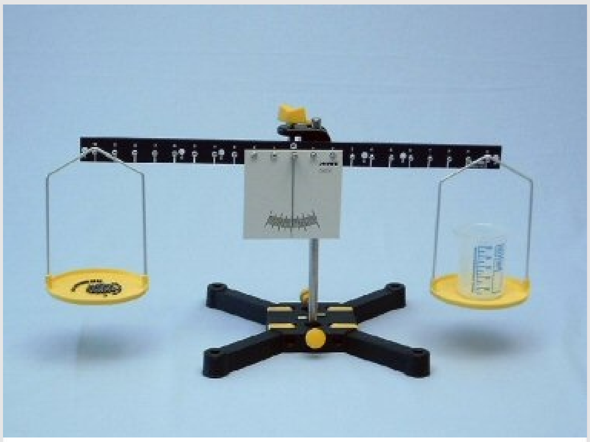
Procedure (2/4)



Balancing the tare weight of a container with shot balls

- Place the 100 ml beaker on one pan and place enough shot balls on the other pan to bring the balance back into equilibrium (tare measurement).
- Fill the beaker with 50 ml of water and determine the mass of the water as before.
- Note the results in the protocol.

Procedure (3/4)

When weighing solid objects, the scale could not always be brought exactly into balance, the pointer was sometimes a little off the zero mark. The reading can be improved as follows:

- Place the wooden column on the left-hand pan and determine its mass (m_1) as precisely as possible. The pointer should still be to the right (!) of the zero mark.
- Read the deflection (A_1) of the pointer in scale units and note the value
- Now place an additional piece of 1 g on the right-hand pan. The pointer must now be on the left (!) side of the zero mark. Read the deflection of the pointer. Also note the deflections (A_2) in the minutes.

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Procedure (4/4)

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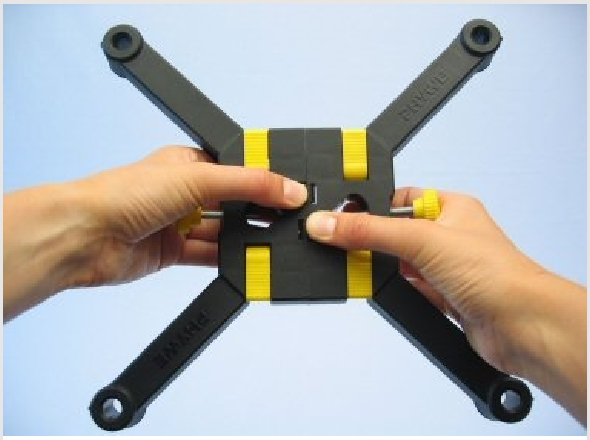

Disassembling the tripod base

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

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Report

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Table 1

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Subject	m $[g]$
Coil spring	
Iron column	
Aluminium column	
wooden column	
250 ml beaker	
100 mm support rod	

Enter your measured values in Table 1.

Task 1 - Mass of water

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Enter the mass of water (50 ml) in the beaker:

$m =$ ________ g

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Task 2 - Deflection of the pointer

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Calculate the difference of the deflection around zero for 1 g by adding the two deflections.

Calculate the mass corresponding to a deflection of one scale division.

Determine the deflection in grams and calculate the exact (corrected) mass m_k the wooden column.

$m_1 =$ ______ g

$A_1 =$ ______

$m_2 = m_1 + 1\,g$

$A_2 =$ ______

Task 3 - Scale parts

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Calculate the mass corresponding to a deflection of one scale division $Skt.$ corresponds:

$1\ Skt \approx$ ______ g

Then determine the mass corresponding to the deflection A_1 corresponds.

Determine the exact (corrected) mass m_k the wooden column:

$m_k \approx$ ______ g

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Task 4

Which physical characteristic can you determine with the beam balance?

- The weight of a body.
- The mass of a body.
- The density of a body.

Check

Task 5

Would you get the same readings on the moon?

- No. Because of the lower gravitational acceleration on the moon, the bodies there weigh less and you need fewer mass pieces.
- Yes, because the beam balance carries out a mass comparison, the acceleration due to gravity is not important for the measurement.

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Task 6

Are there advantages to tare measurement?

- ○ Yes, the tare shot elminates the mass of the cup during the measurement, therefore no second measurement is required for the mass of the cup and no calculation to subtract its mass from the measured value.
- ○ No. There is no advantage, because a second measurement for the mass of the cup must still be carried out.

Check

Additional task 1 - part 1

The sensitivity of a balance is defined as the quotient of mass and deflection. For its measurement, the mass causing a deflection of 1 point is determined. Examine whether the sensitivity of the balance depends on:

- the load on the weighing pans
- the length of the lever arm

by selecting the load and position of the weighing pans according to the following table.

Calculate the sensitivity of the balance in g/sec and enter the values in the table on the next page.

Additional task 1 - part 2

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Position of the weighing pa	Load [g]		Deflection [Skt.		Sensitivity
	left	right	left	right	[g/Skt.]
10	1	0			
10	0	1			
7	1	0			
7	0	1			
10	50+1	50			
10	50	50+1			

Additional task 2

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Does the sensitivity depend on the load on the weighing pans?

- ○ No. The sensitivity is not dependent on the load.
- ○ Yes. The sensitivity depends on the load.

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Additional task 3

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Does the sensitivity depend on the side that is loaded?

- No. The sensitivity is independent of whether the load is on the right or left.
- Yes, the sensitivity depends on whether the load is on the right or left side.

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Additional task 4

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What is the effect of shortened lever arms with the same additional load on the sensitivity?

- Shortening the lever arms has no effect.
- Shortening the lever arms reduces the sensitivity of the balance.

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Additional task 5

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When is the sensitivity of the balance at its highest?

- ○ The sensitivity of the beam balance is highest at the smallest load.
- ○ The sensitivity of the beam balance is at its highest at maximum load.

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Additional task 6

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What can be the reason for the phenomenon from additional task 5?

- ○ At higher loads, the friction at the suspension of the balance beam decreases.
- ○ At higher loads, the friction at the suspension of the balance beam increases.

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Slide	Score / Total
Slide 22: Body properties	0/1
Slide 23: Comparison of measurement results earth/moon	0/1
Slide 24: Advantages of tare measurement	0/1
Slide 27: Sensitivity of the balance (load)	0/1
Slide 28: Lateral dependence of the load	0/1
Slide 29: Effect of the lever arm length	0/1
Slide 30: Sensitivity of the balance (lever arm)	0/1
Slide 31: Friction minimization 2	0/1

Total amount 0/8

Solutions Repeat Exporting text

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