Measurement of forces

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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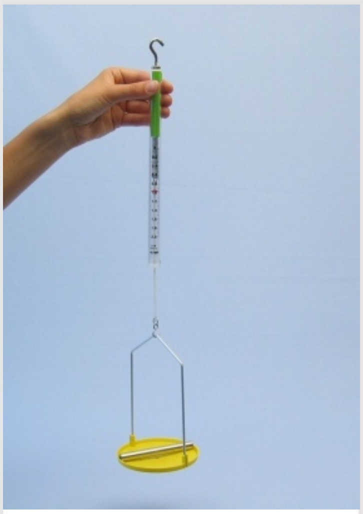

Experimental setup

In order to cause a constant acceleration $\vec{a}$ at a mass m, a certain force $\vec{F}$ is required according to Newton's second law:

$$\vec{F} = m \cdot \vec{a}$$

In practice, the force is often inferred from a known linear relationship between the acting force and an easily measured quantity. Examples are the deformation of an elastic material. In this case we use the length change of coil springs in so-called spring force meters, although this experiment does not specifically deal with Hooke's law.

The acceleration here is the acceleration of gravity $g = 9.81 m/s^2$.

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Other teacher information (1/2)

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Prior knowledge

It is only assumed that students have a basic understanding of the concept of mass. The students should also know that the earth's gravitational field causes a permanent acceleration of gravity towards the centre of the earth.

The SI unit of force F is a Newton N:

$$1\ N = 1\ kg \cdot \frac{m}{s^2}$$

Scientific Principle

The students are to determine the weight forces of different objects via the deflection of a dynamometer.

Other teacher information (2/2)

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Learning objective

The students should become acquainted with the dependence of the reading of spring balances on their orientation and with their adjustment..

Tasks

For this purpose, a spring balance adjusted downwards in the position of use shall be used to determine the weight of the following objects:

1. Helical spring
2. Holding pin
3. Support rod

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Safety Instructions

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

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Student Information

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Motivation

Astronaut on the moon

As you know, every body can be assigned a mass m. This mass is independent of whether you are on the earth or the moon. So why is it that a man can jump much higher and farther on the moon than on the earth?

This is due to the local gravity field. This ensures that we are permanently accelerated towards the ground, because the so-called weight force is acting on us. This weight force is lower on the moon for an equal mass.

The weight force of a body, which results from its mass, is a fundamental quantity of physics. In this experiment you will learn how to determine it.

Tasks

In this experiment you will become familiar with the position dependence and the adjustment of spring balances.

With the spring balance adjusted downwards in the position of use, you can then determine the weight of various objects.

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Material

Position	Material	Item No.	Quantity
1	Support rod with hole, stainless steel, 10 cm	02036-01	1
2	Helical spring, 3 N/m	02220-00	1
3	Spring balance,transparent, 1 N	03065-02	1
4	Spring balance,transparent, 2 N	03065-03	1
5	Holding pin	03949-00	1
6	Balance pan, plastic	03951-00	1

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Set-up

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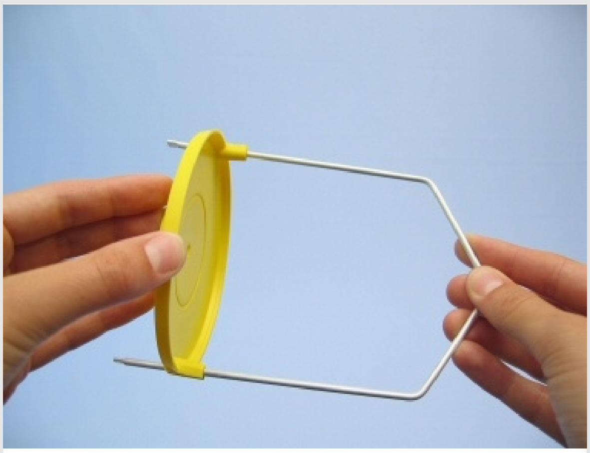

Assembly of the balance pan

Assemble the balance pan as shown in the picture.

Procedure (1/6)

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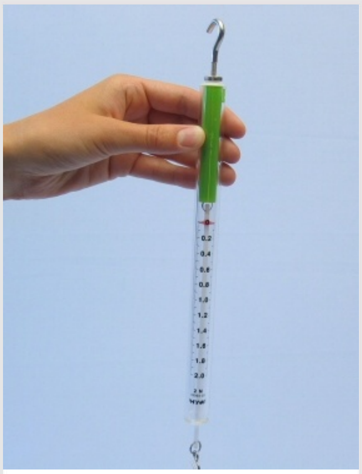

Spring balance vertical

Hold the spring balance (2 N) vertically so that the zero on the scale is at the top.

Observe the position of the marker in relation to the scale.

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Procedure (2/6)

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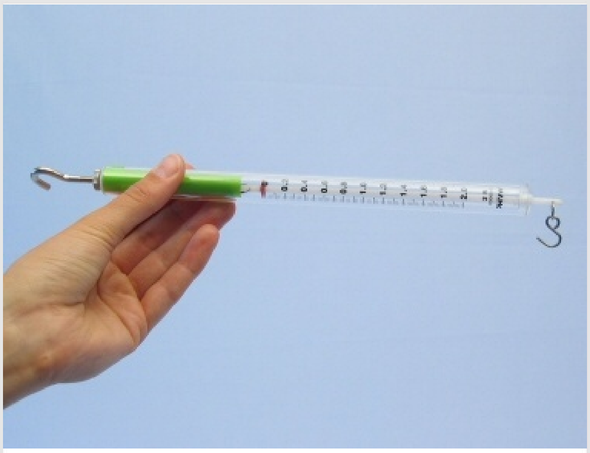

Spring balance horizontal

Now hold the spring balance (2 N) horizontally.

Observe the position of the marker in relation to the scale.

Procedure (3/6)

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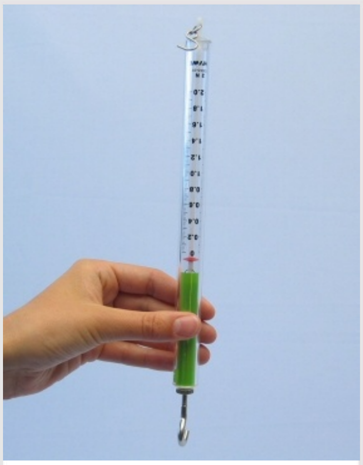

Spring balance vertical (upside down)

Hold the spring balance (2 N) vertically so that the zero on the scale is at the bottom.

Observe the position of the marker in relation to the scale.

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Procedure (4/6)

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Adjusting the scale

- Adjust the scale of the spring balance (upside down / zero point of the scale below) by loosening the counter screw at the head end and turning the hook until the indicator mark is exactly at zero. Then tighten the screw again.
- Now hold the spring balance vertically downwards (zero point up), then horizontally and read the display each time. Enter the measured values in Table 1 in the report.

Procedure (5/6)

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Adjustment to zero

- Adjust the spring balance 2 N held vertically downwards to zero (zero point of the scale at the top).

Procedure (6/6)

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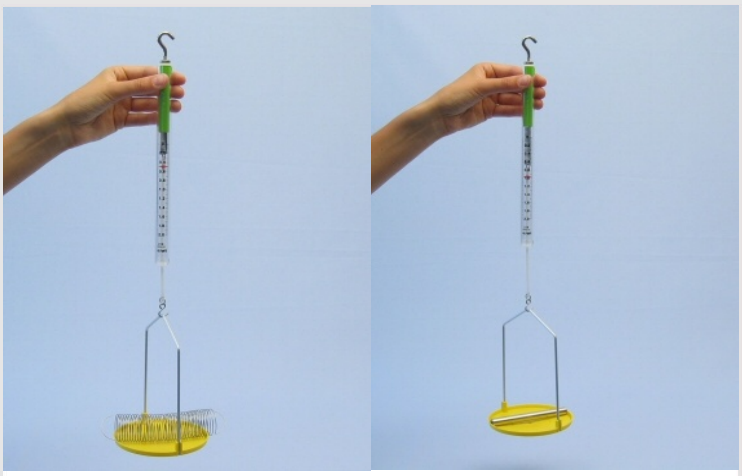

Measuring the helical spring and the support rod

- Hang the balance pan on the hook and note the measured value.
- Place the helical spring, the holding pin and the support rod on the balance pan one after the other.
- Note all measured values in Table 2 in the report.
- Repeat this series of measurements with the 1N spring balance and note these values in Table 2.

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Report

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Table 1

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Spring balance position	$F\,[N]$
upside down	
horizontal	
vertical	

Enter your measurement results in the table.

Table 2

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Enter your measurement results in the table. Use the values in the table to calculate the weight of the 3 objects without balance pan and enter the results.

	Weight force F [N]			
Spring balance	with weighing pan		without weighing pan	
	2 N	1 N	2 N	1 N
Balance pan				
Helical spring				
Holding pin				
Support rod				

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Task 1

As you have noticed, the display changes depending on the position of the spring balance. It's true:

- [ ] The measured value is always highest for the normal vertical position.
- [ ] In the vertical position upside down the measured value is always the smallest.
- [ ] The measured value is always smallest for the normal vertical position.
- [ ] The value of the horizontal position is always between those of the two vertical ones.
- [ ] In horizontal position the scale always shows zero.

Check

Task 2

Reasons for the deviations in the 3 different positions of the spring balancs are:

- [ ] Optical distortions caused by the change in position relative to the eye.
- [ ] The measuring accuracy of the respective spring balances.
- [ ] The dead weight of the suspension on the spring.
- [ ] There are no deviations.
- [ ] The directional dependence of the earth's gravitational field.

Check

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Task 3

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On the 1 N or 2 N spring balance, a graduation mark means

- Always a change of 0.02 N.
- Always a change of 0.1 N.
- A change of 0.01 N or 0.02 N.
- A change of 0.1 N or 0.2 N.

Slide	Score / Total
Slide 20: Position-dependent changes	**0/3**
Slide 21: Justification of the amendments	**0/2**
Slide 22: force gauge graduations	**0/1**

Total amount 0/6

Solutions   Repeat   Exporting text

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