Resolution of a force into two non-parallel forces

(Item No.: P1252400)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 7-10	Mechanik	Kräfte, einfache Maschinen	Zerlegung einer Kraft in zwei nicht parallele Kräfte

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	1 Student

Additional Requirements:

Experiment Variations:

Keywords:

Principle and equipment

Principle

Demonstrate that one force can be resolved into two forces whose lines of action intersect.

Equipment

Position No.	Material	Order No.	Quantity
1	Demo Physics board with stand	02150-00	1
2	Torsion dynamometer	03069-03	2
3	Optical disk, magnet held	08270-09	1
4	Fish line, l. 100m	02090-00	1
5	Scale for demonstration board	02153-00	1
6	Weight holder for slotted weights	02204-00	1
7	Slotted weight, black, 10 g	02205-01	1
8	Slotted weight, silver bronze, 10 g	02205-02	1
9	Slotted weight, black, 50 g	02206-01	1
10	Slotted weight, silver bronze, 50 g	02206-02	1

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Set-up and procedure

Set-up

- Place one dynamometer onto the demonstration board and adjust it.
- Attach a small loop made of fish line to the hook of the weight holder.
- Hang the weight holder with slotted weights (2 x 1 0 g, 1 x 50 g) on the dynamometer; read and record the force F indicated on the dynamometer.
- Place the second dynamometer onto the demonstration board, adjust it, and hook its traction cord to the point of application of force $\vec{F}$.
- Shift the two dynamometers in such a manner that their traction cords enclose an arbitrary angle between them.
- Place the protractor disk such that its centre is behind the point of application of the forces (Fig. 1).

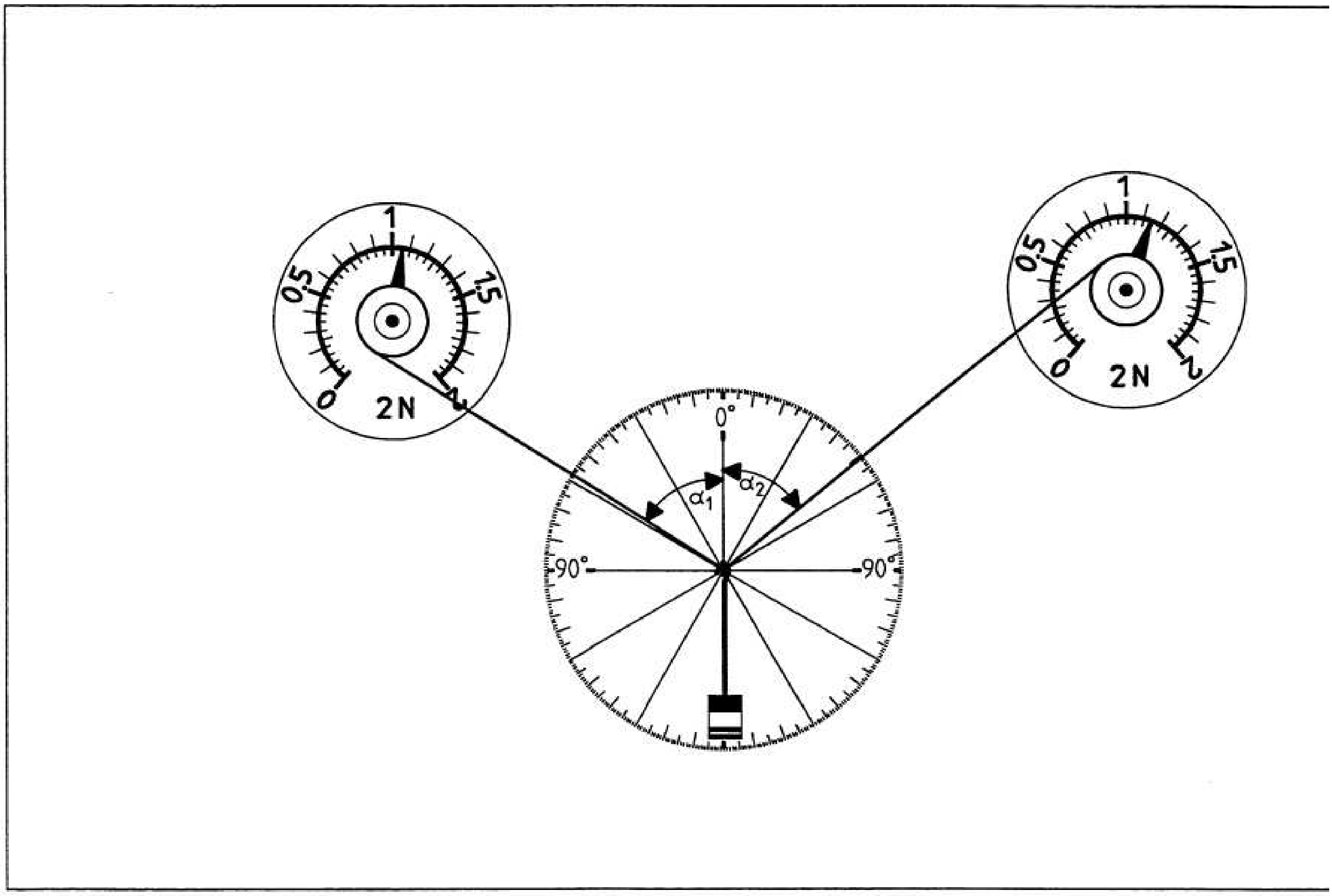

Fig. 1

Procedure

- Place the protractor disk such that its centre is 1 behind the point of application of the forces. F_1 and F_2 and determine the angles α_1 and α_2 which $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ enclose with the perpendicular on the protractor disk.
- Record the results in Table 1.
- Change the position of the dynamometers several times, and determine the respective quantities F_1 and F_2 as well as the corresponding angles α_1 and α_2 (include the case where $\alpha_1 + \alpha_2 = 90°$). While doing so, ensure before each measurement that the point of action of the forces coincides with the centre of the protractor disk. Record the measured values in Table 1.
- Remove the two dynamometers. With the aid of the protractor disk and the scale construct the force parallelogram with the white board pen for one of the investigated cases on the demonstration board (Fig. 2).

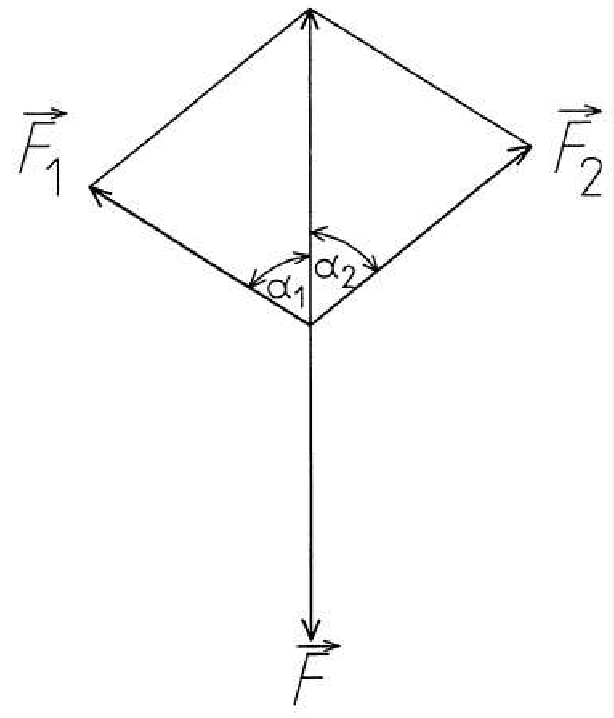

Fig. 2

Observation and evaluation

Observation

$$F = 1.3N$$

Table 1 (Sample measurements)

F_1/N	F_2/N	$\alpha_1/1^\circ$	$\alpha_2/1^\circ$	$(F_1+F_2)/N$	$(\alpha_1+\alpha_2)/1^\circ$
1.06	1.14	58	51	2.20	109
0.66	1.11	60	30	1.77	90
1.53	1.25	52	75	2.78	127
0.78	0.79	36	33	1.57	69

Evaluation

The sum of the magnitudes of $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ is always larger than the magnitude of the force $\vec{F}$ which is to be resolved. The larger the angle enclosed by the forces $\alpha_1 + \alpha_2$, the larger their sum is.

In any case, $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ result in the same action as the force $\vec{F}$.

They are termed the components of $\vec{F}$.

$\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ can be determined by drawing their lines of action and the force $\vec{F}$; thus constructing a force parallelogram, whose diagonal is formed by $\vec{F}$. The components $\overrightarrow{F_1}$ und $\overrightarrow{F_2}$ form the sides of the parallelogram. A force can be resolved into components whose lines of action intersect in the point of application of the force. The components can be determined by construction or calculation.

Remarks

In this experiment the weight holder with slotted weights has been selected to preset a force which is then resolved into its components. A helical spring which has been displaced by a certain distance is also appropriate for pre-setting the force.In this case the position of the protractor disk whose centre marks the end of the extended spring may not be changed.

It is advisable to have the students simultaneously construct the same force parallelogram in their notebooks while the teacher is drawing it on the demonstration board.

The special case in which $\alpha_1 + \alpha_2 = 90°$ was selected so that the students could check their results with a sample calculation even without knowledge of trigonometry.

An additional task could be a graphical check of the remaining measurements.

Recording an exact series of measurements is not absolutely necessary. One can also restrict the experiment to a single measurement of F_1,F_2, α_1 and α_2, determine the force parallelogram by quadrupling the values. In this case, one should however demonstrate qualitatively that the components enclose arbitrary angles and as a result can have differing magnitudes.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com