Composition of non-parallel forces

Physics | Mechanics | Forces, work, power & energy

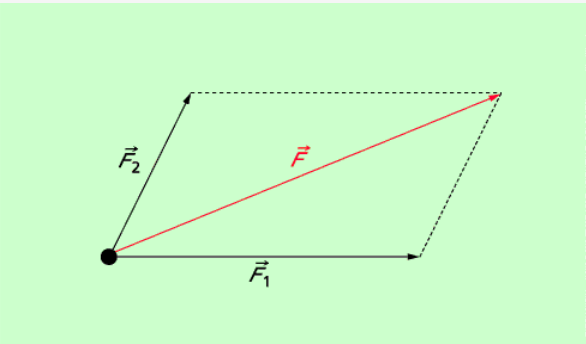
Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/64748c9121530f000293d5ac

General information

Application



Addition of forces

A force indicates how strongly a body is moved or deformed.

Forces are directed (vectorial) quantities: $\vec{F}$

If two forces act on a body, these partial forces combine vectorially to form a resultant force. The so-called resultant can be determined by calculation or drawing.

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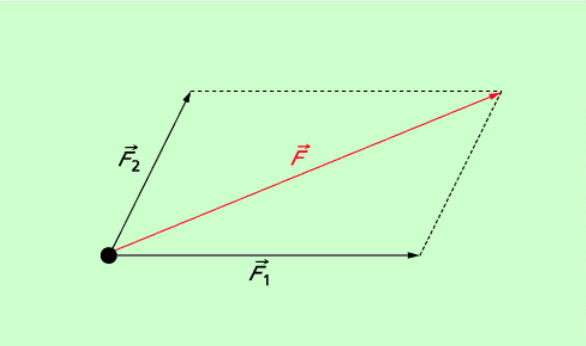
Application



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Other information (1/2)

Prior knowledge

No prior knowledge is required for this experiment.

Principle

It will be investigated how to determine the resultant of two forces whose lines of action are not parallel.

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Other information (2/2)

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Learning objective

With the help of a force gauge, it can be demonstrated that the resultant of 2 forces that do not act in parallel can be determined graphically.

Tasks

- Determine the resultant $\vec{F_R}$ from the measured amounts $\vec{F_1}$ and $\vec{F_2}$
- Understanding the drawing approach with the parallelogram

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Hook on fixing magnet	02151-03	1
3	Torsion dynamometer	03069-03	2
4	Scale for demonstration board	02153-00	1
5	Helical spring, 20 N/m	02222-00	1
6	Optical disk, magnet held	08270-09	1
7	Marker, black	46402-01	1
8	G-clamp	02014-01	2

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Set-up and Procedure

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Set-up

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- Place the hook on the magnet at the top of the demo board and hang the coil spring on the hook.
- Place both force gauges underneath so that the pull cords hooked to the lower end of the coil spring sag slightly
- Adjust both force gauges and then move them so that the coil spring is stretched, e.g. by about 7 cm Place the angle plate on the demo board so that its centre is exactly behind the lower end of the coil spring (Fig. 1).

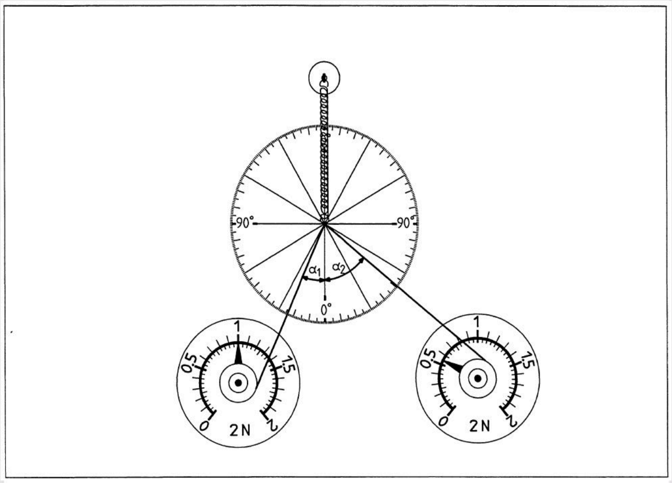

Figure 1

Procedure (1/2)

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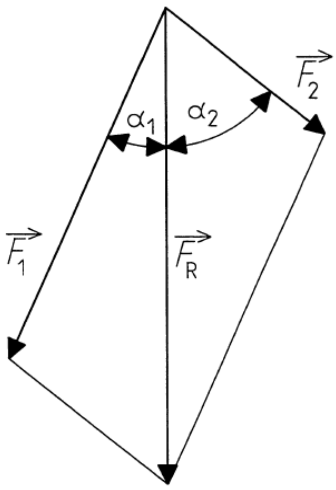

Figure 2

- The forces indicated by the force gauges F_1 and F_2 and read off the angles α_1 and α_2 measure their lines of action with the perpendicular to the horizontal of the angular disc enclosed
- Note results in Table 1
- Change the position of the dynamometers but do not change the position of the angle disc and find the respective magnitudes of $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ and the associated α_1 and α_2 (including the case α_1 and α_2 = 90°); before each measurement, make sure that the lower end of the helical spring (the point of application of the forces) is above the centre of the angular disc; enter the measured values in Table 1.

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Procedure (2/2)

- After the last adjustment, remove one force gauge and use the other to adjust the force. F_R measure, which is necessary for the stretching

  of the helical spring to the centre of the angular disc is required and note the value for F_R
- For a second series of experiments, specify a different elongation of the coil spring, e.g. about 10 cm, different angles for $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ and enter the values in Table 2; finally, determine again F_R for the new values
- For graphical evaluation, remove both force gauges and, with the help of the angle disc and the scale, compare them with the parallelogram of forces on the demo board for one of the cases studied (Fig. 2).

Evaluation (1/3)

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It can be seen from Tables 1 and 2 that the sum of the amounts of $\overrightarrow{F1}$ and $\overrightarrow{F2}$ is always greater than the amount of $\overrightarrow{FR}$ and the greater the angle s α_1 and α_2 enclosed by the force.

In any case, $\overrightarrow{F1}$ and $\overrightarrow{F2}$ produce the same effect as the force $\vec{F}$; $\vec{F}$ is therefore called the resultant $\overrightarrow{FR}$, $\overrightarrow{F1}$ and $\overrightarrow{F2}$ are their components.

Tabelle 1 (Messbeispiel)

$F_1\,/N$	$F_2\,/N$	$\alpha_1\,/1^\circ$	$\alpha_2\,/1^\circ$	$F_R\,/N$	$\frac{F_1+F_2}{N}$	$\frac{\alpha_1+\alpha_2}{1^\circ}$
1,10	1,33	67	50	1,27	2,43	117
1,10	0,64	30	60	1,27	1,74	90
1,02	0,54	24	51	1,27	1,56	75
0,92	0,52	20	39	1,27	1,44	59

Tabelle 2

$F_1\,/N$	$F_2\,/N$	$\alpha_1\,/1^\circ$	$\alpha_2\,/1^\circ$	$F_R\,/N$	$\frac{F_1+F_2}{N}$	$\frac{\alpha_1+\alpha_2}{1^\circ}$
1,46	0,77	24	51	1,81	2,23	75
1,57	0,91	30	60	1,81	2,48	90

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Evaluation (2/3)

$\vec{F}_R$ can be determined as the diagonal of a parallelogram of forces whose sides are formed by the components shown in the same scale.

Two forces whose lines of action intersect, i.e. which have a common point of application, can be replaced by a single force. This can be determined by construction or calculation.

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