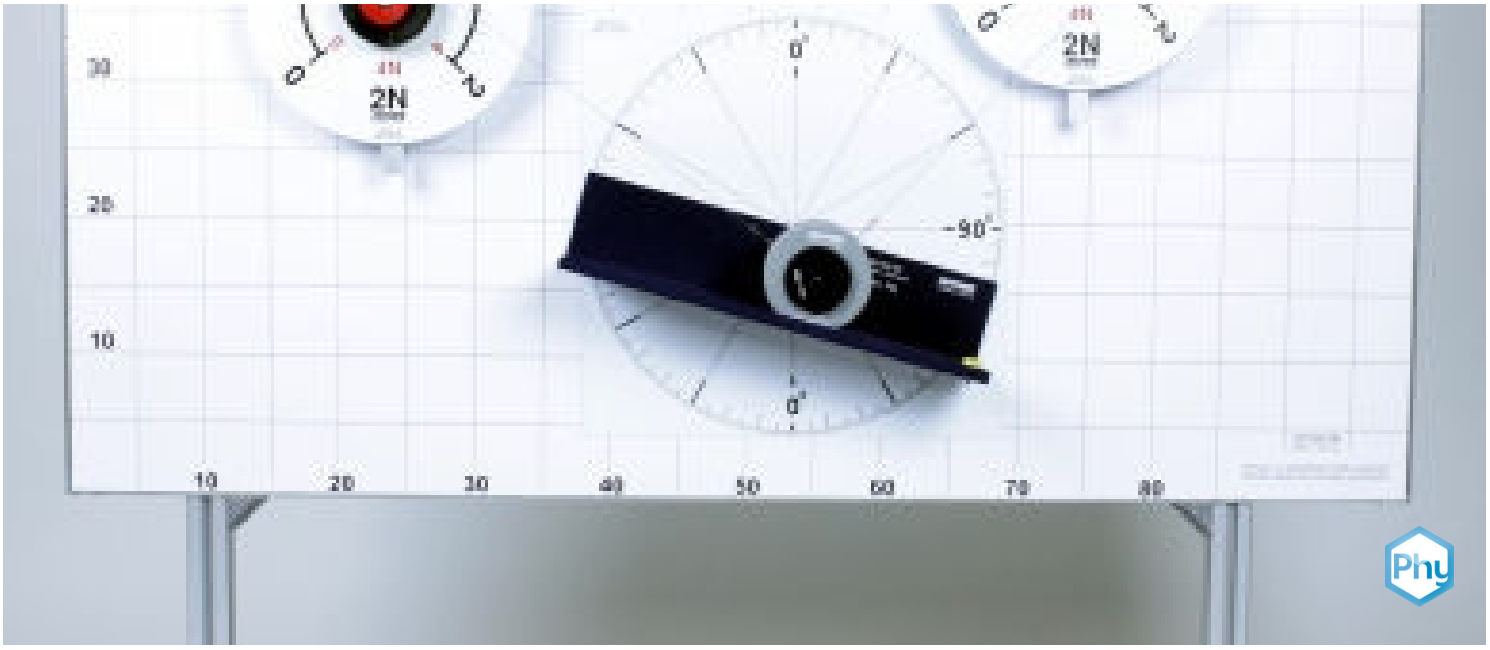
Resolution of forces on the inclined plane



P1252500

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/6614f193eabbd80002581e4f

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General information

Application

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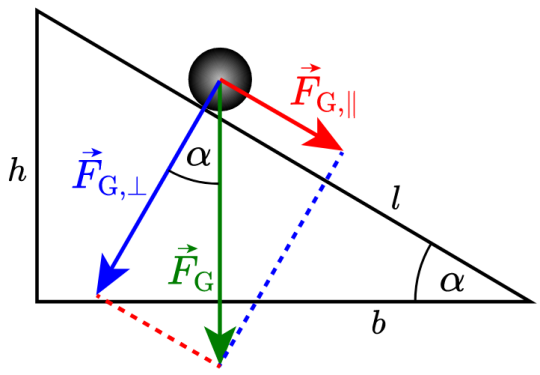

Fig. 1: Force resolution on an inclined plane

The resolution of forces refers to the decomposition of a single force into at least two partial forces acting in different directions.

In this experiment, a force on an inclined plane is broken down into two partial forces that are perpendicular to each other and one of which acts in the direction of the path.

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Other information (1/2)

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Prior knowledge

No prior knowledge required.

Principle

The aim is to demonstrate that the weight force of a body on the inclined plane can be broken down into two components that are perpendicular to each other and one of which acts in the direction of the path.

Furthermore, it will be investigated how the gravitational force can be calculated.

Other information (2/2)

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Learning objective

With the help of the experiment, the students are supposed learn how decomposed forces on the inclined plane can be calculated.

Tasks

The students are supposed to make observations and gather information on the experimental setup and calculate the gravitational force.

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Safety instructions

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The general safety instructions for experimentation in science lessons apply.

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Equipment

Position	Equipment	Item no.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Torsion dynamometer	03069-03	2
3	Inclined plane for demo board	02152-00	1
4	Scale for demo board	02153-00	1
5	Optical disk, magnet held	08270-09	1
6	Roller for inclined plane	11301-01	1
7	Marker, black	46402-01	1
8	Screw clamp	02014-01	2

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Setup and procedure

Setup

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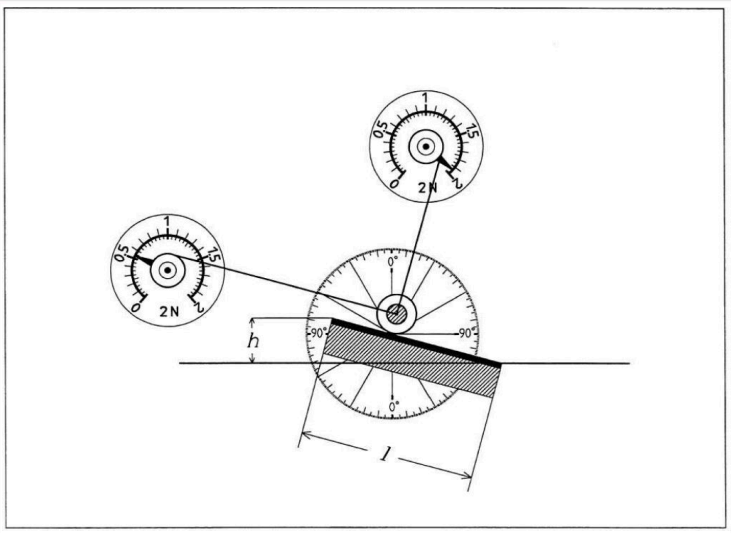

Fig.2: Resolution of forces on an inclined plane

- Place the optical disc on the demo board so that the plumb line is vertical.
- Draw a horizontal line with the marker, e.g. as shown in Fig. 2.
- Place the inclined plane on the optical disc so that it forms an angle α = 15° with the horizontal line and touches the horizontal line drawn previously with its lower edge.
- Bring both dynamometers into the position shown in Fig. 2 and adjust them.

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Procedure (1/2)

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- Measure and note the length l of the inclined plane.
- Measure the height h of the upper edge of the inclined plane starting from the horizontal line drawn (Fig. 2) and note it in Table 1.
- Attach the roller to the pull cord of the left dynamometer and measure and record the weight force F_G of the roller.
- Place the roller on the inclined plane and move the dynamometer until its pull cord runs parallel to the inclined plane.
- Connect and move the right dynamometer with the roller until the pull cord is perpendicular to the inclined plane and the roller lifts slightly off the plane.

Procedure (2/2)

Note: The angle between $\vec{F_H}$ and $\vec{F_N}$ is a right one exactly when FN is minimal; this can be achieved by making small changes to the position of the dynamometer for FN.

- Note the values for F_H and F_N in Table 1.
- Increase the angles α in 15° steps and note the respective values for F_H and F_N in Table 1.
- Determine the values for F_H and F_N with reduced weight force $\vec{F_G}$ of the roller for a constant angle, e.g. α = 60° .
- To do this, first unscrew one and then the other additional weight (50 g each) from the roller and measure F_G like in the beginning of the experiment and then determine F_H and F_N, note the measured values.

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Evaluation

Evaluation (1/4)

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Tabelle 1 l = 31 cm

F_G/N	$\alpha/1^\circ$	F_H/N	F_N/N	h/cm	F_H/F_G
2,0	15	0,53	1,94	8,1	0,26
2,0	30	1,00	1,74	15,5	0,50
2,0	45	1,40	1,40	22,0	0,70
2,0	60	1,75	1,00	26,0	0,87
1,51	60	1,30	0,75	26,8	0,86
0,99	60	0,86	0,50	26,8	0,86

Tab. 1: Examples for measured values

With constant weight force $\vec{F_G}$ is the gravitational force $\vec{F_H}$ the greater and the normal force $\vec{F_N}$ the smaller, the greater the angle of inclination α and thus the height of the inclined plane. In order to obtain quantitative statements, the quotients F_H/F_G are calculated and the result within the measurement accuracy is: F_H/F_G = constant.

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Evaluation (2/4)

The constant has the value h/lwhich is shown after calculating the quotient (see Table 1), so that the following applies:

This allows F_H be calculated.

A sketch on the demo board (see Fig. 3) supports the corresponding facts.

$\overrightarrow{F_H}/\overrightarrow{F_G}$ = constant also means F_H ~ F_G. This can be confirmed by the results of the last two measurement processes (see the last two lines in Table 1).

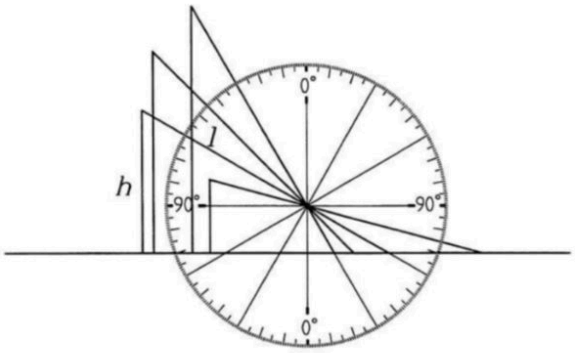

Fig. 3: Graphical evaluation on the optical disc

Evaluation (3/4)

If the students have the appropriate previous knowledge of trigonometry, the result can also be expressed in the form:

F_H / F_G = sin(α) or F_H = F_G + sin(α) be written.

It is advised to utilise the students' existing knowledge of the force resolution and similarity of triangles in order to predict the result of the measurements with the help of a corresponding sketch (Fig. 4). This is then a confirmation experiment with the advantage that the individual steps to the result can be taken with greater clarity of purpose.

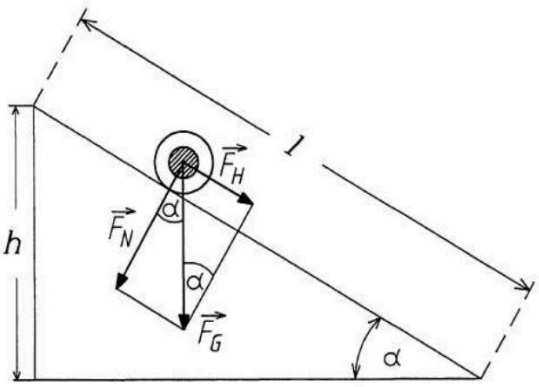

Fig. 4: force parallelogram on an inclined plane

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Evaluation (4/4)

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A sketch plan for the measurements could be drawn on the demo board before the experiment, as shown in Fig. 2.

The relationship between gravitational force and angle of inclination can also be worked out by specifying certain values for FH using weights and determining the corresponding angles. To do this, a pulley (02262-00) is attached to the inclined plane using the knurled screw (Fig. 5).

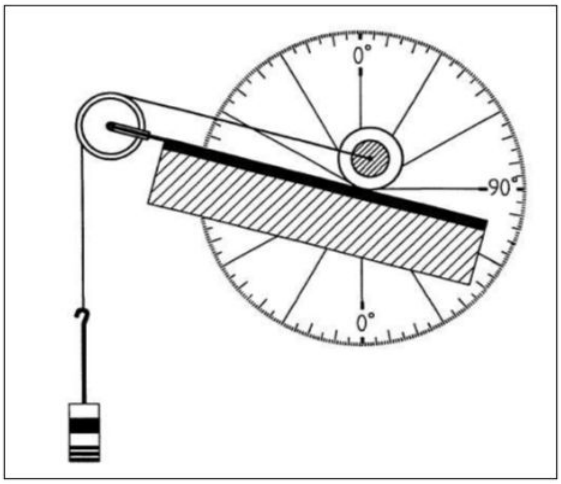

Fig. 5: Dynamometer with roller and weight above pulley

Task 1

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Which formula is used to calculate the gravitational force F_H?

- ○ $F_H = F_G$
- ○ $F_H = F_G \cdot h/l$
- ○ $F_H = F_G \cdot l/h$

Check

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Slide	Score / Total
Slide 16: Slope driving force	0/1

Total score 0 / 1

Show solutions Repeat

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