Determining the coefficient of static friction using the inclined plane

Objects of the experiment

- Determining the coefficient of static friction μ from the equilibrium between the force along the plane and the static friction force on an inclined plane

Principles

A body on an inclined plane with the weight G is subject to a force along the plane (parallel to the plane) of

$$F_1 = G \cdot \sin \alpha \quad \text{(I)}$$

and to a force normal (perpendicular) to the plane of

$$F_2 = G \cdot \cos \alpha \quad \text{(II)}$$

This dependency on the angle of inclination α can be used to determine quantitatively the coefficient of friction μ of the body. The angle of inclination of the plane is increased by moving the support until the body just begins to slide, i.e. the force F_1 along the plane and the static friction force F are in equilibrium. In this experiment the tangent of the angle of inclination is determined from the height h = 5 cm of the support and its distance s from the pivot of the inclined plane are measured.

$$\tan \alpha = \frac{h}{s} \quad \text{(III)}$$

The static friction force is generally taken to be proportional to the force F_2 along the plane:

$$F = \mu \cdot F_2 \quad \text{(IV)}$$

From the equilibrium of forces $F_1 = F$ we can deduce:

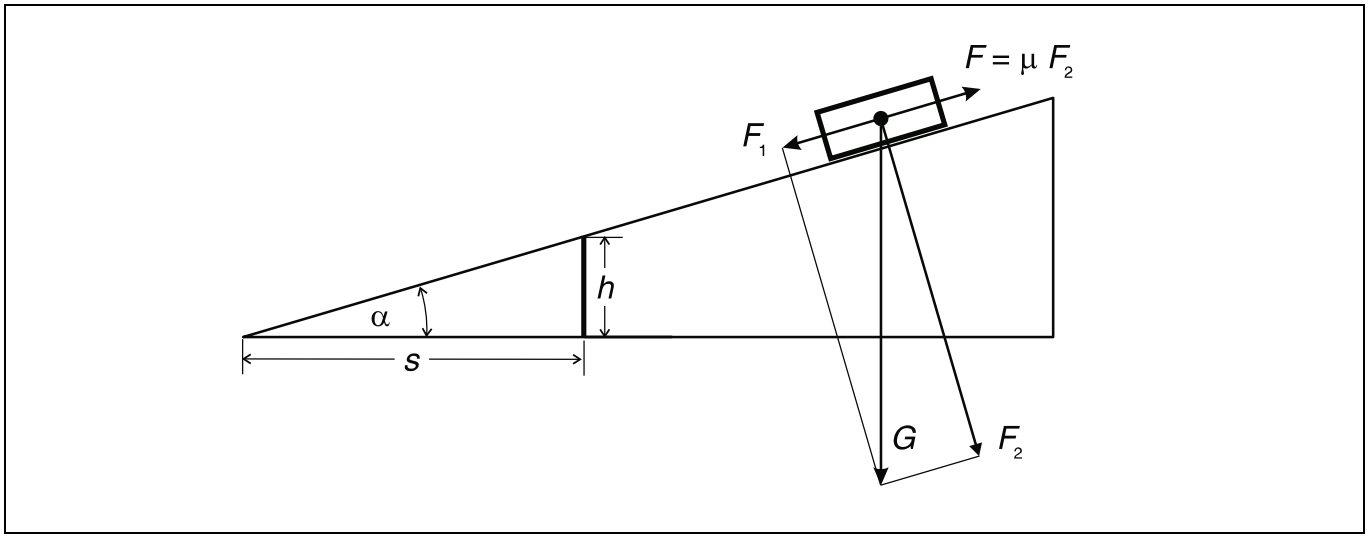
$$F_1 = \mu \cdot F_2 \quad \text{(V)}$$

μ: coefficient of friction

and thus from (I), (II) and (III)

$$\mu = \frac{h}{s} \quad \text{(VI)}.$$

Fig. 1 Equilibrium between the force F_1 along the plane and the static friction force F on an inclined plane.



Apparatus

1 Inclined plane with trolley and screw model 341 21

1 Pair of wooden blocks for friction experiments 342 10

Setup and carrying out the experiment

– Set up the inclined plane and move the support **(a)** to the farthest possible point from the pivot.
– Place block 1 (6 cm thick) on the inclined plane with the plastic-coated side down and slowly move the support inward until the block starts to slide.
– Measure the distance between the pivot and the support using the tape measure and calculate the coefficient of static friction using equation (VI).
– Place block 1 on the plane with the wooden side down and repeat the experiment.
– Place block 2 (3 cm thick) on the inclined plane with the plastic-coated side down and repeat the experiment.
– Turn the wooden surface with the area $A = 12 \times 6$ cm^2 down and repeat the experiment.
– Turn the wooden surface with the area $A = 12 \times 3$ cm^2 down and repeat the experiment.

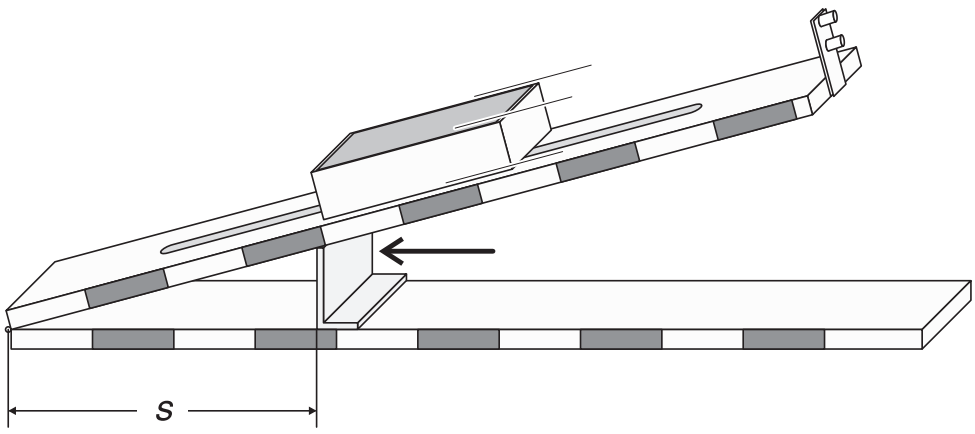
Measuring example and evaluation

Block	Material	$\frac{A}{\text{cm}^2}$	$\frac{s}{\text{cm}}$	μ
1	Plastic	12×6	10.5	0.48
1	Wood	12×6	21.9	0.23
2	Plastic	12×6	9.5	0.53
2	Wood	12×6	20.7	0.24
2	Wood	12×3	21.1	0.24

Results

The coefficient of static friction depends on the material of the contact surface, but not on its surface area.

Fig. 2 Experiment setup for determining the coefficient of friction on an inclined plane



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