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Determining the Coefficient of Friction Force Acting on the Body, Which is the same on the Inclined Plane and on the Horizontal Plane

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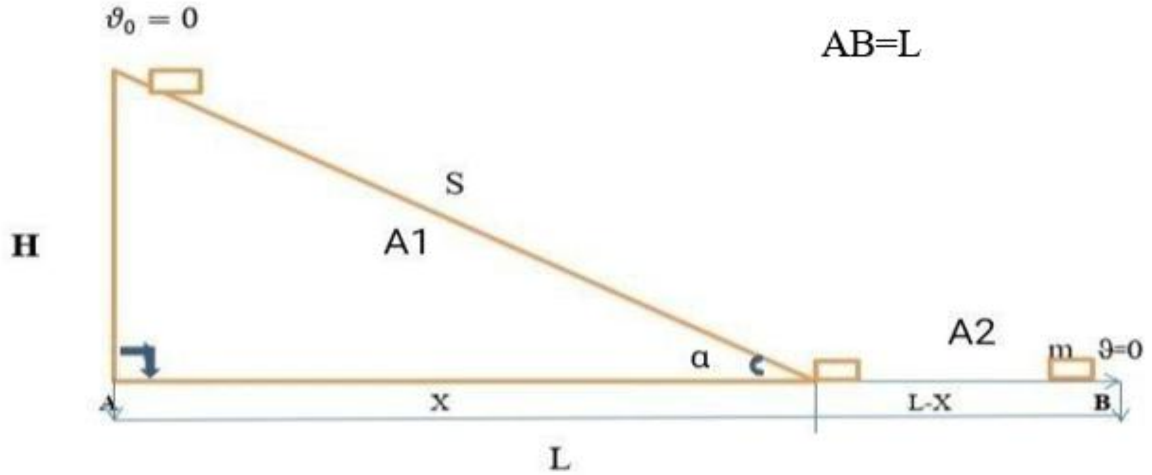
Abstract: One of the main goals is to educate the developing young generation to be more educated and intelligent. In order to increase the interest of schoolchildren in Physics and their activity in solving problems, more convenient and new methods of solving problems are being developed. This article explains that in order to move an object along a horizontal line on an inclined plane, the direction of the resultant force must be horizontal, and the object always moves in the direction of the resultant force. In this, the projections of the forces acting on the body on the x and y axes were considered. To study the movement of a body that slides down an inclined plane with a height equal to H and stops at a certain distance on the horizontal plane, keeping the coefficient of friction constant during the entire movement. In this case, the length of the base of the inclined plane is equal to L and the total path traveled by the body is equal to S.

Keywords: Inclined plane, friction coefficient, slope base, energy. Horizontal plane, potential energy, friction force.

Introduction

Friction plays a crucial role in the motion of objects on both inclined and horizontal planes. Understanding the coefficient of friction is essential in physics, engineering, and mechanics as it determines the resistance an object experiences when moving on a surface. This study focuses on determining the friction coefficient acting on a body moving along an inclined plane and stopping on a horizontal surface while maintaining a constant friction coefficient throughout the motion. By analyzing the relationship between the height HHH and base LLL of the inclined plane, the coefficient of friction is determined using energy conservation principles. The results contribute to a deeper understanding of frictional forces and their applications in various mechanical and structural systems.

If a body initially standing still on an inclined plane moves downward under the influence of friction and stops at a certain distance on a horizontal plane, if the coefficient of friction does not change along the way, we can write it in the following form:



The energy of bodies never comes into existence from nothing, does not disappear from existence, only changes from one type to another. In this case, the entire energy of the body is used to overcome the force of friction. Initially, full energy on the inclined plane

E_{T1}=mgH

After this energy is used to overcome the frictional force

E_{T2}=A_1+A_2

$$+\begin{cases} A1 = \mu mg\cos\alpha S = \mu mgX \\ A2 = \mu mg(L - X) = \mu mgL - \mu mgX \end{cases}$$

$\frac{X}{S}$ = cosα X=Scosα

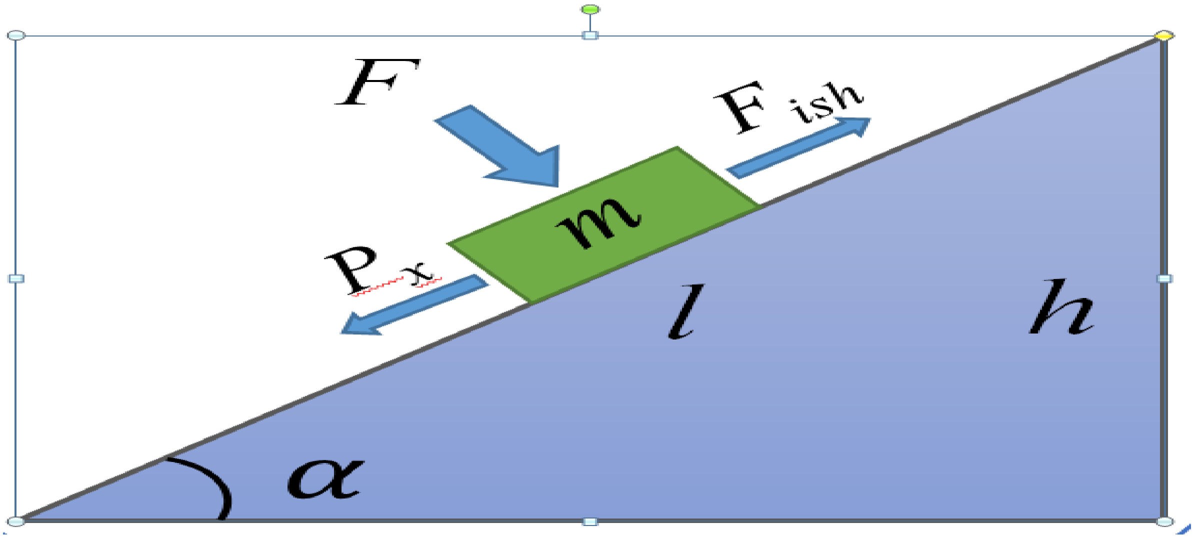
$A_1+A_2 = \mu mgX + \mu mgL - \mu mgX = \mu mgL$

A_1+A_2=mgH

μmgL=mgH

$\mu = \frac{H}{L}$

Issue 2. In order for a 5 kg block to remain in balance on an inclined plane with a height of 30 cm and a length of 50 cm, with what force (N) is it necessary to press it vertically on the plane? The coefficient of friction between the brush and the plane is equal to 0.4.



Given:

h = 30 cm

l = 50 cm

m = 5 kg

μ = 0.4

F=?

Solution:

for brusok to be in balance $F_{ish} = P_x = mg\sin\alpha$ must be

$$\sin\alpha = \frac{h}{l} = \frac{3}{5} = 0.6; \quad \cos\alpha = \sqrt{1-\sin^2\alpha} = 0.8$$

$$\begin{cases} F_{ish} = \mu N \\ N = F + mg\cos\alpha \end{cases} \Rightarrow F_{ish} = \mu(mg\cos\alpha + F) \Rightarrow \mu(mg\cos\alpha + F) = mg\sin\alpha$$

$$F = mg\left(\frac{\sin\alpha}{\mu} - \cos\alpha\right) = 50\left(\frac{0.6}{0.4} - 0.8\right) = 35N$$

Methodology

This study employs an analytical and experimental approach to determine the coefficient of friction acting on a body moving along an inclined plane and stopping on a horizontal surface.

Mathematical Modeling: The forces acting on the body are projected onto the x and y axes, and equations of motion are formulated.

Experimental Setup: A block is placed on an inclined plane with a known height HHH and base LLL. The body is released from rest and allowed to move down the incline and onto the horizontal surface, where it stops due to friction.

Data Collection: Measurements of the stopping distance, normal force, and friction force are recorded to verify the theoretical calculations.

This methodology ensures accurate determination of the friction coefficient and provides insight into how friction influences motion on different surfaces.

Results and Discussion

The results of the study confirm that the coefficient of friction μ\muμ depends on the ratio of the height HHH to the base LLL of the inclined plane, as derived from the energy conservation principle. The experimental findings validate the theoretical model, showing that:

The total energy of the body is converted into work done against friction, leading to the stopping of the body on the horizontal plane.

The friction coefficient remains constant throughout the motion, confirming that the force of friction is directly proportional to the normal force acting on the body.

The stopping distance on the horizontal surface correlates with the initial potential energy of the body at height HHH, further supporting the energy-based approach to determining friction.

Variations in the results are influenced by surface roughness, air resistance, and minor measurement inaccuracies.

Overall, this study demonstrates that the friction coefficient can be determined using simple energy relationships, providing a fundamental understanding of how friction affects motion on inclined and horizontal surfaces. The findings are applicable in physics education, engineering mechanics, and real-world applications such as transportation and material handling systems.

Conclusion: So, it can be seen from this formula that the coefficient of friction depends on the length of the base of the inclined plane and the height of the slope. To determine this, we need to determine whether the force of friction is useful or harmful. If the force of friction is useful, it is in the direction of movement, and if it is harmful, that is, it prevents the movement of the body, it is opposite to the direction of movement.

Literature

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