

NAME _____

DATE _____

Scenario

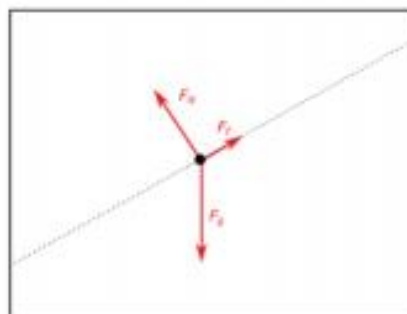
Angela and Carlos are asked to determine the relationship between the normal force on a box of mass m and the angle of incline of the box θ as the box sits at rest on the incline.

Using Representations

- PART A:** The dot at right represents the block on the incline. Draw a free-body diagram showing and labeling the forces (not components) exerted on the block. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. Each force must be represented by a distinct arrow starting on and pointing away from the dot. The dotted line represents the incline.

**Quantitative Analysis**

- PART B:** Start with Newton's second law to derive an equation that relates the normal force with the angle of incline. For each line of the derivation, explain in words what you did mathematically. The first line is done for you as an example. Express your answer in terms of m , θ , and physical constants as appropriate.



$$\Sigma F_y = ma_y$$

Newton's second law states that the sum of the forces in the "y" direction will be equal to the mass of the box times the acceleration of the box in the y-direction, therefore:

$$F_N - mg \cos \theta = 0$$

Since the box would accelerate down the incline (if it were to accelerate) we choose our axis to be down the incline and perpendicular to the incline, so we will find the components of the gravitational force (since it is the only force not parallel or perpendicular to the incline). Then in the "vertical" (perpendicular to the incline) direction, the two forces are the normal force and one of the components of the gravitational force, and since the box is not accelerating in this direction, these two forces sum to zero.

$$F_N = mg \cos \theta$$

Therefore, the normal force is equal to one component of the gravitational force.

2.H Forces on Inclined Planes

Analyze Data

Angela and Carlos then perform an experiment to test the equation they derived in Part B. The following data are collected.

Normal Force (N)	Angle (degrees)
97	10
95	15
85	30
80	35
75	40
63	50
49	60

PART C: Based on the equation you created in Part B, what data should be plotted to create a linearized graph for this experiment?

Students should graph the normal force vs. the cosine of the incline angle.

PART D: What is the physical meaning of the slope?

The physical meaning of the slope will be the weight of the box.