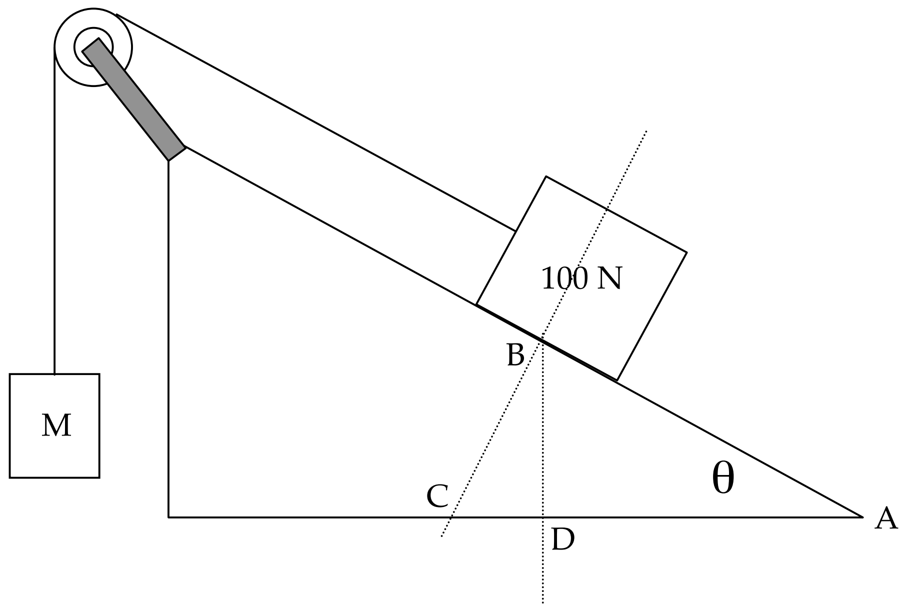
Thinking about Friction, Weight Components and Statics — A Group Exercise



1. The Geometry:

Consider the triangle ADB. If angle ADB is 90°, what is angle DBA? ________________

Consider the angle CBD. Given your answer to the previous question, what is angle CBD? __________

2. The Free-Body Diagram:

Draw and label the *fundamental* forces (as vector arrows) that act on the 100 N block. Draw and label the perpendicular and parallel components (as vector arrows) of the weight. *Make sure that the components of the weight are perpendicular to each other.*

Given the geometry of the system and what you discovered in lab ("Car on the Incline"), what are the mathematical relationships (in terms of θ) for the perpendicular and parallel components of the weight?

W_{perp} = ________________

W_{para} = ________________

Let $\theta = 36.87°$. Calculate the values for the perpendicular and parallel components of the weight.

W_{perp} = ________________

W_{para} = ________________

3. Newton's First Law Relationships

Assume, for the moment, that the incline is frictionless. If the system pictured is in static equilibrium, write (algebraically) the correct 1st Law relationships for the forces on the 100 N block:

$\sum F_{perp}$: ______________________

$\sum F_{para}$: ______________________

Given your answers above, what is the *value* for the tension in the rope and the mass of unknown block M? Include the appropriate units.

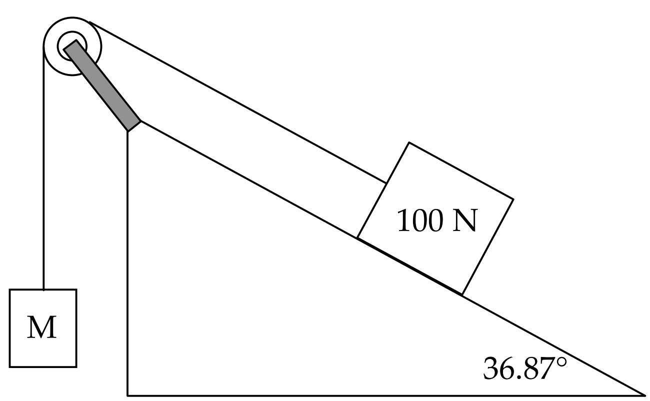
T = ________________ Explain: ____________________________

M = ________________ Explain: ____________________________

4. Introducing Friction

Suppose that M is larger than the value found in Section 3, and you observe the 100 N block remains at rest.

Draw and label the *fundamental* forces that must be acting on the 100 N block. Resolve the weight into its components as you did previously.



If the system pictured is in static equilibrium, write (algebraically) the correct 1st Law relationships for the forces on the 100 N block:

$\sum F_{perp}$: ______________________

$\sum F_{para}$: ______________________

If M = 8 kg, what is the tension in the rope?

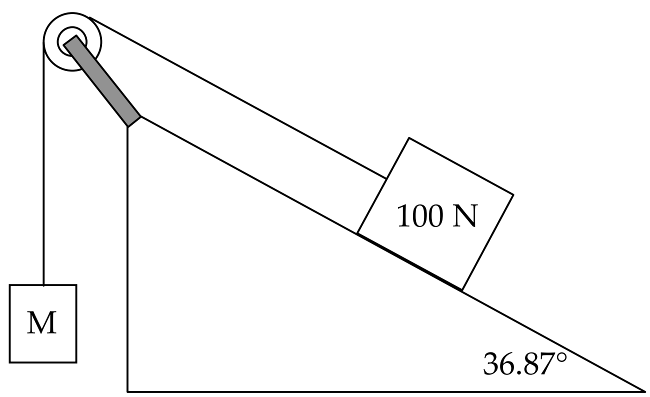
T = ____________________ Explain: __________________________________

Given this value for the tension and the 1st Law relationships you derived above, calculate the value of the force of friction in this case.

F_f = ____________________

Repeat the exercise. This time, let M = 4 kg and assume that the system remains in static equilibrium.

Draw and label the *fundamental* forces that must be acting on the 100 N block. Resolve the weight into its components as you did previously.



If the system pictured is in static equilibrium, write the correct 1st Law relationships for the forces on the 100 N block:

$\sum F_{perp}$: __________________________

$\sum F_{para}$: __________________________

What is the tension in the rope?

T = ____________________

Given this value for the tension and the 1st Law relationships you derived above, calculate the value of the force of friction in this case.

F_f = ____________________

5. Reflection

Summarize what you have learned about:

a. how, knowing the angle of an incline, allows you to calculate the components of weight.

b. the nature of the frictional force that can be produced by a surface.

c. the importance of drawing clear, complete free-body (force) diagrams.