Virtual Learning

Physics

Newton's Laws of Motion & Friction

April 27, 2020

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Newton's Laws of Motion & Friction: April 27,2020

Objective/Learning Target:

Students will examine and solve problems that involve Newton's Laws of Motion and Friction.

Quick Review

James and Sam are moving a table into the shade. A cup of tea, with a mass of 0.54kg, is on the table. James lifts his end of the table before Sam does, and as a result, the table makes an angle of 15º with the horizontal.

1. **Find the component of the cup's weight that is parallel to the table.**

2. **Find the component of the cup's weight perpendicular to the plane of the table.**

Quick Review answer 1

First step is to determine the weight of the cup.

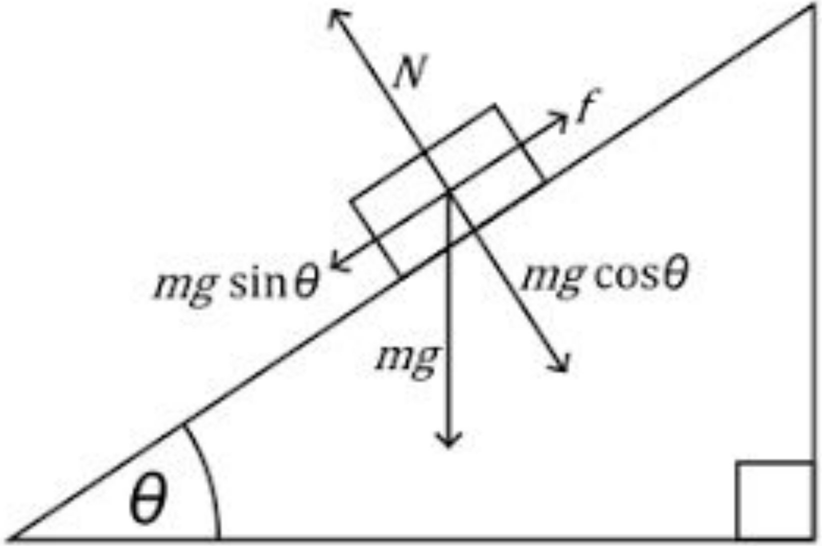
$$F_W = mg = (0.54\ \text{kg})\ (\ 9.8\ \text{m/s}^2) = 5.3\ \text{N}$$

Then find $F_{/\!/}$.

$$F_{/\!/} = F_W(\sin\theta)$$

$$F_{/\!/} = 5.3\text{N}(\sin 15°)$$

$$F_{/\!/} = 1.4\ \text{N}$$



Quick Review answer 2

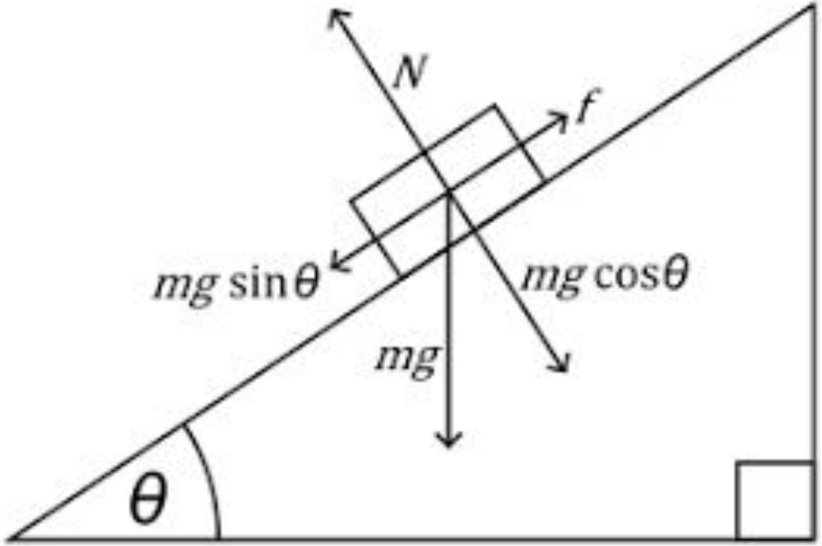
Knowing the weight of the cup is 5.3 N and $F_W = mg$

Then

$$F_{\perp} = F_W(\cos\theta)$$

$$F_{\perp} = 5.3N(\cos 15°)$$

$$F_{\perp} = 5.1\ N$$



Problem Solving Using Newton's Laws

Link: Friction

Directions:

- Read through the linked section that discusses friction..
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

The coefficient of sliding friction for wood on wood is 0.55. What s the force of friction on a wood block of mass 3.5 kg being pulled across a wooden floor?

Practice Problem #1 answer

$F_F = \mu(F_N\quad)$ and $F_N = mg$ on a flat surface.

So

$$F_F = \mu(mg)$$

$$F_F = 0.55(3.5kg * 9.8m/s^2)$$

Practice Problem #2

A boulder of mass 45 kg is pushed on a surface with a coefficient of sliding friction of 0.85.

What force has to be applied to produce an acceleration of 0.20 m/s^2?

Practice Problem #2

According to Newton's 2nd Law of Motion

$F_{Net} = ma$

We also know that $F_{Net} = F_{applied} - F_{friction}$ & $F_F = \mu F_N = \mu mg$

So…

$F_{app} = F_{Net} + F_F$

$F_{app} = ma + \mu mg$

$= 45kg(0.20\ m/s^2) + 0.85(45kg \times 9.8m/s^2)$

$= 9\ N + 375\ N$

$= 384\ N$ **with sig figs →** $380\ N$

Practice Problem #3

Let's revisit the bear at the zoo.Remember he was a 900.-kg polar bear sliding down a wet slide inclined at an angle of 25.0° to the horizontal. This time the slide in not frictionless. The coefficient of friction between the bear and the slide is 0.0500.

a. **What frictional force impedes the bear's motion down the slide?**

b. **What would be the bear's acceleration down the slide?**

Practice Problem #3 Answer

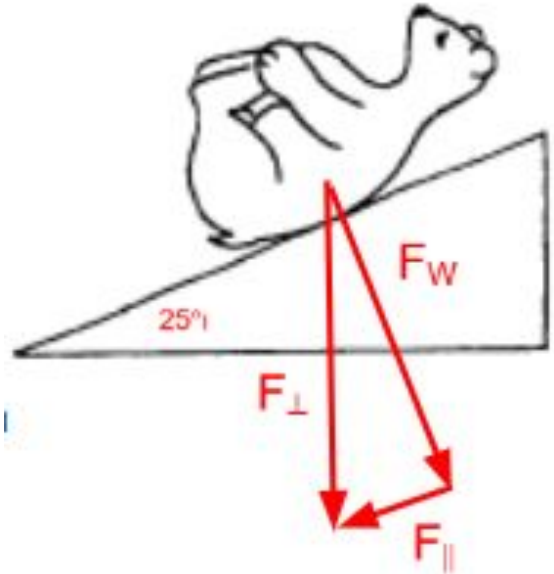
Newton's 2nd law with friction involves net force.

$$a = \frac{F_{Net}}{m} \qquad \& \qquad F_{Net} = F_{\parallel} - F_{friction}$$

$$\begin{aligned} F_{Net} &= F_{\parallel} - F_f \\ &= mg\sin\theta - F_f \\ &= 900\text{kg} \times 9.8\text{m/s}^2 \times \sin 25^\circ - 400\text{N} \\ &= 3730\text{ N} - 400\text{ N} \\ &= 3330\text{ N} \end{aligned}$$

So..

$$a = \frac{F_{Net}}{m} = \frac{3330\text{N}}{900\text{kg}} = 3.70\text{ m/s}^2$$



Practice Problem #3 Answer

$F_{friction} = \mu F_N$

&

$F_N = mg\cos\theta$

$= 900kg \times 9.8m/s^2 \times \cos 25°$

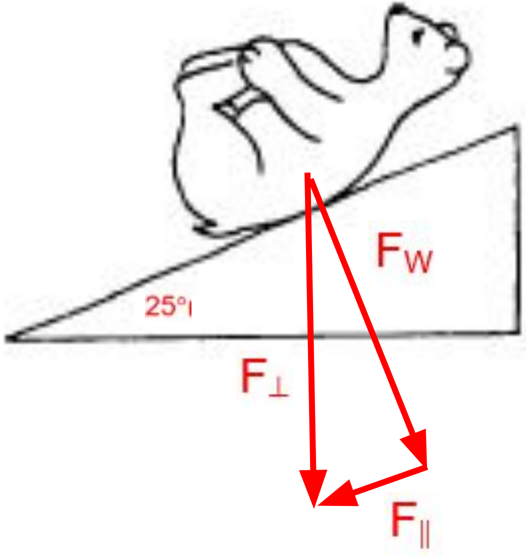
$= 7994\ N$

SO..

$F_{friction} = \mu F_N$

$= 0.0500(7994N)$

$=400\ N$



Additional Practice

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