

Forces in 2 dim.

Normal force F_n = force perpendicular to the surface.

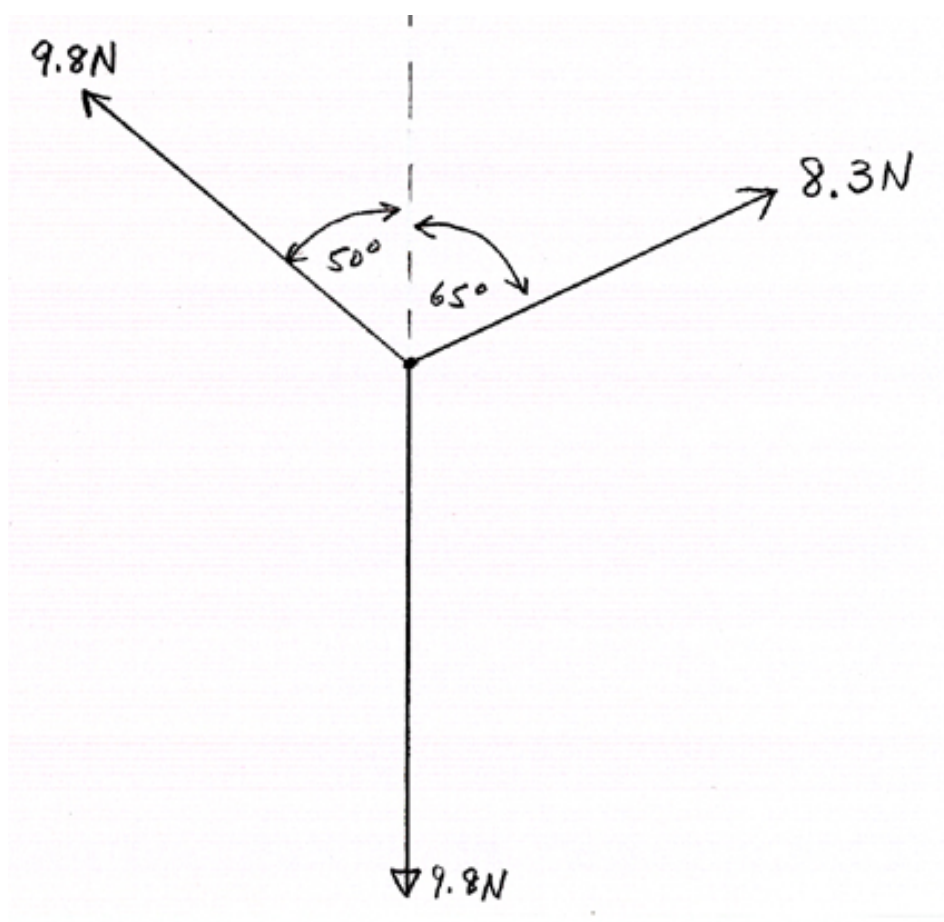
Static Friction

Kinetic Friction

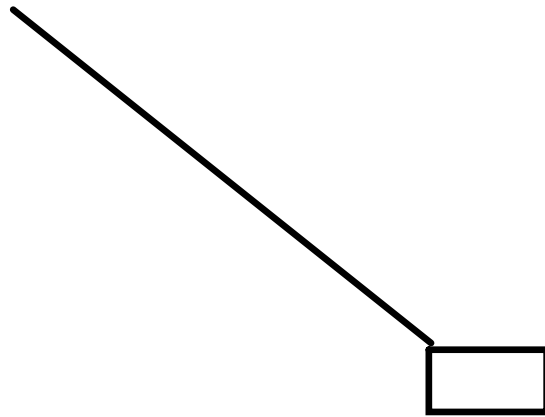
Equilibrium: all forces add up to zero.

=> acceleration = 0

=> velocity is constant

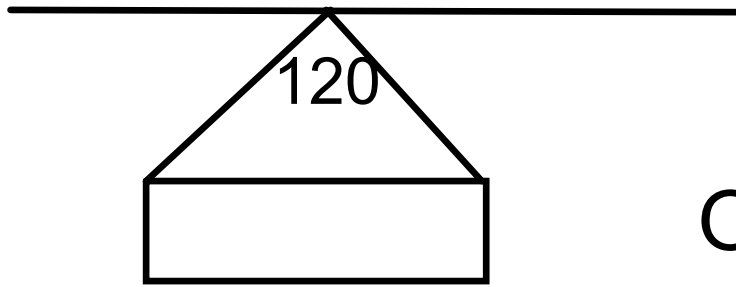


A man pushes a broom with a force of 10 N. The handle of the broom makes an angle of 40 degrees with the horizontal. Find the horizontal and vertical components of the force.

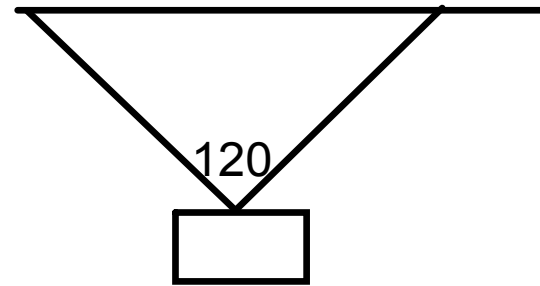


Page 142 # 98

A street lamp weighs 150 N. It is supported by two wires that form an angle of 120 degrees with each other. The tensions in the wires are equal. What is the tension in each wire supporting the lamp?



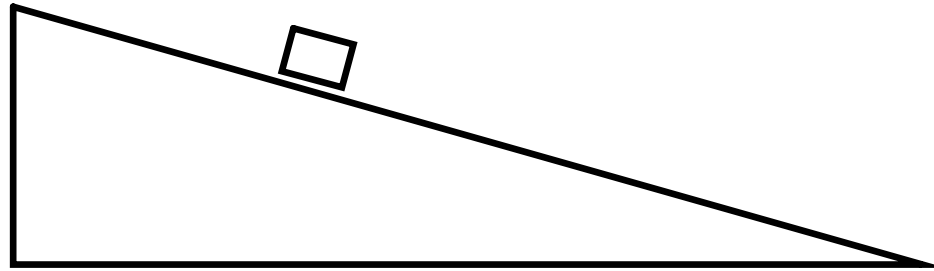
OR



Page 142 # 98

A street lamp weighs 150 N. It is supported by two wires that form an angle of 120 degrees with each other. The tensions in the wires are equal. What is the tension in each wire supporting the lamp?

A 3.2 kilogram box rests on an incline which makes an angle of 30 degrees with the horizontal. Find the component of the weight which acts parallel and perpendicular to the incline.



Static Friction:

Kinetic Friction:

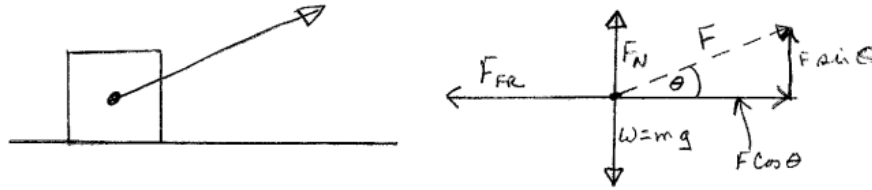
Text Page 128 # 17

A girl exerts a 36 N horizontal force as she pulls a 52 N sled across a cement sidewalk at constant speed. What is the coefficient of kinetic friction between the sidewalk and the metal sled runners?

Page 130 # 30

The coefficient of static friction between a 40.0 kilogram picnic table and the ground below is 0.43. What is the greatest horizontal force that could be exerted on the table while it remains stationary?

If the rope in the previous problem were at an angle of 30 degrees with the horizontal, what would be the maximum force before the table began to move?



$$\begin{array}{l}
 \text{I} \quad \sum F_x = 0 \Rightarrow F_{FR} = F \cos \theta \\
 \text{II} \quad \sum F_y = 0 \Rightarrow mg = F_N + F \sin \theta \\
 \text{III} \quad F_{FR} = \mu F_N
 \end{array}
 \left. \vphantom{\begin{array}{l} \text{I} \\ \text{II} \\ \text{III} \end{array}} \right\} \begin{array}{l} \text{UNKNOWN S} \\ F \\ F_N \\ F_{FR} \end{array}$$

$$\begin{array}{l}
 \text{III} \Rightarrow \text{I} \\
 \mu F_N = F \cos \theta \\
 F_N = \frac{F \cos \theta}{\mu} \quad \text{IV}
 \end{array}$$

$$\begin{array}{l}
 \text{IV} \Rightarrow \text{II} \\
 mg = \frac{F \cos \theta}{\mu} + F \sin \theta \\
 mg = F \left(\frac{\cos \theta}{\mu} + \sin \theta \right) \\
 F = \frac{mg}{\left(\frac{\cos \theta}{\mu} + \sin \theta \right)}
 \end{array}$$

$$F = \frac{(40 \text{ kg})(9.8 \text{ m/s}^2)}{\left[\frac{.866}{.43} + .5 \right]} = \frac{392 \text{ N}}{2.5} = \underline{\underline{156 \text{ N}}}$$

Check: IF $\theta = 0$ then

$$F = \frac{392 \text{ N}}{1 + 0} \checkmark = 392 \text{ N AS before}$$

Text P 128 #20

Suppose the sled in problem 17 is resting on packed snow. The coefficient of kinetic friction is now only 0.12. A person weighing 650 N sits on the sled, what force is needed to pull it across the snow at constant speed?

Page 130 # 24

A shuffleboard disk is accelerated to a speed of 5.8 m/s and released. If the coefficient of kinetic friction between the disk and the concrete court is 0.31, how far does the disk go before it comes to rest? The courts are 15.8 m long.

Equilibrium: all forces add up to zero.

=> acceleration = 0

=> velocity is constant

Page 143 # 100

You are shadowing a nurse in the emergency room of a local hospital. An orderly wheels in a patient who has been in a very serious accident and has had severe bleeding. The nurse explains that in a case like this you will tilt the patient's bed with the head downward so that blood will go to the head. She tells you that, for most patients the largest angle that the bed can be tilted without the patient beginning to slide off is 32 degrees from the horizontal. On what factor or factors does this angle of tilting depend? Find the coefficient of static friction between a typical patient and the sheets.

The handle of a mop is being held so that it makes an angle of 38 degrees with the horizontal. The mop has a mass of 1.8 kilograms. The coefficient of static friction is 0.28. What force must be applied to start the mop moving?

Mastery Problem:

A box having a mass of 12 kilograms is sitting on the floor. There is a pole rigidly attached to the box and the pole makes an angle of 25 degrees with the horizontal. The coefficient of static friction between the box and the floor is 0.20 and the coefficient of kinetic friction is 0.10

(A) Would it be easier for a person who wants to move the box to do so by PUSHING on the handle, or by PULLING on it, or would the effort be the same in either case?

(B) What is the minimum effort needed to start the box moving?

(C) If the person applied a constant force which just got the box moving, what would be its acceleration when it was moving?