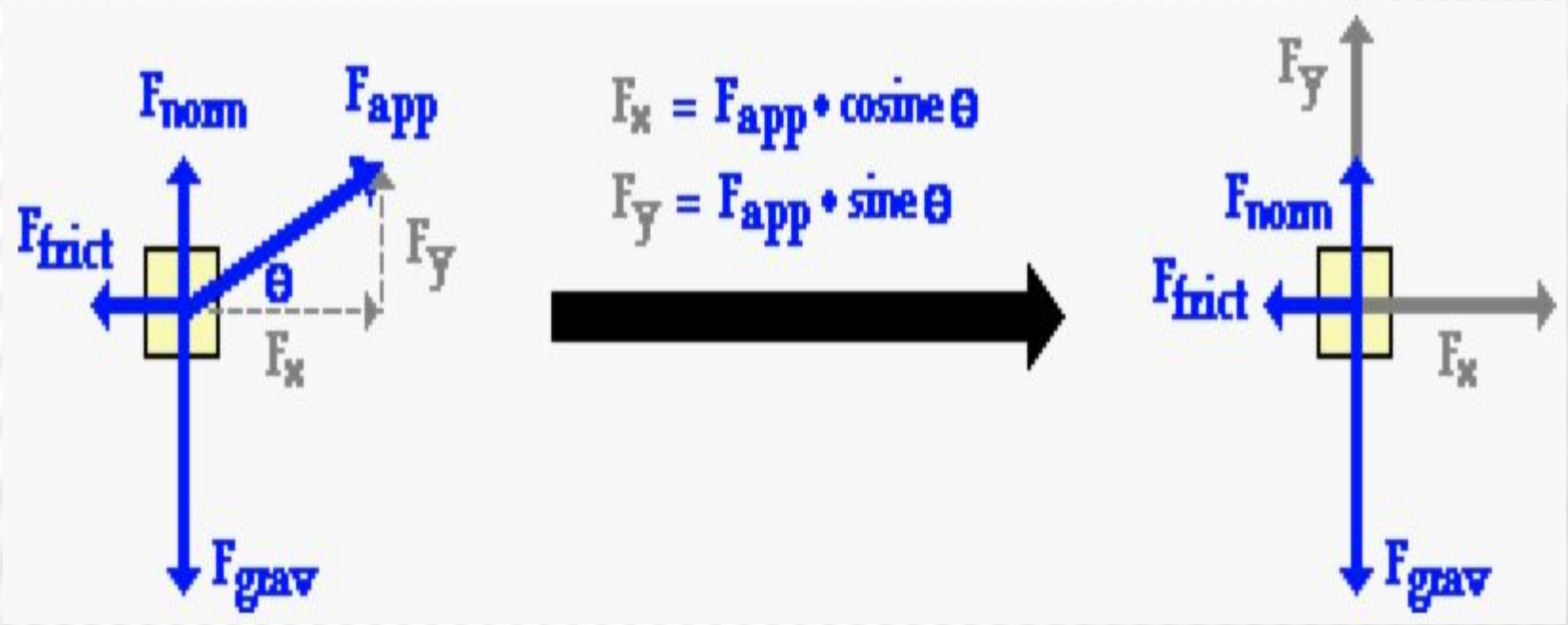
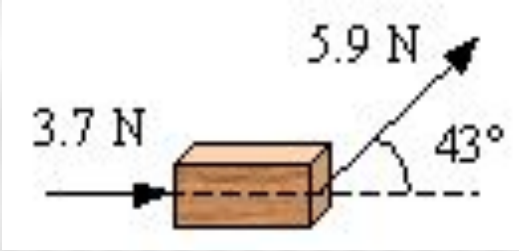


FORCES APPLIED AT AN ANGLE & INCLINED PLANES

FORCES AT AN ANGLE – YOU DO

1. A box of books weighing 325 N moves with a constant velocity across the floor when it is pushed with a force of 425 N exerted downward at an angle of 35.2 degrees below the horizontal. Find the coefficient of friction between the box and the floor.

2. Two forces act on a 4.5-kg block resting on a frictionless surface as shown. What is the magnitude of the horizontal acceleration of the block?



FORCES AT AN ANGLE – YOU DO

1. A box of books weighing 325 N moves with a constant velocity across the floor when it is pushed with a force of 425 N exerted downward at an angle of 35.2 degrees below the horizontal. Find the coefficient of friction between the box and the floor.

Constant velocity means no acceleration, which means that the forces in ALL directions are balanced.

$F_f = 425 \cos(35.2) = 361.7$ N

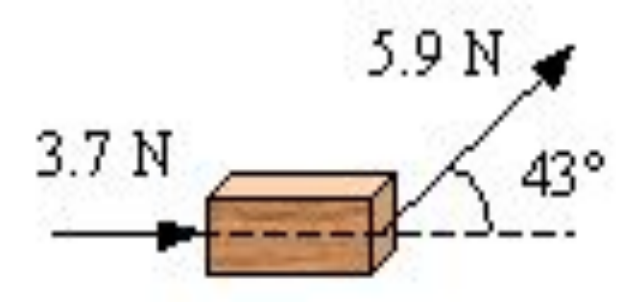
$F_f = \mu_s F_n$

Fn = mg + 425 sin (35.2) = 325 N + 425 sin(35.2) $F_n = 548.2$ N

$\mu_s = 0.61$

FORCES AT AN ANGLE – YOU DO

2. Two forces act on a 4.5-kg block resting on a frictionless surface as shown. What is the magnitude of the horizontal acceleration of the block?

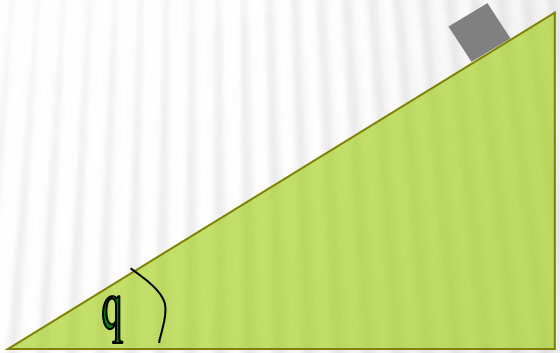


Resolve into components, Add the forces, then find F_{net} = ma.

3.7 N + 5.9 N cos 43 = F_{net} = 8.3 N

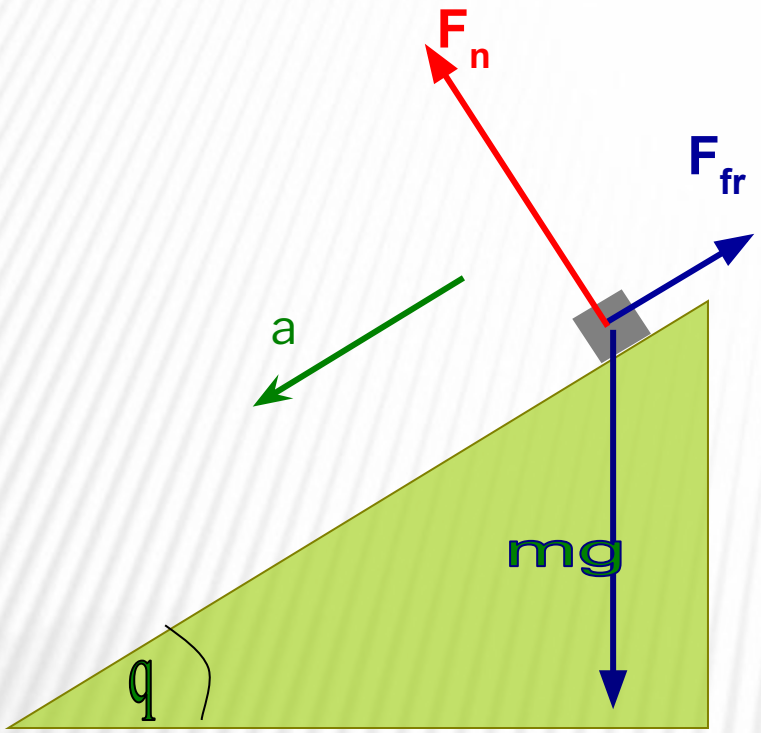
a = F_{net} / m = 8 .3 N / 4.5 kg = 1.8 m/s^2

INCLINE



Draw a free-body diagram for a block accelerating down a ramp.

FORCES ON AN INCLINED PLANE

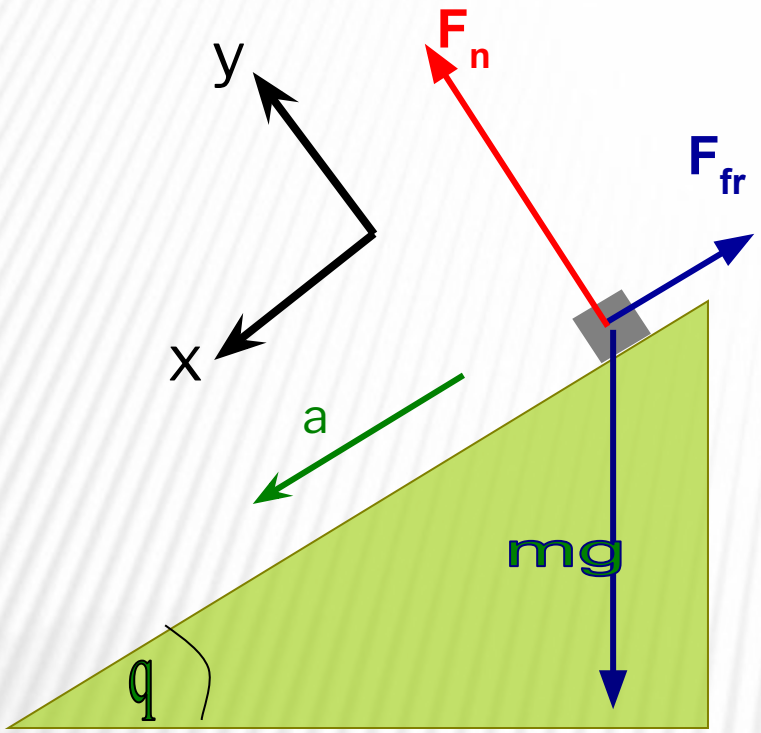


Oh no!
This will be ugly!

We will have to resolve F_n, F_{fr}, F_{net}, and a into components!!!

Or … will we?

FORCES ON AN INCLINED PLANE



Solution:
Choose a more convenient coordinate system!

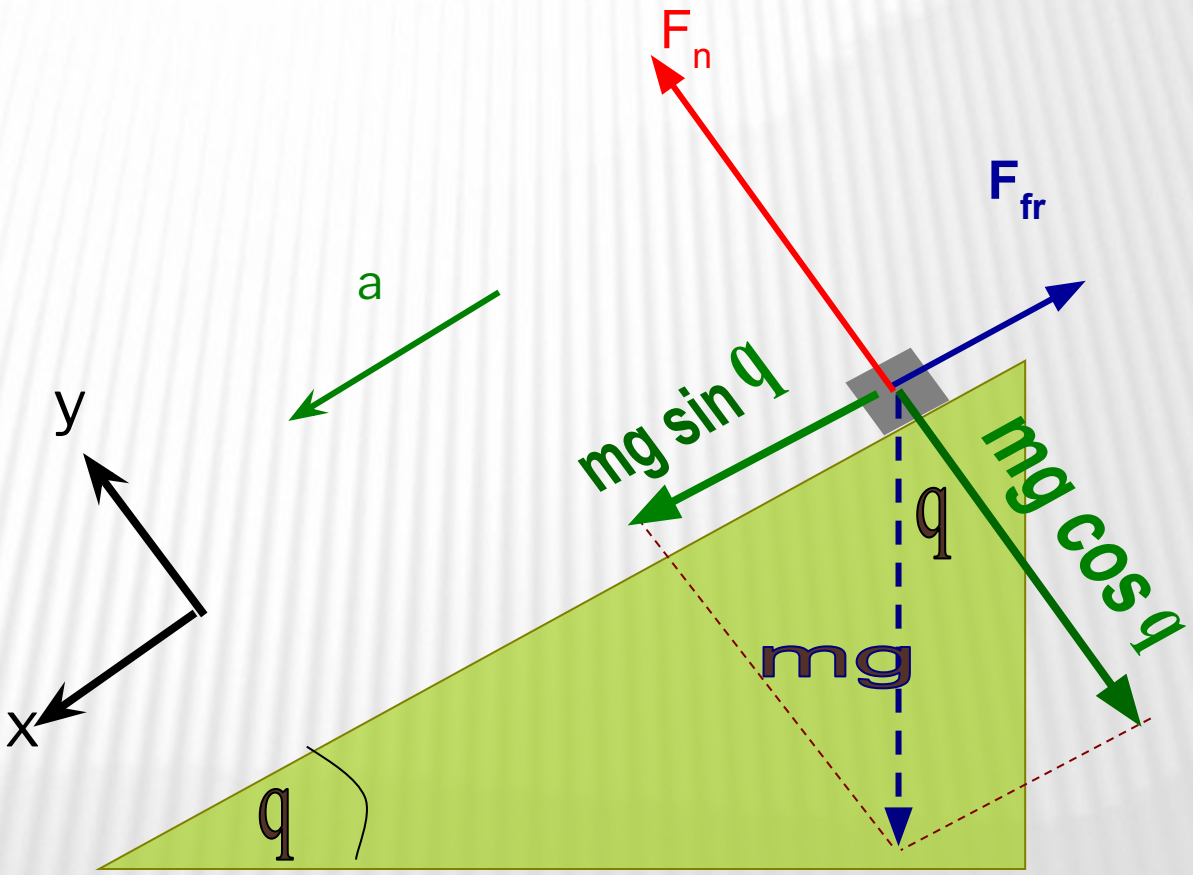
Make x be parallel to incline and y be perpendicular.

Now, only mg has to be resolved into components.

Motion and all the other forces will be in the x or y direction.

FORCES ON AN INCLINED PLANE

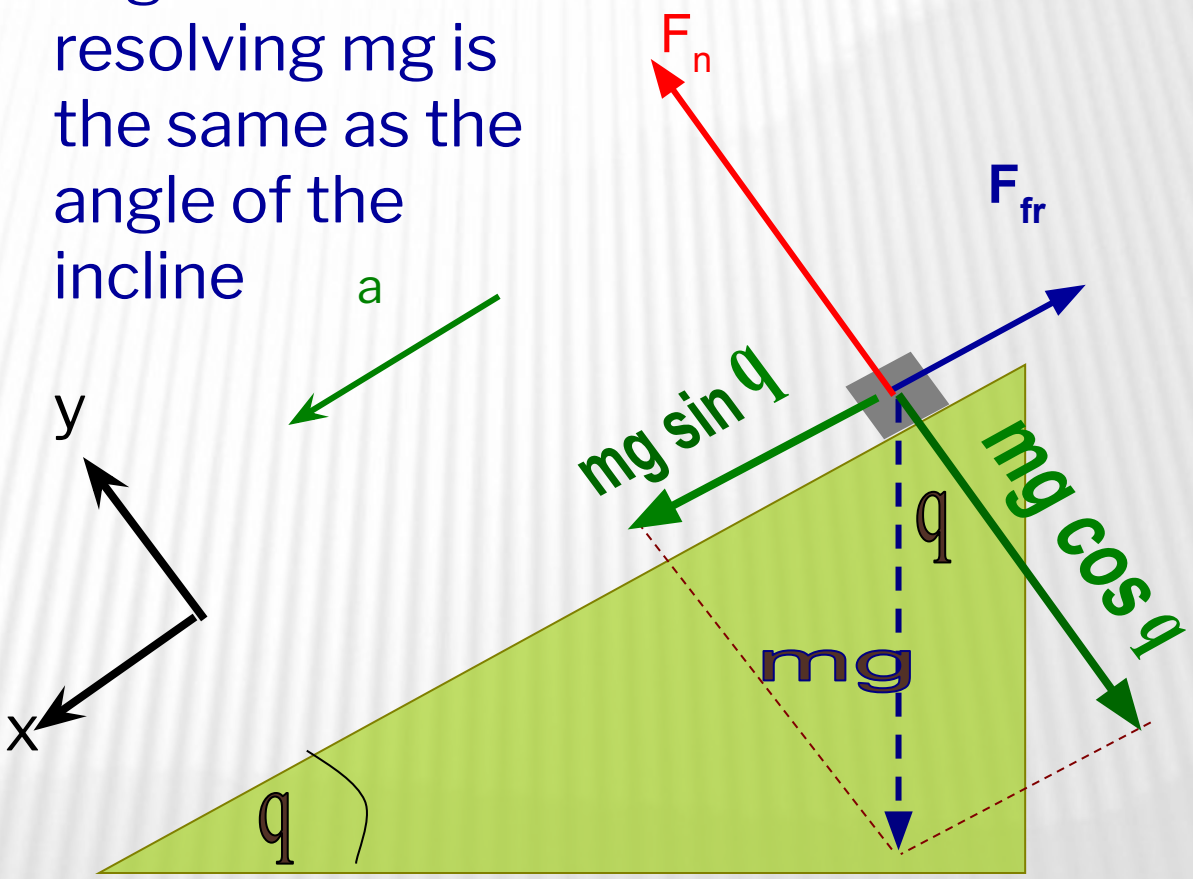
The only force that we have to resolve into components is weight



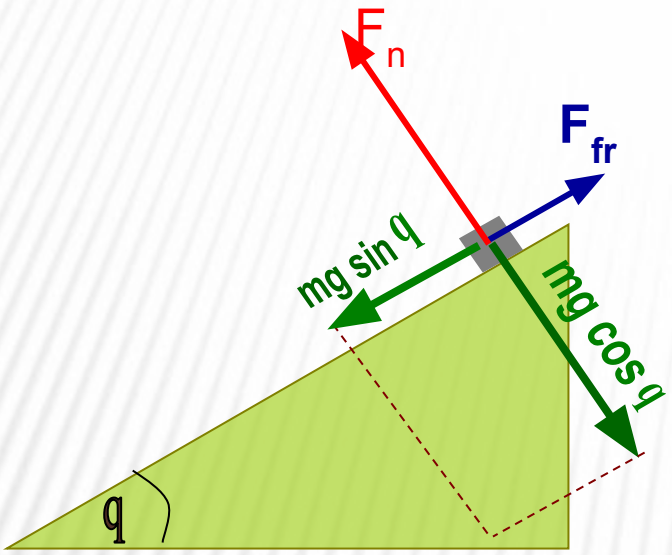
FORCES ON AN INCLINED PLANE

The only force that we have to resolve into components is weight

Notice that the angle for resolving mg is the same as the angle of the incline



Resolve vector mg into two components. Now instead of three forces, we have four forces

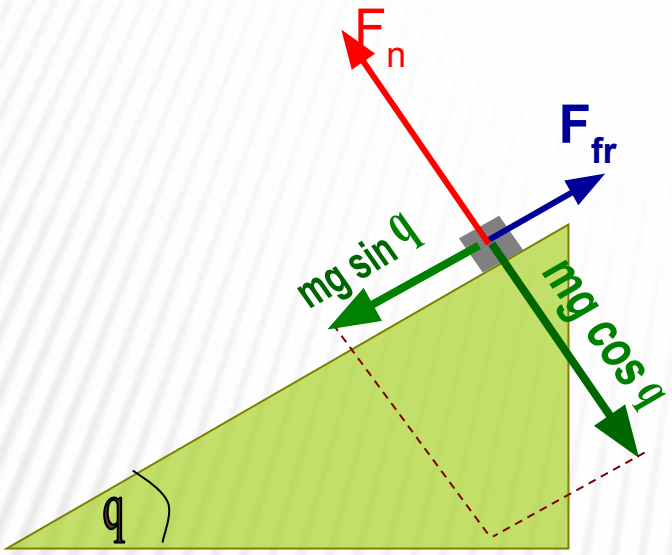


direction perpendicular to the incline:

$F_{net} = ma = 0$

$F_n = mg \cos \theta$

Resolve vector mg into two components. Now instead of three forces, we have four forces



Write the F_{net} equations

direction perpendicular to the incline:

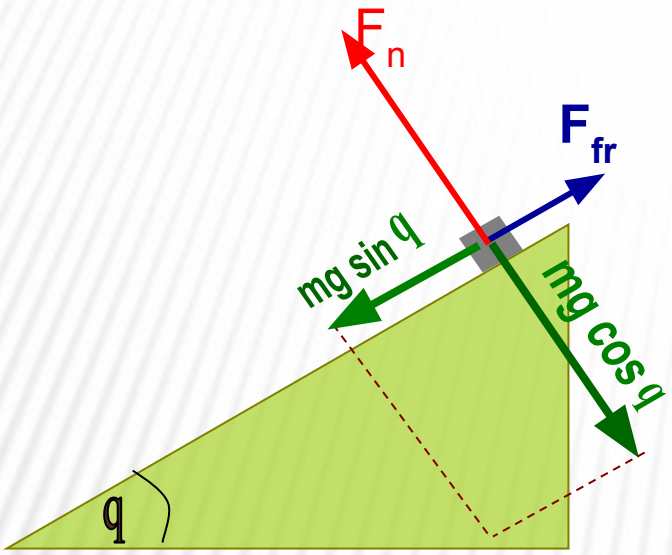
$F_{net} = ma = 0$

$F_n = mg \cos \theta$

force pressing the object into the surface is not full weight mg, but only part of it,

So the normal force acting on the object is only part of full weight mg: $F_n = mg \cos \theta$

Resolve vector mg into two components. Now instead of three forces, we have four forces



direction parallel to the incline:

$F_{net} = ma$

$F_{net} = F_f - mg \sin \theta = ma$

The force that causes acceleration downward is only part of the full force of gravity.

Greater acceleration the steeper the slope.
If the incline = 0, then there is no horizontal movement due to gravity.

INCLINED PLANE – WE DO

A cute bear, m = 60 kg, is sliding down an iced incline 30^0. The ice can support up to 550 N. Will bear fall through the ice? If the coefficient of the friction is 0.115, what is the acceleration of the bear?

What's my strategy??

INCLINED PLANE – WE DO

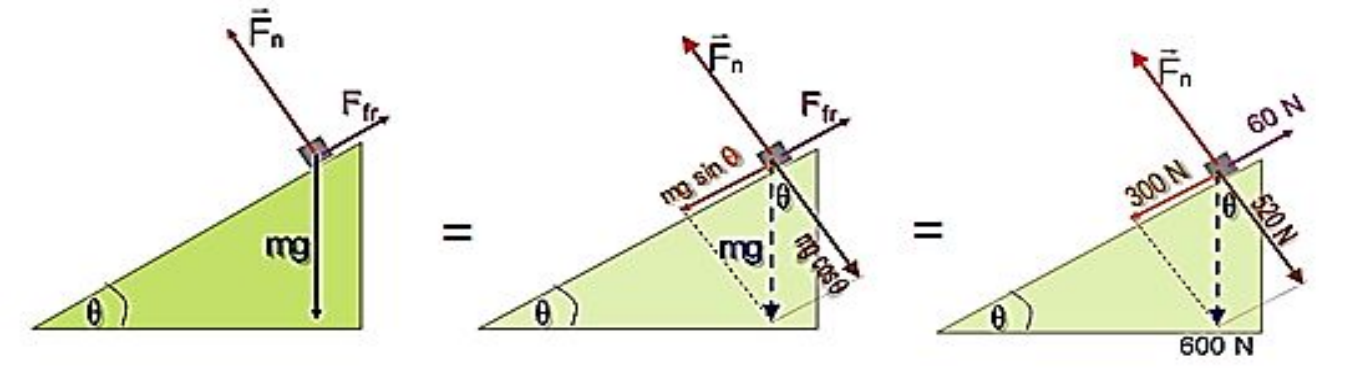
A cute bear, m = 60 kg, is sliding down an iced incline 30^0. The ice can support up to 550 N. Will bear fall through the ice? If the coefficient of the friction is 0.115, what is the acceleration of the bear?

<u>What's my strategy??</u>

1) Draw the free-body diagram
2) Choose a coordinate system with x parallel to incline
3) Resolve mg into components
4) Add vectors perpendicular to plane and set $F_{net} = ma = 0$.
5) Add vectors parallel to plane and set $F_{net} = ma$.

INCLINED PLANE – WE DO

A cute bear, m = 60 kg, is sliding down an iced incline 30^0. The ice can support up to 550 N. Will bear fall through the ice? If the coefficient of the friction is 0.115, what is the acceleration of the bear?



m = 60 kg

$\theta = 30^0$

$\mu = 0.115$

$g = 10\ m/s^2$

<u>Perpendicular direction</u>:

$F_{net} = ma$

$a = 0$

$F_n - mg \cos\theta = 0$

$F_n = 520\ N < 550\ N$

ice can support him, but he should not eat too much

<u>Parallel direction:</u>

$F_{net} = ma$

$mg \sin\theta - F_{fr} = ma$

N

$300 - 60 = 60\ a$

$a = 4\ m/s^2$

$F_{fr} = \mu F_n = 60$

INCLINED PLANE – YOU DO

3. A block weighing 15.0 newtons is on a ramp inclined at 40.0° to the horizontal. A 3.0 Newton force of friction, Ff , acts on the block as it is pulled up the ramp at constant velocity with force F, which is parallel to the ramp.

Find F.

4. A 75 kg box slides down a ramp inclined at 25^0 with an acceleration of 3.60 m/s^2.

a) Find the coefficient of friction.

b) What acceleration would a 175 kg box have on this ramp?

INCLINED PLANE – YOU DO

3. A block weighing 15.0 newtons is on a ramp inclined at 40.0° to the horizontal. A 3.0 Newton force of friction, Ff , acts on the block as it is pulled up the ramp at constant velocity with force F, which is parallel to the ramp.

Find F.

Constant velocity = no acceleration. This means that forces in parallel to the inclined plane are also balanced.

$F_f = F$

F = 12.6 N

INCLINED PLANE – YOU DO

4. A 75 kg box slides down a ramp inclined at 25^0 with an acceleration of 3.60 m/s^2.

a) Find the coefficient of friction.

b) What acceleration would a 175 kg box have on this ramp?

$F_{net} = mg \sin 25 - F_f = ma$

$F_f = mg \sin 25 - ma = 40.6$ N

$F_f = \mu_s F_n$ $\mu_s = F_f / F_n = 40.6 / mg\cos 25 = 0.06$

$a = (mg \sin 25 - F_f) / m = 3.6\ m/s^2$

EXIT TICKET

Using pictures, words, and equations, describe how to solve an inclined plane force problem.