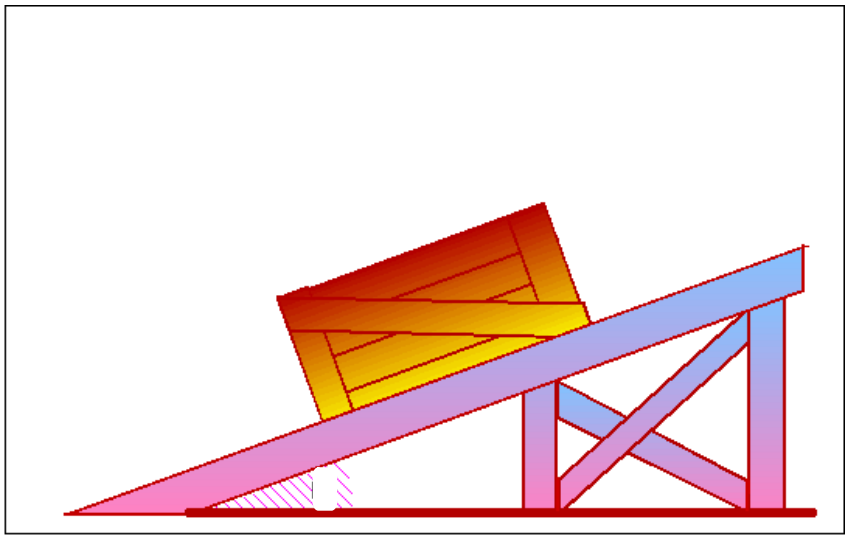
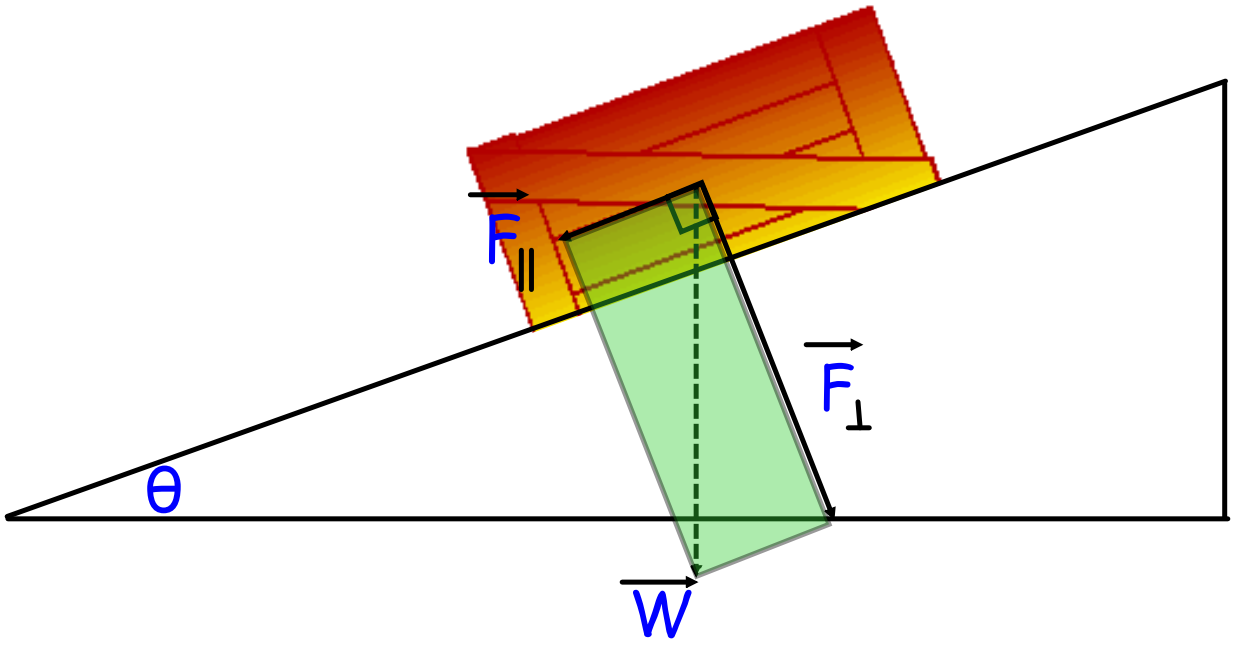
Gravitational Forces and Inclined Planes

The gravitational force acting on an object is directed toward the center of Earth. The object's weight, $\vec{W}$, can be represented by a vector directed down.



On an incline like the one above, the weight of the box is broken up into two components. One is the axis along the incline, and the other is the axis perpendicular to it.

$\vec{F}_{\parallel}$ $\vec{F}_{\perp}$



Calculating the values of $\vec{F}_{\parallel}$ and $\vec{F}_{\perp}$

Example:

A trunk weighing 562 N is resting on a plane inclined at 30.0^0 from the horizontal. Find the components of the weight parallel and perpendicular to the plane.

What happens when the ramp (slope) changes its pitch? How does this affect the parallel and horizontal forces?

Try the previous example with the following angles.

a) 15^0

b) 45^0

c) 60^0

What can you conclude about the parallel and horizontal forces when the ramp is affected?

The inclined plane also exerts an upward force perpendicular to its surface, the normal force, $\vec{F}_N$.

Looking at these components,

$$\vec{F}_N + \vec{F}_\perp = 0$$

If there is no friction between the trunk and the plane, the only force along the plane would be the parallel component ($\vec{F}_{\parallel}$)

$$\vec{F}_{\parallel} = \vec{W} \sin\theta$$

According to Newton's second law:

$$\vec{a} = \frac{\vec{F}}{m}$$

Substituting the values of the parallel force...

$$\vec{a} = \frac{\vec{W} \sin\theta}{m}$$

But the weight to mass ratio is constant for everyone near the surface of the Earth

$$\vec{g} = \frac{\vec{W}}{m} \qquad \text{so...} \qquad \vec{a} = \vec{g}\sin\theta$$

As the plane becomes more horizontal, the acceleration approaches zero. When the plane is tilted more vertically, the acceleration approaches a value closer to gravity (9.8 m/s^2)

Example Problem

The 562 N trunk is on a frictionless plane inclined at 30.0^0 from the horizontal. Find the acceleration of the trunk. What is its direction?

Usually there is friction between the inclined plane and the object on it.

If the object does not move on its surface there is **static** friction acting on that object.

To find the coefficient of static friction, we need the equation from last year...

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