Normal Force

Scott N. Walck

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The normal force is produced by a surface.

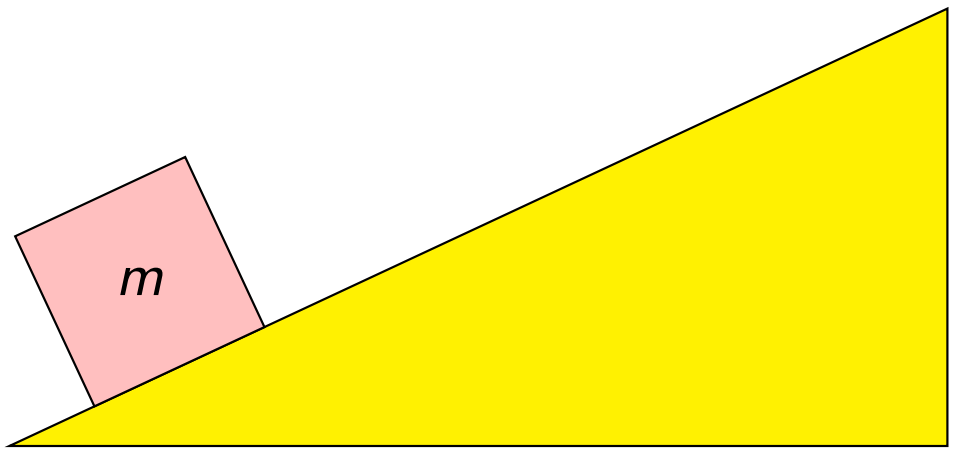
- "Normal" means perpendicular.
- An object in contact with a surface experiences a normal force from the surface.
- The normal force acts perpendicular to the surface, and prevents the object from falling into the surface.
- The magnitude of the normal force depends on the situation. There is no equation for the normal force like there is for the force of gravity.

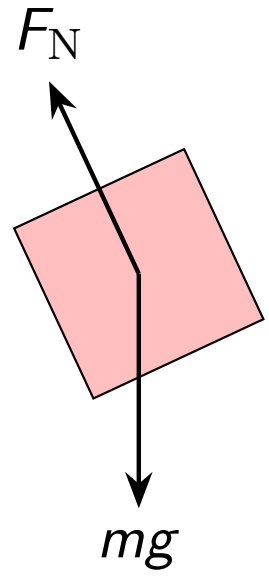
List of forces so far

Force	equation
somebody pushing	
gravity (weight)	$F_{\mathrm{G}} = mg$ downward
normal force	

- weight = the force of gravity
  The weight of an object is the force of gravity that acts on that object.
- normal = perpendicular
  Normal force is produced by a surface. The force acts in a direction perpendicular to the surface.

Box on a ramp

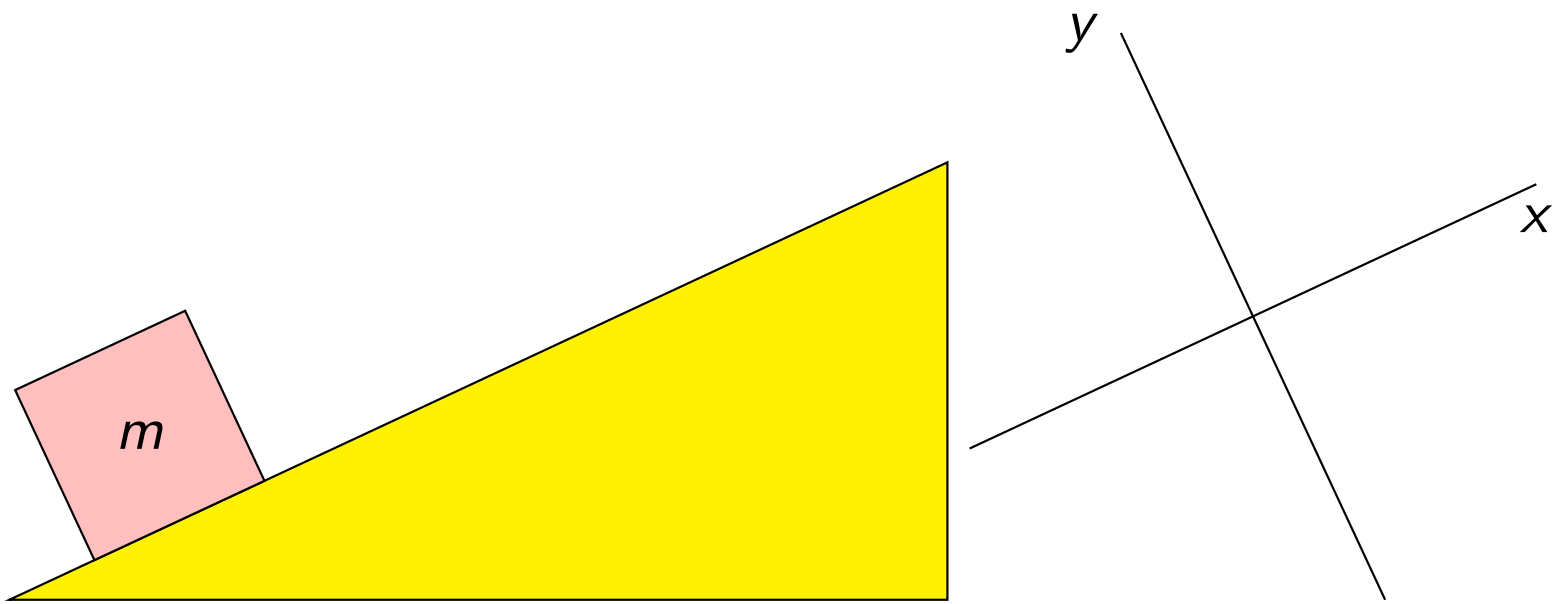




Two forces act on box:

- Gravity (mg)
- Normal force (F_{N})

Use a tilted coordinate system for ramp problems

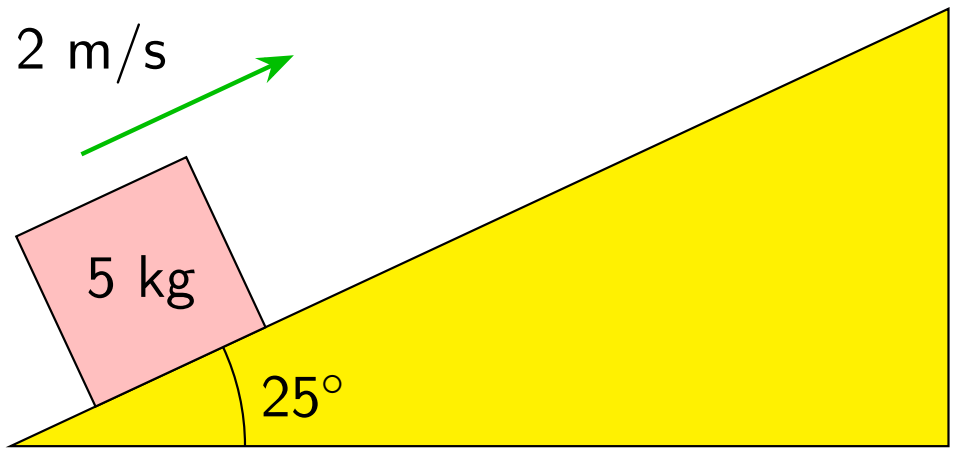


- The box slides along the ramp, so

$$a_y = 0.$$

Ramp problem

We give the box a shove so that it is moving up the ramp at 2 m/s.

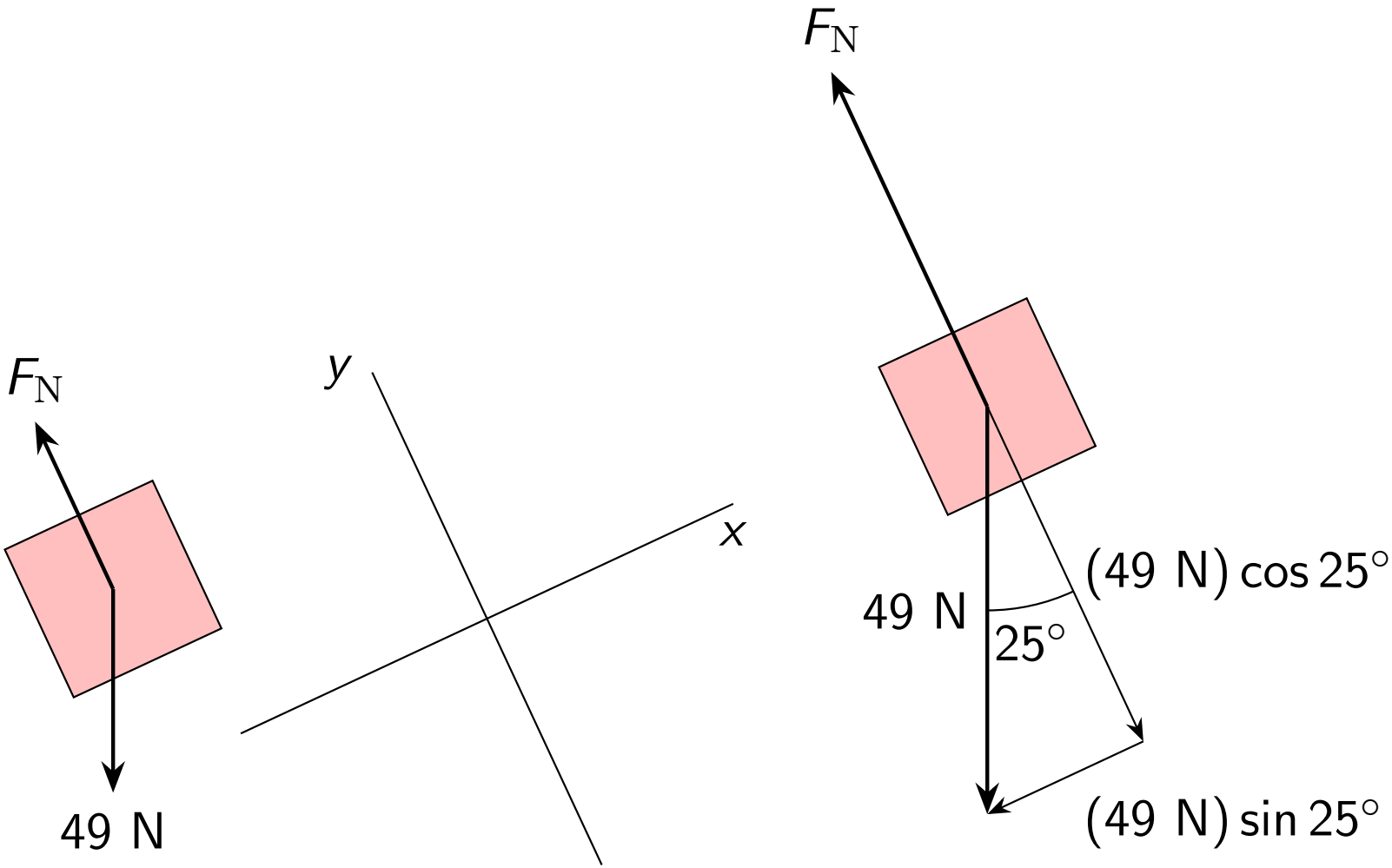


(a) How far up the ramp does the box go?

(b) How much time does it take to go up the ramp and back down to the initial position?

Solving the ramp problem

Since $m = 5$ kg, the weight of the box is $F_{\mathrm{G}} = mg = 49$ N.



Apply Newton's Second Law

In the x direction:

$$F_{\text{net},x} = ma_x$$

$$-(49\ \text{N})\sin 25^\circ = (5\ \text{kg})a_x$$

$$a_x = -4.14\ \text{m/s}^2$$

In the y direction:

$$F_{\text{net},y} = ma_y$$

$$F_{\text{N}} - (49\ \text{N})\cos 25^\circ = (5\ \text{kg})a_y$$

$$F_{\text{N}} = (49\ \text{N})\cos 25^\circ = 44.4\ \text{N}$$

Use the CA equations to finish the problem

(a) To find how far the box goes up the ramp, use the position-velocity equation in the x direction.

$$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$$

$$0 = (2\ \text{m/s})^2 + 2(-4.14\ \text{m/s}^2)(x - 0)$$

$$x = 0.48\ \text{m}$$

(b) To find time from beginning to end, use position-time equation.

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$

$$0 = 0 + (2\ \text{m/s})t + \frac{1}{2}(-4.14\ \text{m/s}^2)t^2$$

$$t = 0.97\ \text{s}$$