Physics 20

Unit B: Forces and gravitation

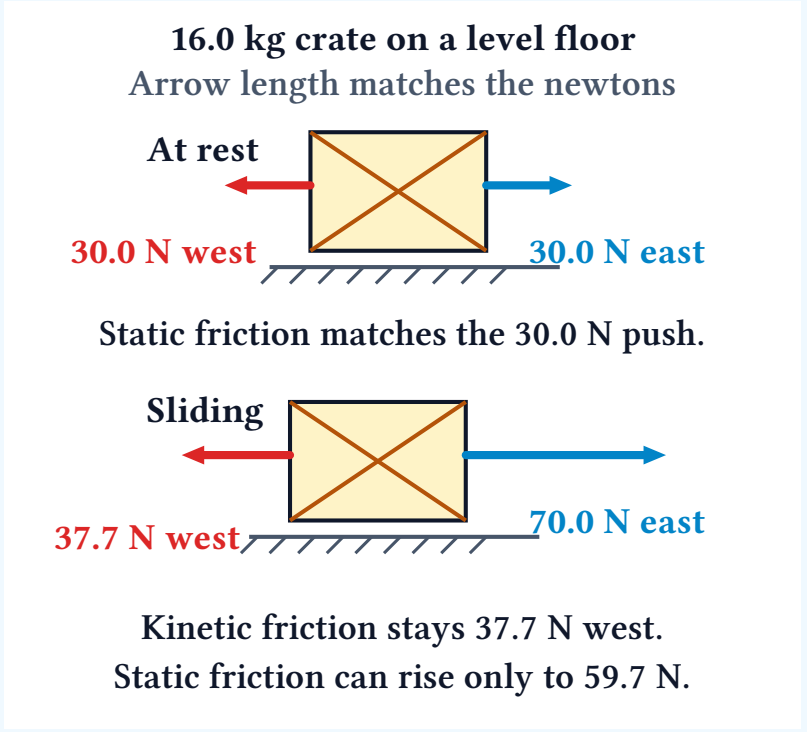
Friction and vector forces

A 16.0 kg crate that waits, then slides

- A 16.0 kg crate on a level warehouse floor stays at rest under a 30.0 N horizontal push.
- The same crate slides once the push reaches 70.0 N, with friction still opposing the motion.

Friction and resultant force

- Static friction uses μ_s, the coefficient of static friction, and it matches your push up to μ_s times the normal force.
- Kinetic friction uses μ_k, the coefficient once the crate is sliding, and it equals μ_k times the normal force.
- The east and north ropes can be replaced by one arrow with a single length and a single direction.



Key terms

static friction

Static friction adjusts up to a maximum of μ_s times the normal force and holds the contact at rest. (f_s max = μ_s N)

kinetic friction

Kinetic friction equals μ_k times the normal force and points opposite the sliding motion. ($f_k = \mu_k$ N)

normal force

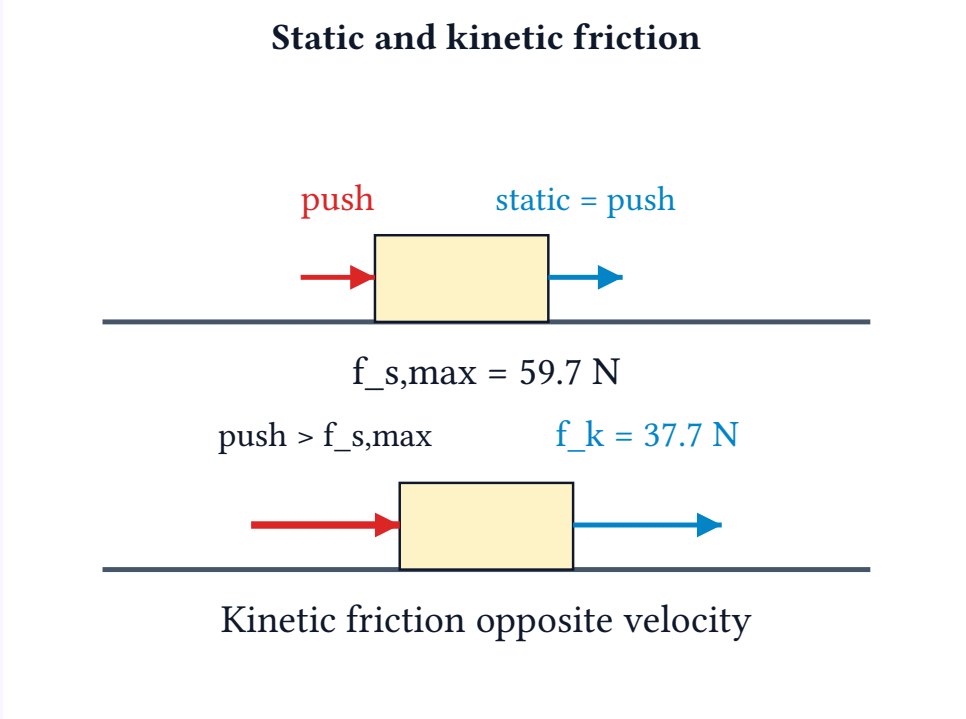
The normal force is the support force a surface exerts perpendicular to the surface. (N)

resultant

The resultant is the single vector that replaces two or more component vectors, with magnitude and direction.

Static and kinetic friction

- Below the maximum, static friction equals the applied push and the crate stays at rest.
- The maximum static friction for the crate is 59.7 N.
- Once sliding starts, kinetic friction stays at 37.7 N opposite the velocity.

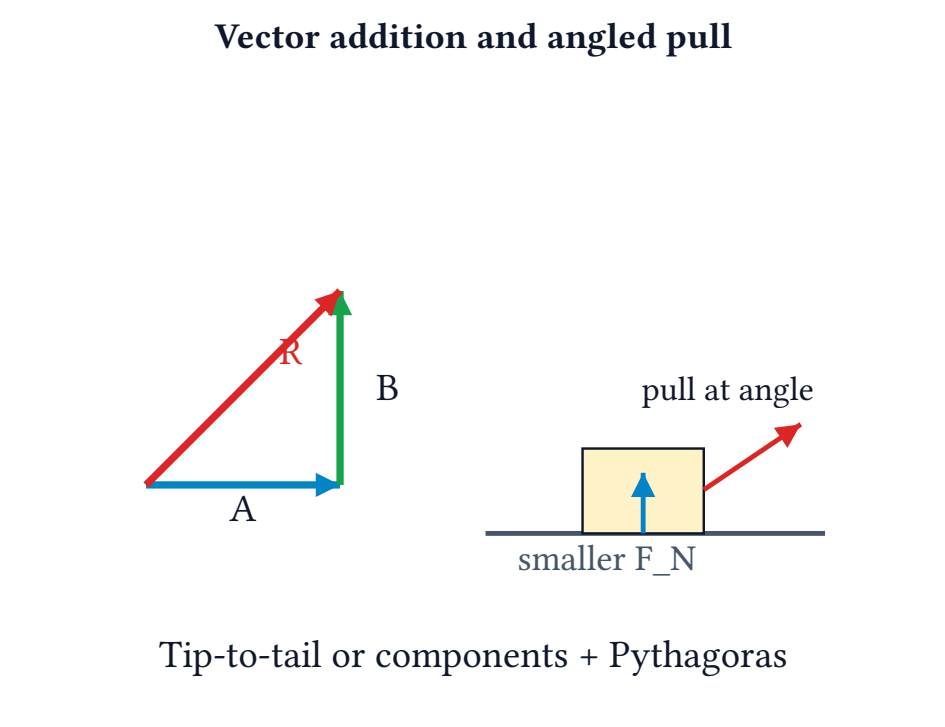


Acceleration once the crate slides

- A 70.0 N east push acts while kinetic friction is 37.7 N west.
- The horizontal net force is 32.3 N east.
- The acceleration of the 16.0 kg crate is 2.02 m/s squared east.

Components on paper and on a grid

- Draw the arrows tip to tail. The closing arrow is the one resultant.
- Or square each leg, add, take the square root, and use inverse tan for the angle.
- A pull with an upward angle lifts a little, so the floor pushes up with a smaller normal force.



A 30.0 N closing arrow

- Ropes of 18.0 N west and 24.0 N south act on a sled.
- Find the resultant magnitude and the angle south of west.
- State which component is adjacent to that angle.

Drag and a diagonal

- A 10.0 kg bin on a level floor has μ_k of 0.200, and its normal force equals its weight.
- Find the kinetic friction, aimed opposite the slide.
- Then find the resultant of 9.0 N east and 12.0 N north.