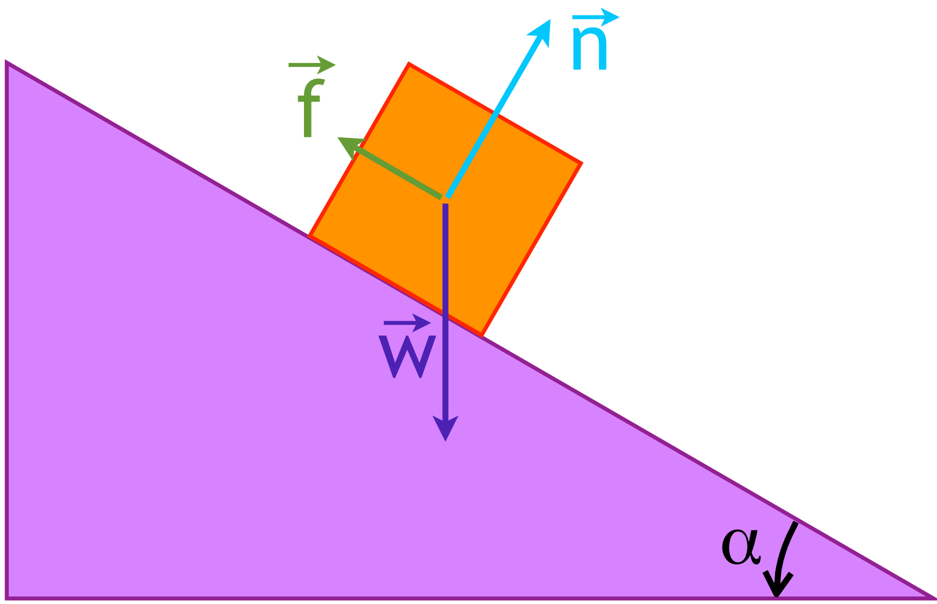
A block of mass *m* is at rest on a sloped surface, as shown below. What is the magnitude of the friction force?



A. mg

B. $mg \sin \alpha$

C. $mg \cos \alpha$

D. 0

E. None of the above

Text ‘PHYSJC’ and your answer to 22333

Chapter 5.3
Frictional Forces

PHYS1210 - Prof. Jang-Condell

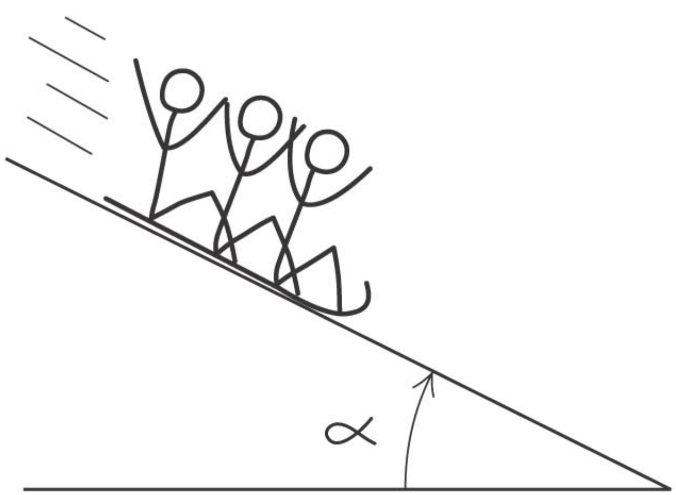
Goals for Chapter 5

- To use Newton's first law for bodies in equilibrium
- To use Newton's second law for accelerating bodies
- To study the types of friction and fluid resistance
- To solve problems involving circular motion

Acceleration down a hill

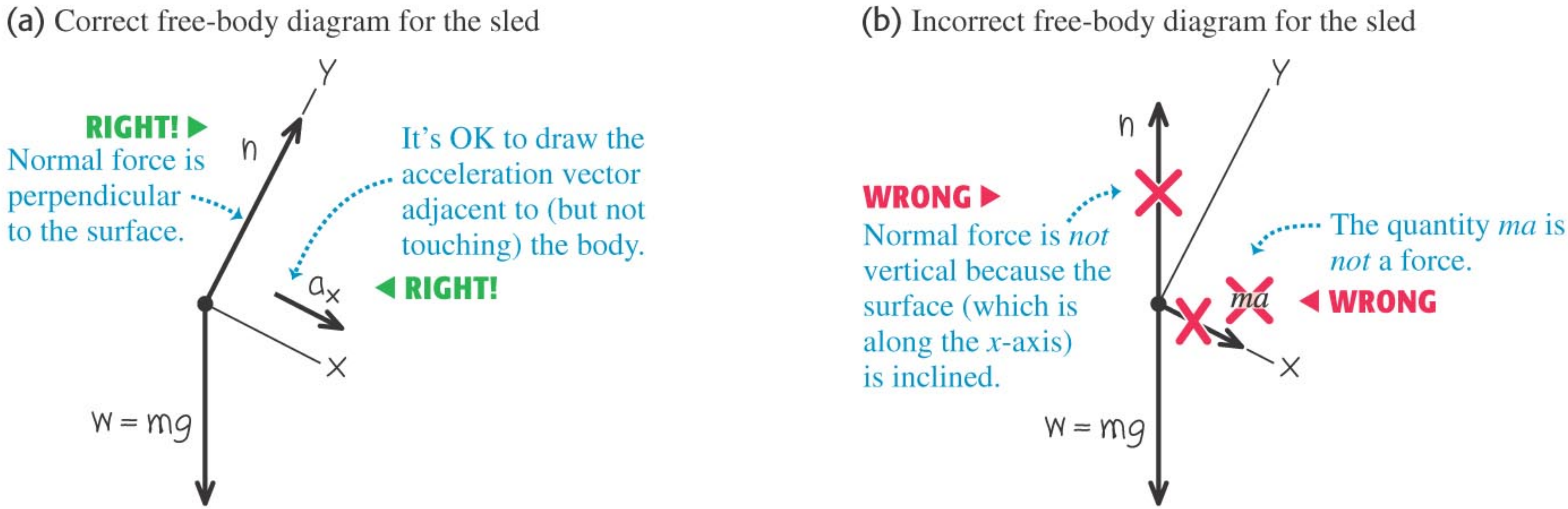
- What is the acceleration of a toboggan sliding down a friction-free slope? Follow Example 5.10.

(a) The situation



Two common free-body diagram errors

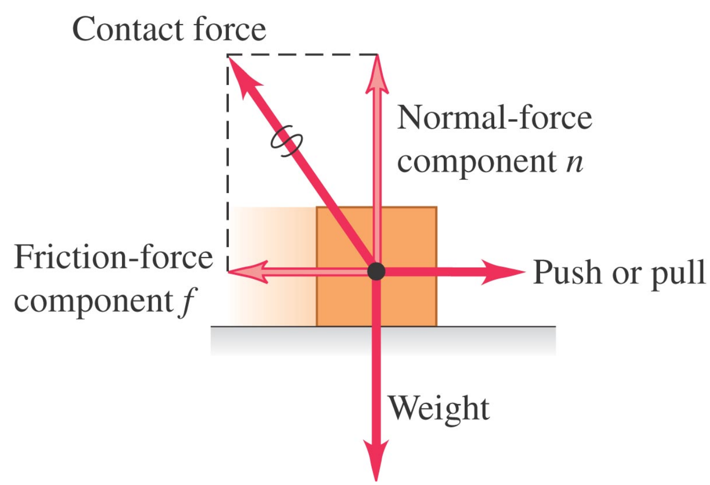
- The normal force must be perpendicular to the surface.
- There is no "$m\vec{a}$ force."
- See Figure 5.13.



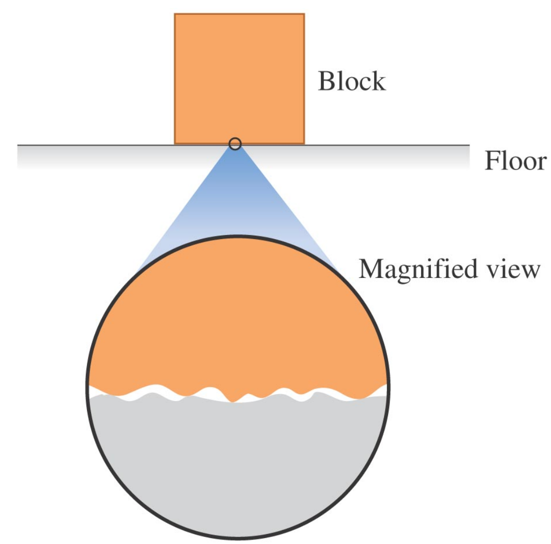
Frictional forces

- When a body rests or slides on a surface, the *friction force* is parallel to the surface.

The friction and normal forces are really components of a single contact force.

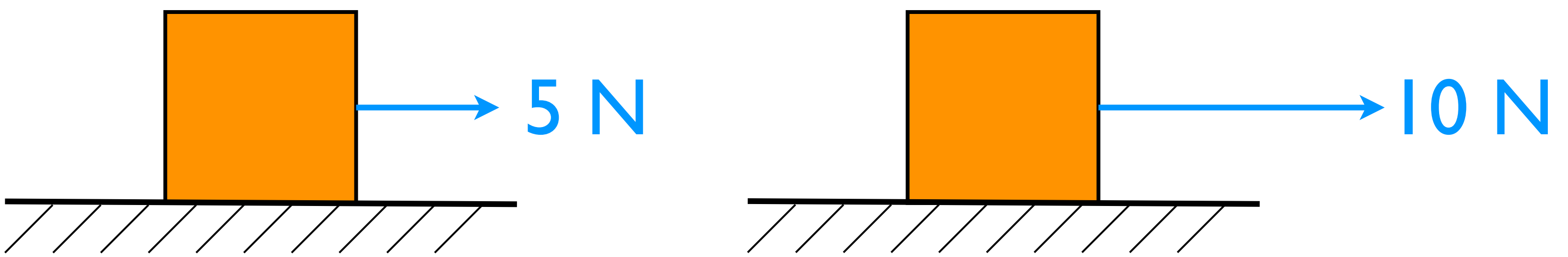


- Friction between two surfaces arises from interactions between molecules on the surfaces.



On a microscopic level, even smooth surfaces are rough; they tend to catch and cling.

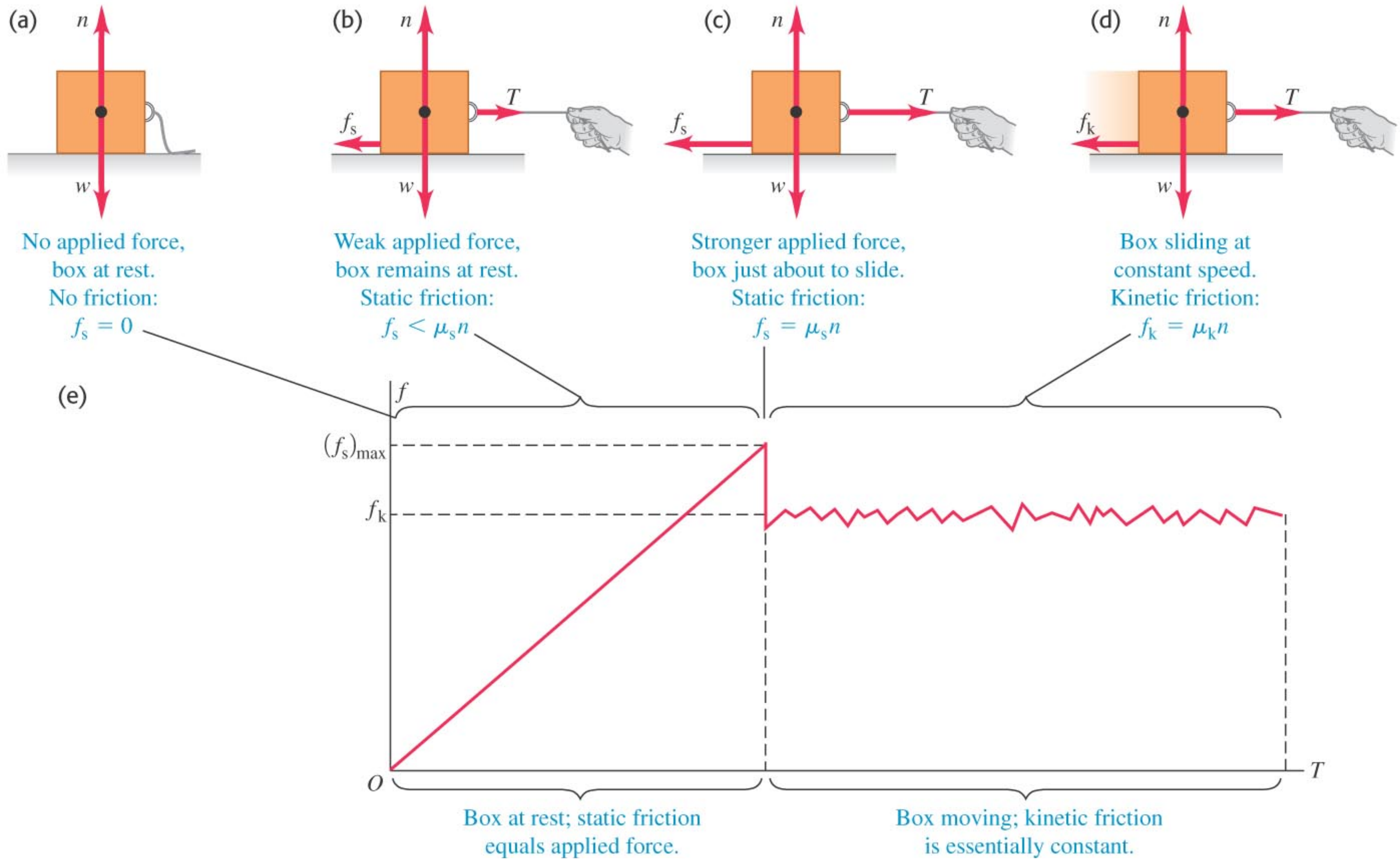
You pull on a block with 5 N of force, but friction keeps it at rest. You try again with 10 N of force, but it still won't budge. What is the magnitude of **static** friction in each case?



Text 'V' and your answers to 22333.

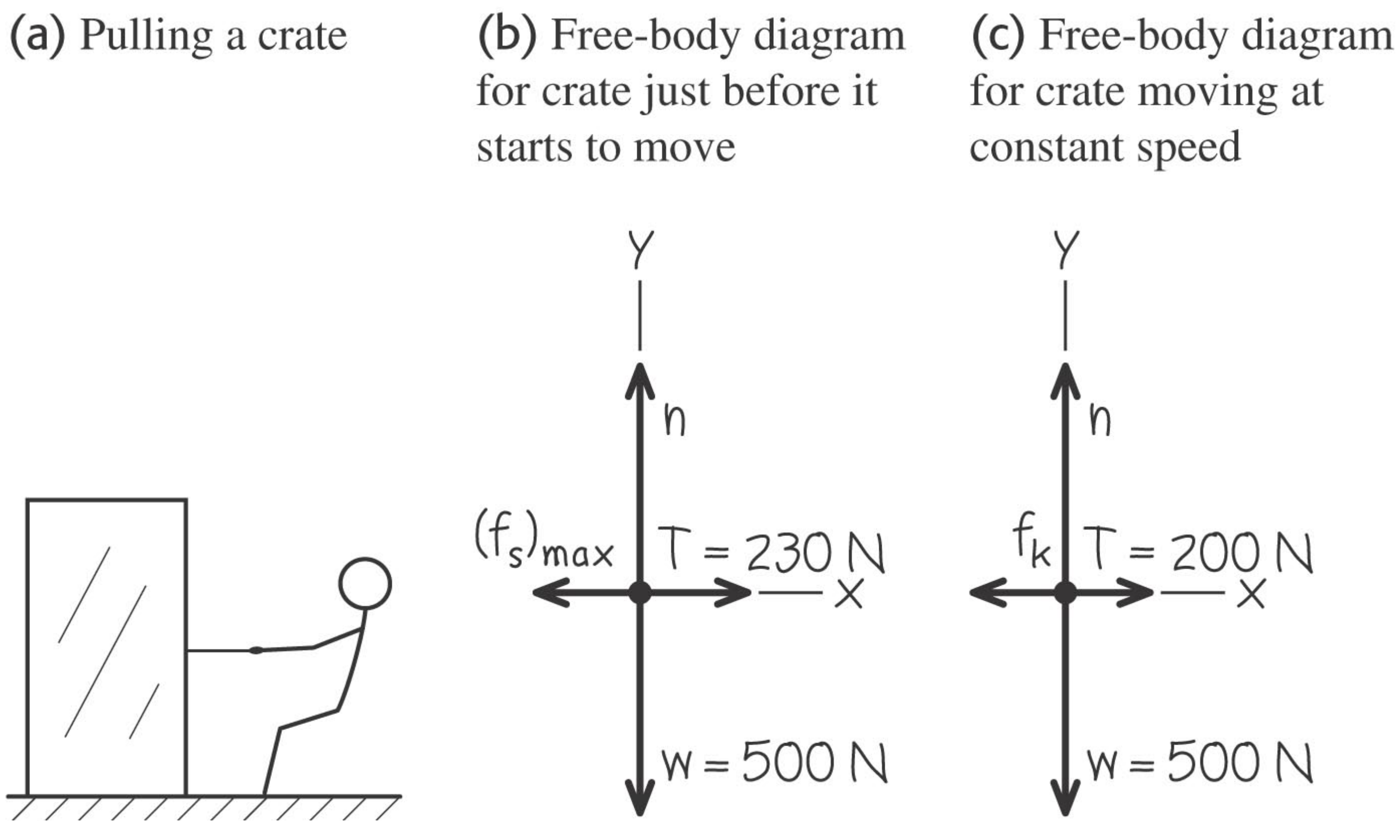
Static friction followed by kinetic friction

- Before the box slides, static friction acts. But once it starts to slide, kinetic friction acts.

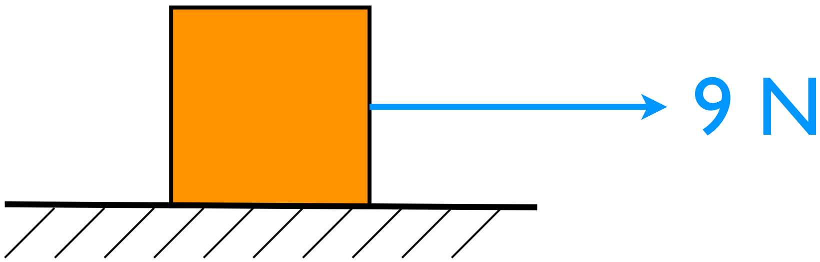


Friction in horizontal motion

- Before the crate moves, static friction acts on it. After it starts to move, kinetic friction acts.
- Static friction only has its maximum value just before the box "breaks loose" and starts to slide.



You manage to get the block moving, and it slides with constant speed while you pull on it with 9 N of force. What is the magnitude of **kinetic** friction?



F. less than 9 N
G. 9 N
H. greater than 9 N
I. Not enough information

Text your answer to 22333.

Kinetic and static friction

- The magnitude of friction depends on the normal force.
- *Kinetic friction* acts when a body slides over a surface.
- The *kinetic friction force* is $f_{\mathrm{k}} = \mu_{\mathrm{k}} n$.
- *Static friction* acts when there is no relative motion between bodies.
- The *static friction force* can vary between zero and its maximum value: $f_{\mathrm{s}} \leq \mu_{\mathrm{s}} n$.

What are the units for μ_k and μ_s?

K. N

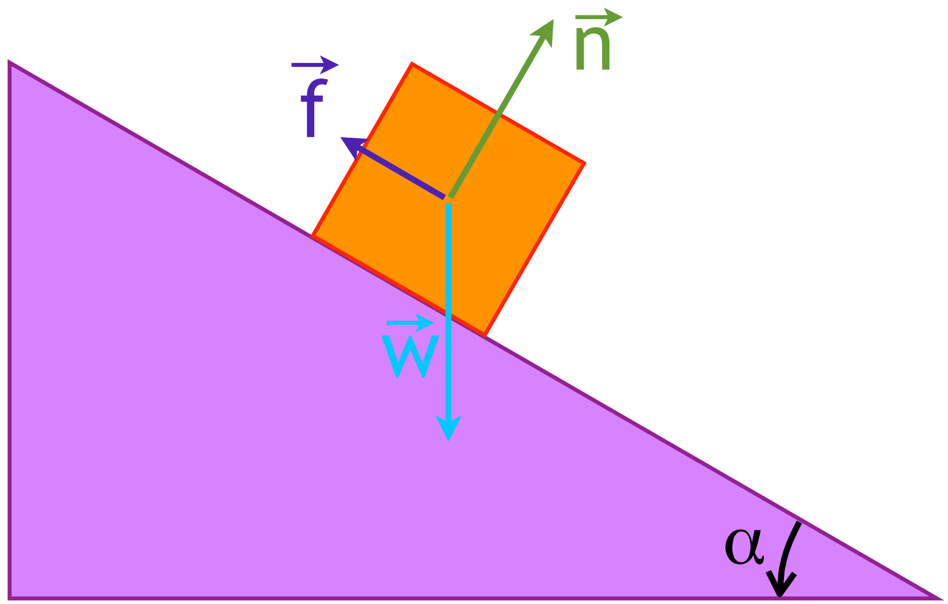
L. m/s^2

M. radians

N. None of the above

Text your answer to 22333

Now with Friction!



What is the maximum angle α before the box starts sliding down?

A heavy truck and a small car are traveling at speed v on the same road. They both slam on their brakes and skid to a halt. Assume that the coefficient of friction is the same. Which of the following is true?

Q. They both come to a stop in the same distance and same time.

R. The car stops in the least distance and in the least time.

S. The truck stops in the least distance and in the least time.

T. The truck stops in less distance, but they both stop in the same time.

U. The car stops in less distance, but they both stop in the same time.

Fluid resistance

- Small objects, low speed:

$$f = k\, v$$

- Large objects, high speed:

$$f = D\, v^2$$

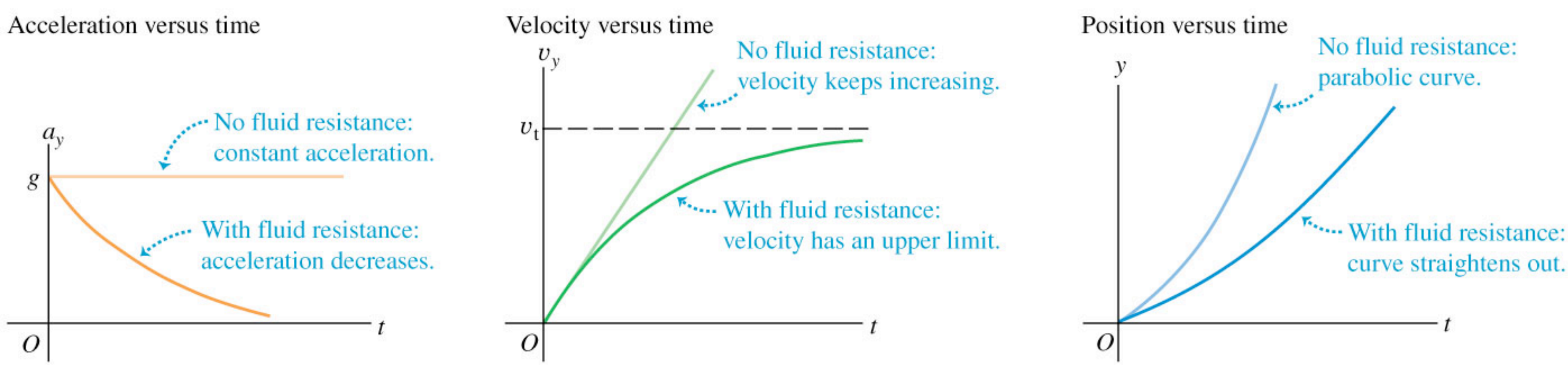
Fluid resistance, small objects, low speed

- Terminal speed:

$$v_t = mg/k$$

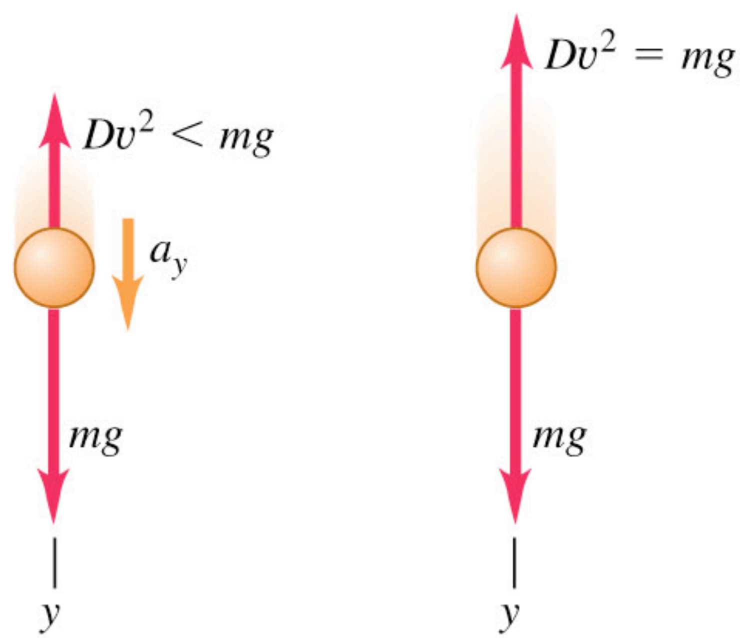
- Equation of motion:

$$v_y = v_t\,[\,1\text{-}e^{-kt/m}]$$



Fluid resistance, large objects, high speed

(a) Free-body diagrams for falling with air drag



Before terminal speed: Object accelerating, drag force less than weight.

At terminal speed v_t: Object in equilibrium, drag force equals weight.

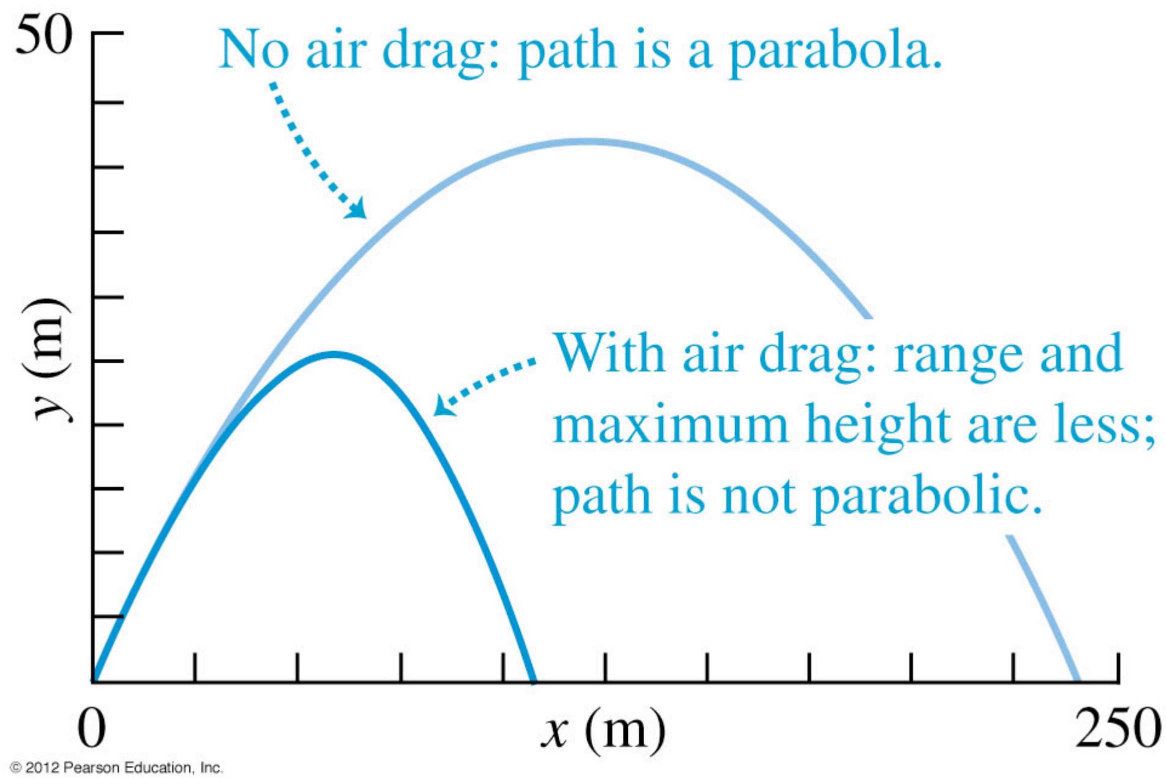
- Terminal speed:

$$v_t = \sqrt{mg/D}$$

Fluid resistance

	Small objects, low speed:	Large objects, high speed:
Force	$f = k\, v$	$f = D\, v^2$
Terminal speed	$v_t = mg/k$	$v_t = \sqrt{mg/D}$

Fluid resistance, high speed



Trajectory of a baseball