Announcements

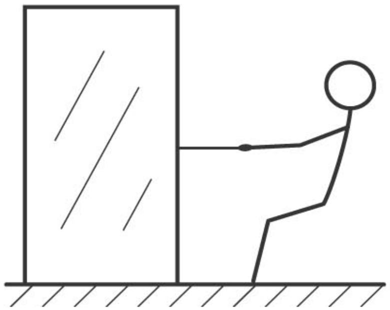
MIDTERM EXAM 1 is **today**, 5-7 PM in Clark 101

- Exam schedule: Feb 11 (Clark 101), Mar 8, Apr 10 (both White B51), 5 - 7 PM
- Makeup schedule: Feb 12, Mar 5, Apr 9, 5 - 7 PM, (Clark 317)
- Final exam: May 1, 2 - 4 PM, White B51

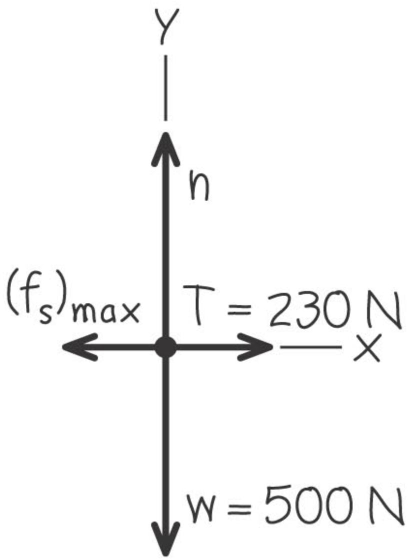
Example problem

You want to move a 500-N crate across a level floor. To start the crate moving, you have to pull with a 230-N horizontal force. Once the crate "breaks loose" and starts to move, you can keep it moving at constant velocity with only 200 N. What are the coefficients of static and kinetic friction?

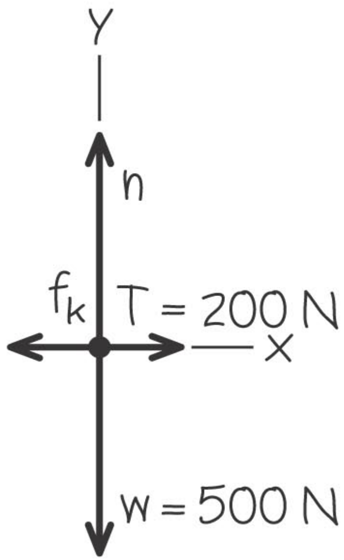
(a) Pulling a crate



(b) Free-body diagram for crate just before it starts to move

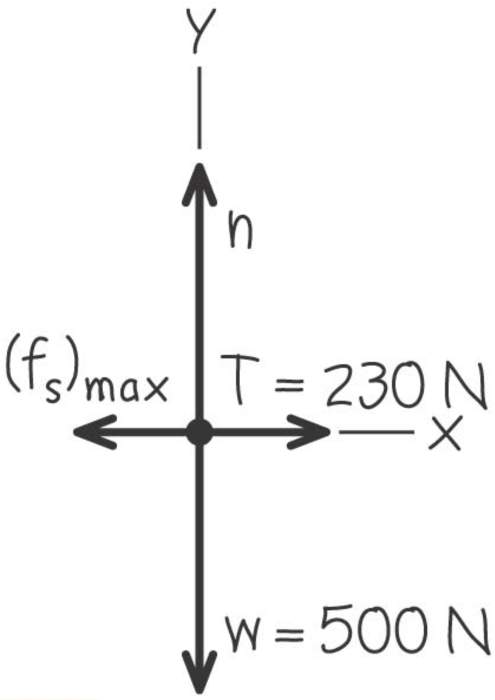


(c) Free-body diagram for crate moving at constant speed



Before the crate moves

(b) Free-body diagram for crate just before it starts to move

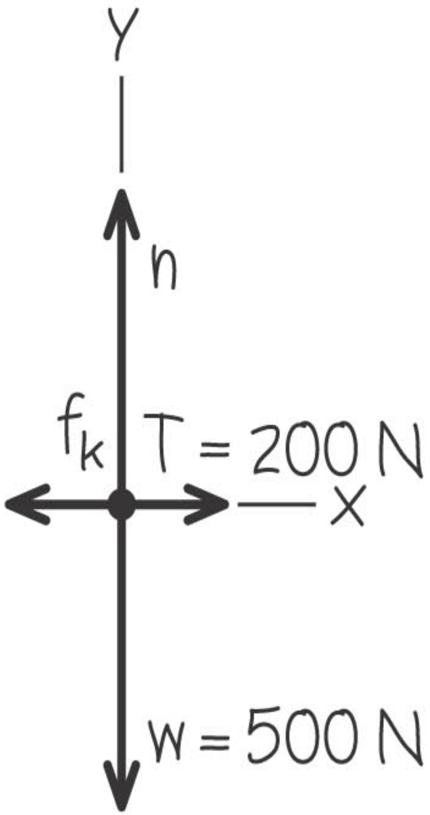


$$\sum F_x = T + (-(f_s)_{max}) = 0 \quad \text{so} \quad (f_s)_{max} = T = 230\text{ N}$$
$$\sum F_y = n + (-w) = 0 \quad \text{so} \quad n = w = 500\text{ N}$$

$$f_s = \mu_s n$$

$$\boxed{\mu_s = \frac{(f_s)_{max}}{n} = \frac{230\text{ N}}{500\text{ N}} = 0.46}$$

After the crate starts moving



$$\sum F_x = T + (-f_k) = 0 \quad \text{so} \quad f_k = T = 200\text{ N}$$
$$\sum F_y = n + (-w) = 0 \quad \text{so} \quad n = w = 500\text{ N}$$

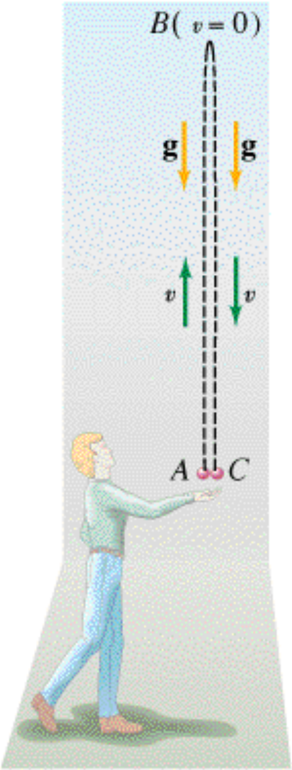
$$f_k = \mu_k n$$

$$\boxed{\mu_k = \frac{f_k}{n} = \frac{200\text{ N}}{500\text{ N}} = 0.40}$$

Free Fall example problem

A baseball is thrown up in the air at an initial velocity of 22.0 m/s.

(a) How high up does it go?
(b) How long is it in the air if you catch it at the same height you initially let go of the ball?



Some helpful equations:

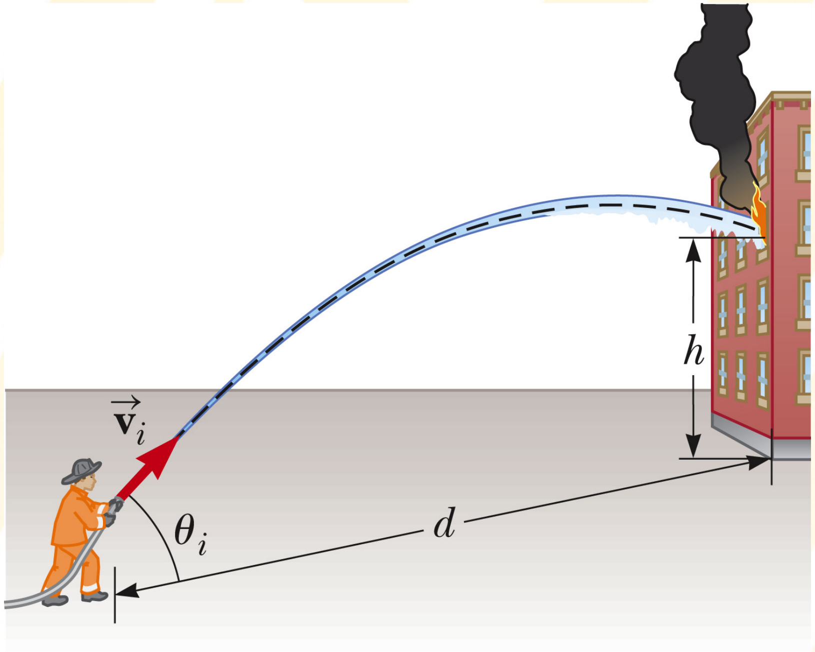
$$v(t) = v_0 - gt$$

$$y(t) = y_0 + v_0 t - \frac{1}{2}gt^2$$

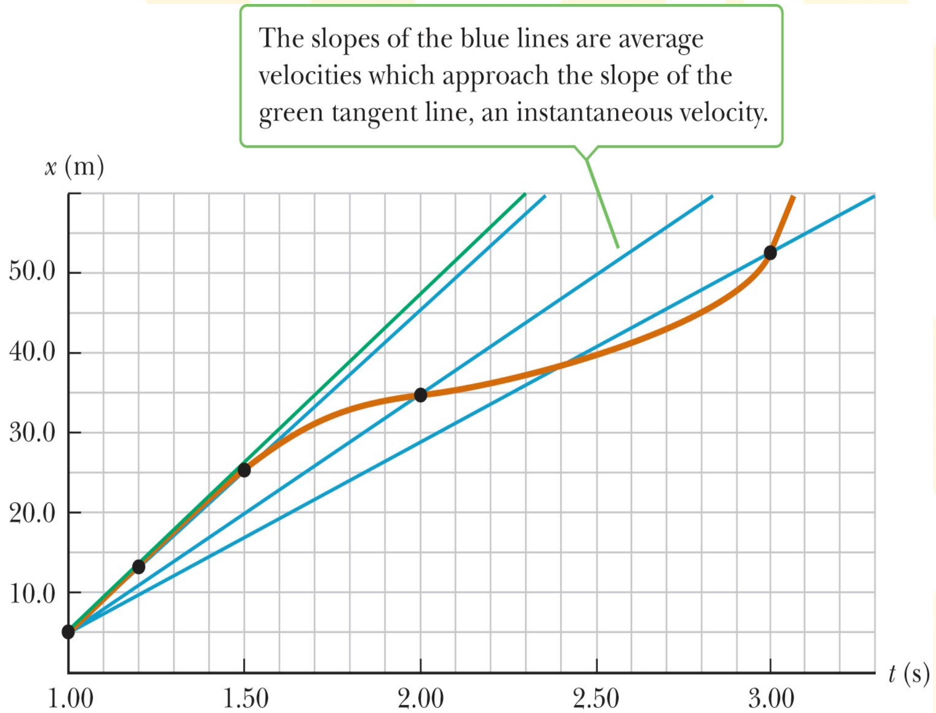
Projectile motion example problem

A fireman d = 57 m away from a burning building directs a stream of water from a ground-level fire hose at an angle of 23° above the horizontal.

If the speed of the stream as it leaves the hose is v_i = 40 m/s, at what height will the stream of water strike the building?



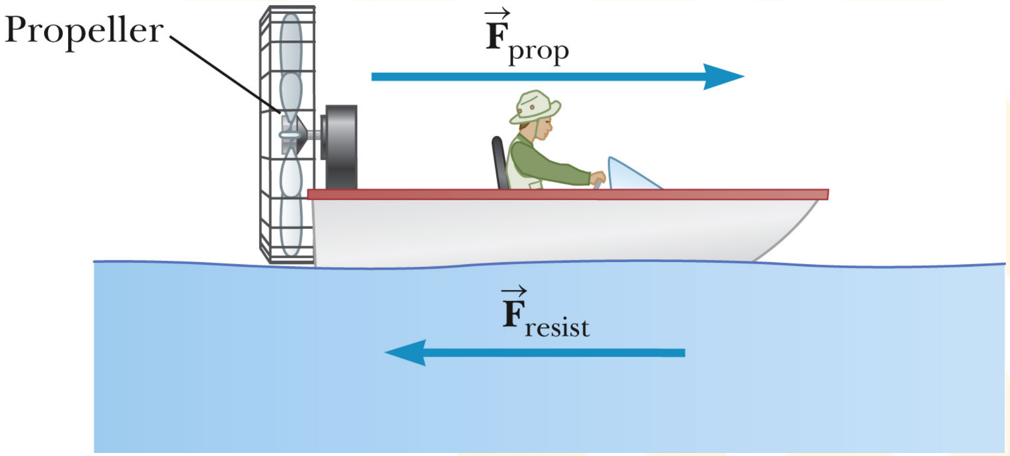
Average and instantaneous velocity



What is the average velocity in the time interval between 1s and 3s?

What is the instantaneous velocity at t = 1s?

Newton's 2nd law



A boat moves through the water with two forces acting on it. One is a 2000 N forward push by the water on the propeller, and the other is a 1800 N resistive force due to the water around the bow.

A. What is the acceleration of the 1000 kg boat?

B. If it starts from rest, how far will the boat move in 10s?

C. What will its velocity be at the end of that time?

The bird feeder

A 150 N bird feeder is supported by three cables.

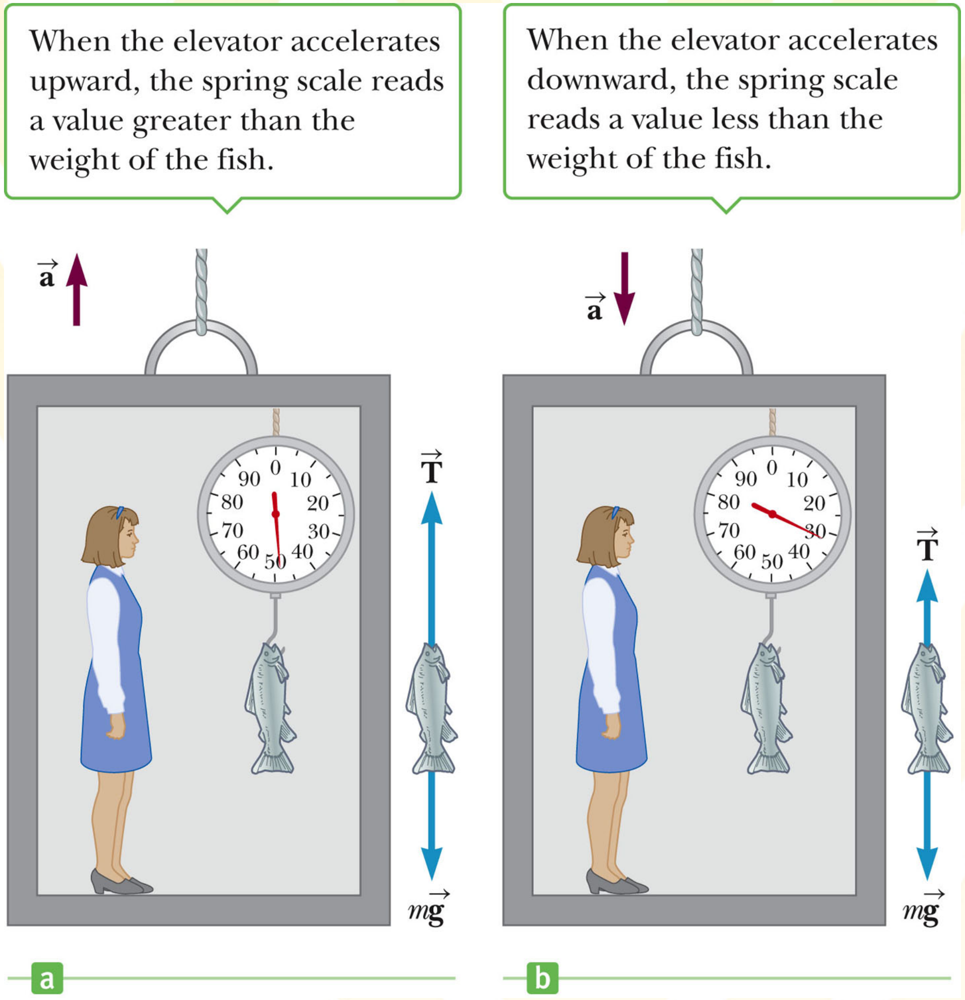
Find the tension in each cable.

Weighing a fish in the elevator

A woman weighs a fish with a spring scale attached to the ceiling of an elevator. While the elevator is at rest, she measures a weight of 40 N.

A. What weight does the scale read if the elevator accelerates upwards at 2 m/s^2?

B. What does the scale read if the elevator accelerates downwards at 2 m/s^2?

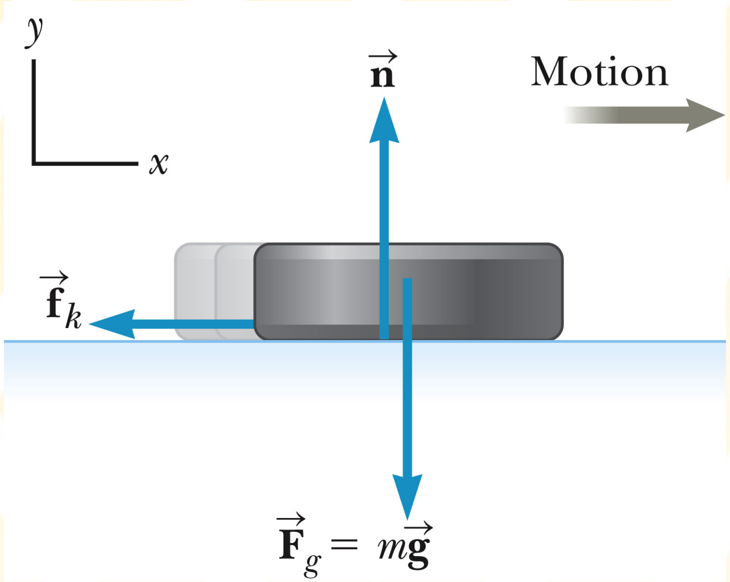


Example problem: Friction

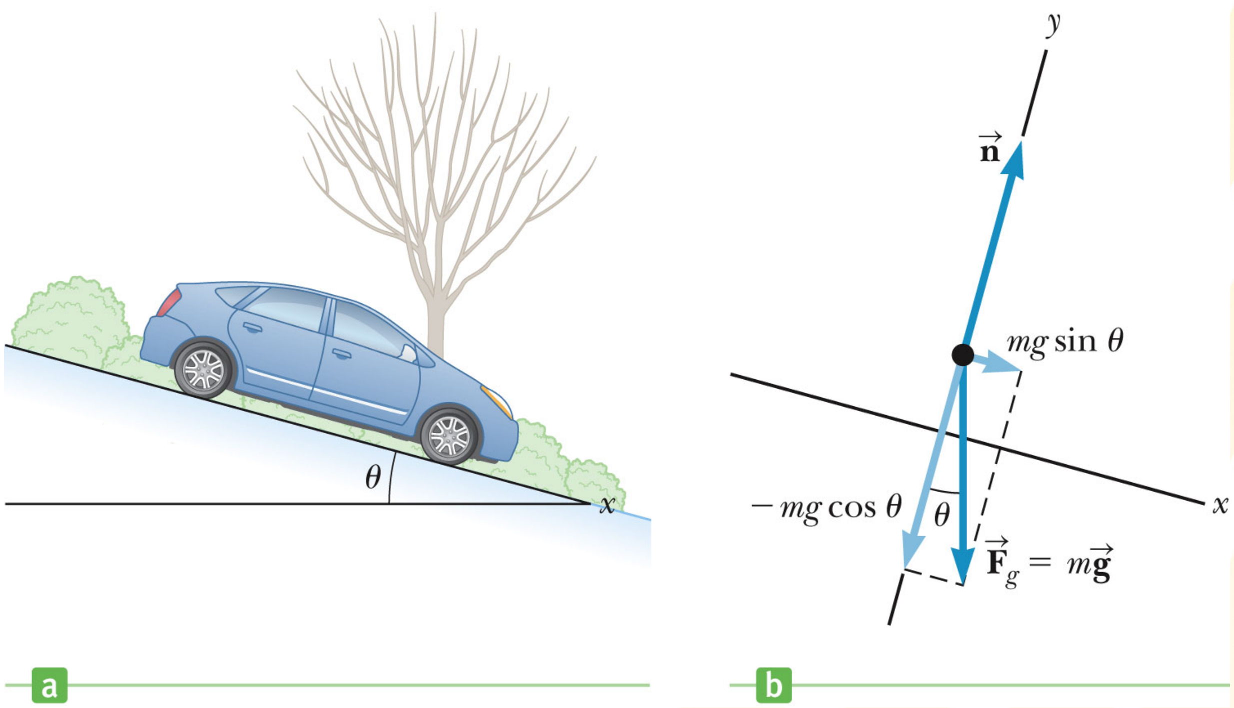
A hockey puck struck by a hockey stick is given an initial speed v_0 in the positive x-direction. The coefficient of kinetic friction between the ice and the puck is μ_k.

A. Obtain an expression for the acceleration of the puck as a function of μ_k and g.

B. Use the result of part (a) to obtain an expression for the distance, d, the puck slides. The answer should be in terms of v_0, μ_k, and g only.



The runaway car



A car of mass m is on an icy driveway inclined at an angle of 20º.

A. Determine the acceleration of the car (no friction)
B. If the length of the driveway is 25 m and the car starts from rest at the top, how long does it take to travel to the bottom?
C. What is the car's speed at the bottom?