Announcements

1. **Exam 1 occurred…**
   a. Scores:
      i. 75th percentile =
      ii. 50th percentile (median) =
      iii. 25th percentile =
   b. You will get the exam back Wed or Thurs
   c. Pick up your exams in boxes by N357 ESC, in hallway by Tutorial lab
   d. They will be distributed according to the first two numbers of CID
   e. Solutions will be posted in glass case in hallway near room N361 ESC, where HW solutions are also posted
2. If you have questions on the exam:
   a. Look over your own exam.
   b. Look over the exam solutions, see if you can figure out what you got problems wrong.
   c. Only then should you come talk to me about things you still don't understand.

Newton's 1st Law, revisited

"Objects will continue to move at *constant velocity* unless acted upon by an outside force."

"Objects at rest will remain at rest, objects in motion will remain in constant, straight-line motion, unless acted upon by an outside force"

Demo: Inertia Card and Ball

Demo: Inertia Hoop and Pen

Demo: Tablecloth jerk

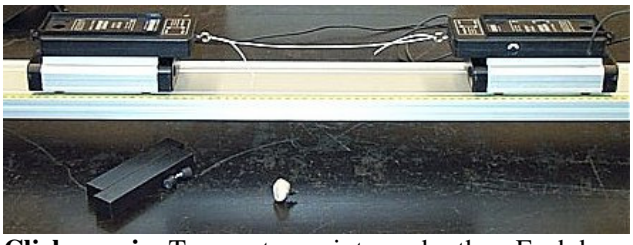
Demo: David and Goliath ball

Newton's 3rd Law, revisited

$$\vec{\mathbf{F}}_{12} = -\vec{\mathbf{F}}_{21}$$

"For every force, there is an equal and opposite partner force"

The demo we didn't do: Force-sensing carts
http://www.oberlin.edu/physics/catalog/demonstrations/mech/thirdlaw.html



Clicker quiz: Two carts run into each other. Each has a force sensor. How do the forces compare?
   a. They are the same
   b. It depends which cart is heavier
   c. It depends if they bounce or stick
   d. It depends which direction they are accelerating

Newton's 2nd Law, revisited

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

Different types of forces:
   Gravity (weight)
   Normal force
   Regular push or pull
   Friction
   Rope (tension)
   Springs

Clicker quiz: To solve a "Newton's second law problem", the first thing you should do after reading the problem is:
   a. Draw a picture
   b. Plug the forces into the left-hand side
   c. Determine the acceleration
   d. Solve simultaneous equations
   e. Day-dream of Hawaii

Elevator Problem: Review

Mary has a mass of 40 kg (weight = 392 N), and stands on an SI-unit scale in the elevator.

a. The elevator is at rest. What is the scale reading?

b. The elevator accelerates **upward** at 2 m/s^2. What is the scale reading?

c. After a while the elevator moves up at a constant speed of 8 m/s. What is the scale reading?

Accelerating Reference Frames

Demo: Rotating chair

To be able to ascribe accelerations to *real* forces, you must be observing the motion from a **non-accelerating (constant velocity) point of view**

Physics lingo: "point of view" = "reference frame"

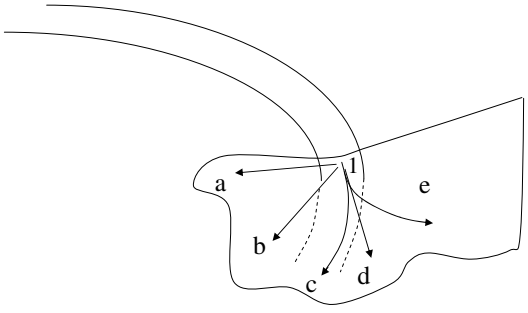
Amusement Park Ride: Floor drops out. What are the forces?

In **accelerating** reference frames, we tend to invent fictitious forces.

Clicker quiz: A car rounds a curve while maintaining a constant speed. Is there a net force on the car as it rounds the curve?

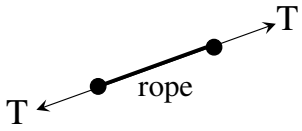
a. No, because its speed is constant.
b. No, because the normal force is balanced by gravity.
c. Yes, because it's changing direction.
d. Yes, because it's slowing down.

Clicker quiz: A car hits an icy spot on the road at point 1. What is the path of the car if there is no friction on the ice?



Ropes and pulleys

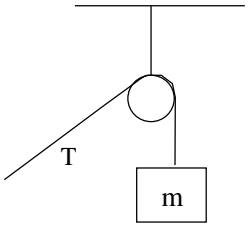
When we pull on a rope, we create tension (T) everywhere in it.



Same on both ends, so no net force on the rope.

What direction do ropes pull? Always _____

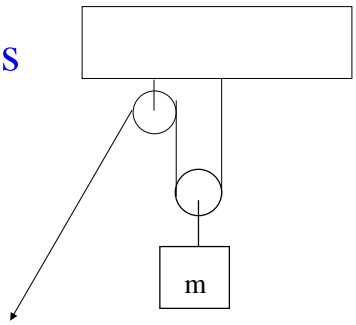
What do pulleys do?
(frictionless, massless)



Does tension = weight of object?

Moveable pulleys

Image credit: wikipedia



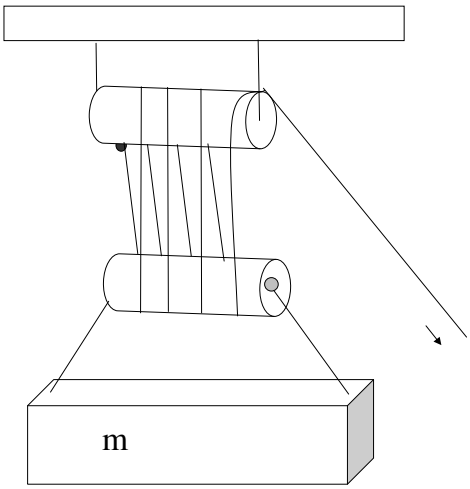
(One of six "simple machines")

Gives *mechanical advantage*

Tension required to hold or slowly lift is *lower* than lifting the mass directly

Solving physics problems:

- Draw FBD of the moveable pulley
  → or sometimes, of the mass & pulley together
- See how many T-vectors are pulling upward
- Solve Newton's 2nd law

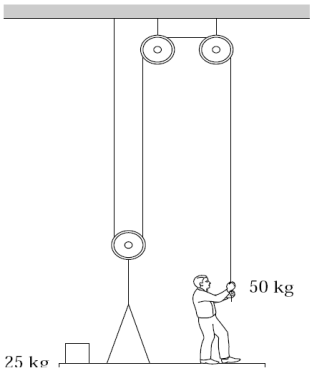


Problem: Assume frictionless, massless string and pulleys, and negligible acceleration. What is the tension in the string you pull?

Demo: Mechanical advantage 8-pulley demo

Clicker quiz: A 100-kg man stands on a 25-kg platform. He pulls on the rope that is attached to the platform via the frictionless pulley system shown here. If he holds the platform **stationary**, with how much force is he pulling on the rope? Ignore friction and **assume g = 10 m/s^2**.

A. 750 N
B. 500 N
C. 250 N
D. 125 N
E. 100 N



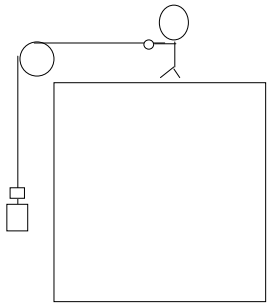
Hint: consider "object" as man + platform + one pulley

Question: What is he pulls the platform up at a **steady rate**?

Demo: Atwood machine with airtrack

Worked Problem: Gilbert (100 kg) is lifting the 50 kg group of boxes over a frictionless pulley while on top of a building. He then steps on some frictionless ice.

a. If we treat Gilbert and the boxes as one group what is the magnitude of the force (from outside) that accelerates the group?



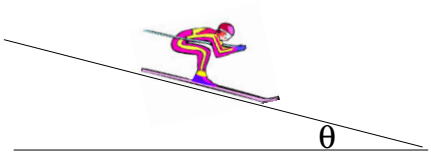
b. What is the acceleration of the group?

c. What is the tension in the rope above the two boxes?

Inclined planes!

(another of the "simple machines")

A skiier is on a hill with no friction. What is her acceleration?



Concepts first:

What force is it that accelerates her?

What is the acceleration for two extremes:

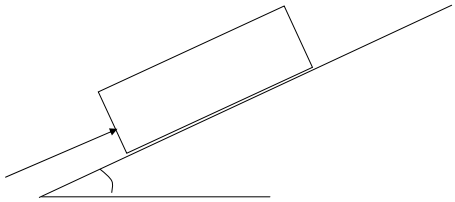
level ground

infinite slope

What is acceleration for a given angle θ?

Worked Problem:

You push with a force of 200 N on a 25 kg frictionless ice block which is on a hill sloping 30° above the horizontal. What is the acceleration of the block?



Same setup:

If you push with the same force, but horizontally what will the acceleration be? (Qualitatively: will it be more, less or the same)