Announcements – 18 Sep 2014

1. Prayer

2. I'll be out of town from Fri – Mon, so I won't have my usual office hours on Monday

3. **HW 6** (due Tuesday) will require free body diagrams to be turned in for some problems. **Use forms at end of syllabus**.
   a. Read the "Free Body Diagrams" page in the syllabus.
   b. Turn them in to the "turn in" boxes near N357 ESC (closed boxes)
   c. They'll be returned to the "turn back" boxes at the same location (cubbyholes)

"Which of the problems from last night's HW assignment would you most like me to discuss in class today?"

Newton's Third Law Review

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

<u>Forces always come in *pairs*</u>

$$\vec{\mathbf{F}}_{1-2} = -\vec{\mathbf{F}}_{2-1}$$

Question

Are the ***acceleration*** magnitudes of the two objects always the same?

Think about football being kicked…

Demo

Dr. Colton pushing against the wall

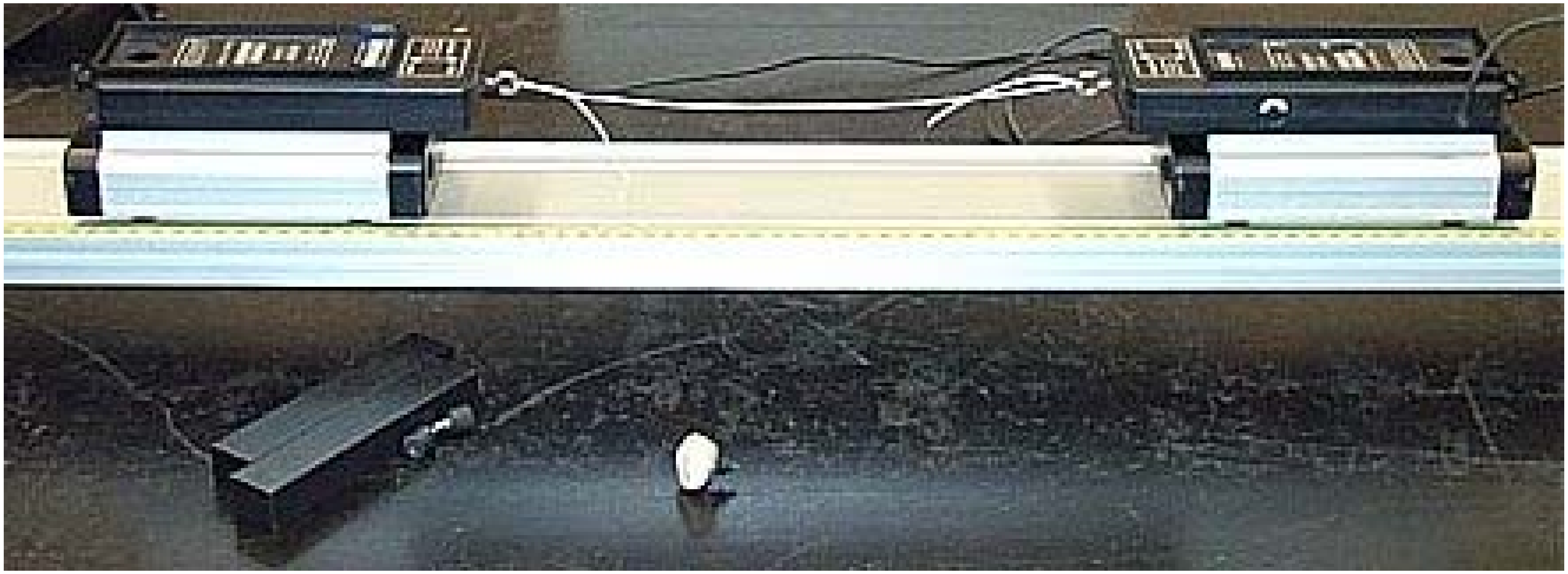
Clicker quiz

A hammer hits a nail, and the nail is driven into the board. The magnitude of the force of the nail on the hammer is ____________ the force of the hammer on the nail.

a. less than
b. the same as
c. more than

Demo

Force-sensing carts



Clicker quiz: Two carts run into each other. Each cart has a force sensor. How do the forces' magnitudes compare?

a. They are the same
b. It depends which cart is heavier
c. It depends if they bounce or stick
d. It depends in which direction they are accelerating

Newton's 1st Law, revisited

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

or

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

From warmup

The force required to maintain an object at a constant speed in free space is equal to

a. the mass of the object
b. the weight of the object
c. zero
d. the force required to stop it
e. none of the above

Demos

Demo: Tablecloth jerk
Demo: Inertia Hoop and Pen
Demo: David and Goliath ball

Video: Shifted air track

Clicker quiz: Relative to the table, how will the glider move?

a. It will move left when the track moves left
b. It will move right when the track moves left
c. It will stay motionless as the track moves left

Back to Newton's Second Law

Solving Newton's 2nd Law problems

1. Draw the correct free-body diagram

2. Apply N2 to both the x- and y-components:

   $\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$

   → m is the mass of the object
   → Be careful with positive vs. negative; forces are vectors!

3. Treat these equations as **blueprints**
   → Fill in the blueprints with the information you're given, to get the "real equations"

<u>Multiple objects:</u>

- Draw a free-body diagram and write eqns for each object, separately
- If objects are connected, you can treat them as group

Clicker quiz

A monkey starts to slide down a rope. It adjusts its grip until it slides at a constant velocity down the rope. Which of these choices is true in this situation?

a. The gravitational force is equal to the frictional force.
b. The gravitational force is greater than the frictional force.
c. The gravitational force is less than the frictional force.

Elevators

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

a. The elevator is at rest. What does the scale read?

b. The elevator **accelerates downward** at 2 m/s^2. What does the scale read now?

c. After a while the elevator moves down at a **constant speed** of 8 m/s. What does the scale read now?

d. What happens when the elevator begins to stop?

Try it out! The elevators in the Eyring building (sometimes) have scales in them!

From warmup

Ralph was thinking about the demo with the penny and feather falling in a vacuum. The penny and feather both fell at the same rate. He asked, "Does this mean that the force on the penny and the force on the feather are equal?" What would be a good answer (and explanation) to his question?

“Think-pair-share”

- Think about it for a bit
- Talk to your neighbor, find out if he/she thinks the same as you
- Be prepared to share your answer with the class if called on

Clicker: I am now ready to share my answer if randomly selected.

a. Yes

Note: you are allowed to "pass" if you would really not answer.

Worked Problem

Mary (40 kg) and Fred (60 kg) have an argument on frictionless ice. Mary pushes Fred with a force of 120 N (27 lbs) for 0.5 second

What is Fred's acceleration while she pushes him?

What is *Mary's* acceleration while she pushes him?

What is Fred's acceleration after he is out of Mary's reach?

What are their final velocities?

Answers: 2 m/s^2, 3 m/s^2, 0, 1 m/s, 1.5 m/s

Ropes

Pulling on a rope creates tension (T) inside of it. This is a force.

You pull on the rope… and it pulls on you

What direction do ropes pull? Always _______________

If rope is "massless", tension pulling on both ends is: ________

From warmup

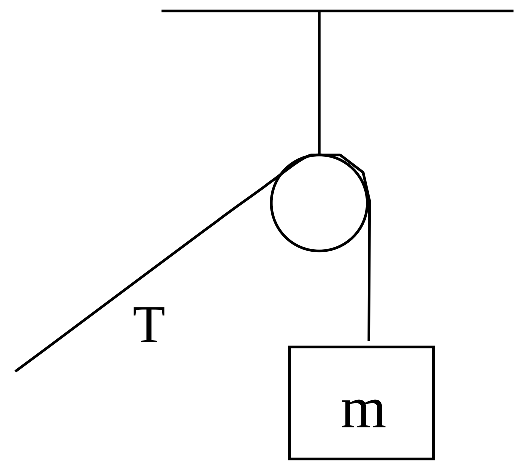
Two teams are having a tug-of-war, using a nylon rope with essentially no mass. Team A (on the left) is winning--both teams are accelerating to the left. What can you say about the tension in the rope?

a. It is higher on the left than on the right.
b. It is higher on the right than on the left.
c. It is constant throughout the rope.

Pulleys

What do <u>pulleys</u> do?

(massless, frictionless)

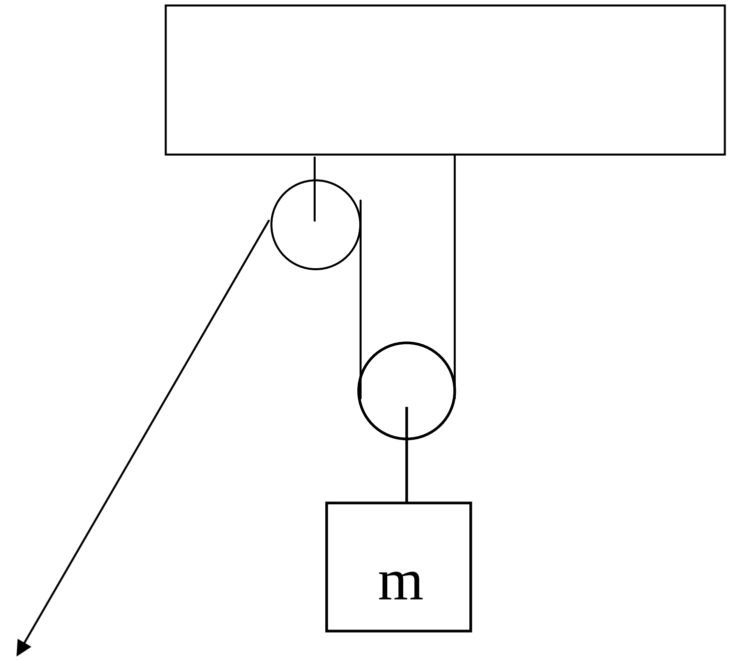


Demo: Basic pulley

Question: Does tension always = 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

Trade off: You have to pull for a **longer distance.**

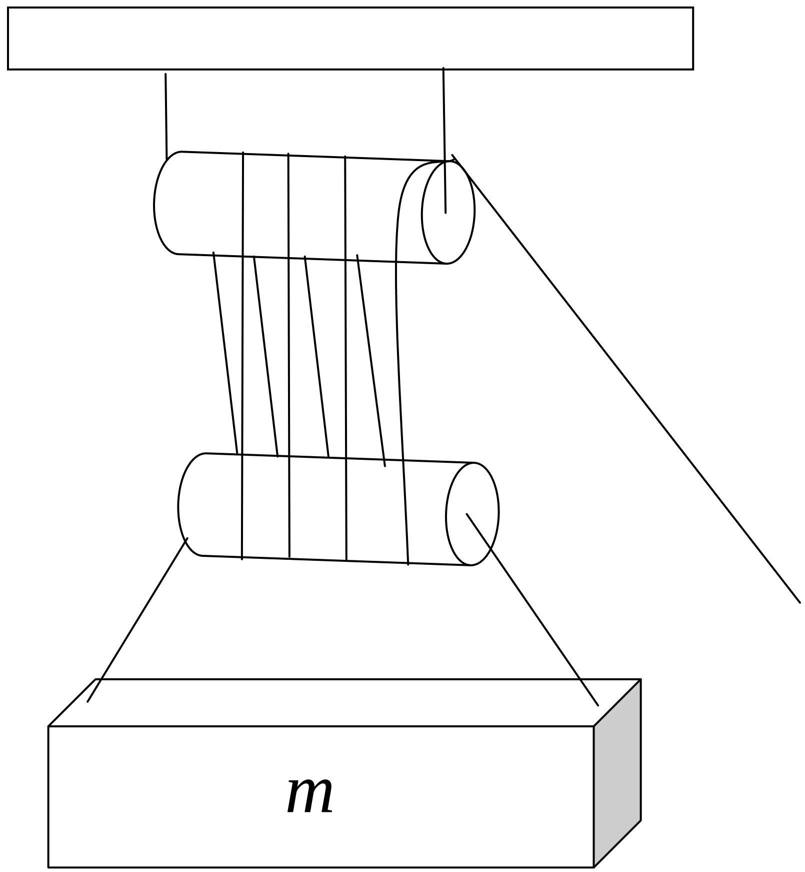
Demo

Mechanical advantage 6-pulley demo

Solving physics problems with moveable pulleys:

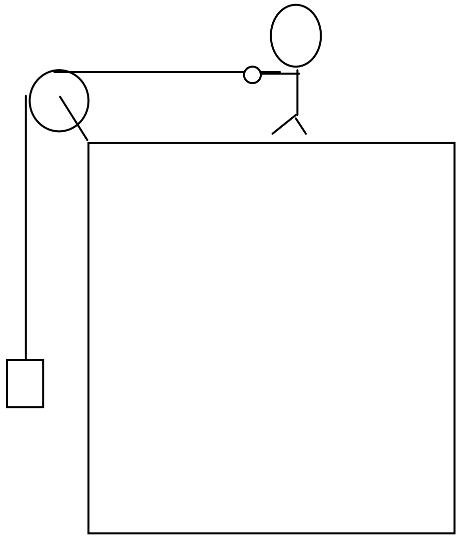
- Draw FBD of the moveable pulley and connected masses
- See how many T-vectors are pulling upward
- Solve Newton's 2nd law

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



Worked Problem

Gilbert (100 kg) is lifting the 50 kg box over a frictionless pulley while on top of a building. He then steps on some frictionless ice. Use g = 10 m/s^2.



a. Treat Gilbert and the box as one group. What is the magnitude of the force (from outside) that accelerates the group?

b. What is the acceleration of the group?

Answers: 500N, 3.33 m/s^2

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

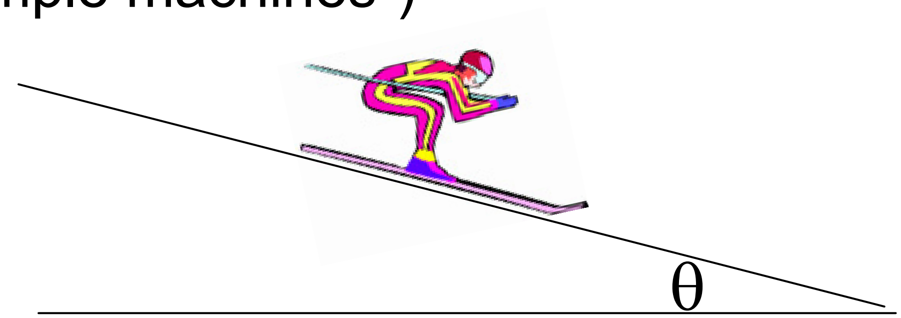
Method 1

Method 2

Answer: 333 N

Inclined planes!

(another of the "simple machines")



From warmup: A skier is on a hill with no friction and a 20° slope. What is her acceleration?

a. Less than 9.8 m/s^2
b. Equal to 9.8 m/s^2
c. More than 9.8 m/s^2

Question

What is her *precise* acceleration? (if no friction, no other forces)

The standard technique: t_______ the a________

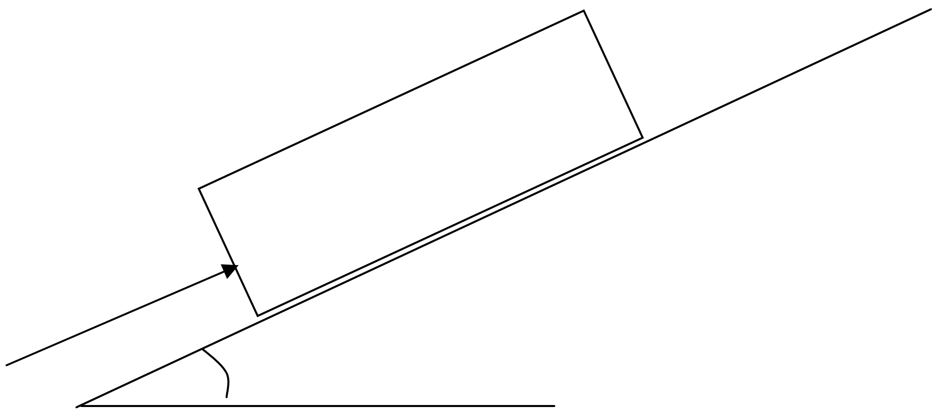
Hint: think of her acceleration for two extremes:

level ground

infinite slope

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? Use $g = 10\ m/s^2$.



Answer: $3.0\ m/s^2$