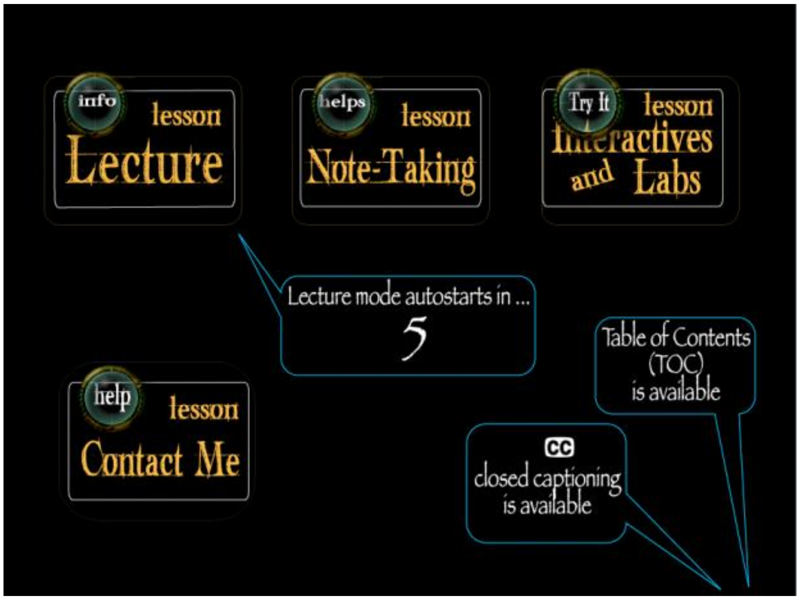
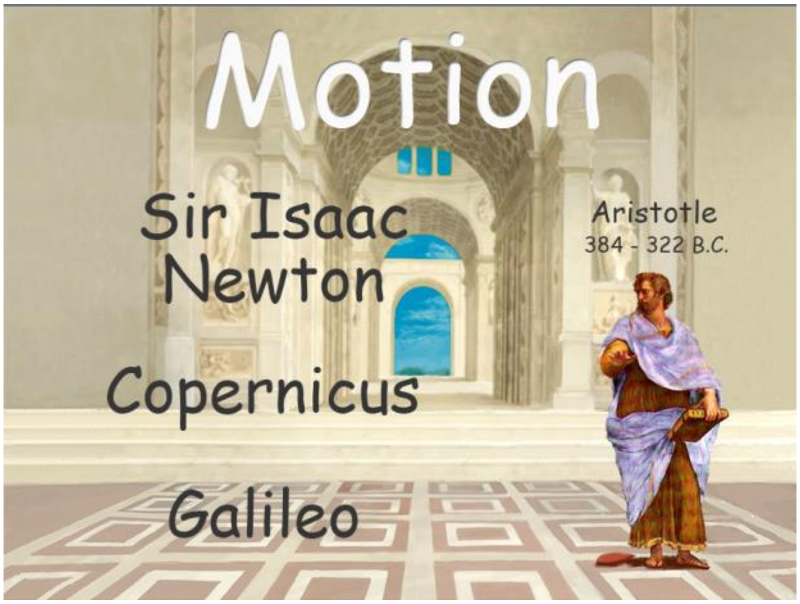
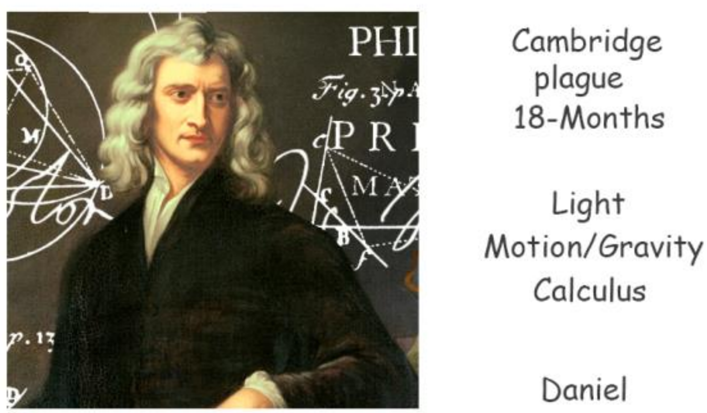
Motion

Monday, February 18, 2013
8:06 AM

Slide	Notes
	
	The history of humankind's understanding of motion begins with the ancient Greeks. In particular, Aristotle who is considered the father of modern scientific thought. He spent a great deal of his life observing things around him and trying to draw conclusions about the nature of the world. His teachings guided scientific inquiry for almost 2000 years.



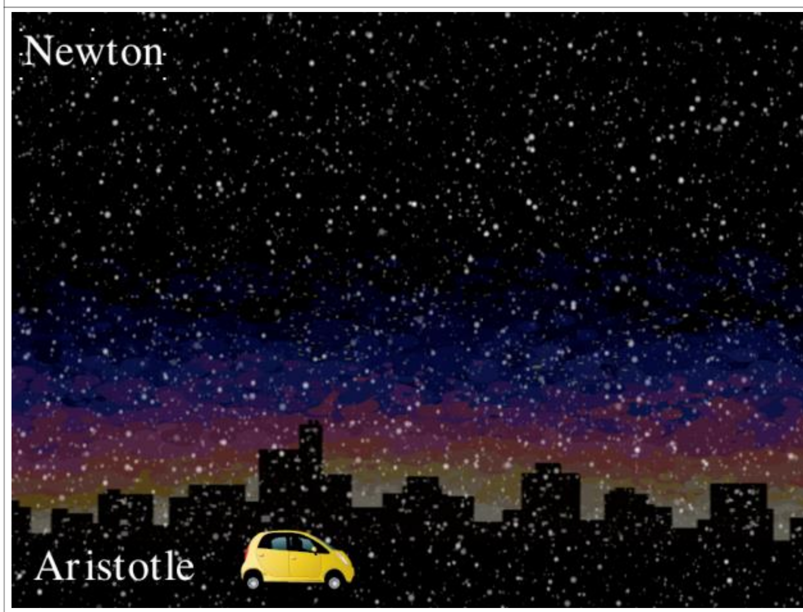
But, during the Renaissance, a few scientists began to notice that some of Aristotle's ideas were not correct. It was hard for most scientists to give up Aristotle's ideas which they had accepted without question, but a few scientists led the way: Sir Isaac Newton, Copernicus, and Galileo. We will talk about Copernicus and Galileo in a latter lesson, but in this one, we will focus on Sir Isaac Newton.



Newton was a student at Cambridge University when a plague came through. All the students were sent home until it passed. In the 18 months he waited for classes to resume, he had an incredibly productive series of explorations.

He made discoveries and equations related to light. He invented the branch of mathematics now known as calculus because his research into motion and gravity showed that algebra alone just couldn't cut it.

He spent more time studying Daniel than in charting the Heavens. He believed science lead him to learn more about God.



1st Law (note to instructor - move car as needed to demonstrate each)

Aristotle vs Newton. Aristotle's views had been around for about 1,000 to 2,000 years. Newton agreed with some of the ideas that Aristotle had, but he had a few new ways of looking at motion. Aristotle says that objects at rest want to stay that way and Newton agrees. However, Aristotle says objects in motion are lazy and want to also be at rest and that is why they slow down.

Newton had other thoughts. He said that the object actually will stay in motion if it were not for it being acted on my another force that is causing it to slow down. Do you know what that force is? Friction! It is an unbalanced force - gravity, air resistance, friction, etc.

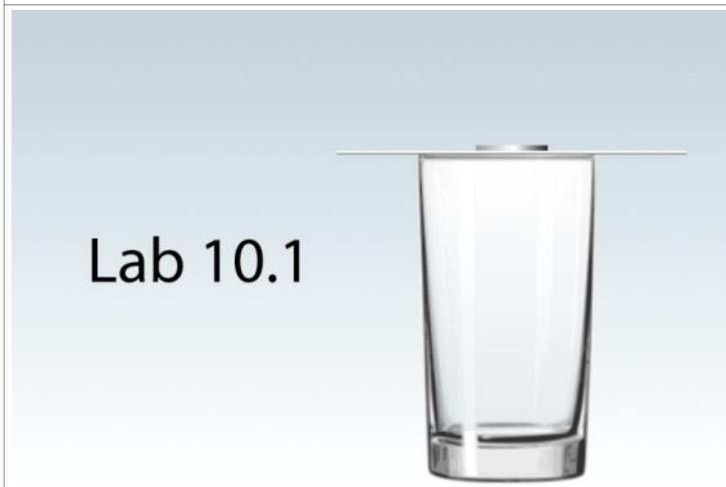
So, an object in motion wants to stay in motion. It isn't just for motion though. Newton says that an object at rest wants to stay at rest. If the car is just sitting there it will stay sitting there unless some force acts on it to make it move. That is called inertia for moth motion and non-motion. Let's take a look at a fun example ... (next slide)

The velocity of an object will not change unless it is acted on by an outside force. | Newton's First Law of Motion

A pilot is flying a mission to drop supplies to an an emergency relief station.

Choose one answer.

- (•) a. The pilot should drop a bit before he is over the target
- ( ) b. The pilot should drop the supplies just after the he passes over the target
- ( ) c. The pilot should drop the supplied when he is directly over the drop target

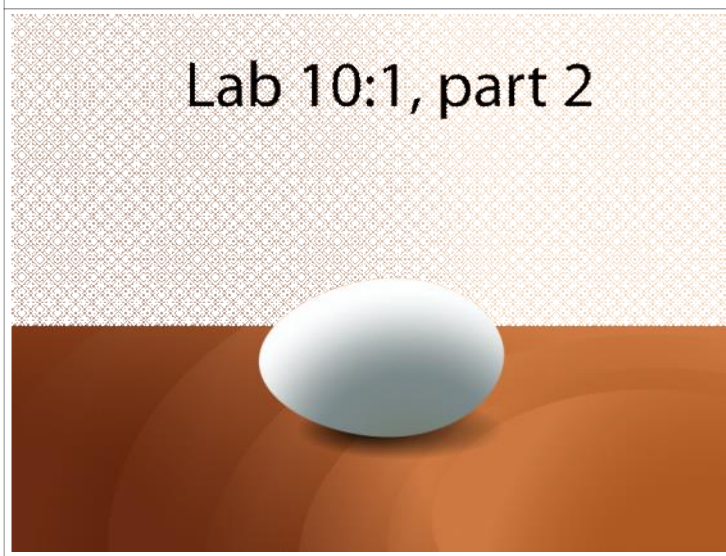


Inertia

Inertia - describes that you must apply a force of an object to change its velocity.

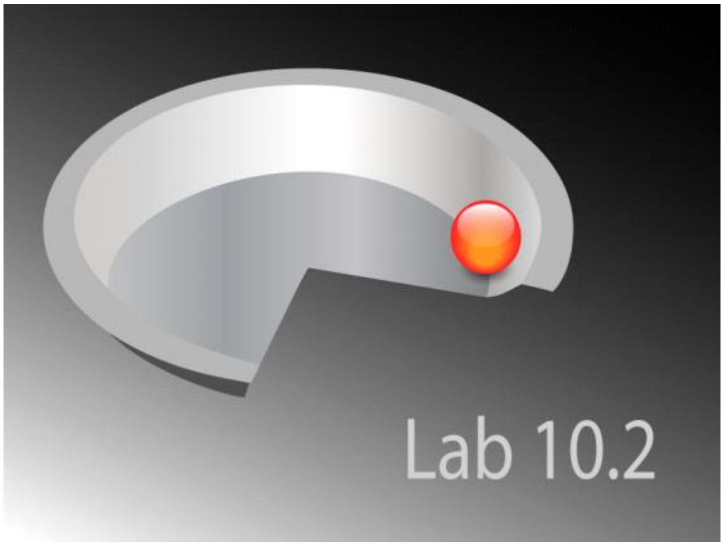
An example is the old tablecloth trick where you pull the tablecloth really fast at a horizontal pull and all the dishes stay put right were they were originally located. That fast pull ends up causing too little friction force to pull the dishes off the table. However, if you pull slowly, that force is strong enough to bring them crashing to the floor.

A way to try this that is safer for your mom's dishes is to put a coin on cardstock above a glass. If you move the card too slow, the coin will follow the card. If you pull fast, clink, the coin will instead be left in mid-air instead and then fall due to gravity.



If you spin a raw egg, the outside of the egg responds to the force you apply and you see the spin it causes. However, if you quickly bring the eggs to a stop and let go just as quickly you will see something interesting. When you let go it will start moving again. Why?

This happens in your inner ear too. Your sense of balance comes from a structure in your inner ear that is filled with a fluid. Little hairs are bend as the motion of the fluid changes. If you spin round and round and then suddenly stop, the motion of the fluid is much like the motion inside the egg. That is why you feel dizzy.



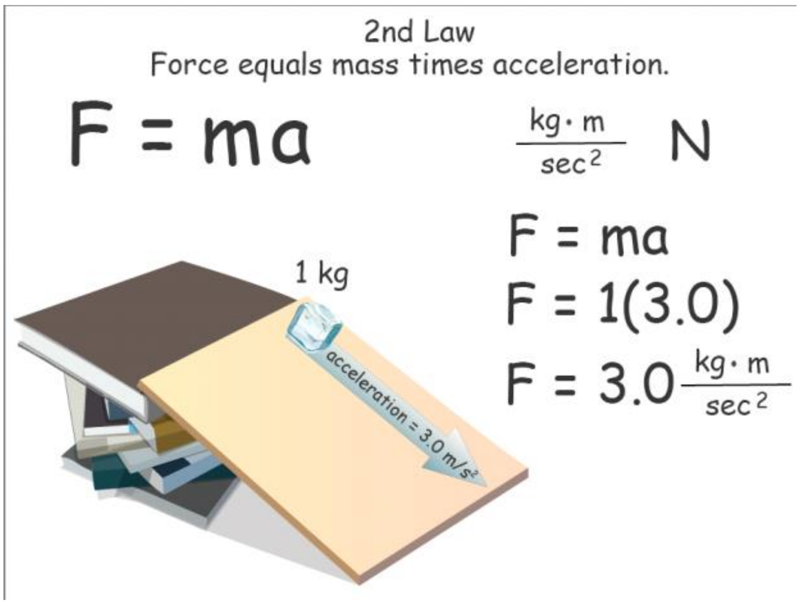
If you cut into a pie pan as you see here and give the marble a good push so that it goes around the edge, what happens to its motion as it leaves the pie pan? What angle will it continue to travel at when it goes off the tin? Will it curve or go straight? I think it will go straight, but try it out to see if I am right.

(mouse and turn table - live class)

A cruel boy places a mouse on a rotating disk. He speeds it up until the mouse can just barely hang on to the spinning disk. If he stops the disk spin to a complete halt, the mouse will most likely ...

Choose one answer.

- a. fly off the disk in an arc
- b. continue to spin around the disk
- c. stop instantly with the disk
- d. fly off the disk in a straight line



Newton's 2nd Law involves an equation that can let us calculate the relationship between how heavy something is and how much force is needed to accelerate that object. Newton's 2nd Law: Force equals mass times acceleration.

Let's take a look at the units: Kg*m/sec^2. It could also be N which is Newtons

Now let's try an example of the math involved [see slide]

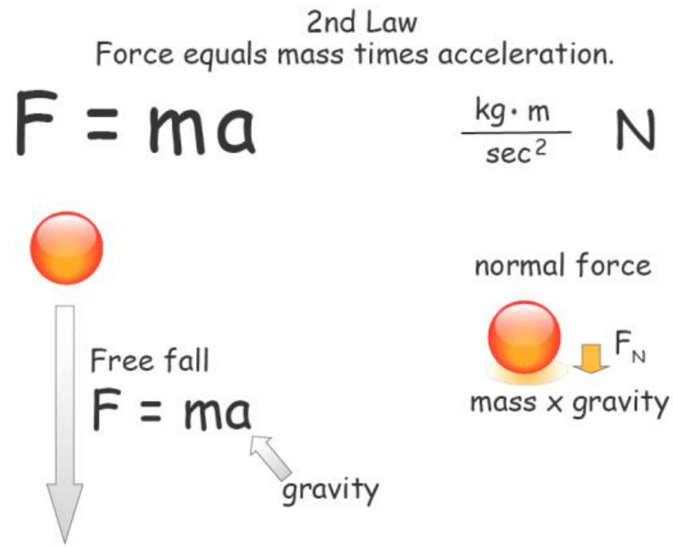
When an object is acted on by an outside force, the strength of that force is equal to the mass of that object times the resulting acceleration. [Newton's Second Law of Motion]

An ice cube (mass = 1 kg) slides down an inclined serving tray with and acceleration of 3.0 m/s^2 . Ignoring friction, how much force is pulling the ice cube down the serving tray?

Choose one answer.

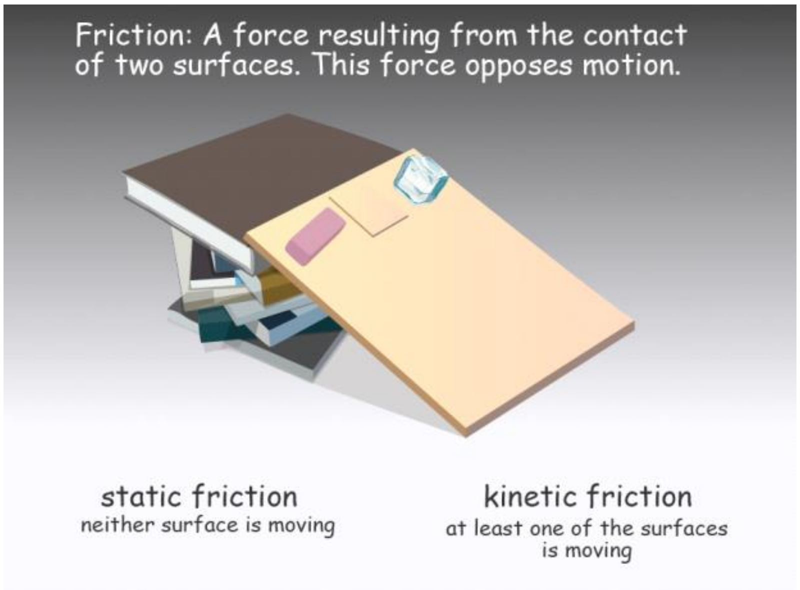
- a. 3.0 N/s^2 down the tray
- b. Not enough information.
- c. 3.0 m/s^2 down the tray
- d. 3.0 N down the tray

Free fall can also use Newton's Second Law. The acceleration is



what gravity is.

You don't have to even be moving to have forces at play. When you stand on something the amount of force you are pushing down on that surface is mass times gravity, but you are not falling because the surface is pushing back up with the same force mathematically. This is called normal force.



Friction

You probably already have noticed that some things move more easily than others. In this module's lab, you will be exploring it. Set up a ramp and let some things slide down the ramp. Some will slide down slowly because friction is close to being the same as the force of gravity. Other things will slide more readily because it

What is friction? Friction is the force that slows things down. It is caused by the surface of one object microscopically locking into the surface of another object. Some surfaces are rough and lock more than others than may be smooth.

There are two types of friction. Static friction and kinetic friction. Static friction is the friction involved when you must apply force to get something moving that is at a standstill. It will take more effort than what you have when an object is already moving and your force is only what is needed to keep it moving. When it is a moving object it is kinetic friction. Static friction will be a larger number than kinetic friction.

A force resulting from the contact of two surfaces. This force opposes motion. — friction

The friction that exists between surfaces when neither surface is moving relative to the other. — static friction

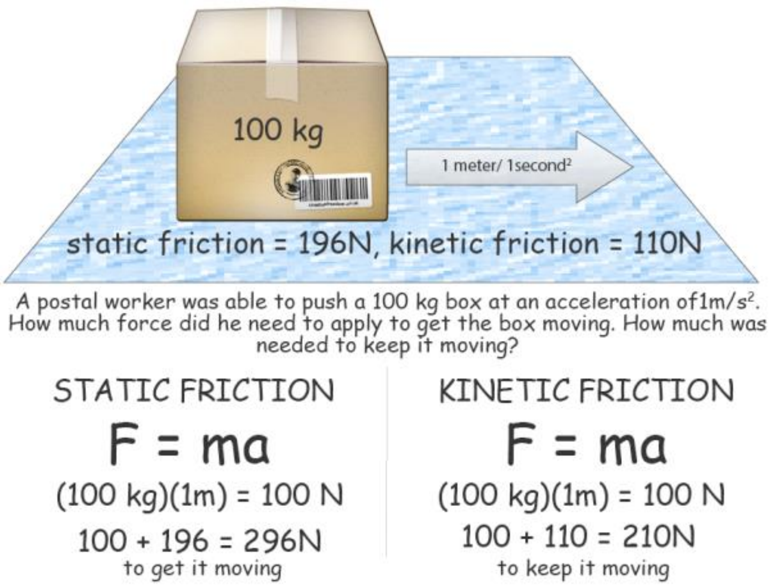
The friction that exists between surfaces when at least one of them is moving relative to the other. — kinetic friction

You are looking through a physicist's notebook and notice two numbers for the friction between wood and table top:

8 N
11 N

Which is static and which is kinetic friction?

11 N — static friction
8 N — kinetic friction



[Join the Blackboard Collaborate session]

Let's try a problem that includes friction. A postal worker was able to push a 100 kg box at an acceleration of 1 m/s^2. How much force did he need to apply to get the box moving? How much was needed to keep it moving?

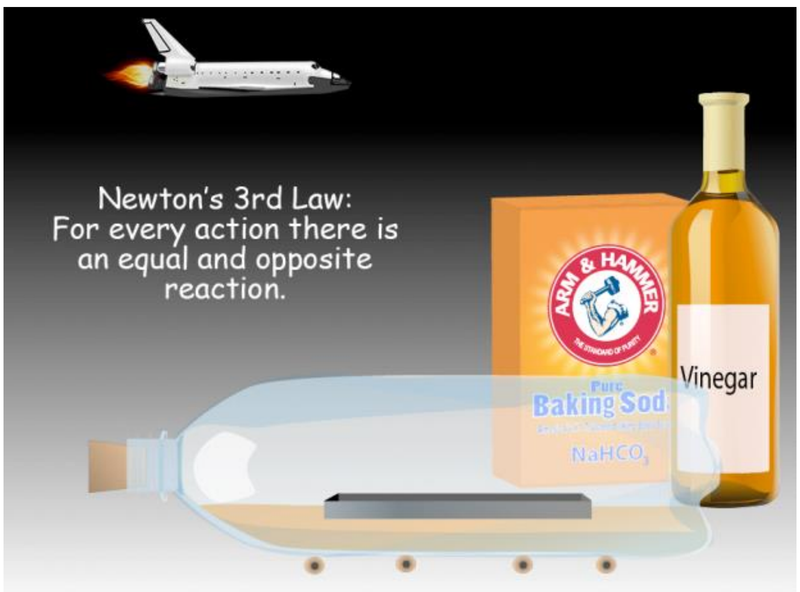
F = ma. We plug in the mass of the box and the acceleration of the box. That gives us 100N. But the postal worker had to also apply force to get it moving, so you will add in the static friction to get 296 N.

We do much the same for the kinetic friction. When we add it on we get 210 N.

A man pushes a heavy cart with a force exerted of 250 Newtons to keep it moving at a constant velocity. What is the kinetic frictional force between the cart and the ground?

Choose one answer.

- a. 246 N against the cart's motion
- b. Not enough Information.
- c. 250 Newtons against the cart's motion
- d. 200 N against the cart's motion



3rd Law

Examine the lab set up and predict what will happen. You place some vinegar into the bottle. Then make an aluminum foil boat that has some baking soda on it that you slip int to the bottle through the bottle top. Put a cork in and then shake so that the vinegar and baking soda mix. What will happen to the cork after a few seconds? When that happens, what will happen to the bottle that is sitting on pencils to reduce friction. Hopefully you realize that the force of the cork and air escaping will push the bottle forward much like the space shuttle's engines pushing backwards makes the space shuttle move forward.

Now we understand Newton's 3rd Law: For every action there is an equal and opposite reaction.

For every action, there is an equal and opposite reaction.	Netwon's Third Law of Motion

1st Law

Objects at rest will stay at rest. Objects in motion will stay in motion at constant velocity, unless acted upon by an unbalanced force.

2nd Law

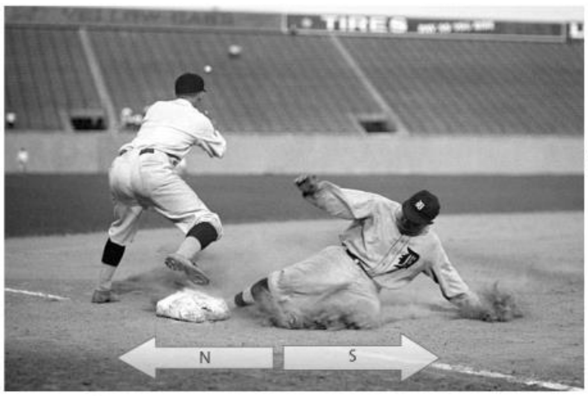
F=ma

Force equals mass times acceleration.

3rd Law

For every action there is an equal and opposite reaction.

Summary [read slide]



Legendary Ty Cobb, early proponent of the slide

A baseball player, mass 80 kg, slides in to 3rd base. His acceleration is 5.0 m/s^2 south, what is the kinetic friction between the player and ground?

Friction brought him to a complete stop, so

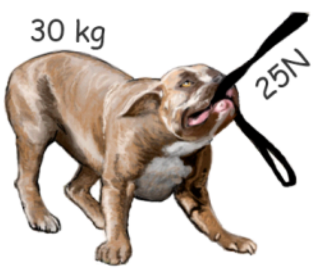
$80 \times 5.0 = 400$ N south

A baseball player (mass = 80 kg) is running north towards base. In order to avoid being tagged by the ball, the baseball player slides. If his acceleration in the slide is 5.0 m/s^2 south, what is the kinetic frictional force between the baseball player and the ground?

Choose one answer.

- a. 400 m/s2 south
- b. 400 N north
- c. 400 N
- d. 400 N south

30 kg



20N static friction

A dog resists the owner. It weighs 30 kg. It is pulling away from the owner with a force of 25 N and the static friction between its paws and the groud is 20 N. What is the minimum force the owner can pull to get the dog moving?

$25 + 20 = 45$ N

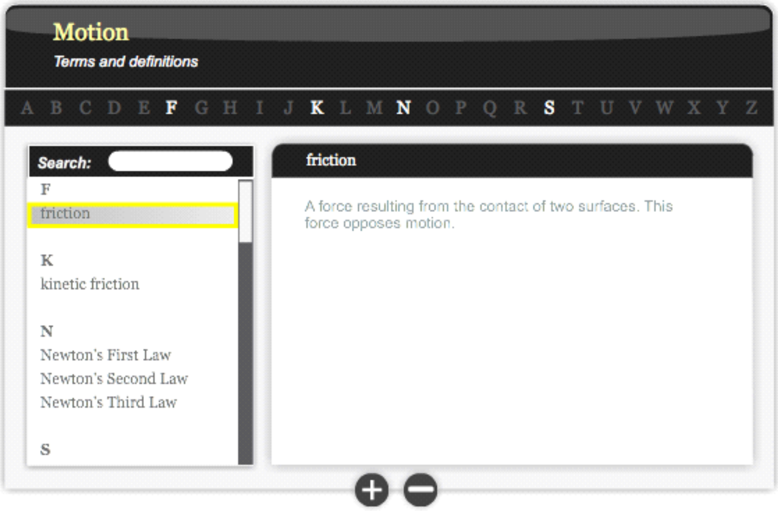
Try It

A dog (mass = 30 kg) is resisting its owner while on a walk with a force of 25 N. In addition, the static friction between the dog and the ground is 20 N, while the kinetic friction is 6.0 N.

What is the minimum force the exhausted owner must exert to get the dog moving?

Choose one answer.

- a. 51 N
- b. 45 N
- c. 30 N
- d. 1.7 N

	Glossary
	Contact: teacher.tammy.moore@gmail.com