Chapter 4-1 Notes

Force

Force

- Force is a push or pull exerted on some object.
- Forces cause changes in velocity.
- The SI unit for force is the Newton.
- 1 Newton = 1 kg m/s^2

Move the Matchstick Demo

2 types of forces

- Contact Force – physical contact between two objects
- Field Force – does not involve physical contact between two objects. Example is electrical forces

Field Forces

- Magnetism
  - Launcher
  - Iron Filings Demo
- Electricity
  - Van De Graff

Force Diagrams

- A free-body diagram is used to analyze only the forces affecting the motion of a single object.
- Use force diagrams to find x and y components and then to find the resultant.

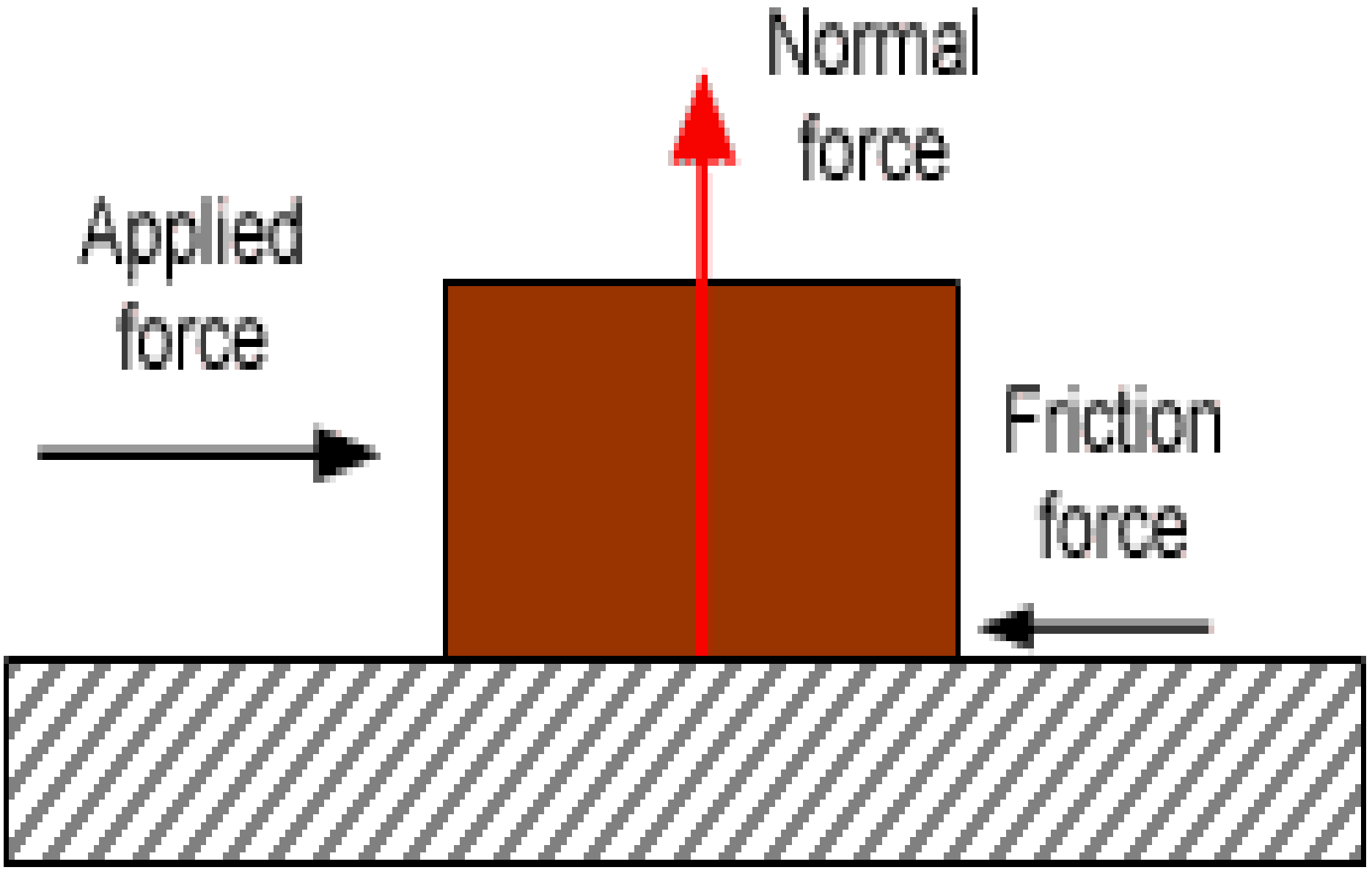
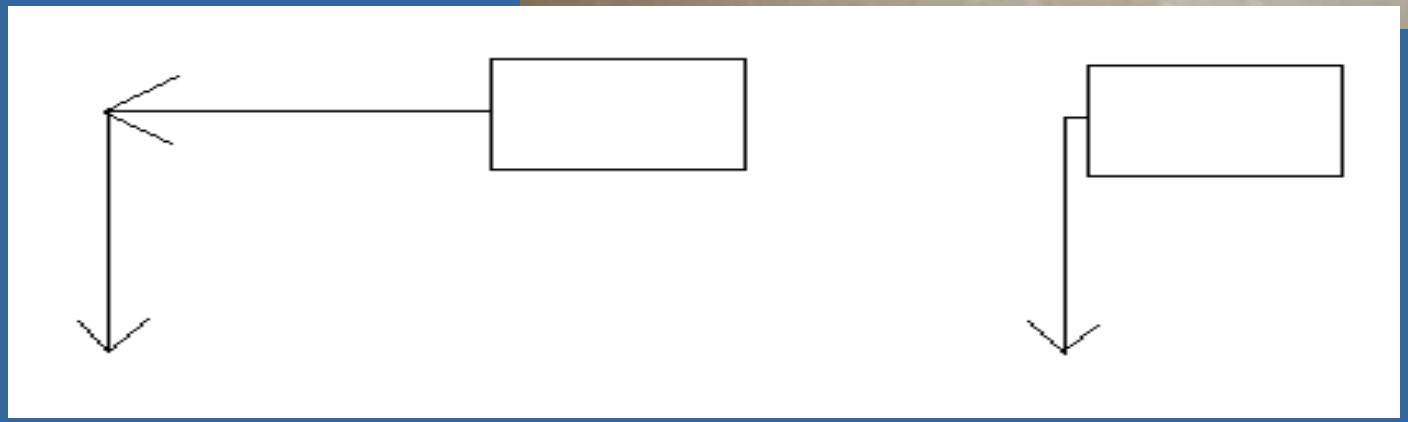

Normal
force
Applied
force
Friction
force

Table Walker / Force

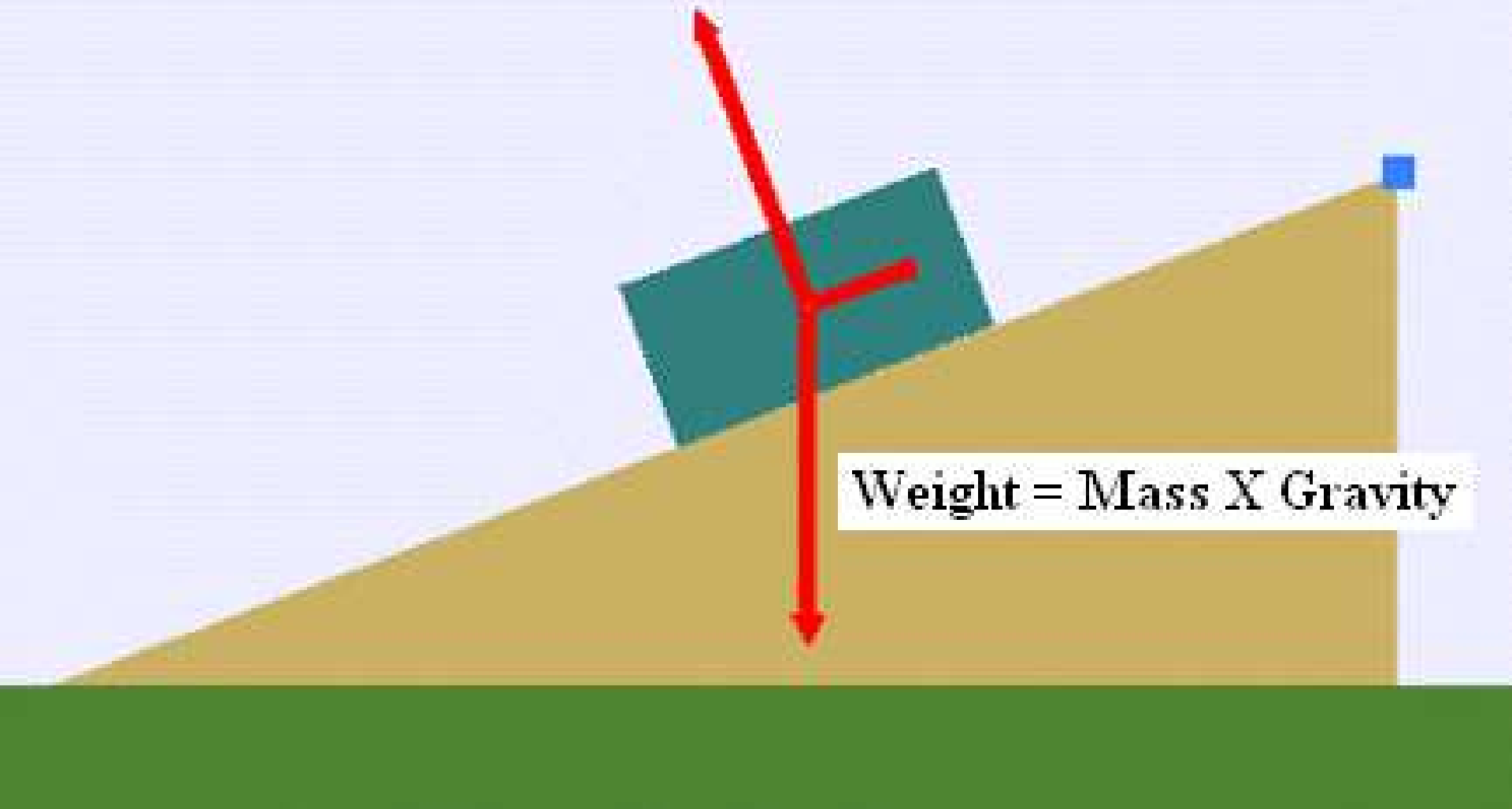
Force Diagram



Normal Force

- Every object has an equal and opposite force.
- The weight is the first and most obvious force.
- However, the equal and opposite force is called the normal force.
- Normal force is always 90 degrees to the horizontal.

Normal Force - 90 Degrees to Horizontal



- A man pushes a car with a force of 40 Newtons South while another man is trying to help and pushes with a force of 60 Newtons East. What is the car's resultant force and direction?

Balanced Force

When each force is equal, then it's a balanced force.

For example, if the force of gravity and the normal force are equal, then the object will not move up or down.

Unbalanced Force

When the forces are not equal, they are unbalanced. Imagine a washing machine with a load of towels all to one side. It jumps around and moves. Imagine a car with wheels out of balance. You feel the shake in your steering wheel.


WelcomeTo

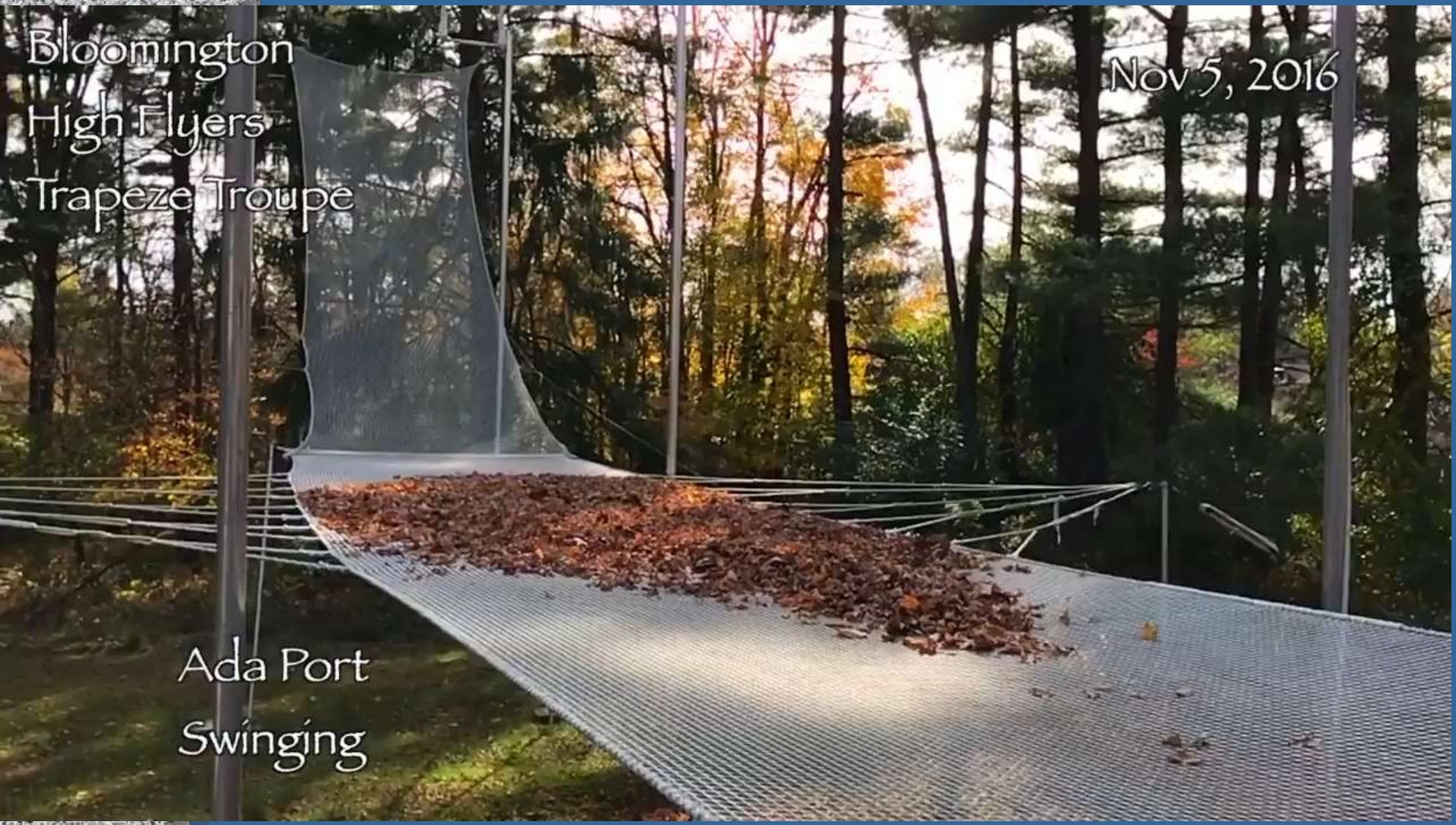
Demos

- Bird Balance
- Metal Toy Balance
- Nails Balance and Spangler Video
- Rattleback Balance
- 2 liter on board balance

Chapter 4-2 Notes

Newton's First Law

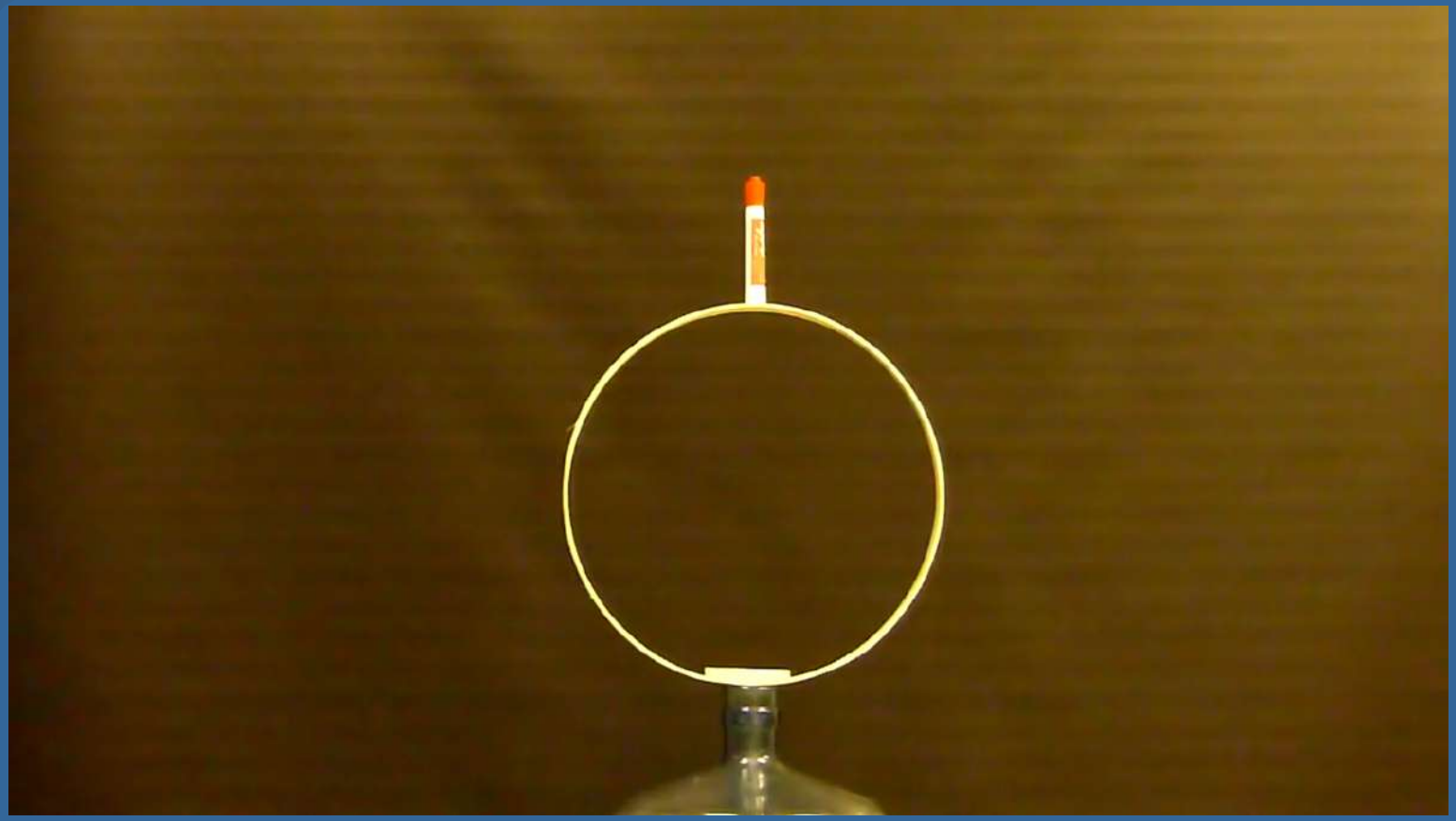
- Newton's First Law – An object at rest remains at rest and an object in motion continues in motion with a constant velocity unless acted on by an outside force.
- The tendency of an object not to accelerate is called inertia.
- When the net external force on an object is zero, its acceleration is zero.


Bloomington
High Flyers
Trapeze Troupe
Nov 5, 2016
Ada Port
Swinging


Photron

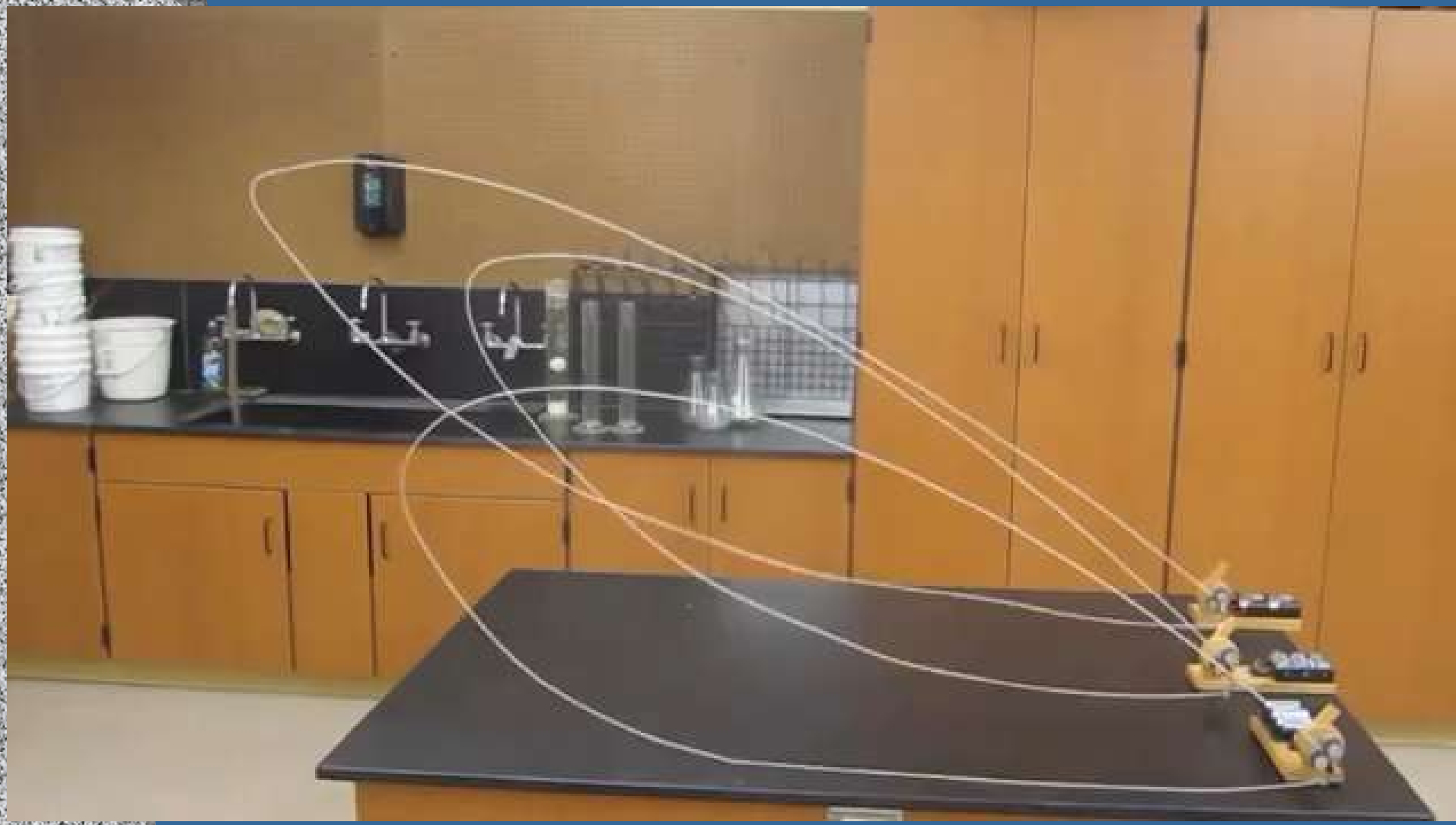
Inertia Tablecloth Demo

- Motorcycle Video
- Tractor Video



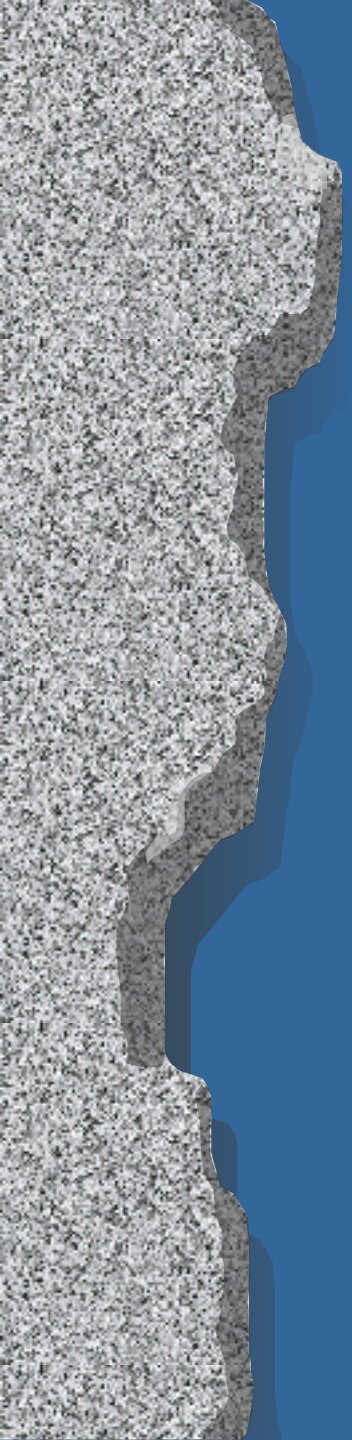
Woosh Bottle Demo

- Mardi Gras Inertia Beads



- The net external force is the vector sum of all the forces acting on an object.
- A simple problem occurs when all forces act directly along the x and y axis. You would just add and subtract and use Pythagorean theorem.

- An apple falls, the gravitational force on the apple is 2 N downward, and the force of the wind on the apple is 1 N to the right. Find the magnitude and direction of the net force of the apple.



Mass

- Inertia depends on the amount of mass.
- The greater the mass, the less the body accelerates under a force.
- The opposite is true also.
- Therefore, mass, which is a measure of the amount of matter in an object, is also a measure of the inertia of an object.

Equilibrium

- Objects that are either at rest or moving with a constant velocity are in equilibrium (balanced)

Chapter 4-3

Newton's 2nd and 3rd Laws

Newton's 2nd Law

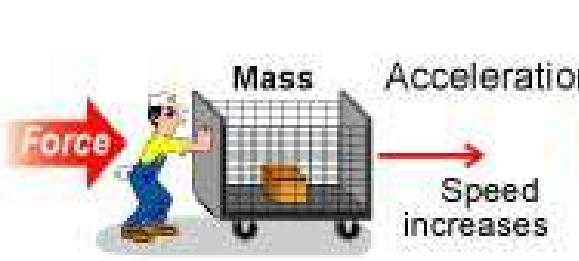
- Force is proportional to mass and acceleration.
- Force = Mass x Acceleration (F=ma)
- A = $(V_f - V_i)$/time

Newton's Second Law of Motion

$$\text{Acceleration } (\text{m/sec}^2) \rightarrow a = \frac{F}{m}$$

F ← Force (N)

m ← Mass (kg)



$$a = \frac{F}{m}$$

$$a = \frac{F}{m}$$

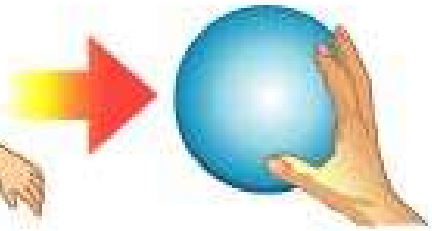
$$a = \frac{F}{m}$$

F=MA Demos

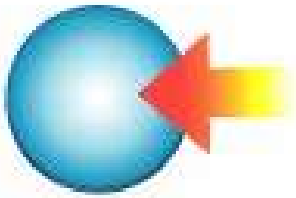
Newton's 3rd Law

- Forces always exist in pairs.
- Every action has an equal and opposite reaction.

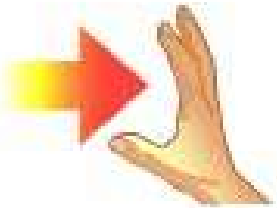
Newton's Third Law of Motion



When you throw a ball you create action and reaction forces.



Action force on ball

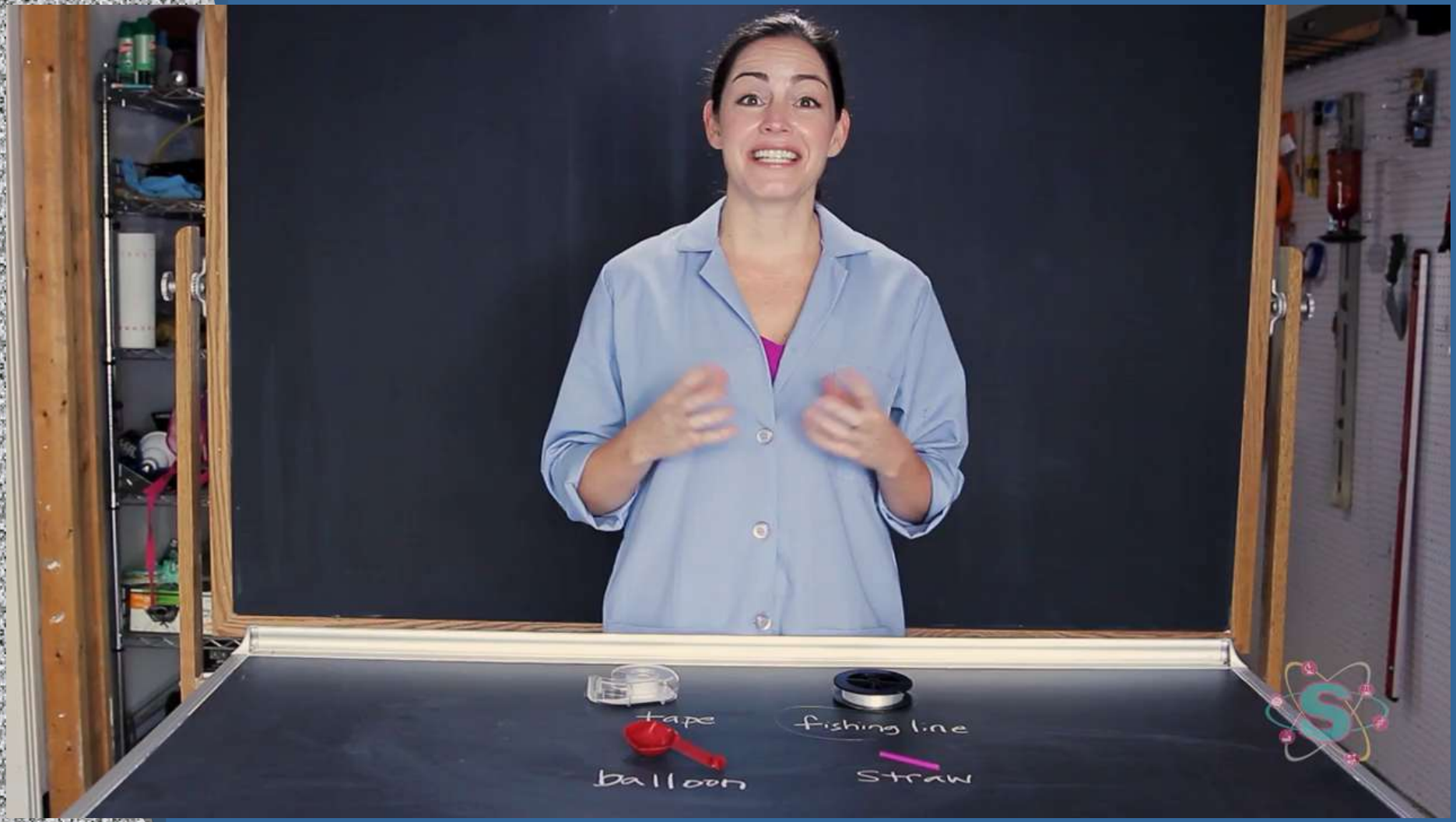


Reaction force on you

For every action force, there is a reaction force equal in strength and opposite in direction.

Practice 4B

- #1: The net external force on the propeller of a 3.2 kg model airplane is 7 N forward. What is the acceleration of the plane?
- Knowns?
- Unknown?
- Equation?
- Answer?


tape
fishing line
balloon
straw

Chemical Reactions – Newton's 3rd Law

Chapter 4-4

Weight, Force, and Friction

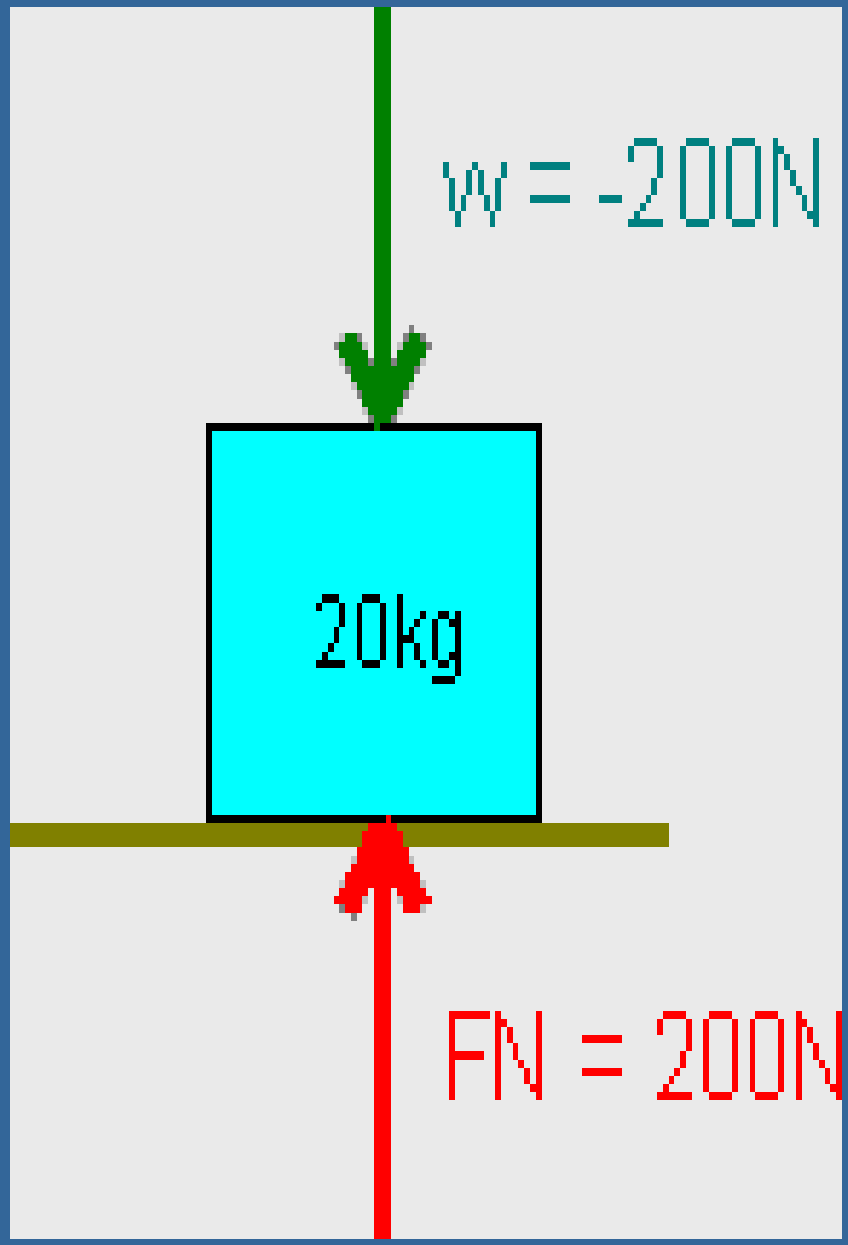
Weight

- Weight is the magnitude of the force of gravity acting on an object.
- Weight = Fg
- Fg = mass x gravity

Normal Force

- Normal Force is a force exerted by one object on another in a direction perpendicular to the surface of contact.

- The normal force is always perpendicular to the surface but is not always opposite the force of gravity.



Friction

- Friction opposes the applied force.
- Two types of friction: Static and Kinetic

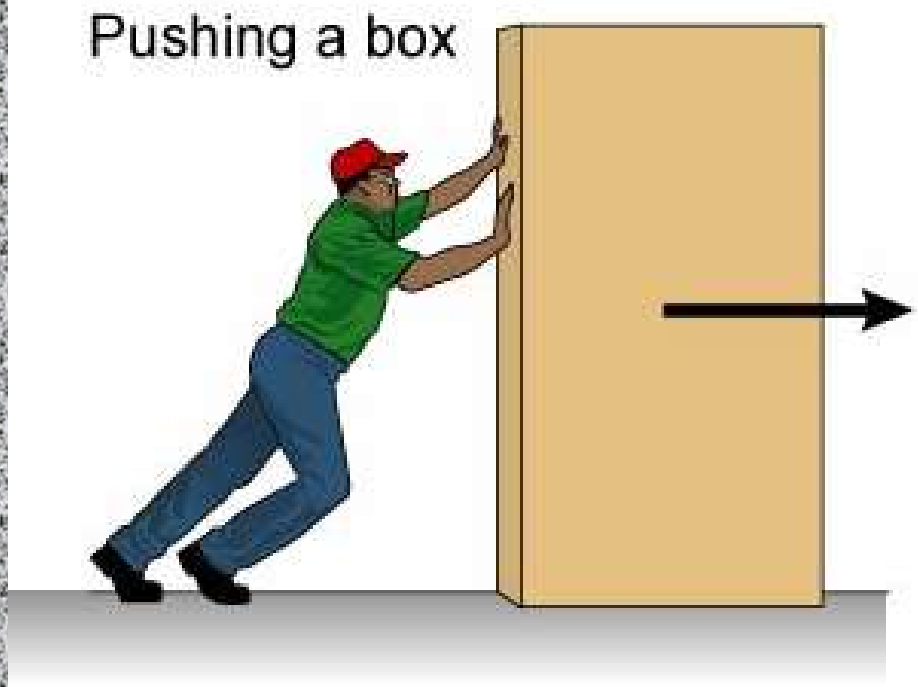
Static Friction

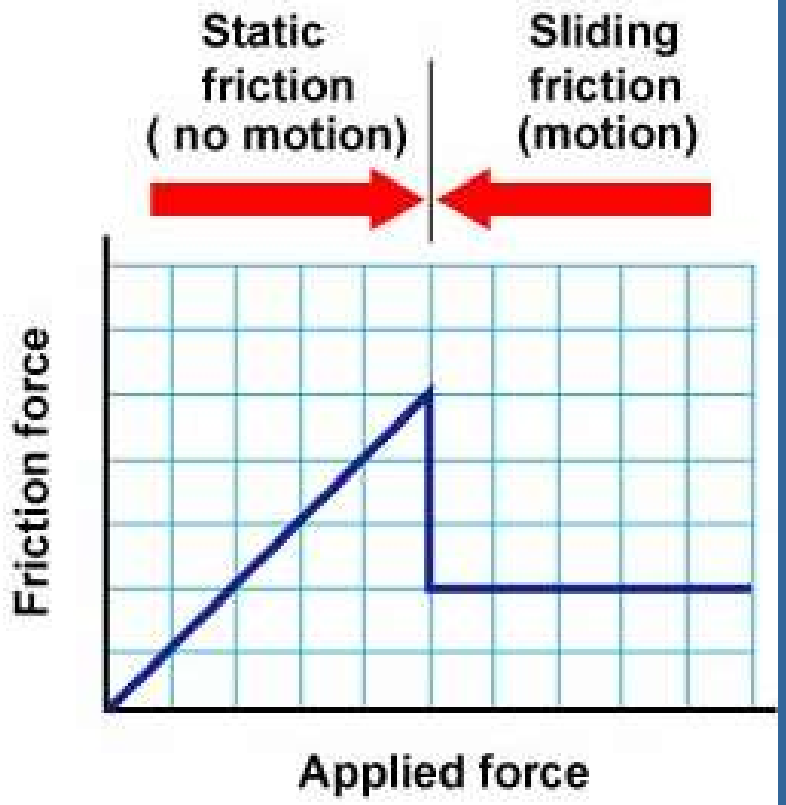
- The resistive force that keeps objects from moving is called the force of static friction.
- Static Friction = F_s
- As long as the object doesn't move, the static friction is always equal to the opposite in direction to the applied force.
- $Fs = -F_{applied}$
- When the applied force is as great as it can be without moving the object, the force of static friction reaches its maximum value, called F_{smax}

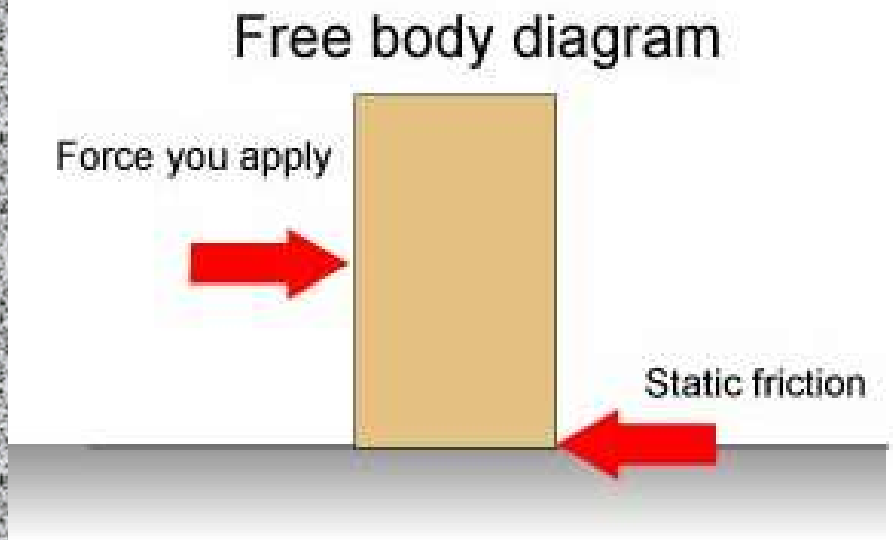
Kinetic Friction

- Once an object exceeds F_{smax}, it begins to move.
- The resistive force that opposes the relative motion of two contacting surfaces that are moving is called the force of kinetic friction (F_k)

Friction Forces







- It is easier to push a chair across the floor at a constant speed than to push a heavy desk across the floor at the same speed.
- Because the desk is heavier than the chair, the desk experiences a greater normal force and therefore greater friction.

Coefficients of Friction

- Friction depends on the surfaces in contact.
- The quantity that expresses the dependence on frictional forces on the particular surfaces in contact is called the coefficient of friction.
- Coefficient of friction is represented by the symbol μ and pronounces mu.

Coefficient of kinetic friction

- $\mu_k = F_k/F_n$
- Divide the Force of kinetic friction by the normal force

Coefficient of static friction

- $\mu_s = F_{smax} / F_n$
- Divide the maximum value of static friction by the normal force

- If the value of μ is known and the normal force is known, then the magnitude of the force of friction can be calculated.
- $F_f = \mu F_n$

- The kinetic friction is always less than or equal to the maximum static friction.
- Think about pushing a car that is sitting still or pushing a car that is already moving.
- The coefficient of kinetic friction is always less than or equal to the coefficient of static friction.

Sample Problem 4C

- A 24 Kg crate initially at rest on a horizontal floor requires a 75 N horizontal force to set it into motion. Find the coefficient of static friction.
- Knowns?
- Unknown?
- Equations?
- Answer

Materials	μ_s	μ_k
Wood on wood	0.5	0.3
Waxed ski on snow	0.1	0.05
Ice on ice	0.1	0.03
Rubber on concrete (dry)	1.0	0.8
Rubber on concrete (wet)	0.7	0.5
Glass on glass	0.94	0.4
Steel on aluminum	0.61	0.47
Steel on steel (dry)	0.7	0.6
Steel on steel (lubricated)	0.12	0.07
Teflon on steel	0.04	0.04
Teflon on Teflon	0.04	0.04
Synovial joints (in humans)	0.01	0.01


NEWS

Air Resistance

- Whenever an object moves through a fluid medium, like air or water, the fluid provides a resistance to the motion.
- When an object falls through the air, its velocity increases until the air resistance balances the downward force of gravity.
- The object falls with a constant speed, called terminal speed.