

Big Idea 13 : Forces and Changes in Motion

- A. It takes energy to change the motion of objects.
- B. Energy change is understood in terms of forces--pushes or pulls.
- C. Some forces act through physical contact while others act at a distance.



Image taken from: <https://webstockreview.net/explore/justice-clipart-unbalanced-force/>

Benchmark Number & Descriptor

- SC.6.P.13.1
- Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.
- SC.6.P.13.2
- Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.
- SC.6.P.13.3
- Investigate and describe that an unbalanced force acting on an object changes its speed, direction of motion, or both.

How did that move?



Newton

FORCE

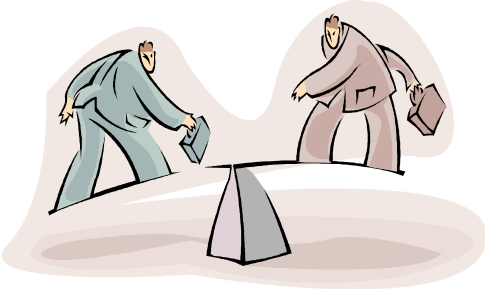
- A force is a push or a pull on an object.
- Objects will always move in the direction of the force.



TYPES OF FORCES

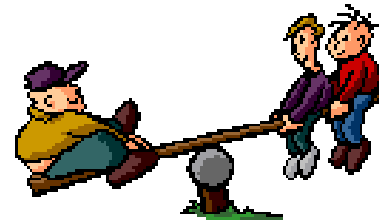
Balanced Force

- Equal forces are applied to an object.
- Forces work against each other and cancel each other out.
- Motion or direction does NOT Change.



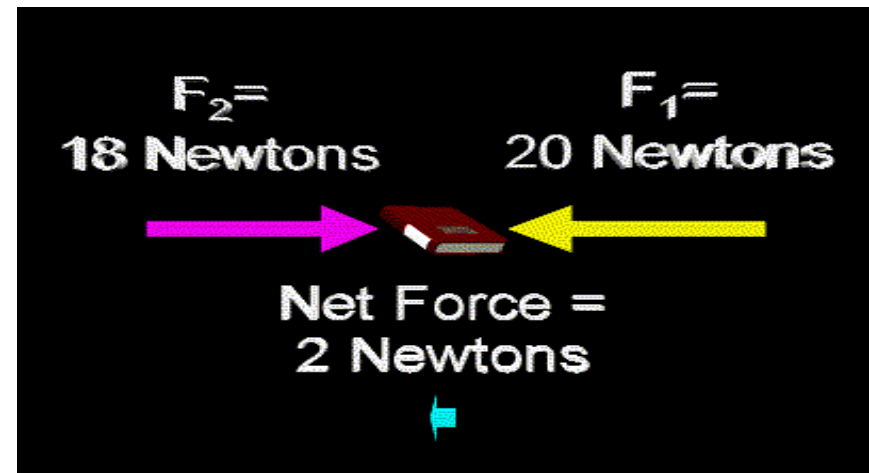
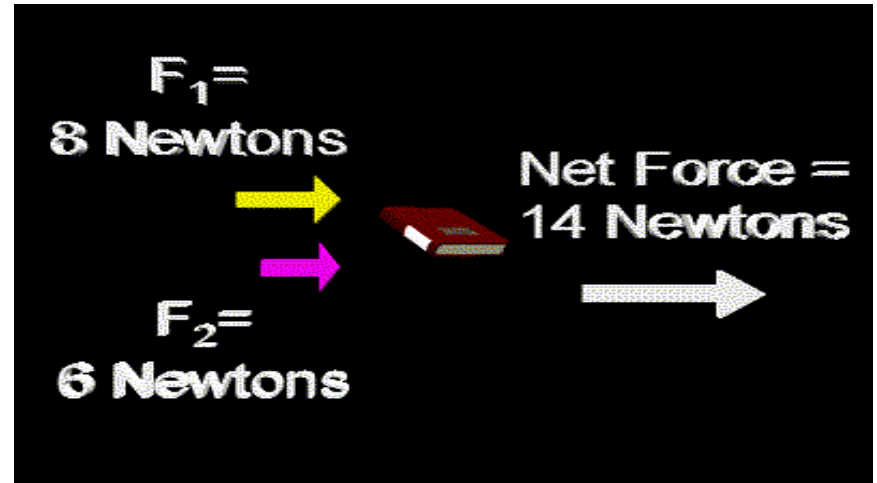
Unbalanced Force

- Unequal forces are applied to an object.
- Objects motion or direction will change.



NET FORCE

- Combination of all forces acting on an object
- If the forces are acting in the **same direction** on the object, **add the forces** together.
- If the forces are acting in the **opposite direction** on the object, **subtract the forces**.



Knowledge Check



- 1. What two words describes the term “force”?
- 2. If two people of the same weight and size sit on opposite sides of a see-saw, what type of force will they represent?
- If 100 grams of coins are placed on the left side of an equal arm balance and 50 grams were placed on the right side:
 - What type of force will be represented?
 - What will be the net force?

Knowledge Check



- 1. What two words describes the term “force”?

Push and Pull

- 2. If two people of the same weight and size sit on opposite sides of a see-saw, what type of force will they represent?

Balanced force – the see-saw would not move

- If 100 grams of coins are placed on the left side of an equal arm balance and 50 grams were placed on the right side:
 - What type of force will be represented? Unbalanced force
 - What will be the net force? 50 grams to the left



Sum of Forces
 Values
 Sound

Reset All

Sum of Forces



Left Force



Right Force



Return



Types of Forces

Contact forces: interactions between objects that touch



applied force



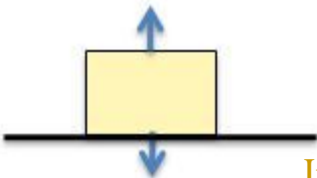
spring force



drag force



frictional force



normal force

Non-contact forces: attract or repel, even from a distance



magnetic force



electric force



gravitational force

SLOW IT DOWN!

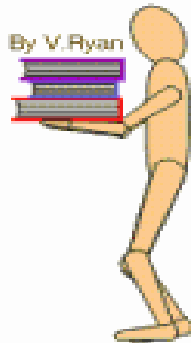


FRICTION

A force that opposes motion

STATIC FRICTION

- A force is applied to an object and no movement occurs
- Keeps objects at rest
- Books are staying in his hand due to static friction.



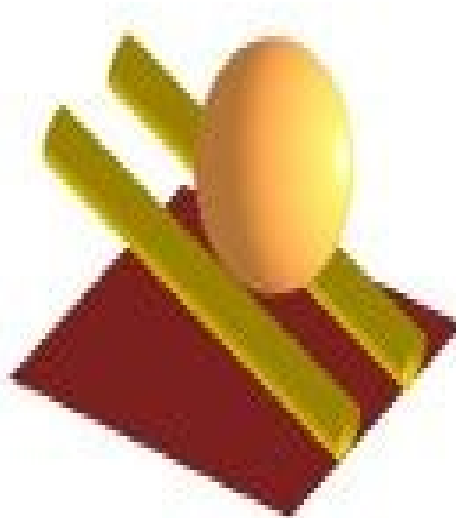
KINETIC FRICTION

- Friction between moving objects
- Three types:
 - Rolling
 - Sliding
 - Air Resistance

EXAMPLES of KINETIC FRICTION



Sliding Friction



Rolling Friction



Air Resistance

Knowledge Check



- 1. What is a force which resists motion called?
- 2. Give an example of static friction.
- List the three types of kinetic friction and, give an example of each.

Knowledge Check



- 1. What is a force which resists motion called?

Friction

- 2. Give an example of static friction.

A box sitting on the floor (no movement)

- List the three types of kinetic friction and give an example of each.

Rolling – bike tires in motion

Sliding – baseball player sliding into the base

Air Resistance – paper airplanes flying through the air

A FORCE TO OVERCOME...

GRAVITY



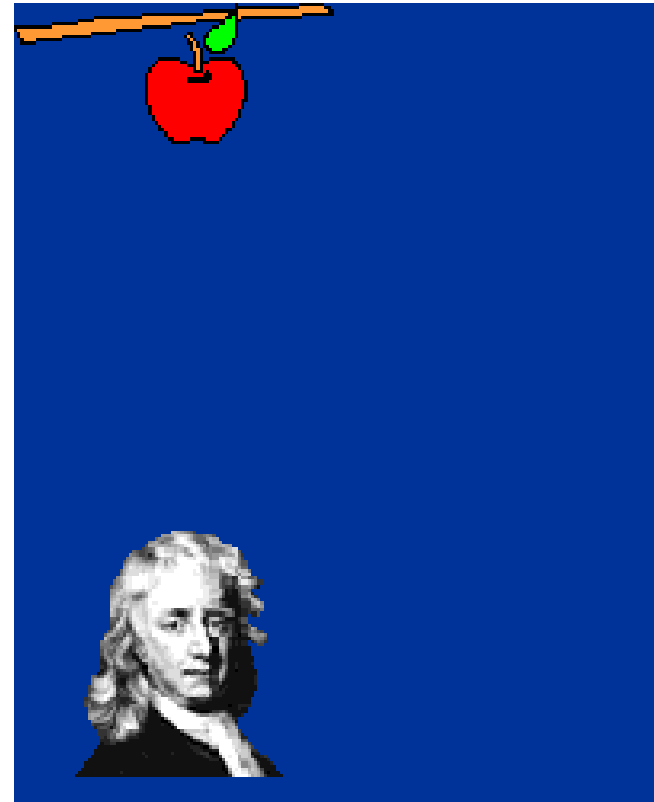
GRAVITY

- Force of attraction between objects due to their masses and distances apart
- Universal Force because everything has mass, therefore everything is affected by gravity
- When standing on the Earth, gravity attracts us towards the center of the earth so we do not fall off.



Universal Law of Gravitation

- Isaac Newton concluded that the same law of gravity applies to every object in the universe.
- The greater the masses of the objects, the larger the gravitational force between them. Finding the gravitational force between two objects requires multiplying the masses of the two objects. If your mass were to be twice as much, the gravitational force between you and Earth, which is your weight, would double. If Earth were to become twice as massive without changing its size, your weight would also double. Increasing either mass increases the gravitational force between two objects; decreasing their mass decreases the gravitational force.



<http://csep10.phys.utk.edu/astr161/lect/history/newtongrav.html>

MASS vs. WEIGHT

MASS

- How much matter, “stuff”, is in an object
- Does not change wherever you go
- Standing on Earth vs. Standing on the Moon = you are made of the same “stuff”, therefore your mass is the same.
- Measure mass with a balance

WEIGHT

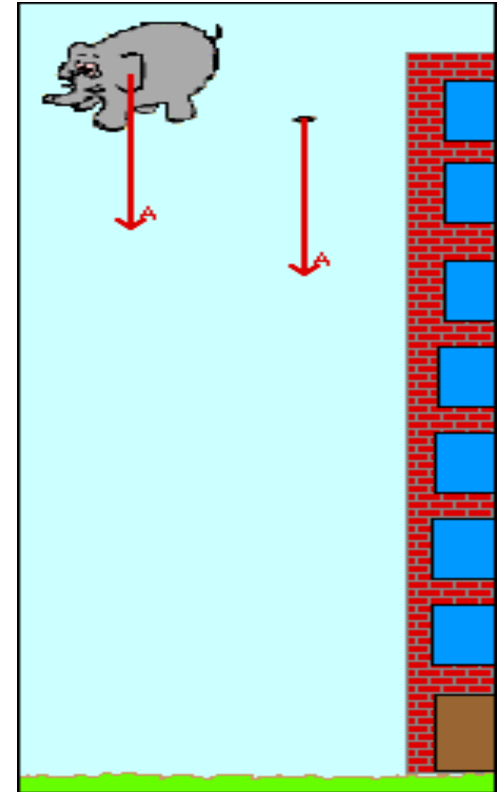
- Can change at different locations
- Based on the pull of gravity
- Weight = 100 lbs on Earth
Weight = 1.6 lbs on the moon
- Gravity is $\frac{1}{6}$ of Earth because the size of the moon is smaller than the Earth.
- Measure weight with a spring scale

GRAVITY and FALLING OBJECTS

ACCELERATION

- All objects fall to the ground with an acceleration rate of 9.8 m/s^2
- without the presence of air resistance.

Suppose that an elephant and a feather are dropped off a very tall building from the same height at the same time. Suppose also that air resistance could somehow be eliminated such that neither the elephant nor the feather would experience any air drag during the course of their fall. Which object - the elephant or the feather - will hit the ground first? The animation at the right accurately depicts this situation. The motion of the elephant and the feather in the absence of air resistance is shown. Further, the acceleration of each object is represented by a vector arrow.

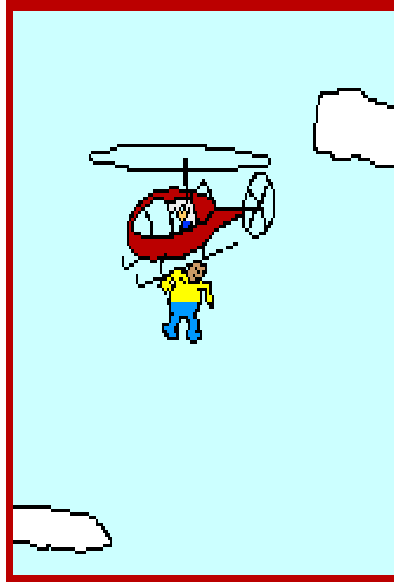


<http://www.physicsclassroom.com/mmedia/newtlaws/efff.cfm>

GRAVITY and FALLING OBJECTS

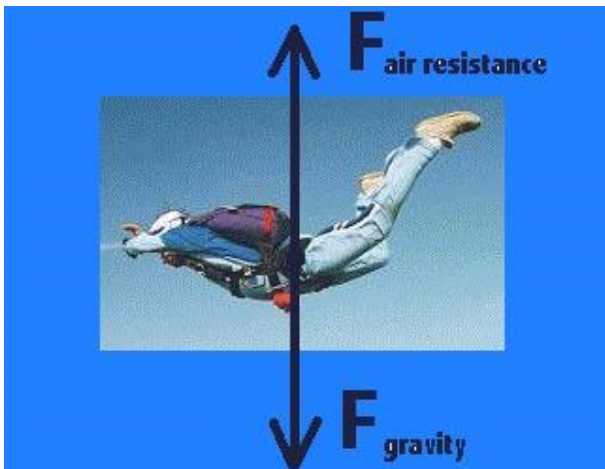
TERMINAL VELOCITY

- Objects reach terminal velocity when the amount of air resistance = the pull of gravity


$$a = \frac{F_{\text{net}}}{m}$$
$$a = \frac{1000 \text{ N}}{100 \text{ kg}}$$
$$a = 10.0 \text{ m/s}^2$$

(down)

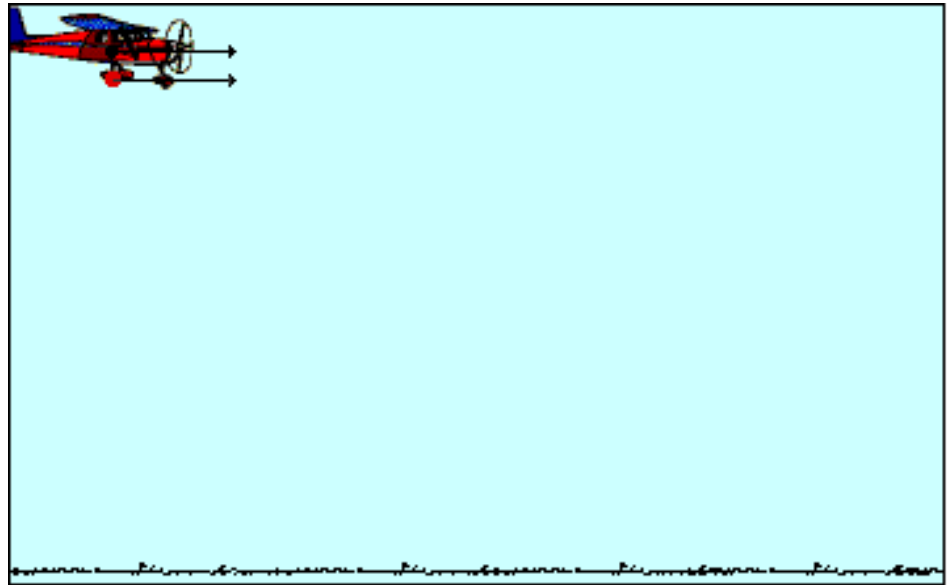
<http://www.northallertoncoll.org.uk/physics/Module%202/Terminal%20Velocity/Terminal%20Velocity.htm>



GRAVITY and FALLING OBJECTS

PROJECTILE MOTION

- When objects are thrown, they curve to the ground due to the round Earth and gravity.



<http://www.physicsclassroom.com/mmedia/vectors/pap.cfm>

Knowledge Check



- 1. Why is gravity considered a universal force?
- 2. What is the difference between mass and weight?
- 3. What is the acceleration rate on Earth due to gravity?
- 4. When will a sky diver reach terminal velocity in his/her jump?

Knowledge Check



- 1. Why is gravity considered a universal force?

Gravity affects anything with mass, and every object in the universe follows the law of gravity

- 2. What is the difference between mass and weight?

Mass stays the same wherever you go.

Weight will change due to the factor of gravity.

- 3. What is the acceleration rate on Earth due to gravity?

9.8 m/s^2

- 4. When will a sky diver reach terminal velocity in his jump?

When the downward force of gravity = the upward force of air resistance

Who Put This All Together....

Sir Isaac Newton



Newton's 1st Law

- **States:** An object at rest/motion stays at rest/motion until an unbalanced force acts on it.
- **Motion Aspect:** Cannot be shown on Earth due to friction
- **Rest = Inertia:** An object's resistance to change in motion. Related directly to mass.
 - Greater mass = Greater inertia
- Take a look at this website page to see an example of Newton's 1st Law.
- <http://teachertech.rice.edu/Participants/louviere/Newton/law1.html>



This marble will not move unless a force applied to it.

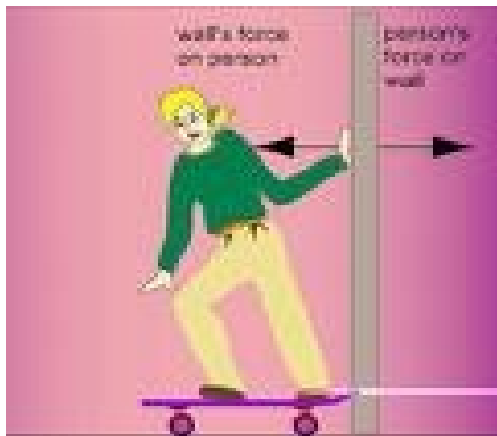
Newton's 2nd Law

- **States:** An object will accelerate in the same direction of the force.
- **Motion Aspect:** Acceleration is affected by the mass of the object and the force applied.
 - Larger mass needs greater force to accelerate.
- **Formula:**
 - *Force = Mass x Acceleration*
 - $F = MA$
 - $M = F/A$
 - $A = F/M$
- Take a look at this website page to see an example of Newton's 2nd Law.
- <http://teachertech.rice.edu/Participants/louviere/Newton/law2.html>



Newton's 3rd Law

- **States:** For every action there is an equal and opposite reaction.
- **Motion Aspect:**
 - Action-Reaction Pairs:
 - Act on different objects with equal force at the same time
- Take a look at this website page to see an example of Newton's 3rd Law.
- <http://teachertech.rice.edu/Participants/louviere/Newton/law3.html>



Action-Reaction Pair:

Action: Skater pushes on the wall.

Reaction: Wall pushes on skater.