Warm Up

1.) What kind of force, balanced or unbalanced, changes an object's motion?

- unbalanced forces

2.) What happens to an object when all forces are balanced?

- it will either remain stationary or remain in constant motion

3.) Who wrote the book Philosophiae Naturalis Principia Mathematica, which described universal gravitation and the 3 laws of motion?

- Sir Isaac Newton

Forces

Why science teachers should not be given playground duty.

Key Terms

Balanced: When the net force on an object is zero. There will be no change in the motion of an object; object is either motionless or maintaining a constant speed.

Force: A push or pull acting on an object

Friction: A force that opposes motion between two surfaces that are touching

Gravity: The force of attraction between two masses

Inertia: Tendency of an object to resist a change in its motion

Magnetic Force: Force of attraction or repulsion exerted by a magnet

Unbalanced: When the net force of an object is greater than zero; there will be a change in the motion of the object; a motionless object will begin to move, while an already moving object will change its speed or direction

Warm Up

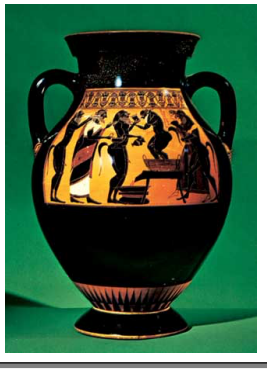
1.) What is the tendency for an object to remain in motion? -inertia

2.) What is the force of attraction between two masses? -gravity

3.) What is the force that opposes motion between two surfaces? -friction

Britannica Pathways Activity

"Forces on Objects"



Video Demos

- Coin Drop Trick

- Egg Drop Trick

- Tablecloth Trick

Video Demos

- What happened in each of the videos?
- How does it work?
- Which Law of Motion was demonstrated?

- The objects (coins, eggs, dishes) are sitting at rest and will remain at rest until another force acts on them. When the card/pan was removed from under the coins/eggs, gravity acted upon them, causing them to fall straight down. When the cloth was pulled, the dishes stayed in place because there was no other force to make them move.
- Why didn't friction pull the objects? There was some friction present, but not enough to cause the objects to move in the same direction as the card/pan/cloth were pushed/pulled.

Warm Up:

* NO warm up page this week!

Cut and Glue in Foldable.

- Cut all solid lines, fold all dotted lines.

-Glue on Right side of INB

History of Sir Isaac Newton

Read together and Pick out the important details. Write under The "Sir Isaac Newton" Flap in your Foldable.

Isaac Newton was born at Woolsthorpe near Grantham, England on 25 December 1642. His father died before he was born and in 1645 his mother married a clergyman from North Welham in Leicestershire. She went to live with him while Isaac Newton lived with his grandmother. When her second husband died in 1656 Isaac's mother returned to Woolsthorpe and Isaac Newton went to live with her again.

From the age of 12 to 14 Isaac Newton went to Grantham Grammar School. During this time he lodged with an apothecary and his family. Then in 1659 Isaac had to leave to help his mother on the family farm. Isaac Newton was not in the slightest bit interested in running a farm and in 1660 he went to the grammar school again. In 1661 he went to Trinity College Cambridge. Isaac Newton obtained a BA in 1665. In 1666 Isaac Newton was forced to flee Cambridge because of an outbreak of the plague and he returned temporarily to Woolsthorpe. He returned to university in 1667.

In 1667 Isaac Newton was elected a fellow of Trinity College. The same year he was elected a member of the Royal Society. In February 1672 a paper he wrote about light and colours was read to the society. In 1669 Isaac Newton became professor of mathematics. In the meantime, in 1668, he invented a reflecting telescope and discovered the moons of Jupiter.

Isaac Newton published his masterpiece Philosophiae Naturalis Principia Mathematica in 1687. It set out his theory of gravity and his laws of motion.

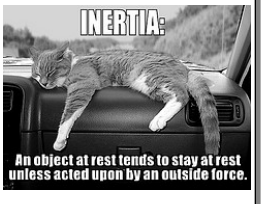
In 1703 Isaac Newton became president of the Royal Society. He was knighted in 1705.

Meanwhile in 1704 Isaac Newton published another great work about light.

Isaac Newton died at the age of 84 on 20 March 1727.

1st Law of Motion

- An object will keep doing whatever it is doing, whether it is sitting still or moving, unless the forces acting on it become unbalanced.
  - Ex: If you have ever left your roller skate lying in the hallway, it will stay there until someone or something moves it. If you are riding your skateboard and you hit a rock, the board will stop but you will keep moving until something stops you.
  - Gravity & friction are 2 common unbalanced forces that often change an object's motion.
  - Inertia: the natural resistance of an object to change its motion.



2nd Law of Motion

- The smaller the mass of an object, the greater its acceleration when a force is applied to the object.
  - Ex: If you apply the same force to an object with a small mass, like a tennis ball, and an object with a large mass, like a bowling ball, the object with the small mass will accelerate more than the object with the large mass.
  - The greater the force applied to an object, the greater the object's acceleration.
  - Ex: If you drop a heavy object and a light object at the same height, they will accelerate at the same rate and hit the ground at the same time because the force of gravity is acting on the objects.
  - Can be determined by the formula

$$Acceleration = \frac{Force}{Mass}$$

F=ma

THE MORE FORCE... THE MORE ACCELERATION

- Variations on acceleration formula

$$Force = Acceleration \times Mass$$

$$Mass = \frac{Force}{Acceleration}$$

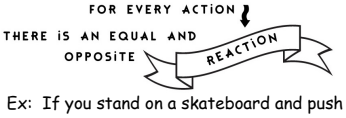
F=a F=m

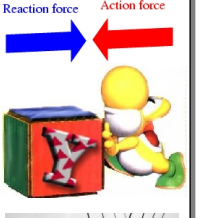
The same force exerted on a larger mass produces a correspondingly smaller acceleration.

- Units...
  - Acceleration: m/s^2
  - Mass: kg
  - Force: Newton (N) or (kg x m/s^2)
  - Acceleration & force have a direct relationship, what you do to one...you do to the other.
  - Acceleration & mass have a inverse relationship, what you do to one... you do the opposite to the other.
  - In order to change the acceleration of an object you can either....
    - Decrease the mass of the object.
    - Increase the force being applied to the object.

3rd Law of Motion

- When one object exerts a force on a second object, the second object exerts a force back that is equal, but in the opposite direction.





  - Ex: If you stand on a skateboard and push against a wall, you will roll backwards. The wall pushes back on you with the same force.
  - Action/Reaction Pairs
    - Motion of each object can't always be detected.
    - Even though they are equal & opposite, they don't cancel each other out because they don't act on the same object.

Warm Up

1.) The force of attraction or repulsion exerted by a magnet.

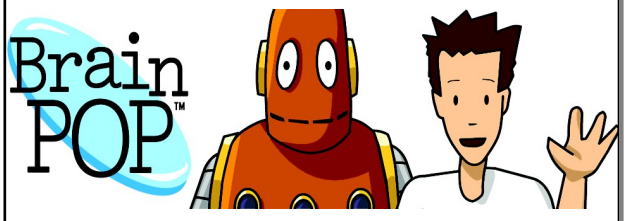
-magnetic force

2.) A push or pull acting on an object

-force

3.) What is the difference between a contact force and a field force?

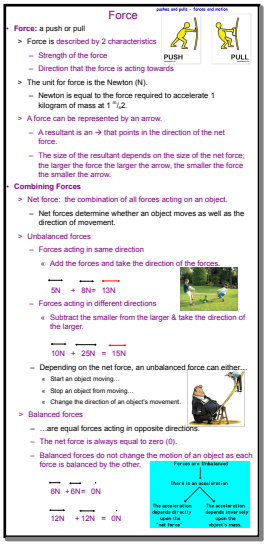
-contact forces occur when objects touch each other; field forces happen when to objects interact without touching each other

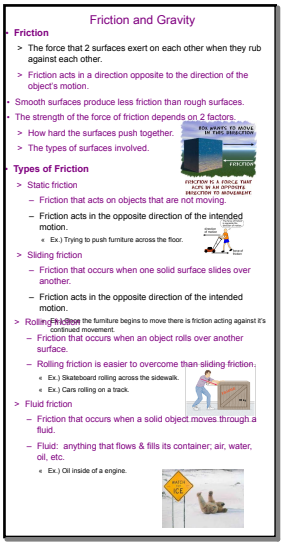


Warm Up

1.) Describe the law of motion that uses force and mass.

2.) What is the formula for finding acceleration when dealing with force?





Warm Up

1.) Which type of friction, sliding or rolling, is the easiest to overcome?

-rolling

2.) Which type of friction occurs between objects that are stationary?

-static

3.) Combine these forces:

12N ➡ + 15N ⬅ + 5N ➡

-3N ➡

Friction and Gravity

- Gravity
  - > Naturally occurring force within the universe that draws or attracts objects to each other.
  - > Sir Isaac Newton is credited as the discoverer of the scientific concept of gravity.
- Law of Universal Gravitation.
  - > The force of gravity acts between all objects in the universe.
  - > The gravity of each individual object is different and can negate the attraction of the other. $F_g = G\frac{m_1 m_2}{r^2}$
    - – m_1 m_2 = mass of the 2 objects,
    - – r = distance between the objects,
    - – G = the Universal Gravitational constant.

- Gravity & Motion
  - > Free fall
    - – The state in which the only force acting upon a falling object is gravity.
      - « Acceleration due to gravity is 9.8 m/s^2.
      - « Vacuum: a volume of space that is empty of matter, including air.
  - > Air resistance
    - – Upward force extended on falling objects.
    - – Air resistance is proportional to the surface area of an object.
      - « The greater the surface area the greater the air resistance.

- Terminal velocity
  - > Greatest velocity an object can reach.
    - – Upward force of air resistance is equal to the downward force of gravity.

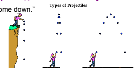
$$V_t = \sqrt{\frac{2mg}{\rho A C_d}}$$

- – Where V_t is the terminal velocity.
- – ***m*** is the mass of the falling object
- – *g* is gravitational acceleration at the Earth's surface
- – C_d is the drag coefficient
- – *p* is the density of the fluid the object is falling through
- – ***A*** is the object's cross-sectional area.

A projectile often moves horizontally as it moves upward and/or downward.

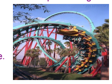
- Projectile motion
  - > An object thrown or shot will fall at the same speed (g; acceleration due to gravity) as an object dropped from a certain height.
  - > "What goes up, must come down."

Types of Projectiles



Friction and Gravity

- Momentum
  - > "The quantity of motion."
  - > A product of an object's *mass* and its *velocity*.
  - > Described by both the *strength* & *direction*.
  - > The greater the momentum, the harder to stop a moving object.
  - > There are 2 main types
    - – Linear momentum
      - « Momentum in a straight line.
    - – Angular momentum
      - « Momentum in an instant or at a specific point.



  - > Mass & velocity have a direct relationship to momentum.
    - – Increase mass, increases momentum
    - – Increase velocity, increases momentum
    - – Decrease mass, decrease momentum
    - – Decrease velocity, decrease momentum
- Can be found using the formula

$$Momentum = Mass \bullet Velocity$$

- Variations on the momentum formula

$$Mass = \frac{Momentum}{Velocity} \qquad Velocity = \frac{Momentum}{Mass}$$

- Units for momentum
  - > Momentum is a derived unit meaning *its unit is a combination of other units*.
    - – (kg * m/s); kilogram times meter per second
    - – (N *s); Newton times a second

- Conservation of momentum
  - Conserve/conservation in "everyday" language means to save.
  - Conserve/conservation in Science means to begin & end with the same amount.
    - – Momentum may be transferred from one object to another but none is lost.
      - « Ex.) Newton's Cradle

Warm Up

1.) What does "conservation" mean in regards to science?

- to begin and end with the same amount

2.) What is the formula for finding momentum?

- Mom. = mass x velocity

3.) Find the net force:

13N ⇨ + 3N ⇦ + 12N ⇦ + 2N ⇨

- 0N

Warm Up

1.) If an object slows down from 15 meters a second to 5 meters a second, over a period of 45 seconds, what is the car's acceleration?

-0.22 m/s^2

2.) Using the formula v2 = v1 + (a x t), calculate the final speed for an object that accelerates from 62 m/s at a rate of 3 m/s^2 over a period of 30 seconds.

152 m/s