Review
Chapters 1-9
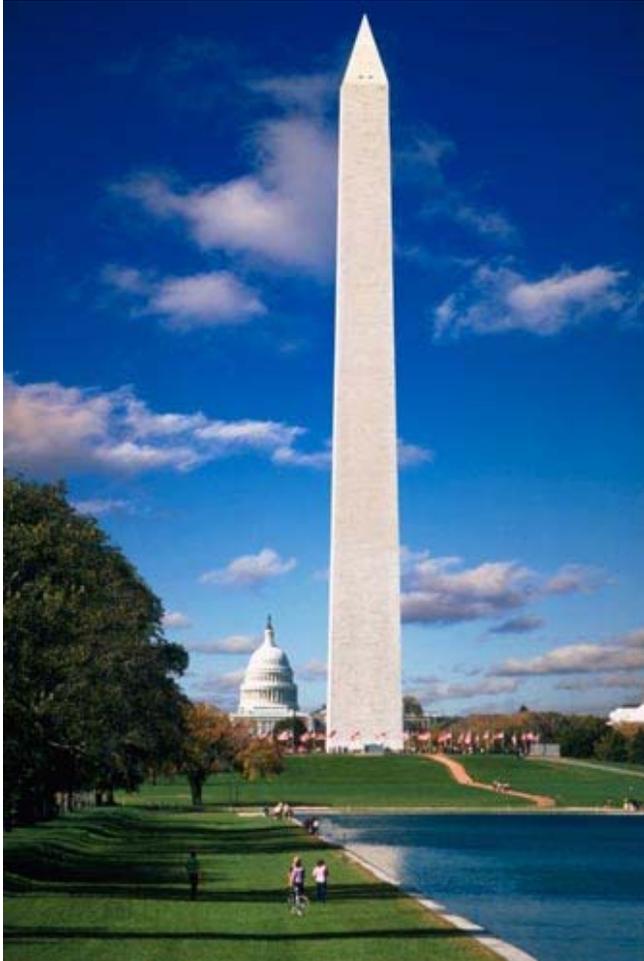
Did you read the article
on helmets before coming
to class?

    A. Yes
    B. No

Review Sessions

- Th 4-6 in W112 BNSN
- Th 6-8 in 377 CB
- F 3-5 in 445 MARB

Forces on an object

Washington Monument

Block inside monument

A man in an elevator moves upward at constant speed. What can we conclude about the forces acting on the man?

- There is a significant gravitational force exerted by the earth on the man.
- There is a significant electrical force on the man because he is a charged object.
- There is a significant contact force on the man exerted by the floor.
- There is only one significant force on the man.
- The motion of the man is an accelerated motion.
- The motion of the man is motion in a straight line at constant speed.
- The motion of the man is uniform motion.
- The weight of the man is a force directed downwards.
- The contact force on the man is directed downwards.
- The forces on the man are unbalanced.
- The man exerts a force on the elevator floor.

The moon moves in a circle around the earth. How do we understand its motion in terms of forces?
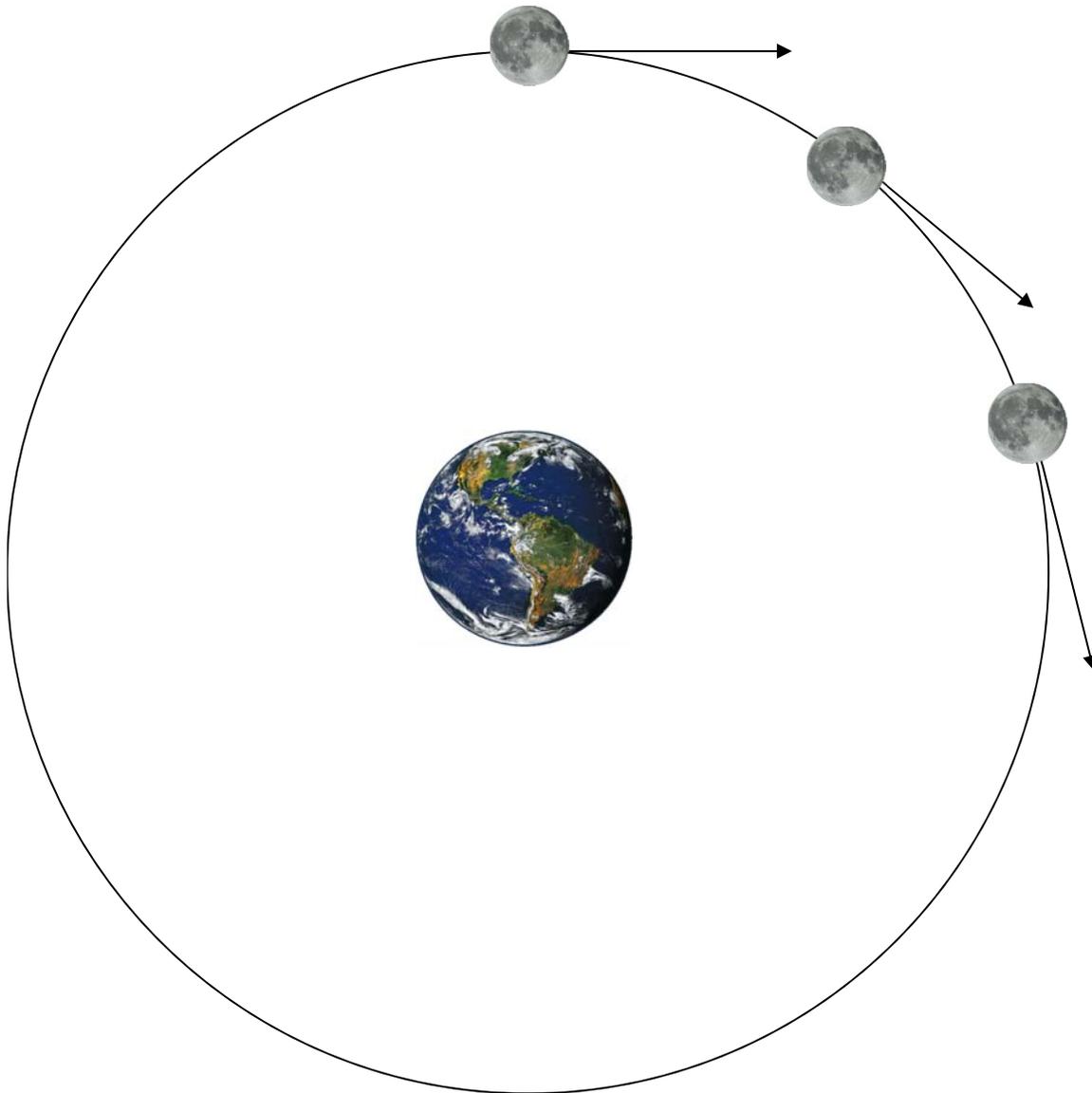
The moon moves in a circle around the earth. How do we understand its motion in terms of forces?

- There is a significant gravitational force exerted on the moon by the earth.
- There is a significant electrical force on the moon because it is a charged object.
- There is a significant contact force on the moon because of something it touches.
- There is more than one significant force exerted on the moon.
- The moon moves in a straight line at constant speed.
- The moon's motion is accelerated motion.
- The gravitational pull of the earth on the moon is directed toward the earth.
- There is a force on the moon that is directed away from the earth.
- The force(s) on the moon is/are balanced.
- The moon exerts a force on the earth.

A book lies on a table. What is the reaction (second force required by the Third Law) to its weight?
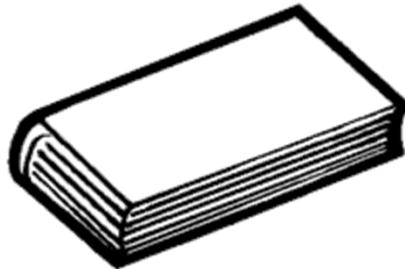
A book lies on a table. What is the reaction (second force required by the Third Law) to its weight?

- The reaction force to the weight is the force exerted by the book on the table.
- The weight of the book is the force exerted on the book by the earth.
- The weight of the book arises from an interaction of book and table.
- All forces arise from the interaction between two objects.
- The weight of the book is a force.
- The reaction force (second force required by the Third Law) is the force exerted on the earth by the book.
- The weight of the book arises from the interaction of book and earth.

A bicyclist crashes. Explain to your neighbor how a helmet helps prevent injury

Ping Pong Ball Cannon
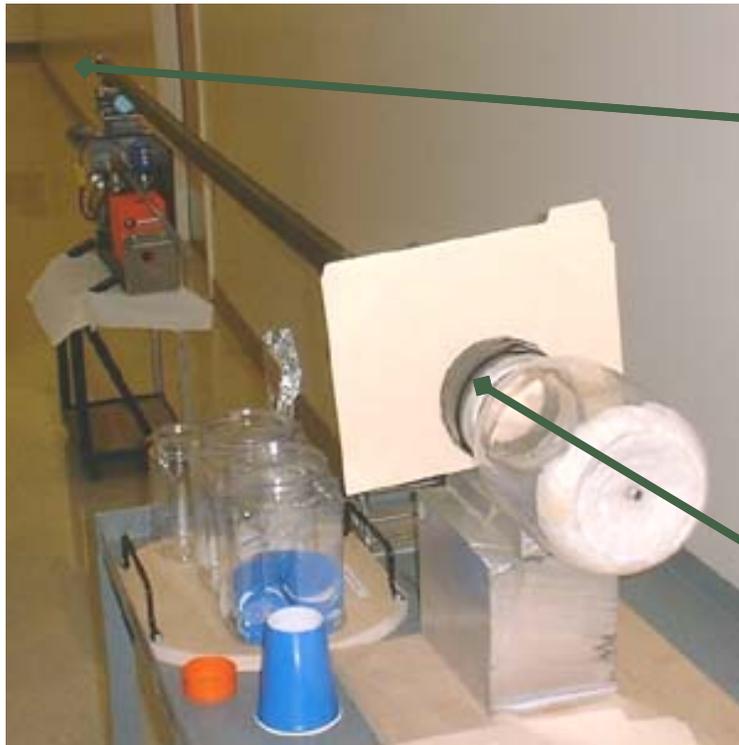
Ping pong ball analysis

- What are the horizontal forces on the ball?
  - Pressure = Force / area   (Force = Pressure x Area)
  - Cross-sectional area of the ball is about 1.75 in^2
  - Pressure is 15 lbs/in^2
  - Force = 25 lbs (110 Newtons)

- Mass of ball is about 2.3 grams (0.0023 kg)
  - Acceleration =F/m
  - Acceleration is about 48,000 m/s^2

- Predicted Final velocity: v = 570 m/s or 1300 mph
- However, the air molecules only move around the speed of sound (340 m/s) and some air leaks around the front of the ping pong ball.
  - Measured speed: 270 m/s (600 mph)

- Energy = $\frac{1}{2}mv^2$ = 83 Joules

- Comparison: 10 lb bowling ball dropped 1 m has about 45 Joules of energy when it hits the floor

A truck moving at high speed collides with a mosquito. How do we understand what happens in terms of Newton's Laws of Motion?

Robert Archer Collection

A truck moving at high speed collides with a mosquito. How do we understand what happens in terms of Newton's Laws of Motion?

- The mass of the truck is greater than the mass of the mosquito.
- The truck and mosquito exert forces on one another as a consequence of their interaction.
- The truck exerts a greater force on the mosquito than vice versa because it is traveling at a higher speed.
- The mosquito exerts a smaller force on the truck than vice versa because it has a smaller mass.
- The truck exerts a greater force on the mosquito than vice versa.
- Truck and mosquito exert forces on each other of exactly the same strength.
- The resulting accelerations of truck and mosquito are exactly the same.
- The resulting acceleration of the truck is greater than the acceleration of the mosquito.
- The resulting acceleration of the mosquito is greater than the acceleration of the truck.

In a vacuum, a feather and a hammer fall with exactly the same acceleration. How can this be understood?

In a vacuum, a feather and a hammer fall with exactly the same acceleration. How can this be understood?

- There is a significant gravitational force on each object.
- There is a significant electrical force on each object because they are charged objects.
- There is a significant contact force on each object because of something they touch.
- The Second Law of Motion says that the acceleration does not depend on the mass of an object.
- The strength of the gravitational forces on the two objects is the same.
- The masses of the two objects are the same.
- The gravitational pull of the moon on an object depends on the object's mass.
- The larger the object's mass, the stronger the moon's pull on an object.
- The equality of accelerations is only coincidental. It would not be true on Mars.
- The larger the mass of an object, the smaller the acceleration for a given force.
- The gravitational pull on the hammer is larger than on the feather, but the mass to be accelerated is larger.
- The gravitational pull on the feather is smaller than on the hammer, but the mass to be accelerated is smaller.
- The accelerations of the two objects are the same only if the accelerating force is gravity.
- The gravitational pulls on the two objects are different and the masses are different.

A horse is tied to a stationary log by a rope. If the force exerted by the horse on the log has exactly the same strength as the force exerted by the log on the horse (Third Law), how can the horse ever move the log? Don't the forces cancel each other?

www.goatlike.com

A horse is tied to a stationary log by a rope. If the force exerted by the horse on the log has exactly the same strength as the force exerted by the log on the horse (Third Law), how can the horse ever move the log? Don't the forces cancel each other?

- The horse exerts a force on the log (transmitted by the rope).
- The log exerts a force on the horse (transmitted by the rope).
- The force exerted by the horse on the log has exactly the same strength (but opposite direction) as the force exerted by the log on the horse.
- The horse cannot accelerate the log because the log always pulls back on the horse just as hard as the horse pulls forward on the log.
- To know whether the log will accelerate (begin to move), we must focus our attention on forces on the horse.
- To know whether the log will accelerate, we must focus our attention on forces on the log.
- There is a significant downward gravitational force on the log called its weight.
- There is a significant electrical force on the log because it has an overall net charge.
- There are significant contact forces on the log.
- The pull of the horse and the drag of the ground on the log are both significant horizontal contact forces on the log.
- The drag of the ground on the log must always be exactly equal and opposite to the pull of the horse on the log (by the Third Law).
- The horse can accelerate the log by pulling forward harder than the backward drag force of the ground on the log.
- The vertical forces on the log (weight and vertical contact force with the ground) are not balanced when the horse drags the log on the ground and accelerates it.

A girl is standing on bathroom scales in an elevator. The elevator is initially at rest, then begins to move upward. What happens to the forces on the girl?

A girl is standing on bathroom scales in an elevator. The elevator is initially at rest, then begins to move upward. What happens to the forces on the girl?

- There is a significant gravitational force on the girl.
- There is a significant contact force on the girl.
- When the elevator is at rest, the reading on the scales tells the girl what the contact force is.
- When the elevator is at rest, the girl's weight downward is smaller than the contact force upward (or else she would fall through the floor).
- When the elevator is at rest, the strength of the contact force on the girl is equal to her weight.
- When the elevator accelerates upward, the forces on the girl are balanced.
- When the elevator accelerates upward, the girl's weight changes significantly.
- When the elevator accelerates upward, the contact force on the girl increases.
- When the elevator accelerates upward, the reading on the scales will stay the same as it was before starting while the elevator gains speed.
- When the elevator accelerates upward, the contact force (upward) on the girl is smaller than the girl's weight (downward).
- When the elevator accelerates upward, the reading on the scales is greater than the girl's actual weight.

Chapter 6 -- Buoyancy

- ## Review

  - ### Pressure

    - Focus on unbounded fluids

  - ### Archimedes' Principle

    - What is the buoyant force equal to?
    - Why do some objects sink and some float, even if they are the same size?
    - What forces are involved in determining if an object will float or sink?

A cork floats at rest in a glass of water. What can we say about the forces on the cork?

- There is a significant gravitational force on the cork (called its weight).
- There is a significant electrical force on the cork because it is a charged object.
- There is a significant contact force on the cork because of something it touches.
- The contact force exerted by a fluid is called the buoyant force.
- The direction of the buoyant force is downwards.
- The motion of the cork is accelerated motion.
- The forces on the cork are balanced.
- The buoyant force is equal to the volume of displaced water.
- The buoyant force is equal to the weight of the displaced water.
- The buoyant force is equal to half the weight of the cork.
- The total volume of the cork is the same as the volume of displaced water.
- The weight of the cork is equal to the weight of the displaced water.
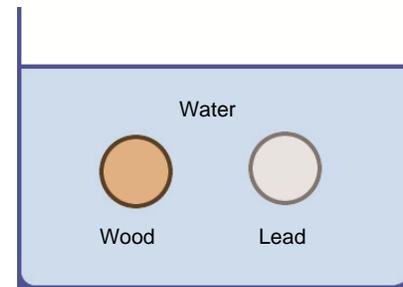
Consider two balls submerged in water, one made of wood and the other of lead.
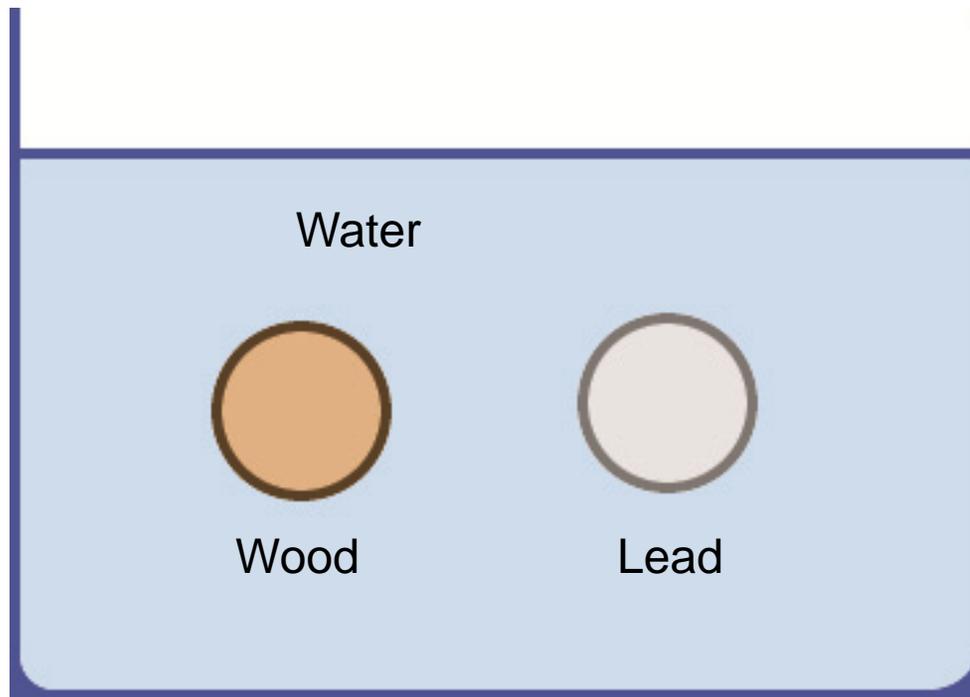
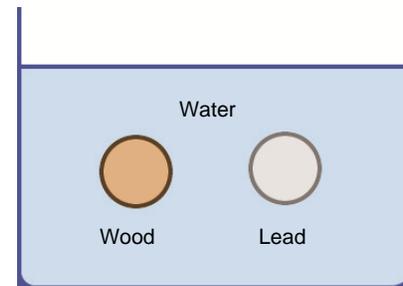Both balls are exactly the same size!

When both balls are submerged, which one is experiencing the greatest buoyant force?

A. Wood

B. Lead

C. Both the same

D. No way to determine this with information given

When both balls are submerged, which one is experiencing the greatest gravity force?

A. Wood
B. Lead
C. Both the same
D. No way to determine this with information given

After releasing the balls, one floats upward and one sinks. When they finally come to rest, which one will have the smallest buoyant force acting on it?

A. Wood

B. Lead

C. Both the same

D. No way to determine this with information given
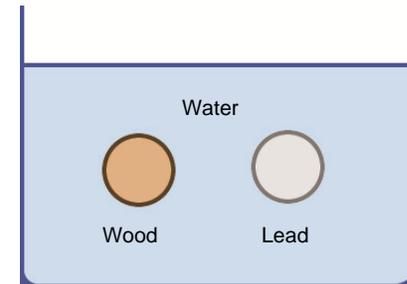
A deep-sea diver with attached weights is completely submerged in water. The volume of the weights is not insignificant. When the diver releases the weights, he rises to the surface. How do we understand this motion in terms of the forces?

- There is a significant gravitational force on the diver.
- There is a significant electrical force on the diver because he is a charged object.
- There is a significant contact force (the buoyant force) on the diver.
- The strength of the buoyant force on the diver depends on his mass.
- The direction of the buoyant force is always downward.
- The strength of the buoyant force depends on the density of the diver.
- The buoyant force on the weights depends on the weight per unit volume of the water.
- The buoyant force on the weights depends on the volume of the weights.
- The buoyant force on the man changes from downward to upward when he releases the weights.
- The buoyant force on the man increases when he releases the weights.
- When the diver releases the weights, his effective volume decreases by the volume of the weights.
- When the diver releases the weights, both the effective weight and buoyant force on the diver decrease.
- The buoyant force on the weights is less than their weight.
- When the diver releases the weights, the effective buoyant force decreases but the effective weight of the diver decreases more.

Chapter 7 -- Relativity

- **Review**
  - Postulates
    - Speed of Light
    - Motion Symmetry
  - Predictions
    - Length Contraction
    - Time Dilation
    - Non-simultaneity of Events
    - Mass Increase
  - Be able to explain
    - Light Clock thought experiment
    - Real clock experiment
    - Muon observation

Muons are radioactive particles which decay into an electron and 2 neutrinos with an average lifetime measured when they are at rest of 2 microseconds (2×10^{-6} seconds). In this amount of time, light can travel at most 600 meters. Muons are sometimes produced in the upper atmosphere by cosmic rays (protons) that bombard our atmosphere from space. When produced in this way, the muons are travelling at nearly (but less than) the speed of light but are observed nevertheless to travel much further than 600 meters. How can this be?

- In the muon's frame, its lifetime on its own clock is 2 microseconds.
- The speed of light is different in the two frames of reference.
- An observer in the muon's frame observes that the muon's clock is running slow.
- The laboratory observer observes that the muons travel a shorter distance in the laboratory than light could travel in a muon's rest lifetime.
- The laboratory observer reckons that the muon's clock is running fast compared to her own.
- The moving muon's lifetime as measured by the laboratory observer is longer than when the muon is at rest.
- Moving clocks run slow when compared to stationary clocks.
- In the muon's frame, the depth of the atmosphere is less than the laboratory observer measures it to be in her own frame.
- The muon exceeds the speed of light as measured in the laboratory frame.
- The moving muon travels more than 600 meters in the laboratory because its lifetime is dilated.

Chapter 8 – Conservation Principles
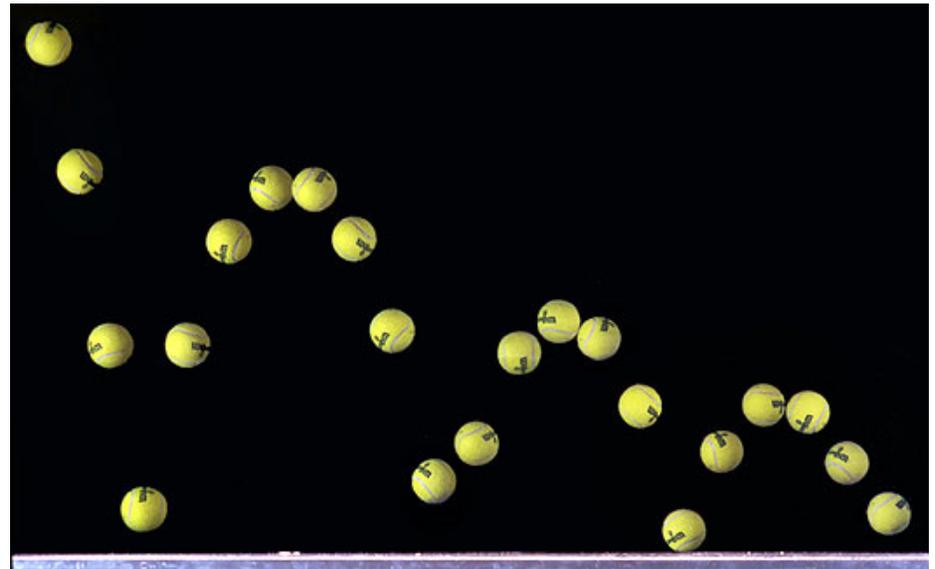
- ## Review
  - Things that are conserved
    - Mass
    - Electric charge
    - Linear momentum
    - Angular momentum
    - Fundamental Particles
- ## Remember
  - A conserved quantity is one that does not change during a process

A ball is dropped from a height of 10 feet and bounces several times before finally coming to rest on the ground. Which of the following is conserved in this process?

A. The kinetic energy of the ball

B. The gravitational potential energy of the ball

C. The internal energy of the ball

D. The momentum of the ball

E. Only the total energy of the ball and the surrounding environment

Chapter 9 -- Energy

- **Review**
  - Different Types of Energy
    - Kinetic – Energy of Motion
    - Potential – Energy of Position
    - Internal – Inside Materials
  - How Energy is Transferred
    - Conduction
    - Work
    - Convection
    - Radiation
  - Energy Conversion and Conservation
    - Know when and what types of energy are conserved in a system

The space shuttle is traveling at a constant speed and constant elevation in orbit around the Earth. Neglect any effect due to the tiny amount of air outside the shuttle. Which of the following is conserved while the space shuttle is traveling in these conditions?

A. Only Kinetic Energy
B. Only Gravitational Potential Energy
C. Both types of energy are conserved
D. Only the Total Energy of the system is conserved

A pendulum is drawn to the side, released from rest, swings back and forth, but eventually comes to rest again at its lowest point. How do we account for the energy of the pendulum?

- A conserved quantity is one that does not change with time.
- When the pendulum reaches its highest point, it has the greatest amount of kinetic energy.
- When the pendulum reaches the lowest point of a swing, it has less gravitational potential energy than at the highest point.
- When the pendulum reaches the lowest point of a swing, it has more kinetic energy than at the highest point.
- The pendulum has the same amount of kinetic energy at the highest and lowest point of a swing.
- The pendulum has the same amount of gravitational potential energy at the highest and lowest point of a swing.
- Kinetic energy is not conserved during a swing of the pendulum.
- During a swing, kinetic energy increases when gravitational potential energy increases.
- Gravitational potential energy is not conserved during a swing of the pendulum.
- When the pendulum finally comes to rest, energy has been destroyed.
- Internal energy (of the surrounding air) gradually increases during the motion.
- The temperature of the surrounding air remains strictly the same during the motion of the pendulum.
- Internal energy is not conserved during the motion.
- Total energy (kinetic + gravitational potential + internal) is conserved during the motion.

Frank "Cannonball" Richards