SEGWAY

Activity Kit Contents

NOTE

You'll also need to take:

- Segway
- Helmet

Kit content:

- Gyroscopes & Pedestals (14)
- String (pieces and roll)
- Scissors (1 pair)
- Envelope
  - Description & Procedures
  - Printout of PowerPoint Slides
  - Student Evaluations– Master & copies (20)
  - CD

Segway

By

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What is a Segway Human Transporter?

The Segway Human Transporter is a unique self balance electric powered transportation device.

How does the Segway self balance? How do you balance? What prevents you from falling over?

Balancing act, the true magic of engineering…

If you stand up and lean forward you will probably not fall why?

Your brain knows you are out of balance because fluid in your inner ear shifts and triggers you to put your leg forward and stop the fall. If you keep leaning forward your brain will keep putting your leg forward to keep you upright. Instead of falling you walk forward

Activity:

Have the students stand and lean forward from their feet not the waste and keep leaning until they're about ready to fall over. Ask them to describe what they were feeling, what they thought their body was doing and what happened when they were about to fall. What did they do?...

Segway self balance

The segway can self balance because of technology called dynamic stabilization. We have an inner ear, eyes, mussels and a brain to keep us balanced,

Activity:

Ask the students how they think our inner ear, eyes, mussels, and brain keep us balanced. What do they think their body is doing to keep them balanced.

The segway uses solid state gyroscopes (tilt sensors), high speed microprocessor, and powerful motors to keep it balanced. Segway's act in similar fashion to humans except with wheels instead of

legs, a motor instead of muscles, microprocessors instead of a brain, tilt sensor instead of an inner ear balancing system

Like your brain, the segway knows when you are leaning forward or backwards. To maintain balance it turns it wheels at just the right speed so that you move forward instead of falling.

How does a tilt sensor work

A tilt sensor is a solid state gyroscope. A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. Angular momentum of an object rotating about some reference point is the measure of the extent to which the object will continue to rotate about that point unless acted upon by an external torque. If a point of mass rotates about an axis, then the angular momentum with respect to a point on the axis is related to the mass of the object, the velocity and the distance of the mass to the axis. Angular momentum is important in engineering because it is conserved quantity.

Activity:

Have the students sit on rotating stool and hand them two 5 lb weights. Rotate the students on the stool have them bring the weights close to their bodies and then bring them out. Ask the students to describe what happened.

Angular momentum of a mass about some origin is defined as:

AM=r X p

Where:

AM is the angular momentum of the mass

R is the position of the mass expressed as a displacement vector from the origin

P is the linear momentum of the mass

X is the vector cross product

When the student is spun on the stool with the hands and weights extended the student has a known angular momentum. When the student brings the weights into his or her body he or she accelerates because angular momentum is conserved stays constant. The angular momentum does not change.

When a rotating body is acted on (torque) its angular momentum changes.

Activity:

Have the students sit on a rotating stool and hand them a bicycle wheel with handles. Have the students hold the handles while you spin the bicycle wheel at a high rate. Ask the students to apply a

torque to the wheel. Ask the students to explain what happens. The students precess in the direction they apply a torque to the wheel.

Activity:

Hand out toy gyroscopes and have the students spin the gyroscopes and describe what happens as the toy gyroscopes slow down. The force of gravity wants to pull the gyroscope down applying a torque to the gyroscope. The gyroscope begins to precess and rotate in the plane the gyroscopes is resting. This is called precess. An important process for the Segway tilt sensor.

Activity:

Have the students spin their gyroscopes and balance it on a piece of string slightly above horizontal and explain how the gyroscope seems to defy gravity.

What is precess

Precession is a change in the direction of the axis of a rotating object. Our precession (activities with the gyroscope and bicycle wheel) is torque induced. Torque induced precession is the phenomenon in which the axis of a spinning object wobbles when a torque is applied to it. The movement at any instant is at right angle to direction of the torque. As the students apply a torque to the bicycle wheel there is a force at right angles to the spinning wheel that causes the rotating stool and the student to move.

This is an important concept in the ability of the segway to self balance. The segway is an inverted pendulum and wants to fall over. As the segway begins to fall (applying a torque to the internal gyroscope) it applies a force that the tilt sensor picks up. This signal is sent to the microprocessor, and the microprocessor having input that the segway is about to fall over sends a signal to the motors to rotate the wheels to prevent the segway from falling over.

Activity:

Ask the students to discuss how they think the segway works? How many tilt sensors does the segway need to work properly? How many motors? How fast does the computer have to be? Does the segway have to constantly check to see if it is about to fall? How does the segway balance going down a hill or up a hill? Are the same principles used? What happens when the segway is stopped after moving.