Go for a Spin!

What to do: Experience rotational physics first-hand as you vary your body position to control your speed on a spinning platform.

What's the big idea?
Rotational motion is best described as a rotation of an object in a circle around a fixed point. The numerical quantity that is used to measure rotational motion is called "angular momentum." It can be calculated by multiplying the object's mass by its velocity and the radius. These three variables are dependent on each other, because in a closed system (the rotation is not affected by outside forces) the total amount of angular momentum stays constant. If one of the variables changes, the other two must also change. This explains why the decrease in the radius of a rotating object causes its velocity to increase.

Sports connection
When an ice skater is twirling, she becomes a "closed system." If she pulls her arms in, she is decreasing her radius (the distance between her arms and the center of rotation). For her angular momentum to remain constant, the decrease in radius for her arms must be compensated for by an overall increase in her rate of rotation. That is, by pulling her arms in, she substantially reduces the time for each rotation.

Similarly, when a gymnast leaves the mat, he has all the angular momentum from his push-off; none can be gained or lost. However, for various moves, the gymnast will need to change his rate of rotation while in the air. He does this by changing the distance of his center of mass from the axis of rotation. His spinning speed increases or decreases when the distance between the mass and the axis of rotation changes.

Find out more:

- Angular Momentum [link to: http://www.lightandmatter.com/html_books/2cl/ch05/ch05.html#Section5.1]
- Topend Sports [link to: http://www.topendsports.com/sport/gymnastics/physics.htm]

Bounce!

What to do: Launch yourself 20 feet in the air on a bungee-harnessed trampoline.

What's the big idea?
As you jump, the ends of the bungees move higher up the pole. When gravity pulls you back down to Earth, the force of your weight stretches the bungees, giving them potential energy. After you hit the trampoline and start moving up again, the tension of the bungees is released as kinetic energy (energy of motion), which shoots you up higher and higher.

The trampoline works together with the bungees. After you land on the trampoline, it is stretched downward and has lots of potential energy. When the trampoline pushes you upward, it gives its potential energy to you. The instant you leave the trampoline, it has given over all its energy to you. As you rise into the air, your convert your kinetic energy into potential energy and, on your way down, you turn it back into potential energy. Combined energy from the trampoline and the bungees increase your jumping power and stabilize the jump. This gives you the ability to stay in the air longer and go higher. You can try to do back flips and front flips, which are impossible on a normal trampoline without many years of practice.

Sports connection

- There are two types of trampolines: competitive and recreational. Competitive trampolines are used in sports for higher jumps, stunts, and acrobatics. Recreational trampolines are used for home exercise and fun.
- Trampolines are widely used in gymnastics. Gymnasts are tested when they perform different acts, maintain their balance, and bounce on a trampoline.
- Trampoline exercises help improve skills needed for diving and skiing.

Find out more:

- Bungee Trampoline [link to: http://www.trampolinerebounders.com/bungee_trampoline/]
- Potential Energy [link to: http://www.ele.net/algor/ff_pe.htm]

High Cycle

What to do: Ride a counter-balanced unicycle across a beam 20 feet in the air!

What's the big idea?
A secret to riding a unicycle is to keep equilibrium, which means to stay in balance. Hypothetically, if you could have perfect balance and not be affected by any outside forces, you would remain in stable equilibrium and not fall over. Therefore, the secret to not falling off a unicycle is to keep the contact point between the tire and the ground directly under your center of gravity (or the center of mass). As soon as the center of gravity is outside the base area, the force of gravity applies a torque (rotational force) about the contact point and pulls it to the ground. To keep yourself from falling off the front or back, you have to pedal at varying speeds. While unicycling, when you begin to fall forward, your center of gravity is pushed ahead so to compensate you speed up to get the wheel under you, if you begin to fall back you slow down your pedaling. Once a rider becomes proficient, these adjustments happen naturally.

Sports connection
The ability to keep balance and understand the position of your body in space plays an important role in many sports. From soccer to tennis and even rock climbing, changing your center of gravity to match your moves is the key to efficiency in nearly every sport. Our ligaments within the joints of the body have cells that tell our brain what position the joint is in and whether it is moving. When you are shooting baskets or passing the soccer ball, your body's joints are constantly communicating with the muscles, telling them when to contract, when to relax, and keeping your body stable and efficient. If an injury occurs, this communication is disrupted, but it can be restored with exercise. A simple activity such as balancing on one foot can help prevent ankle, knee, and foot injuries.

Find out more:

- The Physics of a Unicycle [link to: http://www.angelfire.com/un/unicyclephysics/]
- Balance Training [link to: http://sportsmedicine.about.com/cs/conditioning/a/aa062200a.htm]

Coaster Physics

What to do: Go for a spin (literally!) in a full-motion, 360-degree flight simulator that takes you on a ride on Kennywood Park's beloved "Phantom" roller coaster.

What's the big idea?
The amazing thing is that a roller coaster has no engine. The train is pulled to the top of the hill in the beginning of the ride, but from there it must complete the trip on its own. As the train is pulled to the top, it is gaining potential energy. The higher the lift, the greater the amount of energy the train gains. That is why the first hill, or the lift hill, is the tallest in the entire ride. As the train passes the lift hill, gravity comes into play. It pulls it down, causing it to accelerate, and potential energy is converted into kinetic energy. The faster the train moves, the more kinetic energy it gains. As it begins to climb the next hill, the speed decreases, as does the kinetic energy.

As mentioned earlier, energy cannot be created or destroyed, but it can be converted from one form to another. As the train accelerates down the lift hill, potential energy is converted into kinetic energy. When the train ascends another hill, the kinetic energy is converted into potential energy again. Conservation of mechanical energy continues throughout the entire ride. It is because of this phenomenon that a roller coaster is called a "coaster." After the initial input of energy to carry the train up the lift hill, the roller coaster simply coasts through the rest of the ride. However, certain amount of energy is lost to friction, which works in the opposite direction of the motion. At the end, brakes stop the train and take the remaining kinetic energy out of the system.

Find out more:

- Roller Coaster Physics [link to: http://ffden-2.phys.uaf.edu/211_fall2002.web.dir/shawna_sastamoinen/roller_coasters.htm]
- Build Your Own Roller Coaster [link to: http://dsc.discovery.com/games/coasters/interactive.html]

You-Yo

What to do: Become a human yo-yo on the 24-foot-high arch with a three-foot flywheel mounted at the top. Whisk yourself high in the air and soar with the help of kinetic energy.

What's the big idea?
Before a yo-yo begins its fall, it has stored energy due to its position. At the top, it has its maximum potential energy, which is transferred into kinetic energy as it falls down the string. Due to the acceleration of gravity, the speed at which the yo-yo drops increases with time, and therefore the rate of rotation also increases. The speed and rotation rate are the greatest when the string is completely unwound. At the end of the string, the linear momentum is converted into angular momentum, and the yo-yo will continue to spin at the bottom of the string because the string is loosely looped around the axle. If you slightly tug the string, you will create friction between the yo-yo's axle and the string. When the axle encounters resistance, the angular momentum of the yo-yo causes the string to wind around the axle and the yo-yo starts climbing back up the string.

Sports connection

- Playing yo-yo is fun, but learning yo-yo tricks is even more fun! The most popular yo-yo tricks are sleeping, looping, off-string, and free-hand.
- Every year there are international contests for yo-yo players, where yo-yo professionals from around the world match their strengths against each other.
- Chico, Calif. Is home of the National Yo-Yo Museum, which has the world's largest public display of yo-yos.

Find out more:

- Physics of Yo-Yo [link to: http://www.madsci.org/posts/archives/oct98/907781908.Ph.r.html]
- Yo-yo Physics [link to: http://clackhi.nclack.k12.or.us/Physics/projects/Final%20Project-2005/2-FinalProject/yoyo/physics%20of%20yoyo.htm]