



SPINNING TOPS

Do you have a spinning top in your toy box? According to the Cambridge Dictionary, a top is "a toy with rounded sides, a flat top, a vertical handle, and a point at the bottom, that turns round and round on the point when the handle is pushed and pulled up and down or twisted."

Most people have enjoyed playing with a top at some time in their lives. In fact, tops have been around for thousands of years! They have been found at archeological sites on every continent of the world except Antarctica, some dating back to 3,500 B.C.! Ancient tops were often made of clay, ceramic, wood, or ivory. Some tops found in ancient Roman ruins were made of bone. It is possible that the first tops were made of things found in nature, like acorns, seashells, and even eggs.



Playing with a top can be fun and amusing. Perhaps you have used your fingers to start the spin, or even pulled on a string to set a top in motion. Somehow the top stays upright for some time before it begins to wobble and fall. A top is a simple toy but explaining what makes it spin requires some very complicated physics and mathematics!

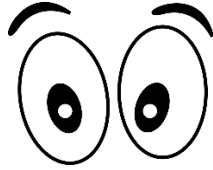
Physics is the branch of science that studies matter, motion, and energy. The laws of physics are expressed in mathematical formulas. Some of the physics concepts involved in a spinning top include **potential energy, kinetic energy, momentum, angular momentum, torque, gravity, and friction.**

- To make a top start spinning, you must apply a force called **torque**, a force with a tendency to twist or turn something.
- This force changes the top's **potential energy** (stored energy) into **kinetic energy** (energy something has because it is in motion). Another example of something with potential energy is an arrow in a bow that is pulled back and ready to shoot. All kinetic energy begins as potential energy.
- Once the top begins to spin, it spins around the **axis of rotation**, which gives it **angular momentum**.
- **Rotation** is the circular movement of an object. A three-dimensional object rotates around an imaginary line (axis of rotation) passing through its center. Angular momentum describes the spin of objects turning around an axis that passes through their center.
- Angular momentum will not change until it is acted on by another external, or outside force. This is known in physics as the **law of conservation of angular momentum**. A spinning figure skater is also using angular momentum.



- In the example of a spinning top, the external forces acting to change the angular momentum will include **friction, gravity**, or a person touching it.
- Friction is a force that resists, or stops, motion between two surfaces. The very fine point of the top that is in contact with the surface minimizes, or decreases, the amount of friction acting on the spinning top.

- When friction makes the top slow down, it will begin to wobble. The top of the axis is tilted to the side allowing gravity to pull it down. Gravity is the force that makes everything fall toward Earth. **Gravitational torque** is the force acting on a top once it is slightly tipped.
- At this point it starts to spin on another axis. In physics, this is known as **precession**.
- The top continues to slow down, wobbles, and eventually falls and stops.



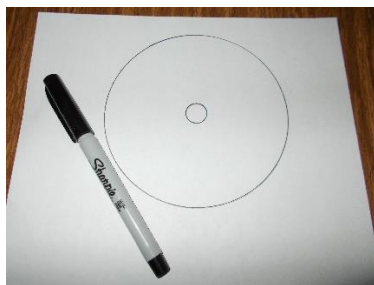
ACTIVITY: Make a spinning top from a CD, a marble, and a bottle top

Materials:

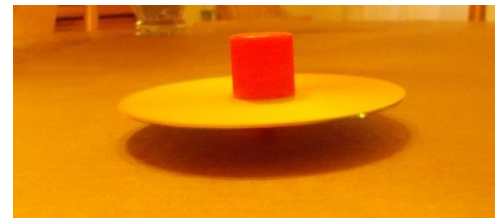
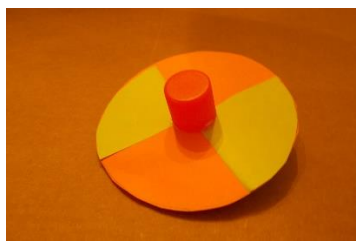
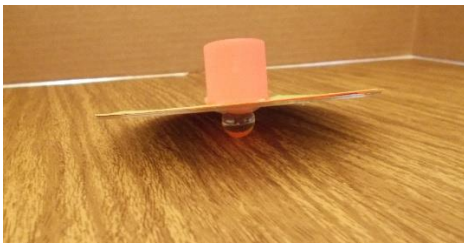
- An old CD or DVD
- Plastic bottle top
- Marble
- Coloring tools, such as markers, crayons, or colored pencils
- Hot glue or other liquid glue
- Paper (white paper for coloring, or construction paper)
- Scissors



1. Trace a circle on your paper using your disc as a guide, and then cut it out.



2. Decorate the paper. Spirals are a good choice, or four sections colored with two alternating colors. You will see these blend when the top spins!
3. Glue your paper to the top of your disc.
4. Glue the marble to the center on the bottom of the disc.
5. Glue the bottle cap to the top of the disc.
6. Now, take it for a spin!



DISCUSSION: Let's review the concepts used to set your top in motion, watch it spin, wobble, and eventually come to a stop! First, you applied torque to change the top's potential energy into kinetic energy. This created angular momentum, and you watched the top spin around its axis of rotation. Friction acting on the marble began to slow the top, causing it to wobble. As gravitational torque pulled the top down into precession, it began to wobble more until it eventually fell and stopped. And you thought you were just having fun!

ADDITIONAL RESOURCES

Books available from the Washoe County Library System:

Cool Gravity Activities: Fun Science Projects about Balance by James Hopwood

Forces and Motion by Peter Lafferty

Forces and Motion by Alvin Silverstein

Isaac Newton and the Laws of Motion by Jordi Bayarri

Motion by Darlene Lauw

Physics: Investigate the Mechanics Of Nature by Jane Gardner

Science Stunts: Fun Feats of Physics by Jordan D. Brown

What are Newton's Laws of Motion? by Denyse O'Leary

Who was Isaac Newton? by Janet B. Pascal

Videos:

The Action Lab, "The Top That Spins Forever" <https://www.youtube.com/watch?v=rNNZ1B9hTws>

Children's Museum Houston, "Science is Tops" <https://www.youtube.com/watch?v=i9OmA0nNXco>

PBS Learning Media, NASA Physics and Engineering, "Rotations in Space"

https://pbslm-contrib.s3.amazonaws.com/WGBH/conv18/npe11_int_spacerotations/index.html

PBS Science Trek, "Gravity!" <https://www.pbs.org/video/gravity-m3swlv/>

Physics Girl, "Bizarre Spinning Toys" <https://youtu.be/1Tx7FgZuV3U>

Websites:

LEGO Education, Early Simple Machines Set, Spinning Tops

<https://education.lego.com/en-us/lessons/esm/spinning-tops#connect>

NASA Science, Space Place, What is Gravity? <https://spaceplace.nasa.gov/what-is-gravity/en/>