How does it Work?

Tops -- Newton's First Law of Notion states that an object in motion will remain in motion on a straight line unless acted upon by an outside force. This is known as the principle of inertia. The principle of rotational inertia states that a spinning object will continue to spin unless acted upon by an outside torque. A spinning top on a level surface spins around its axis and does not fall. Spinning the top produces rotational inertia (amount of spin and the direction of spin) which keeps it in place as it rotates. The forces which cause it to stop rotating, and therefore fall, are friction (between the table and top) and air resistance.

Rattlebacks have a counterclockwise spin bias that results from the shape of the smooth ellipsoidal bottom and the distribution of the mass with respect to the axis of spin. The long axis of the ellipsoid is aligned at an angle of 5 to 10 degrees to the long axis of the flat top. Just prior to reversing direction, a Rattleback rocks up and down on its long axis, hence the name.

Jearl Walker, "The Amateur Scientist", Scientific American, October 1979.

Topsy-Turvy Tops will invert if there is sufficient angular momentum so that the stem of the top dips. If the stem touches and slides across a flat surface, then the friction can enable the top to flip.

Ivar Peterson, "Topsy-Turvy Tops", Science News, Vol. 146, page 108.

Spring-Ups -- Before the toy begins moving, energy is stored as elastic potential energy in the toy's spring when the energy of your muscles pushes down on the toy and makes the suction cup stick. When the suction cup lets loose, the elastic potential energy is converted to kinetic energy. The toy has the most kinetic energy when the spring is completely expanded. You cannot change the height of the jump or the toy speed from one trial to the next; the amount of kinetic energy is constant. As this happens, the kinetic energy is being changed into gravitational potential energy.

Spring-ups often have a flipping motion because the spring often bends slightly as the suction cup releases. As a result, the force exerted is not perfectly vertical.

At its highest point, almost all of the toy's kinetic energy is converted into gravitational potential energy. In most cases, the toy will still have some rotational motion, so it must still have some kinetic energy. As the toy comes back down, the gravitational potential energy is converted back to kinetic energy. When the toy hits the table and stops, it loses both its potential and kinetic energy. Where does the energy go? Primarily, it becomes heat energy, but some of it goes into sound energy.

Wind-up toys -- The energy is supplied by human muscles winding the spring. This energy is stored in the spring as elastic potential energy and is stored there until you release the winder. Then the potential energy is converted to the kinetic energy of the toy's movement. The toy moves, and its internal parts also move. Both of these movements involve kinetic energy. This toy has the most potential energy when you have finished winding the winder and haven't yet released it. The toy has the most kinetic energy when it is moving fastest ----- somewhere in the middle of the motion. The force of friction between the tires and the floor causes the toy to slow down and eventually stop. The toy's kinetic energy is turned into thermal energy - the toy and the floor each get a little warmer.

Balls -- A ball held at some distance above the ground possesses gravitational potential energy from the force needed to lift the object against gravity. When it is released, it falls and gains kinetic energy and loses potential energy. When the ball collides with the floor, some of this kinetic energy is stored as elastic potential energy in the ball and the floor. The particles in the ball and the floor squeeze together like tiny springs. How well the material in the ball springs back to its original shape after being deformed determines the height of the rebound. If the material absorbs the potential energy and returns to its original shape slowly or not at all, much of the energy is not returned to the motion of the ball, resulting in a low bounce. The collision is said to be inelastic.