

COUNTER INTUITIVE AND ABRACADABRA EVENTS

<EXPLANATIONS>

by

Dr. Joe Laszlo

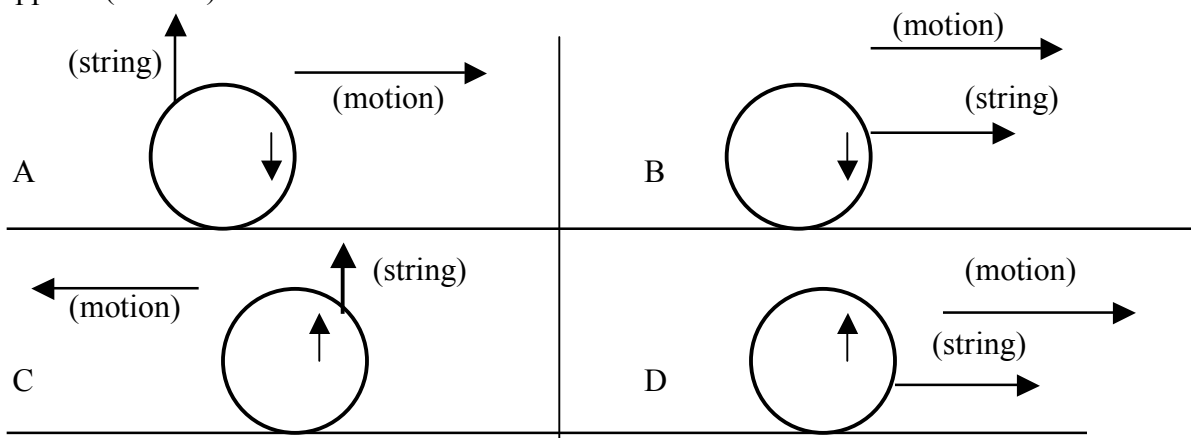
&

Mr. Jim Redmond

The philosophy behind using these particular counter intuitive events was to choose ones that use; **A.** a minimum of equipment and materials, **B.** recycled things whenever possible in keeping with the current world-wide “Green Movement”, and **C.** very little pre-preparation time. Finally, they can all be explained *qualitatively*. Is this important? You decide!!!!

1. THE GIANT YOYO. The GIANT YOYO can be made from a variety of materials including small, cable (wire) spools to foam core. An empty 16 mm projector reel would even work. They can be assembled using an electric glue gun or dry wall screws.

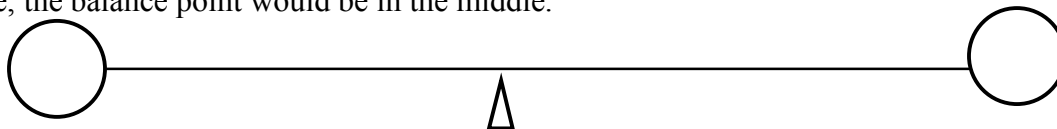
The first three trials (A, B, & C) are set ups and are the “sleight of hand” part that a magician might use. They cause the observer to become complacent and figure that the yoyo will move in the direction of the unwrapping line. However, Newton’s 1st and 2nd Laws of Motion prevail. In Trial D the yoyo seems to defy the wound up line, but in reality, if the force is great enough to overcome the inertia the object will move (1st law), and accelerate in the direction that the force is applied (2nd law).



2. A BALL ON A WIRE. When balanced horizontally, the balance point is close to the ball.

When balanced vertically, the system is easier to balance with the **ball up**. This is because the base of support, the long section of wire is easier to get under the mass of the ball. With the system ball down, the long section of wire has many moments of inertia and whips around fast making it difficult to move the base of support under it.

3. TWO BALLS ON A WIRE. If you were to add another identical ball to the other end of the wire, the balance point would be in the middle.



If you were to bend the wire double at the balance point, and attempt to balance it with both balls up, you would have a difficult time. This is because the added mass and the reduced length of wire would make it difficult to get the base of support under the masses.

You can re-bend the wire into an M shape. The M needs to be bent so that the tennis balls are below the point in the middle of it. You are causing the center of gravity (tennis balls) to be

below the base of support (point of M), which causes even greater stability. An interesting variation of the M gadget can be made using balls of unequal mass and size!!

4. MIRACLE GLUE AND EGG CARTON. There is no miracle glue!! All are merely empty shells. The eggs have been blown out and the shells washed and dried. The first two eggshells in the end of the carton are filled with lead shot. The lead was glued in place using white glue. All eggshells except the “model” were glued to the inside of the carton using a hot glue gun.

The center of gravity is at the “glued” end of the carton and hence the carton remains on the hand as though it were glued.

5. VARIOUS CARTESIAN DIVERS. There is much in the literature about the making of a Cartesian Diver. The divers have been made from small syringes ballasted with shot, from a cut-off Beral pipette with a bolt on it, medicine droppers, and even a paper match. My diver is of a half of a soda straw, bent double, with paper clips attached to hold the “legs” of the diver together and as ballast. It will require three to four paper clips, depending on how recently you purchased them. It needs to be tested in a container of water to make sure it is just barely floating, before it is put into the soda bottle of water.

When you squeeze the soda bottle containing the diver, pressure forces additional water into the diver and compresses the air trapped in it. This causes the mass of the diver to increase, and the density of the diver becomes greater than the surrounding water so it sinks.

The long tank with the spigot is made from two plastic tennis ball containers. You could also use liter soda bottles. The bottom is cut out of one of them and it is glued to the top of the intact one. You can use hot glue and a turn or two of transparent packaging tape to seal the joint. The hole is made near the bottom of the intact container using a nail that was heated in a flame. A plastic tap (spigot) is glued into the hole. These taps can be purchased at aquarium supply stores.

The long tank is filled with water. The soda straw diver is adjusted by squeezing it and forcing some air out and water in so that it just barely sinks. When you put it into the long tank, you must give it a shove to make it sink. The pressure of the water at the bottom of the long tank holds the diver down. As the level of the water changes while it is allowed to drain out through the tap, the water pressure will gradually decrease to a point where it can no longer hold the diver down, so the diver will surface.

6. THE ORANGE WITH A LIFE JACKET. When a fresh orange is placed into a container of water, it should float. If it sinks do not use this one and find one that *will* float. The orange peel should be scored on the four quadrants so that it can be removed intact. If the peel is placed into the water it should float, however the “naked” orange should sink. This is because the sugar in the orange juice and the pulp etc. cause it to have a density greater than water.

Restore the peel around the “naked” orange and put a rubber band around the peel to hold it in place. Return it to the water and it should again float as though there were a life preserver around the orange. If you notice the inside of the peel is rather spongy and hence has air trapped in it that increases the total buoyancy.

7. BUOYANCY IN FREE FALL. Buoyancy does not exist in free fall. For an object to float in a liquid, the object must displace a volume of that liquid whose mass is greater than the object. In addition, the liquid must be “contained” so that it has something to push against while pushing up on the object. Then the container and the liquid are in free fall, there is nothing for the liquid to push against, and cannot push the floating object upward. Buoyancy is temporarily suspended.

This apparatus is made from a piece of thin walled plastic tubing with stoppers in each end, and taped to hold them in place. The floating object is a ping-pong ball. The electrician's tape in the center is to give an index mark to show that the ping-pong ball does not move during free fall.

8. THE HANGING CHAIN. The chains assume a symmetrically curved shape of an inverted Catenary Arch. It happens because of the mass of the chain links are of uniform density and are attracted by the uniformly pull of gravity. Historically the Catenary arch has been used in medieval cathedrals. It was intuitively applied to building and later found to have uniform distribution of compressive force. The Gateway to the West Arch in St. Louis Mo. is such a structure.

9. COUPLED PENDULUMS. Every object has a natural resonant frequency at which it vibrates. Attaching a flaccid spring to two bobs is the standard way of connecting the pendulums. However having multiple pendulums suspended from the same support material will also couple them. Considering the two pendulums of the same length, the one in motion will cause the other to oscillate because of they are alike. The odd pendulum will swing for short periods then be dampened and motionless for awhile. The energy from the moving pendulum is transferred to the identical one at a regular rate, but only sporadically to the odd pendulum.

10. THE FALLING WINE GLASS. The small mass on the long string becomes an instant pendulum, which has a continuously changing period because the length changes due to the falling wine glass. When the length becomes short enough the kinetic energy of the pendulum is such that it wraps around the point of suspension, the pencil (or your finger). This usually happens fast enough to entirely stop the fall and thereby preserve the wine glass.

11. SINGING WINE GLASSES. This is a classic quantitative demonstration of basic laws of sound. The empty wine glass has a higher pitch, when stroked compared to the one half-filled with water. This is because energy of stroking the rim of the glass is transmitted to the glass and air and also the volume of water. The vibrating water, being dense, uses up much more energy than does the vibrating glass. Hence the combined vibrations are slower, accounting for a lower pitch of the sound. If the wine glasses are struck with say a spoon, they will ring with the same tone that is gotten when they were stroked.

It is possible to get some wine glasses to sing by stroking their base. If you hold the stem and run your finger around the base, the wine glass will sing as it did when you stroked the rim, but with a different pitch. If you hold the wine glass by the goblet part and tap the base, you will find that it is a different pitch than you would hear when tapping the goblet part.

12. THE LOST BEAKER. This is a demonstration using the index of refraction. It is sort of like Harry Potter's Cloak of Invisibility. The clear liquid is baby oil or mineral oil, which has the same index or refraction as the Pyrex glass in the beakers. When the small beaker is in the large one with air surrounding it, the light goes through air to glass to air to glass to air to glass to air to glass to air to your eye. Each time it goes into a different transparent medium, it changes speed. When the small beaker is immersed in the oil, light is able to pass through the system unimpeded, at the same speed. Hence the small beaker appears invisible.

13. THE TWO-BALLOON PARADOX. This demonstration is an example of the surface-volume ratio law. It is the reason life is based upon cells. The surface-volume ratio law states that as the volume of an object increases the amount of surface area containing the volume proportionately, decreases. This means that when you were a baby, you had proportionately more outer covering (skin) than you do now as an adult.

If you hold a baby who is wearing only a diaper, they usually feel warmer to you than you feel to yourself. Why? Because they are losing heat faster than you are. This is because they have proportionately more skin for their amount of volume than you do!! Why do the balloons do what you observed?

The smaller of the two balloons actually had proportionately more elastic balloon skin exposed to the air pressure in the room as compared with the larger balloon. This means that the pressure was proportionately greater on the small balloon. Hence the air pressure in the room forced the air out of the small balloon into the larger one.

Sperm whales are known for diving deep into the oceanic abyss in search of their favorite food, the giant squid. How are they able to withstand the tremendous pressure of the ocean depths? Because of their large size, they have a smaller surface area in proportion to their volume. The pressure is distributed over a larger volume and hence the whale is able to do this wondrous feat.

The materials to make this apparatus can be found at any aquarium supply store. This includes the T's, both the hard and soft tubing, and the suction cups. Balloons are sold almost everywhere.

14. THE KINETIKOS. (A.K.A. Popsicle Stick Bomb) The KINETIKOS is an example of mechanical energy such as is found in a wound up spring that could power a toy car. To assemble the KINETIKOS, the popsicle sticks are stressed a bit as they are bent to fit the configuration. When the KINETIKOS strikes a hard surface, at least one of the joints gives way allowing the entire structure to fly apart, as all of the Popsicle sticks go back to their original shape. The potential energy stored during the bending emerges as kinetic energy or motion during the destruction of the KINETIKOS.

15. THE WIDE RUBBER BAND. This is a bit more complicated than the KINETIKOS. It is made of atoms arranged into long molecules that are attached to one another by cross-linkages. In a relaxed RUBBER BAND, these molecules are jumbled up like a pot of cooked spaghetti. The molecules go in every direction. They have kinetic energy and are moving. When you stretch the RUBBER BAND, you cause many of the molecules to straighten out, and slow down. The slowing down of the molecules causes a release of kinetic energy, which is felt as heat.

When you allow the stretched RUBBER BAND to become slack, the molecules that were straightened out and moving slowly, again become jumbled like the pot of spaghetti and start moving faster. More energy needed to enable them to continue to move. They must take in energy from the surrounding to achieve their previous level of kinetic energy. This absorption of energy from an area is usually felt as cold.

You can prove the above explanation by doing the following. Hang a rubber band from a ring stand and hang a mass on the rubber band so that it stretches. Heat the rubber band in the center with a hair dryer or a gently with a candle. As the rubber band gets warmer, it will become shorter. WHY? Because the molecules are again moving fast and jumbling up like the mixed spaghetti, and *pulling upward*.

These counter intuitive demonstrations are good to use as examples of student science fair projects. For example the beakers and the index of refraction could be a project where a student tested all manner of liquids and combinations with different transparent materials.

I have used them as a weekly bonus question in a college level physical science class. Students weren't required to answer them. JL