# CIRCUS SCIENCE

## Post-Show Classroom Materials Section One
## Line Juggling: Newton's First and Second Laws

**Our students have already learned the concepts of Inertia and Force Equals Mass Times Acceleration many times over on the playground. They just may not have realized they were experimenting with science every time they played catch. Use this simple game to prove this to them!**

- Give your volunteers one juggling scarf each (or you can also crumple up the lightest napkins you can find, then smooth them back out flat.)
- Have students throw their scarves/napkins up gently and clap once before catching them.
- Throw them twice as hard to get two claps.
- Throw them twice as hard again to get four claps.
- Challenge the kids to throw them as hard as they can to get the highest numbers of claps they can. Could they even spin around and then catch them?
- Continue this game to reinforce the concepts the students <u>already know:</u>
    - Your throw is a force. (*A force is any Push or Pull.*)
    - If you throw it, it goes. If you don't throw it, it stays. (*Inertia*)
    - If you throw it harder, it goes faster and higher. If you throw it softer, it goes slower and lower. (*F=mA*)
- Line the students up shoulder to shoulder starting with a group of three.
    - Have the students simultaneously throw their scarves straight up, then take a step to the right.
    - Each student then catches the scarf thrown up by the person next to them.
    - The end student on the far right must dash behind the line to the opposite side to catch the scarf coming down on the far left.
- With crumpled and then smoothed out napkins, lines of three kids will usually be the most successful. With actual juggling scarves (about $.50 to $1.00 each on Amazon,) you can build up to lines of six, seven, or even more!

## Discussion Questions

- What other playground games demonstrate Forces, Inertia, and F=mA? How?
- Are there any playground games that don't?
- Inertia says something that's not moving cannot move all by itself. So why do things fall to the floor when I let go of them? (The force of gravity is *pulling* them.)
- When a magician yanks a tablecloth out from under a dinner setting, why do the plates stay on the table? (You can demonstrate this with heavy plastic dinnerware!) Without a strong enough force acting directly on the plates, their inertia keeps them where they are.

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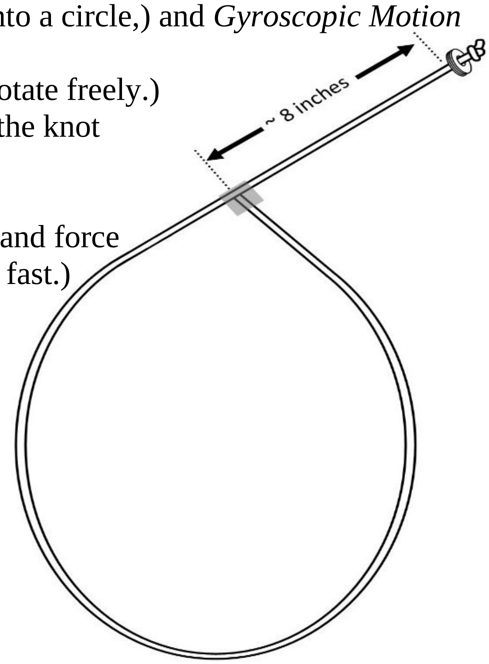
# CIRCUS SCIENCE

## Post-Show Classroom Materials Section Two
## Lassos: Centrifugal Force and Gyroscopic Motion

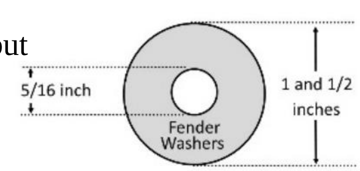
**Our students have already learned the concepts of Centrifugal Force and Gyroscopic Motion many times over on the playground. They just may not have realized they were experimenting with science every time they threw a frisbee or rode a bicycle. Use these simple exercises to prove this to them!**

- Cut a six-inch or larger diameter circle out of cardboard.
- Have a student try to balance it on its thin edge standing still. Does it work? *No!*
- Have a student roll it forward. Does it balance easily on its thin edge then? *Yes!* These are the same forces at work that keep kids upright on their bicycles, that make frisbees fly, and that keep cowpoke lassos spinning flat.
- Make your own kid lassos for about $2.00 each from simple hardware store supplies.
  - Cut a seven-foot length of ¼-inch diameter clothesline.
  - Circle the rope back on itself and duct tape one end perpendicularly leaving a tail of one foot.
  - Tape four 5/16 inch x 1 and ½ inch fender washers together in a stack. (Don't block the hole.)
  - Feed the rope through the washer holes and tie a knot. (There should be about 8 inches between the washers and the duct taped connection. Tie the knot near the end so there is no excess rope sticking out.
  - Kid lassos can also be purchased at westernstageprops.com for ~ $6.00
- Experiment with *Centrifugal Force* (the force pulling the rope outward into a circle,) and *Gyroscopic Motion* (the forces keeping the rope flat and level.)
  - Hold the washer's only. (Not the rope. The knot must be able to rotate freely.)
  - Point the rope downward. Make sure your fingers aren't keeping the knot from turning.
  - Use more <u>wrist</u>, than arm to make steady circles.
  - Vary the spin faster and slower until you find just the right speed and force to create and keep the circle. (Most often, people try to spin it too fast.)




### Discussion Questions

- Imagine a ball in a bucket. If you turn the bucket over, will the ball fall out? But what if the bucket goes upside-down while you are swinging it in a circle with your arm? What's keeping the ball in the bucket then? (Try this demonstration if you like!)
- Can you think of some amusement park rides that use the same forces?
- What about smaller toys on the playground? (Hula Hoops, Jump Ropes, Merry-Go-Rounds, Tetherballs?)
- Have you ever seen a tetherball rope break in a game? What happened?
- Speaking of tether balls, can you think of something that works in a similar way, but is much, much bigger? How about the Earth spinning around the Sun! But what's our rope? Gravity pulls us in just like the rope pulls the tetherball!

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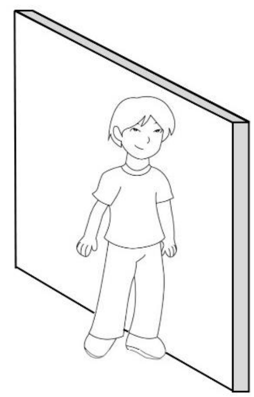
# CIRCUS SCIENCE

## Post-Show Classroom Materials Section Three
## Feather Balancing: Center of Gravity

**Our students have already learned the concept of Center of Gravity many times over on the playground. They just may not have realized they were experimenting with science every time they stacked blocks, leaned a broom against a wall, or walked a balance board. Use these simple exercises to prove this to them!**

- Everything has a center of gravity, including us! Ours is usually right behind our belly button. And as long as we keep our center of gravity (our belly button) over our base (our feet,) then we stay upright. But what happens if our belly button goes past our feet? We fall! That's why it's easier to balance with your feet further apart. When your feet are in a line (like on a balance beam,) it only takes an inch or so for your belly button to drift past your feet, and down you go!
- Try it! Walk normally with your feet apart. Now walk heel to toe in a straight line. Put a finger on your belly button. You can see that the moment you start to fall is the same moment when your belly button passes outside your feet!
- Stand next to a wall sideways with the long edge of your left foot snug against the wall *while* pressing your left shoulder snug against the wall. Can you pick up your right foot for three seconds? *No!* (Make sure your left foot is <u>fully</u> against the wall.) You can't get your belly button over that inside foot, so you can't balance on it!



- Now experiment with center of gravity by balancing peacock feathers! ($.50 to $1.00 each on Amazon—the longer the better! They are also available at most chain craft stores.) Another option is to pinch the end of one drinking straw; then slide it slightly inside another. Do this with five straws, and you'll make a single three-foot-long straw that, though it isn't quite as easy to balance as the feathers, does do the job.
- Hold your hand out flat, place the base of the feather in the center of your palm, and watch the <u>top</u>. Where that top (the center of gravity) goes, your hand (the base) must follow. If the top falls to the left, you go to the left—not just your hand, but your whole body to follow it. If the top goes forward, you go forward. Keep following that center of gravity with the base. Remember to always watch the top!
- Try it on just one finger! (Some people find that easier!) Can you toss it straight up and switch hands? Can you balance one in each hand? (That's super hard!) Can you tilt your head back and balance it on your chin?
- Keep moving, but watch out for chairs, walls, and friends!

### Discussion Questions

- We all know about balance beams in gymnastics, but how is center of gravity important in other sports?
- Imagine a stack of four dice next to a single die. Where do you think the centers of gravity are on them? Now try to blow each of them over with a single breath. (Try this demonstration if you like!) Which one is easier to blow over? Race cars are built to be very low. Have you ever seen a bus on a racetrack? No? Why not?
- Which is easier: carrying one thirty-pound suitcase with one hand or carrying two twenty-pound suitcases with one in each hand? Why do you think that is?