



A science show with an explosive mix of juggling and fun!

GRAVITY! CATASTROPHE!



**This study guide is intended for K-6.
Some activities are better suited for younger or older students.**

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“I try to show the public that chemistry, biology, physics, astrophysics is life. It is not some separate subject that you have to be pulled into a corner to be taught about.”

- Neil deGrasse Tyson

“Somewhere, something incredible is waiting to be known.”

- Carl Sagan

What to Expect - Performance Overview

The Zaniac takes a tornado of juggling skills, combines it with a whirlwind of science knowledge and sends it crashing directly into your student’s brain. Alex Zerbe uses his formidable juggling skills and wacky sense of humor to demonstrate and explain the following scientific concepts

- Acceleration of Gravity
- Center of Mass
- Simple Machines
- Centripetal Force
- The Scientific Method
- Angular Momentum *not every performance
- The Solar System
- Vortexes
- The Bernoulli principal

This performance focuses on physics, the science that deals with matter, energy, force, and motion.

Your students will be captivated as The Zaniac transforms an audience volunteer into a model of the inner solar system (asteroid belt included), creates toroidal vortexes with a garbage can, and catches a shovel with his face to explain center of mass. This interactive performance will spark your students' curiosity about science while keeping them thoroughly engaged.

“Alex's science show, Gravity Catastrophe! was a great way to kick off our school's science fair. I've gotten several unsolicited emails from parents saying that their kids loved the show and are excited to participate in the science fair.”

– Mary Woodward Elementary School

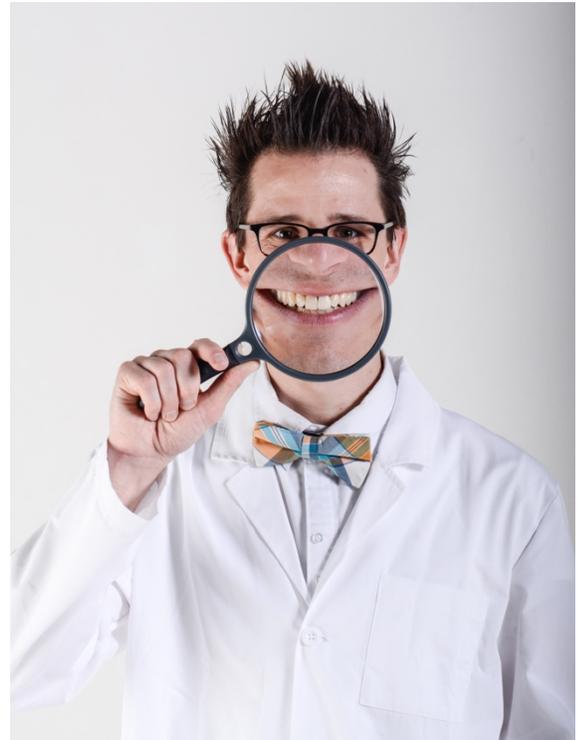
Alex Zerbe's Biography

Alex Zerbe has been interested in how the world works for as long as he can remember. He was fortunate enough to have his interest encouraged by his parents and a series of great teachers.

One of his favorite science memories is of a story told by Mr. Wilson, Alex's seventh grade science teacher. Mr. Wilson told the class about a toddler who naturally used the scientific method. The toddler had observed adults coming in a door and grew curious about how the door worked. She approached the closed door and started exploring and experimenting by pushing and playing with the door knob. Through her experimentation, she was able to turn the door knob and get the door to open. This toddler used her natural curiosity and ability to explore the world around her to discover new information. This story convinced Alex that everybody who is curious about the world, and open to evidence to explain the questions that arise from that curiosity is a scientist. To this day Alex believes that, "We are all Scientists!"

Alex loves reading science fiction. Some of his favorite books are the Foundation series by Isaac Asimov and Ender's Game.

Since performing his first school program in 1998, Alex has performed in 14 countries, been awarded two Guinness World Records, appeared on America's Got Talent and Last Comic Standing as well as television in Canada and China. He loves performing for kids and their parents and has done shows for over 2,000 schools in 44 states.

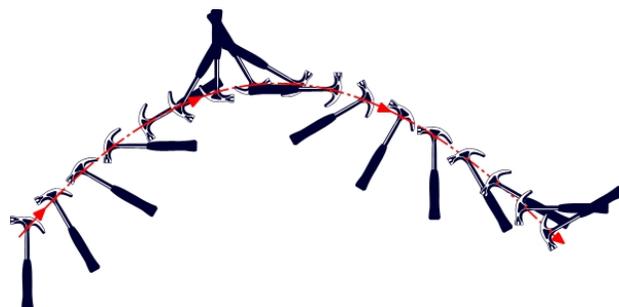


Vocabulary Terms

(Some of the vocabulary terms are used in the activities outlined in the guide, while others will become relevant in the performance)

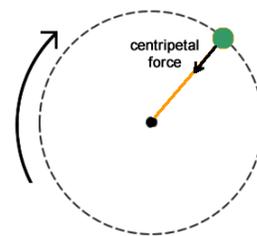
- **Gravity:** The force that attracts a body toward the center of the earth, or toward any other physical body having mass. Everything that has mass will create a gravitational pull.
- **Acceleration of Gravity:** How objects speed up as they fall towards the ground. The acceleration of gravity is the same for all objects regardless of how much they weigh. For example, if you drop a truck and a lemon from the same height at the same time, they will both hit the ground at the same time.
- **Matter:** Physical substance in general.
- **Mass:** The amount of matter an object contains. Mass is not the same thing as weight. If you took something with the mass of 5 kilograms to the moon, the mass does not change, even though the weight will be 1/6 of what it is on the Earth.

- **Center of Mass:** It is the average position of all the parts of a system according to their masses. You can find the center of mass of an object by flipping it into the air. An object will always rotate around it's center of mass. Check out the hammer →



- **Simple Machine:** A device that can redirect force and/or change the magnitude of a force. There are six classic simple machines: The lever, the wedge, the inclined plane, the screw, the pulley and the wheel and the axle.

- **Centripetal Force:** A force that acts on a body moving in a circular path and is directed toward the center around which the body is moving. This force is called the centripetal force which means "center seeking" force. Anytime something is moving in a curve, it's experiencing a centripetal force.



- **Friction:** the resistance that one surface or object encounters when moving over another. Also called rubbing or abrasion.

- **Diabolo:** Also know as a Chinese yo-yo. A juggling prop consisting of an axle and two cups or discs. This object is spun using a string attached to two hand sticks. The diabolo is used as an example of a simple machine, in this show.



- **Juggling Clubs:** A prop used by jugglers. They are similar to bowling pins but are different in size, weight and weight distribution.
- **The Scientific Method:** A process of discovering knowledge. A systematic way of learning about the world around us. This process has six steps.
 - 1) Formulate a question. Ask a question about something you've observed.
 - 2) Gather information. Do research about your question and write down the sources of the information.
 - 3) Make a hypothesis. Take an educated guess about what the answer to your question might be.
 - 4) Create and conduct an experiment that will test your hypothesis.
 - 5) Collect and record the data from your experiment. Write it all down! Make a cool graph if you can.
 - 6) Come to a conclusion. Determine whether you should accept or reject your hypothesis.



Watch the Zaniac's Scientific Method Music Video at amazingschoolassembly.com or type "Zaniac Science" into YouTube's search feature.

- **Momentum (linear momentum):** The force of a moving object. The amount of momentum is the product of how much mass the object has and how fast it's moving (it's velocity).
- **Angular Momentum:** The force of a rotating object. All rotating objects create angular momentum. The amount of angular momentum is a combination of much mass the object has and how fast it is rotating. Your bike wheels generate angular momentum when they spin. The force of that angular momentum makes it easier for you to balance on your bike.



- **Vortex:** A mass of fluid or air with a whirling motion that tends to form a cavity or vacuum in the center of the circle. Two examples of vortices are a tornado, and a whirlpool or eddy.

Swirling water creating a vortex



Angular momentum keeps the spinning bike tire upright.

Acceleration of Gravity/Law of Falling Objects Activity

Let's discover how things fall!

What you'll need:

- 1) Objects of different weights that can be dropped on the ground
Ideas for objects: hard back book, rubber ball, small plastic toys, a crayon, a hammer (go outside for the hammer so you don't damage your floor).
- 2) A chair to stand on while you drop things

Stand on top of your chair while holding two different objects, one in each hand. Hold the objects so that the bottom of each object is at the same height. Drop both objects at the same time and observe what happens. Do the objects hit the ground at the same time? Do the objects speed up as they approach the ground?

Now try dropping a small plastic toy or similar object at the same time as a sheet of paper? Repeat the experiment but crumple up the sheet of paper into a small wad. Did you notice any changes?

You should discover that all objects hit the ground at the same time regardless of how much they weigh. The sheet of paper falls more slowly because its large surface area and light weight makes it susceptible to air resistance.

This is a great exercise to do in pairs. One person can drop the object and the other can observe closely.

For a great example of how air resistance affects falling objects, watch this video of a bowling ball and a feather being dropped at the same time in a room that has had all of its air removed (a vacuum chamber)

<https://www.youtube.com/watch?v=E43-CfukEgs>

If you'd like to watch another fascinating video about how gravity works. Check out "Gravity Visualized" It explains how planets orbit each other and why all of the planets in the solar system orbit in the same direction among other things. I found this a great introduction to general relativity.

<https://www.youtube.com/watch?v=MTY1Kje0yLg>

Fun with Levers!

A lever is a simple machine that can redirect force and change the magnitude of a force.

What you'll need:

- 1) A spoon or fork
- 2) Something to launch with your spoon or fork like mini-marshmallows or wadded up paper, baby carrot slices work great!

You might not realize it but forks and spoons can be used as levers. Place your small object on end of the handle of your fork or spoon, now press downward on the opposite end (the part you usually put in your mouth). Your downward motion on one end will change into upward motion on the opposite end of the lever. This upward motion should propel your small object into the air.



The point at which a lever operates is called a fulcrum. Can you point out the fulcrum in your fork lever?

You can also create a lever with a ruler and a pen or pencil. The pencil will be your fulcrum. Simply place your pencil under your ruler so that it's perpendicular to the ruler. You can move the pencil to different locations under the ruler and observe how the magnitude of the force changes depending on where you place the pencil. Experiment with different pencil placements and see what effect they have while operating your lever.

Centripetal Force Experiment

Centripetal force is the force that makes objects move in a curve. Any object that moves in a curved line is experiencing a centripetal force.

What you'll need:

- 1) A plastic cup with some water in it.
- 2) An area that might get a little wet 😊

Put your arm straight out in front of you and point your thumb inwards so that it points toward the ground. Now hold the cup of water with this hand.

This next part might take a little practice. You're going to try to swing the cup up and above your head in a circular motion. If done correctly, the cup of water will turn upside down and all the water will stay inside.

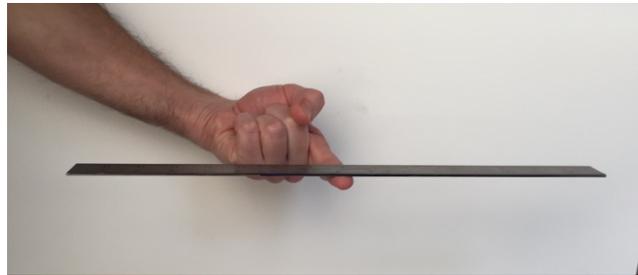
Center of Mass Experimentation

The point of this exercise is to see how the center of mass of an object changes depending on how the mass is distributed.

What you'll need:

- 1) A ruler
- 2) A small object like a rock or block of wood that can be taped to the ruler
- 3) Masking tape.

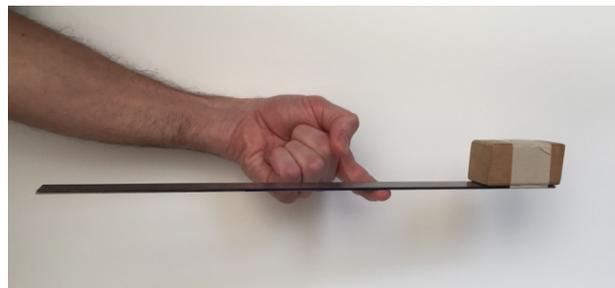
The first step is to find the horizontal balance point of the ruler. To do this, rest the ruler on top of one finger from each hand. Slowly slide your fingers toward each other while keeping the ruler flat. Because the ruler is uniform and the center of mass is in the center of the ruler, your fingers should meet at the 6-inch mark. You should be able to balance the ruler with one finger that's placed right below the 6-inch mark. Congratulations, you've found the horizontal balance point of the ruler. It's right below the ruler's center of mass.



The balance point and center of mass is at the 8-inch mark of my 16-inch ruler

If you throw the ruler into the air so it spins end over end, you'll see that the ruler rotates around the 6-inch mark. Objects always rotate around their center of mass with they are flipped into the air.

Now tape your small wooden block to one end of the ruler and repeat the experiment. You'll find the balance point and center of mass have moved! Flip the ruler with block attached into the air and noticed that the ruler now rotates around the new center of mass.



By adding the wood block to the ruler, it has changed the center of mass, it's now at the 10-inch mark

Create a Vortex

What you'll need:

- 1) A large glass full of water
- 2) A spoon

This is a short exercise that's easy to do. Start stirring the glass of water by moving the spoon around the edges of the glass. Try to keep your stirring motion smooth and consistent so you don't spill. The goal is to get the water moving fast enough that it creates a cavity in the center. If you use a larger container and spoon, like a big pot, your vortex will last longer once you take the spoon out.

Angular Momentum Activity

Angular momentum is the force generated by rotating objects. Let's see that force in action!

What you'll need:

- 1) Coins
- 2) A clear, smooth table top or floor

Take one of your coins and try to balance it on its edge. You'll find it's difficult, if not impossible to do (the nickel is the easiest because it has the widest edge).

We are going to use angular momentum to make the coin balance on its edge. Angular momentum is a force generated by rotating objects so it's time to rotate some coins!

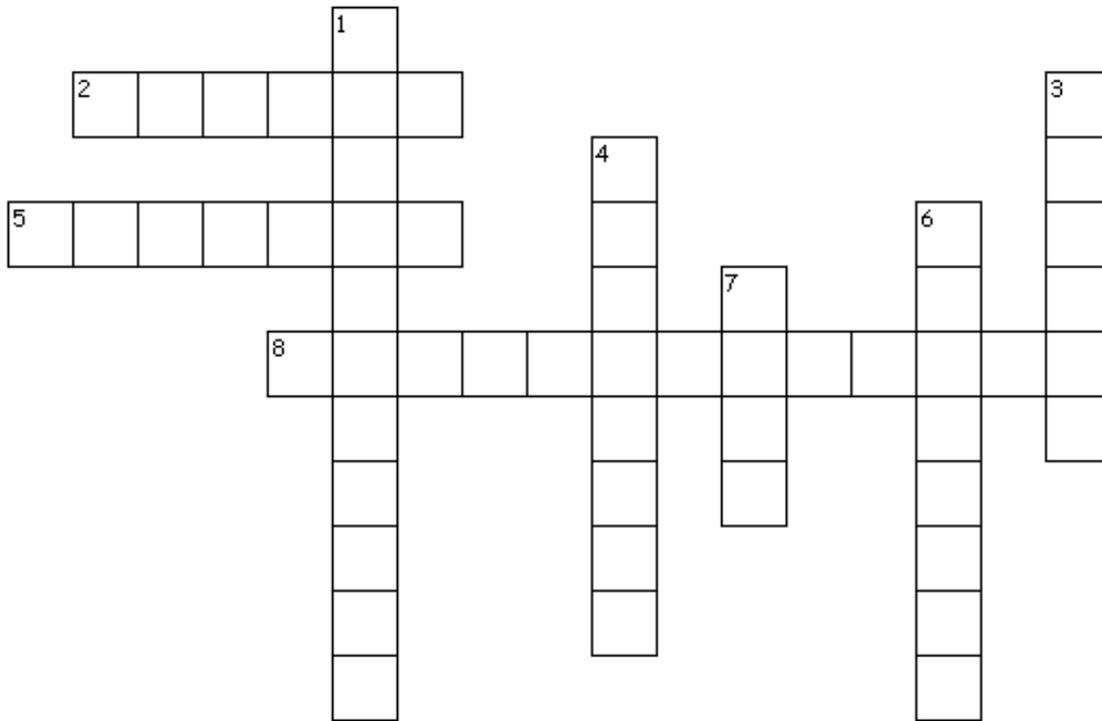
Spin one of your coins by holding it between the table and the index finger of your less dominate hand and flicking the edge of the coin with the index finger of your dominate hand (see picture). The coin should spin around the table on it's edge for several seconds.



You can also rotate a coin by rolling it. Roll a coin down a long smooth surface (gym floor works great!) See how long the coin stays on it's edge before coming to a stop.

The angular momentum that your bike wheels generate as they spin is what make it to balance on your bike. It's exactly like the rolling coins! Can you think of other rotating objects? Remember, all rotating objects generate angular momentum.

Gravity Catastrophe Crossword



Across

2. A whirling mass of fluid or air that tends to form a cavity
5. The force that attracts objects to the earth or other massive body
8. A device that can redirect force or change the magnitude of a force

Down

1. This force makes objects move in a curved line
3. Physical substance
4. The force created by a moving object. It's the product of the object's mass and speed
6. Also know as rubbing or abrasion
7. The amount of matter in an object

Audience Etiquette

Alex Zerbe's performance is exciting and fast paced. Students should be reminded before the show what it means to be a good audience.

- Don't talk to your neighbors
- Show your appreciation by clapping, not screaming
- Alex uses volunteers during the performance and only picks students who are sitting quietly.
- Remember any questions that you think of, Alex will take as many as he can near the end of the show.

Crossword Answers

Across

2. Vortex
5. Gravity
8. Simple Machine

Down

1. Centripetal
3. Matter
4. Momentum
6. Friction
7. Mass

Introduction

I'd like to introduce a two-time Guinness World Record holder. This guy was voted Seattle's Funniest Prop Comedian, he's appeared on America's Got Talent and Last Comic Standing, but most importantly, he is currently ranked Seattle's 3rd Best Air Guitarist.

He's blessed with the muscular physique of Taylor Swift.
Please put your hands together and make some noise for the Zaniac,
Alex Zerbe! (Zur-bee)

Technical Requirements

- The performance typically runs 60 minutes but can be lengthened or shortened if necessary
- Alex will need a 6 or 8 foot table and an extension cord at the performance location.
- Alex likes to have an hour to set-up his show but can do it in 30 minutes if necessary. He can set up his props on the side of the gym and move them into place if the gym or stage is being used by a class.
- It takes Alex about 30 minutes to pack up his gear, longer if he's being mobbed by students ;-)
- Alex needs a space that's at least 4 meters deep and 5-6 meters wide.
- Alex would like to talk with someone about how the students will be sitting to make sure he knows where the front row will be, how many kids there are and to establish an aisle up the middle.
- Alex provides his own sound system that is great for up to 700 kids. The person who introduces Alex will need their own microphone because Alex's mic is taped to his face.
- Alex will provide a written introduction. It's laminated, ooooo fancy.

Additional Technical Requirements if Alex is Flying to your Venue

- The performance typically runs 45-55 minutes but can be lengthened or shortened
- An adequate sound system with one xlr (mic cord) input and electricity upstage right.
- A 6 or 8-foot table upstage left
- Another small, 2 to 4-foot table
- One plastic garbage can 22 inches tall and 19 inches wide at the opening, see photo
- One shovel with the handle cut so the entire shovel is 40 inches long, see photo. The shovel and garbage can can both be purchased at Home Depot (probably) ☺
- One 6 or 8-foot ladder if possible and easy

