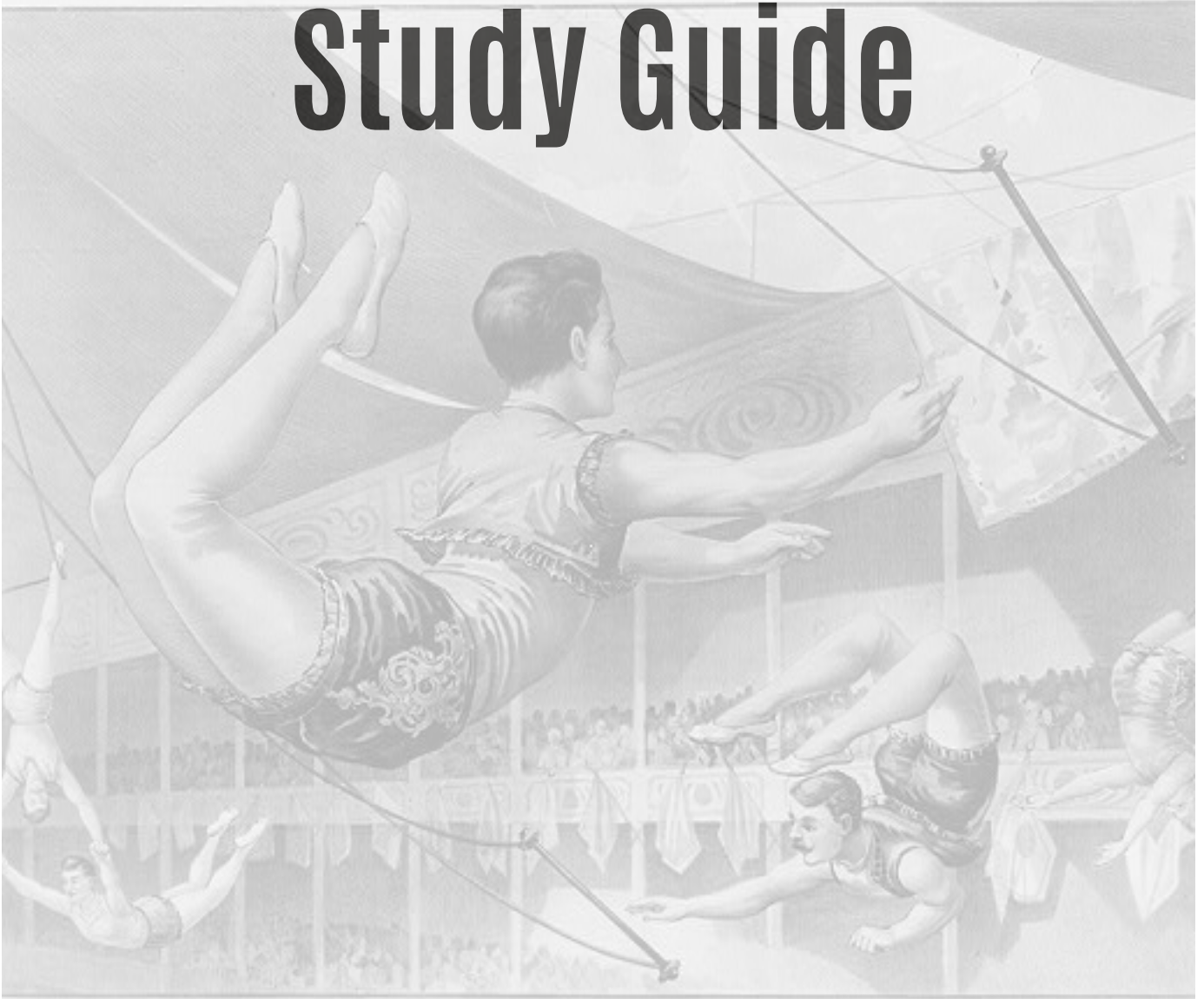


Science And Circus Study Guide



The
CIRCUS
Science
Spectacular!



What is The Circus Science Spectacular?



The Circus Science Spectacular uses assorted circus arts to explain different elements of science. The show features Steve Russell and Kobi Shaw, both graduates of Ringling Brothers and Barnum and Bailey Clown College, where they learned skills such as clowning, balancing, juggling, hat tricks, stilt walking, unicycling and much more.

What is a Circus?



The roots of the circus can be traced to ancient Rome, where chariot races, acrobatics, and various performances entertained large crowds of people.

What we might first recognize as a modern circus began in England in 1768. A man named Philip Astley had a horse who did tricks, and Astley could do acrobatics while riding on his horse. He discovered that if the horse cantered in a circle that was 43 feet across, an acrobat could more easily do his tricks while standing on the horse's back. That circle became the circus ring, which was the "stage". As the popularity of Astley's circus grew, more and different acts began performing - including trapeze artists, clowns, stilt-walkers, teeterboard troupes, and gymnasts.



Circus as an historic form of American entertainment dates back to the late 1800s. Originally circuses traveled from town to town by circus wagon and performed under canvas tents. There was much excitement when the circus came to town, often beginning with a parade and the setting up of the canvas performance tent. Later on, modern circuses came to travel by train or truck, and now often perform within indoor arenas. Most circus performers still present their acts inside a circus ring. Some circuses have up to 5 rings, but some modern circuses have no rings at all.

A **Ringmaster** hosts the show, introducing the acts. The Ringmaster outfit is designed to look like 18th-century gentleman's horse-riding clothes, reminding us that the first circuses began as horse shows.



Animals, such as elephants and tigers, used to be a big part of circuses. This was especially true in the early days, bringing exotic animals to towns before things like zoos existed. Now, only a few circuses still use trained animals.

CHERRY PIE!



In the circus, Cherry Pie refers to some extra work you might do, besides your own act or job. Sometimes it means putting up the tent. Sometimes it means helping the vendors sell popcorn. In this Study Guide, it refers to an extra activity that you can do to explore more circus or science!

The Wild and Wonderful World of Words!

If you listen closely to Ringmasters, you'll notice they use a lot of fancy words, in fancy ways. Two common language tools ringmasters use are **synonyms** and **alliteration**.

A **synonym** is a word or phrase that means the same as another word or phrase. Some synonyms for "ball" might be: orb, sphere, or globe. A ringmaster will try to find different and interesting ways to describe something.

Alliteration is repeating the same letter sounds, over and over again. Peter Piper picked a peck of pickled peppers is a tongue-twister with alliteration!

So, instead of saying "unicyclist", a ringmaster will say something like, "The One-Wheel Wonder!" A troupe of trapeze artists might be called "The First Family of Fearless Flight!"

Activity: Come up with your own description of a circus act. It can be a real act, or one that you make up. Make sure you use synonyms and alliteration to make the performer seem more exciting and colorful.

What does science have to do with the circus?



A circus would not be possible without science! From laws of motion to simple machines, there are examples of science everywhere in the circus.

When Philip Astley discovered just the right size for the circus ring, that was the result of experimenting. He tried circles of different diameters (diameter is an imaginary straight line across the widest part of the circle). He paid attention to the forces of gravity (how much the earth pulls things toward its center) and the effects of inertia (the tendency for objects to want to stay in place, or to want to keep moving in the direction they are moving). Using that study and research, he found best-sized ring. He didn't know it, but he used science to invent the circus!



Every time a juggler tosses a juggling club or a trapeze artist flies through the air, you are witnessing things like forces and motion, friction, gravity, inertia, acceleration and momentum. When the circus loads big heavy equipment onto their train, or hoists an aerialist to the top of the circus tent, a simple machine, such as an inclined plane or a pulley, is needed. A unicyclist or a Human Cannonball cannot propel themselves without the third law of motion. The circus is a perfect place to see examples of science in action!



Who was Sir Isaac Newton?



Sir Isaac Newton was from England and lived from 1643-1727. He was an important figure during the Scientific Revolution, making discoveries in optics, motion and mathematics. There is a famous myth connected with Sir Isaac Newton that he discovered gravity while sitting under an apple tree and an apple fell on his head. Actually, Newton saw an apple fall from a tree and wondered why the apple fell straight to the ground and not at an angle. This inspired him to start exploring the concepts of motion and gravity, which eventually led him to develop The Laws of Motion and his theory of gravity.

There are three basic Laws of Motion:

First Law

An object that isn't moving will stay in one spot unless an outside force pushes or pulls it. And an object that is moving will continue to move in a straight line at the same speed unless an outside force makes it change direction or speed.

In other words, a juggling ball doesn't juggle itself! An object won't move unless a force moves it. So, we need to use our hand (an outside force) to make the juggling ball move in a pattern.



If we were to try to juggle in space, where there is no gravitational pull from the earth, the juggling balls would stay in motion, in a straight line - meaning they would never come back to our hands. A space juggling act sounds cool, but it would be very disappointing! It is the force of gravity bringing the ball back to our hand that makes a juggling pattern successful.

Second Law

Force is equal to mass times acceleration, and a change in motion or speed depends on how much force is used.



In simpler terms, mass is kind of like weight (in Earth's gravity), and a change in acceleration occurs when something speeds up, slows down, or changes direction. If you wanted to throw a heavy bowling ball into the air, it would take more muscle than if you were to throw a ping pong ball in the air. With a massive object, you need to use more force to change how fast it moves. This is the second law at work.

Third Law

For every action, there is an equal and opposite reaction.

If you have an action of kicking a ball, the reaction is the ball moving away from your foot, equal and opposite to the energy of the kick. When you apply a force to something, that object will respond to that force in an equal and opposite way.





CHERRY PIE!

Ok, now that you know something about circus and something about the laws of motion, let's combine the two!

Let's pretend you are a juggler. If you can already juggle, all the better. Find a ball that fits comfortably in your hand.

Hold the juggling ball. Which of the Laws of Motion can you observe while just holding the ball?

Throw the ball. Which Laws of Motion do you (or the ball) experience?

Which laws come into play when you catch the ball?

How many of the laws can you describe for each of these stages of juggling?



During The Circus Science Spectacular, you will learn about both the world of circus and concepts of science. Here are vocabulary words to listen for within the show.

Circus Words

Balance - tricks that involve placing an object (or even a person) on some part of the body - hand, foot, head, shoulder, etc. The object has only one point of contact. If the person doesn't move to keep it under control, the object will fall.

Clubs - a weighted juggling prop with a head and handle, not to be confused with bowling pins which may look similar but are much heavier and are weighted differently. Juggling clubs are used by advanced jugglers.



Clown - a person who makes people laugh by using tricks, facial expressions, physical movements, jokes, or funny sounds. Clowns used to wear a lot of makeup and special costumes, but these days, clowns can go without makeup and can be dressed like normal people. It is the ability to make people laugh that makes someone a clown.



Clown College - The Circus Science Spectacular performers (Steve and Kobi) both went to Ringling Brothers and Barnum and Bailey Clown College. As students, they learned many things that are useful for performing the art of clowning. This included makeup application, sewing costumes and physical skills such as stilt walking, unicycling, juggling, tumbling, and more.

Clown Gag - a joke or short skit that a clown performs for an audience.



Human Cannonball - a circus act where a performer is shot from a large cannon and flies across the arena, landing on an airbag or net.

Juggling Balls - typically bean bags or weighted balls, approximately in 2.5 inches in diameter used for juggling, preferably with enough weight for your hand to close around easily when catching them.

Pie - used in clown gags, these pies are made of shaving soap and are typically pushed by one clown into another clown's face.

Scarves - lightweight, gauzy squares of material used for juggling, best used indoors for beginning jugglers



Sideshow - in early days of circus, there was often another tent that housed a sideshow. It was a smaller show that would feature unusual acts or performers. Sometimes, you would see people performing feats of strength, or you might see a sword swallower, fire eater, or someone lying on a bed of nails.

Teeterboard - a circus act where the weighted force of a person lands on one end of a teeterboard, catapulting the person waiting on the opposite end of the teeterboard.

Trapeze Artists - made up of flyers and catchers, these circus performers fly through the air as they swing and release, transferring mid air from one swinging trapeze to another on the opposite side.



Science Terms and Concepts

Acceleration - the rate of change of velocity, or how fast an object or person changes speed. It can mean speeding up, slowing down, or changing direction.

Air - a form of matter made up of a mixture of invisible, odorless, and tasteless gasses. Mostly made of the gasses oxygen and nitrogen, this mixture surrounds the earth, and allows us to breathe.

Air resistance - when friction slows the movement of something moving through the air. The friction of the atmosphere will slow and eventually stop an object in motion.

Catalyst - something that speeds up a chemical reaction or change without being used up or being permanently changed at the end of it.



Contact Force - a force between two objects that can only exist if these objects make direct contact with each other, like when a foot kicks a ball.

Exothermic reaction - a chemical reaction in which energy is constantly given off, often in the form of heat. All combustion reactions (explosions) are exothermic reactions.

Friction- occurs when two surfaces move over each other. Air resistance and water resistance are friction forces caused by the movement of something through the air or the water. The friction of the atmosphere will slow and eventually stop an object in motion.

Force - a push or pull. Nothing can move unless a force is applied to it. Force can be used to start or stop an object in motion or cause it to change direction. Force is measured in units called newtons (N).

Gas - a state of matter that has no fixed shape and no fixed volume. When matter becomes a gas, the molecules are so loose that they can move freely about any space.

Gravity - the force of attraction between any two bodies. It gets stronger with larger mass of the bodies. The force of gravity decreases if the objects are further apart. The Earth's gravity keeps us from floating away. The sun's gravity keeps the Earth in orbit.



Hoverboard - a means of transportation that travels just above the surface of the ground, using fast-moving air to force the hoverboard upward, reducing friction.

Inertia - a property of matter by which it remains at rest, or remains in motion in the same straight line unless acted upon by some external force.

Invisible force - forces acting on us and things around us, but they can't be seen. These forces include things like gravity, friction and air resistance, to name a few. These are also considered non-contact forces.

Kinetic Energy - the kind of energy in moving things

Liquid - a form of matter between solid and gas. Liquid particles have more space between them, so they don't stay in one position. The movement of the particles causes the liquid to be able to change shape. Liquids will flow and fill the lowest portion of a container, taking on the shape of the container but not changing in volume.

Mass - the amount of matter or substance that makes up an object. It isn't the same as weight, even though people often make that mistake. What we call weight is really a measurement of the effects of gravity on an object's mass. So, on earth, with gravity, things with more mass weigh more. In space, where there are little or

no effects of gravity, the mass of an object stays the same, but our idea of how much it weighs is different.

Matter - the material that something is made up of. There are four natural states of matter: Solids, liquids, gasses and plasma. Plasma is found in stars and lightening, and is at a VERY high temperature.

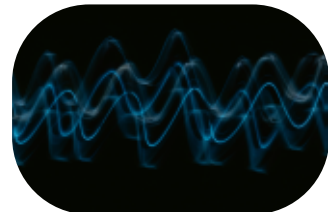
Newton (N) - how force is measured. A Newton is a unit of force.

Potential energy - energy that is stored up in an object due to its position, electrical charge, or mass. A ball at the top of a hill has a potential energy. A battery that isn't being used has potential energy.

Simple Machine - a simple machine is a device used to make tasks easier. The six types of simple machines are: incline plane, wedge, screw, lever, wheel/axle, and pulley.

Solid - a form of matter that we can observe that holds its shape in everyday situations.

Sound Waves - vibrating forms of energy that are made of molecules. If you could see them, these vibrations would look like waves on the ocean. Sound waves can travel through solids, liquids and gasses. The vibrations from sound waves cause our ears to send signals to our brains to create sound.



Weight Distribution - when the weight of something is spread out equally. The circus act of laying on a bed of nails is an example of how weight distribution works. When you have hundreds of nails in a bed, each nail holds a little bit of weight, and that is why an individual nail among the hundreds doesn't cause any harm to the person lying on it.

Visible Force - a force that occurs when two or more objects come in contact with one another. A force in which the contact can be seen, such as kicking a ball with your foot, or pushing or pulling a door with your hand.

Volume - there are two different kinds of volume. One describes how loud something is ("Hey! Turn down the volume!"). The other volume means the amount of space that a substance or object occupies. In The Circus Science Spectacular, we talk about the second kind - the kind that takes up space.



CHERRY PIE!



Science - Air Resistance Experiment

Air resistance is an example of friction which occurs between air and another object. Also referred to as “drag”, the force of air resistance always opposes the motion of an object. This causes items to move or fall more slowly.

For example, someone jumping out of the plane needs a parachute to allow them fall slowly to earth to ensure a safe landing. Air gets underneath the parachute. Because it has volume, air fills up the parachute and keeps it from falling immediately to the ground. Air resistance keeps the parachutist safe.

In the circus, many things fly through the air - from juggling clubs to people! All of these experience air resistance as they pass through the air. Many circus performers, especially performers who are aerialists or flyers, need to reduce their air resistance. They wear smooth, close fitting costumes. This allows them to fly through the air faster and with more ease. Do you think a cape would a cape slow them down, or would it help them fly?

Experiment: Take a sheet of paper and hold it so it is flat, in relation to the floor. Drop the piece of paper from chest height.

Observe and discuss how the paper falls.

Now crumple up that same piece of paper into a ball and drop it from chest height.

Discuss the differences of how the ball of paper fell as opposed to the sheet of paper.

Give the ball of paper to one student and get a second sheet of uncrumpled paper to another student.

Keep the sheet of paper uncrumpled.

Have the class form an **hypothesis** (an educated guess) about which piece of paper will hit the ground first. Have the two volunteer students drop their papers at the same time, from chest height. Notice which paper - the crumpled or uncrumpled - hits the floor first.

Try it a few times and see if the results are the same each time.

Discuss why the papers might fall at different rates. Does crumpling the paper make it heavier?

Share your findings with other people in your class, and see if they have the same results.



The Hover Disc!

One of the effects we sometimes present in our show is having someone from the audience float across the stage on our hovercraft. A hovercraft makes use of air pressure to reduce friction. When friction is reduced, the board, chair, and person can easily glide over a hard surface.



We made our own human-sized hovercraft. It is a bit too big for most people to build, so we found a way for you to have a "pocket-sized" version.

You will need:

- balloon
- CD (ask permission, of course)
- strong glue or a hot glue gun
- sports top to a bottle



1. Apply glue to the rim of the sports top . If you are using a hot glue gun, take extra care to be safe. The glue can burn you, if your hands are unprotected.



2. Center the sports top over the hole in the CD, and press the sports top into place. Allow the glue to set.



3. Make sure you can pull the sports top open and closed while it is attached to the CD. Close it and prepare for the next step.

4. Blow up the balloon, and stretch the mouth of the balloon over the closed cap. You need to keep the air in the balloon as you do this, so you might need another hand to help you pinch the neck of the balloon closed while someone else stretches the mouth to fit over the sports top.



5. Lift the sports cap into the "Open" position and let the hover disc float over a smooth, flat surface.



More to think about...

Now that you have your Hover Disc, you might want to explore some more questions:

- Does the Disc travel farther on the shiny side or the side with the printing?
- Does the surface under the Disc make any difference? Grass? Cement? Dirt? Carpet?
- How many Lego people can we put on the Disc and still have it float?
- How can I make the Disc move? What outside forces can I use to make it go faster?
- What would happen if I placed the Hover Disc on a bowl of water?
- What would happen if I used a bigger balloon?

These are questions scientists would ask if they wanted to learn more about this machine that they built. And the best way of discovering new facts is by using something called...

The Scientific Method

Imagine you're trying to figure out how something works or why something happens, like why plants grow towards the sun or how a toy car moves. Well, the scientific method is like a special way to answer those questions. It's a way scientists use to explore and understand the world around us. Here's how it works:



Ask a Question: First, you think of something you want to know more about. Like, "Does it matter which side of the Disc is used?"

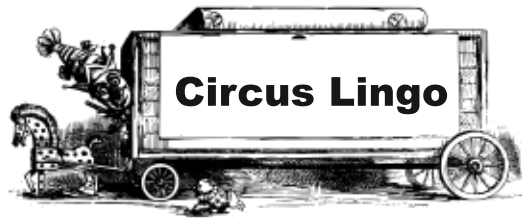
Make a Hypothesis: This is like making a guess or a prediction about what you think the answer to your question might be. For example, you might say, "I think the shiny side will be better because it is smoother."

Experiment: This is where you test to see if your guess was right. You might set up a simple experiment by making two Discs - one shiny side up and one shiny side down.

Collect and Analyze Data: During your experiment, you pay close attention and collect information or data. This could be measurements, observations, or anything you notice. After your experiment, look at all the information you gathered to see what it tells you. Did your results match your hypothesis?

Draw a Conclusion: Based on your data, you decide if your hypothesis was correct or not. If it was right, great! If not, that's okay too. Scientists learn from all results, whether they're what they expected or not. Share what you found out with others. This could be by writing a report, making a presentation, or simply telling someone about your experiment. Someone could have the same conclusion you came up with, or someone might have different information. By sharing your findings, someone might be able to help you discover new questions or hypotheses.

And that's the scientific method! It's like a step-by-step process scientists use to solve mysteries about the world.



Sometimes you can tell what country someone is from by the language they speak. The circus community has its own language. Well, they don't have an actual whole other language, but there are many words that circus people use when they talk to each other. See how many you can use in your school or home. It just might confuse people you know!

Aba-daba — A dessert

Alfalfa — Paper money.

All Out and Over — The entire performance is concluded, the audience has left.

Annie Oakley — A free ticket to the circus.



Big Top — The main tent used for the performance.

Blow Off — The ending joke of a clown gag.

Brodie — To accidentally fall down.

Butcher — Strolling vendor selling refreshments or souvenirs.

Clown Alley — The clowns' dressing and prop area.

Donniker — A rest room or toilet.

Fink — Anything that is broken. "It's fink!"

First of May — A performer or worker in his first season in the circus.

Jackpots — When performers tell stories, they are "trading jackpots".

Joey — A clown

Pie-Car — The railroad dining car where the circus people get their meals.

Rigging — The apparatus used in high wire or aerial acts.

Style — To strike a pose that invites applause. Ta-Daah!



Style!

And a phrase that some circuses use as they end their performances, "May All Your Days Be Circus Days!"



So, from The Circus Science Spectacular, thanks for reading, and
May All Your Days Be Circus Science Spectacular Days!



Circus Science



Using the study guide for The Circus Science Spectacular, fill in these circus terms and science terms.



A crossword puzzle grid with 25 numbered starting points for words:

- 1: Down, 1 cell
- 2: Across, 5 cells
- 3: Down, 2 cells
- 4: Across, 10 cells
- 5: Down, 10 cells
- 6: Across, 4 cells
- 7: Across, 4 cells
- 8: Across, 15 cells
- 9: Down, 1 cell
- 10: Across, 4 cells
- 11: Down, 1 cell
- 12: Across, 3 cells
- 13: Down, 1 cell
- 14: Across, 7 cells
- 15: Down, 1 cell
- 16: Down, 1 cell
- 17: Across, 5 cells
- 18: Across, 10 cells
- 19: Down, 1 cell
- 20: Down, 1 cell
- 21: Across, 8 cells
- 22: Across, 7 cells
- 23: Across, 10 cells
- 24: Across, 6 cells
- 25: Across, 6 cells



Circus Science

Across

- it can be solid, liquid, gas or plasma
- look like bowling pins but aren't (two words)
- Sir Isaac _____
- a circus pose that says "I'm done! Clap now!"
- devices that makes tasks easier (2 words)
- extra work a performer does at the circus (two words)
- the circus began with this animal
- an invisible force that keeps us grounded
- solid, liquid, gas and plasma are forms of this
- a body at rest wants to stay at rest. A body in motion wants to stay in motion.
- when a body stays at rest or stays in constant motion
- inventor of the modern circus (two words)
- something that speeds up a reaction
- a restroom at the circus

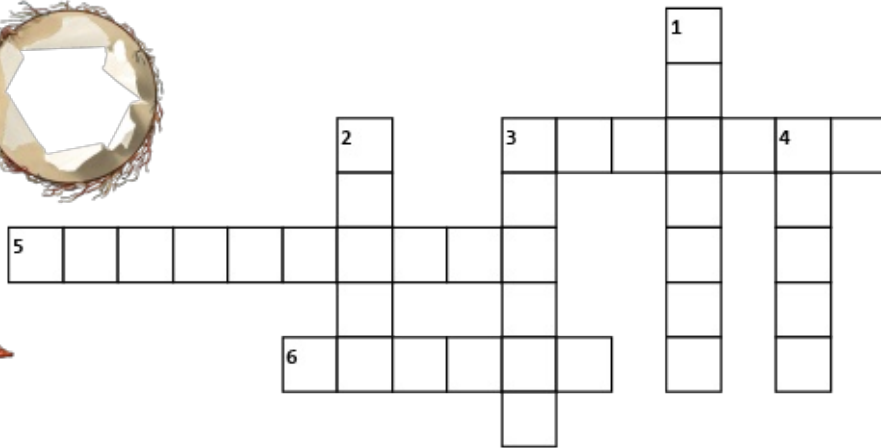
Down

- funny circus folks (circus lingo)
- it's 43 feet wide
- a pretty funny school
- another tent at the circus that presents unusual acts
- the easiest objects to juggle
- it's made of soap, but looks delicious
- the host of the circus
- circus term for paper money
- a push or a pull
- swings that are high in the air, used by flyers and catchers
- invisible, odorless, tasteless gasses that we breathe
- the resistance that happens when two surfaces touch each other

Bonus: Which word is in the puzzle twice?



Quick Crossword!



Across

- 3. a trick where you keep something on your hand, nose, or chin - without holding on to it.
- 5. the "stage" that circus people perform on
- 6. scientist Sir Isaac _____

Down

- 1. what makes a juggling ball fall
- 2. the first animal that performed in a circus
- 3. the name for the large tent
- 4. a funny circus performer

The Circus Science Spectacular Word Search

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | J | I | W | S | C | B | M | T | A | N | M | B | V |
| T | S | I | T | N | E | I | C | S | S | O | I | L | E |
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| N | O | E | W | M | G | E | J | G | T | L | W | G | J |
| S | R | W | N | O | B | Y | A | O | R | I | I | C | E |
| B | A | T | N | T | S | A | P | O | M | E | R | E | G |
| G | W | O | N | I | L | I | G | A | S | O | I | E | N |
| V | R | N | U | O | S | G | S | U | E | E | V | E | I |
| A | E | N | T | N | O | S | C | L | O | W | N | E | E |
| S | O | Y | T | L | A | T | J | U | G | G | L | E | R |
| C | G | R | A | V | I | T | Y | B | R | C | R | A | O |
| P | T | N | T | I | C | W | G | V | N | T | S | G | O |
| A | I | T | R | E | N | I | G | G | Y | C | I | A | P |
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NEWTON
 MOTION
 GRAVITY
 BIGTOP
 MASS
 JUGGLER
 CLOWN
 INERTIA
 SCIENTIST



Fill in the Blanks

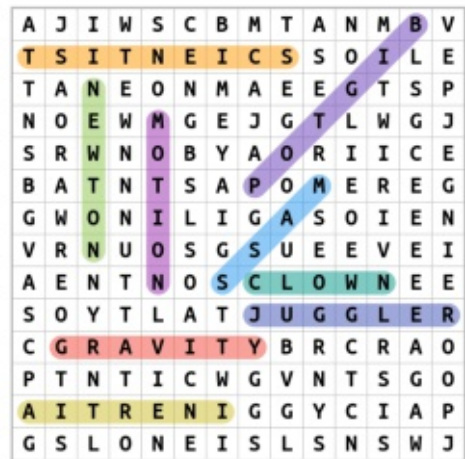
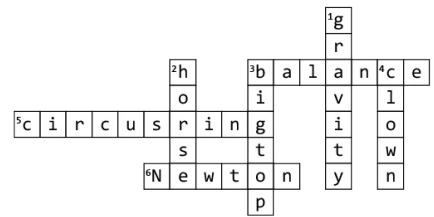
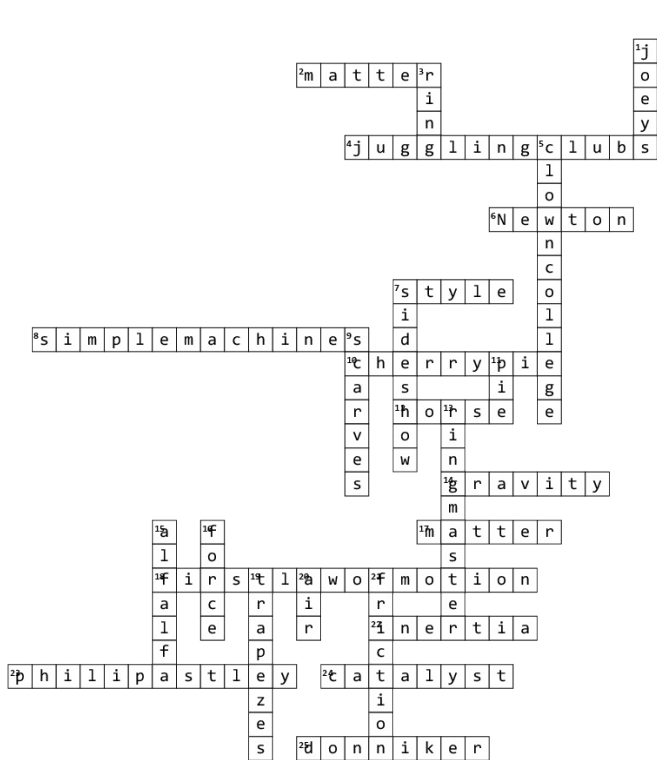
1. Part of the first Law of Motion is: A body in motion wants to stay in _____.
2. Philip Astley found that the best size for a circus _____ is 43 feet across.
3. _____ are the easiest objects to juggle, when first learning.
4. Something that speeds up a reaction is called a _____.
5. According to circus slang, to take a Brodie means to _____.
6. Kinetic Energy is the kind of energy found in _____ things.
7. A _____ is a device that makes tasks easier.
8. The bed of nails works because of _____ distribution.
9. In the circus, the act that has people flying from swing to swing is called the _____.
10. The person who introduces all of the acts is called the _____.

Vocabulary Words

Fall Down Ringmaster Catalyst Simple Machine Ring
Moving Motion Scarves Trapeze Weight



We Have Answers!



Fill in the Blanks

1. Motion
2. Ring
3. Scarves
4. Catalyst
5. Fall Down
6. Moving
7. Simple Machine
8. Weight
9. Trapeze
10. Ringmaster