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SODA BOTTLE TORNADO

EXPERIMENT GUIDE

as seen on YouTube™

POWERED BY Steve Spangler SCIENCE

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SODA BOTTLE TORNADO

How long does it take to empty a one liter bottle full of water? You'll amaze your classmates and explore some of the scientific properties of air and water when you learn how to empty a full bottle of water in just a few seconds.

WHAT YOU NEED

- WATER
- TORNADO TUBE WITH SMALL OPENING
- COLOR FIZZERS
- 2 EMPTY ONE LITER BOTTLES
- ADULT SUPERVISION

1

Fill a bottle with water.

2

Add one Color Fizzer to the bottle.

3

Screw on the Tornado Tube with the small opening.

4

Attach an empty bottle on top.

5

Flip and twirl to create a tornado inside the tube.

!

Watch the tornado form inside.

HOW DOES IT WORK

If you've ever watched the water drain from the bathtub, you've seen a vortex. A vortex is a type of motion that causes liquids and gases to travel in spirals around a center line. The vortex in this experiment is created when gravity pulls a liquid through an opening to form a rotating tornado.

Swirling the water in a bottle while pouring it out causes the formation of a vortex, making it easier for air to come into the bottle and allows the water to pour out faster. If you do not swirl the water and just allow it to flow out on its own, then the air and water have to essentially take turns passing through the mouth of the bottle, thus the "glug-glug" sound!

TAKE IT FURTHER - POUR CHALLENGE

1. Fill the soda bottle to the top with water.
2. Here's the challenge: How long will it take to empty all of the water in the bottle into the pitcher on the table? Record your prediction on a piece of paper.
3. Without squeezing the sides of the bottle, time how long it takes to empty all of the water. You might want to repeat this several times to validate your time.
4. Then, fill the bottle to the top with water, just as you did before. However, this time swirl the water by moving the bottle in a clockwise or counter- clockwise motion while the water is pouring out. Keep swirling the water until you see the formation of what looks like a tornado! The water begins to swirl in the shape of a vortex and flows out of the bottle. Record your time.
5. Compare your times. Was one method quicker than the other? If so, why do you think you got these results?

WHAT YOU NEED

- 1 ONE LITER BOTTLE
- PITCHER OR BUCKET
- WATER
- STOPWATCH

TAKE IT FURTHER - TWIST OF COLOR

Repeat the original instructions, but this time try adding 2 ounces of colored lamp oil to the water (Lamp oil is available at most department stores where oil lamps are sold.) The oil will float on the surface of the water since oil is less dense than water. When the oil and water swirl together, the less dense oil travels down the vortex first and creates a "colored" tornado effect.

WHAT YOU NEED

- 2 EMPTY ONE LITER BOTTLES
- 2 OUNCES OF LAMP OIL
- WATER
- TORNADO TUBE WITH SMALL OPENING

TAKE IT FURTHER - SWIRLING OBJECTS

What would happen if you put an assortment of small objects in the bottle with the water? Will the objects spin to the center of the vortex or to the outside of the vortex? Make your predictions, then follow the original directions but add in some small objects to the bottle with the water and try it.

WHAT YOU NEED

- 2 EMPTY ONE LITER BOTTLES
- AN ASSORTMENT OF SMALL OBJECTS
- WATER

TAKE IT FURTHER - STYROFOAM TIMER

WHAT YOU NEED

- ONE LITER BOTTLE WITH STYROFOAM BEADS
- TORNADO TUBE WITH BIG OPENING
- EMPTY ONE LITER BOTTLE
- WATER

1. Carefully open the bottle with the Styrofoam beads.
2. Twist on the large connector.
3. Twist on a dry 1 liter soda bottle. Turn it upside down to make your own soda bottle timer.
4. Now, check and see if this timer is accurate. Is this a good way to measure time? Why or why not? How can we test this?

To take it one step further, you may want to add water and see how this timer compares to the dry timer you have right now!

1. Move as many of the beads to one bottle as possible.
2. Over the sink, add water to the bottle without beads. Fill to the brim.
3. Add water slowly to the bottle with the beads. You are filling in all of the little spaces in between the beads. As the beads start to push themselves out of the bottle, slow the water and finish filling to the brim.
4. This is where it gets tricky - you have to connect the bottles. Carefully attach the Tornado Tube to one bottle then connect the remaining bottle. We suggest doing so over a sink until you get the hang of it.
5. Now, check and see the this new water filled timer is an accurate timer? Is this an accurate way to measure time? Why or why not? How can we test this? Is it more accurate or less accurate than the dry timer? Why do you think you are seeing these results? .

ADDITIONAL INFORMATION

How Does a Hurricane Start? The hurricane takes its name from the West Indian word *huracan* which means "big wind." Storms that occur over the Atlantic or the eastern Pacific Oceans are called hurricanes. The same kind of storm that forms over the western Pacific or Indian Oceans is called a typhoon. This name comes from the Chinese word *taifun* or "great wind."

Hurricanes and typhoons are not just violent winds. They are giant, whirling storms that develop in a special way. Hurricanes form only in the tropics where extremely moist air and heat are concentrated over the ocean, near the equator. The water temperature must be at least 80 degrees Fahrenheit both day and night. A wet season with increased rainfall begins in late spring and lasts to early autumn. This is the time of year when hurricanes develop. Evaporation of the warm water into the atmosphere over the ocean makes the air very moist. Winds blowing across the ocean in different directions begin to push masses of warm, moist air toward each other. This event is called convergence. When the air masses collide, the air in the center starts to rise, forming an updraft. At high altitudes, the moist air of the updraft begins to cool and water droplets form. These water droplets form clouds. Large cumulonimbus clouds begin to grow and thunderstorms develop. More thunderstorms form as more convergence and updrafts occur. If the thunderstorms do not dissipate, they may start to gather together. This formation is called a tropical disturbance. Many more thunderstorms join the disturbance. This weather event becomes large enough to be influenced by forces created from the Earth's rotation.

The tropical disturbance begins to swirl and becomes a vortex of thunderstorms. Updrafts are continuously pulling more air into the disturbance. When the winds begin to blow continuously at 23 miles per hour, the storm becomes a tropical depression. The tropical depression continues to gain power and becomes a tropical storm when the wind speed becomes 40 miles per hour. At any time, the disturbance, depression, or storm can run out of hot, moist air and weaken or die out. If it continues to gain strength and wind speeds reach 74 miles per hour, it is called a hurricane.

Hurricanes have top wind speeds between 74 and 180 miles per hour. The closer you are to the storm's center, the faster the wind will be. The energy of a hurricane comes from the heat released when water vapor condenses into a liquid. The atmosphere above a tropical ocean is the only place where enough warm, moist air is available to produce the energy necessary to create a hurricane.

The movement of a hurricane is somewhat predictable. It is so large that it moves with the Earth's wind currents that surround it. These wind currents are very large and steady and don't change course abruptly. Therefore, hurricanes usually travel in one of these wind currents until they meet another wind current, then they may change direction. If a hurricane changes course, it could pass over the same area twice. Sometimes one of these storms can stall over an area for days.

A hurricane covers a very large area. Typically, a hurricane is about 300 miles across. An average hurricane is about 800 to 5,000 times as wide as an average tornado. Hurricanes usually travel across the sea and land at 10 to 32 miles per hour. Some may travel at speeds up to 50 miles per hour. The path of a hurricane usually covers thousands of miles, mostly over the ocean. It is very important to track these huge storms and to make accurate predictions about their movements as many people live in areas affected by hurricanes.

To study conditions inside hurricanes, teams of pilots and weather scientists fly regular missions into these storms. They get measurements of wind speed, temperature, air pressure, and other weather conditions at different altitudes. These investigations help scientists make predictions about hurricane formation and movement.

The National Weather Service names hurricanes to quickly identify them. The names are assigned in alphabetical order alternating between female and male names. There are separate lists of names for hurricanes in the Atlantic and Pacific Oceans.

SCIENCE FAIR CONNECTION

While creating a swirling, twirling vortex of water in a soda bottle is fun, it isn't a science fair project. You can create a science fair project by identifying a variable, or something that changes, in this experiment. Let's take a look at some of the variable options that might work:

- Compare the time it takes to empty the water from one bottle to another using the different sizes of Tornado Tubes-- one with the large opening compared to the one with the small opening. You may want to also observe and note how the vortex looks during each trial.
- Try using different sized bottles and determine how that affects the time.
- Determine the quickest way to transfer the water from one bottle to another. Try it out-- shake, twirl, tip, squeeze. What is the fastest method?

These are just a couple of ideas, but you aren't limited to them! Come up with different ideas of variables to test and give them a try. Remember, you can only change one variable at a time for each test. For example, if you are testing different sized bottles, make sure that all other factors in the test remain the same!

THIS EXPERIMENT

SCAN TO WATCH

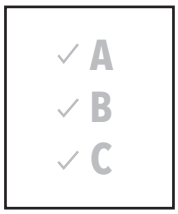
For step by step experiment instructions, the science behind it and ways to take it further, scan the code to the left.

Trouble scanning? Follow the URL below.
http://spanglersci.com/118wsks127tzofz8o3

WHAT ARE THESE SYMBOLS ALL ABOUT?

LAB REPORT

In this section, you will learn to define and prepare your experiments like scientists do. You will ask big questions, develop hypotheses, list materials, write procedures, record results and make big discoveries.

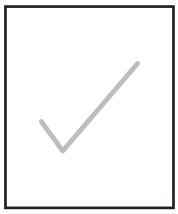


EXPERT VOCABULARY

In this section, you will learn to use the language scientists use to discuss and explain the concepts covered in this experiment.

CRITICAL THINKING

Follow the layers of critical thinking density with this icon. As the beakers fill from page to page, you will notice the level at which the beaker is filled indicates the depth of critical thinking needed to complete the question(s), from least complex being the least full to most complex being the most full.



ASSESSMENT

In this section, you will find questions at a variety of levels which assess student understanding of the scientific content covered in the experiment.

A WORD ABOUT SAFETY

Everything we suggest using in this guide is safe when used with proper adult supervision. We guarantee young scientists will get a lot more from the experience if you're there to guide them. Remember, this is science, and science tends to get a bit messy. Stuff falls on the floor... so you'll need to clean it up. Don't put chemicals in your eyes or ears and don't eat your experiment. Trust us, they don't taste good and it's a bad thing to do. The bottom line is that this science experiment guide requires adult supervision and common sense. These simple concepts help ensure a fun and safe experience.

TEACHER NOTES:

SCIENCE CONCEPTS OVERVIEW ▸ Centripetal Motion I Properties of Air I Scientific Method

The learning experiences contained in the following Experiment Guide are designed to engage students and deepen understanding, not only of the underlying scientific concepts upon which these experiments/demonstrations are built, but also of critical thinking and problem solving skills. Teachers should allow students to actively participate in each activity as an investigation, where questions are being asked, hypotheses are developed and redeveloped, and where students own the discoveries. Vocabulary was included, assessments were created and critical thinking questions were designed with this underlying goal in mind.

Suggested Teaching Points:

Sick Science Teaching Points: The Sick Science video can be utilized in a variety of ways. It can be used to introduce a scientific concept or in place of doing the demonstration/experiment if materials are unavailable. The video can also be used as a review or to help students complete the various learning experiences included in this guide.

Vocabulary: Students enhance their science-content related vocabulary. You may choose to introduce the vocabulary words and explicitly teach the meaning of each. You may also use the vocabulary words as an investigation, where students may research the meanings of the words. Finally, students may develop their own meaning for each word through their experience with the experiments and critical thinking work.

The Scientific Method: Students can complete a full lab report for the demonstration, including asking questions, identifying variables, forming a hypothesis, designing the experiment, collecting data, and drawing conclusions. Differentiation using the lab report is easy. For lower levels, complete the lab report as a class. As students are more independent, encourage students to work in partnerships or groups to complete the lab report. Eventually, students should be able to complete the lab report independently or design a new experiment using the form based on the demonstration completed in class.

Paraphrase: Students will be able to restate the main ideas of a vortex in their own language.

Inference: Students will use knowledge gained from the experiment/demonstration to make judgments about outcomes and conditions of an actual tornado or hurricane.

Real World Application: Students will be able to apply their critical thinking strategies and scientific concepts to a real world scenario.

Literature Connection: Magic School Bus Inside a Hurricane by Joanna Cole. This text allows students to go on an exciting adventure with Miss Frizzle and her class through both a hurricane and a tornado as they learn many interesting facts about these enormous storms.

Writing Connection: Students can practice their informational and procedural writing by creating a step by step "How To Make a Tornado in a Bottle." They should include the important steps and details in the correct sequence, and use transition words and diagrams to support their writing.

Lab Report

NAME

BIG QUESTION:
Scientists ask big questions to guide their experiment.

What big question are we answering in this experiment?

HYPOTHESIS:
Scientists make predictions about what they think will happen during the experiment.

What is your hypothesis for this experiment?

Lab Report

NAME

MATERIALS AND PROCEDURES:
Scientists make a list of materials they need and will use in their experiments. It is important other scientists are able to duplicate and test each other's experiments.

What materials do you need to conduct this experiment?

Write out a step-by-step procedure for this experiment.

Lab Report

NAME

RESULTS AND OBSERVATIONS:
Scientists make observations and take notes as they conduct their experiments. Scientists are good observers and record all results of their experiments. It is important to measure your results using precise units and careful review.

What were the results of your experiment?

What did you observe as you conducted your experiment?

Lab Report

NAME

CONCLUSIONS AND DISCOVERY:
Scientists look carefully at their results, think critically about their observations, and draw conclusions about their experiments, as they relate to their big question and original hypothesis.

What conclusions and discoveries did you make after completing the experiment?

NEXT STEPS:
Sometimes after scientists conduct their experiments, they think of new questions they want to test in new experiments.

What new questions do you have after you have completed your experiment?

Expert Vocabulary

NAME _____

WORDS AND DEFINITIONS —
Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

VOCABULARY WORDS	DEFINITIONS
1 ____ **Hurricane**	A A large rotating storm that forms over warm waters in tropical areas and has wind speeds about 74 miles per hour.
2 ____ **Vortex**	B Movement.
3 ____ **Motion**	C A force that pushes inward in a circular path around another object.
4 ____ **Centripetal Force**	D Movement in a repeated circular motion.
5 ____ **Rotation**	E A type of motion that causes liquids and gases to travel in spirals around a center line

Critical Thinking

NAME

PARAPHRASE —
Students will be able to restate the main ideas of a vortex in their own language.

Think about the experiment we just completed. Explain to a friend what a vortex is and how it helps the air and water change places in this experiment?

Critical Thinking

NAME

INFERENCE —
Students will use knowledge gained from the experiment/demonstration to make judgments about outcomes and conditions of an actual tornado or hurricane.

What will happen when you put an assortment of small plastic objects in one of the bottles? Will the objects that you added spin to the center of the vortex or to the outside? What direction do the objects travel? Make your prediction, then follow the original directions but add in some small objects to the bottle with the water and try it to find out.

Now, tell a partner what you observed and infer (keep this demonstration in mind) what would happen to real objects caught in the path of a tornado or hurricane. Record your thinking with words or a diagram below.

Critical Thinking

NAME

REAL WORLD APPLICATION —
Students will be able to apply their critical thinking strategies and scientific concepts to a real world scenario.

Think about all you have learned about the movement of water. Now, think about currents created under the surface of the water in the ocean. These currents are known as rip currents. You may want to research rip currents to learn more.

If you are swimming in the ocean and find yourself in a rip current, you will feel a pull by the water farther out into the ocean. At first you will want to swim against it and try to get to shore. Experts suggest, however, that the best way to escape a rip current is to allow the current to pull you away from shore until the current breaks. At that point you will be able to break free and swim back to shore. Do you agree with this advice? Why or why not? Support your position with evidence from your research and observations from this experiment.

Assessment

NAME

ASSESSMENT QUESTIONS —
Read each question carefully and circle the letter next to the correct answer or write your response in the box.

1. When the vortex forms in the bottle, the air and the water are...
   a. mixing.
   b. condensing.
   c. switching places.
   d. evaporating.

2. Which of the following storms have a vortex?
   a. Tornado
   b. Typhoon
   c. Hurricane
   d. All of the above

3. A vortex moves in a _____ motion.
   a. straight
   b. circular
   c. pulling
   d. crooked

4. When a vortex forms it is able to continue the spinning motion because of...
   a. centripetal force.
   b. gravity.
   c. the water current' speed.
   d. high wind speed.

5. In your own words, explain why creating a vortex is one of the quickest ways to get the water from the top bottle into the bottom bottle.

Expert Vocabulary - Answer Key

WORDS AND DEFINITIONS —
Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

VOCABULARY WORDS	DEFINITIONS
1 (A) **Hurricane**	(A) A large rotating storm that forms over warm waters in tropical areas and has wind speeds about 74 miles per hour.
2 (E) **Vortex**	(B) Movement.
3 (B) **Motion**	(C) A force that pushes inward in a circular path around another object.
4 (C) **Centripetal Force**	(D) Movement in a repeated circular motion.
5 (D) **Rotation**	(E) A type of motion that causes liquids and gases to travel in spirals around a center line

Critical Thinking- Answer Key

PARAPHRASE —
Students will be able to restate the main ideas of a vortex in their own language.

Think about the experiment we just completed. Explain to a friend what a vortex is and how it helps the air and water change places in this experiment?

Possible Answer:
A vortex is a swirling column of air or water. A vortex was created with the water and air in the bottle when they were trying to change places. The water swirled around the outside to fill the bottom bottle and the air came up through the middle of the vortex to fill the top bottle.

Critical Thinking- Answer Key

INFERENCE —
Students will use knowledge gained from the experiment/demonstration to make judgments about outcomes and conditions of an actual tornado or hurricane.

What will happen when you put an assortment of small plastic objects in one of the bottles? Will the objects that you added spin to the center of the vortex or to the outside? What direction do the objects travel? Make your prediction, then follow the original directions but add in some small objects to the bottle with the water and try it to find out.

Possible answer:
I think that the objects will spin around and around, first from the bottom up to the top then back down to the bottom before breaking free from the vortex.

Now, tell a partner what you observed and infer (keep this demonstration in mind) what would happen to real objects caught in the path of a tornado or hurricane. Record your thinking with words or a diagram below.

Possible answer:
I observed the objects swirling around and around the vortex from the top to the bottom. I think this happened because the objects float. When I looked at how my objects moved, I think that real object caught in a tornado or a hurricane will take a similar path. I think that it will first travel up the vortex from the ground, and then back down before breaking free.

Critical Thinking- Answer Key

REAL WORLD APPLICATION —
Students will be able to apply their critical thinking strategies and scientific concepts to a real world scenario.

If you are swimming in the ocean and find yourself in a rip current, you will feel a pull by the water farther out into the ocean. At first you will want to swim against it and try to get to shore. Experts suggest, however, that the best way to escape a rip current is to allow the current to pull you away from shore until the current breaks. At that point you will be able to break free and swim back to shore. Do you agree with this advice? Why or why not? Support your position with evidence from your research and observations from this experiment.

Possible Answer:

I learned that rip currents occur in shallow water near the shore. They are currents of water that pull water away from the shore out to open water. This happens because breaking waves push water towards the land and then the water that has been pushed up to the beach flows together and finds a place where it can flow back out to sea. This creates a current, just like I saw in the Soda Bottle Tornado experiment. The water moves together, in the same direction.

If I am a swimmer and I am swimming in this area where the water channels together to flow back out to sea, I will be pulled along with that water. That is the rip current. What I know about water currents and from what I observed in this experiment is that the current will eventually end. I should let the current pull me out to sea until the current breaks. At that point then, I can swim back to shore. If I try to swim against the current I will get very tired. Also, I am not a stronger swimmer than the current. It is best not to panic and swim back to shore when I can. Knowing all of this, I agree with the experts.

Assessment

NAME

ASSESSMENT QUESTIONS —
Read each question carefully and circle the letter next to the correct answer or write your response in the box.

1. When the vortex forms in the bottle, the air and the water are...
   a. mixing.
   b. condensing.
   c. switching places.
   d. evaporating.

2. Which of the following storms have a vortex?
   a. Tornado
   b. Typhoon
   c. Hurricane
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3. A vortex moves in a _____ motion.
   a. straight
   b. circular
   c. pulling
   d. crooked

4. When a vortex forms it is able to continue the spinning motion because of...
   a. centripetal force.
   b. gravity.
   c. the water current' speed.
   d. high wind speed.

5. In your own words, explain why creating a vortex is one of the quickest ways to get the water from the top bottle into the bottom bottle.

Possible Answer: *Creating a vortex is one of the quickest ways to get water from the top bottle into the bottom bottle because the air and water need to switch places. With a vortex, the air can come up through the middle at the same time that the water is going down. In many other methods, the air and water have to take turns going through the middle which slows down the process.*

Common Core State Standards

Student Outcomes	Standards
Students will be able to ask and answer questions about key details about their observations and discussion to demonstrate their understanding of the scientific concepts presented through the experiment.	RI.K.1, RI.1.1, RI.2.1, RI.3.1, RI.4.1
Students will be able to ask and answer questions to help determine the meaning of vocabulary presented as part of an experiment.	RI.K.4, RI.1.4, RI.2.4, RI.3.4, RI.4.4, RI.5.4
Students will be able to explain the connection between scientific ideas presented in the experiment.	RI.1.3, RI.2.3, RI.3.3, RI.4.3, RI.5.3
Students will be able to retell key details presented in the experiment in order to understand/determine the main idea.	RI.K.2, RI.1.2, RI.2.2, RI.3.2, RI.4.2, RI.5.2
Students will be able to participate in writing projects and write a sequence of instructions.	W.1.7, W.2.7
Students will be able to refer back to their observations and discussion to demonstrate their understanding of the scientific concepts presented through the experiment.	RI.3.1
Students will be able to use information gained from observations of the experiment to demonstrate understanding of the concepts presented.	RI.4.5
Students will be able to recall information from experiences to answer a question.	W.K.8, W.1.8, W.2.8
Students will be able to use information gained from observations of the experiment to demonstrate understanding of the concepts presented, including how a diagram can clarify understanding.	RI.2.7, RI.3.7