SICK! science®
insanely cool experiences

INERTIA CHALLENGE

EXPERIMENT GUIDE

as seen on YouTube™

POWERED BY Steve Spangler SCIENCE

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Concept based on a video series by Steve Spangler Science and distributed through the YouTube Original Content Series.

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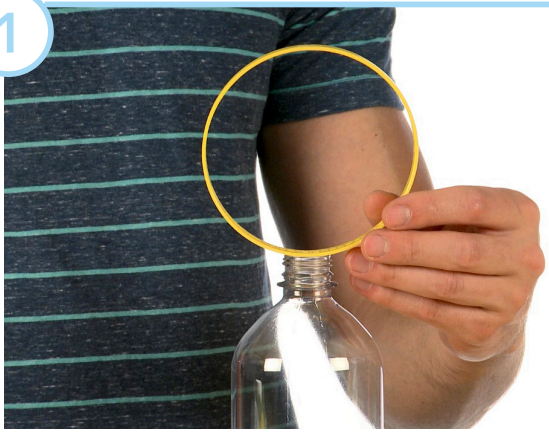
INERTIA CHALLENGE EXPERIMENT

This hands-on science project will teach physics and motion in a simple, yet awesome, way! Do you think you can successfully perform the Steve Spangler Science inertia challenge? Balance a yellow ring on the mouth of an empty 1 or 2 liter bottle and place a hex nut or other heavy object on top of the ring. When the yellow ring is removed, the hex nut will drop straight into the bottle. It might take a little bit of practice, but you'll get it. Inertia rings are a perfect tool for introducing students to physics, motion, and inertia.

WHAT YOU NEED

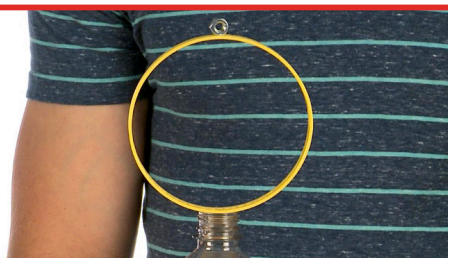
- HEXNUTS
- EMPTY SODA BOTTLE
- PLASTIC RING
- ADULT SUPERVISION

1



Set the plastic ring on top of the opening of the bottle.

2

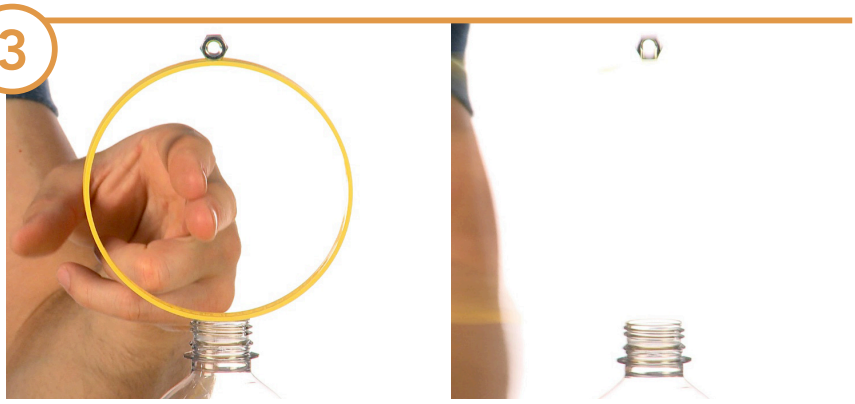


Place the hex nut on the top of the plastic ring.

!

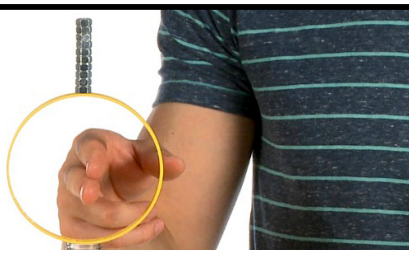
Make sure the hex nut is placed directly above the opening of the bottle.

3



Quickly pull the plastic ring straight out to the side.

!



Stack multiple hex nuts on top. How many hex nuts can you make in?

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/118wsks34tzofz8o3

HOW DOES IT WORK

This experiment works because of Newton's first law of motion, which is the tendency of an object to stay at rest until a force acts upon it. Since the hex nut is not moving while it sits on top of the ring or card, that's what it wants to do - not move. You applied enough force to the ring/card to cause it to zip out from under the hex nut. Basically, you knocked the support out from under the hex nut. For a brief nanosecond or two, the hex nut didn't move because it was already stationary (not moving). But then, as usual, the force of gravity took over and pulled the hex nut straight down toward the center of the Earth.

TAKE IT FURTHER - SCREAMING BALLOON

1. Place hex nut into the balloon. Make sure the hex nut goes all the way into the balloon so that there's no danger of it being sucked out while blowing up the balloon.
2. Blow up the balloon, making sure that its not TOO full as it will easily burst.
3. Tie off the balloon.
4. Place your entire hand over the tied end of the balloon and hold it palm-down.
5. Quickly swirl the balloon in a circular motion to get the hex nut to spin around the inside of the balloon.
6. Stop spinning the balloon and watch as it begins to slow down and eventually stop.

WHAT YOU NEED

- CLEAR BALLOONS
- HEX NUTS
- SAFETY GLASSES

HOW DOES IT WORK

Like the Yellow Ring/Business Card challenge, this experiment demonstrates the second half of Newton's first law of motion - objects tend to stay in motion with the same speed and direction unless a force acts upon it. You are initiating the motion by moving the balloon in a circle, and then the laws of inertia flip the hex nut up on its side and it spins around the inside of the balloon. In this experiment, the force that stops the hex nut from spinning is gravity. Additionally, the hex nut circles the inside of the balloon due to something called centripetal force. Moving objects, like the hex nut, have a natural tendency to travel in a straight line, unless something else is causing it to move in a circular direction. When the hex nut travels through the circular balloon, the hex nut is forced inward towards what is called the center of rotation. Centripetal is a word which means means center seeking, so this isn't a force in and of itself, but rather an adjective describing the direction of the force. It doesn't matter what the object is, if it's moving in a circle, there is some force acting upon it to cause it to deviate from its natural straight line. It's also important to note that the centripetal force changes the direction of the object, but doesn't change its speed.

SCIENCE FAIR CONNECTION

Observing and using the Inertia Challenge is pretty cool, but this activity isn't a science fair project, yet. You can make it one simply by identifying a variable (something that might change the outcome) in the experiment, then testing that variable, and correctly reporting the results. Think about some variables like these that you might test:

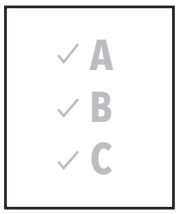
- Try stacking different items on top of the ring to see if you can still land the items in the bottle.
- Try placing different things (like a coin) inside the balloon and see if the law of motion is affected.

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 items inside of the balloon, make sure that all other factors in the test remain the same!

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.

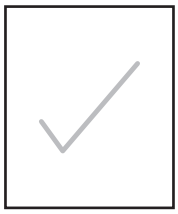


EXPERT VOCABULARY

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 ▸ Force | Motion | Gravity | Newton's First Law

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.

The following are some suggested teaching points that could accompany this experiment/demonstration:

Sick Science Video: The Sick Science video 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 gravity in their own language.

Inference: Students will use knowledge gained from the experiment/demonstration to make judgments about outcomes and conditions of each of the Inertia Challenge experiments (hex nuts with cards, yellow ring and balloons).

Generalize: Students will use knowledge gained from the experiment/demonstration as evidence supporting Newton's First Law of Motion.

Informational Writing: Students will write a piece which explains a new experiment/procedure to demonstrating Newton's First Law of Motion. They may utilize materials already shown, or add additional. Students should remember to include a statement which outlines why they believe their experiment demonstrates Newton's principle as well as a detailed procedure for executing the experiment. Younger students should also use pictures and diagrams to outline/explain their thinking.

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 ____ **Gravity**	A — The action or process of moving or of changing place or position; movement.
2 ____ **Force**	B — The force that attracts a body toward the center of the earth, or toward any other physical body having mass.
3 ____ **Motion**	C — The tendency of motionless bodies to remain motionless and moving bodies to remain in motion.
4 ____ **Inertia**	D — A push or pull upon an object resulting from the object's interaction with another object.
5 ____ **Centripetal Force**	E — The force that is necessary to keep an object moving in a curved path.

Critical Thinking

NAME

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

Read and discuss the following definition with a partner. Rewrite the definition in your own words.

Gravity: The force that attracts a body toward the center of the earth, or toward any other physical body having mass.

Critical Thinking

NAME

INFERENCE —
Students will use knowledge gained from the demonstration/experiment to make judgements about outcomes and conditions of each of the Inertia Challenge experiments (hex nuts with cards, yellow ring and balloons).

Based on what you have seen so far, what inferences can you make from the following statements: Be sure to explain your thinking with "I know/infer this because…"

a) If I use quarters, nickels or dimes and stack them on top of a card over a cup, the coins will fall straight down into the cup when the card is rapidly removed.

b) If I use a playing card and stack pennies over a cup, the pennies will fall straight into the cup when the card is rapidly removed.

c) If I use a plastic soda bottle instead of a cup, and stack pennies on top of the card, the pennies will not fall into the bottle when the card is rapidly removed.

Critical Thinking

NAME

GENERALIZE —
Students will use knowledge gained from the experiment/demonstration as evidence supporting Newton's First Law of Motion.

What is the main idea of the experiments we completed today? Think about it and with a partner explain how these experiments related to Newton's First Law of Motion. Use evidence from the experiments you observed to support your answer.

Assessment

NAME

ASSESSMENT QUESTIONS —
Read each question carefully and circle the letter next to the correct answer or write your response on the back of this page or in the box below.

1. What is gravity?
   a. A type of force
   b. Something only found on the moon
   c. Another name for motion
   d. Something only found on Mars

2. What is centripetal force?
   a. The force that causes an object to fall straight down.
   b. The force that causes an object to move faster and faster by itself.
   c. The force that causes an object to move in a circle.
   d. The force that causes an object to stay in one place.

3. What is Newton's First Law of Motion?
   a. An object will stay at rest until a force acts upon it.
   b. An object will always stay at rest no matter what.
   c. Objects are never at rest; they are always in motion.
   d. Objects in motion will eventually stop because of gravity.

4. On the back of this page, explain why the hex nuts fall into the bottle when you pull the yellow ring out of the way.

5. Predict what you think might happen if you used a ring with a rough surface instead of a smooth surface in the experiment? Explain your thinking in the box below.

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 B Gravity	A The action or process of moving or of changing place or position; movement.
2 D Force	B The force that attracts a body toward the center of the earth, or toward any other physical body having mass.
3 A Motion	C The tendency of motionless bodies to remain motionless and moving bodies to remain in motion.
4 C Inertia	D A push or pull upon an object resulting from the object's interaction with another object.
5 E Centripetal Force	E The force that is necessary to keep an object moving in a curved path.

Critical Thinking

NAME

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

Read and discuss the following definition with a partner. Rewrite the definition in your own words.

Gravity: The force that attracts a body toward the center of the earth, or toward any other physical body having mass.

Possible Answer:
Gravity is an invisible force that pulls people and things down to the ground and keeps them there instead of letting them float away.

Critical Thinking- Answer Key

INFERENCE —
Students will use knowledge gained from the demonstration/experiment to make judgements about outcomes and conditions of each of the Inertia Challenge experiments (hex nuts with cards, yellow ring and balloons).

Based on what you have seen so far, what inferences can you make from the following statements: Be sure to explain your thinking with "I know/infer this because…"

a) If I use quarters, nickels or dimes and stack them on top of a card over a cup, the coins will fall straight down into the cup when the card is rapidly removed.

Possible Answer: *As long as the coins are stacked over the opening in the cup, they should fall straight down into the cup when I flick the card out of the way. I am a force acting on the card, moving it out of the way, and therefore the coins will fall into the cup because gravity pulls them straight down.*

b) If I use a playing card and stack pennies over a cup, the pennies will fall straight into the cup when the card is rapidly removed.

Possible Answer: *As long as the card that the coins or other objects are resting on is a material that does not cause friction (like sandpaper), it should not matter what the card is made of. Friction would be another force that could cause the coins to move even if I didn't actually touch the coins.*

c) If I use a plastic soda bottle instead of a cup, and stack pennies on top of the card, the pennies will not fall into the bottle when the card is rapidly removed.

Possible Answer: *As long as the mouth of the bottle is large enough for the coins to fall in, we can demonstrate this experiment with any type of bottle or cup. The bottle or cup is not a variable that in any way affects the outcome of the experiment or Newton's Law in action.*

Critical Thinking

NAME

GENERALIZE —
Students will use knowledge gained from the experiment/demonstration as evidence supporting Newton's First Law of Motion.

What is the main idea of the experiments we completed today? Think about it and with a partner explain how these experiments related to Newton's First Law of Motion. Use evidence from the experiments you observed to support your answer.

Possible Answer:
Gravity is the only force acting on objects when they are sitting still, so if I don't touch an object it will stay still. I know this because as long as I didn't touch the coins (or hex nuts) they always fell in the bottle (or cup). The only times that the coins (or hex nuts) didn't go in the bottles were when I hit the card so that the card moved the coins and then the coins missed the cup/bottle or when the bottle's mouth was not big enough for the objects to go in.

Assessment - Answer Key

ASSESSMENT QUESTIONS —
Read each question carefully and circle the letter next to the correct answer or write your response on the back of this page or in the box below.

1. What is gravity?
   a. A type of force
   b. Something only found on the moon
   c. Another name for motion
   d. Something only found on Mars

2. What is centripetal force?
   a. The force that causes an object to fall straight down.
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3. What is Newton's First Law of Motion?
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   b. An object will always stay at rest no matter what.
   c. Objects are never at rest; they are always in motion.
   d. Objects in motion will eventually stop because of gravity.

4. On the back of this page, explain why the hex nuts fall into the bottle when you pull the yellow ring out of the way.

   Possible Answer:
   The hex nuts fall into the bottle because gravity pulls it down toward the ground.

5. Predict what you think might happen if you used a ring with a rough surface instead of a smooth surface in the experiment? Explain your thinking in the box below.

   Possible Answer: *I think that the hex nuts will not fall into the bottle. I think this because sandpaper is not a smooth surface. Since it is not a smooth surface, it will create friction. Friction will make it difficult for the hex nuts to separate from the card. The friction will probably prevent the hex nuts from falling straight down into the bottle. The uneven surface of the sandpaper will actually move the hex nuts and that becomes an outside force acting on the hex nuts, and will probably cause the hex nuts to miss the container.*

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 explain the connection between scientific ideas/interactions presented in the experiment.	RI.1.3, RI.2.3, RI.3.3, RI.4.3, RI.5.3
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 use information gained from observations of the experiment to demonstrate understanding of the concepts presented.	RI.3.7
Students will participate in shared writing projects and record scientific observations.	W.2.7
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 write an informative/ explanatory text that includes facts.	W.K.2, W.1.2, W.2.2, W.3.2, W.4.2, W.5.2