SPHERO BOLT LONG JUMP

OVERALL TIME *Up to 1 Hour*

GRADES *1 to 8*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Science*

OVERVIEW

Students will use block coding to get the Sphero BOLT to jump the farthest.

A variety of 3 ramps will be used to see which one results in the longest jump.

Students will record their data in the EDP journal documenting mean, median, mode, and range.

MATERIALS

- **Box of Sand**
- **3 Ramps**
- **Maze Tape or Ruler**
- **Sphero BOLT**
- **Chromebook**

INSTRUCTIONS

Create a simple block code that will send the Sphero BOLT on its way to the ramp.

Make a prediction in your EDP journal as to how the Sphero BOLT will fly for Ramp 1, 2, and 3.

Document your results for Ramp 1, 2, 3. Include heading, speed, duration, and distance traveled (cm).

SPHERO BOLT LONG JUMP

NAME _____

Ramp Height	Speed	Distance (cm)	Heading

When you've tested all your ideas look back at your recording sheet and ask yourself:

- Why did those ideas cause the Sphero BOLT to jump a shorter distance?
- Which ideas helped the Sphero BOLT jump farther?
- Why did those ideas make the Sphero BOLT jump farther?
- Which idea or combination of ideas helped the Sphero BOLT jump the farthest?
- Why did that idea or combination of ideas help the Sphero BOLT jump the farthest?
- Are there any other ideas or combinations of ideas that you want to go back and test?

Mean	*Median*	*Mode*	*Range*

BRIDGE CHALLENGE

OVERALL TIME *2- to 4-hour lesson*

GRADES *2 to 8*

PROGRAMMING LEVEL *Beginning Block: Roll, Delay, Sound, Speak, and Main LED*

CONTENT THEME *Science*

OVERVIEW

Build a bridge using classroom materials and then program the Sphero BOLT to drive across it. This challenge can also include researching different types of bridges and incorporating those concepts into the designs.

MATERIALS

- **Sphero Bolt**
- **Tape**
- **String**
- **Glue**
- **Popsicle sticks, toothpicks, uncooked pasta, balsa wood, cardboard or other building material**
- **Measuring tape or rulers**
- **2 tables or other objects to span the bridge across**

OBJECTIVE

- **I will identify how the Sphero BOLT can cross a bridge constructed with inexpensive materials.**
- **I will illustrate the process of determining which code elements would be best suited to accomplish an objective.**
- **I will drive and create a program that moves the Sphero BOLT over a bridge of my own design.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: BRIDGE CHALLENGE INTRODUCTION

There are a lot of different types of bridges. Which types have you seen before? Research different types of bridges and think of how you might build one for the Sphero BOLT to cross it.

As you learn about different types of bridges, think about the following:

- What kind of bridges exist and how are they designed?
- How are they built?
- How might you construct your bridge?
- How large of a bridge can you build in your classroom with the materials provided?

Watch the video of the Tacoma Narrows Bridge collapse. What are some important things you can learn from watching this video when designing your bridge?

https://youtu.be/j-zczJXSxnw

EXPLORATION: ENGINEERING FRAMEWORK

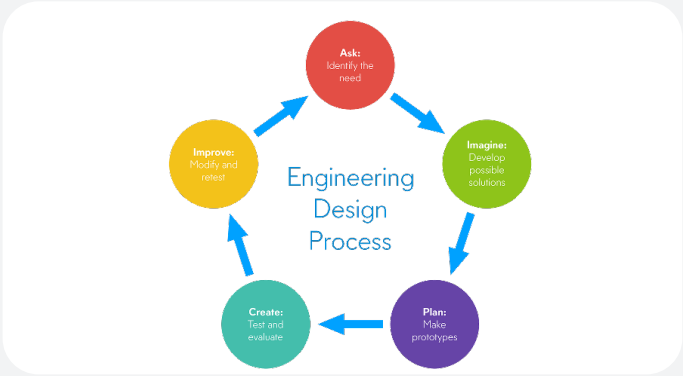
On a piece of paper, list at least five features that your bridge will need in order to support the Sphero BOLT as it crosses.

Think about the Engineering Design Process and how it can help guide your building of a bridge.

As you brainstorm ideas, constraints, and possibilities, consider the following:

- *What are the Sphero BOLT's dimensions?*
- *How wide is the gap that the bridge needs to span?*
- *What are the materials and how can they be used?*
- *What surfaces does the Sphero BOLT drive best on?*

https://youtu.be/nesX_q-wYl8



EXPLORATION: BRIDGE DESIGNS

Take a piece of paper, fold it in half, then in half again the other way. Each one of the boxes created is a space for an idea. Come up with some ideas of your own, and then share with the rest of your team. Collaborate on a single idea.

When working with your team, try to:

- Have one conversation at a time.
- Share as many ideas as possible.
- Be short and sweet.
- Build on the ideas of others.
- Be visual.
- Be encouraging; especially the "This might sound crazy..." ideas.
- Stay on topic.
- Defer judgement.

SKILLS BUILDING: THE SPHERO BOLT PROGRAM

Open a new Blocks canvas and begin to experiment with some code. *Which blocks are best suited to help the Sphero BOLT cross safely?*

While evaluating different materials, think about which will best support the Sphero BOLT's weight and which make it easier for the Sphero BOLT to cross the bridge. All of this will influence the type of program you create.

SKILLS BUILDING: BUILD A BRIDGE

Build that bridge!

Take your time and make smart material decisions during the building process. Always

measure before cutting, and make sure to test for strength and rigidity. Don't hesitate to place or to roll the Sphero BOLT up onto your incomplete bridge from time to time to make sure things are going as planned.

https://youtu.be/-j8C3HgVTMM

SKILLS BUILDING: CROSSING THE BRIDGE

Open back up the program you began in Step 4. Now that your bridge is done, you need to practice having the Sphero BOLT cross the bridge. This may take several tries. Experiment with speed and duration. Also, it is super important that you place the Sphero BOLT in the same starting spot each time before aiming.

https://youtu.be/Qj92sXEvsqo

CHALLENGE: FINAL PRESENTATION

Come together as a class and test the bridges. Set up your bridge and run the program for the Sphero BOLT to cross it.

Each team should make a short presentation (4-5 minutes) about your bridge plan. Your presentation should include the following:

- *Why do you believe your team's bridge was successful (or not)?*
- *Which materials did you use, and why?*
- *What part of the building process was difficult?*

If there is time, try programming the Sphero BOLT to cross other bridges created by your classmates.

REFLECTION

Write your reflections on this activity and discuss with the class.

- Record whether or not your bridge was successful. If it failed, note where the failure occurred.
- *How would you do things differently in the future?*
- *What materials worked best?*
- *What bridge type worked best?*
- *What was the hardest or most fun part of the challenge?*

LIGHT PAINTING

OVERALL TIME *1- to 2-hour lesson*

GRADES *K to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OVERVIEW

Learn how to use long exposure photography to take pictures that capture an image over time. Create a light-filled program using the Sphero BOLT to create your own artwork to share with others.

MATERIALS

- **Sphero BOLT**
- **Two smartphones or tablets**
- **Long exposure photography app (ie. LongExpo)**
- **Tripod that will hold a phone or tablet**
- **Painters tape**

OBJECTIVE

- **I will create a long exposure photograph.**
- **I will create and execute a program, either using the Draw or Blocks canvas.**
- **I will create an original work of art using the Sphero BOLT and long exposure photography.**

EXPLORATION: DRAWING LIGHT WITH THE SPHERO BOLT

Use the Sphero BOLT to paint with light!

Watch the video below to find out how.

https://youtu.be/hek4uEJ7WLw

Sphero BOLT + Long Exposure Photography = Light Painting!

The Sphero Edu app allows you to create programs for the Sphero BOLT. These programs tell the Sphero BOLT what to do. To get started quickly, take a look at the Light Write program (https://edu.sphero.com/remixes/1100273) or Shape Shifter (https://edu.sphero.com/remixes/963849). Light Write uses premade functions that program the Sphero BOLT to draw different letters with light. Shape shifter is a simple Blocks program that allows you to draw all the polygons.

Another place to start is the Draw canvas. If you are unfamiliar with Draw, check out this simple getting-started activity (https://edu.sphero.com/cwists/preview/6872x).

And for you more advanced programmers, give the Blocks or Text canvas a shot.

Remember that your program needs to have the Main LED lights on, and preferably, changing colors throughout the program.

EXPLORATION: CAMERA SETUP

The video below will help you get your camera set up. If you want to follow along, use the Shape Shifter program (https://edu.sphero.com/remixes/963849) and set the number of sides to three.

https://youtu.be/8DU1n2oafP4

There are numerous long exposure photography apps available for smartphones.

Continue to Step 3 to learn how which settings will be most important.

EXPLORATION: FINDING THE RIGHT SETTINGS

Change the settings in your camera app so that it is in "light trail" mode with the highest sensitivity and longest shutter speed possible.

- Sensitivity relates to how much light is necessary to capture an image. A higher sensitivity is typically used when there is less light available for taking the image. For example, a low sensitivity might be used in bright sunlight, but a high sensitivity might be used indoors.
- Shutter speed is the length of time light is exposed to a camera's sensor. A fast shutter speed helps freeze action. A slow shutter speed can make moving objects blurry, often creating a sense of movement.

SKILLS BUILDING: TESTING YOUR PROGRAM

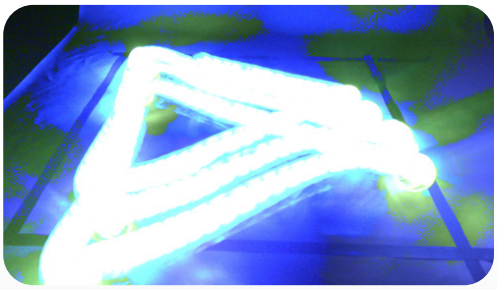
Put the Sphero BOLT in the left corner of your shot and take a long exposure photo as you run one of your programs from the Sphero Edu app.

Did the Sphero BOLT stay in the frame of the camera the entire time? Make any adjustments needed to the camera's position to ensure that the Sphero BOLT stays in the shot the entire time.

If you are struggling with a new program, go back to Step 1 for a couple sample programs you can use.

SKILLS BUILDING: PERFECT PICTURE

What does your picture look like? Did it capture the Sphero BOLT's light trail?
If you were unable to capture a picture similar to the one below, explore the long exposure app's settings. Be sure to ask your teacher if you need additional help.



CHALLENGE: CREATE YOUR OWN ARTWORK

You have had time to prepare the camera and test your programs, and now it's time to create some artwork.

Pick the program (or create a new one) that you want to be your final product. If you want something more spontaneous, don't hesitate to create a new Draw canvas and have at it!

Be sure that the camera is picking up all of the Sphero BOLT's movements. What have you noticed if the program is too busy or the Sphero BOLT's movements are too close to one another?

CHALLENGE: COLLABORATIVE ART (OPTIONAL)

Get together with some classmates and create a collaborative piece of art. You can simply run your programs simultaneously and snap a long exposure picture, or do something new and more coordinated. Again, feel free to use the Draw or Blocks canvas.

Share a picture of your collaborative artwork at the end.

Watch the video below to see how students just like you used their Sphero BOLT to create their own artwork.

https://youtu.be/1NbLRiL1Mbw

REFLECTION

Take some time to reflect on this experience. Use these questions to guide a discussion with a partner:

- *Did your photo turn out the way you thought it would?*
- *What could you do to make your light drawing even better?*
- *How do you think changing the sensitivity or shutter speed might affect your photo?*

If time allows, modify your program until you are happy with your design.

TRACTOR PULL

OVERALL TIME *2- to 4-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OVERVIEW

Explore Newton's Laws of Force and Motion. Build a Sphero BOLT powered tractor and see what happens when speed and mass are changed.

MATERIALS

- **Sphero BOLT**
- **Building Supplies: cups, straws, pipe cleaners, string, masking tape, or a building systems like Lego or K'nex**
- **Measuring Supplies: masking tape, yard stick or measuring tape, Maze Tape**
- **Possible Weights: Maze Tape, marbles, pennies, etc.**

OBJECTIVE

- **I will identify how the Sphero BOLT can power a land-based vehicle constructed with inexpensive materials.**
- **I will illustrate the process of determining which code elements would be best suited to accomplish an objective.**
- **I will program the Sphero BOLT to pull a tractor carrying objects with increasing amounts of weight.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

EXPLORATION: UNDERSTANDING NEWTON'S LAWS

As part of this activity, you will need to describe the various forces acting upon the Sphero BOLT. Take a few minutes to watch Joshua Manley's TED-Ed video on Newton's 3 Laws. It's worth the watch.

https://youtu.be/JGO_zDWmkvk

While watching, keep these questions in mind:

1. *How would YOU explain **inertia** to someone else?*
2. *What is the relationship between **force** and **acceleration**? **Force** and **mass**?*
3. *How would YOU explain the **action/reaction** pair of the Sphero BOLT's and the ground?*

EXPLORATION: BASELINE DATA

This acivity is all about observing and understanding how forces affect the motion of objects. To help you better understand this relationship, let's collect some baseline data to compare later in this activity.

You will need to set up a straight 5m track that your soon-to-be-built tractor will travel down. Find an open space and measure 5m. You can either use masking tape to mark the start and stop of track or stretch a piece of masking tape/Maze full length of the track.

Now use **Part 1** of the attached Tractor Pull Activity Pack to run an initial test, collect the baseline data, and make some early observations.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/72/36/Tractor%20Pull%20Activity%20Pack.pdf

SKILLS BUILDING: TRACTOR BUILD & DESIGN

Now you know how fast the Sphero BOLT travels 5m at a speed of 150. How will that data change when you add a tractor to the Sphero BOLT? How will that change when you add a tractor AND an added weight to pull? We can't find out unless we try.

So, LET'S BUILD SOME TRACTORS!

Be sure to check with your teacher to understand any additional rules or restrictions that may apply to the materials you are allowed to use and not use to build your tractor. Keep in mind that your tractor should not only be Sphero BOLT-driven, but it needs to be able to pull/carry any assigned added weight.

Before you build, brainstorm some ideas with your team. Use the top portion of Part 2 of the Activity Pack to guide your thinking.

Share a picture of your tractor when you are done with this step.

SKILLS BUILDING: TRACTOR TEST #1

Your tractor is done and ready to test. Before you take it to the track, make a couple predictions based on the baseline data and your understanding of the relationship between **force**, **mass**, and **acceleration** (Newton's Second Law).

- Predict the time it will take the Sphero BOLT-driven tractor to travel 5m:
  - _____ sec (at speed 150 without any added weight)
  - _____ sec (at speed 150 with the assigned added weight)

Be sure to record your predictions in Part 2 of the Activity Pack.

Now let's test your tractor. Head over to the track. Place the Sphero BOLT and your tractor down at the start. Aim the Sphero BOLT and run the same program you ran for the baseline data. Record the results in Part 2 of the Activity Pack.

Discuss the results as a team, using the end of Part 2 and all of Part 3 in the Activity Packet to guide your discussion.

What are two things your team can do to make your tractor go faster?

SKILLS BUILDING: TRACTOR TEST #2

What are some ways that you can make the Sphero BOLT and the tractor go faster? Why will that make a difference?

Take a look at Part 4 in the Acivity Pack. Make your predictions:

1. What would happen if you just increased the Sphero BOLT's speed in the program?
2. What would happen if you just decreased the mass of the tractor?

Before you make ANY changes to your tractor, you need to run the speed tests in Part 4. You will use the same tractor you used before but increase the speed in the program. Do this twice with the two new speeds mentioned in the Activity Pack.

Run the tests and record your results. Be sure to run the additional tests at each new speed with and without the added weight.

CHALLENGE: TRACTOR V2

Now it's time to shed some weight. The second part of Part 4 asks you what would happen if you decreased the mass of the tractor.

Brainstorm quickly with your team how you can shed enough weight to make a difference, but keep the structural integrity of the tractor AND still be able to pull/carry the added weight.

Make the necessary changes. When you are done, share a picture of Tractor v2.

CHALLENGE: TRACTOR TEST #3

Head on over to the track with the Sphero BOLT and Tractor v2. You will be using the original speed of 150 but now with a lighter tractor. Run the test with and without the added weight.

Record your results at the end of Part 4 and be sure to discuss your observations with your team.

Hopefully your tractor doesn't end up like the one in the video!

https://youtu.be/-adGzlXOLDQ

HYDRO-HYPOTHESIS

OVERALL TIME *2- to 4-hour lesson*

GRADES *2 to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Science*

OVERVIEW

Design and test a contraption for the Sphero BOLT to carry a load of pennies across a small body of water. You will need to consider buoyancy, density, surface area, and what types of materials float in water. Drive the Sphero BOLT to move the load across a designated distance and/or around floating obstacles.

MATERIALS

- **Sphero BOLT**
- **Foam**
- **String**
- **Cardboard**
- **Scissors**
- **Rubber bands**
- **Tape, pennies**
- **Small swimming pool or large tub of water**

OBJECTIVE

- **I will identify how the Sphero BOLT can power a water-based vehicle constructed with inexpensive materials.**
- **I will drive the Sphero BOLT across a water course in a straight line with a payload attached.**
- **I will learn to improve the Sphero BOLT's performance as the power source for a water-based vehicle.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

EXPLORATION: CAN THE SPHERO BOLT MOVE THROUGH WATER?

The Sphero BOLT can move through the water, *but how can the Sphero BOLT transport a load of pennies while moving through water?*

Using the materials supplied in your classroom, build a watercraft powered by the Sphero BOLT to carry a load of 10-20 pennies.

If given the chance, try driving the Sphero BOLT in water.

- *Does it float? How does it move across the water?*
- *Is it easy to control? Why or why not?*
- *What could you do to improve how the Sphero BOLT performs in water?*

Watch the video below to see how the Sphero BOLT reacts to carrying pennies under water.

https://youtu.be/1lUz0cTSdR4

EXPLORATION: DESIGN IDEAS

Take a blank piece of paper and fold it in half. Fold it in half again the other way so you have four sections. Based on what you know and have learned about how the Sphero BOLT operates in water, think of four unique ideas for a penny-carrying contraption and draw each one in a separate section.

Crazy and weird ideas are encouraged! Pick your favorite to share with your team. Take a look at the video below to give you some inspiration for your ideas!

https://youtu.be/EQa7YStVfWQ

EXPLORATION: FLOATING OBSTACLES

Think of some fun and silly floating obstacles that can mark a spot in the water course that the Sphero BOLT must navigate around. The obstacles should remain in place even if impacted by the Sphero BOLT as it passes by.

SKILLS BUILDING: DESIGN ENGINEERING

Experiment with materials and designs to determine which performs best. *Which elements should you include in your design?*

With your team, review each member's ideas and see if you can come up with any new designs. Select the best design to create and determine the materials needed.

Present a picture of your team's idea to the class and describe why you think it will be successful.

- *What will be the most challenging part of the construction?*

SKILLS BUILDING: BUILD AND TEST

Below is a video and an image to help you with some ideas. Your watercraft **does not** have to look like either of those. Remember, crazy and wacky are just fine.

https://youtu.be/2L-i3z6dRrU

Start building your watercraft with your team. Remember to think about buoyancy, the density of the materials you use, and their surface area. If you are unsure of why those things are important, do a quick search on each one and how they relate to floating objects.

Don't get discouraged if your design isn't working as planned. Keep at it and test your design along the way.

CHALLENGE: SINK OR SWIM

Time to find out which creations will sink and which will swim! Test your contraption with different numbers of pennies. It can be tricky to build a Sphero BOLT-powered watercraft because the Sphero BOLT is partially underwater when it swims.

Your teacher will provide you with directions and specifics of your challenge. May the best boat float!

REFLECTIONS

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What happened the first time you tested your watercraft?*
- *How did your watercraft change from the initial design?*
- *What materials worked best?*
- *What happened when more weight (pennies) were added?*
- *What was the hardest or most fun part of the challenge?*

ATOM TRACKS

OVERALL TIME *Up to 1-hour lesson*

GRADES *5 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OVERVIEW

Use the Sphero BOLT and a pan of paint to see how atoms move in solid, liquid, and gas states. By programming the Sphero BOLT to move about in different sized spaces while tracing its path with paint, you can "see" atomic movement in action in order to compare solid, liquids, and gases as well as comparing atomic movement based on atoms with different mass.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **18in x 18in box**
- **14in x 14in box**
- **9.5in x 6in box**
- **Water-based paint**
- **Paint tray**
- **Gloves**

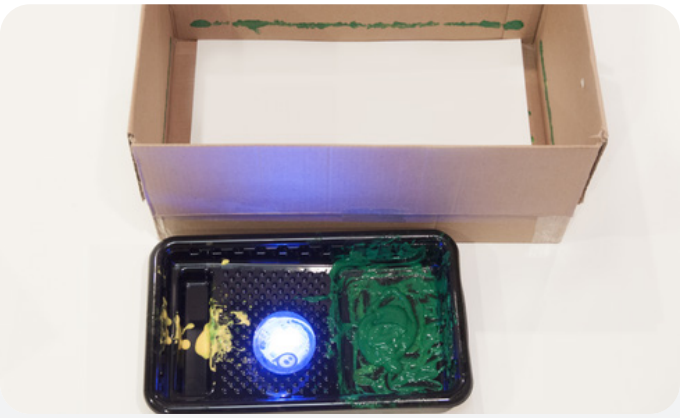
OBJECTIVE

- **I will simulate how atoms move in solid, liquid, and gas states.**
- **I will understand atomic movement and compare different movements based on the state of the atom.**
- **Advanced: I will illustrate a chemical reaction, Boyle's Law, Charles's Law, or Newton's 3rd law.**

EXPLORATION: PAINTING WITH THE SPHERO BOLT

The Sphero BOLT loves to paint! Watch the video below to see how it does. To get started, set up a large box like you see below.

https://youtu.be/2bGOxv-UMXY



EXPLORATION: ATOMS IN MOVEMENT

Atoms are in constant motion. As they move, they are continuously bouncing off of other atoms and anything else they collide with.

Work with your teammates to write a Blocks program that causes the Sphero BOLT to roll and change directions randomly every second- similar to how atoms move.

Watch the video below if you're unsure what to do!

https://youtu.be/gLWTwThLsq8

EXPLORATION: ATOM TRACK PAINTING

When you're satisfied with your program:

1. Cover the Sphero BOLT with paint.
2. Drop it in the box.
3. Aim the Sphero BOLT and run the program.

For additonal observations, try doing the same thing with two or more Sphero BOLTs in one box. (You will need to have another device controlling the additional Sphero BOLT and running the program.)

When the Sphero BOLT runs out of paint, stop the program and take him out of the box. *What does the painting look like? Can you follow the tracks?*

Explore for an added challenge:

- Open the sensor data to preview the different results of your Sphero BOLT's movement. (Note: You can export these results to a spreadsheet if needed.)

SKILLS BUILDING: SMALLER BOX

Pretend the big box in the last experiment was a container of gas. Particles in liquid have a force of attraction drawing them closer together than they would be in a gaseous state, but they maintain the ability to move.

- *What do you think the painting would look like if you used a smaller box to simulate a container of liquid?*

Test it out by repeating the experiment with a smaller box and/or with two Sphero BOLTs in one box. (You will need to have another device controlling the additional Sphero BOLT and running a program.)

SKILLS BUILDING: AN EVEN SMALLER BOX

In a solid state, the force of attraction between atoms is very strong and movement of atoms is limited. This is why a solid takes up less space (or volume) than a gas.

What do you think would happen if you used an even smaller box to simulate a solid?

Test it out by repeating the experiment with an even smaller box.

SKILLS BUILDING: COMPARE & CONTRAST

Compare all three paintings by asking yourself these questions:

- *What is similar about the paintings?*
- *What is different about the paintings?*
- *How was the Sphero BOLT's path affected by the size of the box?*
- *What does this tell you about how atoms move in a solid, a liquid, and a gas?*

CHALLENGE: SIMULATE DIFFERENT GASES

Watch the video below.

https://youtu.be/EsvXhIZbFVY

Consider doing the experiment again with multiple Sphero BOLTs and adjusting the movement of atoms to simulate different gases based on their masses such as helium and krypton, or neon and argon.

BONUS: Record your experiment by pressing the three dots in the top right corner and tap on "Camera."

Explain what is happening in your experiment while you are recording.

CHALLENGE - OTHER SIMULATIONS

Using Block Coding, create a program to model or illustrate one of the following (Research more about these laws, if needed):

- Chemical reactions
- Boyle's Law
- Charles's Law
- Newton's 3rd law.

Test your program and simulation, analyze the data, and make changes as necessary.

HELMETS FOR THE WIN

OVERALL TIME *Up to 1-hour lesson*

GRADES *5 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OVERVIEW

In this activity you will learn about g-forces, how they are measured by an accelerometer, and identify and complete the six parts of the scientific method based on the provided question and experiment. This short activity explores the scientific method through a discussion around concussions and g-forces. Which helmet configuration will best protect the Sphero BOLT?

MATERIALS

- **Sphero BOLT**
- **Boxes or containers**
- **Small helmets**
- **Rubber bands**
- **Foam insert**
- **Shop towels**

OBJECTIVE

- **I will learn about the scientific method.**
- **I will make educated predictions, experiment, analyze data, draw conclusions, and share their findings.**
- **I will be able to identify and complete the six parts of the scientific method based on the provided question and experiment.**
- **I will learn what g-forces are and learn how they are measured by an accelerometer.**

**The experiments in this activity are not meant to provide exact data but to provide a visual representation of possible outcomes. Sensor streaming may provide inconsistent results. We recommend multiple tests be done.*

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: G-FORCES

What is a g-force?

The **g-force** (with **g** from gravitational) is a form of acceleration that causes the accelerating object to experience a force acting in the opposite direction to the acceleration, thus causing a perception of weight. The term g-force is technically incorrect as it is a measure of acceleration, not force.

Imagine a running back getting the handoff from the quarterback and running up field. He's the object accelerating in a given direction. Now picture a linebacker. He wants to stop the running back from making it up field. He's the force acting (accelerating) in the opposite direction.

Both players experience g-forces when they finally collide. Sometimes one experiences more than the other.

EXPLORATION: MEASURING G-FORCES

An accelerometer is a device that measures acceleration. Acceleration is the rate of change of the velocity of an object. The accelerometer in the Sphero BOLT reads g-forces (g). A single g-force from a human being is equivalent to about 9.8 m/s2 depending on the eleveation of where you live. Accelerometers are useful for sensing the smallest vibration to the bigger bumps, drops, and crashes that your SPRK+ will inevitably experience.

Accelerometers are electromechanical devices that sense either static or dynamic forces of acceleration. Static forces include gravity, while dynamic forces can include vibrations, movement, and orientation. Accelerometers can measure acceleration on one, two, or three axes.

EXPLORATION: REAL LIFE G-FORCES

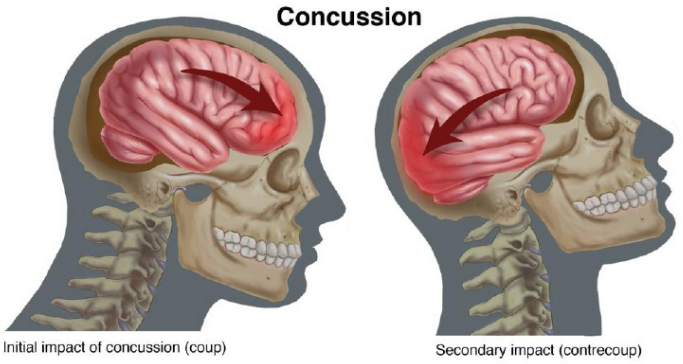
Have you ever stubbed your toe or bumped your head? If so, you've experienced g-forces in your life.

There is a lot of research and discussions right now around g-forces in professional and youth sports. Conucussions are a common injury in many contact sports. They are caused by acceleration forces (like whiplash or a blow to the head) that shakes the brain inside the skull.

Most helmets are designed to absorb the g-forces caused by falls, bumps, and crashes. Modern research explains that a concussion can deliver 95 g on the human body. The average football player experiences 103 g when hit hard during a game, where as the average fighter pilot only experiences 9 g.

Quick question: *What's the difference between the g-forces felt by a football player and the g-forces felt by a fighter pilot*? When you have time take a few minutes to do some searching to find out.

Resources: concussion, from Science Daily



EXPLORATION: WHAT IS THE SCIENTIFIC METHOD?

Take a few minutes to watch "The Scientific Method" by Sprouts on Youtube.

https://www.youtube.com/watch?v=yi0hwFDQTSQ&t=359s

Pay close attention to the six steps of the Scientific Method. What are they (in order)? What do you do during each step?

Download or print the attached chart ("Scientific Method.pdf) to use for the rest of the activity.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/f7/2a/Scientific%20Method.pdf

SKILLS BUILDING: WHICH WORKS BETTER?

So here is where ALL this comes together.

Your Sphero BOLT has an accelerometer. It measures g-forces on three different planes. We're going to use the sensor to measure the amount of g-force the Sphero BOLT experiences after a fall from about three feet.

As you briefly learned in Step: 3, most helmets are designed to protect your head from g-forces acting on your brain. In this experiment we will test three different modified mini helmets to see which one will protect the Sphero BOLT from experiencing too many g-forces.

The three helmets include:

1. Maroon: The Sphero BOLT sits in the helmet and is only held in place by two paper towels.
2. Gold: The Sphero BOLT is suspended in a hammock of sorts made out of women's nylons.
3. Green: The Sphero BOLT is surrounded by one-inch thick packing foam.

Using the Scientific Method chart from Step: 4, do the following:

1. Write down the question for this experiment --> *Which modified helmet will best protect the* Sphero BOLT *from experiening too many g-forces?*
2. Record your hypothesis. Remember your hypothesis is an educated guess of what is going to happen during the experiment based on the little information you've been given thus far. It can start with something like, "I think..."

Record your hypothesis.

SKILLS BUILDING: THE EXPERIMENT

The Control

Experiments usually have a control group to give base data. In this case, you'll drop the Sphero BOLT without a helmet from about three feet off the ground. Here are the steps:

1. Open the attached program titled Helmet Test *(https://edu.sphero.com/remixes/821341)*.
2. Be sure that the Sphero BOLT is paired to your device.
3. Start the program.
4. Hold the Sphero BOLT about three feet above the ground and let it go.

The program is designed to register three ranges of g-forces. As mentioned previously, a concussion can deliver 95 g. The accellerometer in the Sphero BOLT will register about 14 g, so we will use a multiplier of 7 to give us a rough idea of whether or not the Sphero BOLT gets a concussion.

- **Green** -- It's just a bump. It'll be ok. (less than an estimated 50 g)
- **Yellow** -- That really hurt. Put some ice on it. (between an estimated 51 and 90 g)
- **Red** -- We probably should take it to the doctor. It's eyes don't look right. (more than an estimated 90 g)

If all goes as it should, the Sphero BOLT will turn red and you should hear an ambulance siren.

The Variables

Experiments also have experimental variables. These are the different things that are being tested, usually one at a time. In this case we are testing three different modified helmets. Here are the steps for the remainder of the experiment.

1. Place your Sphero BOLT into the first helmet to be tested.
2. Be sure the Sphero Edu app is open and that the robot is paired with your device.
3. Open the attached program titled Helmet Test.
4. Start the program.
5. Hold the helmet about three feet off of the ground. Be sure to hold it so that the actual top of the helmet is what will hit the ground when dropped.
6. Let go of the helmet.

Repeat steps 4 and 5 for each helmet. You can start and stop the program for each drop to record individual readings if you'd like.

What were the results? Which was the better helmet based on this experiment? Record what happend (colors the Sphero BOLT changed) in box for of your Scientific Method chart.

CHALLENGE - WHICH HELMET WORKS BEST?

So which was it? Which modified mini helmet kept the Sphero BOLT *from going to the emergency room?*

The last two steps in the Scientific Method are Draw a Conlcusion and Communicate the Results. Here's what you need to do to wrap this all up:

1. Take a look at the results you recorded in box 4 of your chart. Was there a clear "winner" or was the experiment inconclusive (that means the results experiment didn't give you enough to answer the original question)?
2. Write down your conclusion in box 5. In other words, answer the original question. If you can't answer the question, say that and tell why.
3. Last, communicate your findings. Get creative here. You'll need to attach an image to this step that communicates the results of the experiment and the answer to the original question. Maybe hold up the best helmet or take a picture of your chart. It's up to you. Have fun with it.

ORGAN QUIZ

OVERALL TIME *Up to 1-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OVERVIEW

Identify the organs in the human body and then create your own quiz!

MATERIALS

- **Organs PDF**
- **Butcher paper**
- **Markers or crayons**
- **Scissors**

OBJECTIVE

- **I will name the nine vital organs and where they are located in the human body.**
- **I will create my own game by editing the provided code.**

EXPLORATION: THE ORGANS

Grab your stack of organs and begin to color each one. As you color them, take a moment to read the captions. You might learn something about an organ that you didn't know before.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/c9/75/Organ%20Quiz_Organs.pdf

When you are done coloring, carefully cut out each organ.

EXPLORATION: THE BODY

Where do all these parts go? They need a body, of course!

Work with a friend or a partner for this step. Grab some butcher paper and make sure it's a little taller than you. Lay the butcher paper down on the floor and lay down on top of it. Ask your partner to trace an outline of your body. You will use this outline to place the different organs as they are called out during the Organ Quiz.

Place your organs where they should go on the body outline you and your partner made.

EXPLORATION: TAKE THE QUIZ

Have you studied up? Do you know where all nine organs go in your body? I hope so because it's time to play the Organ Quiz!

Watch the video to learn how to play the game: Organ Quiz.

https://youtu.be/3LFTehM1alU

Be sure to lay down the body outline and gather all the organs before you play. When you're done, use your camera to take a snapshot of your organs located on the body outline.

SKILLS BUILDING: ADD PARTS TO THE BODY

Attached to this activity is a program titled "Organ Quiz." Open the program - we're going to edit it to add an additional organ: the Pancreas!

- Go to the Function (green) tab, then select “edit”, then, “evaluate.”
- Find the Speak blocks that contain the 9 organs. Tap the first If/Then block and then copy. Scroll to the bottom of the program and tap the last If/Then block. Tap the paste button.
- Tap the Variables tab at the bottom (red), then Add New, then Number (check), then name the variable Pancreas (done), then 1 (check).

SKILLS BUILDING: VARIABLES

1. Now you can replace the If/Then Heart variable you copied earlier with the Pancreas variable. Do this for both variables in the block grouping.
2. Change the Organ = 9 block to Organ = 10 (because we added one more organ) and check. Now, edit the Speak block text by tapping on it and type in the new label “Pancreas” to be spoken and save. Select Done.
3. There are a few last things to change on you main canvas. Go to the Set Number block with organ = Random Int 1 to 9 located at the top of the program. Change from 9 to 10, indicating 10 organs to label.
4. Select the Operators tab, then add an “add (+)” to the If/Then block with other organ variable listed. Select Variables and move the Pancreas variable you made to 0 next to the + you just added.
5. Go to the bottom of your program, before the Main LED block and add a Set block from the Operators tab. Choose Number (check), change the 0 to 1 (check). Now add the Pancreas variable to the open blue circle in that block.
6. Run your program!

CHALLENGE: BUILD YOUR OWN QUIZ

Build your own quiz! Brainstorm ideas of other complex objects that could be labeled. Examples may include the parts of cell or parts of a flower.

By editing the Organs Quiz or beginning a blank program canvas, work with your partner or small group to:

1. Change the number of variables (parts you need to label)
2. The words spoken in the function.
3. Finally, include content materials for others to study as well as cut out they can use for your quiz.
4. Switch programs with another group and attempt their test. Good luck!

PLANETS QUIZ

OVERALL TIME *2- to 4-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Science*

OVERVIEW

Create your own quiz by editing this block program.

MATERIALS

- **The Sphero BOLT**
- **Planet packet**

OBJECTIVE

- **I will learn about the eight planets in our Solar System.**
- **I will execute a Blocks program.**
- **I will deconstruct the attached program.**
- **I will edit the attached Blocks program to make your own quiz.**

EXPLORATION: LEARN ABOUT THE PLANETS

Review the attached Planet Quiz Research Guide to learn all about the 8 planets in our solar system. As you are reviewing the guide, highlight key facts that you believe to be important. Once you are done reviewing, work with a partner to share the most important attributes of each planet.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/dc/70/Planets%20Quiz%20-%20Research.pdf

EXPLORATION: PLANET CARDS

Cut out each planet in the below Planet Pack PDF.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/74/ee/Planets%20Quiz.pdf

On the back of each planet are three facts. These are the facts that you will learn about in this activity and that the Sphero BOLT will quiz you on.

SKILLS BUILDING - TAKE THE QUIZ

Have you cut out the planets? Have you studied up on each one? Are you ready for the quiz? Watch this video to see an introduction to the game.

https://youtu.be/yID6KH_hFnc

This game works best in a group of 2-3 players. The goal of the game is to name the planet to match the spoken fact. Here's how to play:

- Connect the Sphero BOLT to the app and start the linked "Planets Quiz" program to hear the first fact. There are 3 possible facts for each planet.
- Pick up the planet you think matches the fact and check the back to see if you're right.
- Shake the Sphero BOLT to hear the next fact, and continue to see how many the group can answert.
- Restart the program and keep playing until you can get all 8 correct.

SKILLS BUILDING: DECONSTRUCTING A PROGRAM

We will now deconstruct the Planets Quiz program.

- Go to the Function (green) tab, then select "edit", then planetPicker.
- Remove If/Then blocks (purple) for planets 5-8. Look for the planet number to help you locate them. Select Done.
- On you main canvas, go to the Set Number block with planet = Random Int 1 to 8 located at the top of the program. Change from 8 to 4, indicating only four planets to pick.
- Remove the last four planets variables (red, labeled with the planet name) from the If/Then block.
- Now when you run your program, you should only have 4 planets to choose from and only four facts per round.

CHALLENGE: WRITE YOUR OWN QUIZ

You will now create your own quiz about a different topic of your choosing (Animals, computers, video games, sports, etc.)

- Work with a partner to create 3 facts about 4 different related topics (*ex: Write 3 facts about each of the following: baseball, football, basketball and golf*).
- Open your edited Planets Quiz program. Find the Speak blocks by editing the planetPicker Function that contains the 12 facts.
- Edit each block of Speak block text to include facts you have created. Run the program again with your facts.

CHALLENGE - CREATE YOUR OWN QUIZ EXPERIENCE

Create your own quiz-style program by:

- Changing the number of facts.
- Changing how many facts are given each round.
- Adding your own variables and function.
- Changing what action is done to hear the next fact.

Add any idea you think would enhance the quiz, and be sure to include content materials for others to study prior to your quiz.

BLOCKS 1: INTRO & LOOPS

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Beginning Block: Roll, Delay, Sound, Speak, and Main LED*

CONTENT THEME *Technology & Engineering*

OVERVIEW

Welcome to your first Blocks activity! This lesson introduces you to the Blocks canvas. Learners will be challenged to create a program using block coding and gain an understanding of loops and operators.

MATERIALS

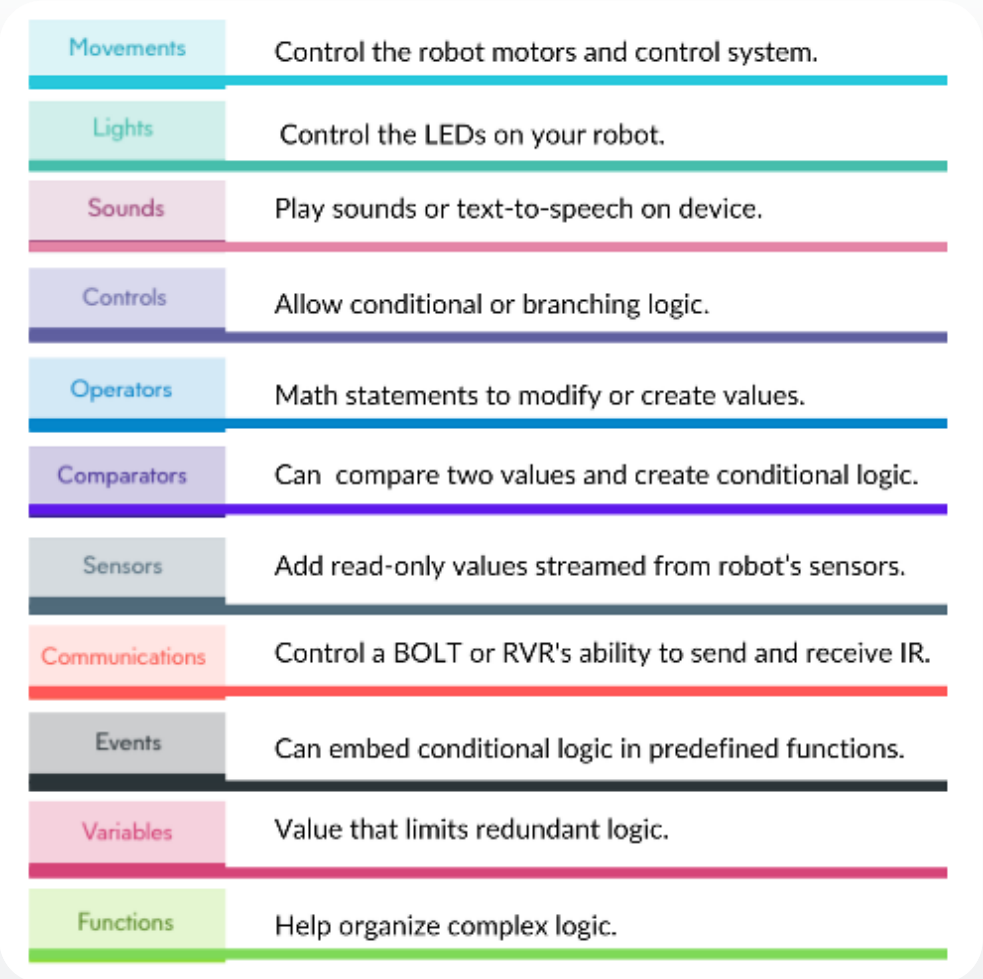
- **Sphero BOLT**

OBJECTIVE

- **I can practice refactoring code.**
- **I can define and use loops.**
- **I can create and execute a Blocks program.**

EXPLORATION: BLOCKS CATEGORIES

The Blocks programming canvas is designed to teach principals of programming. At the bottom of the Blocks canvas you will find 11 block categories. To view the blocks within a category, simply select the category tab.



SKILLS BUILDING: PROGRAM A SQUARE

Follow along with the video below to create a Blocks program. You will program your Sphero BOLT to move in a square with roll and delay blocks.

https://youtu.be/ZfpPvnEsbto

SKILLS BUILDING: REFACTORING WITH LOOPS

Now let's refactor your code so that it draws a square using a loop.

- **Refactor** is a common term used by developers that means to improve the way your code is written while still making sure it performs that same action.

You will use a loop to repeat any repeated actions in your original code. A loop repeats a series of blocks as many times as you want.

- *Why would this be useful?*
- *How do loops make it easier to create a shape with five sides, ten sides, or even 100 sides?*

Watch the video below for guided instructions.

https://youtu.be/6zoXyh5Qoz0

CHALLENGE: LIGHTS & SOUNDS

Add an extra layer of fun to your program by including lights and sounds as your Sphero BOLT moves in a square. Use the video below if you are unsure how to do this.

https://youtu.be/x0ly6eYu6Lg

CHALLENGE: OTHER SHAPES

How would you change your code to make a different shape?

1. Draw a triangle on a piece of paper. How is it different from a square?
2. Create a new program that has your Sphero BOLT robot move in a triangle. Challenge yourself and see what other shapes you can code.

REFLECTION

Think about the following questions on your own or with a partner:

- *What is a loop?*
- *What are the benefits of refactoring your code to use a loop?*
- *Are there actions you repeat every day? If you could program these actions, how would you write a loop to repeat them for you?*

MAZE MAYHEM

OVERALL TIME *1- to 2-hour lesson*

GRADES *2 to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Technology & Engineering*

OVERVIEW

Program the Sphero BOLT to navigate your own original maze. To complete this challenge, you must gather data about the best route through the maze and figure out how to build a program so the Sphero BOLT can successfully navigate through the mayhem.

MATERIALS

- **Sphero BOLT**
- **Sphero BOLT maze tape (or masking tape)**
- **Stopwatch or timer**
- **Measuring tape or rulers**
- **Protractors**
- **Large space on the floor**
- **Books and other everyday objects to build the maze**

OBJECTIVE

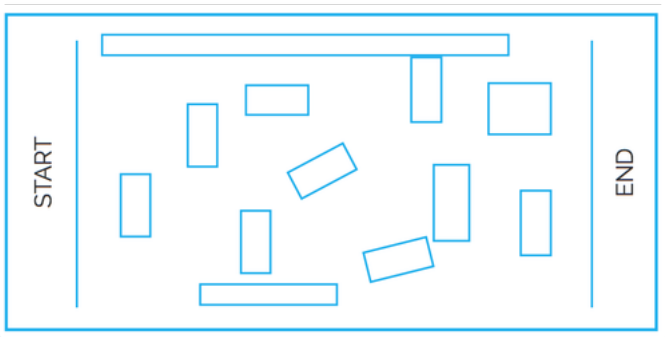
- **I will evaluate a maze for the quickest and most efficient solution.**
- **I will create a program to navigate the Sphero BOLT through a maze using Blocks and the Blocks Canvas.**

EXPLORATION: MAZE INSPIRATION

What does it take for the Sphero BOLT to navigate a maze? It's definitely more than just driving it around. In this activity you will gather data and program the most efficient path through a maze.

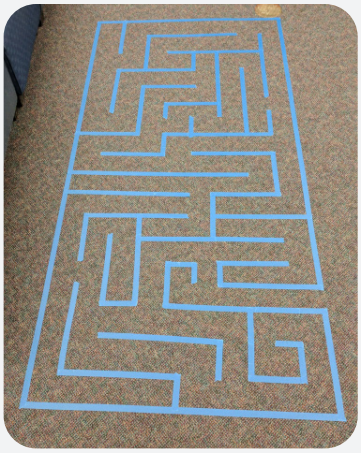
Below is a video and an image with examples of possible mazes.

https://youtu.be/X9rElBhT9nE



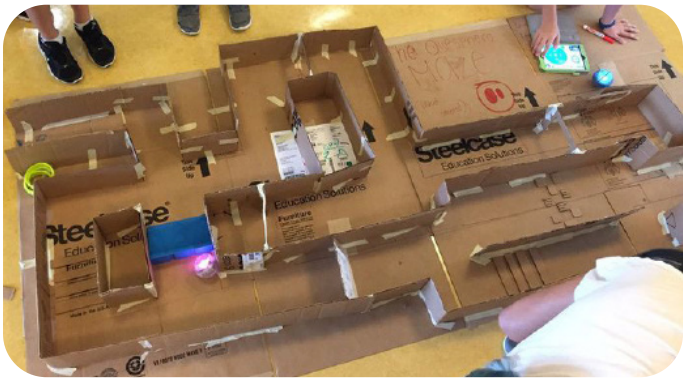
EXPLORATION: MAZE BUILDING

Your maze can be as simple as blue tape on the floor. It doesn't take much to create a path for the Sphero BOLT to navigate. If you have the space, grab some object from around the room to create walls and a path for the Sphero BOLT. Things like books, Lego bricks, boxes, shoes, or even waste baskets will work.



As you create this maze, add some obstacles to make the path more difficult. Narrow passages can be tricky too.

SKILLS BUILDING: HOW FAR DOES THE



SPHERO BOLT TRAVEL?

To navigate the maze quickly and effeciently you'll want to determine how far the Sphero BOLT travels. You will need to know how far the Sphero BOLT travels in a set period of time (for example, in 1 second). Watch the video below to get started.

https://youtu.be/_RDZQvh3Qlc

Create a program that will help you take this measurement. (**HINT:** Start with a simple roll block, set the speed and set the duration to one second.)

SKILLS BUILDING - NAVIGATING THE MAZE

Using the data you gathered in Step 3, write down instructions for what you want the Sphero BOLT to do. Draw the maze on a piece of paper, determine the Sphero BOLT's path and take measurements of distances and angles. Something like this:

- Go straight for 40 cm
- Stop
- Turn left 90 degrees
- Go straight for 20 cm

Next to each instruction, write which block you would need to complete that instruction. When you are done, you will have step-by-step instructions for the Sphero BOLT to move through the maze.

CHALLENGE: MAZE MAYHEM!

Time to put all of the planning to work and start programming!

Test your program as you go. Modify the program as needed. Remember you are programming for quickness and efficiency.

HINT: If you find that the Sphero BOLT isn't turning consistently or as sharp as you'd like, explore the Delay block unter "Controls."

REFLECTION

Write your reflections on this activity.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What route worked best?*
- *What was the trickiest part of the maze?*
- *What was the most challenging part of the activity?*

BLOCKS 2: IF/THEN/ELSE

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OVERVIEW

In this activity, you will learn your first conditional by building a fun animal sound game with your Sphero BOLT. This is a great follow-up activity to Blocks 1.

MATERIALS

- **Sphero BOLT**
- **Download and print Toss Game.pdf** *https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/dd/06/Toss%20Game.pdf*

OBJECTIVE

- **I can define and use conditionals, including if/then/else statements.**
- **I can create and execute a Blocks program.**

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION: CONDITIONALS

Most software programs include conditionals. A conditional is an action that takes place when certain conditions are met. An example is an if/then/else statement.

EXPLORATION: TOSS GAME OVERVIEW

In this activity, you will design your own "Toss Game" to show your understanding of conditionals. Watch the video below for an overview.

https://youtu.be/GOUmz02io94

Animal sounds?

Yup. Animal sounds.

Which animal sound is the most difficult for you to imitate?

SKILLS BUILDING: INITIAL LOGIC

In this video you will learn how to write the initial logic for the toss game.

https://youtu.be/hh2SMKLb1aM

SKILLS BUILDING: IF/THEN/ELSE

Show your understanding of conditionals by using an if/then/else statement to develop the main structure of the game. Follow along with the video below.

https://youtu.be/kiIZqp5M1xw

- *Why is it important to select TOTAL on the Accelerometer sensor?*
- *What does g measure?*
- *What do you think the g-force of an astronaut leaving the atmosphere is?*

SKILLS BUILDING: ANIMALS ROAR

Finally, add the logic for a random animal sound to play when the Sphero BOLT is tossed, and for the Sphero BOLT to stay quiet when it's not being tossed.

- *Why is it unnecessary to place an additional Accelerometer sensor measuring force under 3g under the ELSE condition?*

Watch the video below to see how you can make animals roar!

https://youtu.be/pQaHEobtfj0

CHALLENGE: PLAY THE TOSS GAME

Now you get to play the game!

Did the game playout like it was meant to? If not, go back into your code and see what is causing the issue. This is called **debugging**. Replay the game after each change you make to the code.

Watch the video below to see how to play the game.

https://youtu.be/NZe3N3tOCtk

CHALLENGE: RECORD THE GAME

When you have conquered your challenge, run your program and record your Sphero BOLT at the same time to share with your teacher.

Take a look below to see how to record your Sphero BOLT!

https://youtu.be/u7zvS2-Rvn0

CHALLENGE: ADD A TIMER

Instead of having the toss game loop forever, add a custom timer that will end the game automatically after a set amount of time.

See how you can set a timer in this video.

https://youtu.be/dQGseEkLbmw

REFLECTION

Write or reflect with a partner about what you learned in this activity:

- *What is a conditional?*
- *What was the conditional used in the toss game?*
  - Draw a diagram that shows the logic for this game.
- *What is an example of a conditional in your daily life?*
  - Write it as an if/then/else statement.

BLOCKS 3: LIGHTS

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OVERVIEW

In this activity, you will build a spinning top program where the gyroscopic spin rate will control the main LEDs, and you will use the concepts of normalization and absolute value. This is a great activity after you complete Blocks 2.

MATERIALS

- **Sphero BOLT**

OBJECTIVE

- **I can use a gyroscope to calculate rotational velocity.**
- **I can learn what absolute value is.**
- **I can create and execute a Block program.**

EXPLORATION: SPINNING TOP

In this activity you will learn a new way to control the Sphero BOLT's lights and use them to build a creative program that replicates a spinning top toy.

- *How do you think the Sphero BOLT can recognize when it's spinning or rolling? Do you know of a sensor that might do this?*
- *What other devices can recognize rotation?*

EXPLORATION: LED

- *What does LED stand for?*
- *Can you think of other devices (besides the Sphero BOLT) that use LEDs?*
- *Why does the Sphero BOLT only need three different color channels?*

To learn more about LEDs, take a look at the video below.

https://youtu.be/AgSSSOKIJZA

EXPLORATION: GYROSCOPE

Change the Sphero BOLT's red and green color channels to visualize the gyroscope's sensor values.

- *What is the vertical axis also known as and how is it measured?*
- *What is the horizontal and forward axis known as?*
- *How do you designate whether the Sphero BOLT spins clockwise or counterclockwise? What is your value range?*

SKILLS BUILDING: PROGRAM FRAMEWORK

Setup the framework for the spinning top program.

- *Why should the stabilization feature be turned off to complete this assignment?*

Take a look at the video below to see how to setup the framework for the spinning top program.

https://youtu.be/MNo6hEfJr2Y

SKILLS BUILDING: GREEN FOR "IF" (POSITIVE VALUES)

Use the gyroscope sensor data to modulate the green channel on the LEDs, and introduce normalization.

- *Why are we normalizing the gyroscope spin rate with these two numbers?*
- *What happens if you spin the Sphero BOLT clockwise? Why does this happen?*

Learn how to modulate the green channel on the LEDs below.

https://youtu.be/GNng3GLfaqA

SKILLS BUILDING: RED FOR "ELSE" (NEGATIVE VALUES)

Use the gyroscope sensor data to modulate the red channel on the LEDs, and introduce "absolute value."

- *What is absolute value?*
- *Why is the absolute value necessary when determining the LED channel scale?*

Learn how to modulate the red channel on the LEDs below.

https://youtu.be/JB2ecAVRRnE

CHALLENGE: SENSOR STREAM

Now that you've completed building this program, investigate the gyroscope sensor stream data.

- *What did you notice about the sensor data?*
    - *Pay special attention to the gyroscope pitch and roll.*

Take a look at the video below to check out the Challenge!

https://youtu.be/TUgb4exCDn8

REFLECTION

Write or reflect in a group what you learned with the Sphero BOLT:

- *What is a gyroscope?*
- *How does the the Sphero BOLT's acceleration and direction affect the velocity?*

BLOCKS 4: VARIABLES

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, Complex Controls (If Then), and Comparators*

CONTENT THEME *Technology & Engineering*

OVERVIEW

In this activity, you will use variables to build a hot potato game powered by the Sphero BOLT. You will also learn about loop until statements, and randomness within bounds to bring this classic game to life. This is a great activity after you complete Blocks 3.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencil**

OBJECTIVE

- **I can create code from pseudocode.**
- **I can define and use variables, conditionals, loops, random within bounds, and data types.**
- **I can create and execute a Blocks program.**

WARNING: If the Sphero BOLT is dropped from a distance of more than 36 inches (3 feet or .9 meters) above the ground, it may crack.

EXPLORATION

In this activity, you will create a Hot Potato game with your the Sphero BOLT.

EXPLORATION

Learn the concepts you will use to create this game: loop until and random within bounds.

- *What is a variable?*
- *What is an operator?*
- *What is a loop until statement?*
- *What does random within bounds mean?*

Watch this video to learn how to create the game.

https://youtu.be/Va-jHqk62-w

EXPLORATION

Now, write down very detailed instructions for how you might build this game. These instructions are called **pseudocode**.

- **Pseudocode** is a term for the instructions that software developers write BEFORE they write code. By writing pseudocode first, a software developer can make sure the logic for the program makes sense before translating the steps into a language the browser can understand, like JavaScript.
- Be very specific with the pseudocode you write. Imagine you have to give this piece of paper to a software developer. *Do you think they could build this game with your instructions?*

SKILLS BUILDING: VARIABLES

Create your first variables and learn how they will interact with each other to power the game.

Watch the video below to learn about variables.

https://youtu.be/707A2Yks-40

SKILLS BUILDING: RANDOMNESS & LOOP UNTIL

Use randomness to make the game unpredictable, and loop until to repeat the game logic until the toss variable is greater than the expire variable.

- What is the difference between an integer and a float?
- What are the bounds you have set for your random integer?
- What is the condition that causes the loop to stop?

https://youtu.be/3zjWpE-XeBA

SKILLS BUILDING: IF TOSSED

Create an if/then statement to indicate a toss occurred.

Learn how to create an if/then statement to indicate a toss below.

https://youtu.be/sl0H_5RUmcA

SKILLS BUILDING: CONDITION REACHED

When the toss variable is greater than the expire variable, you need to communicate that the player holding the Sphero BOLT is OUT.

Learn how with the video below.

https://youtu.be/qRU_INLtUeA

CHALLENGE: LET'S PLAY!

Play the hot potato game with a group of friends!

Did the game play as planned? If not, go back to your code to debug and determine what is causing the issue(s). Replay the game after each change you make to the program.

Watch the video below to see how the game is played!

https://youtu.be/MjqCq3hpSQQ

CHALLENGE

Now that you've finished building the program, compare your pseudocode to the code you wrote.

- How close was your pseudocode to the actual code you wrote for the hot potato game?
- Where was your logic off?

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- How well did your pseudocode match the real code? What differences were there?
- What is a variable? Why is it necessary to use variables in a complex program?
- What is the difference between the loop, loop forever, and loop until statements? Which did you use in this game?

DRAW 2: SPELLING

OVERALL TIME *Up to 1-hour lesson*

GRADES *K to 5*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Sopeed, and Color*

CONTENT THEME *Art*

OVERVIEW

In this activity, you will you use the draw canvas to draw letters and words that represent code and execute that code using your Sphero BOLT. Complete the challenge by coding the Sphero BOLT to navigate around an obstacle to better understand how the Sphero BOLT moves through the space around you.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencils**
- **Crayons**
- **Markers**
- **Color pencils**

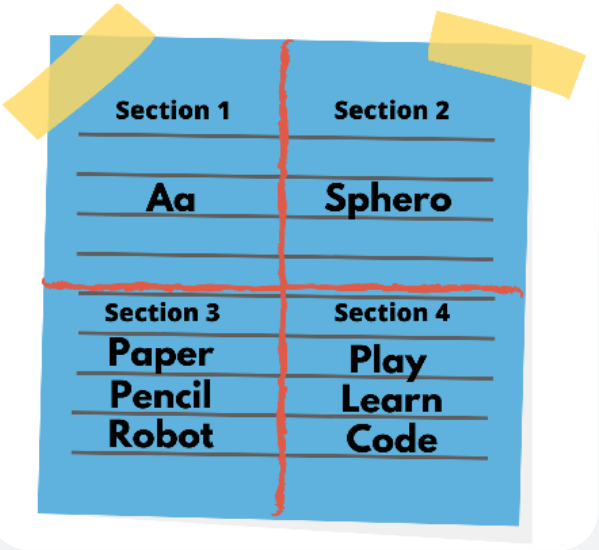
OBJECTIVE

- **I can spell words using the Sphero BOLT.**
- **I can program the Sphero BOLT to navigate around an obstacle and return to the start.**
- **I can create and execute a Draw program.**

EXPLORATION: LOTS AND LOTS OF WORDS

Grab a piece of paper and fold it into four sections. Label each section 1, 2, 3, and 4. Complete the following steps:

- Section 1: Choose a letter and write that letter in both upper and lower case.
- Section 2: Practice writing your first name, using proper capitalization.
- Section 3: Write down the name of three objects you see in the room.
- Section 4: Write down the words for three actions, or things you do.



SKILLS BUILDING: LETTERS

Watch the video below to learn how to program the Sphero BOLT to write letters and words using the Draw Canvas.

https://youtu.be/EGDFUR3-YMs

- Draw the letter from Section 1 of your paper. Try the uppercase letter first and run the program.
- Try the lowercase letter, but this time change the color.

SKILLS BUILDING: WORDS

Watch the video below to learn how to turn a group of letters into a programmed word.

https://youtu.be/8ADbjRUVTMs

Practice spelling your name, first. Do your best to reduce the amount of travel between each letter (as described in the video). Don't forget to start your name with an uppercase letter.

Can you change colors for each letter? What happens to each letter if you change the speed?

CHALLENGE: NAVIGATE

Now you will use your mastery of the Draw canvas to navigate the Sphero BOLT around an object on the floor.

- Find something like a box of crayons or a shoe and place it three steps in front of you.
- Draw a path on the Draw canvas (like in the video) that takes the Sphero BOLT around the object and brings it back to where it started.
- Aim the robot and run the program.

How did it go? What do you need to change to be successful?

Watch the video below to see how to successfully navigate.

https://youtu.be/aBUthRsckVE

CHALLENGE: OBSTACLE COURSE

Work with some classmates to create an obstacle course for the Sphero BOLT. Place a series of different objects around on the floor and decide on the approved path from object to object.

- Challenge your classmates to see who can make it through the obstacle course with the least amount of attempts.
- Once everyone has a successful path through, time each one to see who is the fastest.

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- *How is programming letters in the Draw Canvas different than how you normally write letters?*
- *What did you learn about programming while working with your the Sphero BOLT today?*

SPHERO CITY

OVERALL TIME *4- to 6-hour lesson*

GRADES *1 to 6*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OVERVIEW

Design and construct your own Sphero BOLT City. Build roads, buildings, and all sorts of fun places for the Sphero BOLT to navigate through. Create a program to help the Sphero BOLT get around on its own.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Tape**
- **Any toys/tools you have**
- **A writing utensil**
- **Cardboard**
- **Space to construct your city**

OBJECTIVE

- **I will construct a Sphero BOLT City or a city from history.**
- **I will create a program in the block canvas.**
- **I will execute the program using the Sphero BOLT.**

EXPLORATION: CITY PLANNING

Let's design a city and then learn how to drive your Sphero BOLT through that city. Watch the introduction video below.

https://youtu.be/j8IHE3ApKkg

You have two choices for your city design (your teacher may guide you in this area):

- Design your own unique Sphero BOLT City
- Design a city from history

After you've made your choice, think about what you want your city to look like. Begin by drawing a plan or diagram and determine what materials you will need. Conduct research on your city from history, if needed.

Construct your city using any materials and everyday items. Be creative!

EXPLORATION: CREATE YOUR CITY

Construct your Sphero BOLT City using the materials provided and everyday items. You'll be programming your Sphero BOLT to navigate through your city, so make sure your roads and pathways are large enough to fit your robot. You may want to test as you build by driving your Sphero BOLT through the roadways.

SKILLS BUILDING: PROGRAMMING THE SPHERO BOLT

Now that you have built your city, it's time for the Sphero BOLT to take a tour of the town.

Navigating the Sphero BOLT through your city is similar to navitating it through a maze.

Watch the video below for an example of a city.

https://youtu.be/nwOGqm7Gvhg

- *How far does the Sphero BOLT need to travel for each section? (ex: How far does the Sphero BOLT travel at a speed of 75 for 1 second)*
- *Is each turn 90 degrees or something else? Use a protractor to determine the heading.*

SKILLS BUILDING: NAVIGATE YOUR CITY

Test your program and durability of the city.

- *What worked?*
- *What did not work?*
- *Do you need to improve anything?*

Need inspiration on how to build your city? Take a look at the video below!

https://youtu.be/IZ49u7-IaAk

CHALLENGE: CREATE DIRECTIONS

Have the Sphero BOLT make stops along the way. Maybe the Sphero BOLT drives from the Supermarket to the Sandwich Shop. Or, the Colosseum to the Pantheon.

- Determine the Sphero BOLT's path and take measurements of distances and angles.
- Using this data, write down step-by-step instructions for the Sphero BOLT to move through the city.
- **Make at least two stops in your city**, add narrations to your code using the Speak code block.
  - For example, when the Sphero BOLT stops at the Pantheon, the Sphero BOLT describes the Pantheon's purpose in Ancient Rome (use your research skills if needed!). Or, when the Sphero BOLT stops at the supermarket, the Sphero BOLT describes the purpose of that location in the the Sphero BOLT City.
- Use this information to start programming or share the directions with a partner to see if they can program the Sphero BOLT through your city.

Make sure to save your final program!

SWIM MEET

OVERALL TIME *Up to 1-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OVERVIEW

The Sphero BOLT is training for a swimming competition but doesn't have a swimsuit. Design one that will help the Sphero BOLT win the race.

MATERIALS

- **Sphero BOLT**
- **Rubber bands**
- **Tape**
- **Stopwatch**
- **Plastic tub**
- **String**
- **Washers**
- **Balloons**
- **Plastic folders**
- **Styrofoam**
- **Glue**
- **Other waterproof craft materials**

OBJECTIVE

- **I will identify how the Sphero BOLT can "drive" in water aided by different materials.**
- **I will use the Draw or Block Canvas to program the Sphero BOLT to complete a water course with different Sphero BOLT 'swimsuits' to determine which yields the fastest lap times.**
- **I will learn to improve the Sphero BOLT's performance as the power source for a water-based vehicle.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

EXPLORATION: SWIM!

The Sphero BOLT loves to swim! Check out the video below to see how he races through the water.

https://youtu.be/UoF52-mboIo

Why do you think the Sphero BOLT moves more quickly through the water with the nubby cover?

EXPLORATION: TEACH THE SPHERO BOLT HOW TO SWIM

You can help the Sphero BOLT move through the water the same way you control it on land. Watch this video for more driving directions.

https://youtu.be/wVkrvlbiKJg

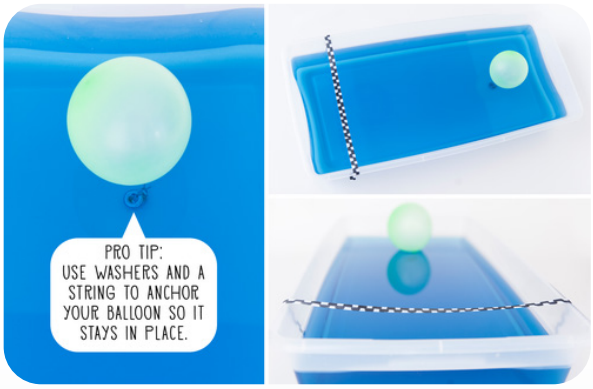
EXPLORATION: PRACTICE LAPS

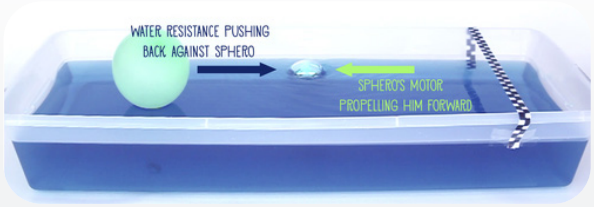
Set your swimming pool and practice racing your the Sphero BOLT around the buoy and back.

Answer the following questions:

- *What's it like driving the Sphero BOLT on water? What do you notice?*
- *Is it easy to control? Why or why not?*

- Think about the forces that are pushing and pulling on the Sphero BOLT. *What could you do to help the Sphero BOLT overcome the water resistance and swim faster?*
- Think about how you move through the water when you swim. *What helps move you forward?*





EXPLORATION: SWIMSUIT DESIGN

Now that you've taught the Sphero BOLT to swim, it's time for a challenge! We're going to see who can design a swimsuit that helps the Sphero BOLT move through water the fastest.

Take a blank piece of paper and fold it in half. Fold it in half the other way so you have four sections. Based on what you know and have learned about how the Sphero BOLT operates in water, draw some ideas of different swimsuits that might help the Sphero BOLT swim faster. Be creative and don't be afraid to have wacky ideas. Watch this video below if you need a little inspiration.

https://youtu.be/BP2HhTgp7gE

SKILLS BUILDING - EXPERIMENT WITH YOUR DESIGNS

Take a look at each of your drawings and ask yourself:

- *What will I make this swimsuit out of?*
- *How will I make this swimsuit?*
- *What features of this swimsuit will help the Sphero BOLT swim faster?*

Experiment with materials and designs to determine which performs best by using the drive function within the Sphero Edu app. *Which elements should you include in your design?*

Which of your ideas do you think will work the best? Make and test those swimsuits. Remember to record how fast the Sphero BOLT swam while wearing each one.

SKILLS BUILDING: CHOOSE A DESIGN

Think about which swimsuit worked best by asking yourself:

- *Which swimsuit made the Sphero BOLT swim the slowest?*
- *Why did that swimsuit slow the Sphero BOLT down?*
- *Which swimsuit helped the Sphero BOLT swim the fastest?*
- *Why did that swimsuit help the Sphero BOLT go faster?*
- *What could you do to improve your design and make the Sphero BOLT go even faster?*
- Finalize and perfect your design for the big competition.

SKILLS BUILDING: BUILD A PROGRAM FOR YOUR THE SPHERO BOLT

To make the laps in the pool more consistent and less subject to variations when driven, write a program using the Blocks canvas that gets the Sphero BOLT around the buoy and back.

You may have to alter the program when you change the swimsuit design. *Why is that?*

CHALLENGE: SWIM MEET

When all the teams are happy with their designs, start the competition!

1. Have each team show off their best swimsuit by explaining how they designed it and why they think it will help their Sphero BOLT win the race.
2. Time how long it takes for each team's Sphero BOLT to swim across the pool, around the buoy, and back across the finish line.
3. The team with the fastest time wins!

REFLECTIONS

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What happened when you changed the swimsuit design?*

CHARIOT CHALLENGE

OVERALL TIME *4- to 6-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Intermediate Block: Simple Controls (Loops), Sensors, and Comments*

CONTENT THEME *Art*

OVERVIEW

Learn how chariots have been used throughout history. Design and create a unique Sphero BOLT chariot, then create a program for the Sphero BOLT to navigate the race course.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Tape**
- **Cardboard**
- **Lego**
- **K'nex**
- **CDs**
- **Cups**
- **Large space on the floor for building the track**
- **Tin foil**
- **Felt**
- **Hot glue**
- **Craft sticks**
- **Straws**
- **Paper clips**
- **Other available found materials**

OBJECTIVE

- **I will identify how the Sphero BOLT can power a land-based vehicle constructed with inexpensive materials.**
- **I will drive the Sphero BOLT around a defined course with a chariot attached.**
- **I will analyze the effectiveness of my work with supporting facts and reflect on the learning.**

EXPLORATION: HISTORY OF CHARIOTS

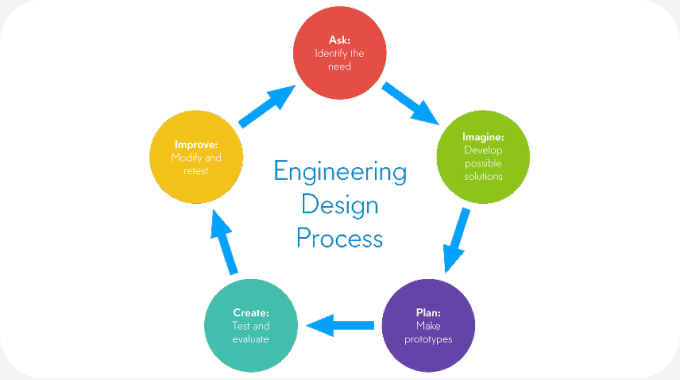
In ancient times, people used something called a "chariot" (a cart, usually pulled by horses) to haul materials, build things or even race against each other.

Draw a sketch of what a horse-drawn chariot looks like. Be as detailed as possible, but draw based on what you already know. Don't look online (yet!)

Your challenge is to design and build a Sphero BOLT chariot. Watch the video below for a quick glimpse into what you will be doing.

https://youtu.be/hB2Q5CHQTRQ

Review the Engineering Design Process image. Refer back to it throughout to better focus your efforts during the process.



EXPLORATION: RESEARCH DIFFERENT CHARIOTS

Research chariots online. Find photos and videos, noting their design and function. Consider these questions:

- *What materials were they made of?*
- *How many wheels did they have and how big were the wheels?*
- *How many horses/other animals were used to pull them?*

EXPLORATION: DESIGNING YOUR CHARIOT

How might the Sphero BOLT be used to pull a chariot? The video below is a good place to start.

https://youtu.be/IqYEcTHzA2Y

Examine the chariot construction materials you have to build with. Brainstorm some possible designs by experimenting with the materials.

- *Will you use wheels?*
  - *What kind and size?*
  - *What will you use for an axle?*
- *Which chariot design might work best? Why?*

Select your favorite idea to share with your team.

EXPLORATION: BUILD YOUR DESIGN

Begin buildings your chariot. Consider testing it along the way. Be sure that the Sphero BOLT fits.

If you are running into issues:

- *Look to see what is touching or dragging on the ground.*
- *Is the chariot too heavy for the Sphero BOLT to pull?*
- *Are the wheels stuck?*
- *Check for anything else that may keep the Sphero BOLT from pulling the chariot.*

EXPLORATION: BUILD YOUR TRACK

If you or your class haven't already, build an oval track on the floor measuring 10 feet long and about 5 feet wide. Blue painters tape works great for this.

SKILLS BUILDING: AUTONOMOUS CHARIOT

Create a program, using the Draw or Blocks canvas, that enables the Sphero BOLT to complete the course autonomously; in other words, on its own. This program can be used as an oppenent during the upcoming chariot race.

At this point, you should take some time to practice driving your chariot around the track. Keep in mind that faster isn't always better when it comes to the Sphero BOLT and chariots. *Why might that be?*

Observe how your chariot and the Sphero BOLT move. *Is there anything you can adjust or change to make it better?*

CHALLENGE: CHARIOT RACE

Time to put your Sphero BOLT Chariot up against your autonomous program and your classmates chariots.

Be sure to take some pictures or record a video to share.

REFLECTION

Write your reflections on this activity and discuss with the class.

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *Why do you think that the culture you studied used the chariot that they did?*
- *What materials worked best?*
- *What was the most challenging part of the activity?*
- *How did the size of the wheels or other design characteristics impact the results?*
- *What materials worked best?*
- *What was challenging and what worked well within your team?*

CHALLENGE - DATA ANALYSIS (OPTIONAL)

How can we make the Sphero BOLT Chariots faster? Let's gather data, evaluate the results, and make some predictions.

- Time the Sphero BOLT Chariots around the track.
- Compile best times in a spreadsheet.
- Evaluate each chariot by listing the materials and weighing it with and without the Sphero BOLT.
- Discuss what made that chariot faster or slower than the others.

Using this data, go back and make modifications to your chariot. Sometimes weight reduction helps. Other times shifting the balance of weight can help as well. Discuss the changes with a peer.

Once your updated chariot is ready, race again to see if the changes made any difference.

WHAT A CHARACTER!

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, complex Controls (If Then), and Comparators*

CONTENT THEME *Art*

OVERVIEW

The Sphero BOLT has a story to tell. Or maybe you do. Either way, let's tell it!

Create a program to animate the Sphero BOLT to act the part and tell a story for all to hear. Take advantage of all that the Sphero BOLT has to offer, from simple movements to lights and sounds. We can't wait to see it!

MATERIALS

- **Sphero BOLT**
- **Craft materials for building characters (18oz cups work great and fit right over the Sphero BOLT)**
- **Green screen**
- **Video editing software (optional)**

OBJECTIVE

- **I can write or retell a story for the Sphero BOLT to tell.**
- **I can create a storyboard to guide my work.**
- **I can program original animations to enhance my story.**

EXPLORATION: PERSONIFICATION

Personification is when you give a human characteristic to something nonhuman. You will be using this literary technique to help tell your story through the Sphero BOLT. You will give it traits and characteristics that would normally be given to a human character. Start thinking about how you will do this with a robot and the Sphero Edu.

The videos below are great resources to see how personification can be used.

https://youtu.be/VqBZMR83wCg

https://youtu.be/1Mb6NxixRk8

EXPLORATION: CHARACTER TRAITS

Whether you are retelling a story or writing something new, consider how you will program the Sphero BOLT to show emotion, communicate with others, and show off its personality.

Brainstorm some ideas on some scratch paper. To help guide you, consider some of the following questions:

- *How can you use the Sphero BOLT's **Main LED** and associated programming blocks?*
- *How can you use **Sound** and **Speak** blocks?*
- Throughout a story, characters express mood and emotion. *How can you program these into the story?*
- *How can you show the Sphero BOLT's character's personality in a way that enganges your audience?*

EXPLORATION: STORY ARC

Every basic story has a beginning, middle, and end. They tend to follow a predictable **story arc**. The video below explains what a story arc is using the classic example of Romeo and Juliet.

https://youtu.be/BaPR0y89s6Y

As you choose your story (retold or new), think about the different dialogue and actions that will happen during each part of your story. These things can be conveyed using the Sphero BOLT's lights, movements, and/or sounds.

SKILLS BUILDING: STORYBOARD

Time to work on your story!

As you begin to develop (or retell) the plot and character development, use a storyboard to help you plan. You can use the storyboard to diagram important moments and plan for specific animations, movements, lights, and sounds. Use the storyboard.pdf below or grab a piece of scrap paper and fold it into nine equal parts.

https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/99/cf/storyboard.pdf

Take a picture of your storyboard(s) and attach to the end of this step.

SKILLS BUILDING: ONCE UPON A … SPHERO!

You've planned your story and how you want to tell it. Now it's time to get the Sphero BOLT involved.

Remember that you can program the Sphero BOLT's main LED, its movement, and add sounds and speech. Using what you know about blocks and a combination of blocks, start to create the moods, emotions, and actions of the Sphero BOLT.

If you need a little help, take a look at the program attached to this activity. It includes some storytelling functions that you could use or look at for inspiration.

If you've chosen to decorate or build around the Sphero BOLT with craft materials, be sure to practice your programs with these on it. The added mass will affect how the Sphero BOLT moves.

CHALLENGE: CENTER STAGE

Let's hear your story! Get the Sphero BOLT ready for the big show.

Practice your story a few times through to get your timing down. Once you're ready, grab a partner to film it all. Start your program and tell your story.

As an added challenge, consider using a green screen. With some simple video editing, you could wisk your audience away to far away lands. Ask your teacher about this.

AVOID THE MINOTAUR

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 8*

PROGRAMMING LEVEL *Advanced Block: Functions, Variables, complex Controls (If Then), and Comparators*

CONTENT THEME *Art*

OVERVIEW

Our hero, the Sphero BOLT, is trapped by a creature from Greek mythology, the Minotaur! In Greek mythology, many heroes used their brains rather than their brawn to outwit their foes. Together with your team, create a program to show how the Sphero BOLT could outwit the Minotaur and escape the maze.

MATERIALS

- **Sphero BOLT**
- **Something to create a simple maze: blocks of wood or boxes, tape, etc.**
- **Cardboard cutout representing the Minotaur.**

OBJECTIVE

- **I will learn how to control the Sphero BOLT using precise code.**
- **I will illustrate how to decide which blocks to make the Sphero BOLT achieve a goal.**
- **I will create and execute a program that moves the Sphero BOLT along a changing path.**
- **I will analyze the program with supporting facts and reflect on the learning.**

EXPLORATION: MINOTAUR'S MAZE

Oh no! The Sphero BOLT is trapped in the Minotaur's maze! Watch this video to find out how you can help it escape:

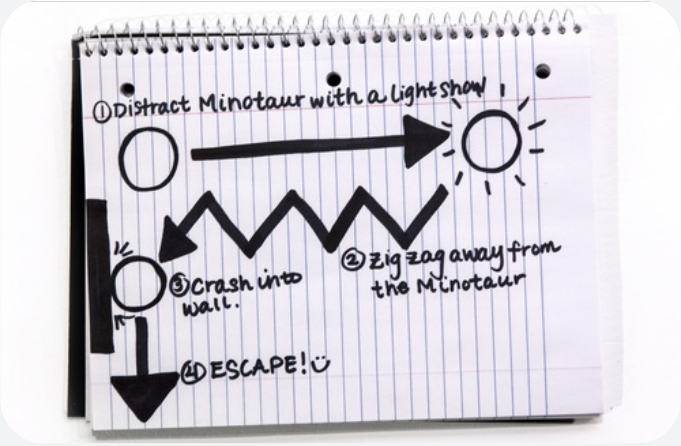
https://youtu.be/1pnmvGkuH7o

EXPLORATION: MAKE A PLAN

In order to escape, you and your teammates must design a program that causes the Sphero BOLT to pull off some fancy moves to confuse the Minotaur.

Start by thinking about what you want your Sphero BOLT to do to accomplish this.

Plan it out by writing or drawing your ideas, like this:



EXPLORATION: DESIGN A MAZE

What should the Minotaur's maze look like? Draw some ideas on paper and evaluate the materials available to you.

EXPLORATION: EXPERIMENT WITH BLOCKS PROGRAMMING

Using the block canvas, experiment with code to make the Sphero BOLT move in different ways, illuminate lights, etc. - the crazier, the better. Your goal is to confuse the Minotaur so you can escape!

Write down each block you used and what it made the Sphero BOLT do. You'll use this list to build your program to escape from the Minotaur.

SKILLS BUILDING: CREATE A MAZE

Using available materials, construct the maze around your block program's logic in which the Sphero BOLT will encounter the Minotaur.

Watch this video to inspire your getaway!

https://youtu.be/N7ihLhL4RN8

CHALLENGE: PROGRAM YOUR ESCAPE

Using the draw or block canvas, develop code that moves the Sphero BOLT erratically yet purposefully - remember, it still has to make its way out of the maze!

Test your program.

Can you improve it? How?

CHALLENGE: CHECK YOUR PROGRAM

Run your program. Did the Sphero BOLT escape the Minotaur? What changes can you make?

Write your reflections on this activity and discuss with the class:

- *What worked and what didn't?*
- *How would you do things differently in the future?*
- *What code worked best?*
- *What was the hardest or most fun part of the challenge?*

DRAW 1: SHAPES

OVERALL TIME *Up to 1-hour lesson*

GRADES *K to 5*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OVERVIEW

Welcome to your first Draw activity! This is a great follow-up activity to "Introduction to Sphero Edu." This lesson introduces you to the Draw canvas by drawing shapes that represent code and executing that code using your Sphero BOLT.

MATERIALS

- **Sphero BOLT**
- **Paper**
- **Pencil**
- **Crayons**
- **Markers**
- **Colored pencils**

OBJECTIVE

- **I can identify and describe shapes.**
- **I can distinguish between two and three-dimensional shapes.**
- **I can compose simple shapes to form larger shapes.**
- **I can create and execute a Draw program.**

EXPLORATION: SHAPES AROUND YOU

- Two-Dimensional shapes are flat and have only two dimensions: length and width. For example, a square.
- Three-Dimensional shapes are solid and have three dimensions: length, width, and height. For example, a sphere.

Look around the room and find an object that interests you.

- *What shapes make up this object?*
- *Are the shapes that make up your object two-dimensional or three-dimensional?*

Now look at your Sphero BOLT.

- *What shapes make up this robot?*
- *What other robots have you seen? What types of shapes make up those robots?*

SKILLS BUILDING: YOUR FIRST DRAWING

The Draw programming "canvas" is designed to teach primary principals of programming like sequencing and basic logic through basic swipes that represent JavaScript code. Watch the video below to learn how to draw basic, two-dimensional shapes with the Sphero BOLT.

https://youtu.be/hC99exl8TVw

SKILLS BUILDING: COLORS AND "WHOOPS"

You can use different colors to make your shapes more unique. Watch the video below and follow along. You'll also learn how to fix a mistake on the Draw Canvas.

https://youtu.be/W8Z4YSp9zkM

CHALLENGE: ROBOT DRAWING

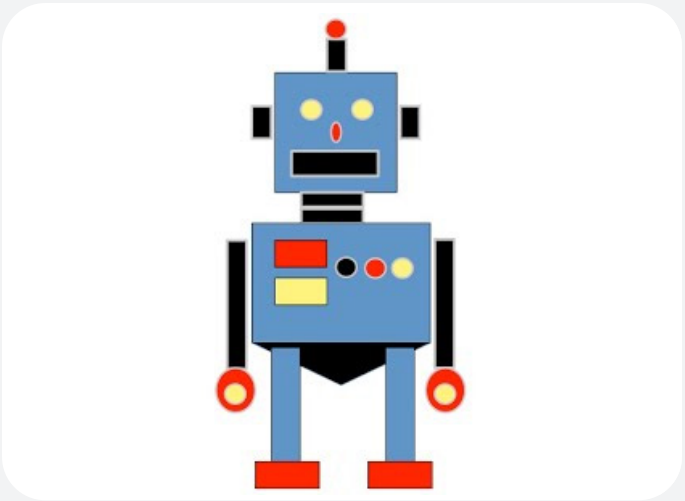
Now it's time to use your newfound programming skills to draw something different. Grab some paper and something to draw with.

Imagine a robot and think about which shapes make it up. On your piece of paper, draw a simple robot using shapes that you are familiar with. Some you may have already programmed the Sphero BOLT to draw today.

Consider the following before drawing your program:

- *How can you draw the robot to make the Sphero BOLT move as little as possible between shapes?*
- *Do you need to redesign the shapes of your robot?*
- *Could you make larger shapes into smaller shapes or combine shapes to make a larger shape?*
- *Should you make your robot different colors?*

Take a picture of your drawing and attach it to this step.



DRAW 3: PERIMETER

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 5*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OVERVIEW

This lesson introduces you to the sensor data in the Draw Canvas. Use this data to calculate the perimeter of a square, rectangle, triangle, and rectangle with unknown side length.

MATERIALS

- **Sphero BOLT**
- **Writing utensil**

OBJECTIVE

- **I can calculate the perimeter of multiple shapes using an equation.**
- **I can use the Sphero BOLT's sensors to gather data.**
- **I can create and execute a Draw program.**

EXPLORATION: PERIMETER

Perimeter is the path around a two-dimensional shape. We will be using the Sphero Edu app's sensor data to calculate an approximate perimeter of three different shapes.

SKILLS BUILDING: SQUARE PERIMETER

Think about these questions on your own or with a partner before watching the video below.

https://youtu.be/K0tU3an6Bcw

- *What is a perimeter?*
- *How do you calculate a perimeter?*
- *Which sensor data do you think could help you measure the perimeter of a shape that the Sphero BOLT draws?*

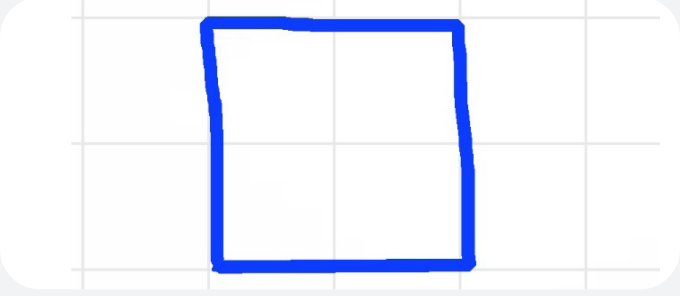
Follow the instructions in the video above to draw a square. Make sure it is two blocks by two blocks.

Use the location graph in the sensor data to calculate the perimeter of this square. (Remember that perimeter is the sum of all sides).

- *What unit of measure does the location graph show?*

Draw a representation of the same square on the Draw 3_Perimeter.pdf handout (*https://sphero-media-sphero-prod.s3.amazonaws.com/cwist/picturesteps/c4/6f/Draw%203_Perimeter.pdf*). Be sure to label the sides of your square.

Use the location sensor data from the graph to measure each side of the square. Remember that a square has four equal sides. Now calculate the perimeter of this square using the blank equation on the handout. *How big is your square?*



SKILLS BUILDING:PROPERTIES OF A RECTANGLE

Start a new Draw program and name it "Rectangle."

A rectangle has four straight sides like a square, but can have one pair of opposite sides that are longer than the other pair.

Draw a rectangle and have your partner check your rectangle for accuracy. Make it three squares by five squares. Run the program so your Sphero BOLT makes a rectangle.

Watch the sensor data. *How is it the same and different from the square?*

Now, just like you did with the square, draw your rectangle on the handout. Use the location data to help you calculate the perimeter of your rectangle. Show your work on the handout.

EXPLORATION: PROPERTIES OF A TRIANGLE

Start a new Draw program and name it "Triangle."

A triangle has 3 straight sides and 3 points (or vertices).
Draw a triangle and be sure to have your partner check your triangle for accuracy. Run the program so your Sphero BOLT makes a triangle.

Watch the sensor data. *How is it the same and different from the square and rectangle?*

Now, just like you did with the square and rectangle, draw your triangle on the handout. Use the location data to help you approximate the perimeter of your rectangle. Show your work on the handout.

CHALLENGE: DIFFERENT SHAPES

Draw a shape with 6 sides in the draw canvas and calculate the perimeter of the shape the Sphero BOLT makes.

What is the name of a shape with six sides?

REFLECTION

Reflect on what you learned with the Sphero BOLT:

- *How do you calculate the perimeter of a shape?*
- *When would you need to calculate the perimeter of a shape in real life?*

AREA OF A RECTANGLE

OVERALL TIME *1- to 2-hour lesson*

GRADES *3 to 5*

PROGRAMMING LEVEL *Draw: Manual Movement, Distance, Direction, Speed, and Color*

CONTENT THEME *Math*

OVERVIEW

Explore the area of a rectangle. Use the sensor data in the Draw canvas to calculate the area of a rectangle in various unit measures. Discover how the calculation of area is used in real life situations.

MATERIALS

- **Sphero BOLT**
- **Graph paper**
- **Pencils**

OBJECTIVE

- **I will calculate the area of multiple shapes using an equation.**
- **I will use the Sphero BOLT's sensor and location graph features to gather data.**
- **I will create and execute a program using the Draw canvas.**

EXPLORATION: FIND RECTANGLES

Look around the room and find objects in real life that are made of rectangles. Remember a rectangle has four straight sides like a square but can have one pair of opposite sides that are longer than the other pair.

- *Is a square a rectangle?*
- *Is a rectangle a square?*

Point these out to your partner and discuss:

How do you tell if one rectangle is larger or smaller than another rectangle?

EXPLORATION: PROGRAM A RECTANGLE

Tap on the "New Program" icon at the top of the activity and select the Draw canvas. Give the program a name like "Rectangle A" and tap "Create."

Draw a rectangle that is 2 blocks by 3 blocks. If you need any help with the Draw canvas, watch the video clip below.

https://youtu.be/ldjdVF97uVo

Have your partner check your rectangle for accuracy. Run the program so your Sphero BOLT makes the 2 blocks by 3 blocks rectangle. As the program is running, notice the sensor data that appears. If you are using a Chromebook, tap the three dots in the top right corner and select "Sensor Data" after Sphero BOLT has completed the program. The sensor data is saved each time you run the

program. The Sphero Edu app will keep the five newest version of the data.

Take a look at the "Location Data" and describe what you see. *Does it show the rectangle you expected?*

Draw a few more rectangles. Make each a different size. Have your partner check to make sure each drawing is in fact a rectangle. Talk about the following:

- *Which of your rectangles was the largest? How can you tell?*
- *How can you uses the sensor data to determine which was larger?*

SKILLS BUILDING: WHAT IS AREA?

The **area** of a two-dimensional object is the amount of space it covers or takes up. You can figure out the actual size of a rectangle by calculating its area. You can do this with other two-dimensional shapes, as well.

Watch the video below with a partner and answer the following questions.

https://youtu.be/1dqAOKdJmRI

- *What is area?*
- *What is the formula of area for a rectangle?*
- *Do you think you could use the location graph and sensor data to calculate the area of the rectangles you programmed?*

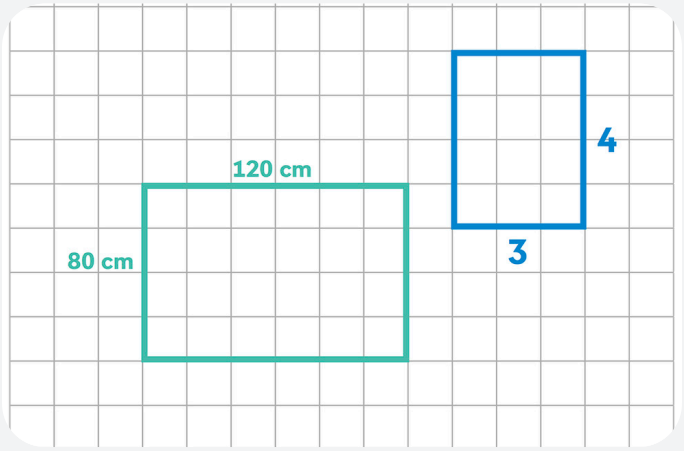
CHALLENGE: FIND THE AREA, PART 1

You can use the first Draw program you created earlier or create a new one. On the Draw canvas, draw two different sized rectangles. Be sure to use the grid on the canvas to help you draw each one. If it helps, use a different color for each rectangle.

Looking at these drawings, determine how many square units each rectangle measures. This is one way to measure the area of each rectangle.

Now, run the program. Watch the location data for each rectangle. After the program stops, tap the three dots in the right corner, and open "Sensor Data."

- Notice that that location data measures the path of the Sphero BOLT in centimeters (cm).
  - On some graph paper, do your best to recreate each rectangle that you drew on the Draw canvas.
  - Using the location data and measurements, approximate the length and width of the two rectangles in centimeters.



CHALLENGE: FIND THE AREA, PART 2

Use the measurements you collected from the Location Data now to calculate the approximate area of each of your programmed rectangles.

Remember that the equation used to find area is: **A** = **l** x **w**.

Show your work on your graph paper and take a picture to attach at the end of this step.

Area = length x width

CHALLENGE: FIND THE AREA, PART 3

Look around your classroom again. Select a few items that are rectangles and go measure them.

On a new piece of graph paper, do your best to recreate the items. Use the grid lines to help you accurately draw each side of the object. Label the length and width of the item on your graph paper.

Now calculate the area of these items. However, this time, you and your partner will do your own calculations on a separate piece of paper. When both of you are done, compare your answers and discuss the following:

- *How did you calculate the area?*
- *Are our answers the same? If not, why?*
- *When else would you ever need to find the area of an object or space?*