HELMETS FOR THE WIN

OVERALL TIME *Up to 1-hour lesson*

GROUPS *Three to four kids*

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

CONTENT THEME *Science*

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.**

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**

**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.

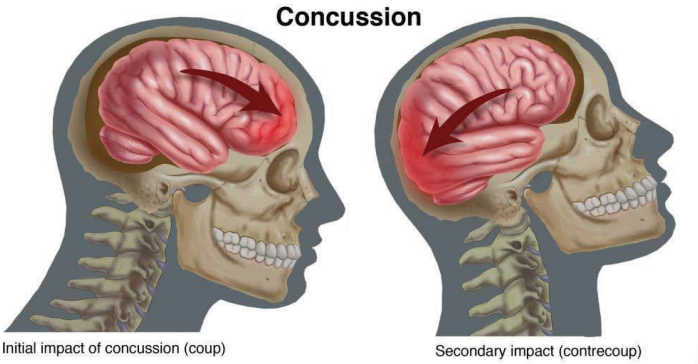
EXPLORATION: REAL LIFE G-FORCES

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 chart below ("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 above, 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 above, 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..."

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 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!