

TRACTOR PULL

OVERALL TIME 2- to 4-hour lesson

GROUPS Three to four kids

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

CONTENT THEME Science

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.

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.

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:

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

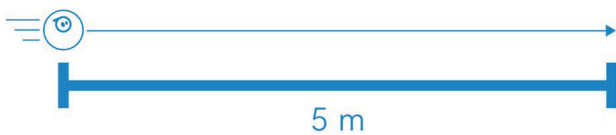
EXPLORATION: BASELINE DATA

This activity 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 Activity 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/-adGzIXOLDQ>