

# ATOM TRACKS

**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 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.

## 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

## 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 additional 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."

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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.