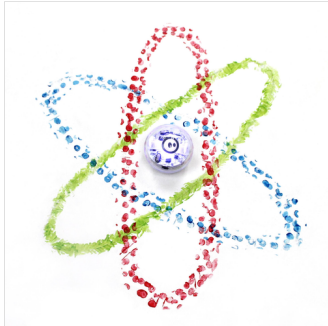


Atom Tracks



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Use Sphero and a pan of paint to see how atoms move in solid, liquid and gas states. By programming Sphero 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.

LEARNING OBJECTIVES:

- 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.

Tags: science painting physics sensors block coding loop forever

Grades: 5 to 12 | **Duration:** Up To 1 Hour

Key Stages: Science.KS3.CC1, Science.KS4.CS1

NGSS: 2-PS1-1, HS-PS1-2, MS-PS1-4, MS-PS3, MS-PS3-4

Supplies: paper, an 18in x 18in box, a 14in x 14in box, a 9.5in x 6in box, water-based paint, paint tray, gloves

Step #1: Exploration - Painting With Sphero

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

YouTube video: <https://youtu.be/2bGOxv-UMXY>



Step #2: 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 Sphero to roll and change directions randomly every second- similar to how atoms move.

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

YouTube video: <https://youtu.be/LXPsgNry93c>

Step #3: Exploration - Atom Track Painting

When you're satisfied with your program:

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

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

When Sphero 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's movement. (Note: You can export these results to a spreadsheet if needed.)

Educator Tip:

If your students are Middle or High School, we encourage to have your students explore the sensor data and see if they can recognize different patterns in the Sphero data.

Step #4: 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 Spheros in one box. (You will need to have another device controlling the additional Sphero and running a program.)

Step #5: 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.

Step #6: 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 Sphero'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?*

Step #7: Challenge - Simulate Different Gases

Watch the video below.

Consider doing the experiment again with multiple Sphero robots 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.

YouTube video: <https://youtu.be/EsvXhIZbFVY>

Step #8: 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.

Educator Tip:

This step is meant for high school students exploring different chemical reactions, as well as Boyle's Law, Charles's Law and Newton's 3rd Law.