Proximity Accelerometer

Speed Slide

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Position, Speed, and Acceleration

Overview

Have you ever wondered how things move? Why do they speed up or slow down, and how can we describe their motion? In this lab, we're going to investigate motion using a ramp, a toy car, and databot. You'll learn how to measure an object's position and speed over time and analyze what happens as it moves. Let's discover the science behind motion and how we can use data to understand it better!

Background

Motion is everywhere, from cars driving down the street to a ball rolling down a hill. To describe motion, we need a reference point—a fixed position to compare where something starts and where it moves. Speed tells us how quickly something changes its position, calculated by dividing the distance traveled by the time it takes.

When an object moves down an inclined ramp, gravity pulls it downward, increasing its speed. At the same time, factors like friction and the ramp's incline angle affect how fast the object moves. Using tools like a databot's distance sensor and accelerometer, we can measure and analyze these changes in motion.

In this lab, you'll observe how the position of a toy car changes over time as it rolls down a ramp. By collecting data on distance and time, you'll calculate the car's speed and understand how its motion is influenced by forces acting on it. This hands-on activity will help you connect abstract concepts like motion and speed to real-world observations.

What You Will Need/Prep

- Databot
- IOS/Android Smart Device
- Install Vizeey™ on your Smart device.
- Ramp and toy car or similar rolling object
- Measuring tape
- Stopwatch or timer
- Graph paper or data graphing app

- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!

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Learning Objectives

By completing this lab, students will:

- Understand how to describe an object's position using a reference point.
- Measure and record time and distance data for a moving object.
- Analyze how an object's speed changes over time as it moves down an inclined ramp.
- Predict and test hypotheses about the motion of an object, including changes in speed and distance.
- Use tools such as a databot and graphing methods to collect, visualize, and interpret motion data.
- Connect the concepts of speed, position, and motion to forces like gravity and friction.

Important Terms

Position: The location of an object relative to a reference point.

Reference Point: A fixed place or object used to determine if something is in motion.

Motion: The change in position of an object over time.

Distance: The total length an object travels, measured in units like meters or centimeters.

Speed: How fast an object moves, calculated using the formula:
Speed=Distance x speed=timedistance.

Time: The duration of an event, measured in seconds, minutes, or hours.

Gravity: The force that pulls objects toward the Earth, causing them to accelerate downhill.

Friction: A force that opposes motion, often slowing objects down.

Data Analysis: The process of examining and interpreting collected data to identify patterns or relationships.

Accelerometer: A sensor that measures changes in velocity or motion.

Proximity sensor or TOF: A tool used to measure how far an object is from a specific point.

Inclined Plane (Ramp): A sloped surface that allows objects to move from a higher position to a lower position, demonstrating the effects of gravity and motion.

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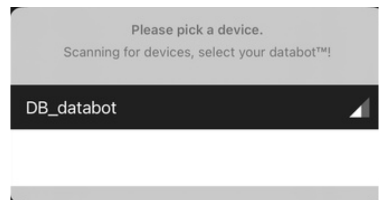
Using Vizeey

In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

Once in the Experiment

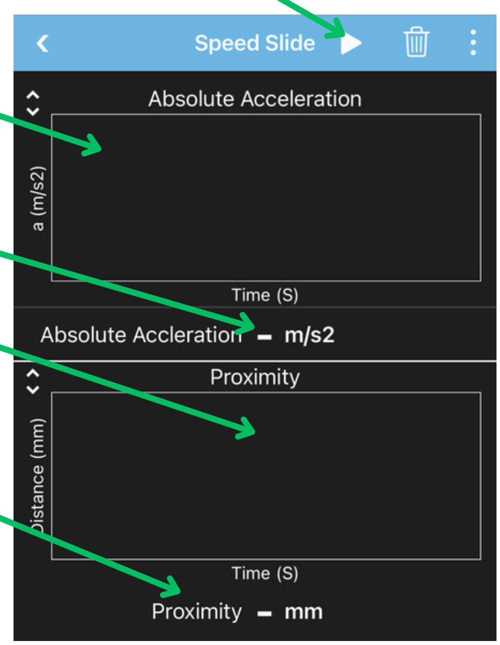
When you start the experiment you will be immediately offered to connect to your databot. Make sure that databot is enabled.



In this lab you will explore motion using two sensors: accelerometer and proximity. You are able to observe:

- databot cart acceleration graph
- Current acceleration
- Graph showing the distance of the cart from the start
- Current acceleration

Press this button to start the experiment.



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Part 1: Initial Observations and Questions

- What do you expect will happen to the car's speed as it moves down the ramp?

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- Will the car travel the same distance each second, or will this distance change?

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Part 2: Hypothesis

Predict how the distance traveled by the toy car will change as it moves down the ramp over time.

____

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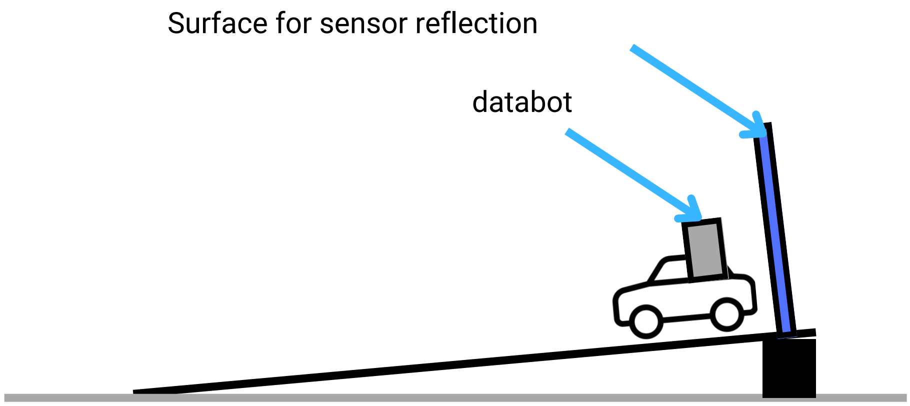
Part 3: Experiment Procedure

Starting Position

1. Attach the databot to a car or a moving platform, ensuring it faces the starting direction.
2. Set up a track for the car to follow.
3. To ensure optimal reflection for the proximity (TOF) sensor, use a flat, reflective surface at the top of the ramp, positioned perpendicular to the databot or vehicle.
4. Turn on databot



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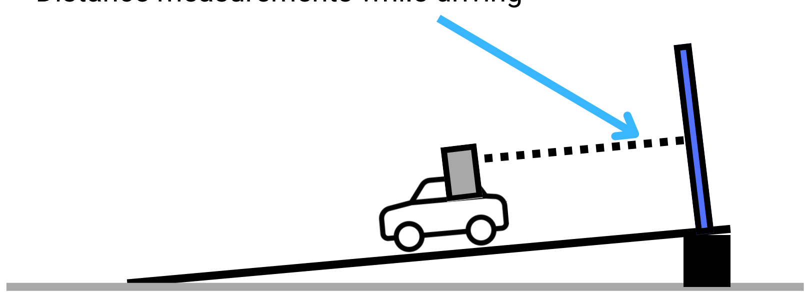
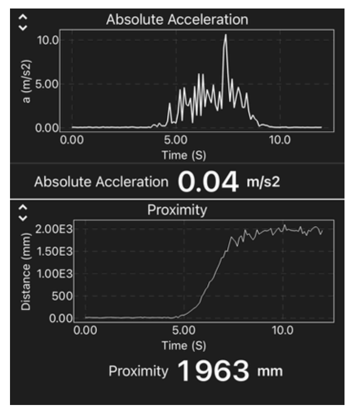
Part 3: Experiment Procedure

- Open the Vizeey app on your smart device.
- Turn on databot (using the small button on the left side)
- Tap on "**Speed Slide**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using:
  - Use these icons at the top of the screen in Vizeey to start and to pause the experiment.
  - Now, start the experiment and release the databot or vehicle. The databot will move down the track, measuring both its acceleration and the distance traveled from the starting point.

Distance measurements while driving

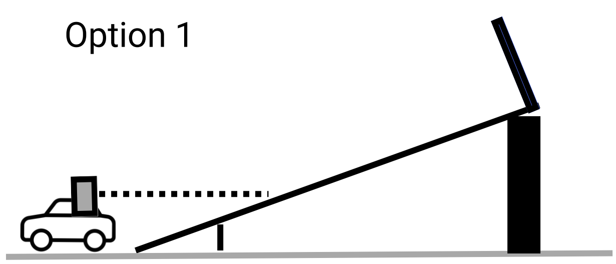




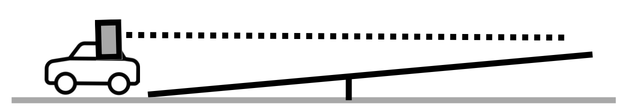
Once the cart reaches the bottom and moves onto a flat surface, several outcomes may occur depending on how the databot is mounted on the cart and the angle of the track.

The moment the car gets off the platform.

Option 1



Option 2



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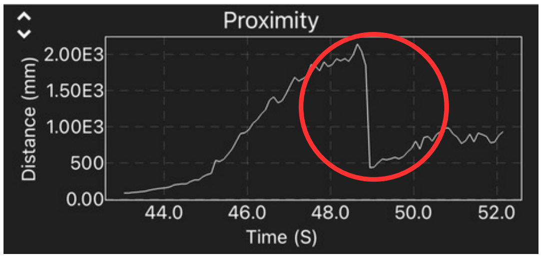
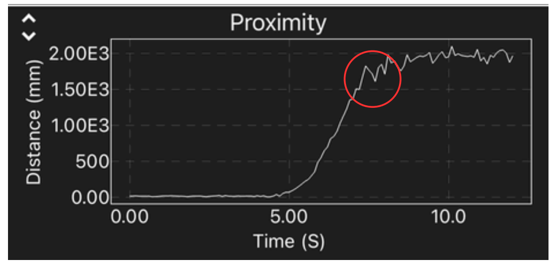
Part 3: Experiment Procedure

Option 1



If the track's incline angle is steep, you may observe significant changes in distance on the graph.

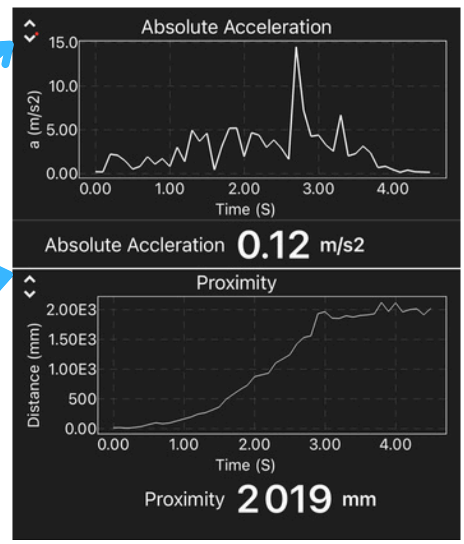
Option 2

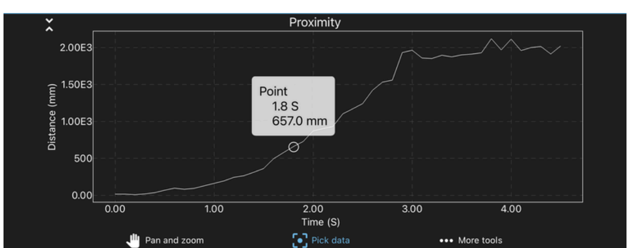


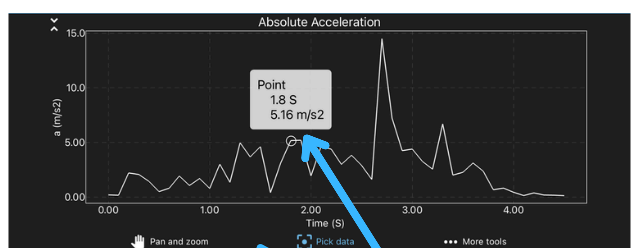
If the platform's incline angle is small, you won't notice significant changes on the distance graph.

After the experiment you will get a graph similar to this one.

Also, you have the opportunity to view these graphics in more detail. Near the graph you can click on the two up and down arrows.







To see the values at any point of the graph, you first need to press the “Pick data” button.

Click on any point on the chart to see the values.

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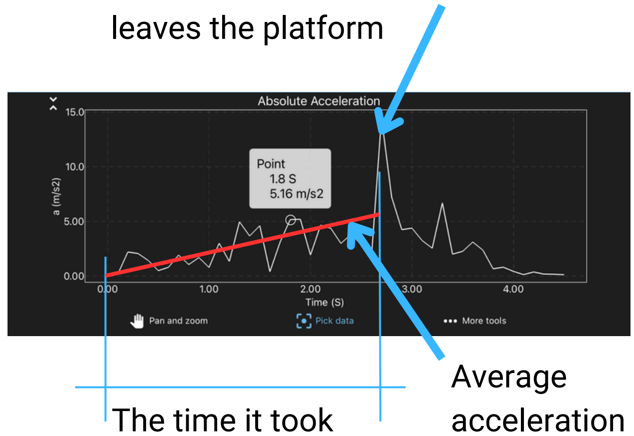
Part 3: Experiment Procedure

Explore the graphs. Using these graphs, you can understand how long the car moved along the platform until it left it. You can also see the acceleration that the car received at each point. You need to collect several of these values and calculate the average acceleration of the car.

As soon as the toy car reaches the edge of the platform and launches off, you'll notice a sharp spike in acceleration on the graph. This spike indicates the precise moment the car leaves the platform. Beyond this point, the data becomes less relevant, as the car is no longer accelerating but instead begins to decelerate due to friction and other forces acting on it.

The moment when the car leaves the platform



The time it took the car to go down

Average acceleration value

For more accurate data, run the toy car several times, fill in the table and calculate the average acceleration. Do not change the platform inclination angle.

Time (s)	Acceleration (m/s2)

Average acceleration value _______

Time (s)	Acceleration (m/s2)

Average acceleration value _______

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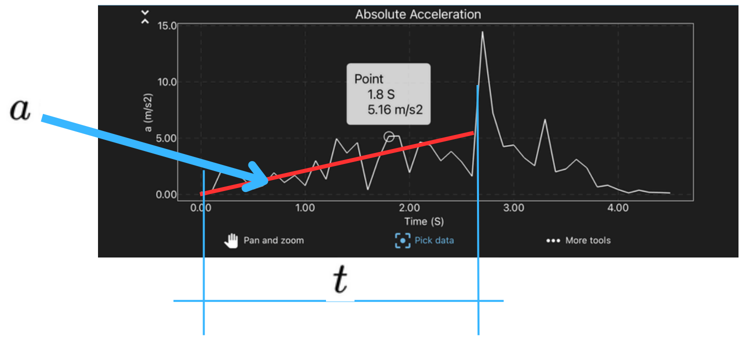
Part 4: Data Analysis

Now we know the average acceleration of the car and the time it took the car to descend from the platform. We can calculate the speed of the car. For this we will use the formula.

$v = v_0 + a \cdot t$ or $v = a \cdot t$

Where.
v = final speed (m/s)
a = acceleration (2.5 m/s²)
t = time taken (2.8 seconds)



$$v = 2.5 \cdot 2.8 = 7.0\,\mathrm{m/s}$$

The car's speed at the end of the platform is 7.0 m/s.

Do your calculations here

______

______

______

Part 5: Concept Questions

Data Interpretation:

- How did the distance the car traveled each second change over time?

______

- Based on your observations, describe the car’s speed as it moved down the ramp.

______

- Was your initial prediction correct?

______

Part 6: Reflection

1. What factors might have affected the car’s speed as it moved down the ramp?

______

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