Accelerometer

Rubber Band Car

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Acceleration, Force, Kinetic and Potential Energy

Overview

Have you ever wondered how a simple rubber band can make a toy car move? In this activity, you will explore the fascinating relationship between energy and motion. Using databot, you'll measure how the car moves over time, calculate its speed, and analyze how far and how fast it travels.

Background

Motion occurs when an object changes its position relative to a reference point. Such terms like **speed**, **acceleration**, and distance are used to describe the motion, and **Newton's three laws of motion** help to understand the behavior of objects in motion.

Motion happens when **forces** and **energy** come together. Energy is what makes things move! It exists in many forms, but two of the most important types of **energy** in physics are **kinetic energy** and **potential energy**. **Potential energy** is the energy stored in an object due to its position or condition. **Kinetic energy**, on the other hand, is the energy of motion, which an object has when it is moving. These two forms of energy are often transformed into one another.

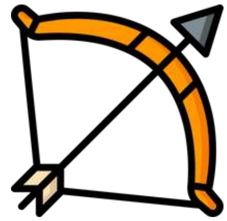
An excellent example of the transformation of different forms of energy is to use a rubber band to start a car. When you pull back the rubber band, it stores elastic **potential energy**—energy that comes from the band's ability to return to its original shape. The more you stretch the band, the more energy it stores. When you let go, this energy turns into **kinetic energy**, or energy of motion, making the car speed across the surface. Other real-world examples of **energy transfer** are archery and catapults, which launch objects using stored elastic energy.

What You Will Need/Prep

- Databot with accelerometer
- IOS/Android Smart Device
- Toy car or similar rolling object.
- Install Vizeey™ on your Smart device.
- Rubber band (preferably of consistent elasticity).
- Measuring tape
- 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!

Accelerometer

Through this hands-on activity, you'll uncover the science behind motion and explore how forces, energy, and speed interact to make everyday objects move. Let's dive into the world of physics and see what the toy car can teach you!



Learning Objectives

By completing this lab, students will:

- Visualize, collect and analyze data
- Measure acceleration of the toy car.
- Understand energy transfer: explain how elastic potential energy is converted into kinetic energy.
- Analyze the relationship between force, mass, and acceleration.

Important Terms

Acceleration: The rate at which an object's speed changes over time.

Elastic Energy: The potential energy stored in a stretched or compressed object, such as the rubber band, which can be released to do work.

Energy Transfer: The process by which energy moves from one system or object to another (e.g., from the stretched rubber band to the moving car).

Force: A push or pull that causes an object to move or change its motion.

Kinetic Energy: The energy of motion. It increases as an object speeds up.

Newton's Laws of Motion describe the behavior of objects in motion:

- First Law: an object will stay at rest or move at a constant speed unless acted on by an outside force.
- Second Law: the acceleration of an object depends on the force applied and its mass expressed in the equation $F = m \cdot a$ (Force equals mass times acceleration).
- Third Law: For every action, there is an equal and opposite reaction.

Potential energy: the stored energy of an object due to its position, shape, or condition.

Speed: The distance an object travels per unit of time.

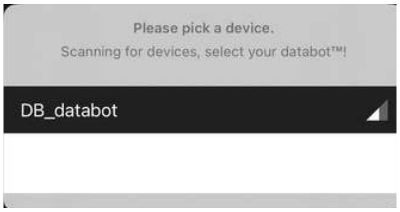
Velocity: Speed in a specific direction.

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.

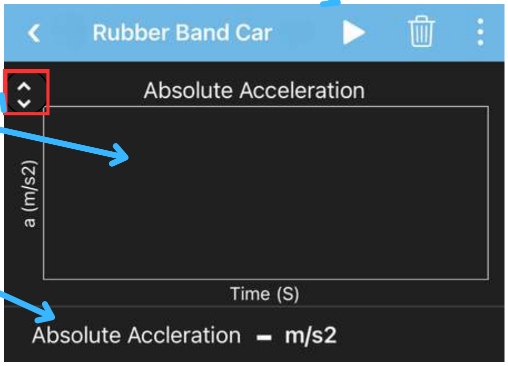
When you start the experiment you will be immediately offered to connect to your databot. Make sure that databot is enabled.



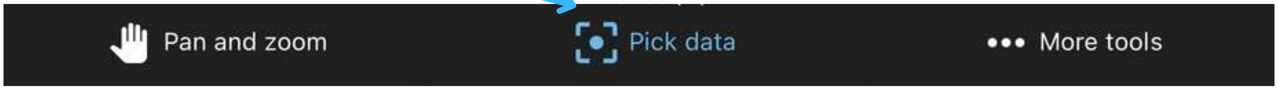
Once in the Experiment

In this lab you will explore motion using accelerometer. You will observe:

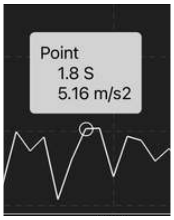
Press this button to start the experiment.



- Acceleration graph
- Current acceleration
- You also have the opportunity to study the chart in more detail after it is created. To do this tap the two up/down arrows. Your data will open in a bigger “zoom” mode.
- By default you will be in Pan and zoom mode which allows you to move the data side from side to side with your finger or pinch to zoom in or out.
- 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.



Part 1: Initial Observations and Questions

1. How does the distance the car travels depend on how much the rubber band is stretched? Will stretching the rubber band more make the car go faster?

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2. What role does the car's weight play in how far or fast it moves?

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3. How does the type of surface affect the car's motion?

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Part 2: Hypothesis

Consider how factors such as the amount a rubber band is stretched, friction, and a mass of the car might influence the motion.

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Part 3: Experiment Procedure

Preparation

Before starting the experiment, follow these steps to ensure everything is set up properly:

- Prepare the Surface: select a flat, horizontal surface for the toy car to move on. Ensure it is smooth and free from obstacles to allow for consistent motion.
- Attach databot: secure databot to the toy car. Depending on the car's design, you can use a rubber band or adhesive tape to attach databot firmly. Ensure it is stable and does not shift during the car's movement.

- Set Up the Launch Platform

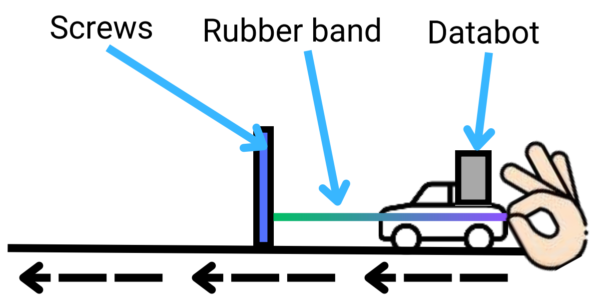
Depending on the available materials, there are two options for setting up the launch mechanism:

Option 1: DIY Rubber Band Launcher

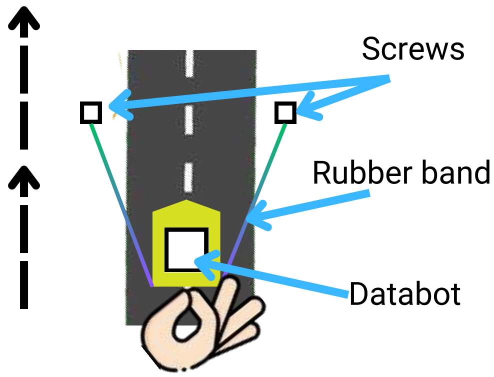
Install two supports to hold the rubber band. These can be as simple as two screws fixed firmly into the surface or a similar structure.
Stretch the rubber band between these two supports. The setup should resemble a slingshot or crossbow mechanism, with the rubber band providing the launching force.

Option 2: Pre-Made Launch Platform

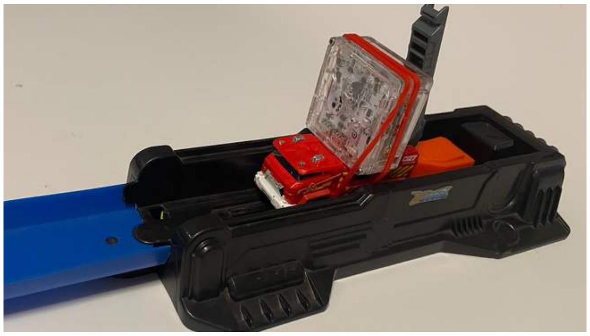
Use a ready-made launch platform, such as the one from a Hot Wheels toy set. These platforms typically use a built-in rubber band for launching and are pre-designed for easy and automatic operation.
If you have access to such a platform, no additional assembly is needed, making this option more convenient.

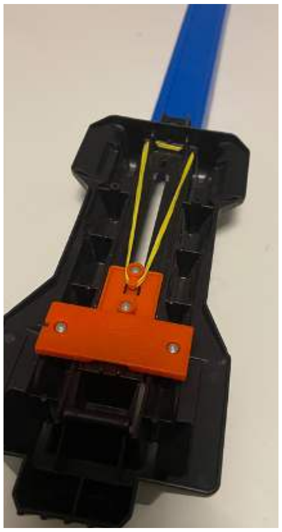


Side view



Top view



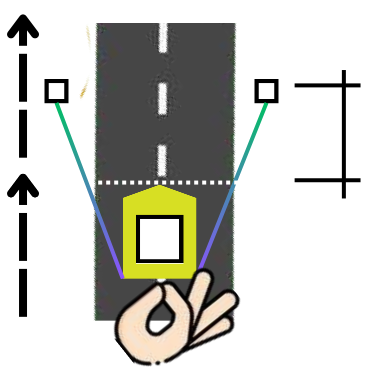


By completing these steps, you'll ensure the setup is ready for accurate data collection!

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 "**Rubber Band Car**" 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.
- Use these icons at the top of the screen in Vizeey to start and to pause the experiment.

Note: Consistency is the key to accurate results. Make sure that the toy car always starts from the same position.



Top view

For a homemade launcher: Mark a clear starting line on the surface and make sure that the car starts from this point every time. This will help you collect consistent and reliable data.

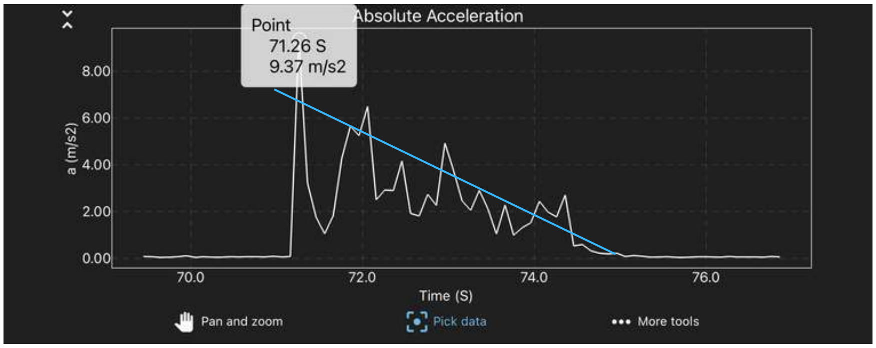
For the Hot Wheels starting track:
The Hot Wheels Starter Track ensures that the car starts automatically from the same position, making it easy to maintain consistency in your experiments.

- Start your experiment using:
- Place the car with databot on the start line.
- Release the rubber band - to make the car go while databot will record acceleration values.

During the experiment, databot will display data on absolute acceleration. This means the orientation of databot on the toy car does not affect the accuracy of the readings.
However, when attaching databot to the car, keep in mind that its weight will shift the car's center of gravity.

Part 3: Experiment Procedure

You can get a similar data graph



This graph show you the maximum acceleration - at the moment the rubber band was released, is 9.37 m/s² .

Part 4: Data Analysis

Analyze the graph you have obtained and give answers to the questions:

- What does the highest point on the graph represent?

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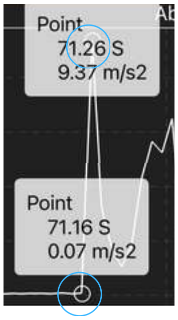
- What is your maximum acceleration? ___

- How long does the car accelerate before it starts slowing down?

Example: 71.26 S - 71.16 S = 0.1 S



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- Why does the graph rise quickly and then fall gradually (or vice versa)?

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- What does the slope of the graph tell us about the rate of change in acceleration?

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- What part of the graph corresponds to the car's motion slowing down due to friction?

___

Part 4: Data Analysis

- What force was applied to launch the car at maximum acceleration?

Using Newton's second law $F = m \cdot a$, you can calculate the maximum force exerted by the rubber band at launch if the car's mass is known. You need to weigh the toy car together with databot.

Example:
Mass of the car: m = 79 g = 0.079 kg
Force applied by the rubber band: $F = 0.079 \cdot 9.37 = 0.740\,\mathrm{N}$

Part 5: Concept Questions

How does the energy stored in a stretched rubber band affect its ability to move the car?

What happens if you change the tension force of the rubber band?

How do you think the graph would change if a lighter or heavier car was used?

What does the shape of the acceleration graph tell you about the car's motion over time?

Part 6: Reflection

1. What factors influenced the acceleration and distance the car traveled?

2. Why does the car move faster when the rubber band is stretched more?

3. Can we use measurements like stretch distance to predict the car's motion?