Sensor Starters

Grades: 4 & Up
Time: 15 Minutes -PDQ 1 & 2

Subject: Physics, Technology, Math, Data Science, STEM
Topics: Acceleration, Speed, 3D Geometry

Meet the Accelerometer!

The **accelerometer** senses motion and it is one of the most widely used sensors in the world. Think of all the devices that you know of that move. Cars, planes, trains, drones, game controllers, washing machines, and even your smartphone. How does your phone know to change **orientation** when you rotate it sideways? The **accelerometer**!

Background

There are different types, but all **accelerometers** work through the use of a "**mass**" that moves when **acceleration** takes place. Just as your body is pressed back into the seat when you **accelerate** in a car, a **mass** within the **accelerometer** moves when accelerating. As the **speed** increases, you are pressed back into the seat, feeling the **acceleration**, or the change in the rate (**speed**) of the car. If the **speed** and direction are constant, there is no **acceleration**.

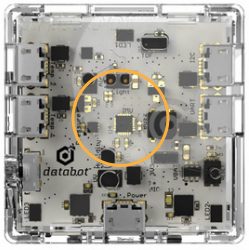
Using mechanical or electrical means to measure this movement, the sensor converts it to numbers that represent the force of **acceleration**.

Acceleration is a "change" in **speed** or direction over time. **Speed** is distance over time such as miles per hour (mph) or kilometers per hour (kph). In physics we frequently use the units meters per second (m/s). Now, for **acceleration**, we add in the rate of change, which is also in seconds, so we end up with meters per second "per second" to express **acceleration**. This is expressed as meters per second squared or m/s2 in the units shown in Vizeey™.

What You Will Need/Prep

- databot & Vizeey™
- IOS/Android Smart Device
- Use Vizeey™ to scan the QR Code Linear Acceleration.

Linear Acceleration
This experiment removes...



*The accelerometer is in a module called an inertial measurement unit (**IMU**). located in the center of the databot PCB.*

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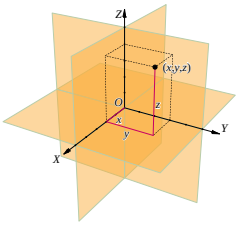


Important Terms

Acceleration: The rate of change in **speed** or direction. *An object moving at a constant **speed** and direction has zero **acceleration**.*

Accelerometer: A sensor that detects **acceleration** - changes in speed and direction.

Cartesian Coordinates: Describes position in three dimensions (3D) using the **Cartesian Coordinates** X, Y, and Z.

IMU: An inertial measurement unit (**IMU**) is sensor device that measures and reports a specific force, angular rate, and sometimes the **orientation** using a combination of **accelerometer**, gyroscope, and magnetometer.

Linear Acceleration: **Linear acceleration** is a change in **speed** in a straight line.

Mass: A quantity of matter or the form of matter that holds or clings together in one body.

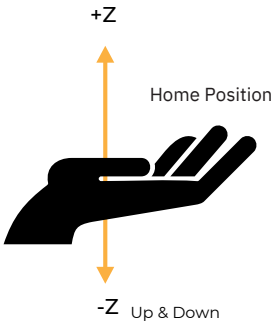
Orientation: The physical position or direction of something.

Speed: The rate of change of position of an object in any direction.

Home Position

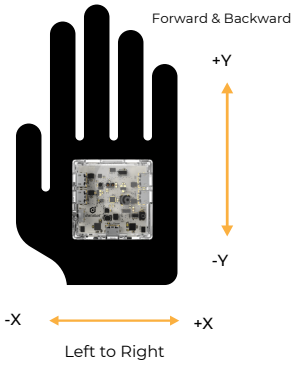
Hold databot in your hand as shown here with the databot logo closest to your wrist.

We call this the “home” position. This is the position we use for experiments so your **accelerometer** reads the correctly for various activities.



3D Cartesian Coordinates

3D **Cartesian Coordinates** are three numbers (x,y,z) that designate the position of something relative to a starting point of zero. For example, stand at a starting point (0,0,0) and move left two steps and you are now at (-2, 0,0). From here, step forward 1 and you are (-2, 1,0). "Float" up 1 step and you are now at (-2,1,1). This remarkable system uses geometry to allow you to communicate your position!



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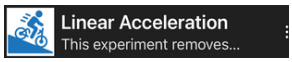
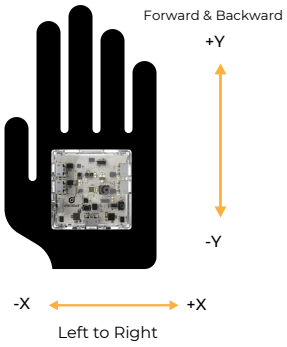
PDQ1 : 3D Thrills with databot

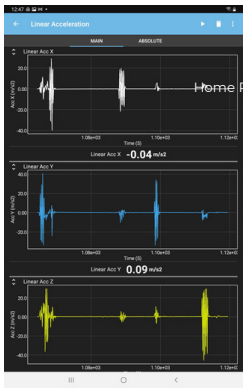
Using the databot **accelerometer** it is possible to read changes in **speed** and direction! First, in order to understand reading "direction" - familiarize yourself with the **orientation** of databot using the 3D Cartesian Coordinate system of X, Y, and Z axes. The **accelerometer** reads forces across these 3 axes. Depending on what direction you move, you will see the force of **acceleration** on a particular axis.

- Open the Vizeey App on your smart device
- Turn on databot
- Tap on "*Linear Acceleration" i*n Vizeey™ to load the experiment. 

- Hold databot in the palm of your hand in the "home" position shown.
- Start your experiment
  - You should see close to 0.0 m/s² on each axis as you hold still. Shake it to equalize the scales on the three axes - your goal is a scale of -20 to +20 on each axis.
- Stop, erase your data, restart as you practice until you get it.



- Clear your data
- Start you experiment again
  - Move databot forward, backward, sideways and up and down. Move with fast, uneven movements that **accelerate**.
- Watch the data visualization of **acceleration** and verbally say each axis as you move.
  - Try to match the graph image shown to the below



Shake it up!

Each axis "auto-scales" based on the highest and lowest value of x, y, and z.

Start by shaking databot on each axis so that you get each axis to display an equal range of -20 to +20 m/s2.

This will match the 3 displays for easier comparison.

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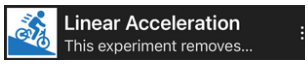
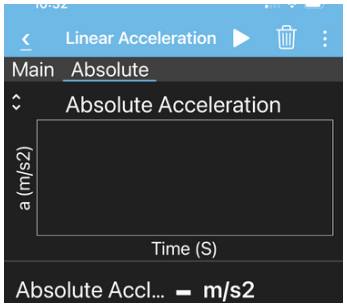
PDQ2: Hop, Skip, Run, Race or Jump

In PDQ 2, **acceleration** from the x, y, and z axes is all combined into one awesome value that represents your total **acceleration**. With databot held tightly against your body, what is the highest rate of **acceleration** you can achieve?

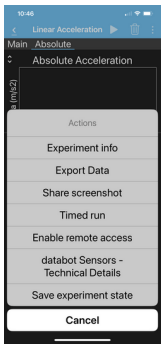
- Open the Vizeey™ App on your smart device.
- Turn on databot.
- Tap on "*Linear Acceleration" i*n Vizeey™ to load the experiment.

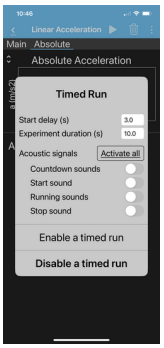


- Swipe left on the screen to the Absolute View screen.



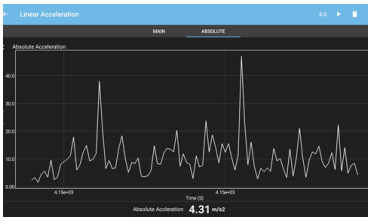
- Tap on the three dot icon at the top of the screen
- Tap on Timed run, it will default to 10 seconds.
- Tap on Enable a timed run, this will return you to the Absolute Acceleration screen for a 10 second experiment.





- Hold databot snugly against your body holding it in your hand and placing it over your heart.

- Start your experiment .
- Start the 3 second countdown and then GO!
- Now leap, cavort, run and move in your best effort to achieve a high rate of **acceleration**.
- After your ten second recording, tap on the graph to see your data.



- Use the "Pick Data" tool at the bottom of the Vizeey™ screen to identify your peak **acceleration**! By tapping on the data, you can see your readings for that time.

**You can also use the Pan and Zoom tool for a closer look at your data.*

Check for Understanding

1. In your own words, explain **acceleration**.
2. Demonstrate and name the three axes of the Cartesian Coordinate System.
3. What are the units we use to express **acceleration**?

Standards & Alignment

NGSS Standards

- Motion and Stability (MS-PS2-1)
- Engineering Design (MS-ETS1-1)

Disciplinary Core Ideas

- Motion and Stability (MS-PS2-1) (HS-PS2-1)
- Forces and Motion (MS-ESS2-2)

Crosscutting Concepts

- Patterns
- Cause and Effect
- Energy and Matter
- Stability and Change

ISTE Standards

- 1.1 Empowered Learner (1.1.d)
- 1.3 Knowledge Constructor (1.3.c)
- 1.5 Computational Thinker (1.5.b)

Science and Engineering Practices

- 3rd Practice: Planning and Carrying Out Investigations
- 4th Practice: Analyzing and Interpreting Data
- 5th Practice: Using Mathematics and Computational Thinking

TEKS -Texas Essential Knowledge and Skills

Elementary Process TEKS

- 5.2D Scientific investigation and Reasoning: Analyze and Interpret Information
- 5.2C Scientific investigation and Reasoning: Collect and record information

Elementary Level Content TEKS

- 5.6D Force, Motion and Energy: Test the effect of force on an object

Middle School Process TEKS

- 6.2C Scientific investigation and Reasoning: Collect and record data
- 7.2E Scientific investigation and Reasoning: Analyze data to formulate reasonable explanations

Middle School Level Content TEKS

- 6.8B Force, Motion, and Energy: Identify and describe changes in position
- 6.8D Force, Motion, and Energy: Measure and graph changes in motion
- 8.6C Force, Motion, and energy: Investigate and describe applications of Newton's three laws of motion