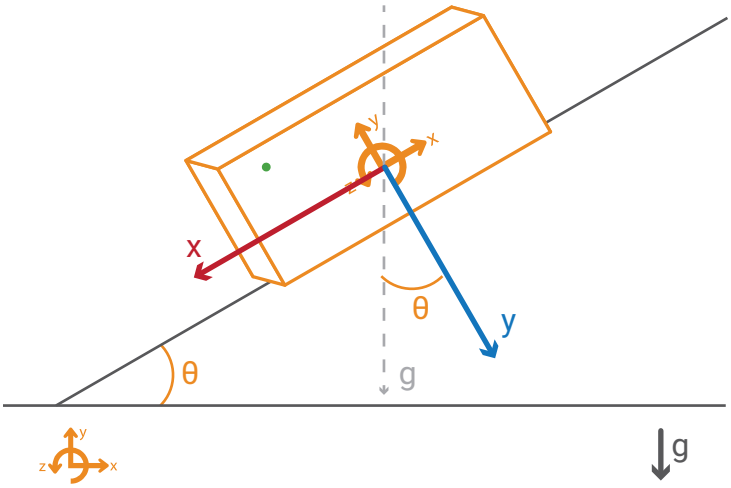
Measure the Angle of an Incline Plane

Exploration

An accelerometer is a device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling us towards the Earth's surface, or the force may be dynamic, like an object moving or vibrating. This lab will show how to use to accelerometer to measure the static angle of a ramp as it rotates between 0° and 90°.

Materials

- PocketLab
- Piece of tape
- Sheet of acrylic, wood, plastic, or thick cardboard



Objective

In this experiment, students will:

1. Use PocketLab's accelerometer and an understanding of trigonometric functions to find the angle of incline of a ramp between 0° and 90°.

Method

1. Attach PocketLab to the piece of acrylic or thick cardboard.
2. Use the tape to secure PocketLab to the surface of the ramp so it will not slip. Make sure the PocketLab is oriented as shown in the diagram.
3. Notice that the y-axis will be reading 1g because of the orientation of the PocketLab. The static force of gravity is pulling down on the accelerometer along the y-axis at a rate of approximately 1g.
4. Rotate the ramp slowly from 0° (horizontal) to 90° (vertical)
5. Notice how the y-axis that was reading 1g will decrease toward 0g as the x-axis will increase from 0g toward 1g. The z-axis should stay the same at 0g. This is because the direction of the static force of gravity isn't changing. The gravity vector is still straight down. However the angle that the y- and z-axis of the PocketLab intersect the gravity vector is changing. When the ramp is completely level, the gravity vector is aligned with the y-axis and perpendicular to the x-axis. As the ramp increases its angle, the y-axis is moving away from the gravity vector while the x-axis is moving toward it. This is why you see the change in the x- and y-axis.
6. When the ramp is at 0° what is the angle between the y-axis and the gravity vector? It is also 0°. When the ramp is at 90°, what is the angle between the y-axis and the gravity vector? The y-axis would be perpendicular to the gravity vector so it is also 90°. We can conclude that the angle between the y-axis of the PocketLab and the gravity vector is the same as the angle of incline of the ramp.
7. We can now use our knowledge of trigonometric functions to find the angle between the gravity vector and the y-axis, which is also the same as the angle of ramp incline. Therefore to find θ for any incline angle you can use the equations below:

$$x = g * sin(\theta);\ y = g * cos(\theta)$$

where x is the x-axis accelerometer value, y is the y-axis accelerometer value, g is the value of the gravity vector and θ is both the incline angle and the and the angle between the y-axis and the gravity vector.

Data Analysis and Observations/Conclusions:

- Use the data and the above equations to find the inclination angle for different points between 0° and 90°.
- Describe the relationship between the acceleration of the x- and y- axis and the inclination angle of the ramp.
- Describe real world applications where using an accelerometer and this principle would be helpful.