Accelerometer: Centripetal Acceleration

Subject Area(s):	Physics, Mathematics, Engineering, Technology
Associated Unit:	None
Associated Lesson:	None
Activity Title:	Understanding centripetal acceleration, radius, accelerometer
Header:	Insert image 1 here, right justified to wrap

Image 1

ADA Description: Students learning about the properties of robots that are needed to break through the door

Caption: Students building robots

Image file name:
Centripetalacceleration_image1.jpg

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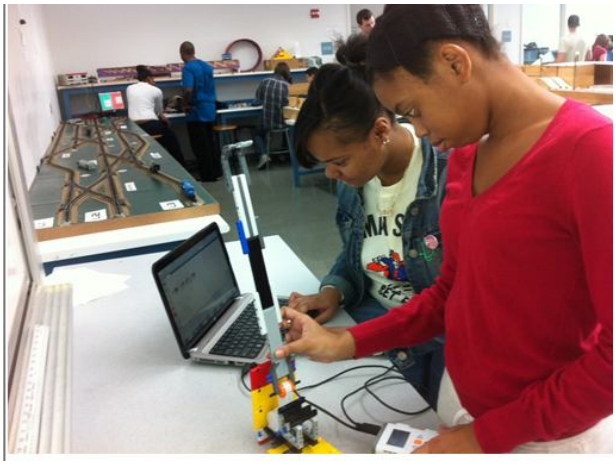

Level:	(9 and 10)
Activity Dependency:	None
Time Required:	50 minutes
Group Size:	Five
Expendable Cost per Group	US $3

Insert Image 2 here, centered

Image 2
ADA Description: Motor with robotic arm and accelerometer
Caption: Accelerometer on robotic arm to monitor tilt across 3 axes
Image file name: Centripetalacceleration_image2.jpg

Summary

Students will work as physicists to understand centripetal acceleration concepts. They will also learn about a good robot design and the accelerometer sensor. They will learn about centripetal acceleration/ force is governed by the radius between the motor and accelerometer. They will also learn about how the mass plays an important role in the centripetal acceleration/ force. It is important for students to learn about how graph their own data.

Engineering Connection

Students will learn to design good robots with proper weight distribution across the robot for their robotic arm. They will also learn about the data logging programs and how to view their own data in the data logging program. They will about how a change in radius or mass can affect the data obtained from the accelerometer through the plots generated from the data logging program. More specifically, they will learn about the accuracy and precision of the accelerometer measurements from numerous trials.

Engineering Category

Relates physics concepts to engineering

Keywords

Physics, centripetal acceleration, centripetal force, accelerometer, data logging

Educational Standards

- New York State Standards
  - New York science: 4.4, 4.5
  - New York Technology 5.1, 5.3, 5.4
  - New York math: 3.1, 3.2, 3.3, 3.5

Pre-Requisite Knowledge: Physics, math concepts and technology (basic programming skills)

Learning Objectives

After this activity, students will be able to:

- Design a lego-based arm
- Program a robot with NXT MindStorms software
- Be able to program the accelerometer and monitor it in data logging
- Be able to manipulate the mass and radius of the accelerometer
- Be able to monitor the change accelerometer sensor when the mass on the arm and the radius from the motor to the accelerometer are changed

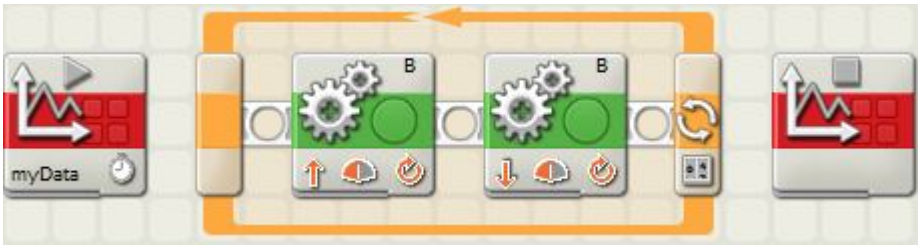

Image 3

ADA Description: Program for lego arm with accelerometer

Caption: Program for data logging with accelerometer

Image file name: Centripetalacceleration _image3.jpg

Materials List

Each group needs:

- Lego NXT Kit
- One NXT Bricks per group
- Accelerometer
- One laptop for data logging

To share with the entire class:

- Computer with NXT MindStorms programming software
- Computer with NXT MindStorms Data logging Program

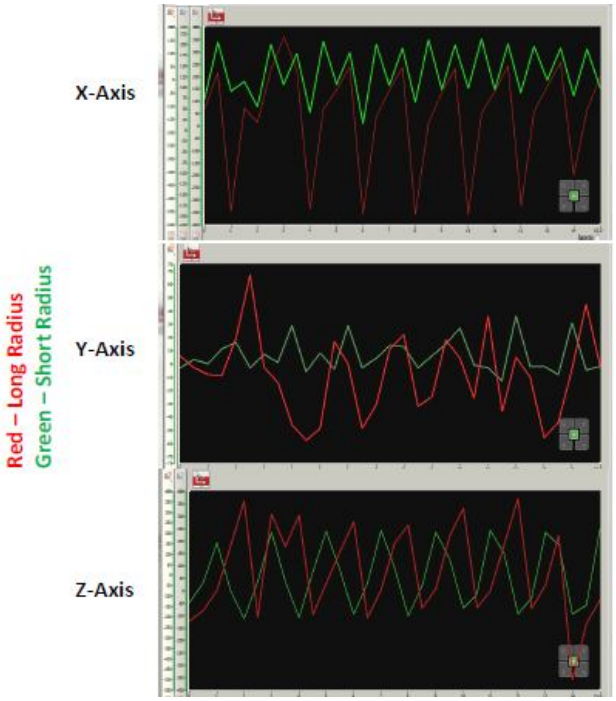

Image 4
ADA Description: Data logging results
Caption: Accelerometer results from data logging show tilt across 3 axes
Image file name: Centripetalacceleration_image4.jpg

Introduction / Motivation

One of the most common problems with students and robotics is that they do not know how to acquire data and how to read graphs. Students often generate results from their

experiments but they do not know exactly how to read their graphs and what they mean. This activity will allow students to see their graphs while they are running their experiment at the same time.

In this experiment, we plan to enrich the students' knowledge physics/ robotics and merge it with the data logging features that Lego Minds offers. Students will have a chance run experiments on their robots after they change the location of the accelerometer. They will learn terms such as force, centripetal force, centripetal acceleration, accelerometer and data logging.

Vocabulary/Definitions

Word	Definition
Force	The push or pull on an object, which may change the shape of the object
Centripetal Force	A force that makes an object follow a curved path
Angular Velocity	Is the magnitude of the rotational speed and is usually measured in radians/ second
Centripetal Acceleration	Is the acceleration that is directed towards the center of the circle
Accelerometer	Measures the change in G-force across the three different axes in the range of -2g to +2g with a scaling of 200 counts per g.
Data Logging	Records data over time via external sensors

Procedure

Before the Activity

1. Students will work in groups the entire time
2. Student will learn about the parts of the robots and the lego mindstorms programming.
3. Students will learn how to record data from data logging using the sensors that are available to them.
4. Ask students to plug in the accelerometer into port four of the robot and ask them if they notice a change in the view option of the NXT brick by clicking the ultrasonic option. If they see a change in the view mode, then the accelerometer is working.
5. Ask students to build their robot arm and tell them to make sure it can move back and forth in a curved path, so they can measure the amount tilt in the robot across the three axes.

With the Students

1. Have students check the robot arm they made and tell them to make sure that the robot follows a curved path.
2. Have the students open up the Lego Mindstorms and the Data Logging program.
3. Have the students program their robot to go back and forth in a curved path.

4. Have the students attach their accelerometer to the robot and ask them to plug the accelerometer into port four.
5. Have the students position their accelerometer along different locations of the robot arm and ask them to monitor the tilt across the three different axes in the data logging program.
6. Then have students plot their results and ask them if there is an equation that relates to the results they obtained.

$$V = \omega r \qquad \text{(Eq. 1)}$$

$$a = \omega^2 r = v^2/r \qquad \text{(Eq. 2)}$$

7. Once the students come up with the equation ask them to connect their results to the equations Eq. 1 and Eq. 2.
8. Ask the students to change the mass on the arm and have them monitor the accelerometer across the three axes with the data logging.
9. Ask the students connect their results to mathematical equations.

Attachments

Accelerometer_Centripetal_Acceleration_Teach Engineering.doc
Accelerometer_Centripetal_Acceleration_Teach Engineering handout.doc
Centripetalacceleration _image1.jpg
Centripetalacceleration _image2.jpg
Centripetalacceleration _image3.jpg
Centripetalacceleration_image4.jpg

Safety Issues

- None

Troubleshooting Tips

Make sure that the arm move back and forth in a circular path

Investigating Questions

How does the accelerometer measure the change in g across the three axes?
How does the design of the robotic arm affect the centripetal acceleration? What features in the robotic arm are important for a high acceleration?

Assessment

Pre-Activity Assessment

Guessing game: Ask them to predict what features are important for a high acceleration.

Activity Embedded Assessment
Design a robot: Tell the students to make a connection between the robotic feature and the equation.

Post-Activity Assessment
Tuning the equation: Ask the students how the centripetal force would change when the radius of the arm changes or when the weight on the arm changes?

Activity Scaling
- For lower grades: 9th grade
- For upper grades: 12th grade

Additional Multimedia Support
None

Other

None

Redirect URL

http://gk12.poly.edu/amps/

Owners
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Contributors

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