Measure Angles with an Accelerometer

Materials: L-g Accelerometer, Go!Link, Logger Lite, Computer, Fathom

Groups: Teachers need to be in groups of 3-4. Roles include: accelerometer experimenter, person to set up and turn on experiment in Fathom, and recorder (to have activity open on their computer).

Mathematical goals:

- For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity*. (F-IF.4.)
- Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.* (F.IF.5.)

Technological goals:

- Teachers will be able to set up experiment in Logger Lite using an accelerometer
- Teachers will be able to export their data as a csv file
- Teachers will be able to import their data into Fathom
- Teachers will be able to create tables and graphs in Fathom based on their data

Lesson Outline:

Background:

An accelerometer is a device that measures acceleration. Acceleration can be static, such as the force of gravity that keeps us from flying off into space, or dynamic such as a moving car or falling object. The acceleration due to gravity is about 9.8 m/s^2. Accelerometers have a variety of uses. Car manufacturers have begun installing them in cars to deploy airbags in a crash. Also, some laptop computers have accelerometers to shut down the hard drive if the computer is dropped, in order to try to preserve the data.

Set up the experiments in Logger Lite.

1) Open a new Logger Lite Window
2) Connect the low-g accelerometer to the Go!Link cable and connect to your computers USB port.
3) Go to the “Experiment” menu and choose Data Collection.

4) Set the Length to 10 seconds and your sampling rate at 20 samples/second.
5) Click the green collect button to run your experiments. Run a few experiments while considering the questions in the following section.

Make Predictions and Conjectures:

Discuss with your group the following questions. Record your answers.

1) Play with your accelerometer. What do you notice?

2) There's an arrow on your accelerometer. Why might this arrow be important?

3) The accelerometer detects different accelerations when it's tilted at different angles. Why might this be so?

4) How does it need to be tilted to increase the acceleration? To decrease the acceleration?

Running Experiment and Exporting it to Fathom

1) Run an experiment in which you rotate the accelerometer one full vertical circle (changing it's tilt) in the 10 seconds.
2) Go to File→Export As→CSV
3) Save this file to your computers desktop (not in the VCL)
4) Open Fathom file *Angles With Accelerometer.ftm.*
5) Go to File→Import→Import From File… and choose you the file you saved from Logger Lite
6) Now you have a collection with your data in it
7) With your collection highlighted, drag a table from the menu bar. You should see your data in the table.
8) Create a new attribute in the table. Call it "Angle."
9) Right click (control click on Mac) on the attribute angle and choose Edit Formula. Cut and paste the formula from the text box.
10) Create three graphs Time vs. Acceleration, Time vs. Angle, and Acceleration vs. Angle.

Making Sense of the Data

1) How do your graphs relate to the tilt of the accelerometer?
2) What point on your graphs represents zero acceleration? How were you holding your accelerometer at this point? Click on this point and see what happens. (Notice the bottom right hand corner of the Fathom window too.)
3) What's the maximum acceleration possible? Where is this on the graphs? What does this value represent? Click on the point and see what happens.
4) What values are possible for the angles?

5) What's the acceleration on the accelerometer is it's tilted at 55 degrees? At what time did this happen?
6) When the angle is increasing what's happening to the acceleration? When it's decreasing? When it's zero?
7) Make three other observations or conjectures based on your data.

Conclusion

The low-g accelerometer measures the static acceleration due to gravity acting upon the device. Gravity "pulls" it towards the center of the Earth, thus perpendicular to the ground. All objects on Earth experience the force of acceleration due to gravity. Unless there are forces to balance this force an object will fall.

Suppose an object is on an inclined plane. If the plane is flat the object won't move at all (the forces are balances). If the plane begins to tilt the object will begin to slide down the ramp, depending on the angle of incline. Why? If the ramp is vertical the object free falls from the ramp and is exposed to the force of gravity (9.8 m/s^2) with the ramp to counteract it at all.

For Further Exploration:

Swing the accelerometer around in a vertical circle and see what happens. Because the low-g accelerometer detects only -5 to +5 g's ($g=9.8m/s^2$) you'll max out the sensor if you swing it too fast. What do you notice? Offer three conjectures based on your results.