

## Fun with Wii-motes

Wii-motes are the remotes that work with the Nintendo wii consol. Students love seeing something they play with at home being used for serious experiments at school.

The wii mote contains three accelerometers, one in each of the three spatial directions<sup>1</sup>. The wii mote will connect wirelessly to a computer which is Bluetooth compatible. Free programs can be downloaded from the internet that will display the data collected by the wii mote. This means that the wii mote can be used as a relatively cheap wireless accelerometer. This can be very useful for measuring the acceleration in things like a model car crash.

A free program that runs on Macs is called DarwiinRemote and can be downloaded from:

<http://sourceforge.net/projects/darwiin-remote/>

For a windows machine you can use the program WiinRemote that can be downloaded from:

<http://onakasuita.org/wii/index-e.html>

*Troubleshooting tip:* If the program will not detect the wii mote make sure that the Bluetooth port is turned on.

### Relevant points from Physics Syllabus:

Point from the year 11 and 12 physics syllabus:

P and H 11.3 c) identifying technology that could be used during investigations and determining its suitability and effectiveness for its potential role in the procedure or investigation

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<sup>1</sup> “The accelerometer is an Analog Devices ADXL330. The ADXL330 is a 3 axis linear accelerometer with a range of +/- 3 g and 10% sensitivity. The chip has a small micromechanical structure of silicon springs and a test mass. Differential capacitance measurements allow displacement of a tiny mass to be converted into voltage. This measures the net force of the mass on the springs, with a rest measurement of +g and a freefall measurement of approximately 0g, i.e. acceleration is measured in a freefall frame of reference. (WiiLi contributors, 2008)” From: Wiggins, Henry Owen, Gesture Recognition of Nintendo Wiimote Input Using an Artificial Neural Network [sites.google.com/site/kindjie/GestureRecognitionofNintendoWiimote1.pdf](http://sites.google.com/site/kindjie/GestureRecognitionofNintendoWiimote1.pdf)

P and H 12.2 a) using appropriate data collection techniques, employing appropriate technologies, including data loggers and sensors

### **Moving about:**

2. -analyse the effects of external forces operating on a vehicle
  - gather first-hand information about different situations where acceleration is positive or negative
  - plan, choose equipment or resources and perform first-hand investigations to gather data and use available evidence to show the relationship between force, mass and acceleration using suitable apparatus
  - solve problems and analyse information involving  $F = mv^2/r$  for vehicles travelling around curves
5. -assess the reasons for the introduction of low speed zones in built-up areas and the addition of air bags and crumple zones to vehicles with respect to the concepts of impulse and momentum
  - identify data sources, gather, process, analyse, present secondary information and use the available evidence to assess benefits of technologies for avoiding or reducing the effect of a collision

### **Space**

1. -perform an investigation and gather information to determine a value for acceleration due to gravity using pendulum motion or computer-assisted technology and identify reason for possible variations from the value  $9.8 \text{ ms}^{-2}$
2. - analyse the forces involved in uniform circular motion for a range of objects, including satellites orbiting the Earth

### **Suggested Activities:**

#### **Circular motion:**

This is an easy way to demonstrate the direction of the acceleration in circular motion.

$$a = v^2/r$$

Swing the wii mote in a circle. Make sure that  $a < 5g$  (a good chance to discuss  $g$  forces), as the wii mote will not detect accelerations greater than  $5g$ , and is most accurate between  $\pm 3g$ . This can be a quick demonstration of the direction of the acceleration.

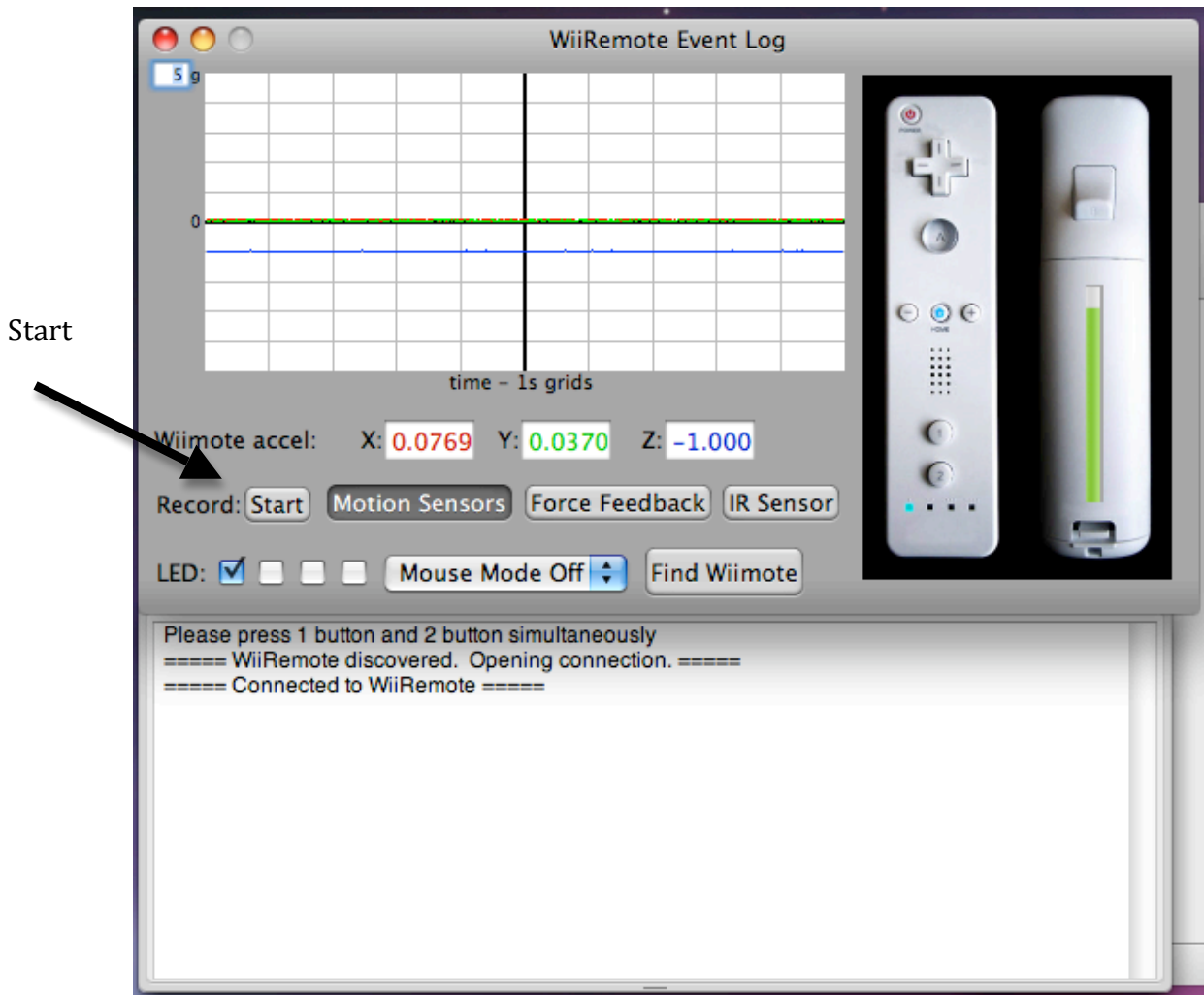
### *An experiment:*

Students should keep  $a$  constant. A value of  $a = 3g$  is a good one to choose. Students can change the radius of the circle by tying a string to the wii mote. They can observe the acceleration of the screen and at each radius swing it at the correct speed to have  $a = 3g$ . In order to calculate  $v$  the students will need to measure the period,  $T$  (more accurate to measure  $10T$ ) and then use speed = distance  $(2\pi r)/T$ . Students can then plot  $v^2$  vs.  $r$  and confirm that the gradient is  $a = 3g$ .

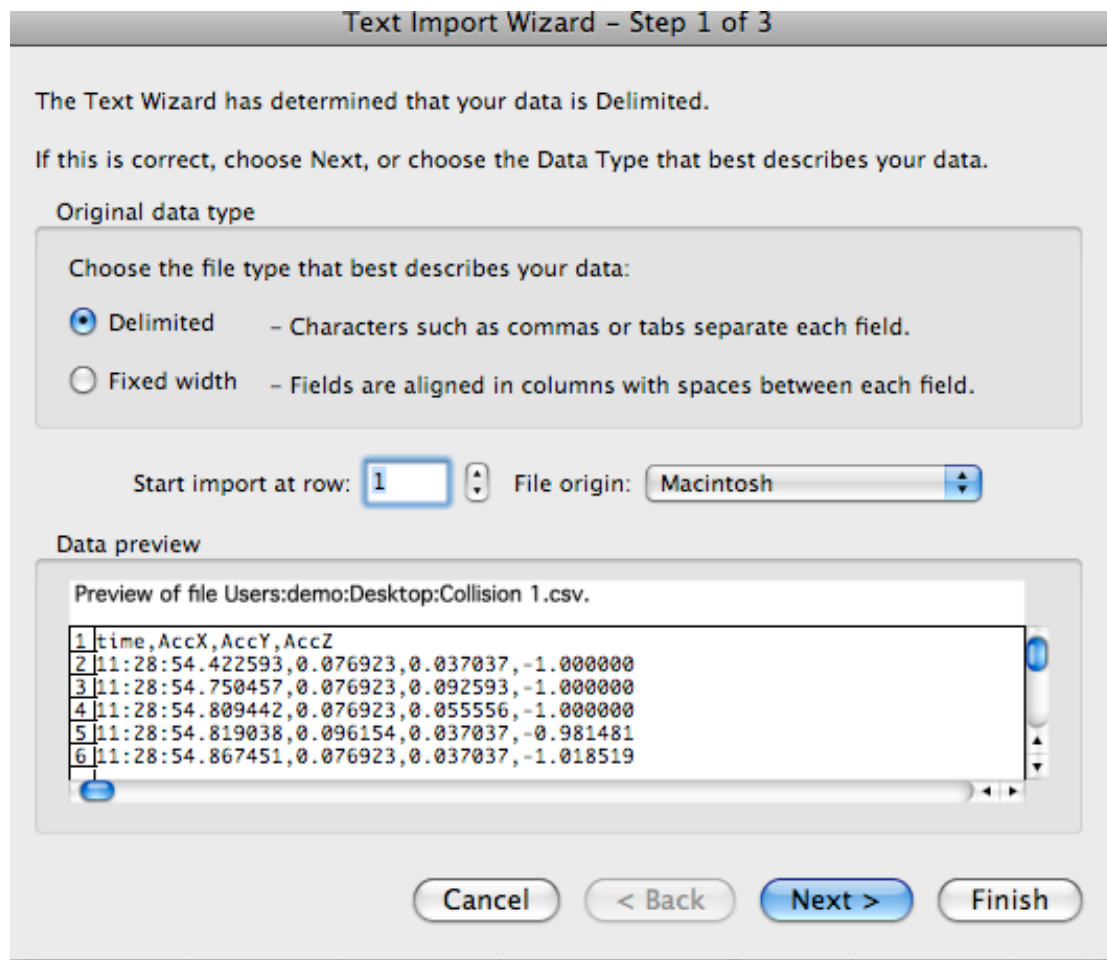
This experiment is much easier to perform than the common one with hanging masses.

### **Impulse**

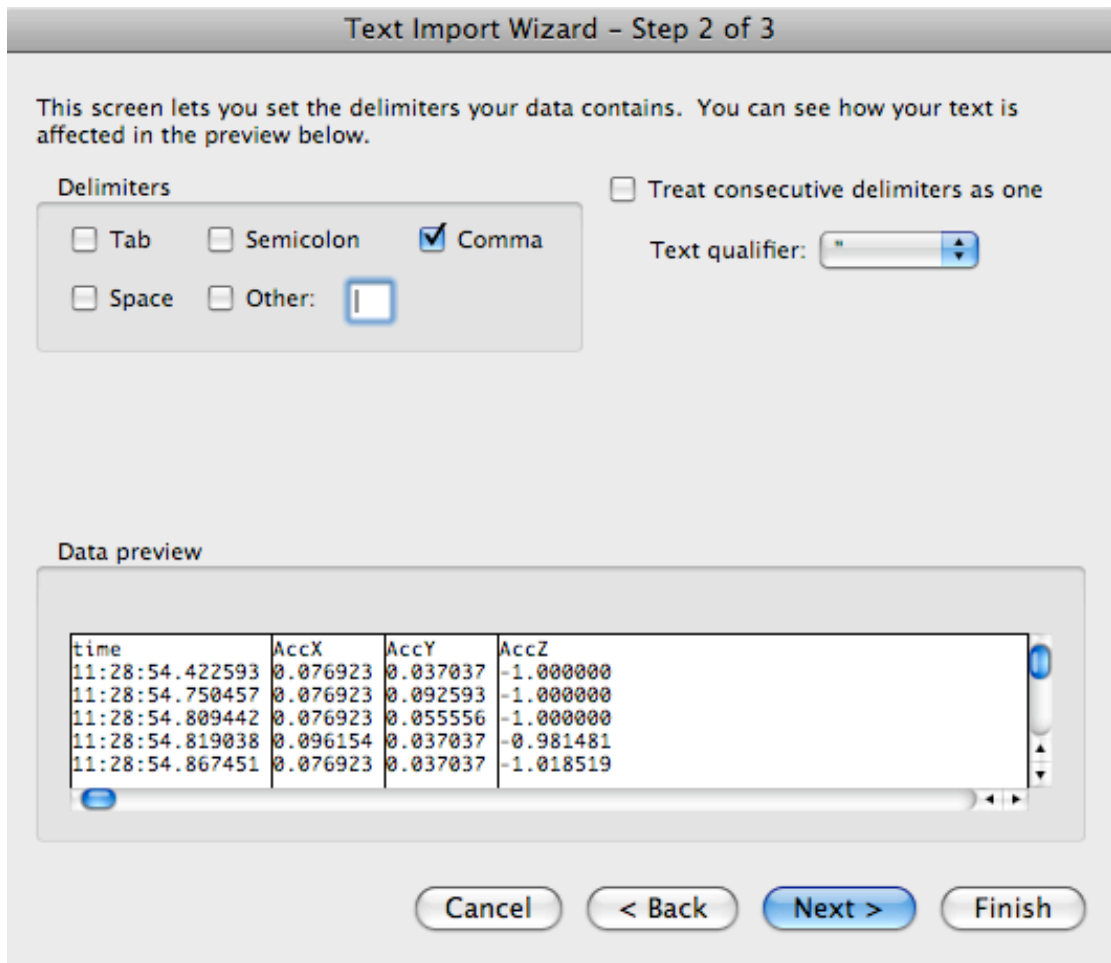
Stick the wii mote firmly to the back of a cart/truck. You can use rubber bands and/or blue tack to do this. It is important that the wii mote does not move about when the cart collides with something. Set up a track that the cart can run down and collide with a barrier at the end. Test this out a few times, make sure that the wii mote shows the collision as a spike. The track should not be too steep as the wii mote works most effectively for accelerations below  $3g$ . You are now ready to collect some data. To do this hit "Start" on the DarwinRemote program.



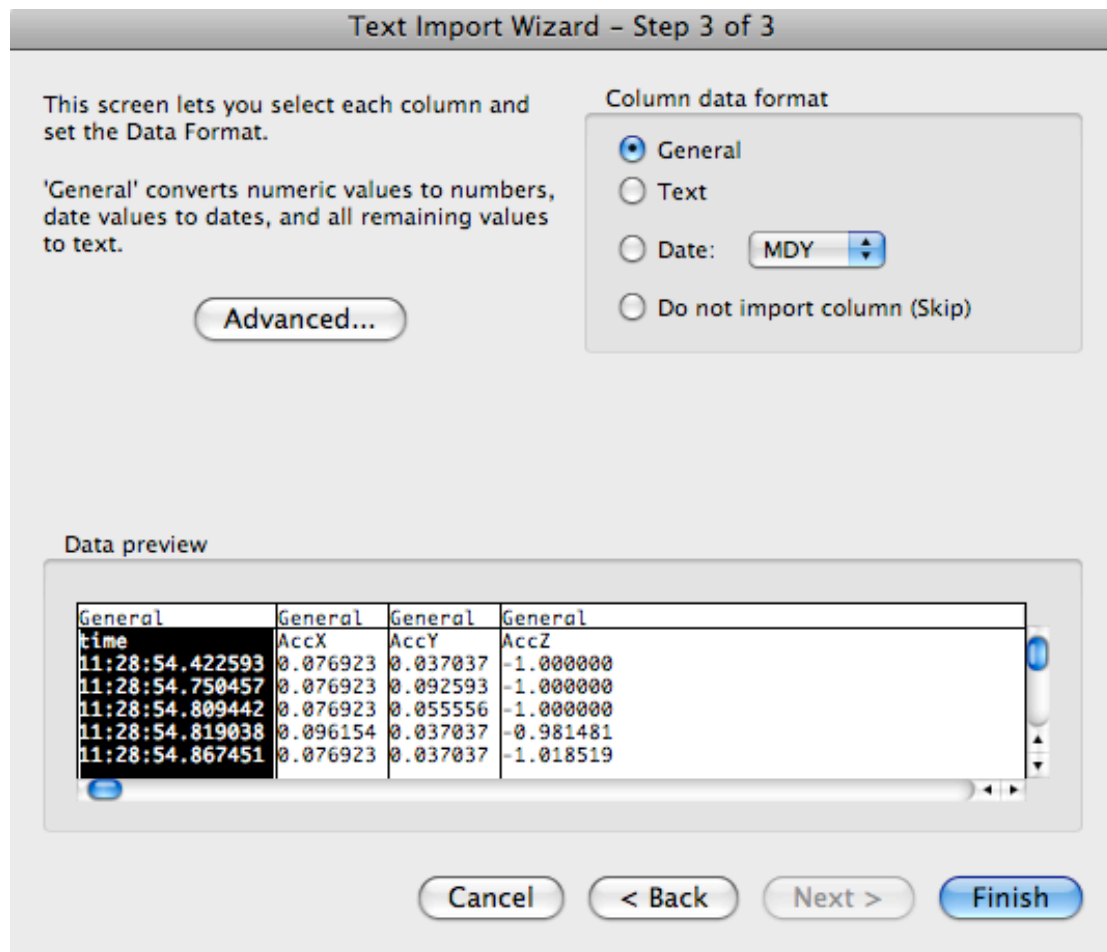
You will then need to enter the location you wish the data to be save to. Once this is done start the cart rolling down the track and record data for the collision. When this is done you want to open the data in excel so that you can analyse it. In order to do this you need to save the data as a ".csv" file. Open the file and use "Save as", call it something like "collision 1.csv". Then open excel and select "import" from the "file" menu. Select "CSV file". Then "Delimited" as shown in the picture below:



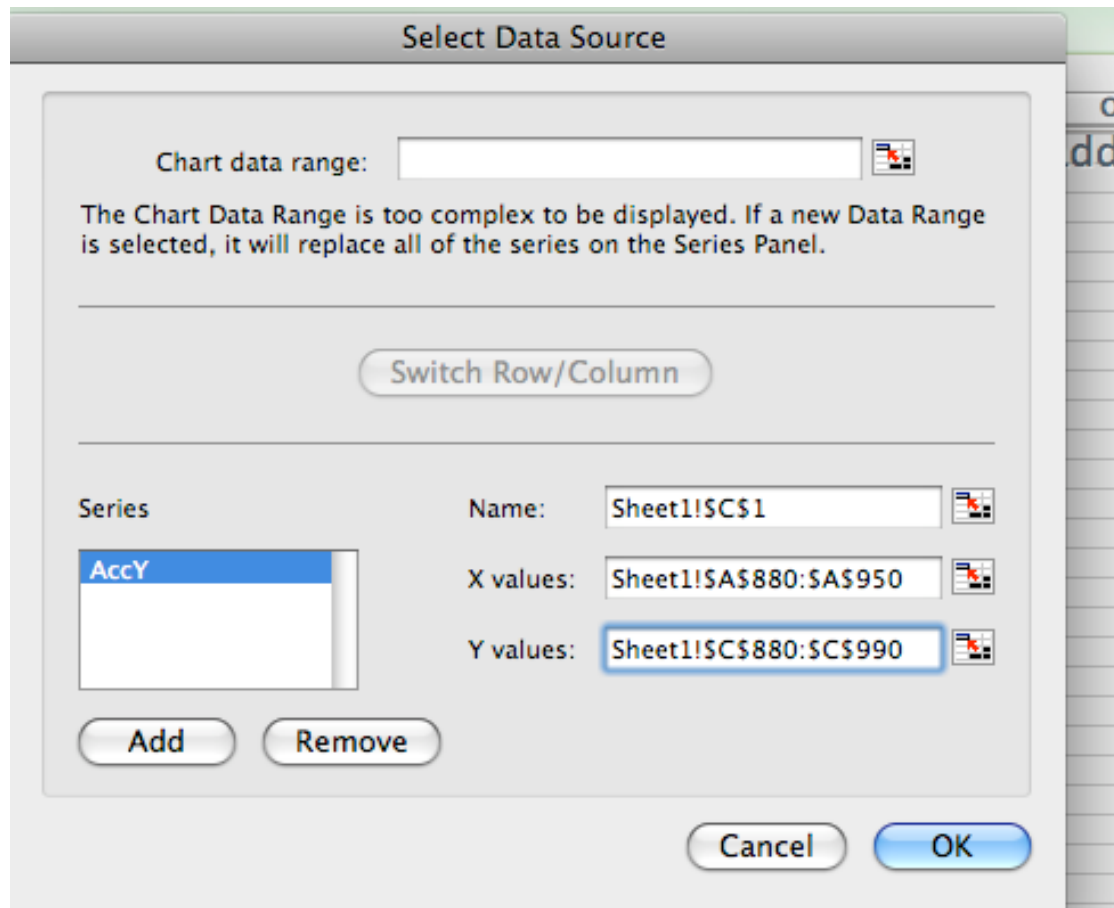
Your delimiters are commas so just select "Comma"



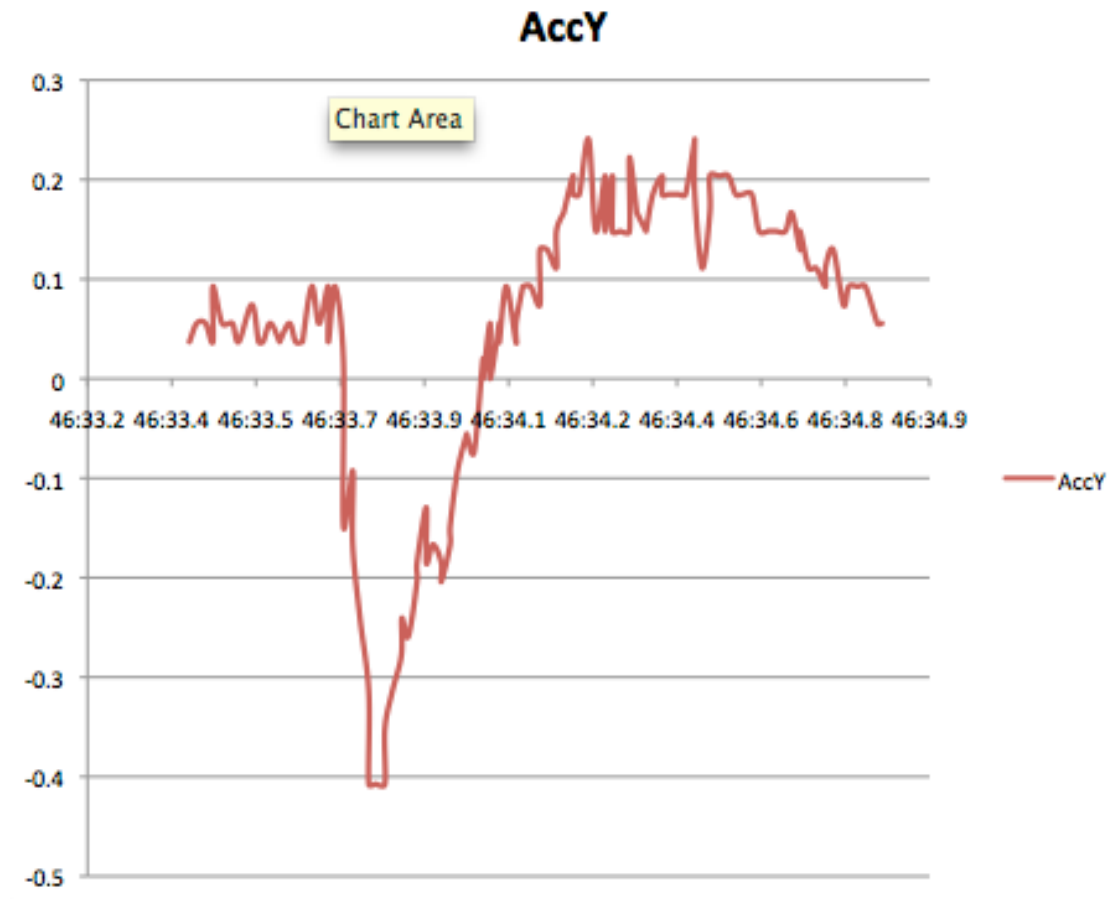
For "column data format" select general:



And now your data should appear. Look at the data to find the part where the collision occurred. This is the part you will want to graph. To graph it choose "Insert Chart". Select an XY scatter chart. Your chart should appear on the screen. However, it will show the data from all three accelerometers. You need to select just the accelerometer you are interested in and also just the time around the collision. Click on the chart and choose "select data". Remove the lines you are not interested in and select the appropriate cells, next to X values and Y values.



When you have done this your chart should look something like this:

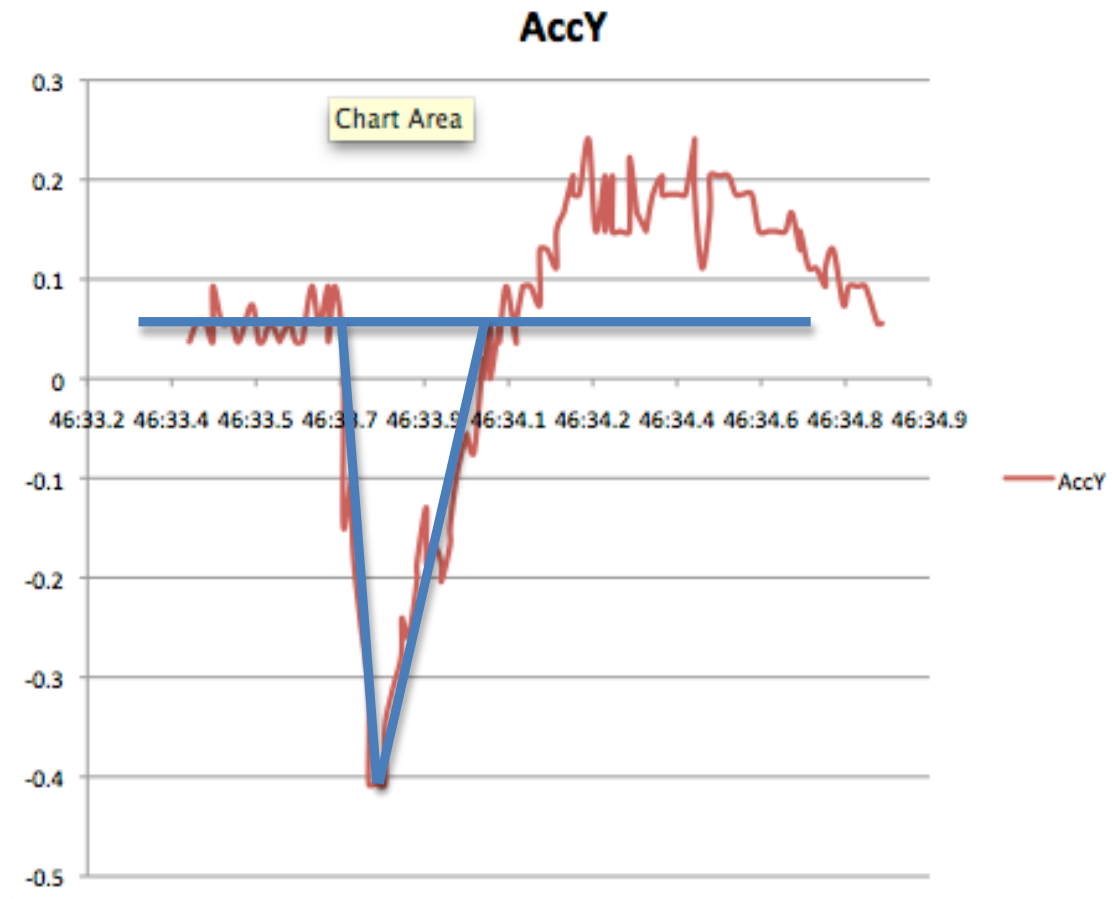


You can now estimate the impulse.

Impulse = force x time

And force = mass x acceleration (Newton's second law)

Impulse is the area under the acceleration/time graph x mass of the cart.  
Print out the graph and draw a triangle over the relevant section:



Use the area of this triangle to estimate the impulse (ie. multiply the area by the mass of the cart).

The impulse is equal to the change in momentum of the cart during the collision. This should remain approximately constant if the cart comes to rest from the same initial velocity. You should try adding crumple zones to your cart (a soft material such as foam can act as a crumple zone). Collect data for this collision (ie. follow the steps above again). Compare the impulse and the maximum acceleration. *How would this effect passengers travelling on the cart?*

### Pendulum

You can show how the acceleration varies as a pendulum swings by using the wiimote as the pendulum bob. The data can be collected and plotted as outlined above if desired.

Notes compiled by Elizabeth Angstmann, First Year Physics director, UNSW