

Ball Toss

When a juggler tosses a ball straight upward, the ball slows down until it reaches the top of its path. The ball then speeds up on its way back down. A graph of its velocity vs. time would show these changes. Is there a mathematical pattern to the changes in velocity? What is the accompanying pattern to the position vs. time graph? What would the acceleration vs. time graph look like?

In this experiment, you will use a Go Direct Motion Detector to collect position, velocity, and acceleration data for a ball thrown straight upward. Analysis of the graphs of this motion will answer the questions asked above

For the experiment	For measurement and analysis
<ul style="list-style-type: none"> • Volleyball or Basketball • Wire Basket 	<ul style="list-style-type: none"> • Vernier Go Direct Motion Detector • Windows PC, Mac or Chromebook • Graphical Analysis Windows or Mac app, or Chromebook web app

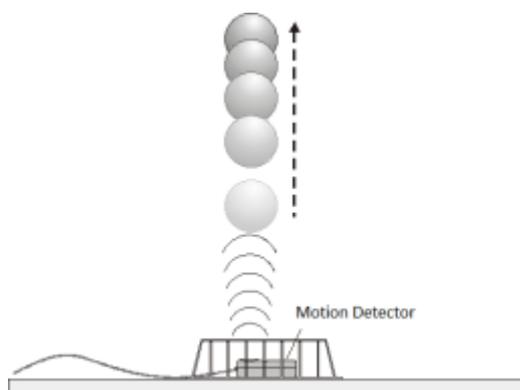
Apparatus

Method

Place the Motion Detector on the floor and protect it by placing a wire basket over it.

Tips to get the best results with you ball:-

- Hold the ball approximately 0.5 m directly above the Go Direct Motion Detector when you start.
- A toss so the ball moves from 0.5 m to 1.0 m above the detector..
- After the toss, catch the ball at a height of 0.5 m above the detector and hold it still until data collection is complete.
- Use two hands and pull your hands away from the ball after it starts moving so they are not picked up by the Go Direct Motion Detector.



Measurement

On the Vernier Go Direct Motion Detector, press the power button once. The LED will blink red. Either connect the Vernier Go Direct Motion Detector to the computer via the USB cable or ensure Bluetooth is enabled on the computer; launch the Graphical Analysis app. From the 'file' icon in the top left of the app window, select 'New Experiment'. A Bluetooth connection will now ask you to choose GDX-MD from a list and select 'done' (note the serial number if you have more than one listed); the LED on your Motion Detector will blink green, indicating that you are ready to record data. A USB connection will take you straight to the graph view and a solid orange LED indicates that the USB connection is made.

You are now ready to record a set of data. First set the Go Direct motion detector as described above with the ball held in place, then select Collect from the top of the graph screen.

Getting started on analysis

Curve fit parameters	A	B	C
Position ($Ax^2 + Bx + C$)			
Velocity ($Ax + B$)			
Average acceleration			

On completion the graph will auto-scale.

On the Position V Time graph select the region where the ball was in freefall. Click or tap graph tools  and choose Apply Curve Fit. Select the Quadratic Equation then Apply. How closely does the coefficient of the x^2 term in the curve fit compare to $\frac{1}{2} g$?

On the Velocity V Time graph select the linear region when the Ball was in freefall. Click or tap graph tools  and choose Apply Curve Fit. Select Linear then Apply. How closely does the coefficient of the x term compare to the accepted value of g ?

On the Acceleration V Time graph during freefall the acceleration should appear more or less constant. Click or tap graph tools  Choose View Statistics How closely does the mean value compare to the acceptable value of g ?

Extension

Perform the experiment with different balls of varying densities, to look at air resistance and buoyancy.