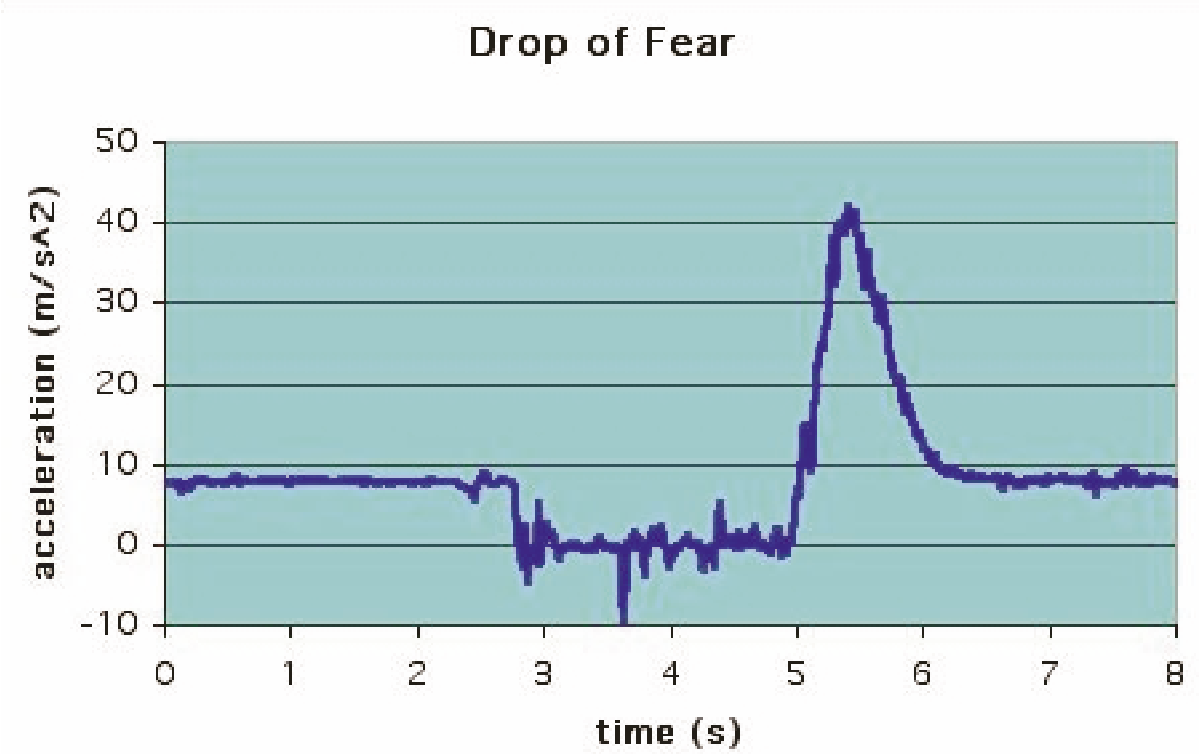
Sample Analysis – The Drop of Fear

The "Drop of Fear" is a free-fall ride. Riders are strapped in a car that is attached to rails on a large vertical tower. The car is then elevated to the top of the tower and "dropped". During the descent, the riders experience "free-fall" before the car is braked to a halt near the bottom of the tower.



The data shown is the graph we collected using the CBL and low-*g* accelerometer. The arrow on the accelerometer was pointed downward. The constant acceleration at the beginning and end of the ride is when the riders are stationary in the car before and after the "drop". Notice that during the drop (between 3-5 seconds) the riders feel no acceleration – a term know as weightlessness. Also indicated on the graph is the large force (over 4 *g*'s at 5.5 s) needed to decelerate the ride after the free-fall.

Advanced Analysis

It is important to understand that the accelerometer data do not represent the net force F, but F + *g*, and to apply Newton's laws accordingly. This should be apparent from the reading of 1*g* (9.8 m/s^2) when the ride is stationary. If the riders are stationary, then there must be no net force. During free-fall, the riders are obviously accelerating (-1*g*). Additionally, even though the riders "feel" weightless, the earth is still pulling on them with a force equal to their weight (hence the acceleration).

To draw more quantitative conclusions, the CBL data can be imported into a spreadsheet program and analyzed. For example, the deviation from 1*g* at the beginning and end of the ride indicates that the accelerometer axis was tilted about 35 degrees from the true vertical direction. Also, the area under the curve during free-fall is equal to the area under the curve during braking. This can be verified using the linear momentum- impulse theorem $\Delta p = \int F dt$ and numerically integrating the data over the different time intervals.