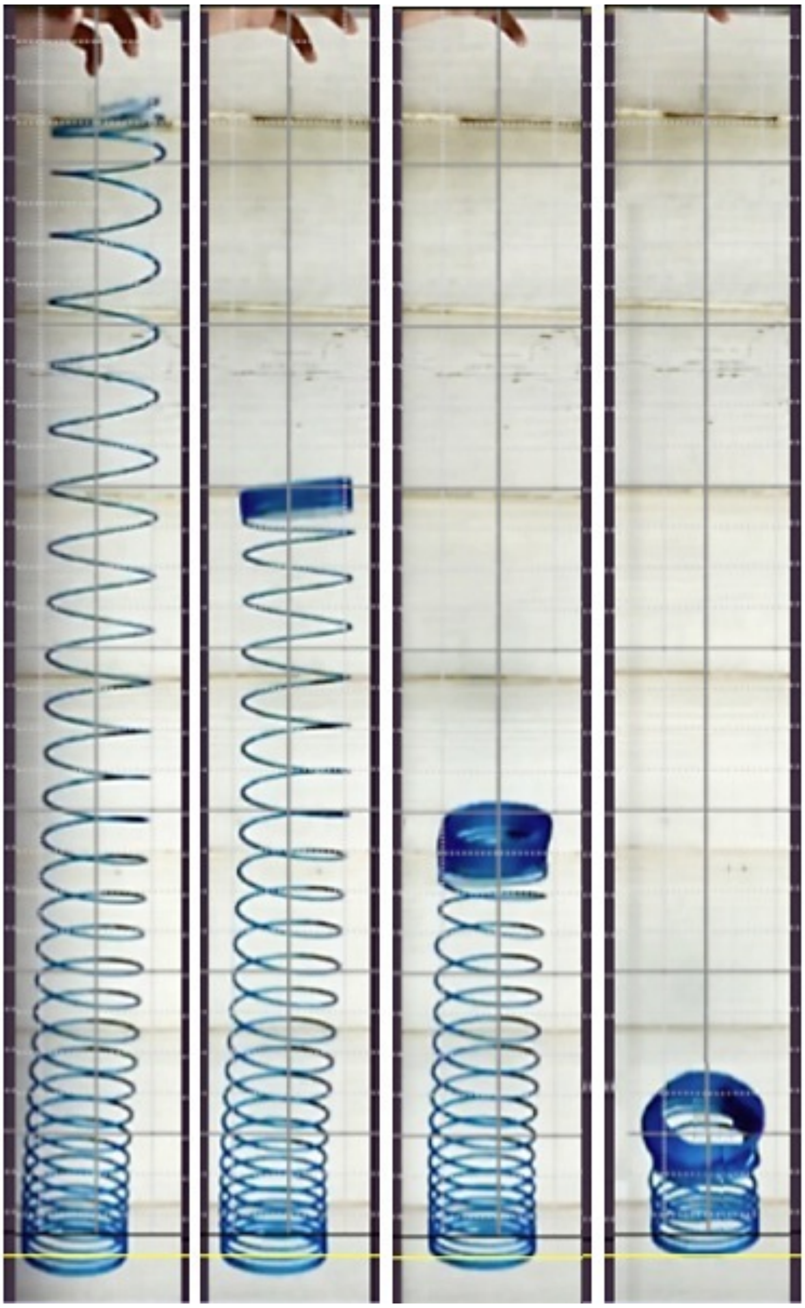
# A falling centre of mass

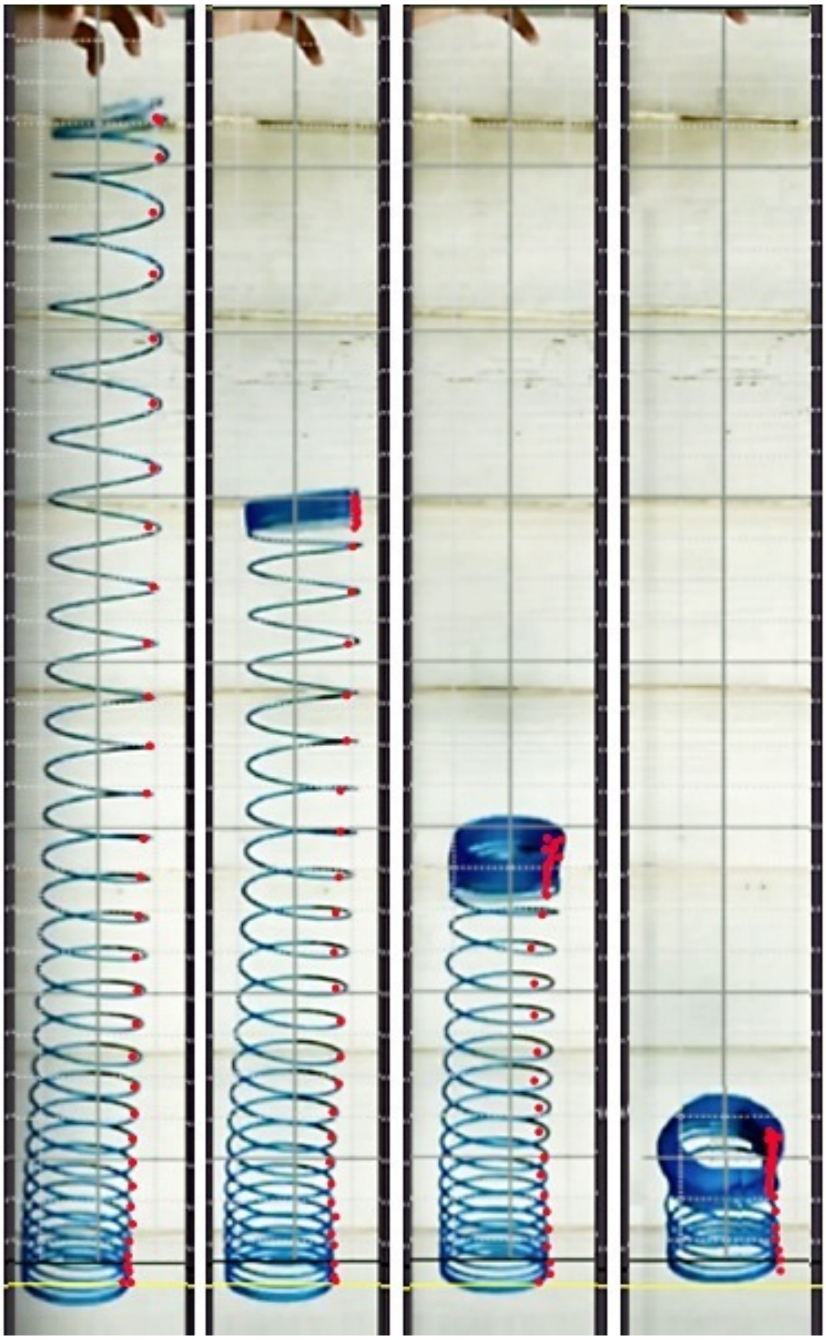
*Shannon and Ian Jacobs*

A plastic slinky (link above) falls in an unexpected way … unexpected because we don't often study or watch the motion of a non-rigid body.



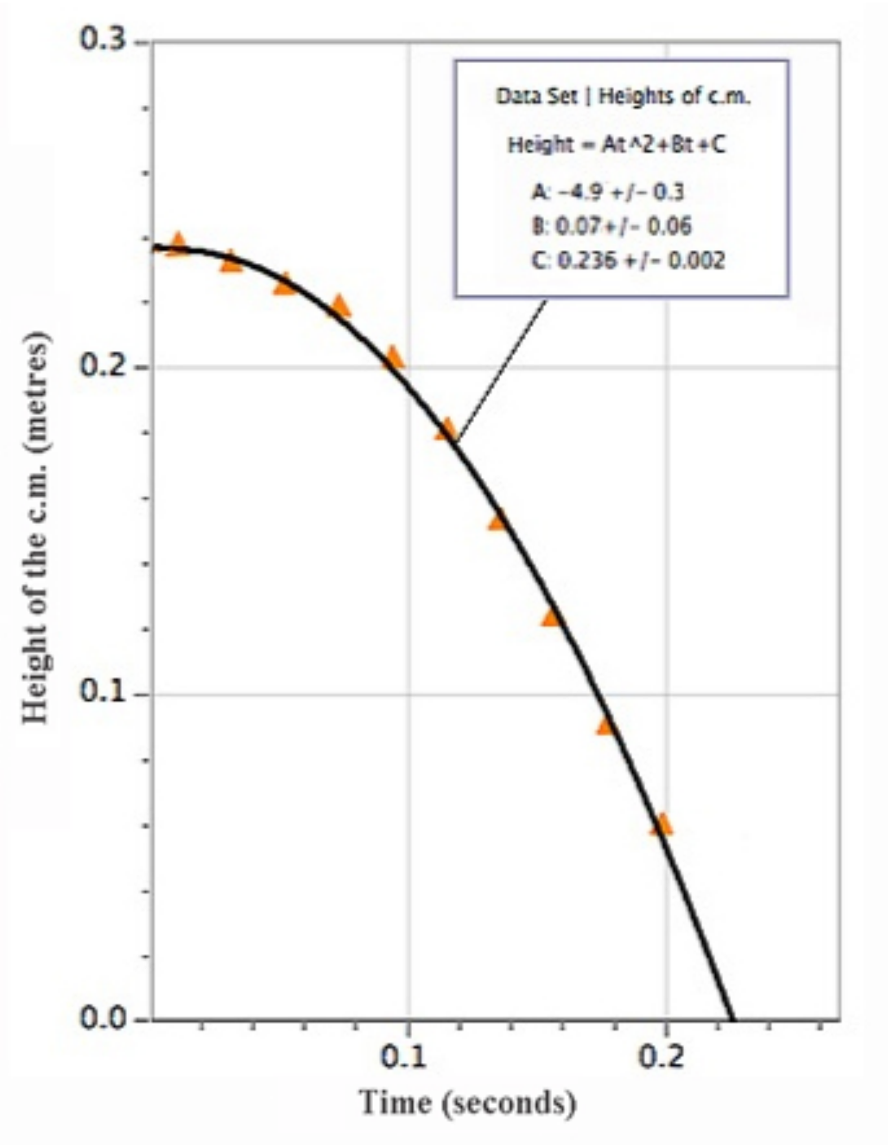
Four frames from the video, at equal time intervals, show that the top rings fall at almost constant velocity as the lower turns remain almost stationary.

We noted in *Centre of mass* (linked above) that the c.m. of a line of equal masses is at their average (mean) distance from any selected point on the line. Distance measurements can be made by clicking on an image in Logger pro (or Tracker) and the computer can then be set to calculate the mean.



Because the lower rings are stationary (the same in each frame) data from column 1 *could* be pasted to later columns, but a mistake would then be propagated through all columns. For that reason a line of dots marking turn positions was put on each frame independently, making sure each data table had 34 data entries.

The centre of mass (the mean distance of rings above the lowest ring) was plotted against time.

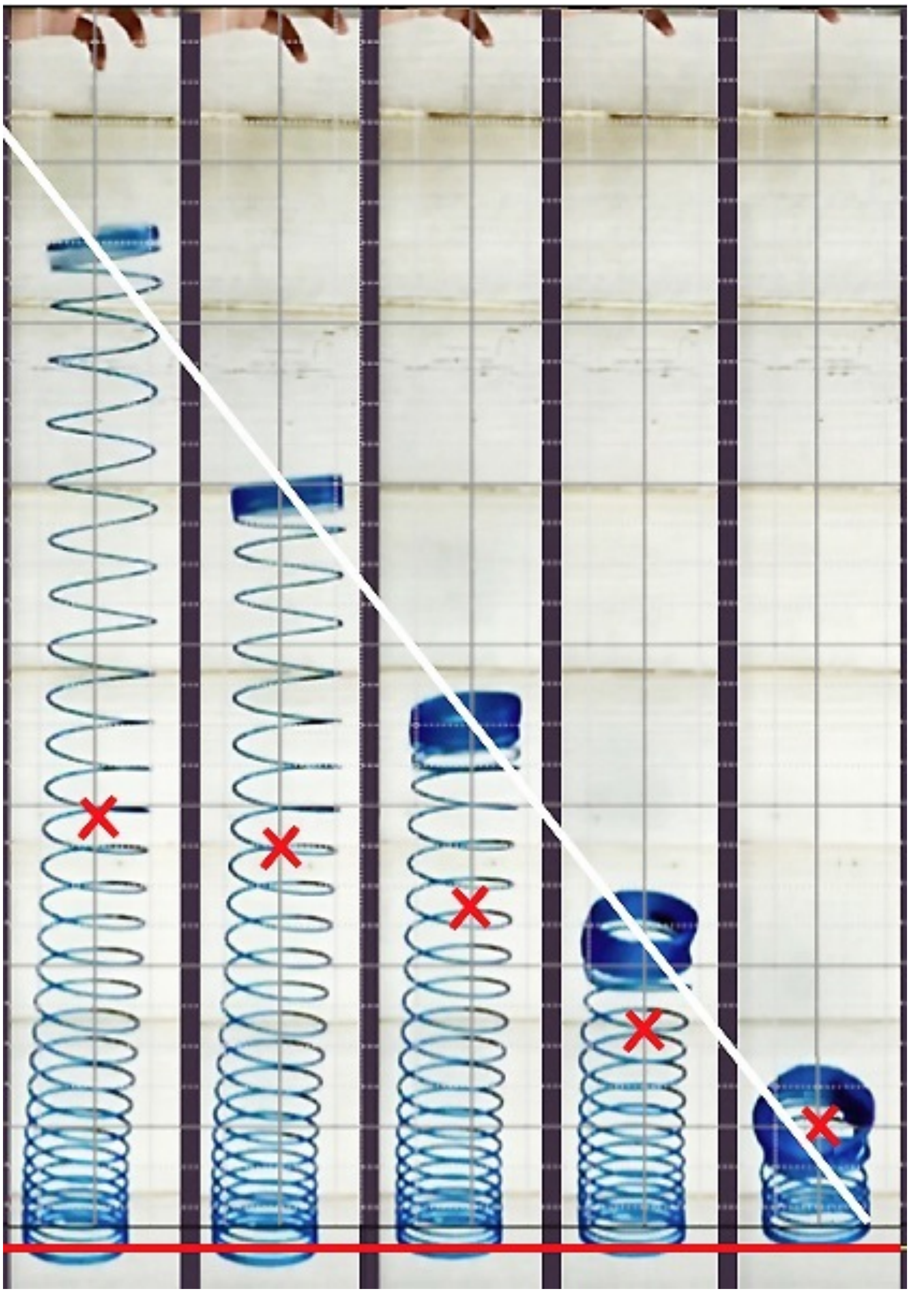



The position of the c.m. as a function of time in seconds.

A computer calculated curve of best fit indicates that the curve is a *parabola,* described by a quadratic function. B is close to zero and C is the intercept on the vertical axis. It is shown elsewhere that the coefficient A in the function $At^2 + Bt + C$ is half the constant acceleration.

> **Note:** the acceleration of the centre of mass, -9.8 m/s/s from the graph, is the accepted value of *g* that all students learn. *The centre of mass does fall like a stone,* but note that a computer calculation of likely uncertainty due to the scattering of points about the line of best fit is ± 0.3 m/s/s. The acceleration of the c.m. has been shown experimentally to be constant and to be between 9.5 and 10.1 m/s/s.

The five selected frames below are separated by equal time intervals. Together they show the almost linear descent of the top turns as they collect together and the calculated positions of the centre of mass, that has been shown to fall with the acceleration due to gravity (in the absence of significant air resistance).



The unexpected feature of this illustration is the slight lifting of the lowest turns before the spring completely collapses. This *second order effect* may be associated with the forward rotation of the upper coils on the right, possibly because the spring is not completely uniform, or the descent may be influenced by increased air resistance between the spring and the wall.