Slinky drop

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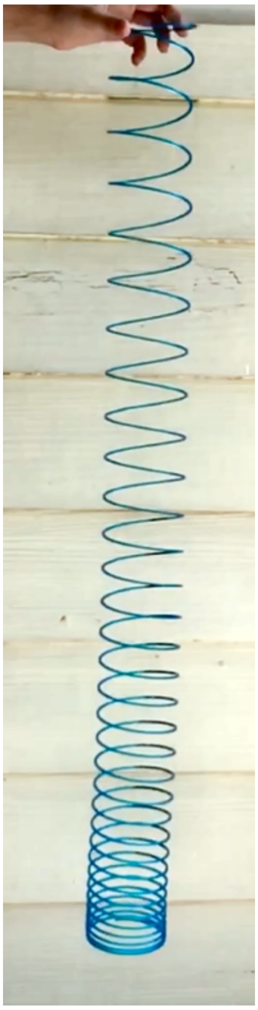
A plastic slinky hangs perfectly still in front of a wall.

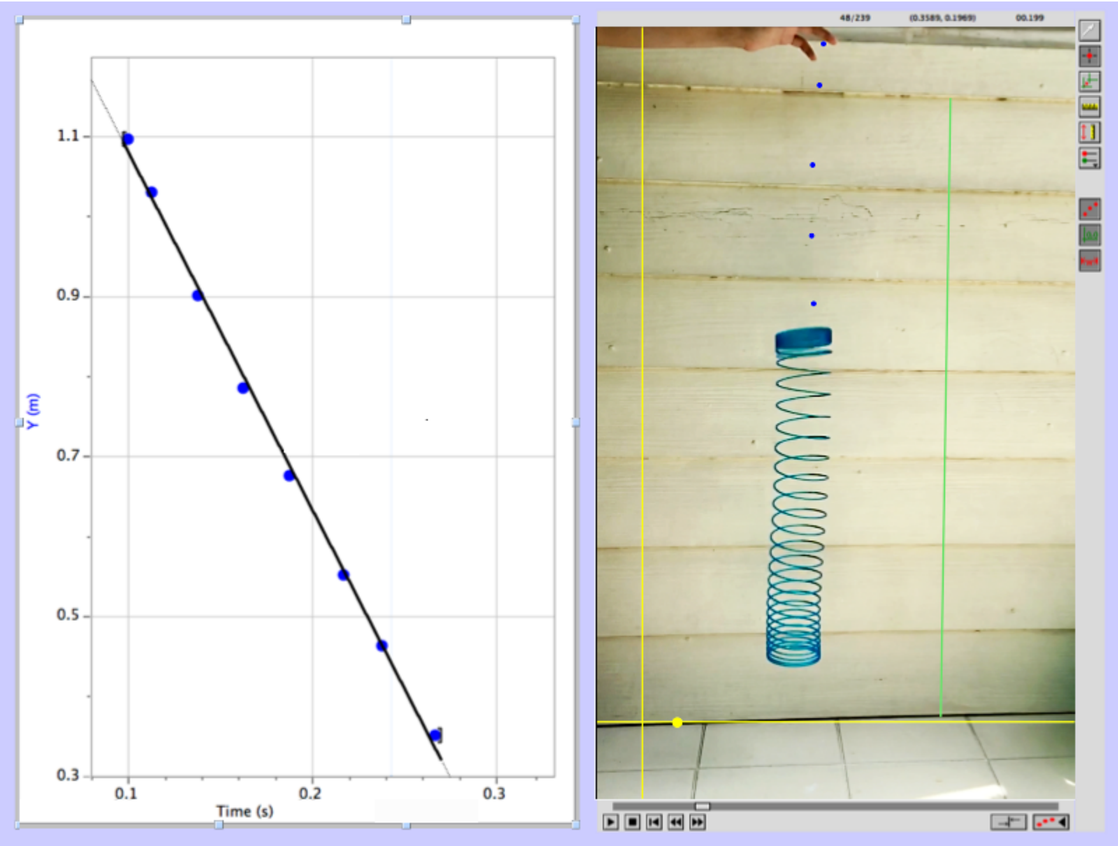


I dropped it.

If you download the pdf you can watch the video here
… or … click the link below this document.

The slow motion video (at 240 fps) is really weird. The top turns collect together and drop downwards. The process keeps going all the way to the bottom. The lower turns stay completely still. The last turn doesn't move at all until it's hit by all the top coils.

We put the video into Logger Pro (a program from Vernier) and plotted a graph showing the position of the top coil as a function of time.



The top turn drops about the same distance each tenth of a second. The velocity is constant and negative (downwards). **That is most odd**. When we drop something normal, like a stone, the velocity increases as it falls and all heavy objects fall the same way.

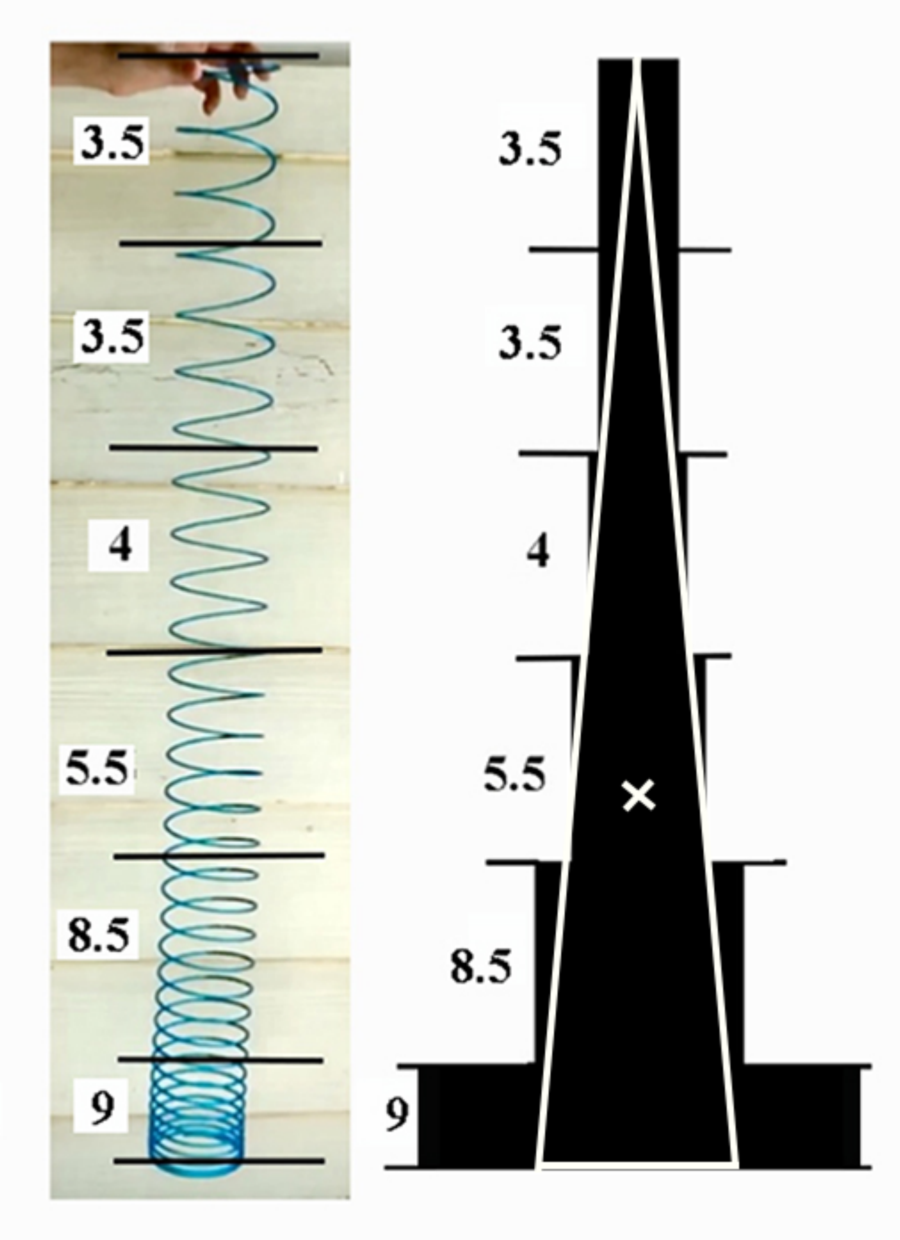
The story is that when Galileo dropped a cannon ball and a penny from the leaning tower of Pisa everyone was astonished to see that they reached the ground at the same time. That's probably just a story, but the physics is right. If they're let go at the same time they land at the same time.

Notice we say **heavy** objects. Unless there is no air to slow it down, a feather goes down slowly and tiny water drops in clouds fall very slowly because of air resistance. *If you drop a bucket of expanded polystyrene balls with diameters from 1 to 50 mm from a high balcony the bigger ones go down faster in order (like raindrops). It makes a nice demonstration but quite a mess to clean up.*

To make sense of the slinky drop, physics types say that …

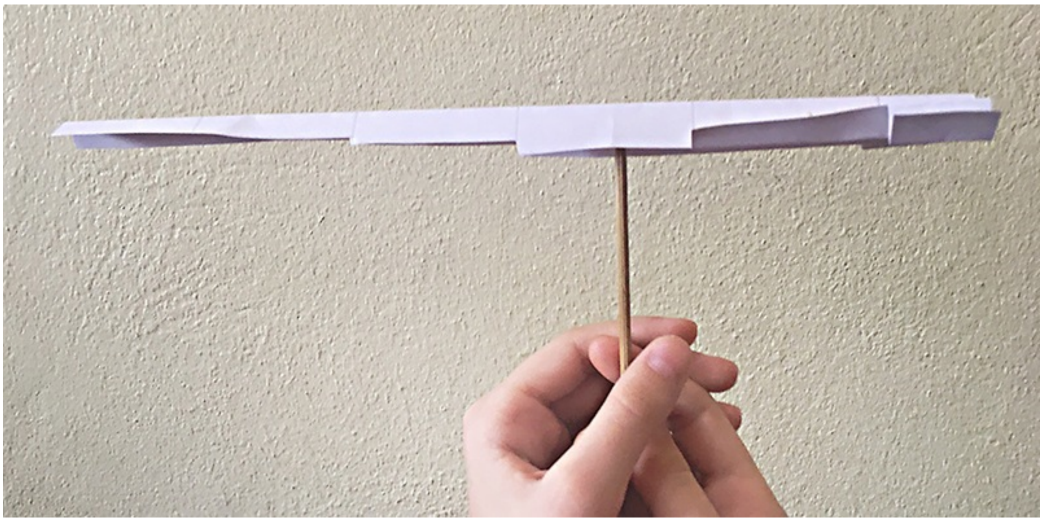
*"Gravity acts on the whole spring and
the centre of mass falls like a stone."*

The approximate number of coils in each length of the hanging spring are shown on the image.

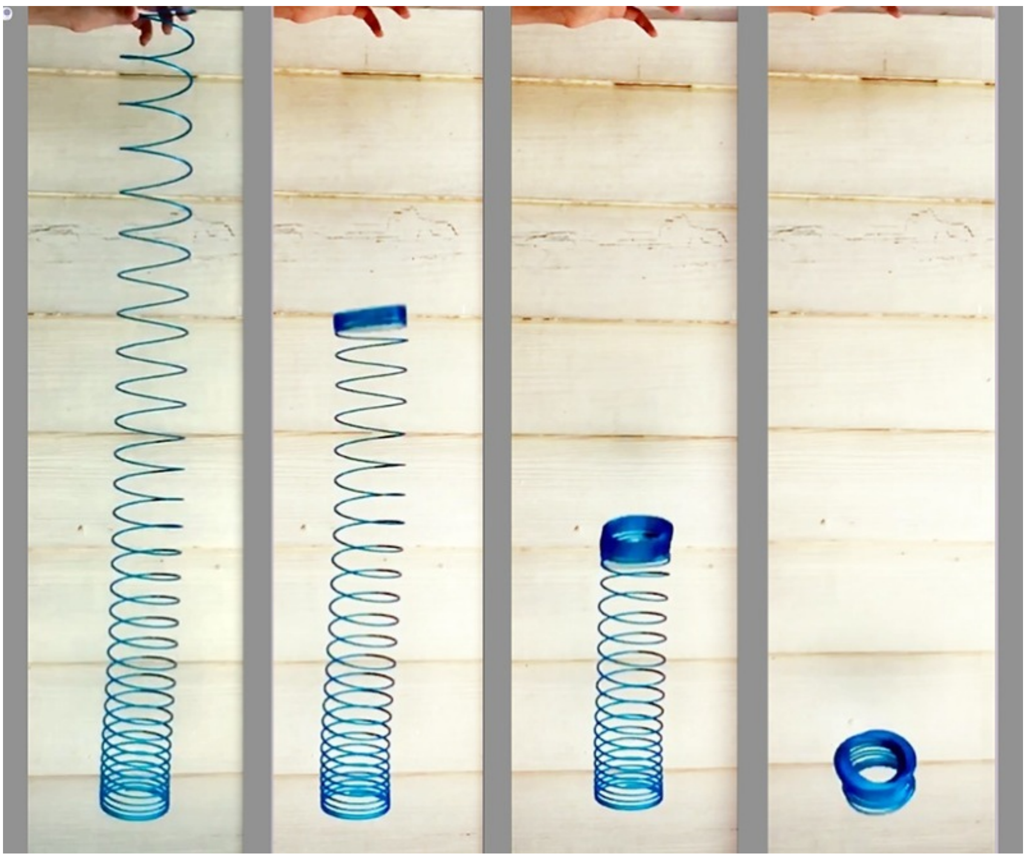


The rectangular areas on the black diagram are in the ratios of the mass of the spring in each length. The centre of mass of the white triangle is marked with a cross, one third of the distance above the base, since the medians of the triangle are divided in the ratio 2:1 by the centroid.

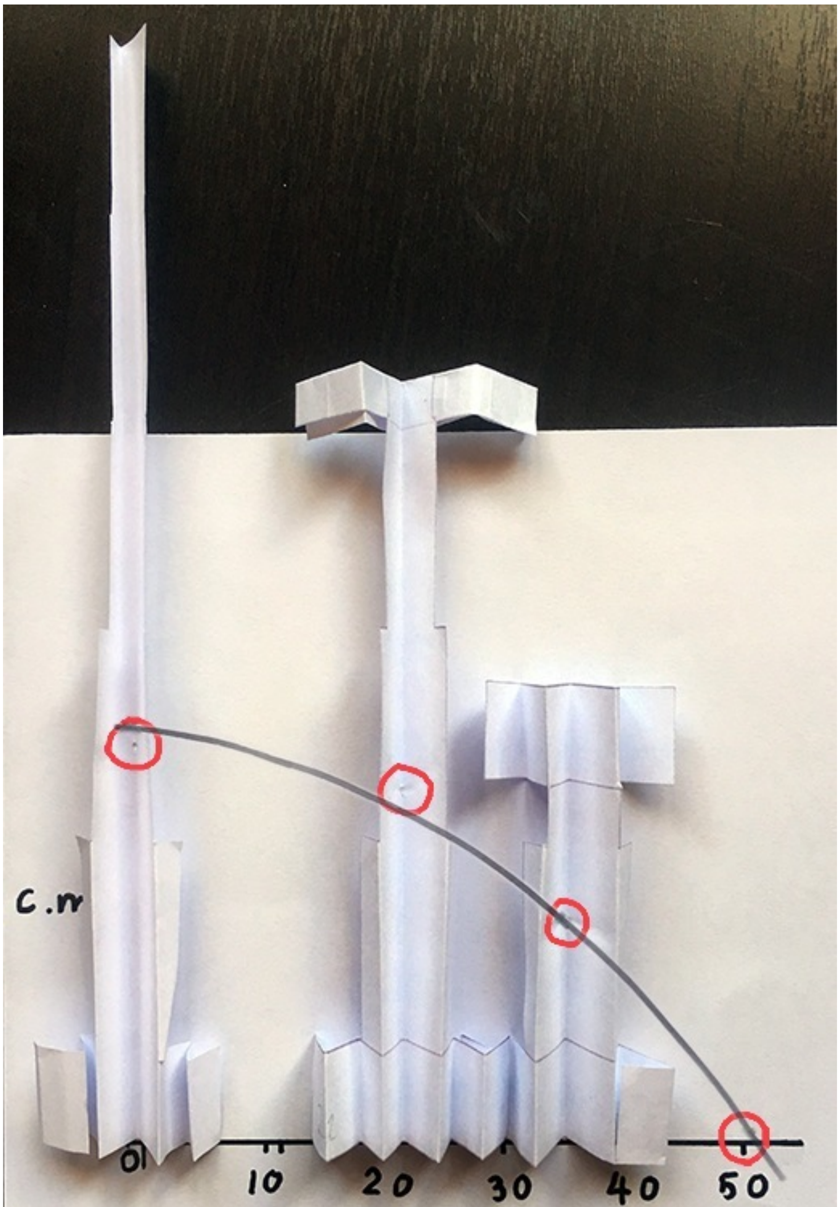
The black pyramid in the diagram above is not a triangle, but the centre of mass will be close to that of the triangle because the extra mass at the top and bottom will have similar effects. The diagram can be printed and the centre of mass of the paper can be found by creasing it lengthwise and balancing it on a point.



This method requires no measurements or calculations and can be used to estimate the centre of mass of the spring at any point in its fall.



The centre of mass of each paper pyramid (found by balancing) is circled in red. The frame number is plotted on the horizontal axis.

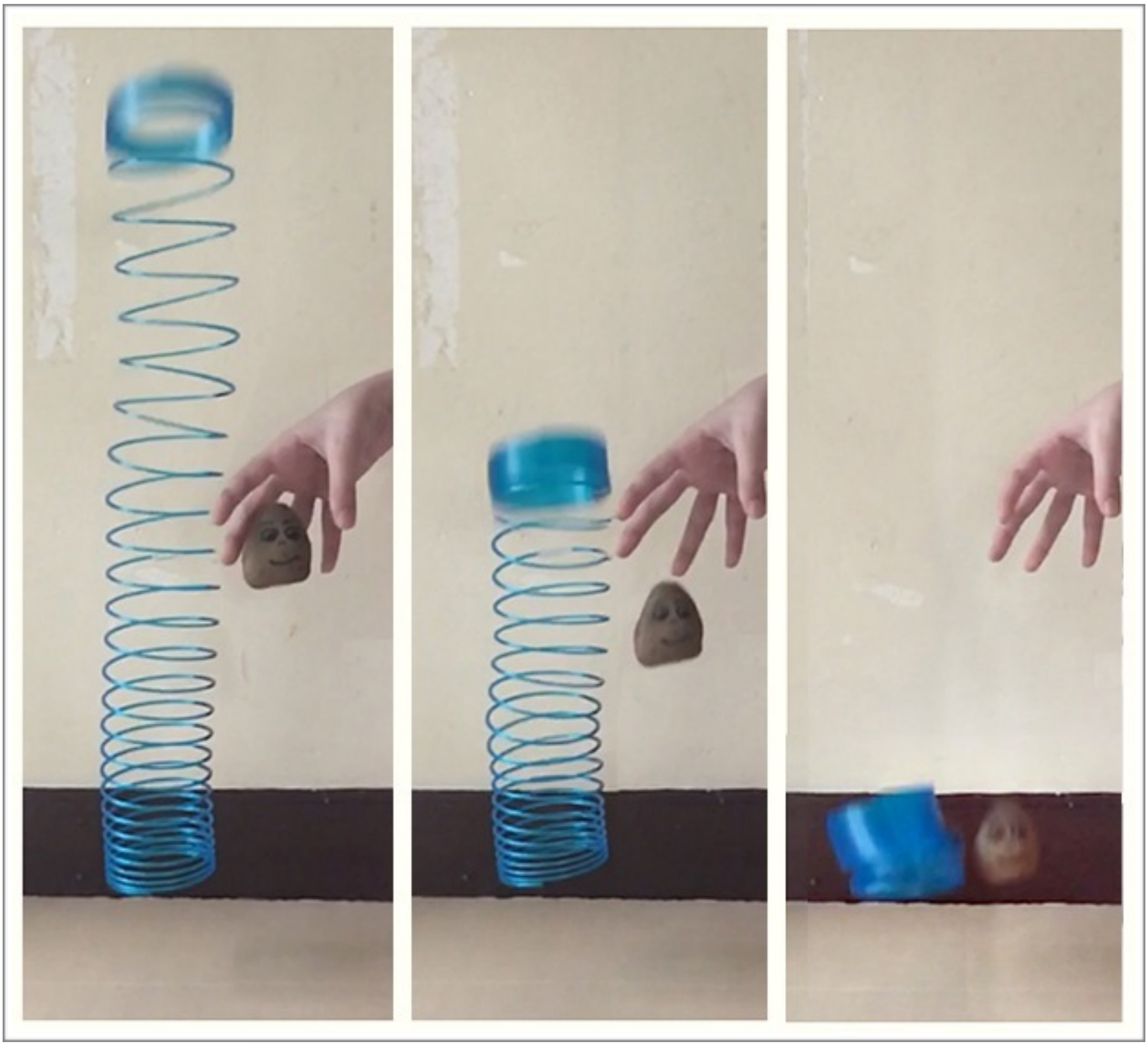


The centre of mass falls as the spring collapses downwards. A smooth curve has been added to the diagram to show the approximate position of the centre of mass of the spring as a function of time.

No calculations have been done for this demonstration. It would be possible to convert the axes to metres and seconds and determine the acceleration of the c.m. but that is left for future work.

To demonstrate that the centre of mass "*falls like a stone*" (that is with the same acceleration), a stone was dropped close to the spring.

Three frames are shown.



Dropping the spring and the stone at exactly the same time is not so easy. The frames have been retouched to synchronise the releases.

We plan to repeat the demonstration with numerical calculation to find the centre of mass as a function of time and find the acceleration of the centre of mass in m/s/s. Assuming air resistance can be neglected, we expect the acceleration of the centre of mass to be g, which is 9.8 m/s/s.