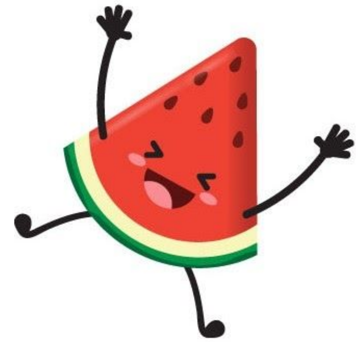
The BIG Watermelon Experiment

Physics, Forces and Flying Fruit



Forces and Implosions

Forces

The entire experiment is really a battle of two opposing forces (the rubber bands and the watermelon).

The force exerted by a rubber band can be measured using a spring scale or a hanging scale like Dr Rob did in the video. Remember though, a scale usually shows weight (kg) not force (Newtons). But it is fairly easy to convert (1 kg is roughly 10 Newtons).

- Try measuring the force of your rubber bands at about a watermelon's stretch size.

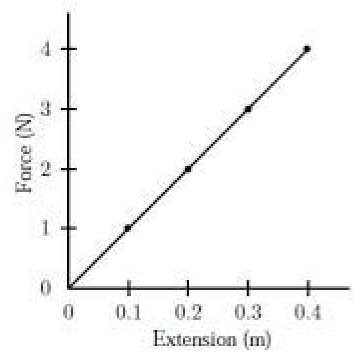
Q. Does the force get greater the more the rubber band is stretched?

A. Yes - and you can also do a simple test (below) on your rubber bands to find out their force constant.

Mini Experiment - Force Constant Test (Hooke's Law)

It is fairly simple to set up and measure the force constant of the rubber band. You'll need:

- some weights (500g, 1kg, 1.5kg etc). You can use water volumes in bottles if it is easier;
- somewhere to hang the rubber band;
- something with which to measure.



Hang the different weights and measure the distance the band stretches.

A plotted graph should look something like the one here. The slope is the force constant (k).

(or simpler still, average the weights(force) added and average the distances stretched, then divide the first by the second).

<u>Hooke's Law is</u>: Spring Force = Force constant x distance stretched

Or **F = kx**

So, your rubber band's force constant (k) will have the units N/m (in other words the force it takes to stretch a certain distance, even though these bands probably won't go to a metre)

Dr Rob did a quick test and calculation with his rubber bands and k = 1.75 N/cm, 175 N/m (this means it would take 175 Newtons of forces (or a 17.5 kg weight on Earth) to stretch the band 1m. But the law doesn't hold forever, and nor does the spring or band, I suspect it would break before it got to 1m!

Counter force

Counter force sounds like a special branch of the army, but in this case it is the force pushing back against the rubber bands. How do we know there is a force pushing back? Because if you apply a force to something it moves, unless there is an equal opposing force.

In this case the opposing force comes from the watermelon.In simple terms a watermelon is a fairly rigid rind, filled with mostly water. Water is almost impossible to compress with rubber bands, so it resists with something called *Hydrostatic force*.

If the rind wasn't so rigid then the whole thing would just deform, and there would be no implosion (boo!). So the mechanical strength of the rind helps too, it keeps the rubber bands out and the watermelon in.

Q. How would the watermelon resist if the rind was super flexible (like a balloon)?

Q. How would the watermelon resist if the melon contained only air, (no red fruit part)?

When you consider these questions you realise it is the combination of things that cause the melon to hold out for so long.

Implosions

Implosions are not as common as explosions, but there are some interesting examples nonetheless.

An implosion is when something collapses in upon itself, and they occur when external forces pushing inwards, overcome internal forces pushing outwards.

If the thing that implodes is mostly made up of air or empty space (like a soft drink can or an old grain silo) then the implosion is pretty much just that. The shell implodes into the space inside.

However in the case of the watermelon (or a collapsing star), there is matter on the inside already, so as things collapse inwards, stuff is also thrown outwards.The implosion creates an explosion, if you like.

Collapsing Stars

Q. Why does a star collapse in on itself?

A. Not every star does, some just run out of fuel, cool down and fade out. But the main reason a star collapses is because of its own gravity.

The longer answer is that big stars (bigger than our sun) create a lot of heat at their cores and this creates a lot of outwards pressure that balances the inward push from gravity. But once that outward force weakens enough, the whole system collapses under the huge gravitational force. Like the watermelon, some matter collapses to a dense core, while a lot of the sun's remains are expelled outwards to the universe (a supernova).

NASA has a great page on Supernovae https://spaceplace.nasa.gov/supernova/en/