BT YOUNG SCIENTIST & TECHNOLOGY Exhibition

STRONGWOMEN SCIENCE

JUGGLING CUSTARD

NON-NEWTONIAN FLUIDS

Circus performers juggle lots of different shapes such as clubs, balls and rings. These are all solid so they can catch them easily.

But can you juggle a liquid?

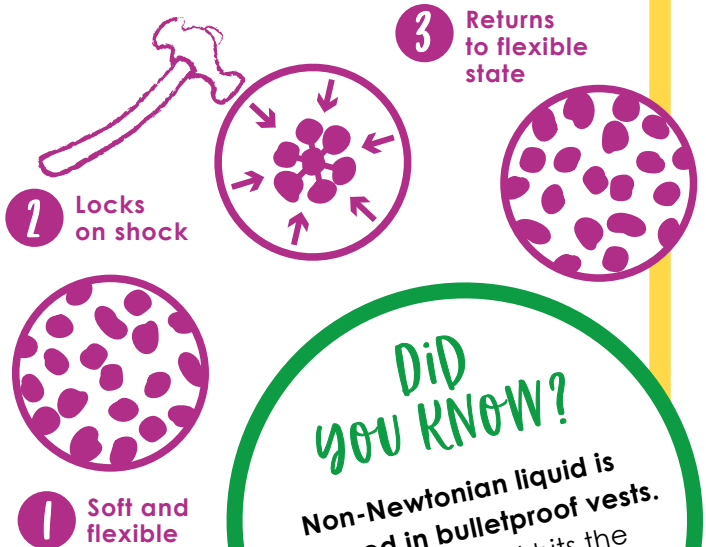
The molecules in a liquid are loosely packed, so they can slide past each other. But in a solid, they're tightly packed together so cannot move. That's why solids feel hard when you touch them, but fluids run through your fingers.

Scientist Isaac Newton (1642-1727) wrote laws on how liquids behave. But a few liquids behave differently – including custard! Custard is a liquid that doesn't obey these laws. It's a rebel liquid, or a non-Newtonian fluid.

When a non-Newtonian fluid is put under pressure, sometimes called stress, the molecules lock together and immediately form a temporary solid. When the pressure is removed, they are able to flow and turn back in to a liquid again.

So how can you juggle custard?

Squeeze some custard really tightly in your hand and all the molecules will snuggle up together, forming a temporary solid. That's your juggling ball.



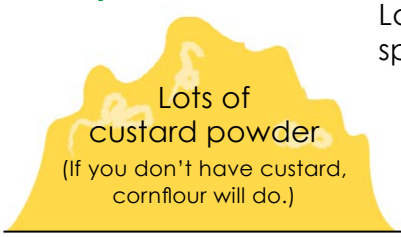
DID YOU KNOW?

Non-Newtonian liquid is also used in bulletproof vests. When the bullet hits the fluid, it goes rock hard and can't get through.

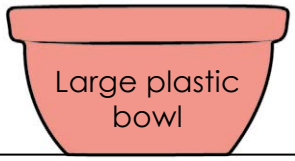
How to make custard juggling balls

What you need:

Large spoon



Lots of custard powder
(If you don't have custard, cornflour will do.)



Large plastic bowl

Measuring jug full of water

Old clothes and coverings
(so you don't get too messy)

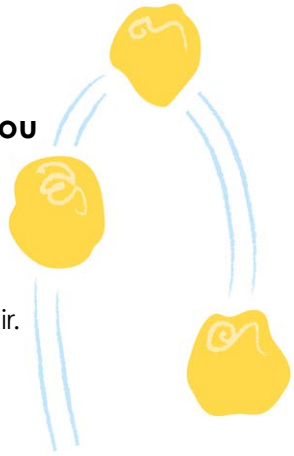
1. Put some cold water in the large bowl.
2. Little by little, add the custard powder and stir with the spoon until you have a thick liquid.
3. Scoop some of the custard in your hand – it will trickle through your fingers. Quickly squeeze the custard and it will become hard. If you stop putting pressure on it, it will immediately turn back into liquid.
4. Add custard powder or cornflour little by little until you get the mixture just right. If it gets too thick, just add more water. If it's too liquid, put in more powder.
5. Keep experimenting until it's liquid enough to flow through your fingers but thick enough to turn into a solid ball when you squeeze it.

Note: You have to make the custard yourself. Ready-made custard in a tin or packet won't work. Cooked custard won't work either.

Tip: Keep a note of how much custard powder and how much water you use to make the perfect mix so you know for next time you make it.

Ta da!

You now have your juggling balls and you can start juggling.



Keep your eyes peeled and you'll see the balls turn back to liquid mid-air. When they hit your hand as you catch them, they turn solid again.

Be careful – if the custard balls fall to the ground they'll make a big liquid splat, so cover the floor if you can.

You can test the non-Newtonian properties of custard in lots of different fun ways. Try making a fist and punching the custard in the bowl. Your hand will bounce off the hard surface and the custard won't splash. The pressure of your punch has made a temporary solid.

Keep going!

You won't get it right first time. The more you experiment, the better you'll get at making juggling balls.

Trial and error is an important part of scientific discovery.

Have you seen our **Juggling Custard** film? Go to the Circus250 YouTube channel for further information and more tricks.

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