**Non-Newtonian Fluids**

Many people have heard of Sir Isaac Newton. He is famous for developing many scientific theories in mathematics and physics. Newton described how ‘normal’ liquids or fluids behave, and he observed that they have a constant viscosity (flow). This means that their flow behaviour or viscosity only changes with changes in temperature or pressure. For example, water freezes and turns into a solid at 0˚C and turns into a gas at 100˚C. Within this temperature range, water behaves like a ‘normal’ liquid with constant viscosity.

Typically, liquids take on the shape of the container they are poured into. We call these ‘normal liquids’ Newtonian fluids. But some fluids don’t follow this rule. We call these ‘strange liquids’ non-Newtonian fluids.

**Stress and strain**In science, stress means that a force is applied to a body. The result of that stress is described as strain. Imagine hitting a metal with a hammer. The force that is applied on the metal causes stress to that particular area. The result of that stress is then described as strain – in this case, possibly a deformation of the metal. Newtonian fluids don’t resist much stress that is applied on them like solids would do, so they don’t show the signs of strain. If you hit water with a hammer, the liquid will not resist much to the stress applied and will also not show signs of strain.

Non-Newtonian fluids change their viscosity or flow behaviour under stress. If you apply a force to such fluids (say you hit, shake or jump on them), the sudden application of stress can cause them to get thicker and act like a solid, or in some cases it results in the opposite behaviour and they may get runnier than they were before. Remove the stress (let them sit still or only move them slowly) and they will return to their earlier state.

Say you want to get some tomato sauce out of the bottle. You know there is some in there, but when you turn the bottle upside down, nothing comes out. So what do you do? You shake or hit the bottle. This causes the tomato sauce to become more liquid and you can easily squirt some out. In this case, the sauce’s viscosity decreases and it gets runnier with applied stress.

Oobleck is a mixture of cornflour and water (similar to uncooked custard) named after a substance in a Dr Seuss book. This liquid is a runny goo until you apply stress to it, and then it suddenly acts like a solid. You can hit a bowlful with a hammer, and instead of splashing everywhere, the particles lock together. You can roll it into a solid ball in your hand, but if you stop moving it, it reverts to liquid and oozes out through your fingers. In this case, the oobleck’s viscosity or resistance to flow increases with applied stress.

**Different types of non-Newtonian fluids**Not all non-Newtonian Fluids behave in the same way when stress is applied – some become more solid, others more fluid. Some non-Newtonian fluids react as a result of the amount of stress applied, while others react as a result of the length of time that stress is applied.

The table below summarises four types of non-Newtonian fluids.

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| Type of behaviour | Description | Example |
| Thixotropic | Viscosity decreases with stress over time | Honey – keep stirring, and solid honey becomes liquid |
| Rheopectic | Viscosity increases with stress over time | Cream – the longer you whip it the thicker it gets |
| Shear thinning | Viscosity decreases with increased stress | Tomato sauce |
| Dilatant or shear thickening | Viscosity increases with increased stress | Oobleck |

**Why do non-Newtonian fluids matter?**The behaviour of non-Newtonian fluids has important implications:

* If a house is built on certain types of clays and an earthquake puts stress on this material through the sudden movement, the apparently solid clay can turn into a runny liquid. This is called liquefaction. Liquefaction was particularly destructive in the Canterbury earthquakes of 2010 and 2011.
* Body armour that behaves like a liquid so that you can move easily but turns into a solid on impact from stress could be useful for police or the military.
* Fun! Making oobleck is a great reason to make a mess, all in the name of science!