Topic: Pressure

Part 1 – Changes in pressure

- All materials are able to expand and contract – usually in response to heating or cooling – but not all materials are compressible by exerting an outside force.
- When solids are compressed, the forces contribute stress to the material and it breaks.
- When liquids are compressed, their volume changes very little, but the compression force may be transmitted over the length of the container holding the liquid. In the case of a garden hose, an increase in pressure in one end may travel 100 feet and result in an increase in pressure at the other end. In the case of a squirt gun the distance is only a few inches, but the squeezing of the trigger pushes the volumes of water along the inside of the squirt gun until it exits - to the dismay of whoever is standing in front of it.

This pressure change in a liquid is called **Hydraulics**, and I would ask that you read this one-page summary and answer a few questions on a google form for this week's science lesson.

Hydraulics

by Chris Woodford. *Last updated: July 2, 2019.*

What's the connection between a water pistol and this gigantic crane? On the face of it, no connection at all. But think about the science behind them and you'll reach a surprising conclusion: water pistols and cranes use the power of moving liquids in a very similar way. This technology is called **hydraulics** and it's used to power everything from car brakes and garbage trucks to motorboat steering and garage jacks. Let's take a closer look at how it works!

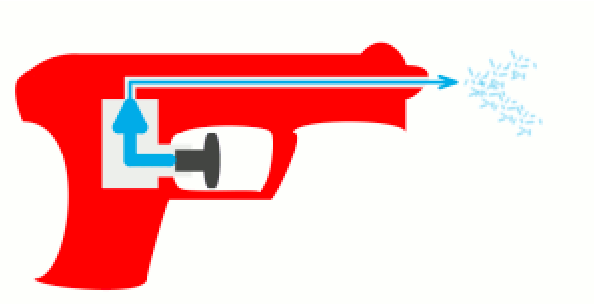
Photo: This crane raises its giant boom into the air using a hydraulic ram.

You can't squash a liquid!

Gases are easy to squash: everyone knows how easy it is to squeeze a balloon. **Solids** are just the opposite. If you've ever tried squeezing a block of metal or a lump of wood, with nothing but your fingers, you'll know it's pretty much impossible. But what about **liquids**? Where do they fit in? You probably know that liquids are an in-between state, a bit like solids in some ways and a bit like gases in others. Now, since liquids easily flow from place to place, you might think they'd behave like gases when you tried to squeeze them. In fact, liquids are virtually incompressible—much like solids. This is the reason a belly flop hurts if you mess up your dive into a swimming pool. When your body smacks into the pool, it's because the water can't squeeze downwards (like a mattress or a trampoline would) or move out of the way quickly enough. That's also why jumping off bridges into rivers can be very dangerous. Unless you dive correctly, jumping off a bridge into water is almost like jumping onto concrete.

Photo: Why does water squirt so fast from a syringe? You can't really compress a liquid at all, so if you force the water up through the wide part of the syringe by pushing hard on the plunger at the bottom, where's that water going to go? It has to escape through the top. Since the top is much narrower than the bottom, the water emerges in a high-speed jet. Hydraulics runs this process in reverse to produce lower speed but more force, which is used to power heavy-duty machines. It's exactly the same in a water pistol, which is effectively just a syringe shaped like a gun.

The fact that liquids don't compress easily is incredibly useful. If you've ever fired a water pistol (or a squeezy washing-up liquid bottle filled with water), you've used this idea already. You've probably noticed that it takes some effort to press the trigger of a water pistol (or to squeeze water from a washing-up bottle). When you press the trigger (or squeeze the bottle), you're having to work quite hard to force the water out through a narrow nozzle. You're actually putting pressure on the water—and that's why it squirts out at a much higher speed than you move the trigger. If water weren't incompressible, water pistols wouldn't work properly. You'd squeeze the trigger and the water inside would simply squash up into a smaller space—it wouldn't shoot out of the nozzle as you'd expect.



If water pistols (and squeezy bottles) can change force and speed, that means (in strict scientific terms) they work just like tools and machines. In fact, the science of water pistols powers some of the world's biggest machines—cranes, tipper trucks, and diggers.

After reading this article, please watch the hydraulic press video, and then answer the questions on the google form:

Hydraulic Press video: https://www.youtube.com/watch?v=gc-qJa9Sw9s

Google form: https://forms.gle/BDHNZGEoN6hhYMXU9