RUN LIQUIDS, RUN

What is viscosity?

Which liquids run the fastest? What properties do they have in common?

Does the steepness of the incline affect the run speed?

Equipment required:

2 x Large pieces of cardboard

Pencil

Ruler

Variety of liquids

Timer

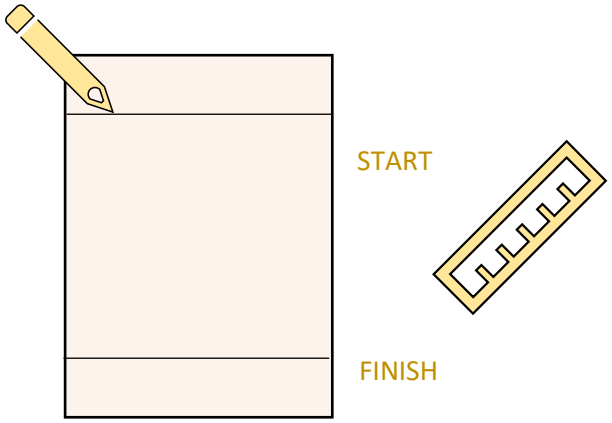
Can you explain the findings?

Run Liquids, Run

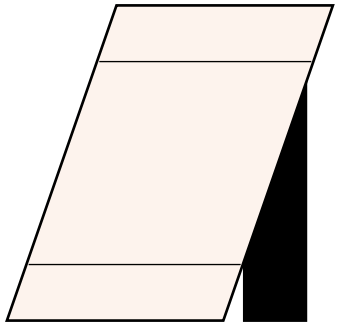
DEPARTMENT OF CHEMISTRY

UNIVERSITY OF OXFORD

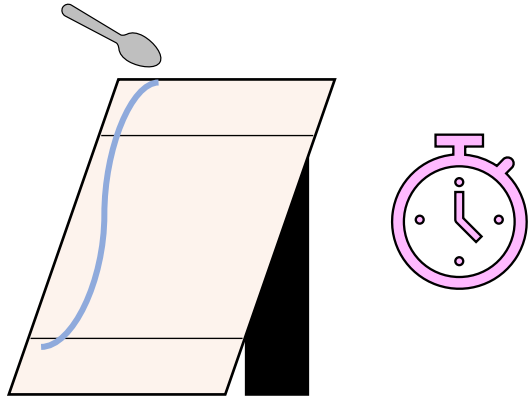
1 Draw two lines, one at each edge, on a large piece of cardboard.



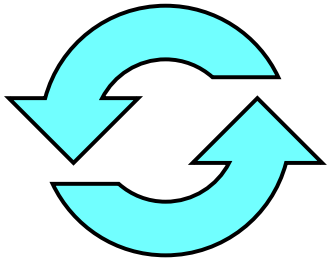
2 Set up a ramp to support cardboard piece.



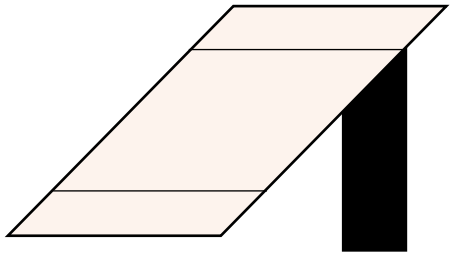
3 Place fluid at top of run and time how long to travel between start and finish lines.



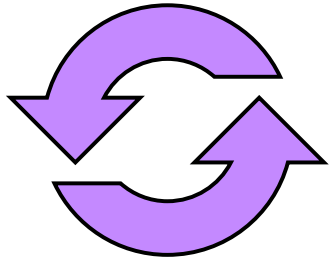
4 Repeat with different fluids.



5 Adjust incline of ramp using new piece of cardboard.



6 Repeat at the new incline.



The science behind the scenes…

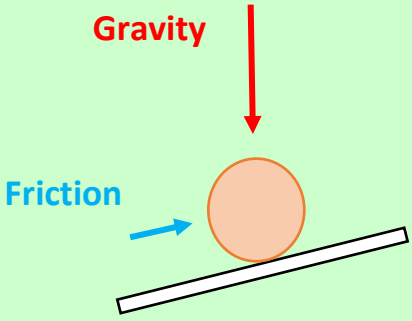
Viscosity is formally defined as a liquid's **resistance to flow**. Hence, a more **viscous** liquid, which has a higher resistance to flow, will be **thicker** and less runny, as it is less willing to flow easily. Runnier liquids have a lower viscosity. An example to illustrate is water vs oil: oil flows much less easily and is much thicker than water – so oil is more viscous than water.

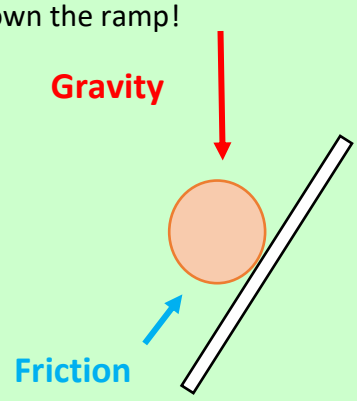
What makes a liquid thicker or runnier?

In between molecules there are **intermolecular forces** which keep the molecules together. If these forces are **stronger**, the liquid flows less easily- in order for a liquid to run, some of these forces must be broken for the molecules to slide over one another.

Why does the slope of the ramp have an effect?

Everything in the world is subject to a force called **gravity**. Gravity is a force which pulls every object down towards the Earth's surface- it is this force that keeps us all on Earth! When the slope is steeper, the liquid experiences a greater contribution from gravity pulling it down the ramp, causing it to fall quicker. The motion of the liquid down the ramp is opposed by forces of **friction**, so the more gravity can help the liquid overcome the frictional forces, the faster the liquid can run down the ramp!





Practical investigation:

Equipment:

- ☐ 2 x Large pieces of cardboard
- ☐ Pencil
- ☐ Ruler
- ☐ Variety of liquids
- ☐ Timer

Method:

1. Acquire 2 large pieces of cardboard. Draw two lines using a ruler (must be a straight line, to ensure fair test): one near the top and one near the bottom of each – the distance between the two lines should be the same on each piece. These will act as the start and finish lines that will be used to time the liquids.
2. Set up a ramp system, where the carboard run board acts as the ramp, supported by any appropriate items you have access to.
3. Measure a spoonful of liquid. Examples of liquids to use that you may find around the house include: cooking oil, ketchup, milk, honey.
4. Transfer spoonful of liquid onto the top of the run. Time how long it takes for the liquid to travel between the start and finish lines on the ramp. The timer should be started when the liquid first passes the start line and stopped when it first reaches the finish line).
5. Repeat with a variety of different liquids.
   Note: the volume of liquid used should be kept the same to ensure a fair test – i.e. a level spoonful.
6. Using the second piece of cardboard, set up a ramp inclined at a different steepness.
7. Repeat testing all the same liquids at new incline.

Questions:

(a) What is viscosity?
[A measure of a liquid's resistance to flow, i.e. how thick liquids are.]

(b) What did you notice about which types of liquids ran the fastest?
[The runnier a liquid is, the faster it runs down the ramp.]

(c) How does altering the steepness of the ramp affect the time it takes for the liquid to run down the ramp?
[The steeper the ramp, the faster the liquid falls down the ramp, as the liquid is being pulled down more by the force of gravity.]

(d) Predict the set up of ramps that would produce the fastest and slowest times.
[Fastest would be completely vertical ramp, full affect of gravity. Slowest would be completely horizontal ramp, no effect of gravity to pull down ramp.]

(e) How do we ensure this is a fair test?
[Use same volume of liquid (i.e. a level spoonful). Ensure consistent and accurate timing. The slope of the ramp should be kept the same whilst different liquids are being tested – slope is then changed to repeat with the same liquids.]

Challenge…

Can you record the times in a suitable table that you can use later to crown the winner of the race?

An example of a table you could recreate is shown below:

Liquid	Runny or thick?	Time (s)

Science isn't just useful in the lab…

Viscosity is an important factor in **blood flow** in the body. Viscosity is a liquid's resistance to flow, so the more viscous blood is, the more resistance it has to flowing. The more blood resists moving, the harder it becomes for the body to pump blood around the body. To correct this, the **heart** tries to pump faster to get the blood, which carries all the essential nutrients we need to survive, around the body better. This results in an elevated (higher) **blood pressure**. The extra strain the heart is under trying to pump more viscous blood around the body can put you at increased risk of a heart attack.

So how does the viscosity of our blood change? Blood is a mixture of different types of molecules and cells, so altering the composition (what it contains) of blood will change its viscosity. An increased level of salt in the blood can make blood more viscous. Our blood contains cells called **red blood cells**, and it is thought that an increased level of salt in the blood will make these cells stiffer, and so makes them harder to flow around our body. This is why eating too much salt is bad for you – build up of too much salt will lead to higher blood pressure.