SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Scientific Inquiry

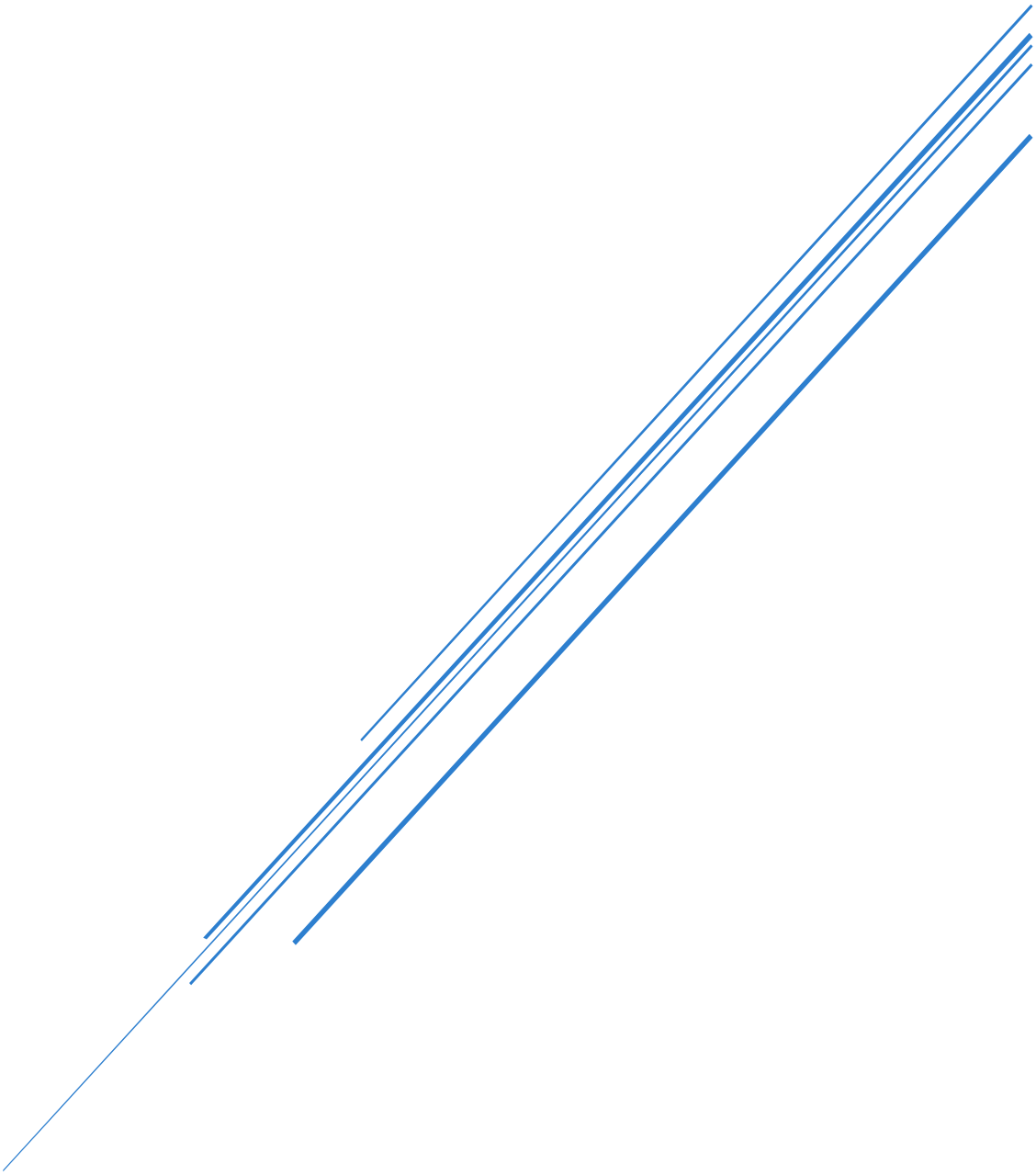
Year 5-6

Owen Dolman

Golden Grove Primary School

VISCOSITY AND TEMPERATURE WITH AN UNEXPECTED RESULT

Owen Dolman



Golden Grove Primary School

Introduction

I was having some apple crumble for dessert, and I wanted to have some custard with it. When I first poured the custard in the bowl it was very thick, however when I heated up the bowl in the microwave, I noticed the custard was now a lot thinner. I found this interesting and wanted to do a project to learn more about this and my dad said he would help me.

The word used for how thick a liquid is, is viscosity [1]. Liquids that have high viscosity are very thick, and they pour very slowly and are hard to stir. Liquids that have low viscosity are thin and runny, and they pour quickly.

I watched a YouTube video [2] where they dropped a marble in different liquids, and you could see how fast or slow the marble fell for each. The marble fell quickly in low viscosity liquids and slowly for high viscosity. I decided to do the same test for a few different liquids but at different temperatures. The time it takes for the ball to fall can be used to compare the viscosity for different temperatures. We watched another video where this type of test was called a falling ball viscometer [3].

Question & Prediction

My question is how does temperature affect viscosity of the liquids? I predict that the balls will fall faster when the liquids are hot (less viscous), and slower when the liquids are cold (more viscous).

A fair test

My science teacher, Ms. Garner, said that we need to have a fair test when we are doing a science experiment in class, and to just change one thing while keeping everything else the same.

For each liquid the only thing I will change is the temperature. I am going to measure the time taken for the ball to fall between two lines to compare. I am not comparing one liquid against another, only the effect of temperature for each. Different liquids will need different balls, as what works for a very viscous liquid may not work for a less viscous one.

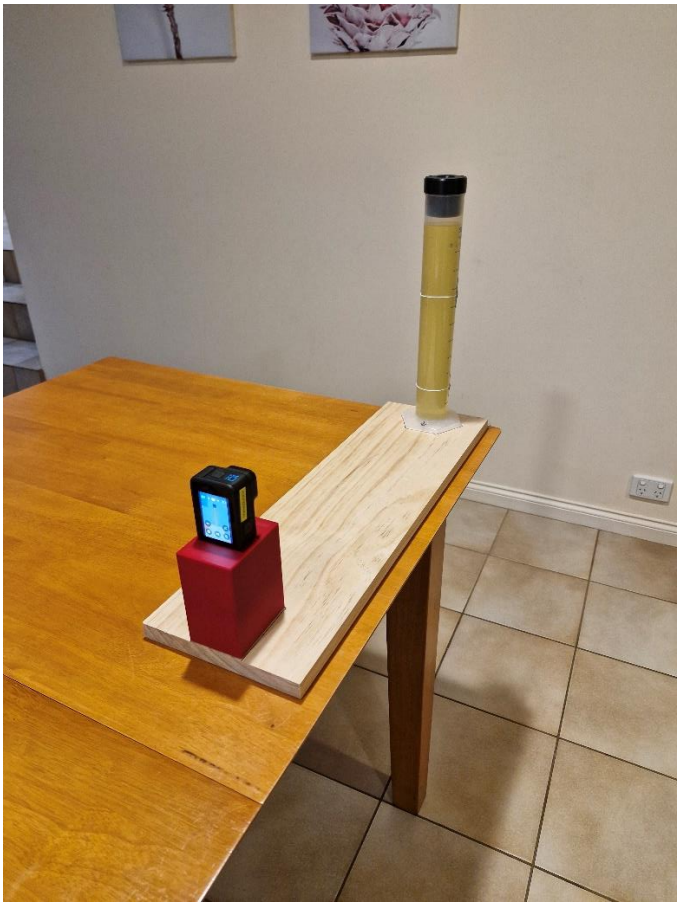
Equipment List

- GoPro Camera
- Wooden plank
- Measuring cylinder
- Liquids
- 3D printed funnel
- 3D printed GoPro stand
- String
- Tape
- Small balls of different materials
- Meat Thermometer
- DJV software
- Fridge
- Kettle
- Saucepan

Test Setup

We used a 500 ml measuring cylinder and taped string taped to the side for the start and finish lines. We made the start line in the middle of the cylinder and not the top because the balls go fast at the beginning when first dropped in. It takes a bit of time for them to get to a constant speed.

We used a GoPro camera on a 3D printed stand to record the balls falling down the cylinder. A wooden plank was used to trace the position of the GoPro and cylinder to make sure they were in the same place every time to make it a fair test.



A 3D printed funnel was used so the balls would fall down the middle of the cylinder. We dropped balls into each liquid and timed how long they took go to between the two lines. Five balls were dropped for each test to get an average of the times.

Liquids

We chose four different liquids to test. We chose clear liquids so that we could see the ball falling. We used liquids that were safe to use. My dad heated the liquids using the kettle for the water, and a saucepan to heat the oil and other liquids. To cool the liquids down, we put them in the fridge. We used a meat thermometer to measure the temperature of the liquids.

- Water
- Vegetable Oil
- Dishwashing Soap
- Golden Syrup

Balls

We used different balls to test each liquid because they needed to be heavy enough to sink in the liquid, but not so heavy that they fall too fast.

- Plastic blue balls, 6 mm Diameter (water, oil)
- Steel balls, 4 mm Diameter (dishwashing soap)
- Steel balls, 10 mm Diameter (golden syrup)

Time

After the tests we downloaded the video onto the computer and watched in slow motion using an app called DJV. We recorded the start and stop times using the app and worked out the difference. We used an Excel spreadsheet to record the times, calculate the averages and make the graphs.

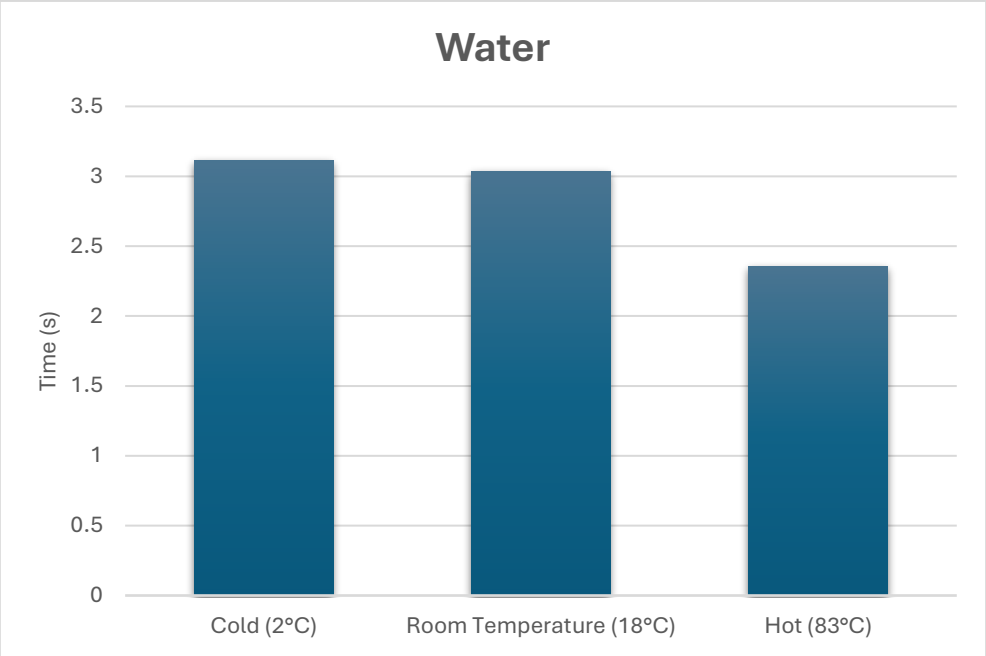
Here is a picture of the ball falling in the vegetable oil. This also shows the start and stop lines, and the black 3D printed funnel at the top.

Results

The temperature measured for each test is shown here. For Golden Syrup we used two hot temperatures instead of a cold temperature because the liquid was too viscous at the cold temperature.

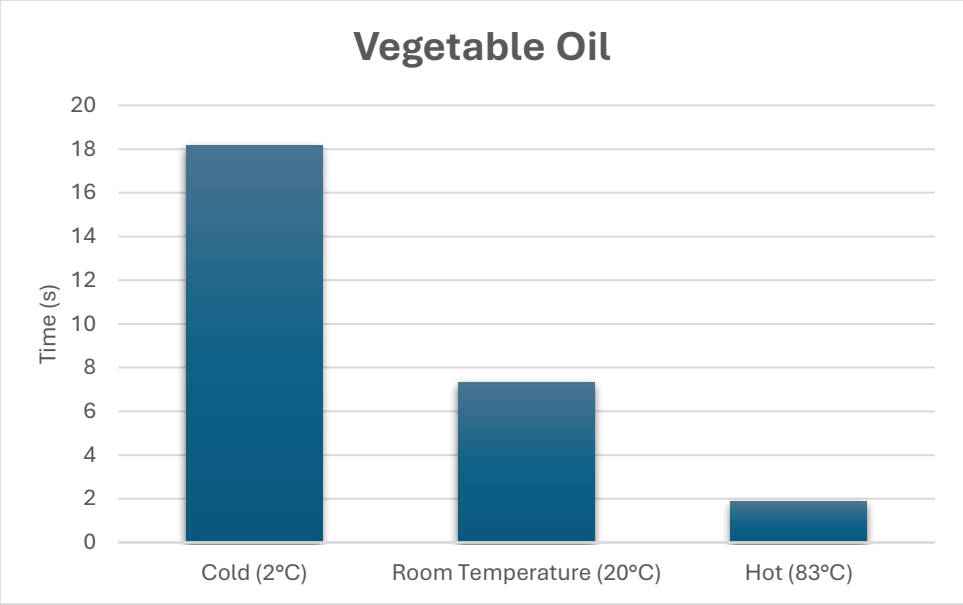
	Cold (C)	Room Temperature (C)	Hot (C)
Water	2	18	83
Vegetable Oil	2	20	83
Dishwashing Liquid	2	20	66
Golden Syrup	-	22	40 and 69

Water



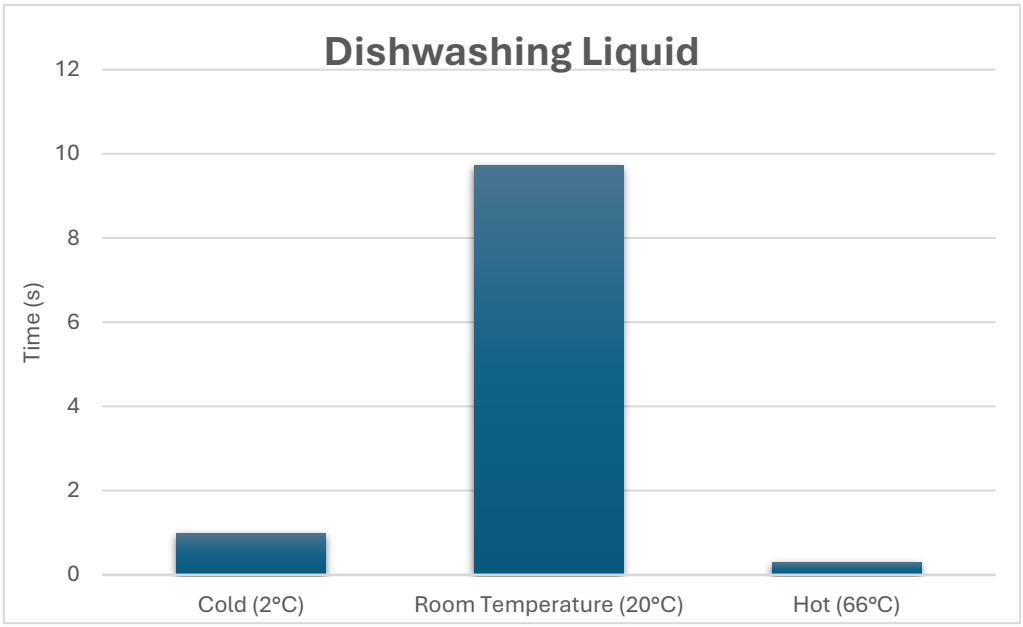
Cold water took the longest for the ball to fall, but it was barely different from room temperature. The hot water was faster than the room temperature and cold water.

Vegetable Oil



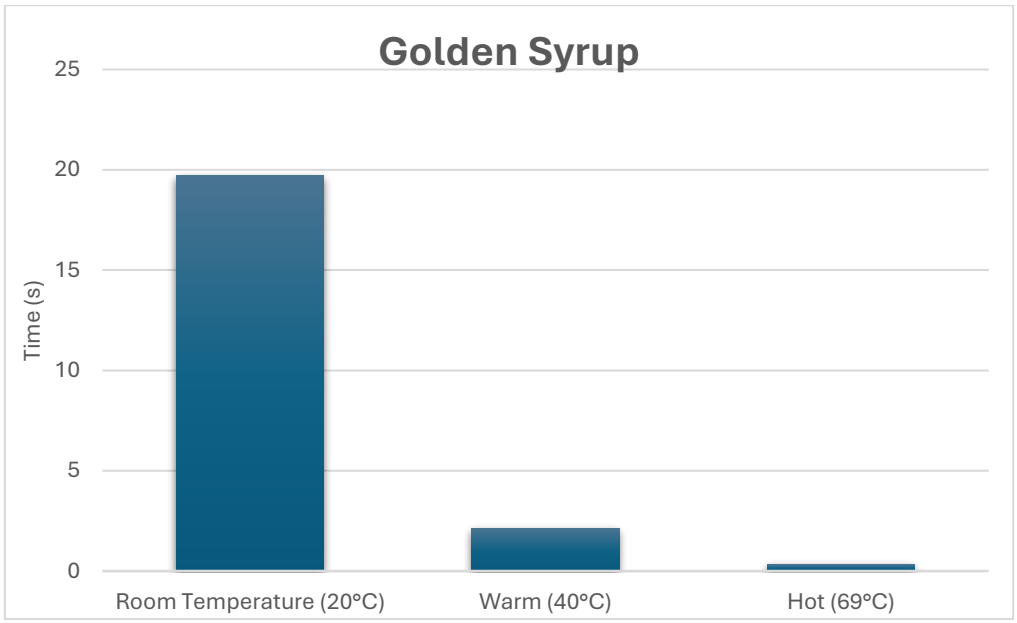
In vegetable oil, there was a big difference between each temperature, the hot being very fast, and the cold very slow.

Dishwashing Liquid



In the dishwashing liquid test, the hot temperature was faster than room temperature, but surprisingly, so was the cold! This was a very strange result. The results matched our prediction for hot, but not for cold. We washed the equipment and repeated the tests to confirm this. We found the same result again.

Golden Syrup



For golden syrup the hot temperature was the fastest, followed by the warm temperature and then the room temperature.

Discussion

My prediction was correct for all the liquids except for the dishwashing liquid. Surprisingly, the dishwashing liquid had a low viscosity at both hot and cold temperatures. My Dad and I did some research and found that for liquid soaps, this can happen because of how the molecules

in the liquid act at low temperatures. Sometimes this is done on purpose so that the liquid soap is not too viscous when cold, but still viscous enough at room temperature so that people still believe it will work well [3]. This shows that viscosity can be very important for different liquids and their uses, and not just for custard!

The test went well but could have been improved by having better lighting for some of the liquids. The golden syrup was very dark, and it was hard to see the balls even in slow motion. Future tests could also look at ways to do the test for liquids that are not clear which would allow for testing of many other liquids.

(1093 words)

Acknowledgements

I'd like to thank my mum and dad for helping with the experiment, the research and helping write this report.

References

1. Viscosity. In *Wikipedia, The Free Encyclopedia*. Retrieved June 26, 2024, from https://en.wikipedia.org/w/index.php?title=Viscosity&oldid=1229209661
2. How to test the Viscosity of a Liquid, Cool Science Experiments Headquarters, YouTube (*https://www.youtube.com/watch?v=2Gdxu4XcsbY)*
3. Falling Ball Viscometer, YouTube, *(https://www.youtube.com/watch?v=taOx94tugXs)*
4. Pengwei J., Jun W., Rongying, S., Li D., and Ying, L., *Parabolic Viscosity Behavior of NaCl-Thickened Surfactant Systems upon Temperature Change*, ACS Omega, 8-40, pp 37511-37520, 2023
5. Pitch Drop Experiment, University of Queensland, (https://smp.uq.edu.au/pitch-drop-experiment)

Viscosity Project Logbook

10/5/2024

Tonight I noticed that custard in my apple crumble was thinner after heating it up. I thought this might be a good project to look at.

Liquid thickness different when heated and that is called viscosity

With my dad we watched some videos on youtube about viscosity. We watched a good video where they dropped a marble in jars filled with different liquids. For the thicker liquids the balls fell slowly. For the thinner liquids they went fast.

How to test the Viscosity of a Liquid (*https://www.youtube.com/watch?v=2Gdxu4XcsbY)*

We also watched another video where the test was called a Falling Ball Viscometer *(https://www.youtube.com/watch?v=taOx94tugXs)*.

My plan is to measure viscosity of different liquids at different temperatures using this type of test.

liquids to test?

honey

water

dish soap

glycerin

veg oil

corn syrup

how to do the test

first, we put a liquid into a cylinder

then we drop a metal ball down it

and record the time of it falling

17/5/2024

My dad has a measuring cylinder we can use for the test.

We tested the go pro Camera

We 3D printed a funnel for the balls to fall down the middle of the cylinder

We bought some liquids for the test (veg oil and dish wash liquid)

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21/5/2024

We 3d printed a stand for the go pro and used a plank of wood with marks on to make sure the cylinder and camera are in the same place for each test to make it a fair test.

We saw the pitch drop experiment on the website. The pitch drop experiment tests if it is liquid. The person who did the experiment was trying to prove that pitch is a liquid. Pitch is very viscous.

https://smp.uq.edu.au/pitch-drop-experiment

Budget

item	*Cost*	*source*
honey	*14.50*	*Amazon*
water	*-*	*tap*
dish soap	*$2.35*	*wooly's*
glycerin	*$15.95*	*Breu store*
veg oil	*$3.55*	*wooly's*
Measuring cylinder	*$15*	*eBay*
Go Pro	*Free*	*Borrow Dad's*
3D printing material		
Thermometer	*$10*	*Woolworths*

25/5/2024

Set-up:

GoPro with a narrow lens and 4x slow-motion (100 frames per second – FPS)

150mm distance between string lines on 500mL measuring cylinder

Experiment 1 – water room temperature (18C) with blue plastic balls

After room temperature test we filled cylinder with tap water and put in fridge

Used app called DJV to watch videos

We used the same camera settings for each test

27/5/2024

Set-up:

GoPro with a narrow lens and 4x slow-motion (100 frames per second – FPS)

150mm distance between string lines on 500mL measuring cylinder

Experiment 2 – Cold water 2°C from fridge, looked about the same maybe a bit slower?

Experiment 3 – Hot water 84°C. Water heated in kettle. Help from Dad for safety. Balls dropped a lot faster.

31/5/2024

Planning for Experiment 4

Cooking oil – room temperature, cold and hot. We will test room temperature first, and then hot by carefully heating in a pan with Dad's help for safety. We will then let it cool down and put in the fridge to cool down fully before we test the cold.

Prediction – the ball will go through the hot oil quicker because it is runnier than the cold oil. That means it's less viscous when hot.

3/6/2024

We dropped blue balls into vegetable oil which was room temperature. Used blue balls. Timed to see how long the ball between the lines the temperature was 20°C

We did another one which is hot at 84°c. My dad used saucepan to heat oil. The balls dropped really fast compared to the room temperature test. After we put the oil in the fridge to cool down.

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7/6/24

Did the test with cold oil which was 4°C from fridge. We used blue balls and drop them down oil and timed how long it took to go between the lines. The balls fell a lot slower.

14/6/24

We tested the washing up liquid using small steel balls at room temp 22c. Measured balls to be 4mm.

After the test we put the liquid in the fridge to cool down.

15/6/2024

Tested dishwashing liquid at 2C

Weird result! (the balls went faster than room temp this was not what was expected) we had used the same steel balls 4mm.

I wonder what hot will do?!

We left it to warm back up to room temp, 22 C and repeated a quick test. We got the same results as yesterday

We will put it back in the fridge to test it again when cold to confirm.

16/6/2024

We testd the cold dishwashing liquids again and got the same result at 2C. The balls went fast again!

We also did the hot test at 66C. My dad heated the liquid up in a saucepan

The Balls fell fast again. We needed to use a torch to see the balls for this test.

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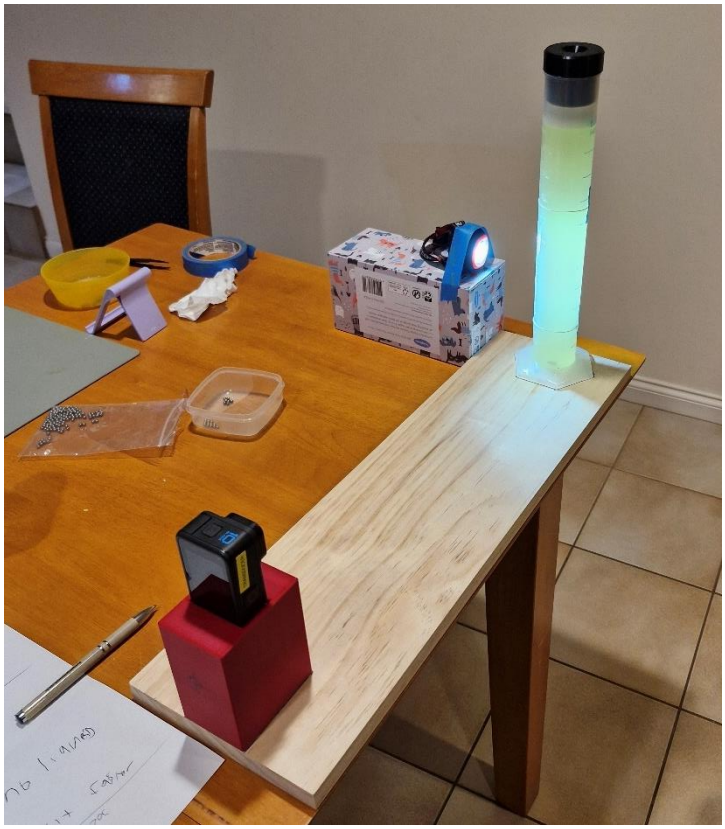

19/6/2024

My mom and dad bought some golden syrup to test as the last liquid. Golden syrup is very viscous.

22/6/2024

We tested the golden syrup at room temperature. It was very dark so we had to use a torch again to see the balls falling. After the test we put the syrup in the fridge. We had to use big steel balls (10mm) because the small one was too slow.

23/6/2024

We took the golden syrup out of the fridge and it was almost solid! We dropped a ball to see what happened and it was going to take a long time to fall. Maybe an hour? It was going to be too viscous to test.

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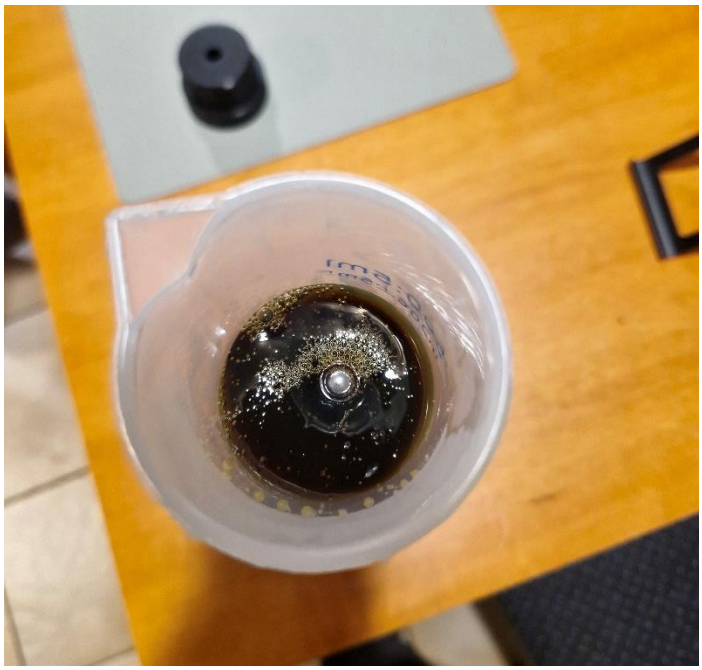

We decided to do just a room temperature and hot test.

My dad heated the syrup up in a saucepan to 69C and we tested it. The ball dropped fast as expected.

While watching the video, we thought we should wait for the syrup to cool down a bit and test again at about 40C to give us 3 points. So we did this and the ball still fell fast, but not as fast as the hot temperature.

27/6/2024

I finished writing the report with some help from mum and dad. I am also going to send it to my science teacher to submit to the competition.

Results

Water

Room Temperature	18		
	Start	Finish	Time
1	6.14	9.1	2.96
2	14.63	17.7	3.07
3	22.23	25.12	2.89
4	30.43	33.18	2.75
5	37.16	40.66	3.5
average			3.034

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Cold (2C)	2		
	Start	Finish	Time
1	50.22	53.6	3.38
2	59.24	62.57	3.33
3	6.57	9.67	3.1
4	14.03	16.89	2.86
5	21.2	24.1	2.9
average			3.114
Hot	83		
	Start	Finish	Time
1	15.77	18.2	2.43
2	21.71	24.07	2.36
3	28.58	30.86	2.28
4	35.37	37.9	2.53
5	41.26	43.43	2.17
average			2.354

Oil

Room Temperature	20		
	Start	Finish	Time
1	7.65	14.92	7.27
2	26.93	34.45	7.52
3	43.05	50.66	7.61
4	0.44	7.46	7.02
5	16.84	24.09	7.25
average			7.334
Cold (2C)	2		
	Start	Finish	Time
1	54.6	73.61	19.01
2	26.86	45.24	18.38
3	57.84	75.55	17.71
4	26.27	43.31	17.04
5	56.27	74.88	18.61
average			18.15

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Hot	83		
	Start	Finish	Time
1	34.09	35.91	1.82
2	41.25	43.11	1.86
3	45.69	47.6	1.91
4	50.61	52.42	1.81
5	54.99	56.86	1.87
average			1.854

Dishwashing Liquid

Room Temperature	20		
	Start	Finish	Time
1	7.58	17.35	9.77
2	25.1	34.79	9.69
3	43.38	53.07	9.69
4	0.57	10.27	9.7
5	17.73	27.49	9.76
average			9.722
Cold (2C)	2		
	Start	Finish	Time
1	57.32	58.27	0.95
2	2.42	3.39	0.97
3	6.88	7.89	1.01
4	11.14	12.15	1.01
5	16.96	17.97	1.01
average			0.99
Hot	66		
	Start	Finish	Time
1	29.15	29.44	0.29
2	35.16	35.46	0.3
3	37.52	37.83	0.31
4	40.18	40.47	0.29
5	42.42	42.72	0.3
average			0.298

Golden Syrup

Room Temperature	20		
	Start	Finish	Time
1	18.09	38.09	20
2	56.41	76.7	20.29
3	32.3	51.97	19.67
4	7.08	26.55	19.47
5	39.07	58.19	19.12
average			19.71
Warm	40		
	Start	Finish	Time
1			1.92
2			2.32
3			2
4			2.27
5			2.14
average			2.13
Hot	69		
	Start	Finish	Time
1	31.32	31.65	0.33
2	39.85	40.19	0.34
3	43.82	44.18	0.36
4	47.47	47.8	0.33
5	50.86	51.2	0.34
average			0.34

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, logbook or entry. One form per entry.

STUDENT(S) NAME: Owen Dolman ID: 0212-010

SCHOOL: Golden Grove Primary School

Activity: Give a brief outline of what you are planning to do.

I am going to measure the viscosity of some common household liquids, and see how this changes with temperature.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead? **Only batteries can be used for Models & Inventions entries*
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control / manage the risk
Thermal risk Poison risk Slip risk	I will get an adults help for heating and handling the hot liquids. I won't use poison/toxic liquids in the project. If there is a spill I will clean it up straight away.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)):

Owen Dolman

SIGNATURE(S):

☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Haylee Garner

SIGNATURE: HG DATE: 19.6.24