Scientific Inquiry

Year 5-6

Zoe Curtis

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Does it dance?

How to make the Oobleck Boogie

Zoe Curtis, St Peters Girls, Stoneyfell (987 Words)

Figure 1 "Synonyms of dance

   1: to move one's body rhythmically usually to music : to engage in or perform a dance

   2: to move or seem to move up and down or about in a quick or lively manner", [Merriam Webster, ref [14]]

Questioning and Predicting

Hypothesis

The question I am investigating is what music, sound, tone or wave makes oobleck dance and bounce the highest.

Prediction

I am predicting that pop music or high frequency sound makes the highest movement.

Planning

I chose this method of investigation because I have seen lots of experiments with oobleck and wanted to find the best way to make cool photographs. I tried to create a method to experiment with sound vibration and oobleck using materials we had at home including an old stereo my mum had. I ended up buying a cheap speaker, everything else we had at home. For my test I will put oobleck in a speaker and play sound through it. When I play sound then the oobleck will move in different ways as the sound waves move through it.

I chose to try a few tests as part of planning to do the experiment to help decide on an oobleck mix and try out a few different sound and music options. Some of the possible variables that I could have used are the mixture of oobleck, music, sound wave shape, volume and the plastic to cover the speaker with. The variable I will measure is the height of the oobleck movement.

My investigation is a fair test because I have a control where I have not changed the speaker, volume or oobleck. I have measured the highest point of the oobleck mass for each sound four times, height is my dependent variable. My independent variable is the sound or music that is played through the stereo.

Set up

1. Setup the speaker facing upwards balanced on something that can get messy.
   a. I balanced it on an old toolbox outside
2. Connect the speaker to the stereo
3. Make the oobleck – 2.5 parts corn flour to 1 part water.
4. Tape the plastic glad wrap over the speaker
   a. Make sure to place something light into the speaker so that the plastic goes all the way to the bottom.

5. Measure 6 tablespoons of oobleck and put it in the speaker
6. Setup the camera to video the oobleck
7. Setup a ruler in the camera frame to measure the oobleck height

I chose the oobleck mix that I did because I found that it relaxed to liquid quickly and made more interesting shapes and moved more. One of the thicker mixes I made (3 parts flour to 1 part water) moved like a big flat singular mass and bounced out of the speaker.

Conducting

1. Set the camera to record.
2. Play each sound for 30 seconds at maximum volume and while it is playing say the name so you can hear it on the video.
3. Repeat step 2 four times.
4. Stop the recording.
5. Watch the videos in slow motion and record the highest point the oobleck gets to above the speaker rim for each round.

Equipment and Materials

The materials required to repeat this experiment are (Figure 2):

- Felt tip pen
- Note book
- Tap Water
- Cornflour
- Food colouring
- Container for oobleck
- Spoon for mixing
- Camera and tripod
- Speaker
- Scrap wood
- Black Paint

- Jigsaw (for cutting wood)
- Ear defenders
- Safety Glasses
- Screwdriver
- Screws
- Stereo
- Toolbox
- Gladwrap
- Tape
- Music and sound files

Figure 2 Materials required

The possible risks of running this experiment are the use of power tools, screws and playing loud music. All participants used safety equipment, ear defenders whenever we were playing the music and safety goggles when cutting the wood and screwing in the speaker. The power tools needed a responsible adult. My Dad used the jig-saw to cut the hole in the wood for me.

Processing and analysing data and information

Some relationships I noticed in the data were that the 40Hz Sine always had the highest score. I wonder if this is because it only gets a little bit of time to rest in between each peak of the waveform.

Conclusions that could be made are that to make oobleck go higher you need a sine wave in low frequency. My findings do not support my prediction because I predicted that pop music or high frequency sound makes the highest movement. This shows that I was wrong because pop music did not do anything to help the oobleck go higher and lower frequencies make it go higher not high frequencies.

The raw data from my test runs is in Table 1 below.

Table 1 Highest measured oobleck point for each sound per test run

Sound/Music File	Max Height 1	Max Height 2	Max Height 3	Max Height 4
30Hz Sawtooth	0mm	0mm	0mm	0mm
30Hz Square	0mm	25mm	45mm	38mm
40Hz Sawtooth	0mm	0mm	0mm	0mm
40Hz Square	0mm	11mm	6mm	17mm
40Hz Triangle	0mm	0mm	0mm	0mm
40Hz Sine	20mm	44mm	52mm	55mm
I Want You Back - Jackson 5	0mm	0mm	0mm	0mm
Stand by Me - Ben E. King	0mm	0mm	0mm	0mm
Illegal - Stanley Clarke	0mm	0mm	0mm	0mm
Video file	MVI_4289.MP4	MVI_4291.MP4	MVI_4292.MP4	MVI_4293.MP4
Time	12:16	12:20	12:24	12:32
Notes	Volume wasn't up for the first two		It went off screen a little	

The chart below shows the maximum height the oobleck reached in each of the test runs as a bar chart for easy visual comparing.
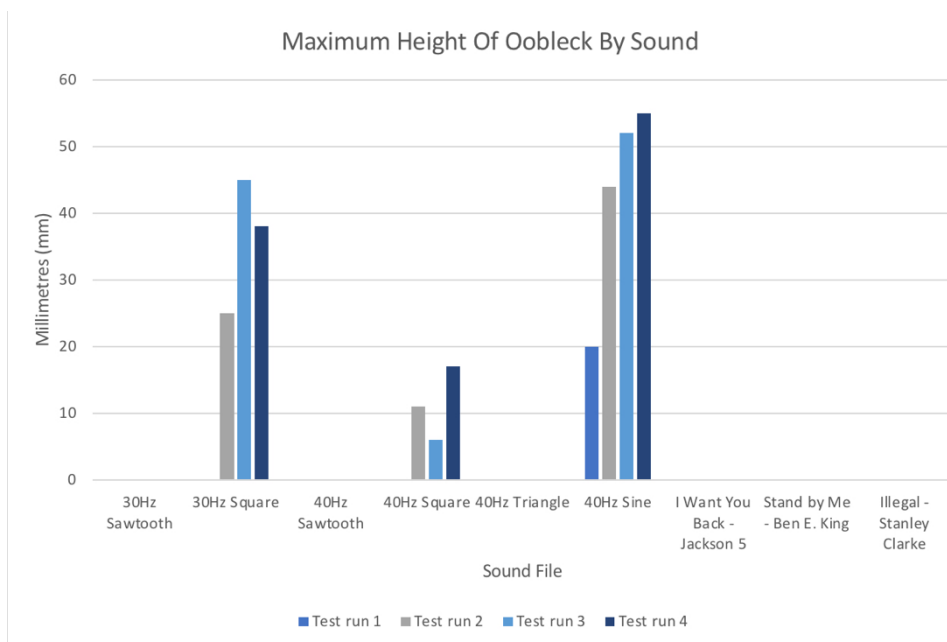

Figure 3 Chart of maximum heights per sound file

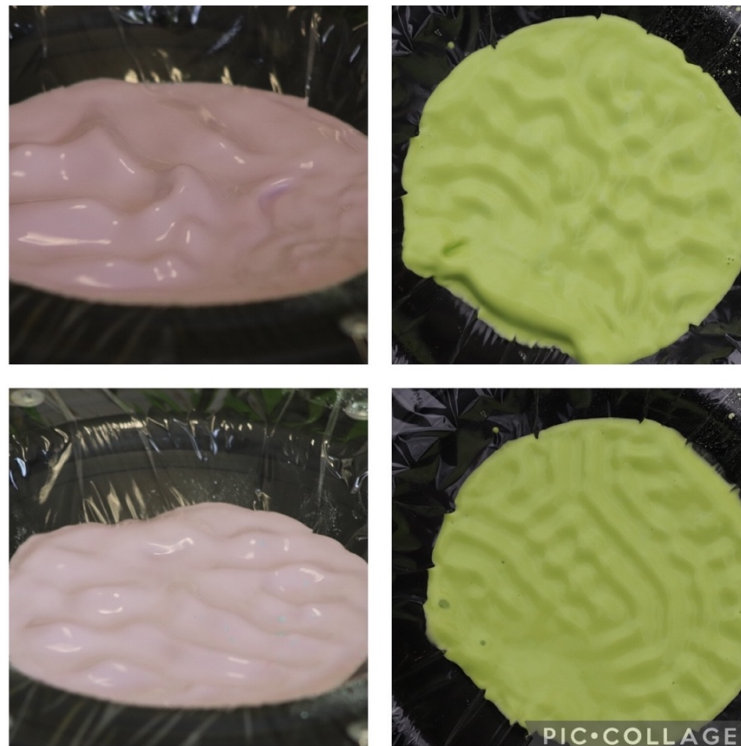The different wave forms created interesting effects on the oobleck as shown in the images below.

Figure 4 40Hz Triangle created a constant ripple effect

Figure 5 40Hz Sawtooth created ripple and bubble effects in the oobleck

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Figure 6 40 Hz Sine became a single very active ball of oobleck

Figure 7 40Hz Square took longer to form a single mass and bounced lower in the speaker

Evaluating

To improve the experiment I could repeat the experiment more times than 4. I could also extend the time that the sounds are played to give the oobleck more time to build up. If I had more money I could have also had more precise equipment like cameras, measuring equipment and speaker.

My findings can be useful to others as I have clear steps if they want to use a speaker to make oobleck dance and go really high in the air.

In my research on non Newtonian fluids [8] I found that researchers investigate how in an earthquake certain types of clay can liquify, which is dangerous if buildings are built on it. My research showed the behaviour of oobleck at low frequencies. Questions that could be further investigated are the effects on other types of non-Newtonian fluids. The STEM Mayhem article [7] explained blood is a non Newtonian fluid. I wonder what impacts low frequency sound have on the human body?

Conclusion

I learnt that to make oobleck jump high you should use a sine sound wave at a low frequency. The goal of my experiment was to find how to make oobleck dance so I can create interesting photos for my photography entry. I learnt a lot about oobleck and how it works and have some great ideas for my photos. Oobleck definitely does dance.

References

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4. Mason, C (2009). *See Inside – How Things Work*, pg 6-7 Making Music. Usborne Publishing.

5. Woodford, C and Parker, P (2018). *Science – a childrens encyclopedia*, Dorling Kindersly Limited.
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   - Pg 18-19 Liquids
   - Pg 52-53 Air
   - Pg 125 Types of Energy – Sound Energy
   - Pg 142-143 Sound
   - Pg 146-147 Music

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8. Non-Newtonian fluids, Science Learning Hub, https://www.sciencelearn.org.nz/resources/1502-non-newtonian-fluids access 28th May, 2023.

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14. AudioMass, open source audio and wave form editing tool, https://audiomass.co, accessed June 10th, 2023.
15. Dance definition, Merriam Webster https://www.merriam-webster.com/dictionary/dance accessed June 25th, 2023.

OSA RISK ASSESSMENT FORM

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

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

STUDENT(S) NAME: _Zoe Curtis_   ID: _____

SCHOOL: _St Peters Girls School_

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

I am planing to do a scientific inquiery on what makes oobleck dance. To do this I will place oobleck in an upsidown speaker and play music.

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?
- 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
• power tools	→ I will get my dad to help me with the power tools.
• loud music	→ I will wear headphones to protect my ears.
• liquids around electrical equipment	→ I will cover the speaker and keep the sterio far away. If it rains I will move inside.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

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

SIGNATURE(S): _ZCurtis_

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

TEACHER'S NAME: _Sophie Dolling_

SIGNATURE: _____ DATE: _26/06/2023_

Journal Log Book

April 21ˢᵗ, 2023

Today I had a talk with my mum. I agreed to enter the 2023 competition, but I started out only planning to enter the photography category.

- brain storming – this year I wanted to enter the photography category. The Vibrations theme gave me the idea of oobleck. I love making oobleck at home and we have made it at Science Alive. I have seen Youtube videos about dancing oobleck. I decided to do an inquiry to help with my photography entry.

- Things I am wondering about:
  - What music does oobleck like to dance to?
  - How to make oobleck movement look good for photos?
  - How to get the biggest movement?
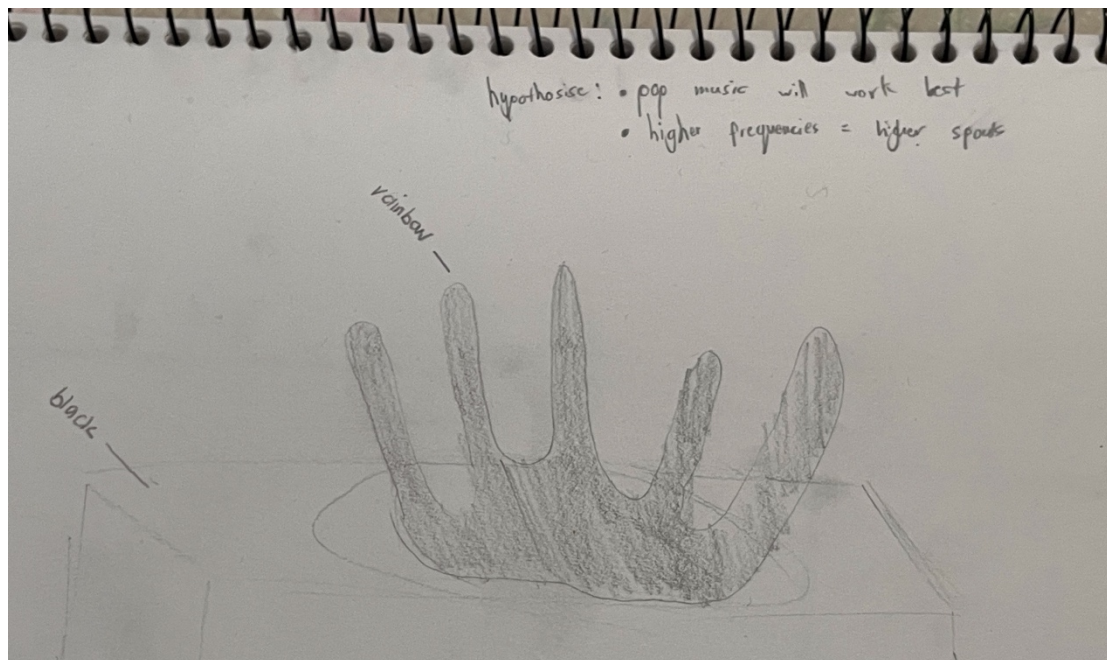- I think Pop music will work best and higher frequencies will make higher spouts.

Figure 1 21st April drawing of the movement I am aiming for

Sunday 7ᵗʰ May, 2023

Today I finalised my entries and titles for submission, then I read the rubric and rules

Sunday 21st May, 2023

Today I looked on gumtree for free or cheap speakers. Mum and dad helped me by contacting the person offering a free subwoofer. In the end I bought a $20 speaker from Jaycar.

Sunday 28th May, 2023

Today I started researching sound, music and oobleck. I learnt some new scientific words and concepts such as viscosity, amplitude, wavelength, frequency, pitch, non-Newtonian liquid, Newton's Law of Viscocity and stress.

I decided on my hypothesis and thought about my variables and prediction.

Dad helped me set up the workbench in the garage. I used the length and width of the wood to calculate the centre. Then I used the diameter measurement of the speaker to calculate the radius and trace a circle using my dad's builders compass on some scrap board. Dad then helped by using his jigsaw to cut out the circle. I painted the wood black to match the speaker and then dad helped me screw in the speaker so it is held steady when playing music.

Figure 2 Creating the experiment setup

Sunday 4th June, 2023

Today I would like to test some variables before deciding on my experiment materials and method. The type of plastic to cover the speaker with (sandwich bag or glad wrap) and the perfect oobleck formula.

What happened: it was hard to get the speaker to work at first. Dad helped troubleshoot.

Figure 3 Initial testing of variables to finalise experiment method and materials

Mum, Dad and I each chose two styles of music each. We tried:

- Happy – Pharrell Williams – Pop
- Mr Perfectly Fine - Taylor Swift – Country
- I Love It - Sneaky Sound System – Dance/Electronic
- Forever Now - Cold Chisel – Rock
- No Diggity - BlackStreet – RnB
- Chameleon - Herbie Hancock – Early Fusion

When we did get the stereo working none of the songs we played made much movement. RnB and the Dance song were the only two where we could see some movement at the edges of the oobleck.
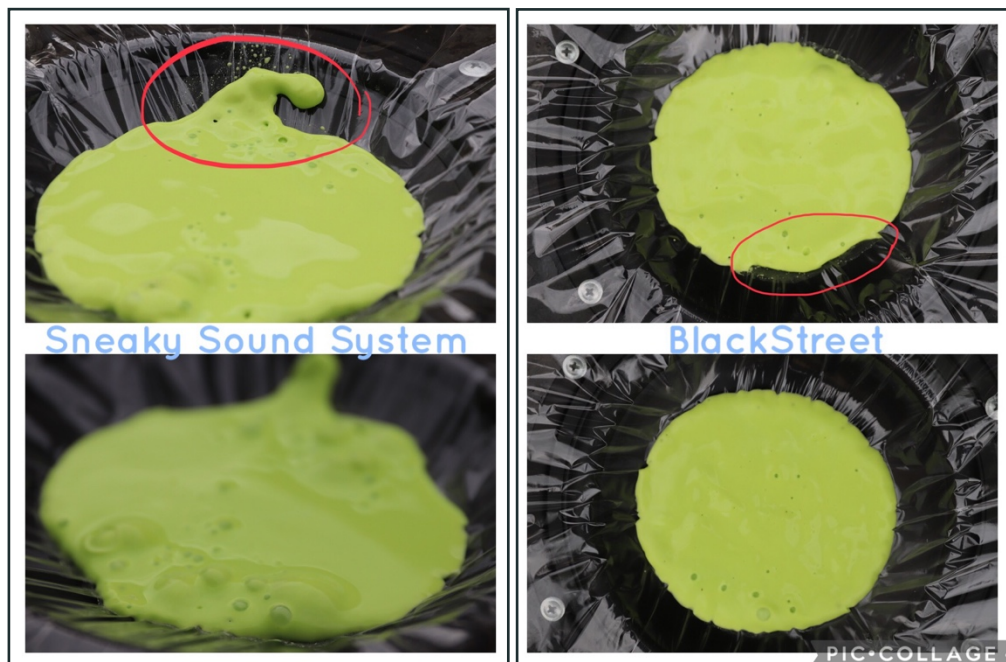
Figure 4 Examples of music effects on oobleck in early testing

Because it wasn't really working I did some more research. I used the Online Generator website referenced in one of the articles and downloaded some sound files with different frequencies. Dad burnt them to a CD for me.

I tried:

- 9999 Hz Square Wave
- 1900 Hz Square Wave
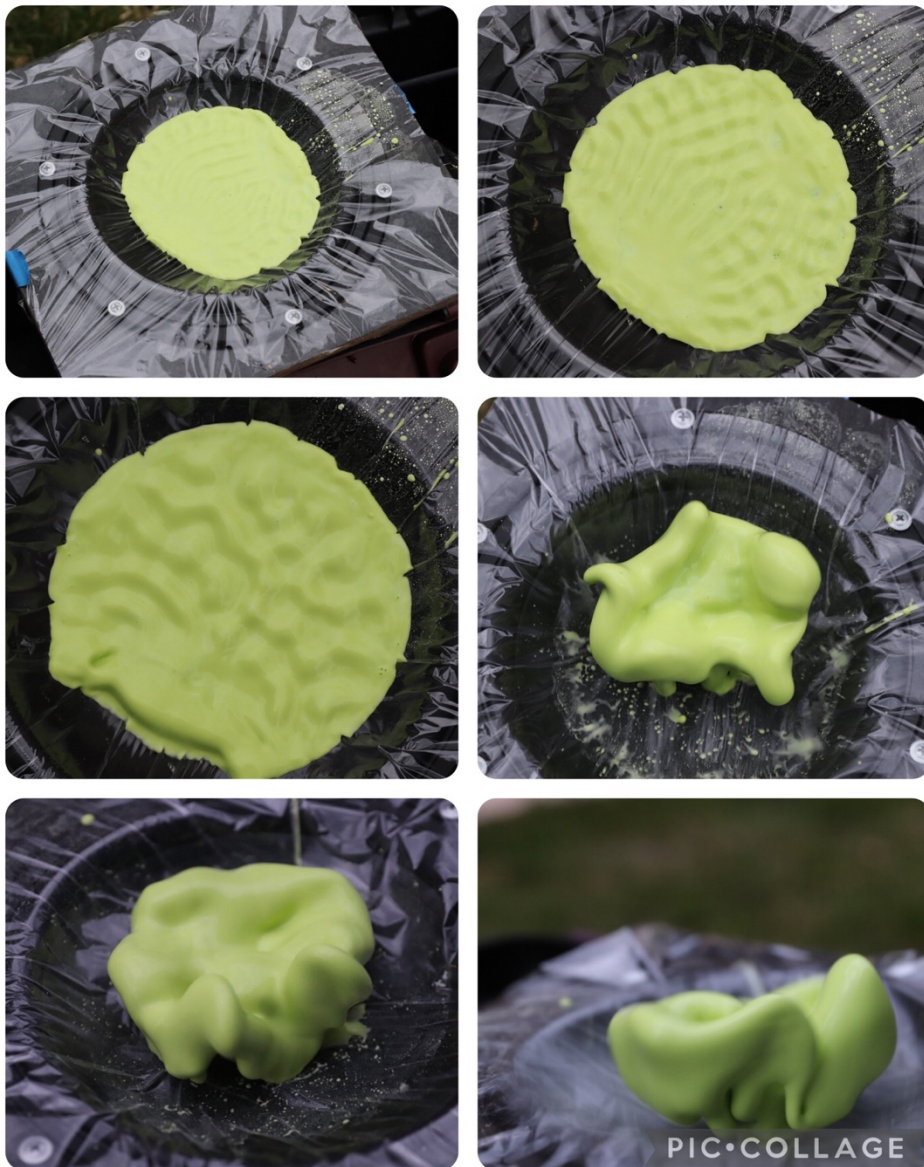- 500 Hz Square Wave
- 40 Hz Square Wave

Figure 5 Examples of generated sound waves on oobleck in early testing

When we played the generated sounds through the speaker the oobleck danced around a lot for the lower frequencies. I took some photos and observed the oobleck. At this point it had started raining outside and we had to test the rest in the laundry. I tried water before trying the same sound files with a runnier version of oobleck. When we tested the water it went everywhere. I set up some rulers to see how high it rose and the water got up to 40cm above

the speaker rim. The highest oobleck jump was 7.5cm above the speaker rim. Mum and Dad helped with the setup and cleanup. Dad taught me how to connect the speaker wires to the stereo and pushed play on the music and sounds for me. I borrowed mums camera to take photos and videos.

Observations:

- The higher viscosity (thicker) oobleck jumped around like a big flat pancake (Figure 6), the lower viscosity oobleck made more interesting shapes, the water went everywhere.
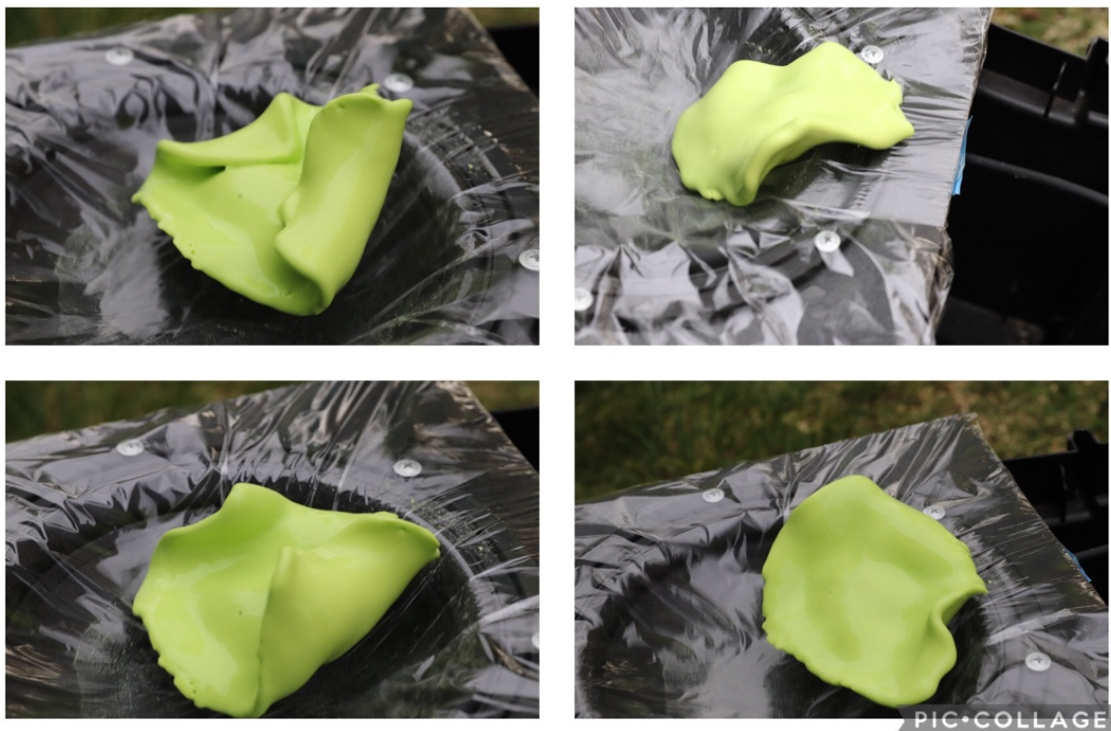- The glad wrap seemed to work better than the sandwich bag plastic.

Figure 6 Example of the movement of thicker oobleck in early testing

Some questions I have are:

- What types of music have low frequency sounds?
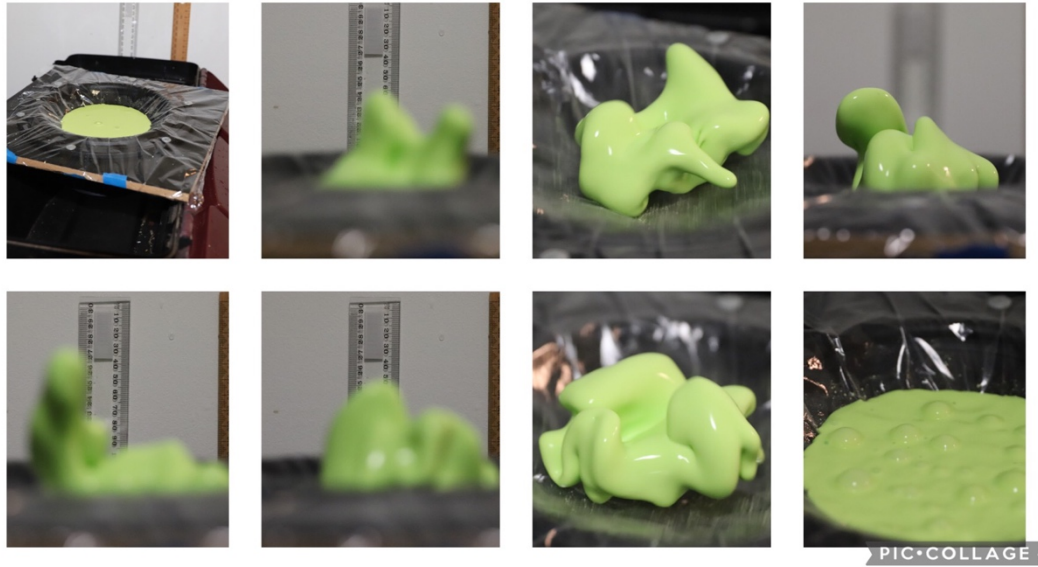- Does the wave form of the generated sound make a difference?

Figure 7 Examples of early testing of setup, how to measure oobleck movement

Sunday 11th June, 2023

Mum and Dad helped with the setup and cleanup again. Mum helped by downloading the photos and videos for me. My cat Stripes was my assistant and checked the setup was correct (Figure 8). I used generated sound and music in my experiment to see the difference between the two and discovered that the repeated simple sound waves make more movement. The speaker and the toolbox moved a lot when I played particular sounds. So in the end I had to hold it to make sure that it didn't move. I had trouble making the oobleck less liquidy. On our first try when I scooped the 6 tablespoons from the bowl the more liquid mixture at the top ran into the spoon. I tried stirring the mixture to get a more even mix before measuring out each tablespoon.

Figure 8 My assistant checking everything is in order

I made two batches to be sure we had the mix right. 2.5 parts corn flour to 1 part water. I discovered that anything less than this in flour was much too liquidy but anything more and it was much too solid. I tried a mixture of three parts flour and one part water but it was much too thick and we could barely scoop it out of the bowl. When I tried this one I only put one tablespoon in the speaker and when I turned on the music the oobleck split into three parts and began to jump out of the speaker.

I used an online tool, Audio Mass, to make the simple generated sound clips 30 seconds long. This tool also let me see the visual representation of the sound. Figure 9 shows roughly one second of the simple and complex sounds of generated noise compared to music.
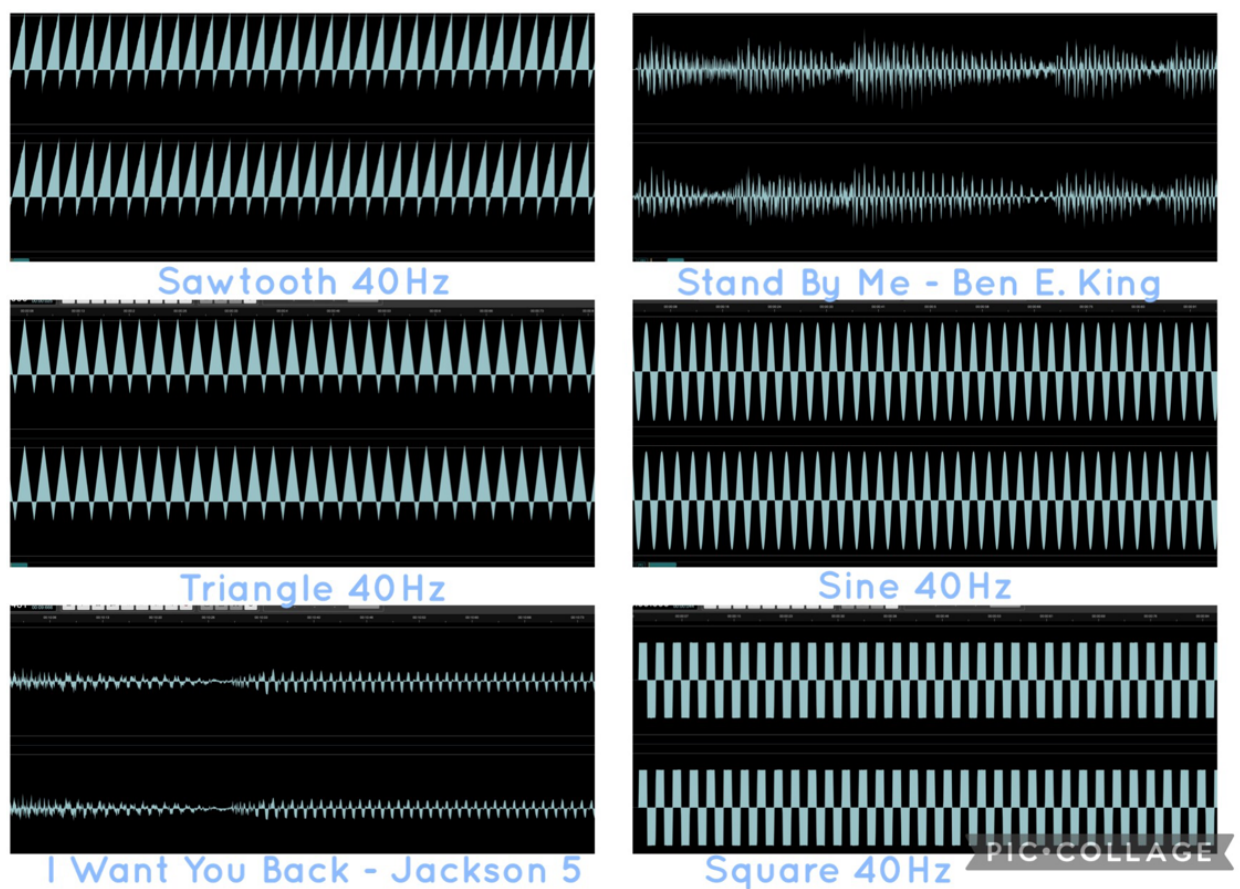

Figure 9 Sound wave files shown in Audio Mass

On the second batch of oobleck the picture below (Figure 10) shows some of the interesting ways the oobleck moved.
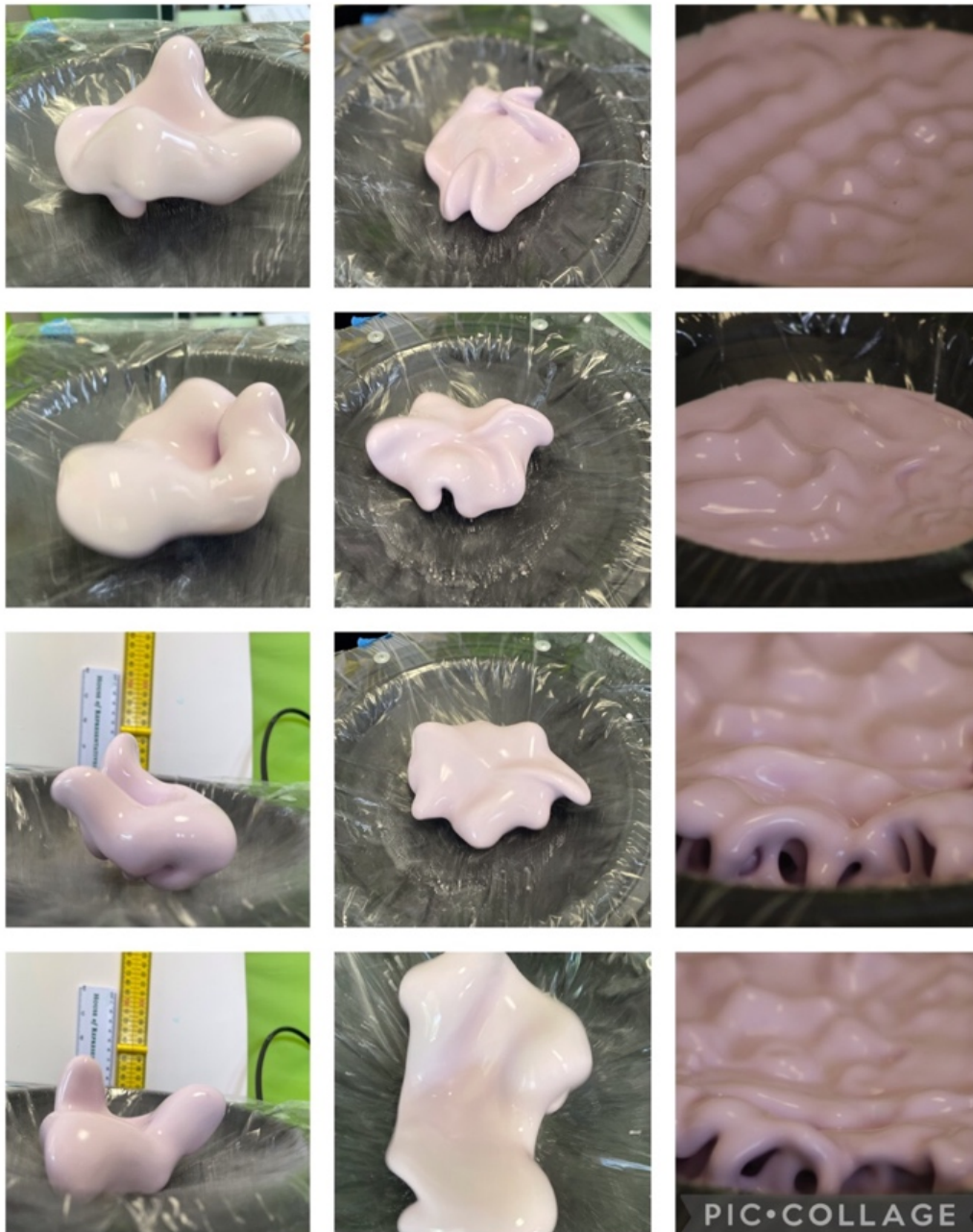

Figure 10 Oobleck movement when sound is played through it

Saturday June 24th, 2023

Today I looked through the video files frame by frame to record the highest peaks of the oobleck with help from dad. In the videos there where 24 frames per second. To record I decided that it had to be above the speaker rim. I also decided that the little spots that fly off do not count so I only measured the main blob.

Two of the runs had small issues. The stereo wasn't on full volume for the first two sound files. In the third run the speaker moved a little from the vibrations and the side of the oobleck was a little out of view of the camera. I decided to keep these in the data as the remaining sounds all played and I was able to see the main blob enough to measure it.

Figure 11 Example of small drops shooting off at much higher levels

Observations:

- 40Hz sine was always the highest
- None of the songs made the oobleck go above the rim I think this is because the songs do not have consistent vibrations
- Sawtooth and triangle didn't make it above the rim
- 40Hz square was always the lowest that did make it above the rim
- The 30Hz square was higher than the 40Hz square I think that is because it had less time to rest between peaks
- In the videos I took from above, the music just bubbled, the sawtooth had small waves and bubbles and the triangle rippled constantly

Sunday 25th June, 2023

Today I finished writing my report and my mum proof read it for me ready for submission.