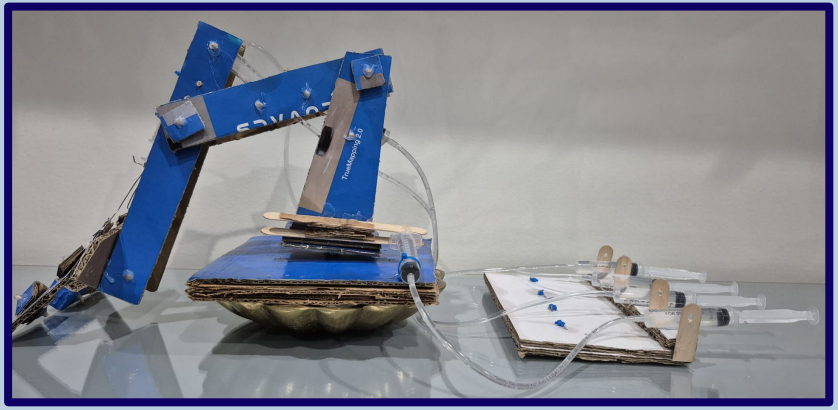


HydroPower: Hydraulic Arm

Yuvraj Dhillon and Princeveer Kailay 9B

PK

BACKGROUND RESEARCH

What are hydraulics?

Hydraulics are machines that use the Pascal's law to function. Pascal's law states that when pressure is applied to a enclosed fluid it gets distributed evenly throughout the enclosed area. The pressure created inside the hydraulics causes one end of the hydraulic to move. The hydraulics are made of a cylinder, a pump and valves. The pump is where the Pascal's law does it's work. In the cylinder there is a piston rod which creates the pressure of the fluid allowing it to move the hydraulic. The pump is the part that powers the piston and allows it to move. Valves in the hydraulic allow the fluid to move in different direction. This allows the hydraulic to move up,down,left and right.

E=m

PK

BACKGROUND RESEARCH

What are the uses of hydraulics?

There are many uses of hydraulics**. Hydraulics are used to carry heavy materials easily. Many things that we see in our everyday life are hydraulics. Cranes are the best example of hydraulics**. **Cranes** move things horizontally and vertically all with the help of fluids. This makes it easy to carry heavy materials. Another use of hydraulic includes **transportation**. In our **cars** that we drive every day, the brakes are hydraulics. Another hydraulic in your car is the **suspension**. Another form of transportation includes **planes**. There are countless hydraulics in aircrafts. When we use elevators instead of having to walk up stairs, the **elevator** operates because of hydraulics. It can move heavy loads of people with very less effort. This is why hydraulics are a thing in the first place. Back home in India, there is a lot of agriculture. **Tractors** also use hydraulics just like cars.

E=m

PK

BACKGROUND RESEARCH

What type of fluids go in hydraulic arms?

Hydraulic arms and many other hydraulics use fluids based on viscosity, compressibility, environment factors, and temperature stability. Using this, many hydraulics use a type of oil called Hydraulic Oil. Hydraulic Oil is non compressible. The hydraulic oil can either be synthetic or mineral based. Other fluids are also water based fluids, biodegradable fluids, and lastly fire resistant fluids.

E=m

PK

BACKGROUND RESEARCH

What is viscosity?

Viscosity is one of the key properties of a fluid. It measures that ability of a fluid's resistance to flow. In hydraulic arms the viscosity is a key concept for the arm to work. This increases the efficiency of the arm. The performance of the arm would be much worse but the amount to fluid used how be a lot less. The less viscous fluid would flow through the pipes at a faster rate. This will increase pressure given to the arm. The more pressure would allow the performance to increase a lot. Less viscous fluid would have be better at moving one thing from one place to another. The less viscous fluid would be more effective. Temperature has a huge impact on the viscosity. The more the temperature increases the lesser the viscosity goes. The lower the temperature would mean the higher the viscosity.

E=m

YD

BACKGROUND RESEARCH

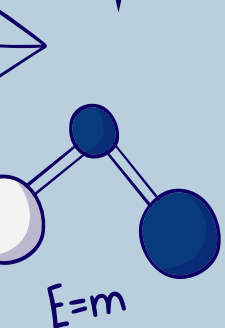
FLUIDS USED	PROPERTIES OF THE FLUIDS
Synthetic Brake Fluid	Synthetic Brake Fluid has the property of being very resistant to moisture and performing better in extreme conditions, viscosity is low. Second least viscous liquid. Better performance in lower temperatures.
Full Synthetic Motor Oil	The second most viscous liquid. Less friction in the liquid resulting in better performance. Keeps viscosity over a wide range of temperatures.
Power Steering Fluid	Most viscous liquids out of all tested. Good with working under higher temperatures.
Control(Water)	Least viscous liquid of all tested, can fit into any space easily, low heat capacity.

YD

BACKGROUND RESEARCH

What is the relationship between viscosity and lifting weight ?

In this experiment we are testing how different viscosity levels affect how much weight something can lift up. Viscosity and lifting weight go hand in hand. In a hydraulic, the arm depends on fluids to pick up heavy objects. If these fluids are not sufficient, the entire hydraulic may not work. If the fluid is too viscous, the fluid flow rate will be very slow. If the flow rate of a fluid is too slow, the responsive time of the arm will be delayed, and energy may lost. If the fluid is too viscous, the pump of the hydraulic would need to work harder. This would defeat the purpose of a hydraulic which is to make lifting heavy things more efficient. On the other side, if the fluid is too thin and a low level of viscosity, the viscosity may not generate enough energy/power to lift up heavy objects. Furthermore, hydraulic arms work more efficient with a fluid not too viscous or too less viscous.



BACKGROUND RESEARCH

High Viscosity in Hydraulic Arm vs Low Viscosity in Hydraulic Arm

High Viscosity Pros:

- Better under warm conditions
- Less leakage

High Viscosity Cons:

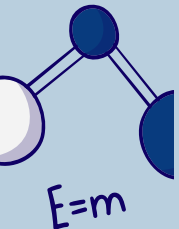
- Slow response time
- Bad under cold conditions
- Pump requires more effort

Low Viscosity Pros:

- Faster flow rate
- Pump requires less effort
- Better under cold conditions

Low Viscosity Cons:

- Bad under warm conditions
- High risk of leakage
- Bad under warm conditions



YD

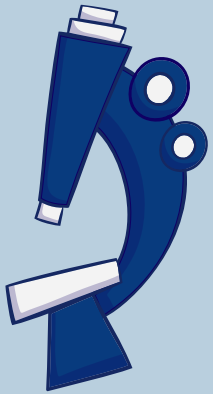
DEFINITIONS:

Hydraulic: A mechanical function that operation using the force of liquid pressure.

Viscosity: The property of a liquid of how fast it will flow.

Efficiency: Ratio of useful energy output to the total energy input in a device or system; usually given as a percent.

Fluid: Any material that flows in response to an applied force.



YD

TESTABLE QUESTION

When picking up a 12 ounce coke can filled with water weights ranging from 20 mL to 60mL, does the viscosity of a hydraulic fluid in the syringe (giving the arm power) affect the performance (ability to pick up weight and move required 30cm distance) of a hydraulic arm?

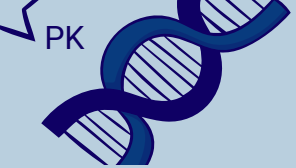
YD

HYPOTHESIS

When adding 4 different fluids of different viscosity levels (Power Steering fluid, Synthetic Brake fluid, Full Synthetic motor oil, Water) in the syringes of the hydraulic arm one at a time, we believe the Synthetic Brake Fluid will perform the best at picking up the heaviest load and transporting it to the required distance of 30cm. We believe this as the Synthetic Brake fluid is not very viscous meaning it will have a faster response time and will flow faster compared to Full Synthetic Motor Oil and Power Steering Fluid. On the other hand, It will be viscous enough to generate enough power. In our background research it is stated, if the fluid is too viscous the response time will be slow and the fluid will not flow. We also know that Power Steering and Full Synthetic Motor Oil are very viscous so they may not work best. It also says, if fluid is too less viscous it may not generate enough energy. We also know water is the least viscous. Using our background research, we think Synthetic Brake fluid will work most efficient.

MATERIALS

- Double Wall Cardboard
- 10 mL Syringes (8)
- Small metal rod
- Syringe tubing
- Zip-ties
- Popsicle sticks
- Skewers
- 12 ounce coke can
- Dead Battery
- Water
- Power Steering fluid
- Synthetic Brake Fluid
- Full Synthetic Motor Oil
- Hot Glue
- Scissors
- Drill
- Pencil
- Box Cutter
- Ruler
- Plyer
- mL measuring cup



WHY CARDBOARD WAS USED ?

We used cardboard because it's readily available as compared to sheet metals and wood. This allows the experiment to be duplicated and tested by anyone. It has the ability to form into any desired shape or structure we wanted with the help of simple tools like box cutters or scissors. Cardboard made it very easy for us to design and create the hydraulic arm according to the requirements. The cardboard hydraulic arm was sturdy and remained steady through the entire experiment and trials very well.

VARIABLES

Controlled Variables: Object being lifted by the hydraulic arm, temperature of the fluid used, size of syringe, size of tubes connecting each syringe, the can, the starting position of the can at the start of experiment, finishing position of can through the experiment, fluid used as weight in the can. Weather conditions inside of testing room of experiment.

Uncontrolled Variables: Air bubbles may be getting formed in syringes

Manipulated Variables: Type of fluids being used, Viscosity of fluids in syringes of the hydraulic arm.

Responding Variables: How much weight the hydraulic arm could carry.

HOW WE ENSURED OUR VARIABLES REMAINED CONSTANT THROUGHOUT ALL 3 TRIALS?

In the controlled variables stated in the previous slide, the object being lifted by the hydraulic arm, temperature of the fluid used, size of syringe, the can, size of tubes connecting each syringe, starting position of the can at the start of experiment, finishing position of can throughout the experiment, fluid used as weight in the can were kept the same.

We ensured that the arm was always lifting up 20, 40 and 60 ml liquid but if the arm could not lift that weight, then we tested the weight upto that range to find the max capacity. For example, the power steering could not lift 20ml. We then tested all weights in between 0 and 20 ml. In the end, we got 12 ml for trial 1.

The size of syringes stayed the same at 10 ml syringes. We did not change any syringe of tubing in any of the trials. We just changed the fluid in the syringes. In the experiment we marked down starting point and finishing point with X's to make sure they were not different. We ensured that only water was in the can to be used as weight.

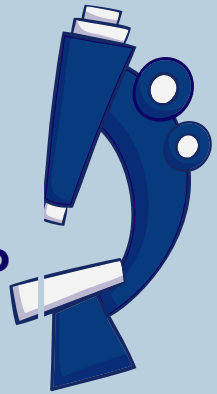
PROCEDURE OF THE EXPERIMENT

1. Build the arm and control panel using the direction as explained in the next few slides.
2. Fill up the four control panel syringes and tubing with Power Steering Fluid. Make sure there are no air bubbles.
3. Attach the open end of the tubing to the other syringes
4. Mark a Starting point and Finishing point 30 cm apart.
5. Put empty can on starting point. Push and Pull Plungers of syringes and try moving can from one point to another.
6. Repeat step 5 for all water weights and record observations.
7. Repeat steps 1-6 for all fluids and water weights.

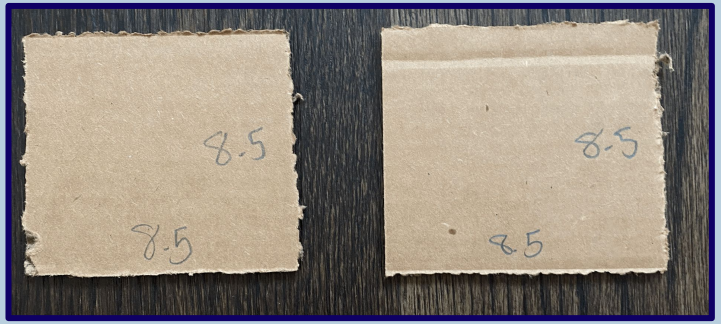
PROCEDURE OF THE BODY

1. Cut 20 cm by 4 cm rectangles out of cardboard.
2. Drill a hole close to the top on the piece of cardboard at either end.
3. Repeat step one and two one more time.
4. Cut out 2 8.5 by 8.5 square from the cardboard.
5. Cut 2 26 cm by 4 cm rectangle with holes on either end like step 2.
6. Cut a quadrilateral with the top of 4 cm, bottom of 7cm, and diagonal of 13cm.
7. Drill a hole like the ones shown in the picture Insert a skewer into one of the 26cm by 4 cm rectangle. Take the other similar rectangle and insert the other end of the swerwer into the same hole as done before.

(Pictures on the next slide)



8.5 cm by 8.5 cm



The top of 4 cm, bottom of 7cm, and diagonal of 13cm

20 cm by 4cm

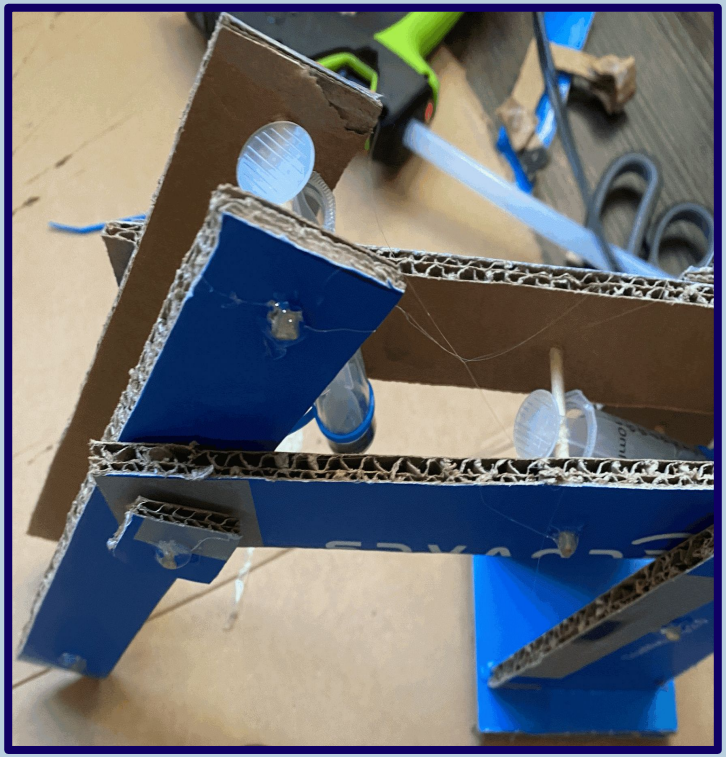
26 cm by 4 cm

PROCEDURE OF THE BODY CONTINUED.....

8. Secure with glue on each end.
9. Attach 20cm by 4 cm rectangle in the other hole of the 26cm by 4 cm rectangle on the outer end of each rectangle.
10. Secure with small cm by cm square to help movement.
11. Take the quadrilaterals and attach them to the remaining holes of both 20 by 4 cm rectangle. Make it vertical so it can stand.
12. Hot glue the two 8.5 by 8.5 cm squares together and then to the structure you made.
13. Drill a hole into the plunger of the syringe.
14. Drill a hole into the center of both of the 20by cm 4 cm rectangles.
15. Take 2 zip ties tie them in loops. Take one zip ties and tie it to the front of the syringe. Insert a skewer into the other loop of the zip ties. Cut off the excess zip tie. Remove the skewer.
16. Insert the syringe in between both 20 cm by 4cm pieces.
17. Do the same thing but this time add it to the support.
18. Attach another syringe the same way but on the 20 by 4 cm rectangle.

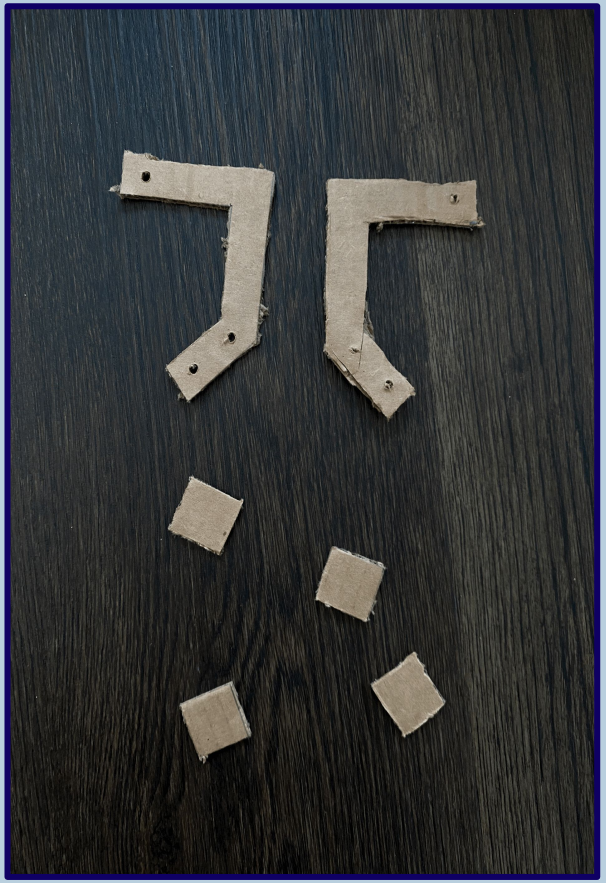
(Pictures on the next slide)


TrueMapping 2.0



PROCEDURE OF THE HYDRAULIC ARM

1. Cut out a diamond as shown in the picture.
2. Cut out two hands as shown in the picture.
3. Under adult supervision use pliers to bend on end of the metal rod.
4. Insert hook into one of the last openings.
5. Insert a skewer between one hand and the diamond with the hole right next to the hook.
6. Add a cm by cm square to hold support.
7. Cut excess skewer.
8. Add glue to end of skewer.
9. Fold a small rectangle of cardboard into 3 parts.
10. Using a small rectangular piece of cardboard fold it into 3 parts.
11. Using a skewer attach this onto the last hole of the hand with glue to secure it down.
12. Repeat for the other hand.
13. Use hot glue on the top of the front of the body to attach the arm.



PROCEDURE OF THE HYDRAULIC ARM CONTINUED.....

14. Cut a hole into the 26 by 4 cm rectangle.

15. Repeat step 15 also make 2 small holes in the top of the plunger. Put the syringe in between the front of the crane.

16. Take the other end of the metal rods and squeeze them through the 2 small holes on the plunger.

17. Cut 2*20cm by 20 cm cardboard squares. Hot glue them together.

18. Drill a hole through the center of this square big enough for a old AA battery.

19. Drill the same size hole into the base of the body.

20. Attach the body to the new base via the battery.

21. Take a syringe and cut off the ends to the plunger like this. (Picture)

22. Take 2 popsicle sticks, one piece of cardboard the height of the remaining plunger. And glue them together.

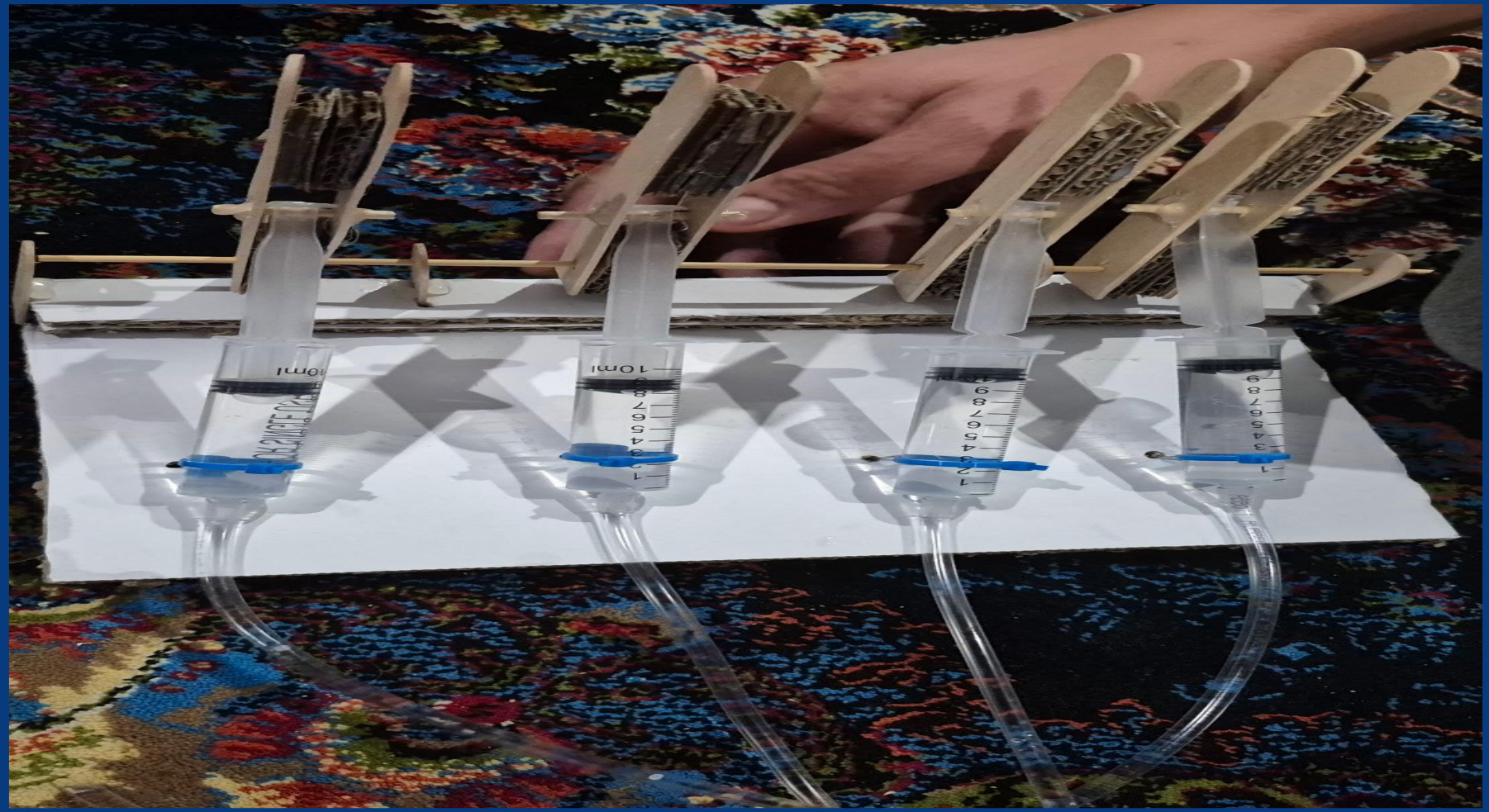
23. Cut a hole through one end of the popsicle sticks and attach the syringe with the use of a skewer. Cut excess of skewer and secure with glue.

24. Attach the base of the body with hot glue.


TrueMapping 2.0

PROCEDURE OF THE CONTROL PANEL

1. Take a 30cm by 20cm rectangle and glue a 30cm by 2 cm rectangle on one of the edges.
2. Cut 4 popsicle sticks from the top and drill holes into the top of the cut stick.
3. Glue them vertical about 7 cm apart on the 30 cm by 2cm piece.
4. Repeat the popsicle stick, cardboard, syringe contraption but with the syringe in the middle.
5. Repeat until you have 4 contraptions.
6. Attach to the control panel through the holes of the popsicle sticks.
7. The popsicle sticks holding the syringe should look like lever.
8. Take one fluid and fill one syringe in the control panel.
9. Add tubing from that syringes and attach to any syringe on the arm.
10. Repeat for rest 3 fluids.
11. Push down one lever and observe what happens to the arm.



POWER STEERING FLUID TRIAL 1 (OBSERVATIONS/ JOURNAL)

- It was very hard to push the syringes compared to other fluids.
- Yellow colour.
- When picking up the coke can filled with 20 mL of water, the Power steering fluid was not able to lift and move the coke can.
- Arm was able to lift 12 mL of water but required extreme effort.
- The fluid was very viscous.
- The power steering fluid couldn't lift the coke can filled with 40 or 60 mL of water.

SYNTHETIC BRAKE TRIAL 1 (OBSERVATIONS/ JOURNAL)

- The fluid was clear.
- Less viscous compared to some of the other fluids
- When picking up the coke can filled with 20 mL of water, the Synthetic Brake fluid picked up the coke can and moved it effortlessly to the finishing point.
- The hand seemed to lose grip once we let go of the syringe controlling that area.
- When picking up the coke can filled with 40 mL of water, the Synthetic Brake fluid picked up the can.
- The syringe controlling the hand had to be held down.
- When picking up the can filled with 60 mL of water, the Synthetic Brake fluid successfully transported the coke can.
- Syringes were easy to push and pull.

FULL SYNTHETIC MOTOR OIL TRIAL 1 (OBSERVATIONS/ JOURNAL)

- The fluid was one of the most viscous liquids.
- Fluid has a yellow colour.
- The syringes are hard to push and pull.
- When picking up the coke can filled with 20 mL of fluid, the hydraulic arm moved it to the finishing point.
- When picking up the coke can filled with 40 mL of fluid, the hydraulic arm moved it to the finishing point but it took more effort than 20 ml.
- The Hydraulic Arm was not able to pick up the coke can filled with 60 mL of fluid.

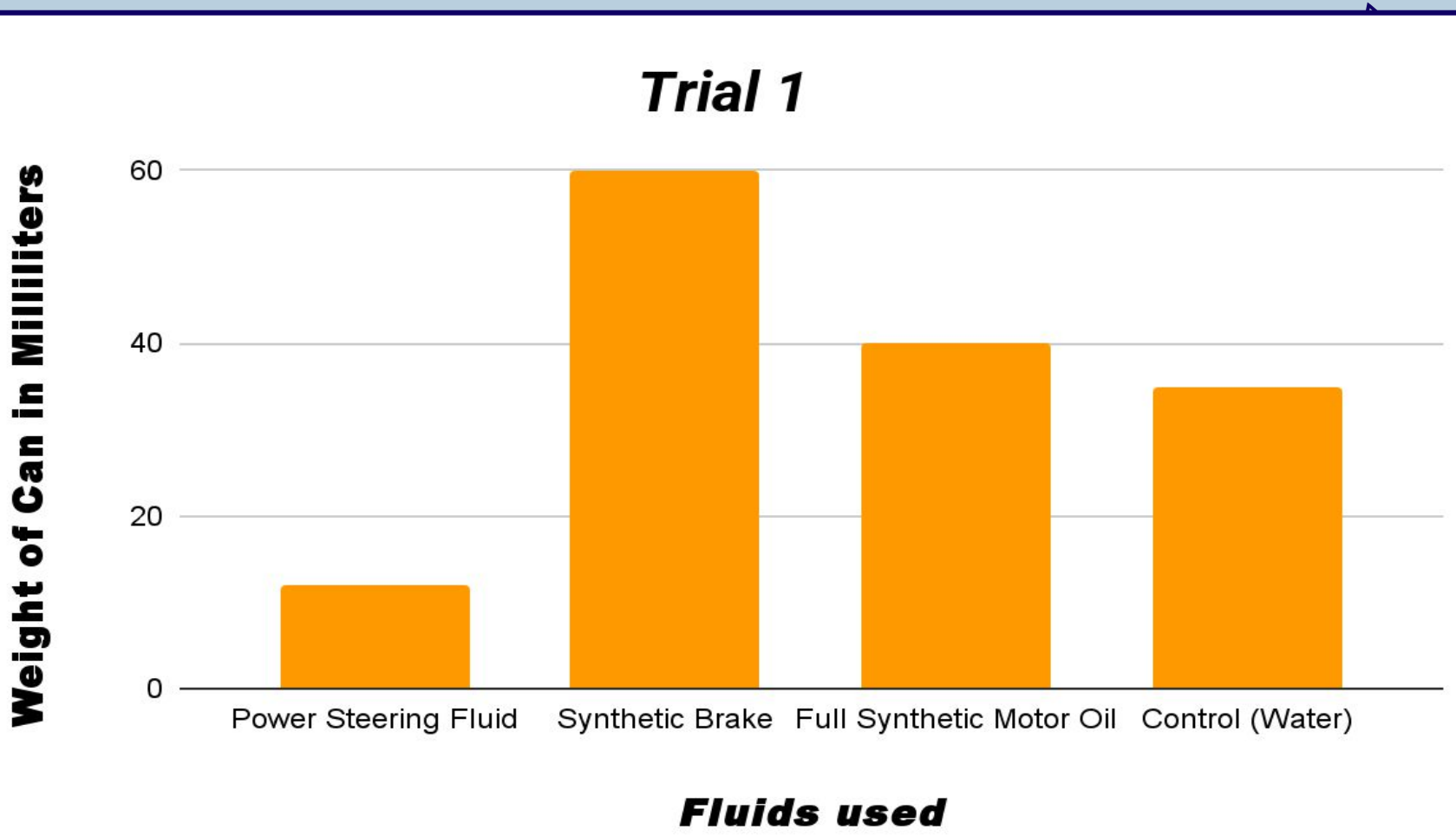
CONTROL (WATER) TRIAL 1 OBSERVATIONS/ JOURNAL

- Control fluid (Water) was a lot less viscous than other fluids
- Clear colour.
- When picking up the coke can filled with 20 mL of water, the Hydraulic arm picked up the coke can and moved it to the finishing point easily but required a little more effort by the syringes.
- Was not able to lift 40 mL.
- When picking up the coke can filled with 35 mL of water, the Hydraulic moved it to the finishing point.
- Couldn't pick up any more weight.

Trial 1 Power Steering Fluid	• It was very hard to push the syringes. • Yellow colour. • When picking up the coke can filled with 20 mL of water, the Power steering fluid was not able to lift and move the coke can. • Arm was able to lift 12 mL of water but required extreme effort. • The fluid was very viscous. • The power steering fluid couldn't lift the coke can filled with 40 or 60 mL of water.
Trial 1 Synthetic Brake Fluid	• The fluid was clear. • Less viscous compared to some of the other fluids • When picking up the coke can filled with 20 mL of water, the Synthetic Brake fluid picked up the coke can and moved it effortlessly to the finishing point. • The hand seemed to lose grip once we let go of the syringe controlling that area. • When picking up the coke can filled with 40 mL of water, the Synthetic Brake fluid picked up the can • The syringe controlling the hand had to be held down. • When picking up the can filled with 60 mL of water, the Synthetic Brake fluid successfully transported the coke can . • Syringes were easy to push and pull.
Trial 1 Full Synthetic Motor Oil	• The fluid was one of the most viscous. • Fluid has a yellow colour. • The syringes are hard to push and pull. • When picking up the coke can filled with 20 mL of fluid, the hydraulic arm moved it to the finishing point. • When picking up the coke can filled with 40 mL of fluid, the hydraulic arm moved it to the finishing point but it took more effort than 20 ml. • The hydraulic Arm was not able to pick up the coke can filled with 60 mL of fluid.
Trial 1 Control (water)	• Control fluid (Water) was a lot less viscous than other fluids • Clear colour. • The control was able to pick up and move the empty coke can to the required distance very easily and required very less effort. • Was not able to pick up 40 mL. • When picking up the coke can filled with 35 mL of water, the Hydraulic arm's height only rose to half of its maximum height, and moved it to the finishing point. • Couldn't pick up any more weight.

FLUID'S ABILITY TO PICK UP 20ML, 40ML, 60ML OF MASS

Trial 1	Synthetic Brake Fluid	Full Synthetic Motor Oil	Contro(Water)	Power Steering Fluid
20ml	Yes	Yes	Yes	No
40 ml	Yes	Yes	No	No
60 ml	Yes	No	No	No


Trial 1
Weight of Can in Milliliters
60
40
20
0
Power Steering Fluid
Synthetic Brake
Full Synthetic Motor Oil
Control (Water)
Fluids used

POWER STEERING FLUID TRIAL 2 (OBSERVATIONS/ JOURNAL)

- Lots of air bubbles were formed.
- It was much harder to push the syringes compared to trial 1.
- Yellow colour.
- Was not able to pick up 20 mL.
- After some tries, Arm was able to lift 12 mL of water by pushing very hard.
- The arm was not able to lift or move 15 ml of water.
- The fluid was very viscous.
- The syringes were nearly impossible to push.

SYNTHETIC BRAKE TRIAL 2 (OBSERVATIONS/ JOURNAL)

- When picking up the coke can filled with 20 mL of water, the Synthetic Brake fluid picked up the coke can and moved it effortlessly to the finishing point.
- The hand seemed to lose grip once we let go of the syringe controlling that area.
- When picking up the coke can filled with 40 mL of water, the Synthetic Brake fluid picked up the can.
- The syringe controlling the hand had to be held down, became little harder to push.
- The synthetic brake could only lift up 55 mL of water, but could not lift up 60 mL of water.

FULL SYNTHETIC MOTOR OIL TRIAL 2 (OBSERVATIONS/ JOURNAL)

- The fluid is more viscous than the rest.
- Fluid has a yellow colour.
- The syringes are hard to push and pull.
- When picking up the coke can filled with 20 mL of fluid, the hydraulic arm moved it to the finishing point.
- Picked up 40 mL.
- When picking up the coke can filled with 42 mL of fluid, the hydraulic arm moved it to the finishing point
- It could not lift the coke can with 60 mL.

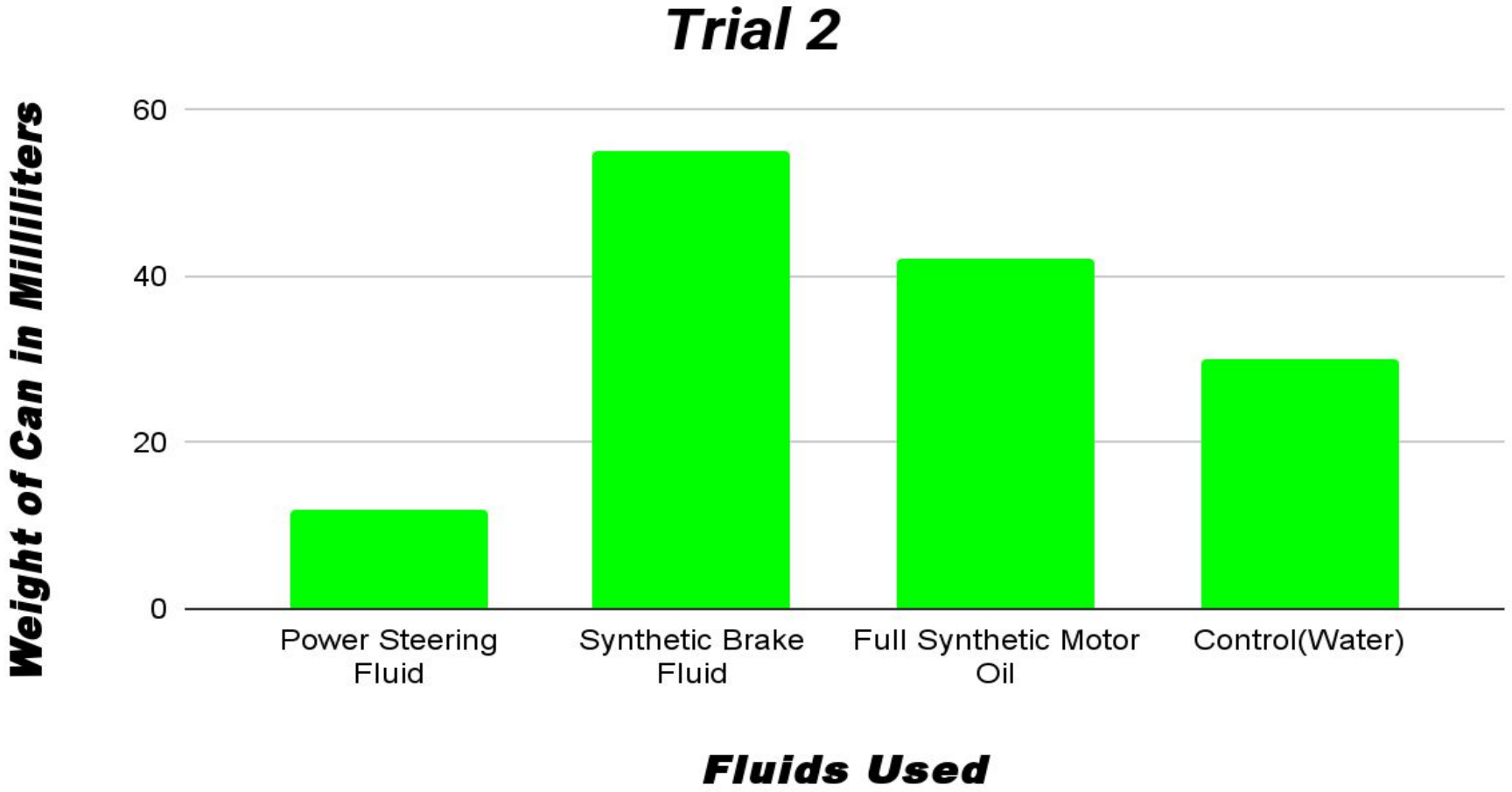
CONTROL TRIAL 2 (OBSERVATIONS/ JOURNAL)

- Control fluid (Water) was clear, was a lot less viscous than other fluids.
- Unlike trial 1, When picking up the coke can filled with 35 mL of water, the Hydraulic arm could not pick up the can.
- When picking up the coke can filled with 30 ml of water it moved the can to the required distance.
- Hydraulic arm couldn't pick up any more weight.

Trial 2 Power Steering Fluid	• Lots of air bubbles were formed. • It was much harder to push the syringes. • Yellow colour. • Could not lift 20 mL. • After some tries, Arm was able to lift 12 mL of water by pushing very hard. • The arm was not able to lift or move 15 ml of water. • The fluid was very viscous. • The syringes were nearly impossible to push.
Trial 2 Synthetic Brake Fluid	• When picking up the coke can filled with 20 mL of water, the Synthetic Brake fluid picked up the coke can and moved it effortlessly to the finishing point. • The hand seemed to lose grip once we let go of the syringe controlling that area. • When picking up the coke can filled with 40 mL of water, the Synthetic Brake fluid picked up the can. • The syringe controlling the hand had to be held down. • The synthetic brake could only lift up 55 mL of water, but could not lift up 60 mL of water.
Trial 2 Full Synthetic Motor Oil	• The fluid is viscous. • Fluid has a yellow colour. • The syringes are hard to push and pull . • When picking up the coke can filled with 20 mL of fluid, the hydraulic arm moved it to the finishing point. • Picked up 40 mL. • Could not pick up 60 mL. • When picking up the coke can filled with 42 mL of fluid, the hydraulic arm moved it to the finishing point.
Trial 2 Control (water)	• Control fluid (Water) was clear, was a lot less viscous than other fluids. • Unlike trial 1, When picking up the coke can filled with 35 mL of water, the Hydraulic arm could not pick up the can. • When picking up the coke can filled with 30 ml of water it moved the can to the required distance. • Hydraulic arm couldn't pick up any more weight.

FLUID'S ABILITY TO PICK UP 20ML, 40ML, 60ML OF MASS

Trial 2	Synthetic Brake Fluid	Full Synthetic Motor Oil	Control (Water)	Power Steering Fluid
20ml	Yes	Yes	Yes	No
40 ml	Yes	Yes	No	No
60 ml	No	No	No	No


Trial 2
Weight of Can in Milliliters
60
40
20
0
Power Steering Fluid
Synthetic Brake Fluid
Full Synthetic Motor Oil
Control(Water)
Fluids Used

POWER STEERING FLUID TRIAL 3 (OBSERVATIONS/ JOURNAL)

- More and more air bubbles continued to form inside syringes.
- Yellow colour.
- Couldn't pick up 20 mL.
- After some tries, Arm was able to lift 6 mL of water by pushing very hard.
- The arm was not able to lift 12 ml of water.
- The fluid was very viscous.
- The syringes were nearly impossible to push.

SYNTHETIC BRAKE TRIAL 3 (OBSERVATIONS/ JOURNAL)

- The fluid was clear.
- Less viscous compared to other fluids.
- Syringes were easy to push and pull.
- As more and more water continued being added to the 12 ounce coke can, the hydraulic arm continued to lift the coke can all the way to 50 mL.
- When picking up the 60 mL coke can it did not work.
- When the coke can was filled with 53 mL of water, the coke can was able to lift up and transport the coke can.
- Some of the syringes needed to be held down.

FULL SYNTHETIC MOTOR OIL TRIAL 3 (OBSERVATIONS/ JOURNAL)

- The fluid is viscous compared to other fluids.
- Fluid has a yellow colour.
- The syringes are hard to push and pull.
- When picking up the coke can filled with 20 mL-35 mL of fluid, the hydraulic arm moved it to the finishing point.
- It became more difficult to move the can as more water was being added to it.
- Some air bubbles became present.
- The motor oil lifted the Coke can with 40 mL of water.
- Could not lift more.

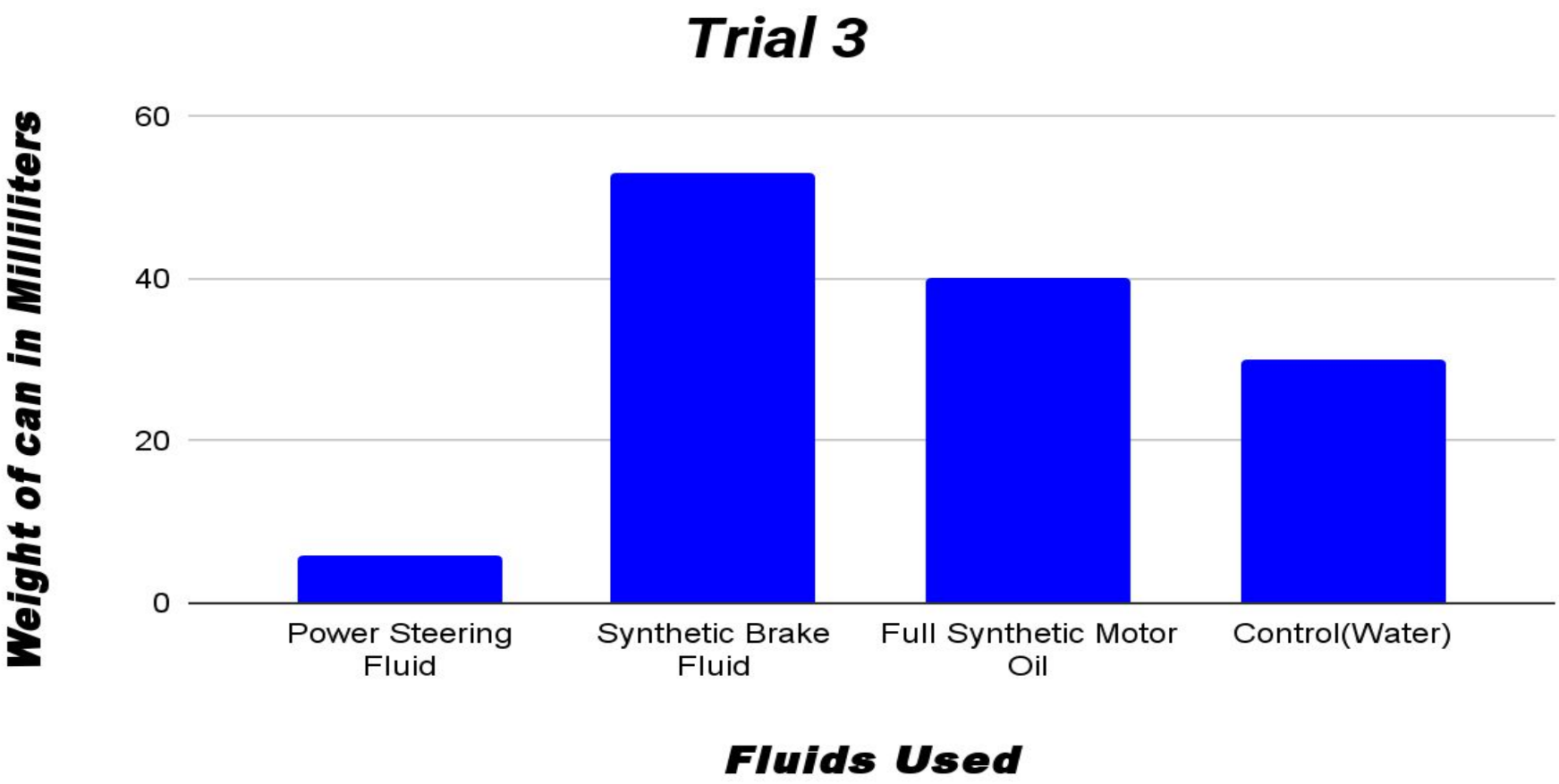
CONTROL TRIAL 3 (OBSERVATIONS/ JOURNAL)

- Control fluid (Water) had air bubbles at the start of the trial.
- Air Bubbles may have affected results.
- Water Clear, was a lot less viscous than other fluids.
- The Hydraulic Arm picked up all levels of weight until 30 mL.
- Hydraulic arm had difficulties moving the coke can filled with 30 mL of water.
- Only moved coke can 20 out of required 30 cm.
- Could not move more weight.

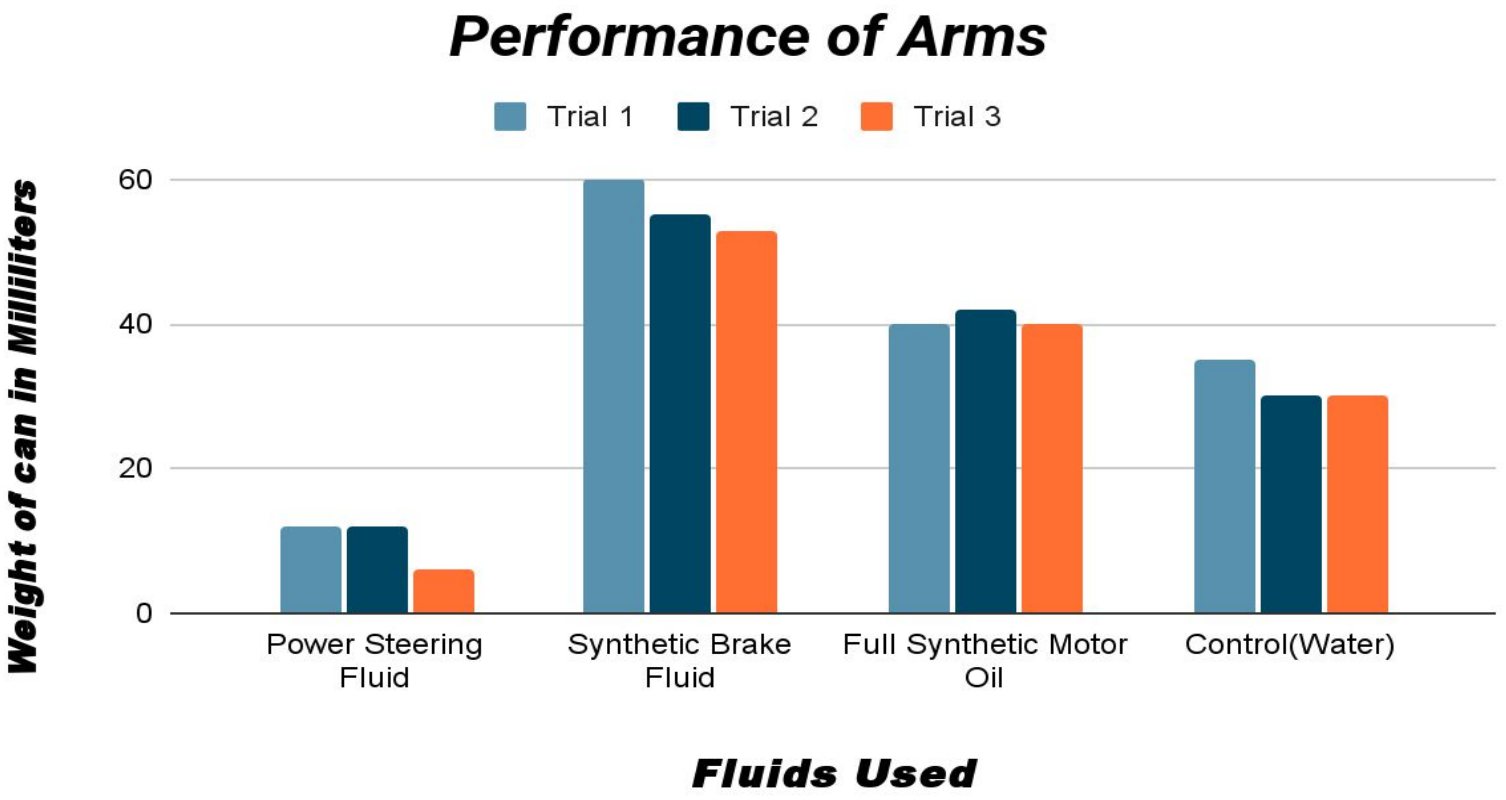
Trial 3 Power Steering Fluid	• More and more air bubbles continued to form inside syringes. • Yellow colour. • After some tries, Arm was able to lift 6 mL of water by pushing very hard. • Could not pick up 20 mL. • The arm was not able to lift 12 ml of water. • The fluid was very viscous. • The syringes were nearly impossible to push.
Trial 3 Synthetic Brake Fluid	• The fluid was clear. • Less viscous compared to other fluids. • Syringes were easy to push and pull. • As more and more water continued being added to the 12 ounce coke can, the hydraulic arm continued to lift it all the to 50 mL. • When picking up the 60 mL coke can it did not work. • When the coke can was filled with 53 mL of water, the coke can was able to lift up and transport the coke can. • Some of the syringes needed to be held down.
Trial 3 Full Synthetic Motor Oil	• The fluid is viscous. • Fluid has a yellow colour. • The syringes are hard to push and pull. • When picking up the coke can filled with 20 mL-35 mL of fluid, the hydraulic arm moved it to the finishing point. • It became more difficult to move the can as more water was being added to it. • Some air bubbles became present. • The motor oil lifted the Coke can with 40 mL of water.
Trial 3 Control (water)	• Control fluid (Water) had air bubbles at the start of the trial. • Air Bubbles may have affected results. • Water Clear, was a lot less viscous than other fluids. • The Hydraulic Arm picked up all levels of weight until 30 mL. • Hydraulic arm had difficulties moving the coke can filled with 30 mL of water. • Could not move more weight.

FLUID'S ABILITY TO PICK UP 20ML, 40ML, 60ML OF MASS

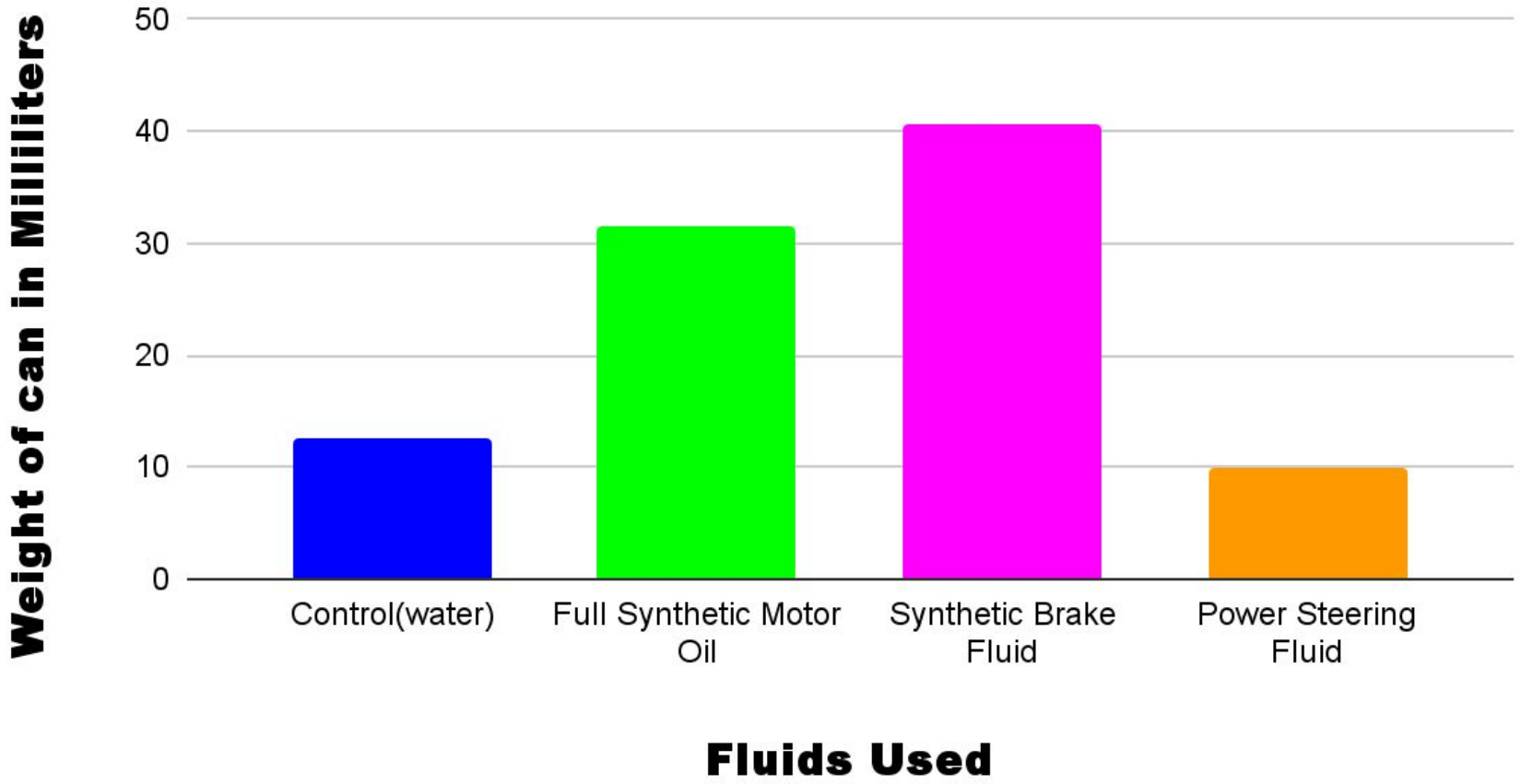
Trial 3	Synthetic Brake Fluid	Full Synthetic Motor Oil	Control (Water)	Power
20ml	Yes	Yes	Yes	No
40 ml	Yes	Yes	No	No
60 ml	No	No	No	No


Trial 3
Weight of can in Milliliters
60
40
20
0
Power Steering Fluid
Synthetic Brake Fluid
Full Synthetic Motor Oil
Control(Water)
Fluids Used

DATA


Performance of Arms
Trial 1
Trial 2
Trial 3
Weight of can in Milliliters
60
40
20
0
Power Steering Fluid
Synthetic Brake Fluid
Full Synthetic Motor Oil
Control(Water)
Fluids Used

Average of all trials

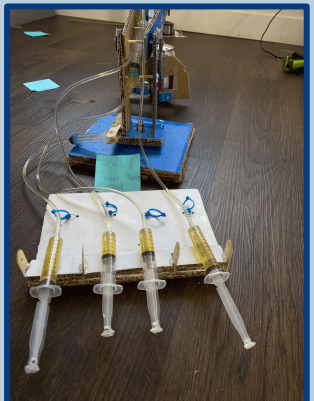


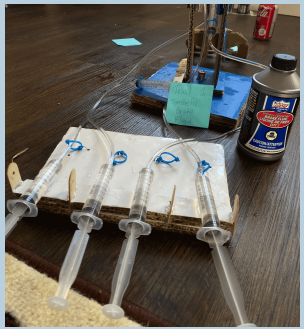
MAXIMUM WEIGHT LIFTED

	Trial 1	Trial 2	Trial 3	Average
Power Steering Fluid	20 ml	12 ml	6 ml	10 ml
Synthetic Brake Fluid	60 ml	55ml	53 ml	31.67 ml
Full Synthetic Motor Oil	40 ml	42 ml	40 ml	40.67 ml
Control(Water)	35 ml	30 ml	30 ml	12.67 ml

COLOUR OF THE FLUIDS OBSERVED

	Power Steering Fluid	Synthetic Brake Fluid	Full Synthetic Motor Oil	Control (Water)
Colour	Yellow	Clear	Yellow	Clear





VISCOSITY LEVEL RANKINGS

1st Place	Power Steering FLuid
2nd Place	Full Synthetic Motor Oil
3rd Place	Synthetic Brake Fluid
4th Place	Control (Water)

HOW HARD THE SYRINGES WERE TO PUSH AND PULL

	Power Steering Fluid	Full Synthetic Motor Oil	Synthetic Brake Fluid	Control (Water)
Trial 1	Hard	Hard	Easy	Easy
Trial 2	Very Hard	Hard	Easy	Easy
Trial 3	Very Hard	Hard	Easy	Easy

CONCLUSION

The purpose of this experiment was to investigate which substance will help increase a hydraulic arm's performance. In order to conduct this experiment, a cardboard hydraulic arm was built. 4 different liquids with different viscosities were tested in order to find out if the viscosity of a hydraulic fluid in the syringe (giving the arm power) affect the performance of a hydraulic arm?

We filled a coke can with different water weight ranging for 20 ml to 60 ml and tested them one by one by lifting the can from one place to another. We tested each water weight and liquid for 3 trials.

At the beginning of the experiment, we hypothesized that, the Synthetic Brake Fluid will perform the best at picking up the heaviest load and transporting it to the required distance of 30cm. We believed that it is not very viscous meaning it will have a faster response time and will flow faster compared to Full Synthetic Motor Oil and Power Steering Fluid. On the other hand, It will be viscous enough to generate enough power unlike water.

CONCLUSION CONTINUED.....

The hypothesis resulted to be correct. The fluid inside the hydraulic arm that worked most efficiently at picking up the heaviest load and moving a 12 ounce Coke can to the required distance of 30cm was the Synthetic Brake Fluid. In trial 1, the Synthetic Brake fluid was able to pick up 60 mL. In the second trial, the Synthetic Brake Fluid was able to pick up maximum 55 mL. For the third trial, the Synthetic brake fluid was able to pick up maximum 53, mL.

The fluid behind the Synthetic Brake fluid in second place was the Full Synthetic Motor oil. In the first trial, it picked up maximum load of 40 mL, second trial 42 mL, third trial 40 mL. The fluid behind Full Synthetic Motor Oil coming in at third place was the control which was water. In trial one, it carried the maximum load of 35 mL, trial two 30 mL, and trial 3 resulted in 30 mL. The fluid behind the Control in the fourth place was the Power Steering Fluid. In the first trial, it picked up maximum load of 20 mL, second trial 12 mL, third trial 6 mL.

CONCLUSION CONTINUED.....

Some of the results and observation we saw in our experiment can be affirmed by our background research. In our background research we stated, if the hydraulic fluid is too viscous, energy may be lost and the pump may need to work harder. During our experiment, we saw how the syringes of the Power steering fluid and Full synthetic motor oil were very hard to push. This may have been due to the fact that these 2 fluids were very viscous.

YD

SOURCES OF ERROR

During the duration of this experiment we were encountered some errors. During the first time we built our hydraulic arm, it didn't work as efficiently due to the fact that our cardboard was too small . In our first attempt at the arm, we used single wall cardboard. The cardboard was not strong enough to work efficiently. This was because the weight of the load was too great for the single wall cardboard. This led us to re make the entire arm with double wall cardboard. This cardboard was stronger and carried the load of the coke can.

Another source of error may have been the air bubbles that formed inside of the syringes. The testing process took 2 days so we had to leave the hydraulic arm sitting overnight. This may have caused air bubbles inside the syringes. This could have altered the performance of the hydraulic arm and ultimately altered the results. Next time we would bleed the system to get rid of any air bubbles

Another Source of Error may have been the cross contamination between the 3 different fluids. The same syringes were used for each of the liquids. When cleaning out the syringes after every trial, small quantities of different fluids may have been cross contaminated together. This may have altered the results.

A big source of error in our experiment was that we did not measure how much force we applied to the syringes. For example, in the observation we mentioned how "hard" it was to push the syringes but we did not measure the input or output force we applied. To further improve our project we can calculate the force we applied (input force) and how was force was given off (output force). This would clearly give us an accurate answer for how efficient each fluid was. The formula for efficiency is output divided by input,

YD

SOURCES OF ERROR

Also, we could have ensure that our can did not drop and spill water during the experiment. Ensuring this could have changed our results because sometimes the water was not exactly 20,40,60 ml.

Last but not least, there may have been changes in the temperature of our testing room. Although we tried our best to keep the temperature of our room constant throughout the experiment, there may have been some changes of temperature over the 2 days of testing.

APPLICATIONS

When looking at this experiment, many people of different professions can learn from the results. For example, If an engineer was to view this experiment they may figure out what liquid will be the most efficient for the hydraulic arm. They could then make a hydraulic arm with the most efficient liquid. This would make the job of lifting heavy loads a lot easier and quicker. So in this case, the engineer would know that (synthetic brake fluid) is the most efficient liquid to use in a possible hydraulic they will make on the future. Our project can also help improve systems we use in our everyday life such as car brakes, as well as wheelchairs by making them smoother and better working as they can use the best fluid.

YD

NEXT EXPERIMENT

When picking up an empty 12 ounce coke can using Synthetic Brake Fluid, how does the material of the hydraulic arm affect its performance?

This experiment relates to our topic as we are still testing hydraulic arms. In this experiment, the manipulated variable would be the material the Hydraulic arm is made of instead of different fluid. For our next experiment, we are using the most efficient liquid that we tested. This is why the next experiment would only use 1 fluid; the Synthetic Brake fluid. We would use materials such as Foam Board, Wood, Recycled Materials, and ect.

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