Cougar Space Squad

Sumner-Fredericksburg High School

Team Members:

Kellian (Kelli) Dillon

Ryan Rich

Kaitlyn Newlon

Jasmine Coronel Mejia

Advisor:

Mrs. Amy Price

Contest Theme:

Transforming Space Technology Into Orbit

Team Theme:

Cadets with a mission of sustainability!

Table of Contents:

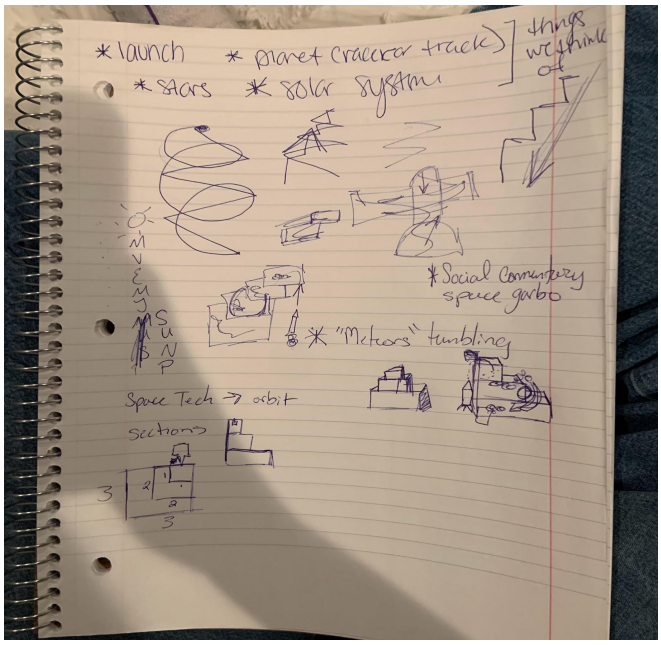
1. Planning Machine Design Sketch and Description

12-28-22

Kellian began brainstorming many different ideas for our project. After reading the article below, we decided to borrow these ideas as the base of our theme.

https://www.forbes.com/sites/bernardmarr/2021/12/10/the-five-biggest-space-technology-trends-for-2022/?sh=47e2ec1e1bf4

These are some pictures of her working on the initial design over Christmas break.



We assigned each member's role.

Designing: Kellian, Ryan, Kaitlyn

These three members worked together to come up with the initial steps and designs. Kelli and Ryan did most of the planning, while Kaitlyn added a few good ideas every so often.

Notebook: Kaitlyn

Since she is not quite as creative with the building process, Kaitlyn's main focus was completing this notebook.

Building: Kellian, Ryan, Jasmine

Jasmine joined the group and these three members were in charge of building the majority of the project. Jasmine was the one to handle the powertools, Ryan handled any electrical work and coding, and Kellian set everything up and worked on small, important details for each step.

Decorating: Jasmine, Kellian

Kellian used her creativity skills and painted the box using spray paint and acrylic paint. Jasmine put some final decorating touch-ups on the boxes, and put a clear coat over them.

Initial Steps:

Box 1

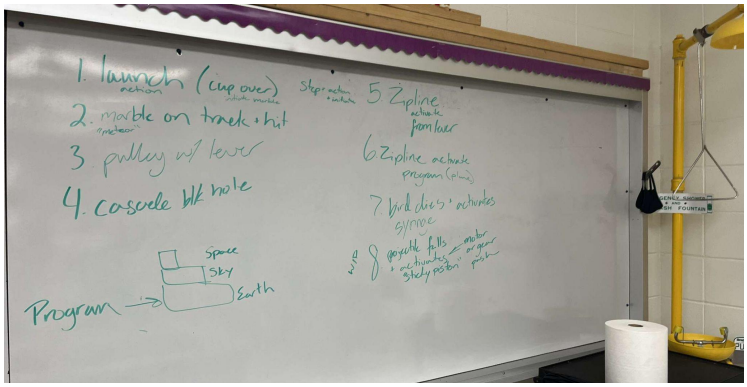
Step 1 : launch (cup over)
Step 2: marble on track and hit
Step 3: pulley with lever
Step 4: cascade into black hole

Box 2

Step 5: zipline activates from lever- satellites
Step 6: zipline hits track, start program (plane)
Step 7: plane hits bird, bird falls onto syringe
Step 8: projectile falls and activates “sticky piston” - motor/gear/push

Box 3

Step 9: rolling object comes out of tornado and starts movement of car
Step 10: cascade chain reaction of planets around sun, falls into a cup
Step 11: weighted cup takes away blocker and moves ambulance
Step 12: ambulance hits something - work in progress
Step 13: spinny thing activates and drops something to activate mug
Step 14: rolling mug activates bath bomb - needs a closed system
Step 15: bath bomb gasses tips a lever and pulls a string
Step 16: string releases

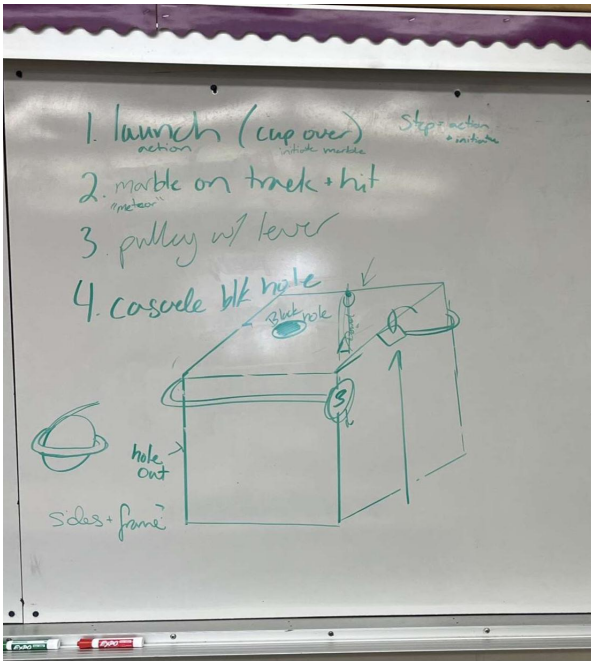


Daily Log: Week 1

01-05-23

We wrote down all of the requirements and brainstormed more ideas for part of the design. We also made a list of the four components and decided where we would use each one. We made our steps for box 1, the highest box, and used inspiration from Mini Golf.

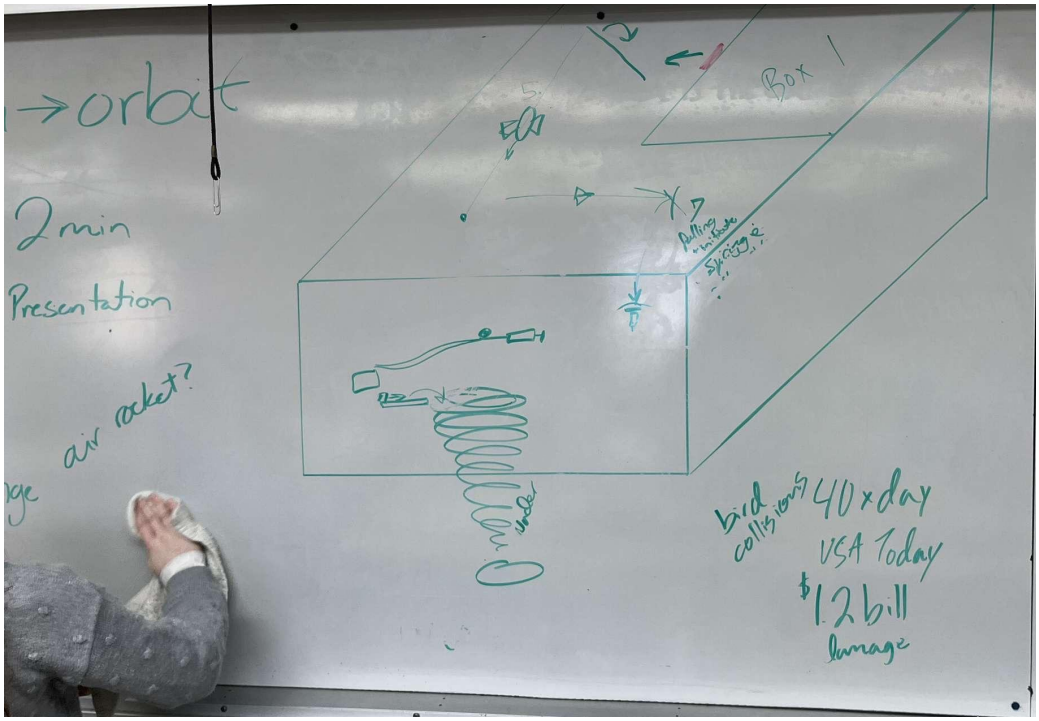
- Black hole inspiration from mini golf



Here is a picture of Kellian standing on a chair to reach the board.

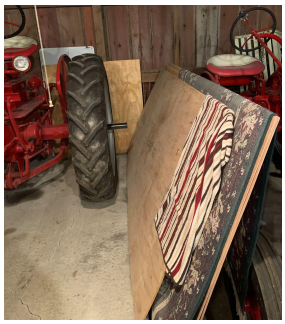
01-06-23

Today we came up with all of the steps for box 2, the middle box, and began to look for any materials we could use.



01-07-23

Today, Kellian worked with her grandfather and uncle to cut plywood leftover from a previous project into the boxes needed for our design. It took about 3 hours, mostly because her younger cousin insisted on helping by throwing bits of sawdust everywhere.

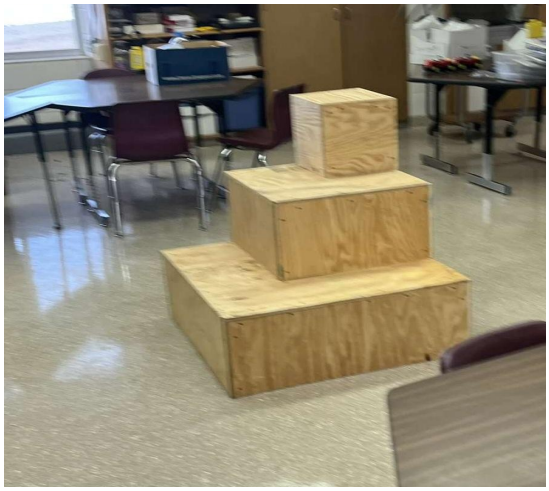



Daily Log: Week 2

01-09-23

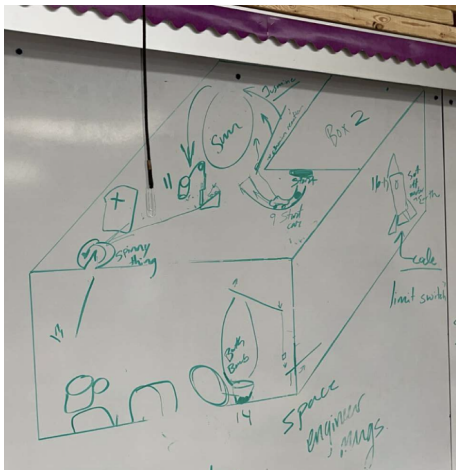
Today we found a few links to help us get more ideas for our final box. Some of the ideas used in these other examples we did not like too much, but some of them we thought were very interesting and unique.
https://www.usatoday.com/story/money/2019/07/08/space-race-inventions-we-use-every-day-were-created-for-space-exploration/39580591/
https://www.3plearning.com/blog/simple-chemistry-experiments-kids-home/
https://www.youtube.com/watch?v=nORRgU8sGdE (mug inspiration)
https://now.northropgrumman.com/how-technology-from-the-space-race-changed-the-world/
https://www.fdmgroup.com/blog/the-5-most-innovative-advances-in-space-technology/
https://www.youtube.com/watch?v=6FzUx2EFk8s (cascade effect inspiration)

We also found a perfect hiding spot for Kellian, which was very entertaining.



01-10-23

Today we finished coming up with the rest of the steps, which will all be part of box 3. Most of the steps are on box 3 because it is the biggest, and they would not really fit anywhere else.



01-11-23

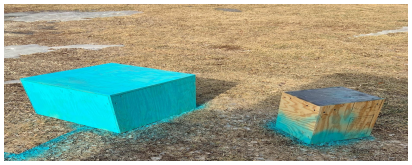
- Use red solo cup for bigger surface area
- https://www.youtube.com/watch?v=hPIMsvKgiOg (homemade bath bomb inspiration)

01-13-23

- https://www.bbcgoodfood.com/howto/guide/how-make-bath-bomb

01-14-23

Today, Kellian reinforced the bottoms of the boxes by adding an extra piece of wood. This was to help prevent the plywood from caving in and help give it more stability. Then she spray painted a base coat on the top two boxes with the help (and hindrance) of her farm cats. Below are more progress pictures of the painting process.

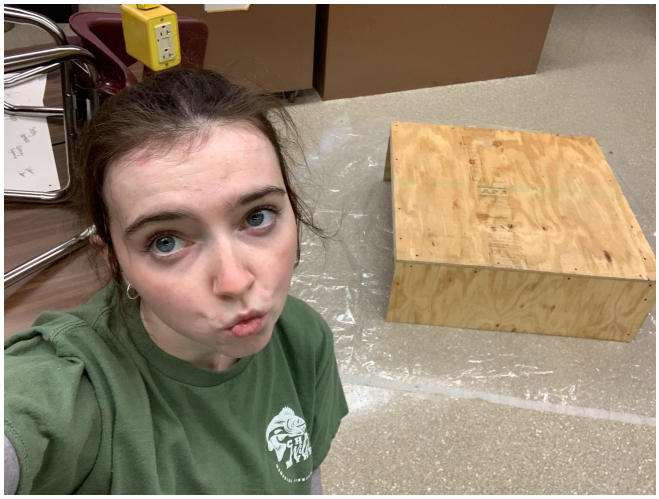


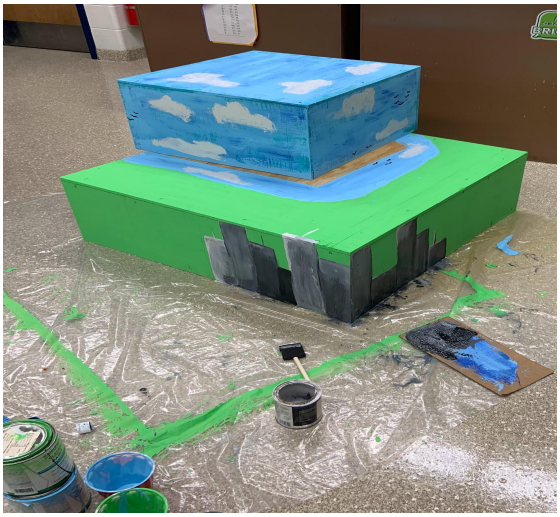
While waiting for the coats of spray paint to dry, Kellian worked on gathering materials and creating a prototype of the citric acid reaction for our chemical component, used in step 14. Through trial and error, Kellian realized the top edge of the closed system needs to be smooth and flush with the item we are attempting to move. The prototype includes two recycled water bottles, a straw, and tape. The final product will be sealed with hot glue or other air-tight alternatives. (see photo below of supplies)

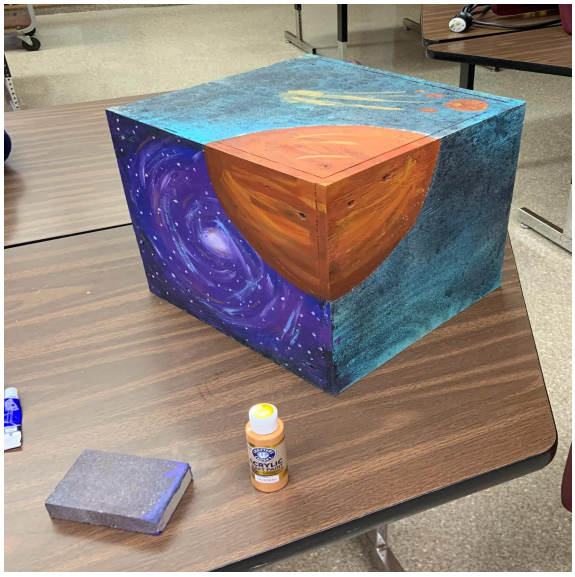
Daily Log: Week 3

01-16-23

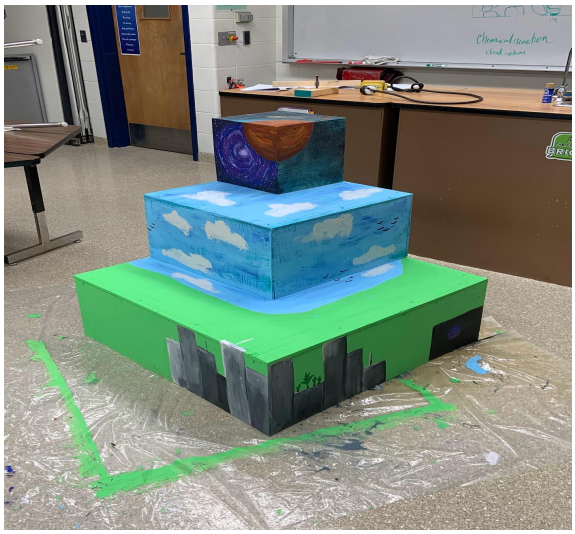
Today, Kellian painted the details on all of the boxes. The bottom box started off unpainted, so it received a base coat first. While waiting for that to dry, more colors were added to the base of the sky and a galaxy scene was painted on the side of the top box. Clouds, birds, and a city scene were added to the bottom two boxes and allowed to dry. In the meantime, Kellian painted details on the top box after sanding away the spray paint in the area of details, including the planet, the shooting stars, meteorites, and Elon Musk's "starlink"as a nod to space technology. A warehouse and launchpad site for the "CSS" (Cougar Space Squad) was added to the bottom box at the end.

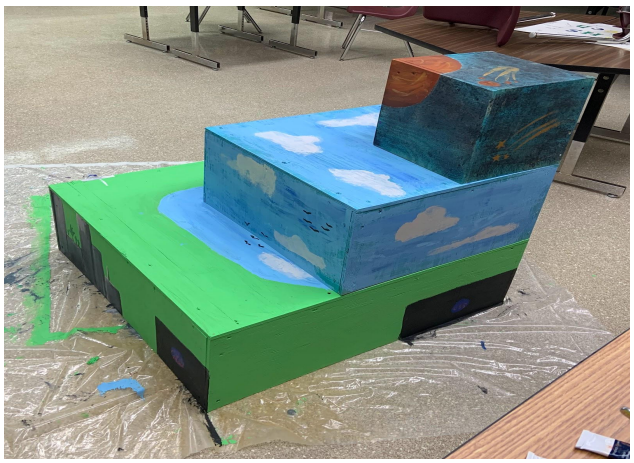






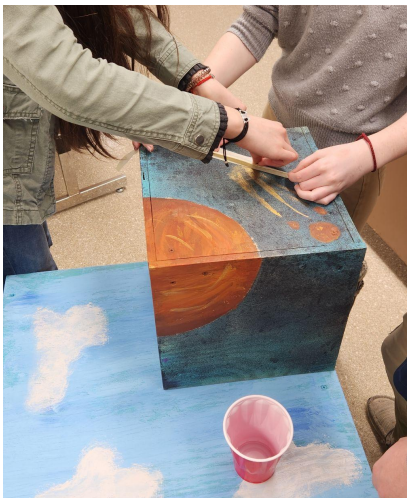
These are the final results before Jasmine clearcoats the project.





01-17-23

Today we began building our steps and Jasmine sprayed a layer of clear coat over the boxes.



01-20-23

Today we are building box one and gathering materials for box 2. We want to make the black hole work by preloading steel marbles into the track and having the cascade release them. We used hot glue to attach the orange tracks

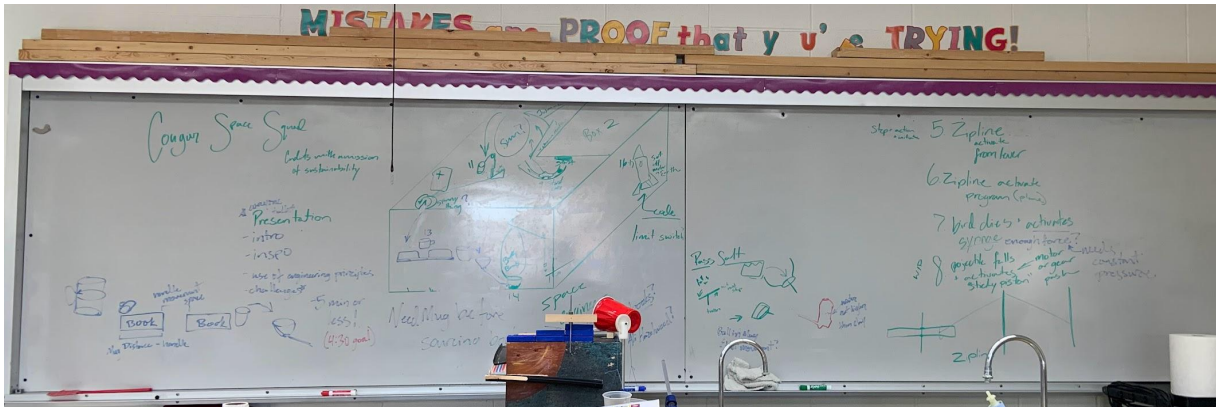
Daily Log: Week 4

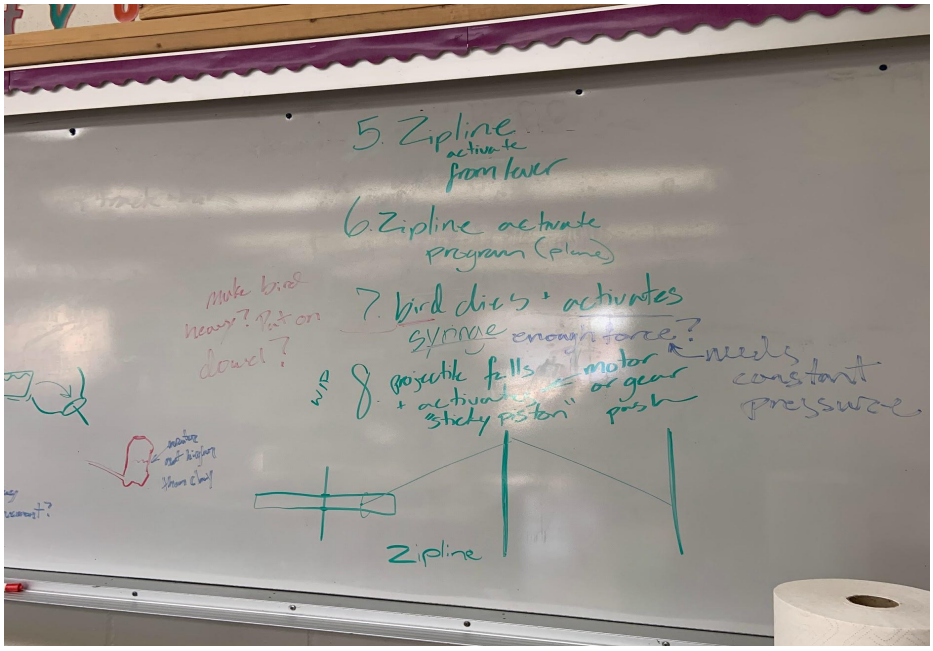
01-24-23

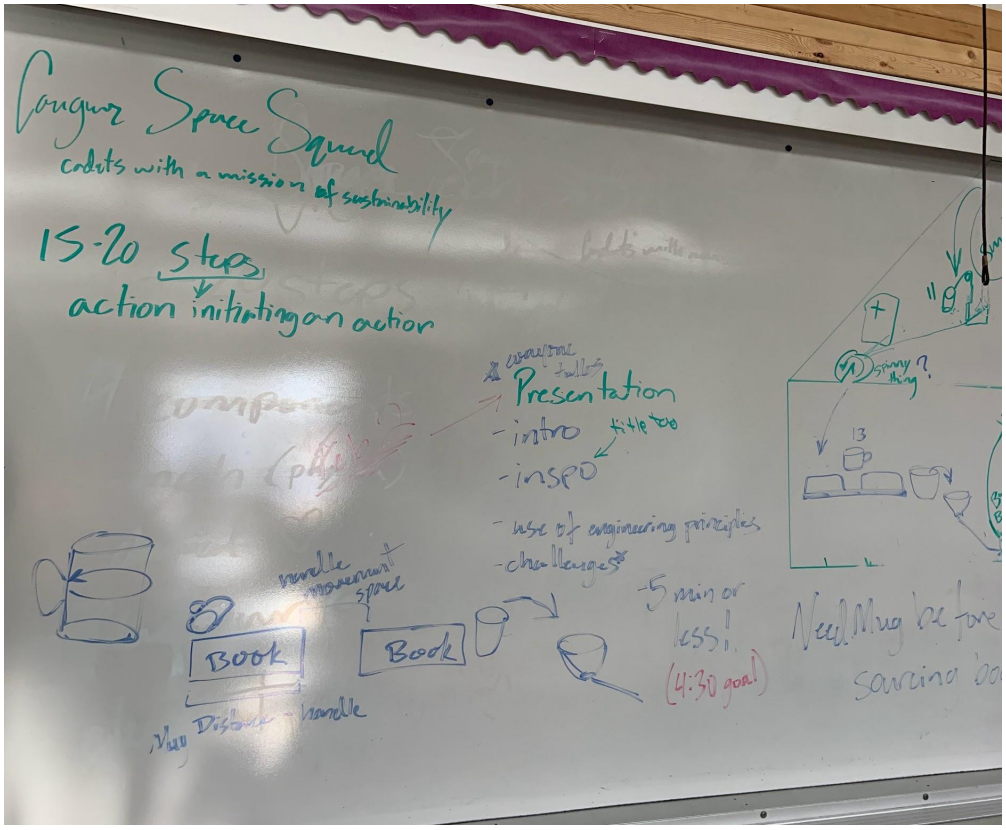
Today we finished building box one. Jasmine drilled a hole roughly about 1 ¼ of an inch in diameter for our cascade effect into the black hole.

01-26-23

Kellian worked after school to create new ideas for the third box. She has begun backwards design to help the completion of the project progress quicker. She developed her idea for the closed system of the chemical reaction by sealing openings with modeling clay. Referencing a youtube video of water pouring in another Rube Goldburg project, Kellian designed a new idea for the mug roll that was inspired by the Pass the Salt Rube Goldberg, YouTube.



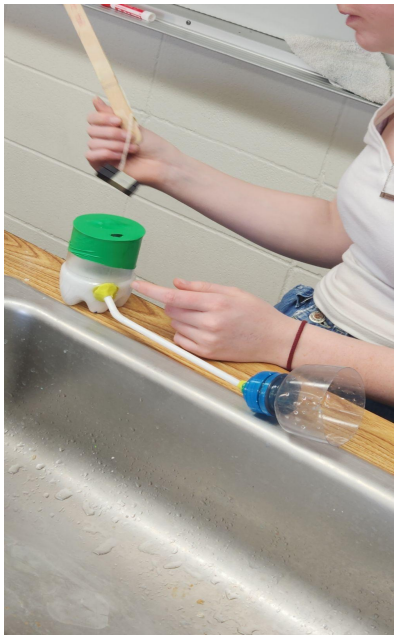

5. Zipline
activate
from lever
6. Zipline activate
program (plane)
7. bird clicks + activates
syringe
8. projectile falls
+ activates
"sticky piston"
motor
or gear
needs constant pressure
Zipline


Cougar Space Squad
cadets with a mission of sustainability
15-20 steps
action initiating an action
Presentation
- intro
- inspo
- use of engineering principles
- challenges
Book
Book
-5 min or less!
(4:30 goal)

Daily Log: Week 5

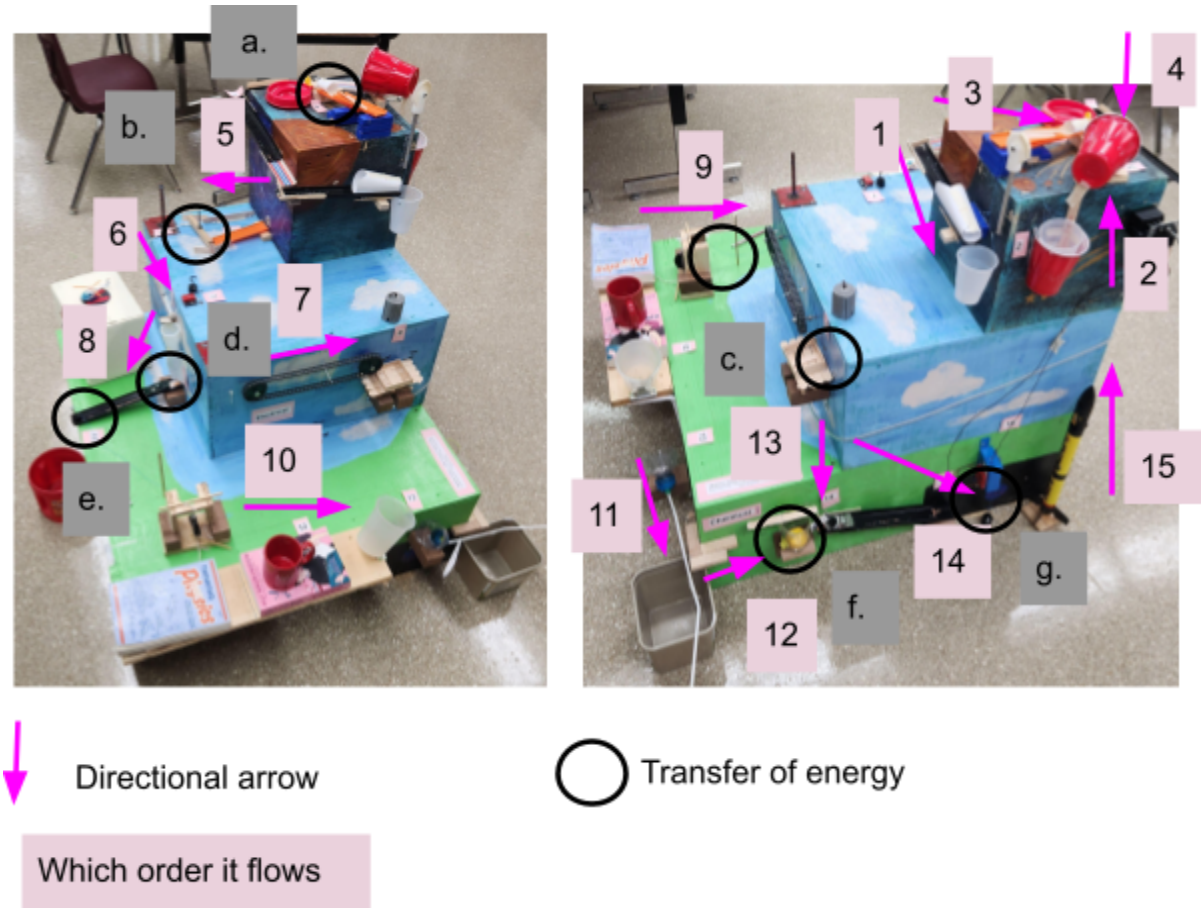
02-01-23

Today, all four of us worked on separate steps by using trial and error. Kellian figured out the bath bomb solution and figured out part of box 3 with the mug and books, Ryan worked on steps for box 2 as well as coding a motor, and Jasmine figured out the final touches for box 1 and began working on box 2, and Kaitlyn painted a Hospital for box 3 as well as help other team members with small details.



Not only is the box a hiding spot for Kelli, she also had to crawl under the box to help Ryan with some electrical work.

2. Final Machine Design Drawing/Image and Description



Our machine is a beautiful combination of directional changes and energy transfers. At point 1, the direction of the ball is downward at an angle into a cup. The cup is a part of the pulley system that pulls the direction of motion upwards again at point 2. This cup tips a marble that impacts a domino at point a. The domino receives the kinetic energy from the marble and unblocks the string prohibiting the flow of our "shooting stars" into the "black hole." The direction changes at point 3 when the string is blocked, then the "shooting stars" enter the "black hole" with a downwards motion. This downwards motion builds energy and impacts a lever at point b. The stars have changed direction (5) within the tubing under our machine. The potential energy of the lever becomes kinetic energy as it pulls the string to release our mass that was previously stuck for a 6th directional turn. The mass impacts with the limit switch and activates the program for our gears to turn. When the gears push a heavy mass off in a new direction (7), it impacts the syringe and provides constant pressure at point c. Attention shifts back to the other side of the box (arrow 8) as the syringe pushes a marble down the funnel. This general downward motion continues as the marble transfers energy to the car at point d. The car gains momentum as it hurdles toward a mass on the string before transferring energy to the mass as it falls at point e. The mass pulls the string in a new direction (9) and allows the built-up energy of the mug to release and roll in direction 10. The mug tilts a beaker of water with power, and the direction of

the water goes downward at an angle instead of horizontal like the mug. Energy is transferred during the chemical reaction as new ions and products are formed and bonds are shifted around (see point f.). A light, popsicle lever falls off the chemical apparatus in a downward direction to set off a car with potential energy in a downward direction at an angle (14). This car transfers energy to a mass at point g. This mass swings to set off the switch that shifts directional movement upward (15). This final action obtains energy from batteries.

3. List of Machine Steps

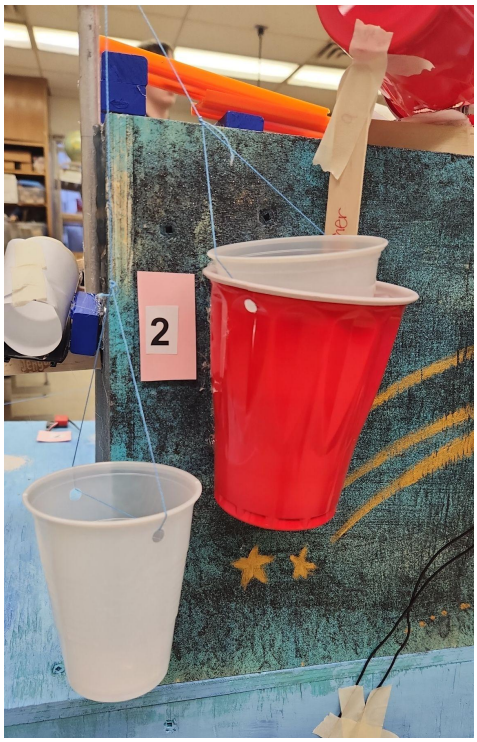
Box 1

Step 1: Release the ball

A bouncy ball will be placed onto the track and go around two sides of box 1, until it falls into a plastic cup.

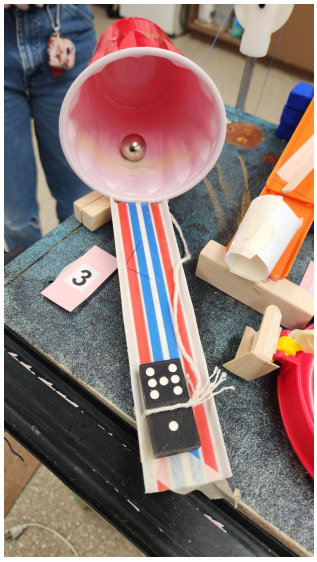
Step 2: Pulley system - Advanced Component **Mechanical**

When the bouncy ball falls into the plastic cup, it lowers and raises another cup by a pulley, which bumps a red plastic cup already tilted on the top of the box.



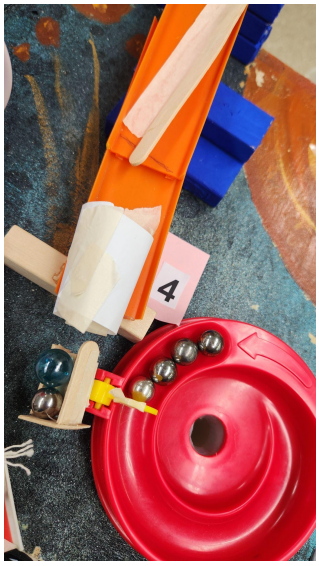
Step 3: Cup releases marble

Once the red cup gets bumped, a weighted marble is released and hits a domino, which is attached to a string.



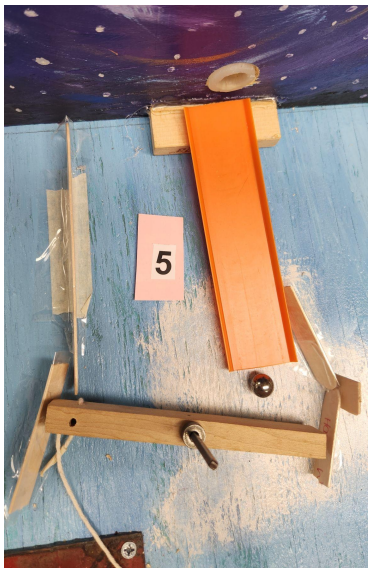
Step 4: Ramp

The marble will hit the domino attached with a string and push it out the way. When the string gets pulled away, 2 weighted marbles will get released and get captured onto the toy funnel.



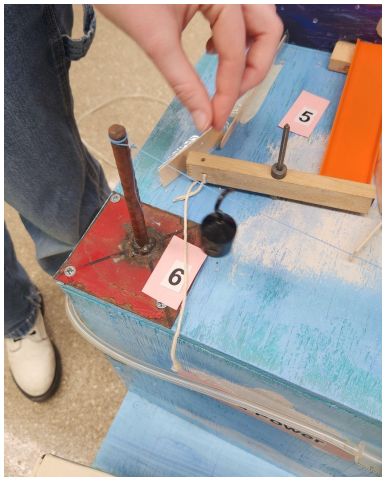
Step 5: Black hole

When the weighted marble gets captured, the weight of it will pull it down, causing a lever to lift and release four more marbles, which then spiral into a black hole. This is where the mini golf inspiration comes in because they are going into a tunnel, leading to box 2.



Step 6: Lever- Advanced Component **Mechanical**

When the four marbles come out of the side of box 1, they will hit a lever attached to a string and also attached to a 50g mass. The string releases the mass.



Step 7: Limit switch- Advanced Component **Electrical**

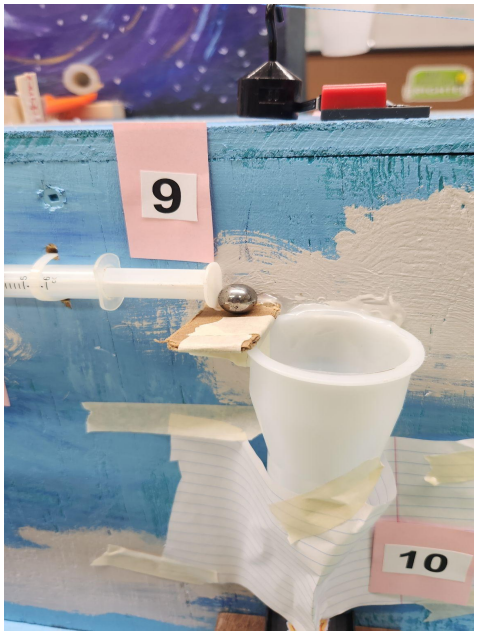
The mass will slide down a zipline and hit a limit switch, starting the motors.

Step 8: Chain and Sprocket

A 500g mass is resting on top of a gear track. When the motors start, the track will move clockwise. The mass falls onto a platform.

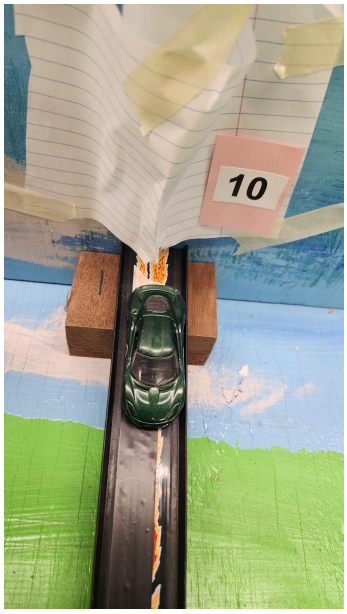
Step 9: Syringe- Advanced Component **Fluid Power**

The mass will push down on a syringe, activating the fluid power. The other syringe will push out.



Step 10: Tornado

The syringe pushes a marble into a funnel, representing a tornado touching the ground.



Step 11: Hospital

The marble will hit a car. The car goes down a track into the hospital.

Step 12: Fixed Pulley- Advanced Component **Mechanical**

The car will knock a mass off of the track and land in a bucket. The mass is attached to a string on a pulley. When the mass drops it releases a dowel holding a mug in place.

Step 13: Mug

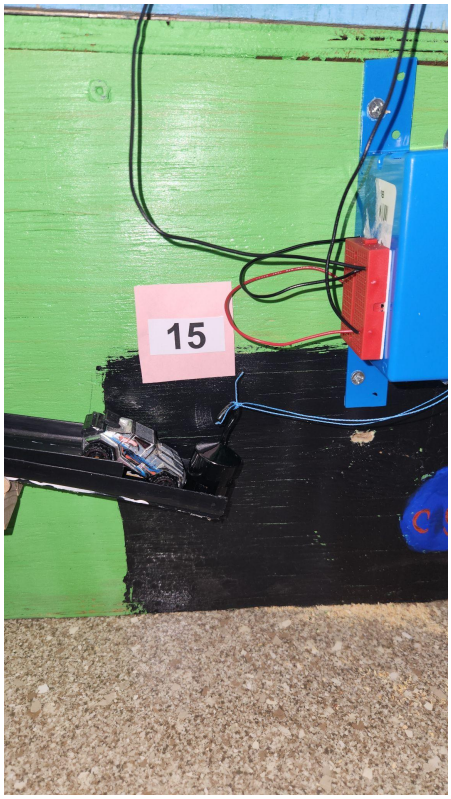
The mug will roll and hit a beaker with water in it.

Step 14: Chemical Reaction- Advanced Component **Chemical Reaction**

The water pours into a funnel, triggering the chemical reaction of citric acid and baking soda. A lever sitting on top of the chemical reaction will tilt.

Step 15: Car

The lever tilting will bump a car on a slanted track. At the end of the track is a 100g mass, slightly hanging off.



Step 16: Rocket- Advanced Component **Electrical**

The mass is attached to a switch. Once the mass is knocked off the track, it pulls the switch off. This starts another motor to launch the rocket. THE END!

4. Cost of Machine and Percent of Recycled Materials Used

Item	**Quantity**	**Origin**	**Cost**
Paint	About 20 colors	Repurposed	$ 0.00
Spray paint	2 cans	*Purchased*	$ 12.89
Red plastic cups	2	Recycled	$ 0.00
Clear plastic cups	2	Recycled	$ 0.00
Plastic tracks	8	Repurposed	$ 0.00
Wooden blocks	18	Repurposed	$ 0.00
Masking tape	20 pieces	Repurposed	$ 0.00
Plastic water bottle	1	Recycled	$ 0.00
Putty	About quarter size amount	Repurposed	$ 0.00
Citric acid	4 grams	Repurposed	$ 0.00
Baking soda	2 grams	Repurposed	$ 0.00
Rubber hose	1	Repurposed	$ 0.00
Spiral funnel toy	1	Repurposed	$ 0.00
Mug	1	Repurposed	$ 0.00
balloon	1	Repurposed	$ 0.00
Marbles	5	Repurposed	$ 0.00
Weighted marbles	2	Repurposed	$ 0.00
domino	3	Repurposed	$ 0.00
pulley	2	Repurposed	$ 0.00
screws	32	Repurposed	$ 0.00
Popsicle sticks	35	Repurposed	$ 0.00
paper	3	Recycled	$ 0.00

string	5 pieces	Repurposed	$ 0.00
motor	3	Repurposed	$ 0.00
Bouncy ball	1	Repurposed	$ 0.00
books	2	Repurposed	$ 0.00
L brackets	2	*Purchased*	$ 3.00
Hinges	1	Repurposed	$ 0.00
Funnel	1	Repurposed	$ 0.00
Plastic beaker	1	Repurposed	$ 0.00
Plywood	12	Repurposed	$ 0.00
Gear track	1	Repurposed	$ 0.00
Gears	2	Repurposed	$ 0.00
Toy helicopter	1	Repurposed	$ 0.00
Toy car	1	Repurposed	$ 0.00
Cardboard box	1	Recycled	$ 0.00
Hot glue	A lot!	Repurposed	$ 0.00
Wooden dowels	4	Repurposed	$ 0.00
Batteries	4	Repurposed	$ 0.00
Limit switch	1	Repurposed	$ 0.00
motors	3	Repurposed	$ 0.00
Battery pack	1	Repurposed	$ 0.00
Rocket	1	Repurposed	$ 0.00

Total Machine Cost: **$17.67**

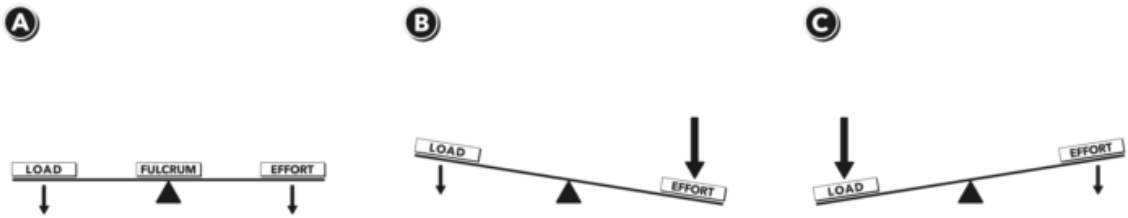
Percent Recycled: **41/43 95.3%**

5. Applied STEM Processes

Mechanical -

Inclined plane - We use our tracks as an inclined plane; we use them mainly as ramps/slides.they are used in the beginning when we make the ball roll down a track into a cup. It is also included when a marble rolls down the track to hit a domino to pull a string releasing more marbles down a track into a hose. We also use it towards the end when we have a car roll down the track to hit a mass in order to set off our step with our mug.

Lever- We use a first class lever in the end steps of our machine. We use it after our chemical step. We use it with the mass on the end. We have a balloon inflate with the gasses from our chemical step tipping the lever causing the weight to shift making it fall on a track releasing a car. First class levers are known as simple machines. They use a beam upon a fulcrum. The load is applied to one end while the effort is applied to the other to counter the load.



Wheel and axle- A wheel and axle is used in our electrical step. We have 2 gears and a track around them. A wheel and axle consists of 2 parts: a round disc which is known as the wheel (or our gears in this case), and a rod going through the center of it known as the axel. We use our wheel and axle to move a mass onto a platform activating our fluid power.

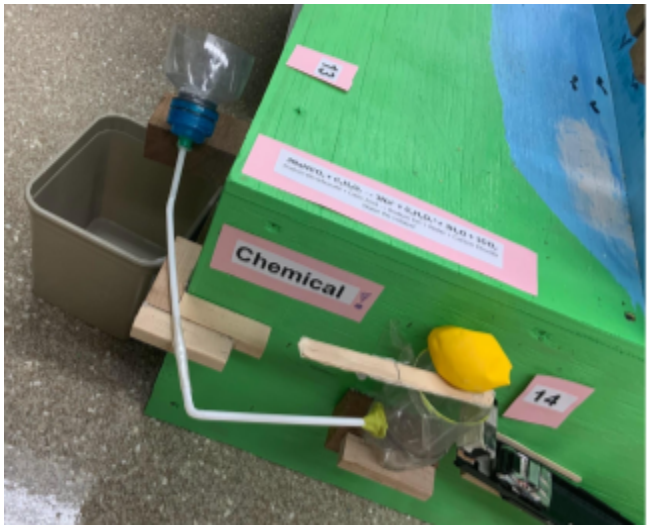
Pulley - We use two fixed pulleys. Our first fixed pulley is in our beginning steps we have a cup attached to each end of the pulley. We use one cup to catch the ball that rolls down our tracks on our first step. The cup that catches the ball moves down with the weight causing the cup on the other end to go up, and the popsicle stick that is attached hits our solo cup releasing a marble. Our next fixed pulley is towards the beginning of our chemical steps. The fixed pulley is used to pull a wood dowel out from underneath the mug. It is used to set off the mug to make it roll. The dowel is pulled out from underneath the mug by the car hitting a mass causing a string to pull the dowel when the mass is shifted down.

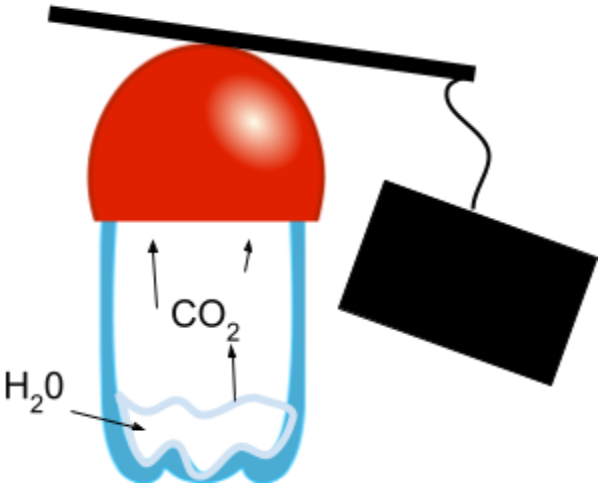
Chemical -

$3NaHCO_3 + C_6H_8O_7 \rightarrow 3Na^+ + C_6H_5O_7^{3-} + 3H_2O + 3CO_2$

Sodium Bicarbonate + Citric Acid → Sodium Ion + Citric Acid Ion + Water + Carbon Dioxide with Water as a Catalyst

This is an example of an acid-base reaction that decomposes into ions and displaces into water and carbon dioxide. My measurements were found from the website below. The ideal gas law (PV=nRT) is also used in my reaction as I harness the power of the CO_2 to move our lever by producing CO_2 according to the same website.





http://scienceline.ucsb.edu/getkey.php?key=7129#

"What's New CO_2? Get to Know a Chemical Reaction." *American Chemical Society,* 2009, https://www.acs.org/content/dam/acsorg/education/outreach/kidschemistry/chemical-reaction-kids-and-chemistry-kit-teacher-guide.pdf.

Fluid Power -

Specific Gas laws used-

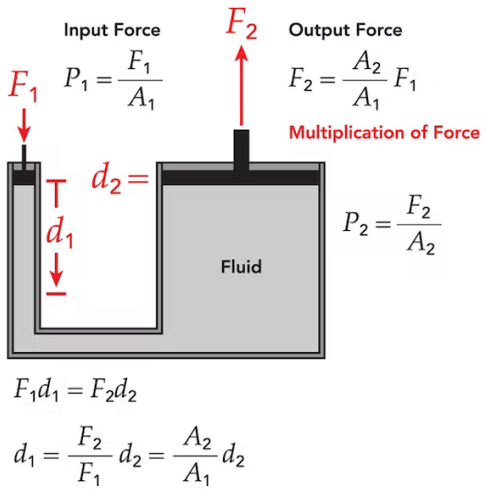
<u>Boyle's Law;</u> $P_1V_1 = P_2V_2$

P_1 - 1st pressure

P_2 - 2nd pressure

V_1 - 1st volume

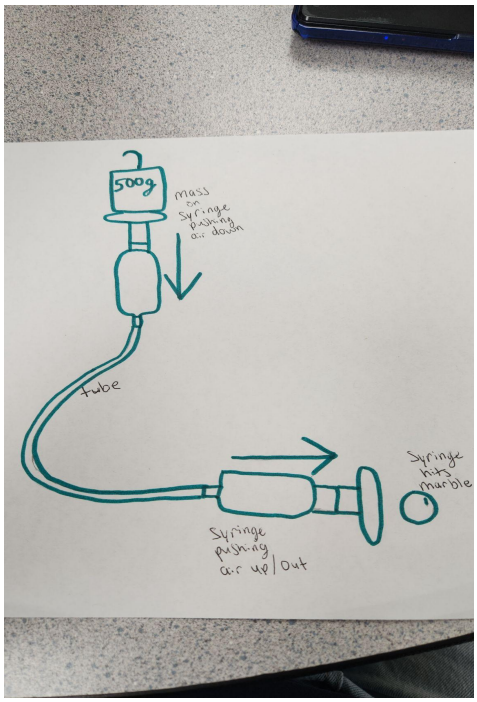
V_2 - 2nd volume



A fluid is any liquid or gas that does not keep its shape and continues to change, when any amount of force or pressure is applied. Boyle's Law describes "fluid" as any gas that keeps its same temperature, when the pressure and volume of the gas is the same. In this case, our fluid is air.

A 500g mass will be dropped on top of one end of the syringe, pushing it down and causing air to be pushed through the tube at constant pressure until it reaches the other syringe. The air pushes the other end of the syringe outwards, which then pushes a marble off of a platform. The same amount of pressure pushed out of the first syringe is the same as how much is pushed from the second syringe. For example, if the first syringe lowers 1 inch, the

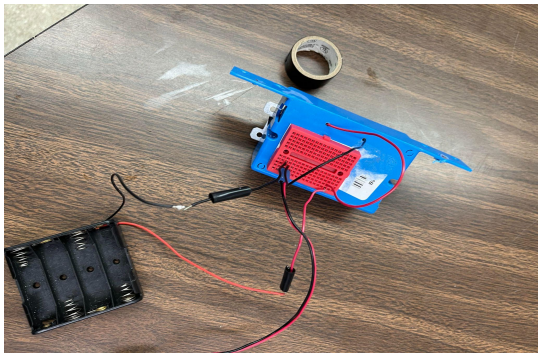
second syringe will then push out 1 inch as well.

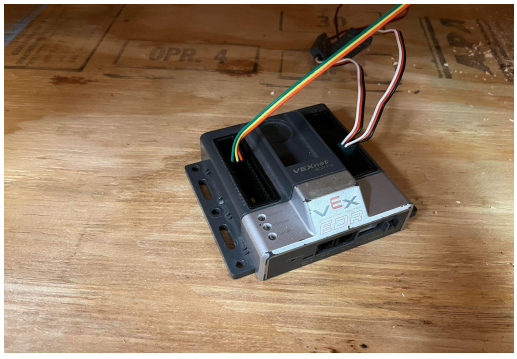


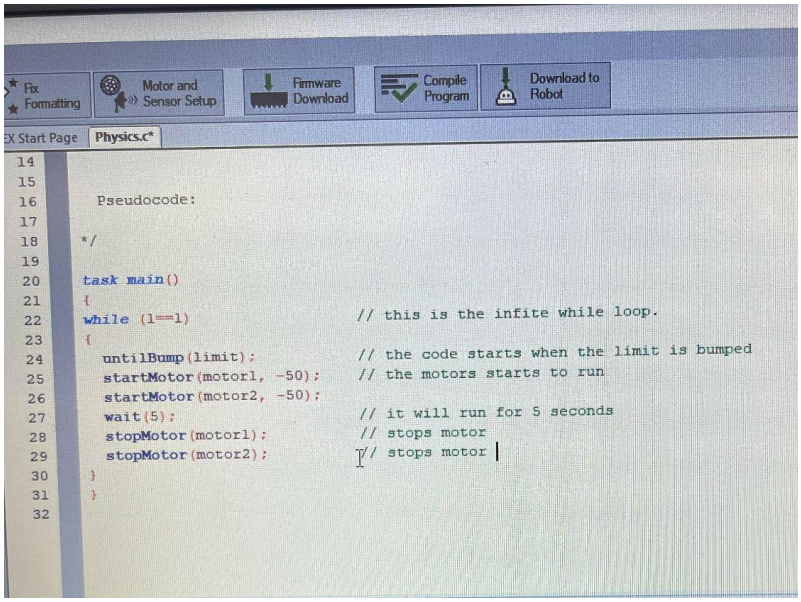
Electrical -

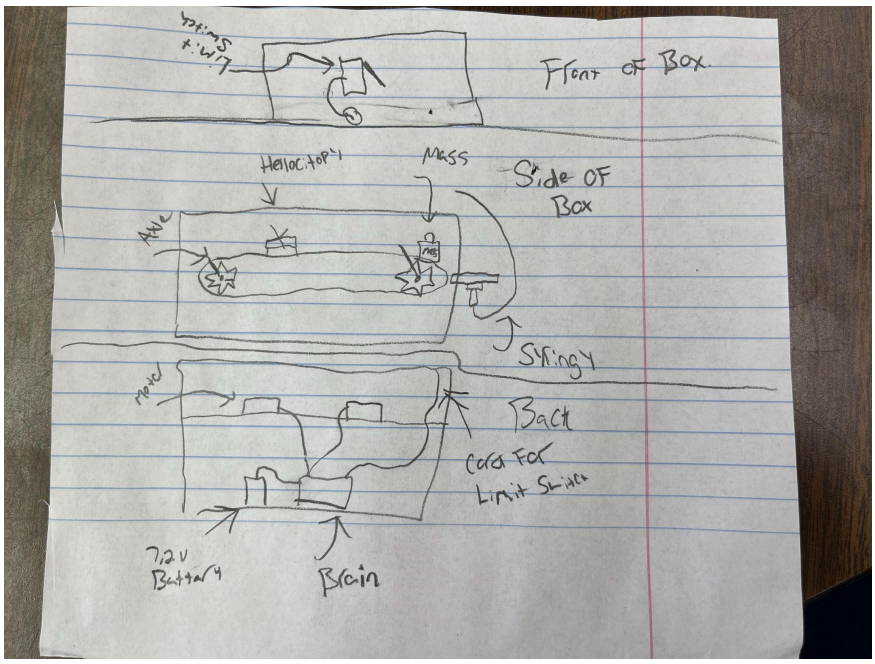
The first electrical design uses 2 motors, that run on a track, that pushes a mass to a platform. The motors run on a 7.2 volt battery that is hooked up to a Vex net brain. I had to code a program from Robotc that when the limit switch is touched, the 2 motors will run for 5 seconds then stop. Usually you have to re-download the code to the brain but I coded an infinite while loop that will repeat the code whenever the limit switch is touched.

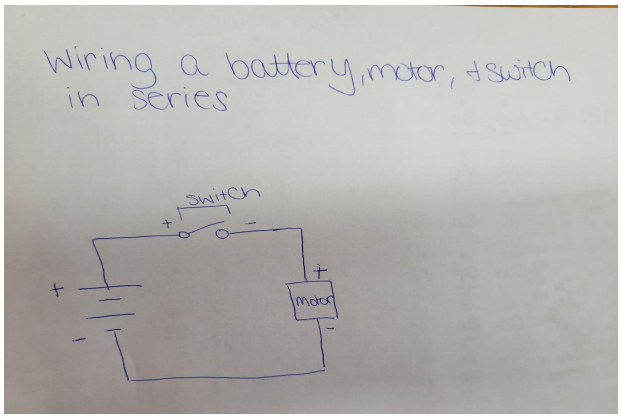
For the second electrical step, a mass pulls down a light switch that runs a motor. The motor runs on 4, 1.5 volt batteries which totals 6 volts. There are 2 breadboards that we used, one near the motor and one connected to the light switch. The switch and motor are wired in series. In a series circuit, the components are connected from start to end. If you remove any component from the breadboard it will not work. How I design the series circuit is that I connected the positive wire from the switch to the wire from the motor. Then the negative wire from the switch is connected to the negative of the battery. Then the positive wire from the battery is connected to the wire from the motor. See diagrams below.






Fix Formatting
Motor and Sensor Setup
Firmware Download
Compile Program
Download to Robot
EX Start Page
Physics.c*
14
15
16 Pseudocode:
17
18 */
19
20 task main()
21 {
22 while (1==1) // this is the infite while loop.
23 {
24 untilBump(limit); // the code starts when the limit is bumped
25 startMotor(motor1, -50); // the motors starts to run
26 startMotor(motor2, -50);
27 wait(5); // it will run for 5 seconds
28 stopMotor(motor1); // stops motor
29 stopMotor(motor2); // stops motor
30 }
31 }
32


Front of Box.
Helicopter
Mass
Side OF Box
Axle
String
motor
Back
Brain


Wiring a battery, motor, + switch in series
switch
+
-
motor

6. Reflection

Successes & Challenges:

A major success for the group was the chemical reaction. We wanted to use citric acid and baking soda with water instead of vinegar and baking soda. Kellian worked on multiple prototypes with different styles and materials. After a lot of work, the right ratio of 2 grams baking soda to 4 grams of citric acid was finally discovered and we were able to achieve our goal of lifting the lever with CO_2

A major challenge for the group was staying motivated. This project required a lot of effort and time, each time it felt like we accomplished our goals, we were told we needed to do more work and change things. It was a challenge to feel like we were ever making progress on the machine when there was always more to do.

A second success for the group was completing the first box with a full run-through. The first box needed a lot of changes and redesigns to accomplish our goals. After way too long of reworking and designing the box, we finally finished it.

Another major challenge we experienced as a group was time-management and certainty in our actions. Every group member had a busy schedule and coordinating times to work as a group was extremely difficult. This project required working on days we don't have school for long hours and coming in early. Oftentimes, only a single member of the group or two worked at a time. This created a third challenge of certainty in our actions. When working on our steps, they often came after something another group member created. Oftentimes, members were hesitant to change something someone else did. When we all worked as a group, almost every action was reassured by another person in the group. This inhibited progress and often put more pressure on whoever answered the questions.

A third success was the first time we let our machine run all the way through with only one touch. This success really boosted our confidence in the machine. This runthrough really encouraged us to keep working hard and stay motivated.

Another success we had is when the program Ryan coded worked for the first time. It helped us keep going as a group and we enjoyed that we could use more electricity because there was no limit on the battery. A challenge in programming is trying to find a way for the code to always run when needed to. Ryan figured this out by creating an infinite while loop so the code will always run without being downloaded to the brain.

RYAN: I have learned a lot from doing this Rube Goldberg. I have learned that time management skills are very needed for this project and also working with a team. I also learned that your first idea may not be the final idea. This project was very fun but very stressful at the same time. When we first started the project, I didn't think that it would be too stressful. The hardest part for me was trying to find ideas that work well and are simple but not too simple. Watching videos on *YouTube* helped me alot to find ideas. While working on the project, I felt the group was falling behind from the due date of it supposed to be done. Then the stress starts to

come in. We had to stay at school longer and try to get all the steps needed. In the longer run, this is going to help me to find solutions to problems from doing the Rube Goldberg because we have been to many problems but always find a solution. This is going to help me in my college classes, especially my computer sciences classes. I think the biggest success was when we got the first box done. We were working on the box for a very long time and fixing things that didn't work, but when it did work I felt so accomplished and eager to keep working to get the whole thing done. This was a tough project, but I learned a lot from the project and had fun.

KAITLYN: Something I have learned while doing the Rube Goldberg machine is even though projects may be difficult at first, once you put everyone's ideas together it can turn out a lot better than expected. One of our biggest challenges was getting box 1 to work every time. We experienced a lot of trial and error, but once we all put our ideas together, it went smoother. I also learned the importance of using your time wisely, because before I knew it, the deadline was already here and it felt like barely anything got done. Me as well as my other team members learned how to work under pressure. Although this seemed stressful at times, we worked together as best as we could and I had fun being included in the process. I think this will help me in the future because I will be able to work in a team, I have learned to give my best effort, and manage my time way better than before.

KELLIAN: This project was difficult. My team is very small and not very "engineer-minded." The Rube Goldberg project forced me to make executive decisions and figure out issues or challenges I face on my own. I ended up taking on a heavy work-load and learning new tasks on-the-fly, tasks like loading a drill bit or identifying when to use hot-glue or screws. Ultimately, this experience helped me solidify my confidence in my abilities to achieve my goals and enforce deadlines without someone else telling me. Working with the group was difficult when we all were tired of engineering without the right mindset, but when we achieved success or set up small steps, morale improved and we became closer. I talked more with my team members, even if it was just complaining. When I needed help with a task, I knew I could ask because they do the same to me. It was a challenge to stay motivated and trusting in my group mates as we all worked on different parts at different times; when progress is unseen, it seems nonexistent. I hope to use my confidence and decision-making skills as I set off for college at Iowa State University where I will likely collaborate with my peers and practice balancing group cohesion and input with executive choices.

JASMINE: There are many things a project like this can teach you, and I will say it has taught me a lot. It teaches lots of teamwork. The most important thing I think you need to learn when working in a team is how others work. I understand not everybody will work the same as me or at the same pace. I think I learned how every person in my group works and what everyone's strengths and weaknesses are. Problem-solving plays a big role when it comes to

building a machine like this one. There are many things that we planned out to make and add into our machine, but they did not work. These things caused us to make decisions on how we can fix it or how we would change it to make it better. Additionally, time needs to be used wisely. I think finding time to be able to work on this machine outside of class was my biggest challenge. Finding time to be able to work on this project outside of class while having 3 jobs can be difficult. Learning to balance things out was very important for me. I have a very good work ethic, and I try very hard to be able to balance things out enough. I do everything I can to be able to get things done on time and in the right way. Towards the end of this project, we started to fall behind. This caused us to feel rushed, but we still got things done and working the way we hoped. I think my work ethic and ability to be able to balance my work, personal, and school life will help me achieve future success. I have extreme dedication which will also help when I will be in college. College may not be as easy or difficult as people make it seem, but I do believe that I will finish what I start just like I did in this project.

Final word count: 1402

7. Bibliography

"Anatomy of Levers, Part 1: First Class Levers." *CrossFit,* https://www.crossfit.com/essentials/levers-article#:~:text=A%20first%2Dclass%20lever%20is,the%20direction%20of%20forces%20applied.

Beckwith, Rachel. "How to Make a Bath Bomb." *Good Food,* https://www.bbcgoodfood.com/howto/guide/how-make-bath-bomb.

Best, Jackson. "8 Simple Chemistry Experiments That Your Kids Can Do at Home." *3P Learning,* https://www.3plearning.com/blog/simple-chemistry-experiments-kids-home/.

Clippard Technical Support Team. "What's the Difference Between Pascal's, Boyle's, and Charle's Laws." *Power and Motion,* https://www.powermotiontech.com/fluid-power-basics/hydraulics/article/21887658/whats-the-difference-between-pascals-boyles-and-charles-laws.

Green, Josie. "Inventions We Use Everyday That Were Actually Created for Space Exploration." *USA Today,* https://www.usatoday.com/story/money/2019/07/08/space-race-inventions-we-use-every-day-were-created-for-space-exploration/39580591/.

"How to Pass the Salt While Social Distancing." YouTube, uploaded by Joseph's Machines, 22 March 2019, https://www.youtube.com/watch?v=nORRgU8sGdE.

Lee, Jane L., and Andrew Wang. "From Weather Forecasting to Climate Change, NASA's AIRS Builds a Legacy." *NASA,* https://www.jpl.nasa.gov/news/from-weather-forecasting-to-climate-change-nasas-airs-builds-a-legacy.

Marr, Bernard. "The Five Biggest Space Technology Trends for 2022." *Forbes,* https://www.forbes.com/sites/bernardmarr/2021/12/10/the-five-biggest-space-technology-trends-for-2022/?sh=47e2ec1e1bf4.

"Ohm's Law Tutorial and Power." *Electronics Tutorials,* *https://www.electronics-tutorials.ws/dccircuits/dcp_2.html.*

Shah, Disha. "5 Innovative Advances in Space Technology." *FDM*, https://www.fdmgroup.com/blog/the-5-most-innovative-advances-in-space-technology/.

Spadoni, Aldo. "How Technology From the Space Race Changed the World." *Northrop Grumann,* https://now.northropgrumman.com/how-technology-from-the-space-race-changed-the-world/.

"Take & Make: Rube Goldberg Machine." YouTube, uploaded by Milwaukee Public Library, 5 April 2021, https://www.youtube.com/watch?v=hPIMsvKgiOg.

"What's New CO_2? Get to Know a Chemical Reaction." *American Chemical Society,* 2009, https://www.acs.org/content/dam/acsorg/education/outreach/kidschemistry/chemical-reaction-kids-and-chemistry-kit-teacher-guide.pdf.

"75 Rube Goldberg Ideas & Inventions." YouTube, uploaded by DoodleChaos, 14 April 2012, https://www.youtube.com/watch?v=6FzUx2EFk8s.