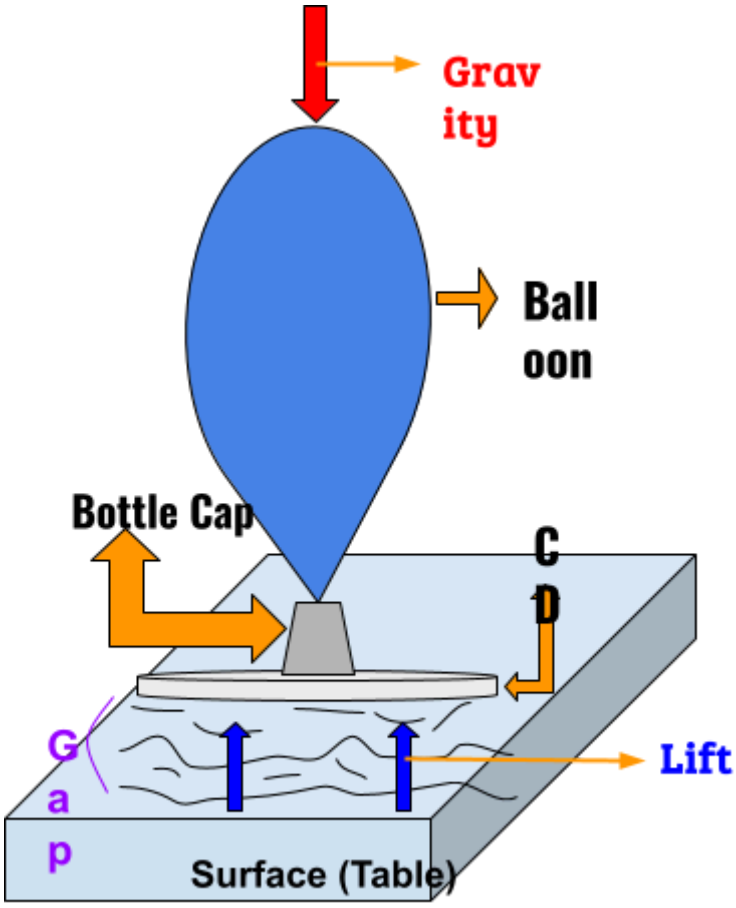
Hovercraft Challenge

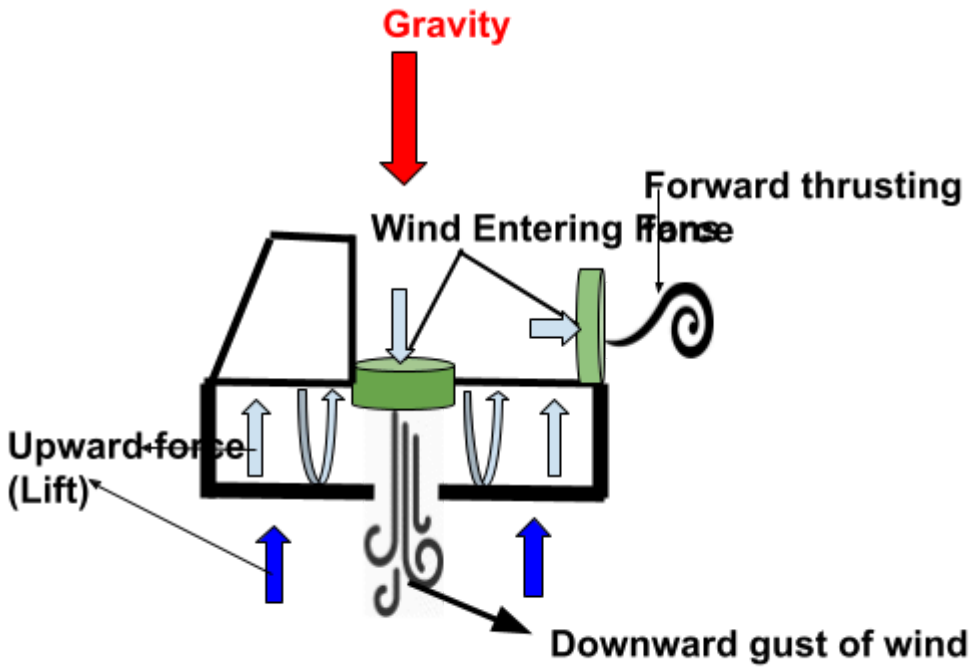
First Some Research before designing:

1. Look at the balloon and CD video https://www.youtube.com/watch?v=qbAuaN8wIvA
Explain and draw how you think the CD is able to travel. You can draw an image to explain as well.
The CD is able to move due to greatly reduced friction. The CD is able to travel due to almost no friction being exerted on its surfaces. Normally the table (or other object the CD is on) and the CD will both experience friction due to them touching; however, the balloon exerts an unbalanced force on the cd causing a lifting force. It does this by pushing air downwards this, in turn, exerts an equal and opposing force, in this case, it is an upward lifting force. This lifting force greatly reduces contact with the surface of the table thereby reducing the friction as a result. You can think of it like, the balloon is creating a cushion of air underneath the CD which allows the CD to glide over the table.



2. What is a Hovercraft?
A hovercraft is a vehicle that can drive on both land and water. It can do this by creating a large gust of downwards air which results in a strong upwards force (the lift force), this can often greatly reduce friction and the amount of energy required to move the craft.

3. How does a Hovercraft work? Draw how it works –Explain and show where air comes in from and how it exists.



Due to newtons third law of motion, we know that every force has an equal and opposite reaction. This is why when the Central fan (Darker green) blows winds down under the hovercraft creating an upward lifting force with equal force to the amount of force the fan is blowing winds at; this force is almost in balance with the force of gravity, this allows the hovercraft to just barely touch the surface it is gliding on. While the central fan keeps the hovercraft “floating” the rear fan (lighter green) pushes the hovercraft forward by the same rule (Newton's third law of motion) that was mentioned before.

4. When did Hovercrafts first appear?

In 1959, Christopher Cockerell manufactured the hovercraft, however, the general idea can be traced back to the 18th century. In 1716 Emmanuel Swedenborg originally imagined the idea but it was later abandoned after he realized that human muscle power would not be enough to power the amount of air required; unfortunately, there was no sophisticated technology back in that time. Sir John Thornycroft tried to bring the idea to life once again (the 1870’s) but the experiments were unsuccessful; the technology was simply not ready yet. It took almost 240 years until the idea could be finally brought to life with the help of more modern technology.

5. Why do Hovercraft hull shapes vary?

The shape of the hull of a hovercraft directly related to how efficient that hovercraft is. The hull can also affect the stability of a hovercraft. For example, a hovercraft with a "**finger skirt**" are several times more efficient than a simple box hull.

6. What are the advantages/disadvantages of a Hovercraft over other types of vehicles?

Advantages:

- Hovercraft can launch and land anywhere
- They can be used on any terrain
- Can reach high speeds
- Very fuel/energy efficient
- Can carry large a amounts of weight
- Cheaper to operate and maintain than a helicopter
- Safer than a helicopter
- Able to carry many people and cargo. Example "In 2006, Kvichak Marine Industries of Seattle USA built, a cargo/passenger hovercraft. It is used as a high-speed ferry for up to 47 passengers and 47,500 pounds of freight serving the remote Alaskan villages of King Cove and Cold Bay."

Disadvantages:

- Though it is cheaper than a helicopter a more appropriate vessel to compare it to is a ship. Though the hovercraft is more like an aircraft than a boat it's application is either on water and land and **cannot** fly:
    - When compared to a ship a hovercraft they have a higher maintenance and initial cost
    - They are also mechanically more complex
    - Newer developments in boats have made hovercraft quite a bit more expensive for daily usage
    - They are very hard to pilot because they are more like helicopters than a boat
    - They are very noisy which is very disturbing to passengers and citizens living close to the port

7. List as many uses as you can find for Hovercrafts in the present.

- Military operations for example "the SR.N1 through SR.N6 craft built by Saunders-Roe in the Isle of Wight in the UK and used by the UK joint forces."
- Foreign aid where a natural disaster has occurred (to transport materials) for example in Madagascar by HoverAid, an international NGO who use the hovercraft to reach the most remote places on the island.
- Used in maritime rescues (Canadian coast guard)
- Used during the rasputitsa ("mud season") as a rescue vehicle
- U.S postal system (to access remote areas)
- Recreational use for example "The Hovercraft Club of Great Britain, founded in 1966, regularly organizes inland and coastal hovercraft race events at various venues across the United Kingdom"

8. What does the future hold for hovercrafts in terms of design and usage?

Efforts are being made to develop a sort of "**Hovertrain**". The idea is that these trains could carry more people faster over a larger distance more cheaply (due to a more efficient system). The use of commercial transport, as well as personal transportation, is definitely a factor if we can engineer a way around many of the disadvantages that the hovercraft currently possess (mentioned above). This could also be used for

navigating very rugged unexplored terrains. For example, a common problem that **Mars rovers** have is that their wheels usually get badly damaged as well as moving at a snail's pace to avoid damage to the robot. A sophisticated hovercraft would be able to solve these problems; by gliding over the surface of the Mars crust it will resist many potential damages, not to mention this will allow it to traverse much more land faster.

Laws of Motion

http://teachertech.rice.edu/Participants/louviere/Newton/law3.html
http://hyperphysics.phy-astr.gsu.edu/hbase/Newt.html

1. Write a brief explanation of Newton's laws of motion:

Newton's first law of motion:
"An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force." This essentially means that objects have a tendency to keep doing what they are unless they are stopped (by an unbalanced force). On earth, there are constant forces like this to stop the object from continually moving such as friction or air resistance so we do not get to usually visualize this; however in space where there is neither air resistance or friction objects keep moving for a very very long time (some minute forces such as weak gravitational as well as magnetic fields can often act as these unbalanced and eventually stop the object).

Newton's second law of motion:
"Acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object)." This essentially is related to the first law, the object will not move unless acted upon by an unbalanced force. The greater the mass of this object the more force is required to move it. There are two factors when it comes to the amount of force required to move an object; A: the mass of the object and B: the acceleration the object will be accelerated towards. This essentially means that each part of the object requires a certain amount of energy to be accelerated to a certain speed so it only makes sense that if you would like to accelerate more of that object you would have to have more force. Now the formula F=M*A makes sense (F=Force|M=Mass|A=Aceleartion) because of the amount of force required to move an object at a certain speed is directly correlated to its mass.

Newton's third law of motion:
"For every action, there is an equal and opposite re-action." This essentially means that any force applied in one direction will experience an opposite but same force. For example in our hovercraft when the **Central fan**(the middle darker green one) pushes air down the hovercraft consequently moves up, this is a great example of the third law of motion.

Design Challenge:

Together with your team, build a working fan propelled Hovercraft using only the materials supplied. Your Hovercraft must be able to hover and move forward using the controls made in your Science class.

Learning Goal:

- ☐ We are learning to use the **design process** to create a product using a **variety of resources and tools.**

Success Criteria:

- ☐ I can accurately and with detail **research** about the problem
- ☐ I can explore and **sketch many** possible solutions
- ☐ I can create an accurate scaled **3D model** on Inventor
- ☐ I can use appropriate materials to **create prototypes**
- ☐ I can test and **evaluate different prototypes** (documented on the chart below)
- ☐ I can **create a final product** that functions as per the design intent
- ☐ I can create a final product that demonstrates **quality craftsmanship**
- ☐ I can create a **meaningful reflection** that describes my process and results via a **digital daily log**.

Materials List:

2 motors with propellers
1 Glue Gun/glue sticks
10” by 20” sheet
Exacto knives

what kind of motors? What is the max rpm

Motor Specifications:

Please dimension your motors and propellers

Foam Core Board:

You have a 10 inch by 20-inch piece to work with.
Foam core board is approximately 3/16 inches thick *please dimension the board, so you can be exact.*

Steps

1. Each **individual** is responsible for sketching out a **min of 3 ideas** to be submitted
2. Once you have completed that get into your groups, discuss all possible solutions
3. Create a 3D model using Inventor of your final design and start construction. (1 per group)
4. Be neat / be clean / be accurate and **do not** waste any materials. (You will be asked to show your leftover material) The less waste you have the better.
5. Follow the design process to ensure you get the best possible solution to this challenge.
6. Most importantly have fun testing your final crafts and record your findings for each test on the chart attached.

Things to keep in mind:

1. Size of your motors and fans
2. The size of the material you must work with. 1 sheet of foam core 10”x20”
3. The weight of your design
4. The aesthetics of your design

To Submit:

- ☐ Your individual sketches (min of 3)
- ☐ Any other research you have done including watching videos, pictures
- ☐ Your assembled Hovercraft on Inventor including all parts
- ☐ Final Hovercraft (Product)
- ☐ Hovercraft Test Sheet
- ☐ Digital Daily log to be submitted every day

Hovercrafts Test

Test	How did your Hovercraft do?	What went wrong?	What can you improve?
#1 Design one Day 9	The hovercraft with one motor did not hover at all, the fans simply spun in vain not lifting the hovercraft whatsoever.	I believe that our hovercraft weighed too much and too much air was escaping for the thrust of the fans to produce enough lift to get our hovercraft to hover.	We wanted to check how the concentration of air (pressure), open holes, and placement of holes affected the design. We thought it would improve if we added more holes.
#2 Quick changes to design one Day 9 + Day 10	We tried several quick fixes like tapping holes and other open regions as well as making more holes in the bottom of the base. This was, however, all in vain as it did not help the hovercraft generate any more lift.	This leads me to the strong belief that the craft simply weighed too much and had to be redesigned.	The new model would be less than half the size and have no hull to hold air, if there is no storage of air no air can leak out, instead it will just directly go towards pushing the hovercraft up.

#3 Day 15	Compared to our first test (did not move a bit) it has improved astronomically. The hovercraft did move forward on its own without any help. This to us indicated it was hovering because the thrust motor was able to push the craft forward meaning there was very low contact with the ground not allowing for any friction.	Of course, it can always be better. I think there was too much air escaping from the top of the fan (where it gets its air from). This was probably a factor in the design due to my fear that the fan would not get enough air not working at all.	I would start by making the airway on top of the fan smaller thus preventing the air from escaping. Another design change I would add is having less contact with the floor by making and elevated section around the perimeter of the hovercraft, this would reduce the friction further. The final thing I would like to try is to have many, many (up to 50-60) really small holes to really take advantage of the pressure increase.
#4 Testing day Video of test: https://drive.google.com/open?id=1KxJuthc-aaeAgbqNrWaQ_HTfAt7bi_P8	The hovercraft performed quite well we had the same results as test #3 (it was the same design). The hovercraft slowly moved forward while hovering. It did not move forward very fast but it did slowly.	It was the same factors that were observed in test #3.	I would love to make a new model if I had more time to test and prototype. The model would be similar to our current model but it would have a better way to mount the lift motor (red propeller). I would also make the hole on top of the lift fan smaller, I believe the fan will still get enough air even with a smaller hole and I would replace my bigger holes at the base of my hovercraft with

			many small ones, this as we learned in class would increase the pressure my hovercraft can output therbye help to increase the lift force. **3D modeled design:** https://drive.google.com/file/d/1znWXWHnZdAyYZ0esB27LHiD26rq3J-Wp/view?usp=sharing
#5			

Hovercraft Rubric

EXPECTATIONS The student will:	**Developing Proficient**	**Mostly Proficient**	**Proficiency**	**Mastery**
Knowledge and Understanding				
Uses the design process to create a product that functions. ***(All steps of SPICE were completed accurately)***			Uses all steps in the design process to create a product that functions. **SPICE**	
Thinking and Inquiry				
Demonstrate the planning and brainstorming process in a variety of relevant forms			Quality and detailed planning and brainstorming.	

(sketches, mind maps, research, etc.) 3 min			(3)	
Application				
Accurate graphic representation of the hovercraft using 3D modelling software. ***(All parts are present, to scale, labelled, dimensions, materials selection, color, fully constraint parts, dimensions)***			Accurate 3D model was created with success – looks like physical product.	
Product functions as per design intent and shows careful craftsmanship. ***(Moves forward with no vibration, colour, asthetics …)***			Product functions as per design intent and shows quality craftsmanship	
Communication				
Digital Daily Log showing ***evidence*** of their progress and results. ☐ What did you do that day ? ☐ What did you learn ? ☐ What proof do you have? ☐ What are your next steps ?			Daily log is completed and it includes evidence of their learning for each day.	

Notes:

Day1 When the assignment was first given to me I carefully read over it and started brainstorming ideas. I wanted to	Day2 The second day after learning the theory behind the of hovercrafts I wanted to see practical examples of hovercrafts being	Day3 I started working on designing a hovercraft in inventor, I took inspiration from two videos I watched on day 2 (https://www.yout	Day4 I started working on designing a hovercraft, I completed 2 designs in inventor, I took inspiration from a video I watched	Day5 The next day I realized that the motors had no air for it to spin because it was sealed off from it's back to remediate the

do research about how hovercrafts in the real world were made and what techniques they use. Not wanting to blindly start designing without having a theoretical concept of the strategies used I started to explore current uses and types of hovercrafts from many different sources: https://www.explainthatstuff.com/hovercraft.html(Entirety) What I learned (Briefly): Here is where I got most of my information about hovercrafts, I understood what they were, How they work, their limitations, The types of hovercraft, their advantages and disadvantages, and history on the hovercraft. https://en.wikipedia.org/wiki/Hovercraft (3.Uses, and 1.4.Skirts and other improvements) What I learned: I learned about there uses in the	built in real life. By doing this I would be able to understand the shortcomings of many designs and how to fix them. I would get to see how people overcome these challenges and what practical techniques they use. Sources: https://www.youtube.com/watch?v=0yFMF1sSb2E What I learned: How to build the skirt, I learned that the inside of the skirt has to be hollow and have small holes at the bottom to let pressurized air threw. https://www.youtube.com/watch?v=X3xiPxPCG38 What I learned: The hovercraft should not be heavy nor should it be tall. The heavier it is the less it will be able to hover. The bottom surface should be smooth(Specific video time from 7:31 to 9:21) https://www.youtube.com/watch?v=ii2b9yyLduE	ube.com/watch?v=0yFMF1sSb2E, and https://www.youtube.com/watch?v=YaDkmrCfGEA) Pictures Design 1: https://drive.google.com/file/d/1wFPn6mQnedfB3dsvNYFabJ6Jhbamafmz/view?usp=sharing https://drive.google.com/file/d/1sIbHAOQ1n_6YeS-PRZvsoVQCviWzCwcU/view?usp=sharing	on day 2 (https://www.youtube.com/watch?v=ii2b9yyLduE) Pictures: Design 2: https://drive.google.com/file/d/1hQYYoVVN4REhVUVLawGM9e9YQFir94_Q/view?usp=sharing https://drive.google.com/file/d/1iNgUf0bjv8UPJVr0aTH3YVlHmiOU5ZtX/view?usp=sharing Design 3: https://drive.google.com/file/d/1yM_lLPFTKezGv_Qh8m687NU9QNGSRkCf/view?usp=sharing https://drive.google.com/file/d/1GJYv0HyOfQ8ZE45ULx0Szus5Vis8mf0F/view?usp=sharing	issue I went with a more open-ended design in which the motors can get sufficient air to create a lift force. I also created another design. Pictures Design 4: https://drive.google.com/file/d/19sw69lISPASr05-2ftUQIbiEs60CUqc9/view?usp=sharing https://drive.google.com/file/d/1AiOfLNxJtxbVY_Y--LdG3gkKO4p35tWA/view?usp=sharing

world in the past present and future https://www.sciencebuddies.org/science-fair-projects/project-ideas/Aero_p033/aerodynamics-hydrodynamics/how-does-a-hovercraft-work#background What I learned: I learned more about how skirts help the hovercraft (Entirety) https://wonderopolis.org/wonder/how-does-a-hovercraft-work (Entirety) What I learned: It was a very understanding that did not go into much detail http://www.discoverhover.org/about hovercraft/works.htm(Entirety) What I learned: More specific details about what a hovercraft is capable of	What I learned: Other ways to manufacture a hovercraft and how to effectively steer one https://www.youtube.com/watch?v=YaDkmrCfGEA What I learned: More on how to make a working skirt https://www.youtube.com/watch?v=gUXEFj0t7Ek What I learned: Potential applications for the future of hover crafts			
Day6	Day7	Day8	Day9	Day10

I and my partner brainstormed on ideas coming up with many: 1 A hovercraft with two motors facing down into a hollow box. This box would then have two large rectangular holes on an angle coming out of the box 2 One motor facing towards the back of the hovercraft to provide forward thrust while another motor faces into a hollow box with many small holes at the bottom to create pressurized air 3 Our final idea was to have both motors face down into the box but rather than have two massive holes we had many smaller holes on the bottom and some holes on the back to provide a forward thrust We finally settled on 3 and started to model it but was not able to finish modelling it Final model stage 1:	Today we finished up the 3d model: Finished final model: https://drive.google.com/file/d/1WauwFNeFu5uge_Lum0kcFvYu0Uzj_SUb/view?usp=sharing https://drive.google.com/file/d/1YOQjbRZ6_SJzjKmCfrwyYvGz2xm4pOho/view?usp=sharing	We got it prepared to laser cut by creating several different parts and following the laser cutting process. We also began assembling the first couple stages of the hovercraft: Laser cut parts: https://drive.google.com/file/d/1oaUom_98KmYdCB5uQd_ty_e4nm813d5O/view?usp=sharing Assembly of the parts: https://drive.google.com/file/d/1J6BTc-xXQLpsvWtYneArc6jgoWtLBM2p/view?usp=sharing	Today we finished assembling our hovercraft as well as adding the motors. We also ran one test, however, it was only with one motor (the wire could not reach both). Assembled hovercraft: https://photos.app.goo.gl/JBBMNgktTN5riJXs5	Today we ran the tests with two motors today by soldering an extension for the ground wire so that it could be connected with the other ground wire (other motor) and to the ground of the variable lab power supply. Video of test being run: https://drive.google.com/file/d/0Bxn9qBl5ReRCX3oydDBMV1dLR1ZFcjF3WkxwaVFCWXZUZU8w/view?usp=sharing The test results were negative (the hovercraft did not float) we identified the problem as being 2 things 1). The hovercraft was too heavy 2). Too much air was escaping from points we did not want it too (the sides instead of the bottom) We tried to make small adjustments to the craft such as taping the holes on the back, taping a portion of the top of the hovercraft where

https://drive.google.com/open?id=11FhC88-L_cxCnwCvpM59UfcF7QAvVR44				the propellers were spinning and making more holes at the bottom. We found that none of this was effective and decided to scrap the design and create a new one
Day11 We finished the new design of the model and started thinking about how we were going to break it up into separate parts to print it. Final model 2: https://drive.google.com/open?id=1y_71zfKi0bJm3uVrUlKgMTSx8lKpF9Y4 Separate parts required to break up while printing (just the base of the model so far): https://drive.google.com/open?id=1egywe7fcVhFtCs33fMRLkoP3s43ObIZW	Day12 Today we finished making all the separate parts required to print and getting them all ready in illustrator. After that, since we could not laser cut it I decided to work on my portfolio (a website). Pictures of the separate parts: https://drive.google.com/file/d/1OfzQhAdxwEPpCCjtsrvnBw2CSzTV2Wg_/view?usp=sharing https://drive.google.com/file/d/1uIcnfftwywTGJS1NZCv8KlkwgjRc1CvA/view?usp=sharing https://drive.google.com/file/d/1KNCfWUQ0qAwfg-jAxcSEyHpLR58n7EDx/view?usp=sharing Picture of all the parts put together	Day13 Today was an uneventful day. The majority of the day we were waiting for people to finish laser cutting. Finally, when it was our turn we made a mistake by setting the power of the laser cutter to 100 instead of 50. This lead to our hovercraft catching on fire inside the laser cutter and becoming completely useless. We did, however, learn to look at the correct values for the material we were using.	Day14 Today we laser cut our hovercraft and started to assemble it. This time the hovercraft did not set on fire but the bottom of many circles got cut off even though in the illustrator file they were not touching the bottom and had a large leniency. We assumed it was the laser cutters preferences where we might have missed the line on top of our circles, this lead to the slightest bit becoming cut off. Pictures of laser cutter cutting our hovercraft: *https://drive.google.com/open?id=1ihPrLucWCGFem_IzvyX9Op8aNpRXzU_P* *(somewhere in*	Day15 Today we finished up assembling our hovercraft and testing it. This, however, took a while because the motor was touching the floor in our current design, to remediate this issue we took our cut-outs and extended the hight of our motor mount to allow for the motor to spin uninterrupted. This was a difficult process and we were not sure if the white glue was going to be enough to hold it up but in the end, it came threw. Video of us testing it: https://drive.google.com/open?id=1D-06qPHAXnD9_

	in an illustrator file: https://drive.google.com/open?id=1zM098eNEybf2Qco22cYyfUeSWzZmkqy7 https://drive.google.com/open?id=1bhIS6xw5HtEfpvScyhXX6Bc078DJl9vX Website link: https://senguptaarmaan.wixsite.com/armaan-portfolio		*the configuration I guess there was a line on top of the very bottom of our circles, we realised this too late as evident by the video.* Pictures of assembled hovercraft: *https://drive.google.com/file/d/1537RCPpWHqZdMULWXbiY_-A3PPvrRY8h/view?usp=drive_open*	DNUFM6aCv64CzLD3dUX I also painted it: https://drive.google.com/file/d/1AgPP3Ce5-xRDmcmQUSDV2Pmj0HV2I0Rx/view?usp=sharing

All inventor file models:

Note these are not in picture format but rather raw original formats (.ipt, .dwg, .iam) . Picture formats are integrated into the daily log.
https://drive.google.com/open?id=1IYbEtwhuuQ2mpeQT6imORU_llT6a2wlV