Fill out this worksheet as you work through the design of your whegs and accompanying adventurer. While the two designs affect each other, some questions will be about one design and others will be about both designs. You will submit this typed and completed worksheet as part of your module report.

A. Define Problem – Both Designs

Write a description of the problem in your own words.

We must design a wheg that when attached to a car, can easily traverse over and through a variety of obstacles in a timely fashion. Our car must have an apparatus to collect vertically raised rings along the track as well.

B. Determine Specifications & Requirements – Both Designs

Ask at least two clarification questions. You will have an opportunity to ask your instructor these questions during class.

1. **Is there a set amount of time our car will have to traverse the obstacle course? ie will we be disqualified after a set time?**

2. **How many attempts are we given to complete the course?**

3. **Will we get a certain type of screw to hold the wheg in place? If so, what does it look like?**

C. Take Measurements of Cars & Obstacles – Both Designs

Understanding the physical dimensions of your challenge will inform your designs. Use the calipers and/or ruler to measure at least two relevant dimensions of the remote-controlled car and/or example obstacles. In particular, consider measuring the height of a tall obstacle and the height of a ring.

1. **Measurements of Obstacles/Ring**
    - **Max Height of Obstacle: 2.918in**
    - **Single Plank Height: 1.415in**
    - **Useable Ring Diameter: 2.7385 (largest diameter) - 0.3815 (band width) = 2.357in**
2. **Measurements of Car and Screws**
    - **Screw holding Adventurer: 0.8645in**
    - **Bolt Part of screw (no thread): 0.354**
    - **Amount of material holding screw to car: 0.315in**
    - **Thread Diameter: 0.234in**
    - **Adventurer Screw Height to Ground: 2.2685in**
    - **Adventurer Height Range: 5in - 6.25in**
    - **Wheel Diameter: 1.0830in**
    - **Extruding Center of Wheel: 0.4825in diameter**
    - **4 Screws to hold wheg in place: 0.278in diameter**

D. Identify Design Decision Criteria - Whegs

Thinking about what would be helpful for the intended user of your product, create a list of at least two criteria by which you will evaluate your design concepts. Indicate whether they are equally important or whether one should be weighted more heavily than the other. Explain why you chose these criteria.

1. **The whegs should be able to traverse soft surfaces, such as a pillow, without tipping over or getting stuck in grooves. This is important because soft, uneven surfaces may be the downfall for a remote controlled car.**

2. **The wheg should be light and agile enough to get over steep inclines and rapid elevation changes in a way that won't compromise movement or performance. This is crucial to the wheg's success, and is drastically more important than the first criteria.**

E. Identify Design Decision Criteria - Adventurer

Thinking about what would be helpful for the intended user of your product, create a list of at least two criteria by which you will evaluate your design concepts. Indicate whether they are equally important or whether one should be weighted more heavily than the other. Explain why you chose these criteria.

1. **The adventurer must be at exactly the right height above the car, so that it can effortlessly pick up the rings along the course. We need to be collecting rings to score points, and having the adventurer at the perfect height allows us to worry about only the wheg performance.**

2. **The most important feature of the adventurer is that it must be secured on the car very well. This would entail two contact points, one on each side of the screw. This is necessary because the adventurer must always be perpendicular to the car to ensure consistent ring collection.**

3. **We must also consider the weight of the adventurer so as to not get disqualified when it is placed on the car itself.**

F. Research Biological Inspiration - Whegs

Research animal legs or other biological features that you could incorporate into your whegs design. Describe or draw at least three biological features below. Explain the pros and cons of incorporating each into your design.

1. **Squirrels are excellent climbers who can traverse the grass and tough surfaces alike, while still effortlessly climbing trees vertically. Their ability to latch on to trees in a way that almost defies gravity made them stick out in our research. They have very sharp claws, which would be good to incorporate into our design to easily mount terrain challenges. Their hyper-extendable wrists and strong hind legs would be difficult to incorporate, as our wheels must be uniform and the car has a predetermined speed its wheels can travel at.**

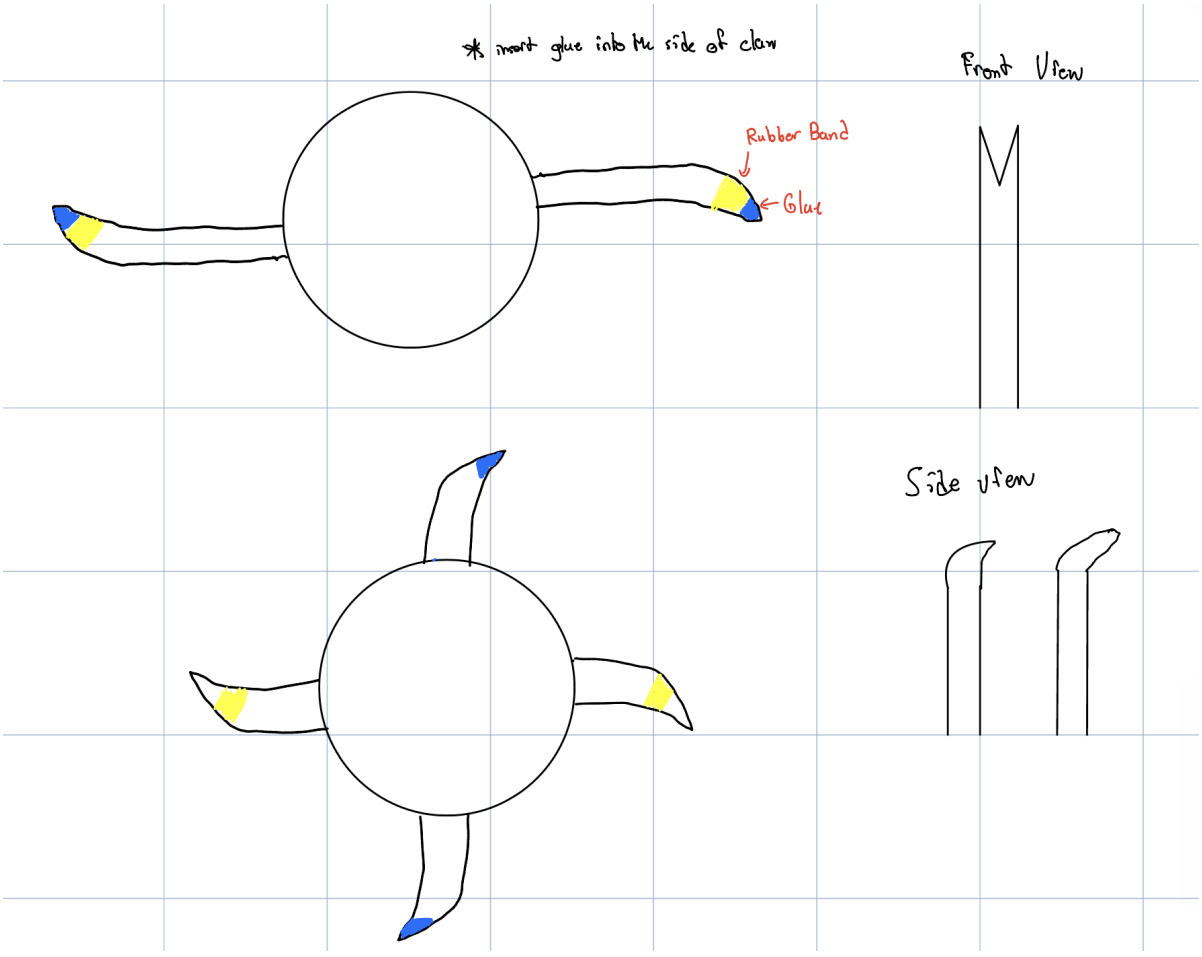
2. **Leopards are also excellent climbers. They often scale trees to hunt and stalk prey, and they can move quickly on land. They have low centers of gravity and are more compact animals, which keeps them more balanced. This would be easier to incorporate into our design than their strong hind legs, as we don't have the ability to alter the motors in the car.**

3. **Mountain goats climb mountains with the use of and spread their two toed feet while climbing to scale near vertical surfaces. We could incorporate a design like this by having the leg of each wheg diverge into two separate 'hooves'. Goats also make use of a soft padding at the back of their feet as well, as it lets them balance and mold into the mountain side. This would be impossible for us to pull off, as our printers can only use PLA.**

4. **Sloth's use curved claws to climb ledges easily. This would be useful in our design when it comes to climbing the planks of wood without getting stuck in the pillow.**

G. Generate Design Concepts - Whegs

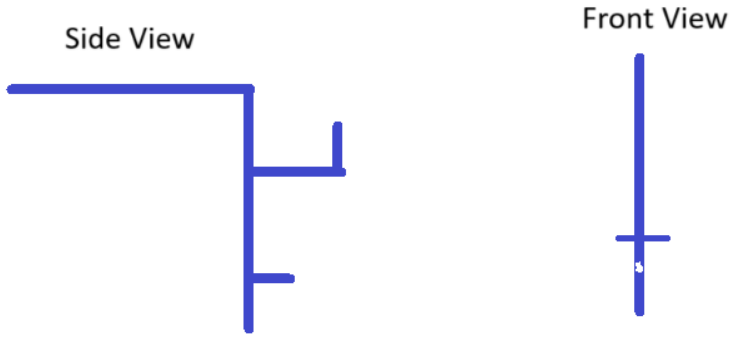
Draw simple sketches of as many ideas as you can for designs and features.



H. Generate Design Concepts - Adventurer

Draw simple sketches of as many ideas as you can for designs and features.

The part extruding from the cart would be to create a corner in order to grab rings and the “hook” below it would hold the rings and help keep the center of mass towards the car. The prongs below the hook would rest on the car itself on both sides of the adventurer to stop it from slipping either way, keeping it upright.



I. Choose Initial Design Features - Whegs

Which of the ideas did you choose? Why? You must use the criteria developed earlier to justify your design choice.

We decided to use 4 curved legs for each wheg. We justified using curved legs because we presumed that it would be easier to climb obstacles with whegs that had curved legs compared to whegs that didn't have curved legs. We chose to specifically use 4 legs because we thought it would allow for the best climbing performance. We also implemented glue on the tips of the wheg. We implemented this because we thought that it would give more grip to the wheg.

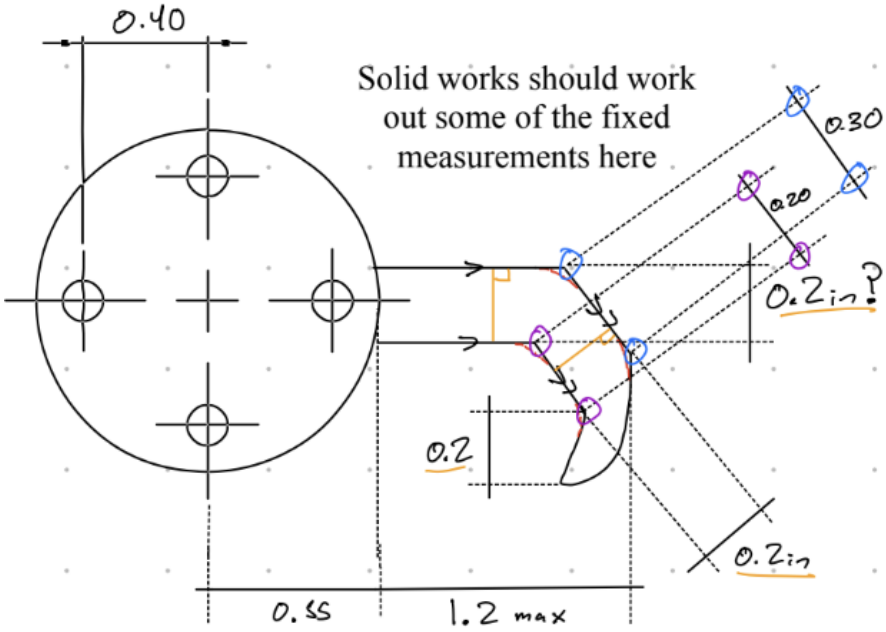
J. Choose Initial Design Features - Adventurer

Which of the ideas did you choose? Why? You must use the criteria developed earlier to justify your design choice.

We ended up going with a long rod-like structure to be our adventurer. We wanted an adventurer that would grab onto the rings easily and hold onto them. At one point we were considering making a box that the ring would be pushed into, but ultimately we decided against it. The rod met our criteria for being effective; in practice the adventurer was able to grab onto the rings and hold onto them.

K. Design a Solution - Whegs

In the space below, create a rough sketch of your design. Include notes highlighting important features. Your sketch can be scanned from a pencil and paper sketch, imported from a tablet, or completed in a software program, like PowerPoint. Do not worry about making your drawing look like a professional engineering drawing.

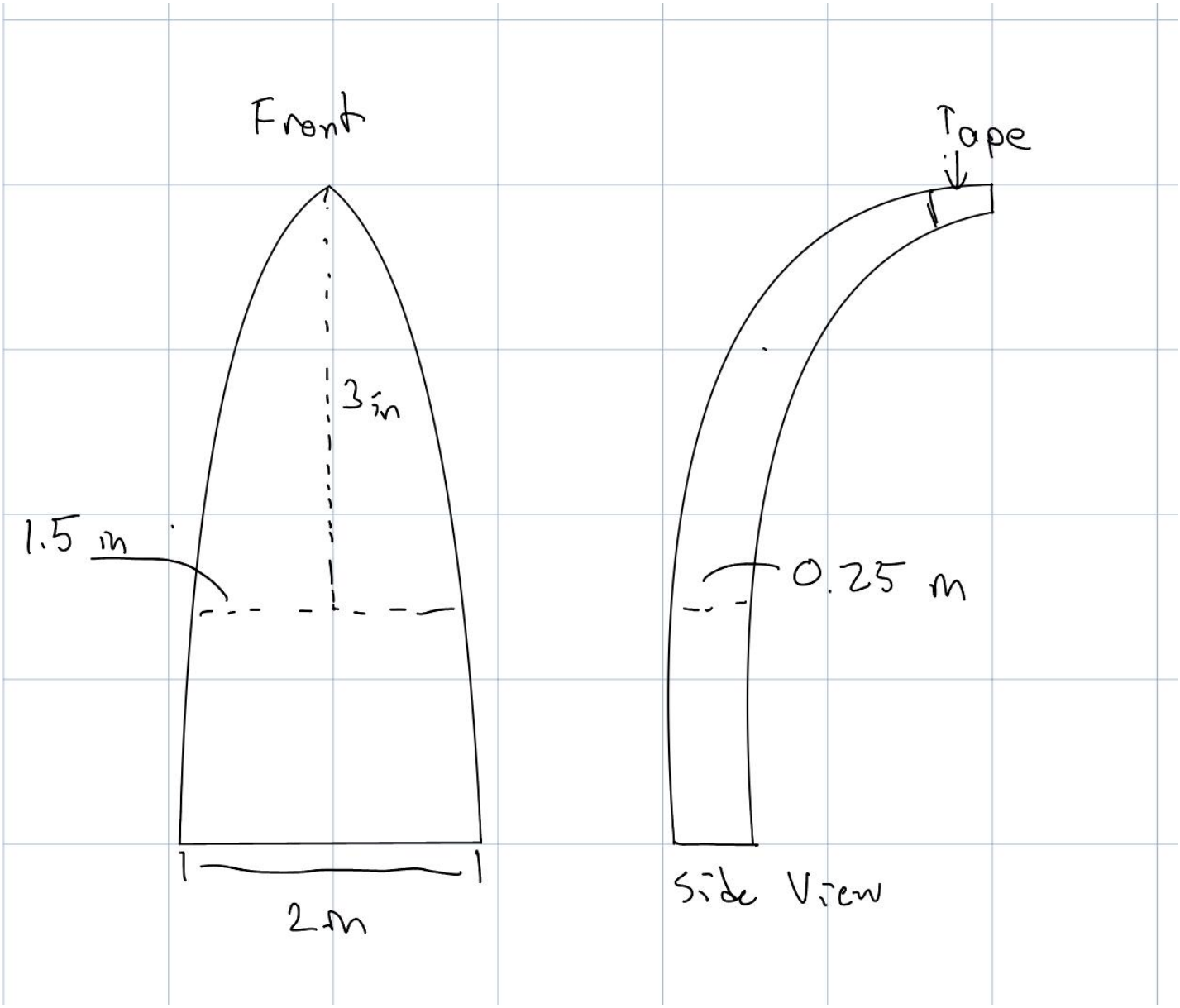


Copy when design 3 more times (90° apart)
It may be better to use 3 spokes to better represent a sloth, but this may come with a trade off.

Note: We ended up making the Angle Much greater so that the legs were more curved, but this design above was used as the foundations for our wheg. We ended up going for the 4 leg wheel. These modifications led to the final product pictured to the left of this text.

L. Design a Solution - Adventurer

In the space below, create a rough sketch of your design. Include notes highlighting important features. Your sketch can be scanned from a pencil and paper sketch, imported from a tablet, or completed in a software program, like PowerPoint. Do not worry about making your drawing look like a professional engineering drawing.



Note: This Design was made with three parts of cardboard that were carefully cut out and hot glued together. It is a large alteration from our first Design.

M. Create and Test Prototype - Whegs

Build a prototype out of cardboard and test its functionality. What potential improvements and/or enhancements come to mind? Continue to iterate your design as time permits, keeping track of the modifications in the space below.

We need to add some sort of grip to the ends of the whegs to prevent it from slipping and hide the possible points of the whegs getting tangled in the carpet.

N. Create and Test Prototype - Adventurer

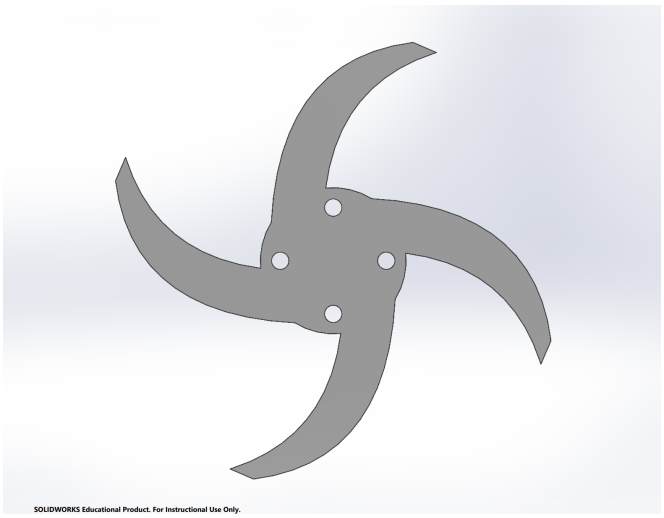
Build a prototype out of cardboard and test its functionality. What potential improvements and/or enhancements come to mind? Continue to iterate your design as time permits, keeping track of the modifications in the space below.

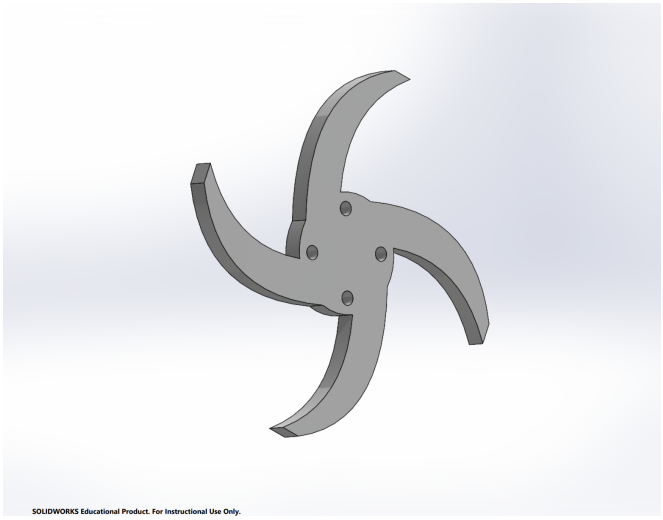
We need to make an adventurer that is much more rigid and less susceptible to bending to allow us to get the rings properly.

O. Model Design in SolidWorks - Whegs

Using the Wheg center SolidWorks file as a starting template, create a 3D model of your design in SoldWorks. Do not modify anything about the holes in the center – these are aligned with the holes in the hubs that will be used to attach the whegs to the car. Once your SolidWorks model is complete, 3D print your whegs at think[box], following the instructions in the Lab Manual. You will submit a pdf of your SolidWorks design along with your Lab Report.

Wheg SolidWorks Model





Pictured above are the Front and SIde View of our Final Wheg Design

P. Document your Design - Adventurer

Document your adventurer design using either photograph(s), or software sketch (2D drawings in PowerPoint, or Corel Draw), or 3D SolidWorks model. You will submit a pdf of your documentation along with your lab report.

Adventurer Photos

Pictured Above is 4 Views of the finished Product of Our adventurer. Its key design Features are Hot Glue At the base to withstand the screw and excessive movement, tape at the tip for ease of ring collection, and multiple layers of cardboard for rigidity.

Q. Evaluate Design - Whegs

After the design competition, think about how both of your designs performed, then answer the questions below as a group.

What were the strengths of your design?
The strengths of our design was that they were supposed to be able to get traction on a wide variety of surfaces, and be able to

What changes would you make to the design in the next iteration of it?
Decreasing the size of the whegs and adding a little more glue for traction would have possibly helped out in the competition.

What were some of the most creative ideas you saw incorporated by other teams in the class?
Having a 2- legged wheg was one of the best and most interesting approaches as the were able to waddle around in a much different manner than other cars and gave them more control

R. Evaluate Design - Adventurer

After the design competition, think about how both of your designs performed, then answer the questions below as a group.

What were the strengths of your design?
Our design was very stable. During the competition we observed that some other groups had very flimsy adventurers that were subject to breaking or bending. Our adventurer was very stable due to it being a thick piece of cardboard held together with hot-glue.

What changes would you make to the design in the next iteration of it?
In the next iteration we would make it longer to improve our ability to collect the rings. In the version we used in competition it was a bit short in length, which affected our ability to collect the rings.

What were some of the most creative ideas you saw incorporated by other teams in the class?

Some teams were very creative with the aesthetic of their adventures. We thought the adventurers with the spongebob and patrick design as well as the sonic design were very creative. As far as performance goes one of the more creative ideas we observed was the adventurer that a team was able to make a structure out of wood and the ring fell onto it so that it would be very secure and had no chance of moving.

Project Management Sheet

	ENGR 130 Module Planning		Module	4	Section	E	Team	1	
			Scheduled		Actual				
#	Task	Deadline	Start	End	Start	End	Primary	Secondary	% Complete
	Brainstorm Ideas on whiteboard	10/17	10/17	10/17	10/17	10/17	All	N/A	100
	Write algorithm for code	10/17	10/17	10/17	10/17	10/17	Angel	Madhav	100
	Write code for a dropped bAll	10/17	10/17	10/17	10/17	10/17	Jonathan	Madhav	100
	Revise and clean code	10/18	10/18	10/18	10/18	10/18	Jonathan	Trevor	100
	Discuss Lab 1 Discussion questions	10/18	10/17	10/18	10/18	10/18	All	N/A	100
	Write discussion questions	10/18	10/18	10/18	10/18	10/18	Trevor	All	100
	Design Initial Sketch for Wheg /Adventurer	10/25	10/19	10/24	10/20	10/24	Jonathan	N/A	100
	Complete Design process worksheet parts A-H	10/25	10/19	10/24	10/19	10/24	Jonathan	All	100
	Take measurements	10/25	10/19	10/19	10/19	10/19	All	N/A	100
	Complete Module Planning	10/25	10/19	10/23	10/19	10/20	Trevor	Madhav	100
	Assemble M4 Part 1 report	10/25	10/19	10/23	10/19	10/25	Trevor	Madhav	100
	Submit M4 Part 1 report	10/25	10/24	10/24	10/25	10/25	Trevor	N/A	100
	Design Initial Sketch for Wheg in solidworks	10/26	10/26	10/26	10/26	10/26	Angel	Jonathan	100
	Design Initial Sketch for Adventurer	10/26	10/26	10/26	10/26	10/26	Trevor	Madhav	100
	Assemble M4 Part 2 report	10/30	10/27	10/29	10/24	10/24	Trevor	All	100
	Submit M4 Part 2 report	10/30	10/30	10/30	10/24	10/24	Trevor	N/A	100
	Confirm final final design for wheg	10/27	10/27	10/27	11/15	11/15	All	N/A	100
	Confirm final design for adventurer	10/27	10/27	10/27	11/16	11/16	All	N/A	100
	3D print wheg	11/10	11/10	11/13	11/17	11/17	All	N/A	100
	Construct adventurer	11/10	11/10	11/13	11/20	11/20	All	N/A	100
	Construct car without the adventurer	11/21	11/21	11/21	11/20	11/20	Angel	Madhav	100
	Test Design with whegs	11/21	11/21	11/21	11/21	11/21	Jonathan	Trevor	100
	Modify design if necessary	11/21	11/21	11/21	11/21	11/21	All	N/A	100
	Test design with adventurer	11/21	11/21	11/21	11/21	11/21	Madhav	Angel	100
	Assess effectiveness of ring collecting ability	11/21	11/21	11/21	11/21	11/21	All	N/A	100
	Evaluate the final car Design	12/5	12/5	12/5	11/21	11/21	All	N/A	100
	Discuss strengths and weaknesses of wheg	12/5	12/5	12/5	12/6	12/6	Trevor	Angel	100
	Discuss strengths and weaknesses of adventurer	12/5	12/5	12/5	12/6	12/6	Madhav	Jonathan	100
	Complete obstacle course chAllenge	12/5	12/5	12/5	12/5	12/5	All	N/A	100
	Complete Design process worksheet	12/5	1/11	12/5	12/6	12/6	All	N/A	100
	Assemble M4 Part 3 report	12/8	12/5	12/7	12/7	12/7	Jonathan	All	100
	Submit M4 Part 3 report	12/8	12/8	12/8	12/7	12/7	Jonathan	N/A	100

Last Updated	
Madhav	12/6