Evidence of Learning #2

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Abstract

Going to the red planet has always been NASA's goal. In the past few decades, we have sent countless satellites and rovers to study Mars. Through these missions, we had successes and failures. Entering the Martian atmosphere is by no means easy. One of the main reasons for this is because Mars' atmosphere is smaller than Earth's atmosphere. As a result, when a spacecraft is entering Mars, it doesn't have enough air resistance to slow itself down. Due to this, the spacecraft will continue to travel at an incredibly fast velocity. To solve this problem, a large amount of engineering, math, science, and technology are implemented for the landing trajectory. You literally need all of man's power to make the landing successful on Mars. With this in mind, I conducted an experiment which simulated an atmospheric entry in Mars. I initially had a set design but as I ran multiple trials, I modified it so the landing would be successful. Over the course of the trials, I realized that we must understand physics, particularly Newton's three laws to solve this problem.

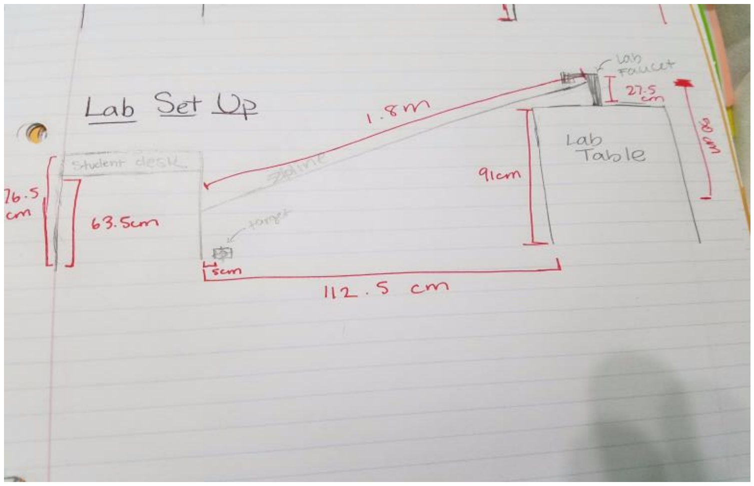
What is the Problem in the Experiment?

In this experiment, we must have a model spacecraft drop a marble at the intended target area. The marble represents a rover or a manned vehicle that needs to descend and land at a particular location. Doing this is a very big challenge. While entering the Martian atmosphere, engineers need to know the exact time in which they have to drop the rover/ manned vehicle. If they are off by just a little bit then the consequences can be catastrophic. In order to prevent this from happening, engineers need to design a spacecraft that can release the equipment just at the right time. This is exactly what I am trying to test in this experiment. Again, the marble must reach the target area by being dropped by the “spacecraft” at the right moment.

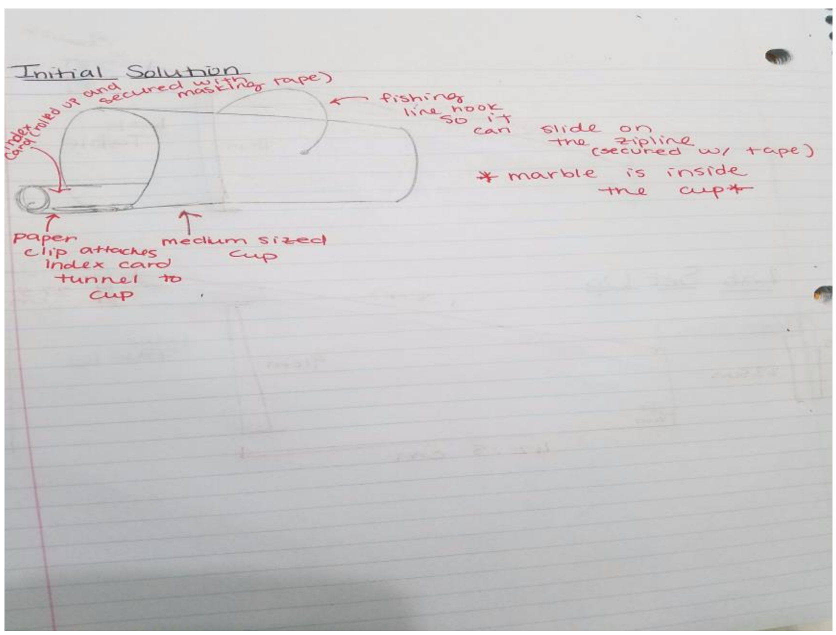
Criteria and Constraints

To stimulate the exact situation that would take place during the atmospheric entry of Mars, there were multiple criteria and constraints placed in this experiment. For example, the bottom point of the zip line must be 20 inches below the top point of the zip line, the zip line is 6 ft. long, the cup (spacecraft) should be able to carry the marble down the zip line, and you need to calculate the exact time at which you must tip the spacecraft so it drops the marble. In addition to this, I only could use masking tape, an index card, a paper clip, 9 feet of smooth line, and a medium sized paper cup. With this criteria and constraints, I did come up with a way to solve the problem.

Lab Setup



Initial Solution



Approach

After carefully analyzing the situation, I proceeded to design my spacecraft. Since the cup needed to carry the marble down the zip line, I designed it so the marble would not fall out. Using the resources that were provided, I used the index card and rolled it up to make it look like a tunnel. This would give a better guidance for the marble. In order for the index card to not fall off during the descent, I utilized a paper clip to secure it to the paper cup. The index card was also put into place because I believed that it will make the marble go to the intended target when I tipped at the appropriate time. I also used a fishing line to create a loop, allowing the cup to travel down the 1.8 meter zip line.

Trial 1 Observation

Although my initial design was a good starting point, I did not consider the factor of balance. As I tested my spacecraft, the marble fell out immediately and the cup faced downward as it traveled down. The first design of this spacecraft did not meet the criteria and constraints in this trial.

Solution

In order to resolve the balance issue, I decided to place the cup backwards. This means that the side with the opening is facing up as it travels down the zipline. I also replaced the fish line with the index card so the cup will have better balance.

Trial 2 Observation

These new model was definitely was more successful than the first one. However, I ran into another problem. That was Newton’s First Law: an object at rest stays at rest and an object in motion will stay in motion. When I released the cup to go down the zip line, the marble inside jumped back out. At first, I was unsure of why that happened but I quickly realized that it was because of Newton’s First Law. The cup was in motion but the marble inside was at rest. It kept on falling out because of inertia (it wanted to stay at rest).

Solution

In order to stop the marble from falling out, I put piece of tape (rolled it so the sticky side would be in contact with the marble) near the edge of the cup. This would stop the marble when it is about to jump out, allowing the cup to carry it until it drops it at the designated target.

Trial 3 Observation

The cup was successful in that it carried the marble down the zipline without dropping it at an unintended location. However, I couldn't effectively tip the spacecraft to drop the marble at the target with the given time.

Solution

In order to solve this issue, I placed a marble sized hole on the side of the cup and attached a fish line at the bottom of the cup. The fish line would allow me to yank the cup when I wanted to drop the marble. The hole in the side also would allow the marble to easily fall out with some guidance.

Trial 4 Observation

The new spacecraft model was very sufficient this time. All I had to do for this trial is time when I was going to yank the cup so the marble will fall through the hole and onto the target area. After many tries, I successfully had my spacecraft drop the marble at the target.

Analysis and Conclusion

I initially started with a certain design but as I went through the engineering design process, I modified and improved my spacecraft and eventually solved the problem. By identifying what problem I was trying to solve and understanding what my criteria and constraints were, I had a clear idea of what I had to do to be successful. In the 2030s, NASA is planning to have a manned mission to Mars. In order to be a successful astronaut, you must need to be skilled in various fields. I personally hope to go to Mars as an astrobiologist because I can obtain samples with little to no contamination. However, my spacecraft must first reach the surface of the Mars successfully. As I mentioned before, it takes every human power to land a vehicle on Mars so I must be knowledgeable on how I make it to the surface.