Lego Mass Thrower
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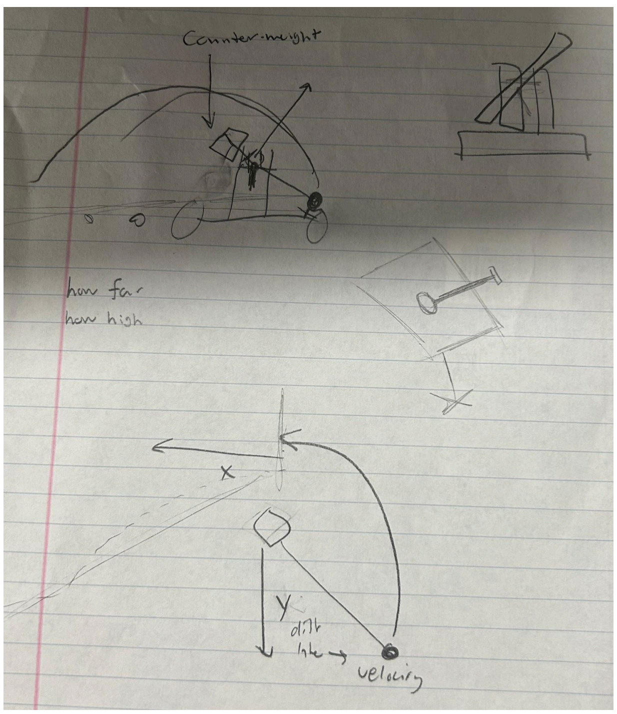
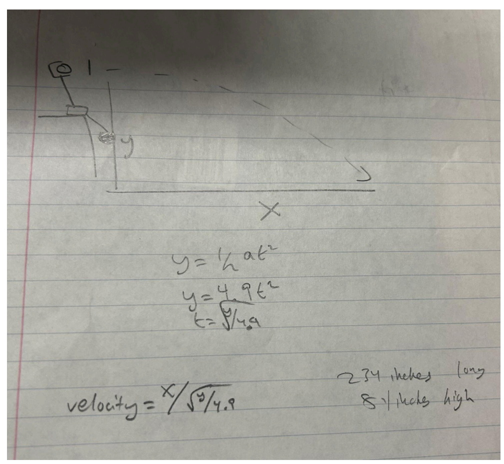
8/25/25

## Task:

We were tasked with creating a LEGO structure that could launch a LEGO ball as far as possible. We were not allowed to use any electronics or motors, just transferring potential energy into kinetic energy. For the source of energy, we were allowed to use rubber bands and/or our hands to hold the structure in place.

## Engineering Notebook:

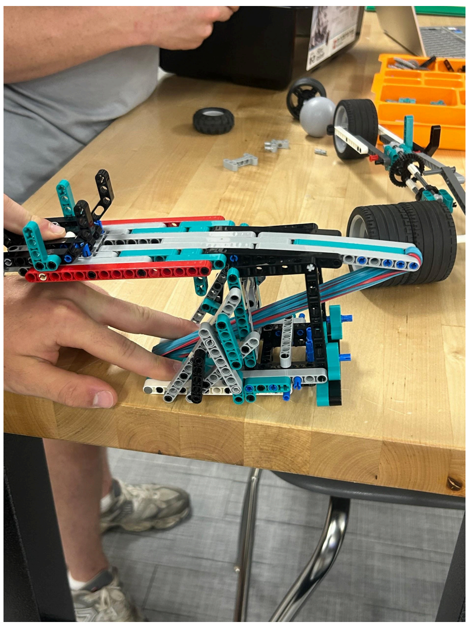


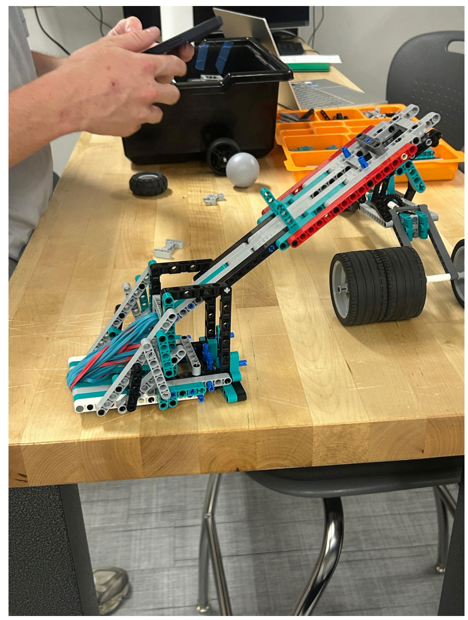

At first, we planned to have a counterweight on the opposite side of the ball. We thought that holding the weight as high as we could and letting go would be enough to launch the ball. Unfortunately, we couldn't find enough mass to generate enough potential and kinetic energy to launch the ball. Instead, we switched to using rubber bands on the opposite side of the ball connected to the platform. This allowed us to pull back the catapult to full tension and let go to launch the ball. Finally, we ditched the wheels as we worried this would interfere with the catapult and offer unexpected and undesired side effects such as the catapult rolling off the table.

# Testing:

Our first launches showed significant problems in our first design. The Ball holder interfered with the launch and caused the ball to get stuck and launch at the ground. After fixing it, the ball still launched too low. We fixed this problem by adding a stopper so that the launching arm didn't go past 90 degrees. Later, we began adding rubber bands to increase the potential and kinetic energy of the launch. This, however, caused the launching arm to bend and snap off on some launches. We proceeded to go into a cycle of reinforcing and adding rubber bands over and over until we reached the limit and created a stable launcher.



Catapult under full tension



Catapult after being released

# Data:

To collect our data, we launched off the top of a table and marked where the ball landed on the ground. We then measured the horizontal distance the ball travelled in inches using a tape measure, as well as the vertical distance the ball travelled in inches. We calculated that the ball travelled 234 inches (9.54 meters) horizontally and 51 inches (1.3 meters) vertically. We used the distance formula “$D= \frac{1}{2}at^2$” where a equals acceleration and t equals time. Since we know that the acceleration of gravity is -9.8m/s/s, and we know how far the ball travelled, we can rearrange the equation in terms of those values to be velocity $=\frac{x}{\sqrt{y/4.9}}$. Solving this equation gave us the launch velocity of 11.55 meters per second. After converting units, we estimated that the ball was launched at 25.83 mph. Next, we used Vernier video analysis to determine the actual launch velocity of the ball. We took a video of the ball launch and imported the video into Vernier video analysis. Then, we plotted a point at each frame of where the ball was. Finally, we measured a reference point on the video and inserted it into the video to give the software a conversion factor. The software then gave us a real launch velocity of 18.4 mph.

## Conclusion:

Overall, the project went very well for my group. As a group, we worked very well together, with everyone finding something to do to be productive. Our teamwork strategy was a divide-and-conquer type system, with everyone finding something that needed to be improved on or built and taking the initiative to do that on their own. For example, at one point, Aden was setting up the rubber bands on the catapult, I was strengthening the catapult arm, and Grayson was finding us pieces and organizing them for future use. Thus, my role in the team was structural integrity of the catapult to make sure everything stayed intact as we added more energy. The one thing I think we could improve on was our minimal preparation. Although we had an initial plan written down, we quickly changed plans and never assessed how we would do it. This led to us constantly undoing and redoing the catapult, as we had not planned ahead. For example we made a very thin base that prevented us from strengthening the middle of the arm. Overall, though, as a group we did pretty good, and I will try to do better preparation next time.