<u>Lego Mass Launcher Project</u>

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Introduction:

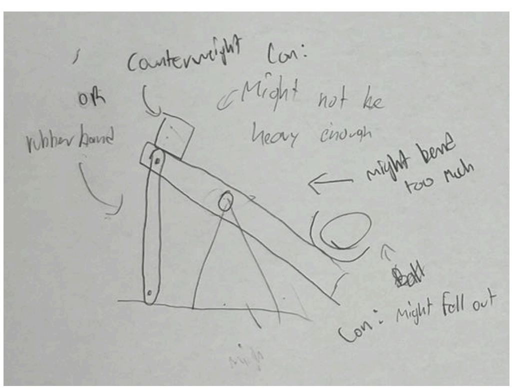
For this project, we had to brainstorm and construct a Lego Mass Launcher designed to launch a projectile (the ball) away from the launcher using only potential energy. We also had to find the initial launch velocity by collecting data and using basic principles of projectile motion.

Brainstorming:

Kevin - I thought of making a catapult system with a weight on the opposite end of the ball being attached, with the plan being to simply drop the weight causing the ball to get launched forward and into the air.
Issues with this idea were creating a system that prevented the weight from damaging itself along with the surfaces while still falling hard enough to launch the ball.

Daniel - My plan for the mass launcher was to make a slingshot catapult with two poles on opposite sides sitting on base. The plan was to wrap a rubber band around each pole and have a little pole in the middle to hold the rubberband, and then let go of the rubber bands which would make the ball launch away from the base.

Aarush - For my idea, I thought of using a catapult design where the arm of the catapult would be attached to a center pivot connected to a base and would be able to rotate freely. At the right end, there is a small cup to put the ball in. At the left end, I thought of attaching a counterweight to propel the ball forward or attaching rubber bands from the arm to the base to use the tension to propel the ball.



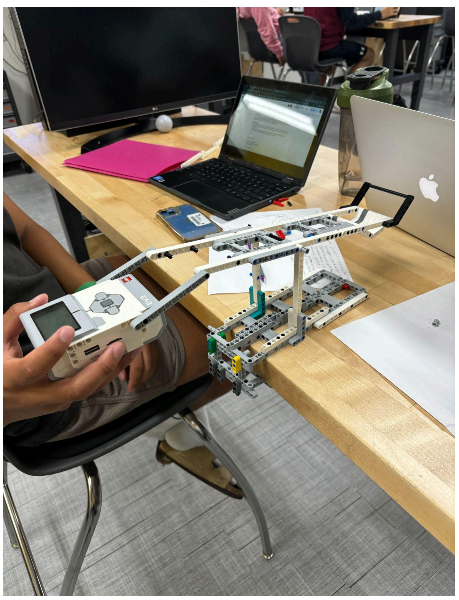
Aarush's design

In the end, we decided to go with a catapult design since all our ideas involved using a catapult. The catapult arm would rotate around a center beam, connected to the base of the catapult. The ball would sit on one end of the catapult. On the other end, we decided to attach a counterweight (the EV3 brick) to the other end of the arm to propel the ball forward.

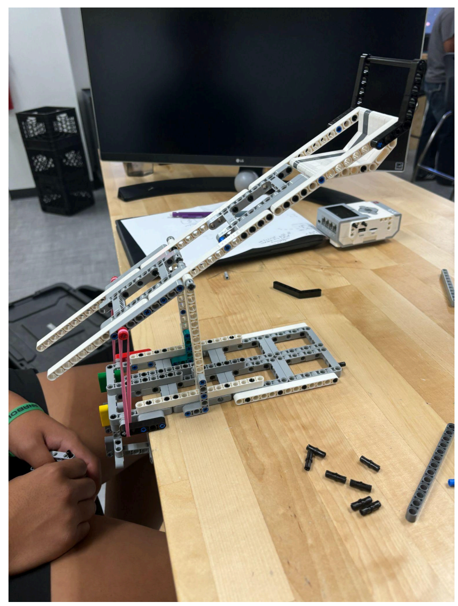
Building Process:

We began with building the catapult with a wide base and a long arm and attaching a weight to the opposite side of the ball. We then saw that the weight was causing too much stress and force on the structure so we had to take it off and decided on using rubber bands as the new method to create force for the ball. We noticed that the bands caused the structure to bend, so we created a clip-like attachment that would hold the structure to the table. Now with this, it would cause the structure to fling itself off the table after launching the ball so we put another clip on the other side of the table to hold the catapult in place.

Switching from the counterweight to rubberbands



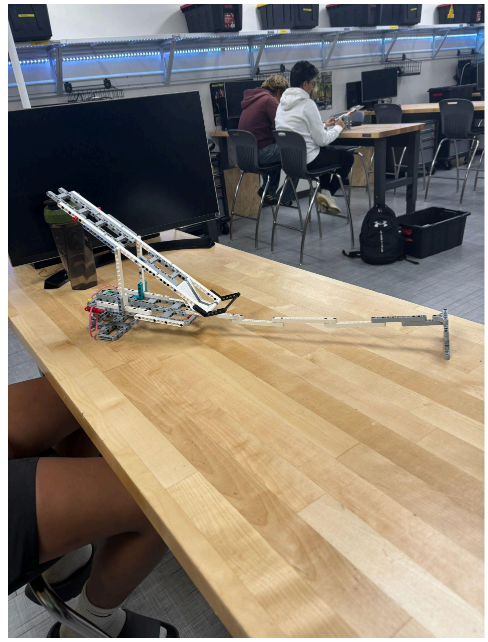
Launcher with brick on



Launcher with rubber bands

Added the back supporting clip securing the structure

Back clip

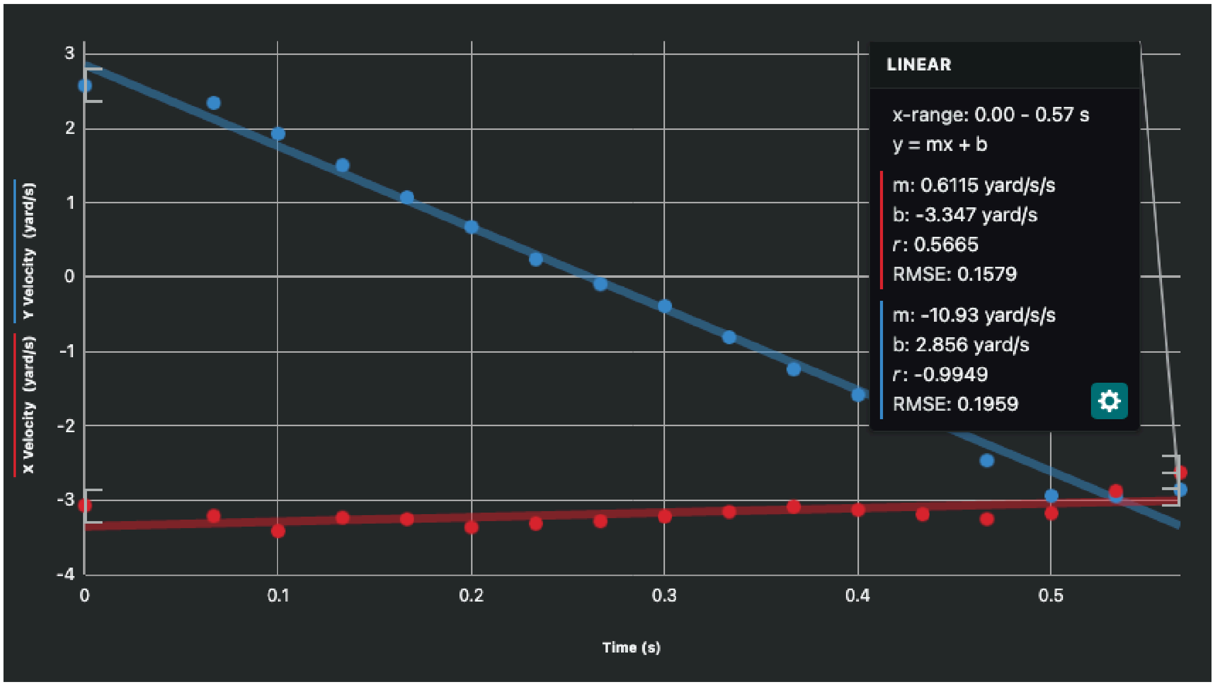


Launcher with back clip on

Data Collection:

After we finished our catapult, we decided to collect our data using Vernier Video Analysis Software. In order to do that, we need to film a video of the ball getting launched.

After we did that, we uploaded the video to Vernier Video Analysis and used the video tool to pinpoint the location of the ball over time, which was shown on a Velocity-Time graph (red - x velocity over time, blue - y velocity over time). We made the best-fit line for both the x and y axis with their equations shown in the screenshot.



Velocity-Time Graph of Ball

Since we are finding the initial launch velocity, we need the initial x and y velocities, which are shown by the y-intercepts of these equations. Doing that, we get:

- Initial x velocity: 3.347 yd/s
- Initial y velocity: 2.856 yd/s

Results:

Using the x and y velocities, as well as the Pythagorean Theorem (plug-in x-velocity for a, y-velocity for b), we get 4.40 yd/s or 4.023 m/s as our initial launch velocity.

Conclusion:

Overall, I think we succeeded in this project since we successfully made a Lego mass launcher that threw the ball and also calculated the initial velocity. At the beginning of the process, we started with the catapult launcher with a counterweight attached to it, but as we continued to build, we encountered many problems and learned to tweak our design accordingly to arrive at the final build, which uses a rubber band and is more structurally stable. The one thing we did well was changing and adapting our build as we encountered problems. Also, we managed to successfully come to a good compromise when brainstorming our build. Despite that, I think the one thing we could have done better is more properly document our building process since we forgot to take photos of the build when we made changes to the build.