# Beachwood High School Team A

# C35

# Air Trajectory Design Log

# Materials

- wood
- pvc pipes
- screws
- clamp
- metal rod
- string
- tape
- drill
- cyanoacrylate
- masses
- tubing
- 3d printed materials

3d printed materials:

- mass cap
- mass body
- laser holder
- protractor holder
- drop tube to tubing connector

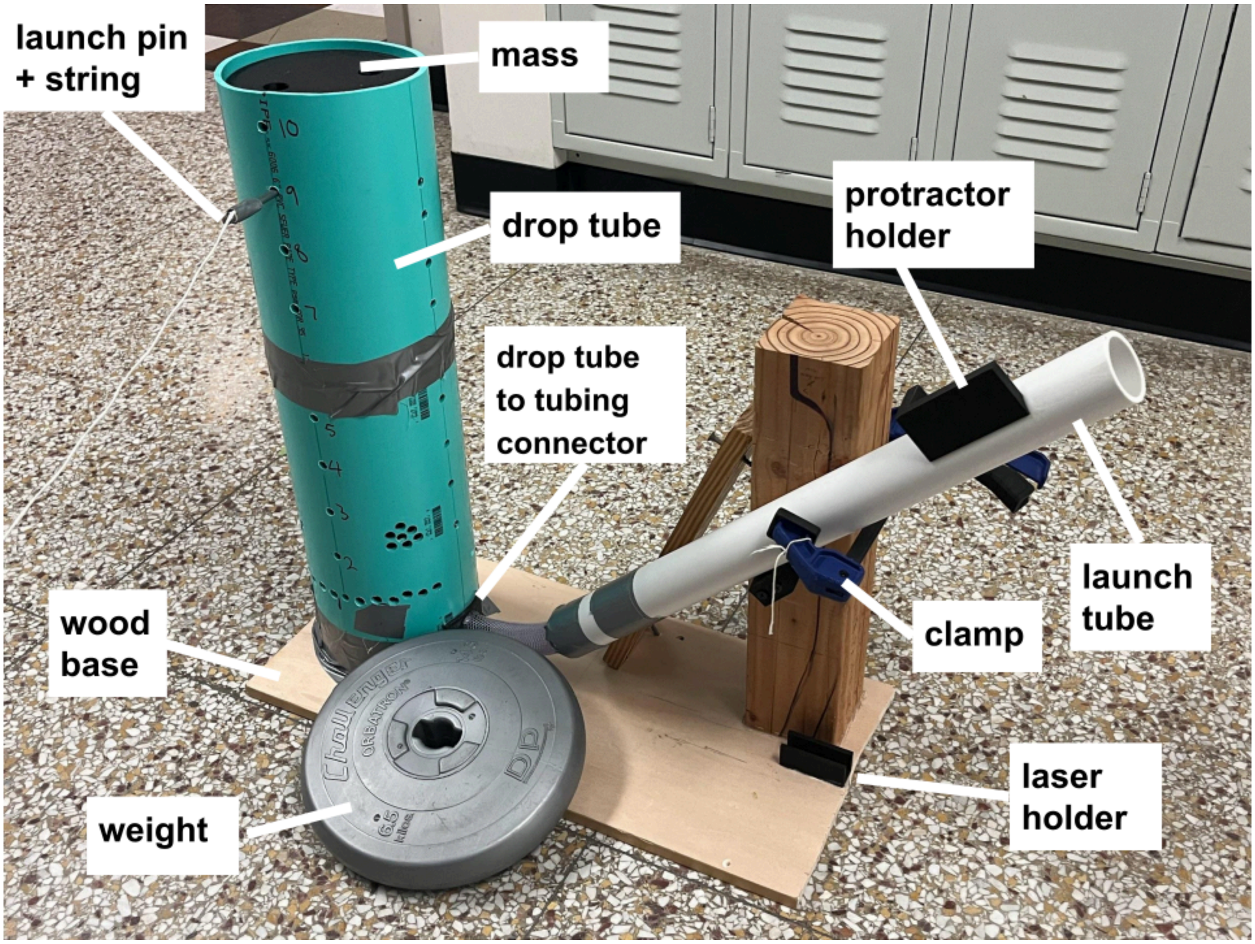
3d printer information:
Hardware: AnkerMake M5C
Software: AnkerMake Studio
Filament: Elegoo PLA
All models were CADed from scratch by me

Mass cap and mass body make up the mass. Weights are taped inside the mass

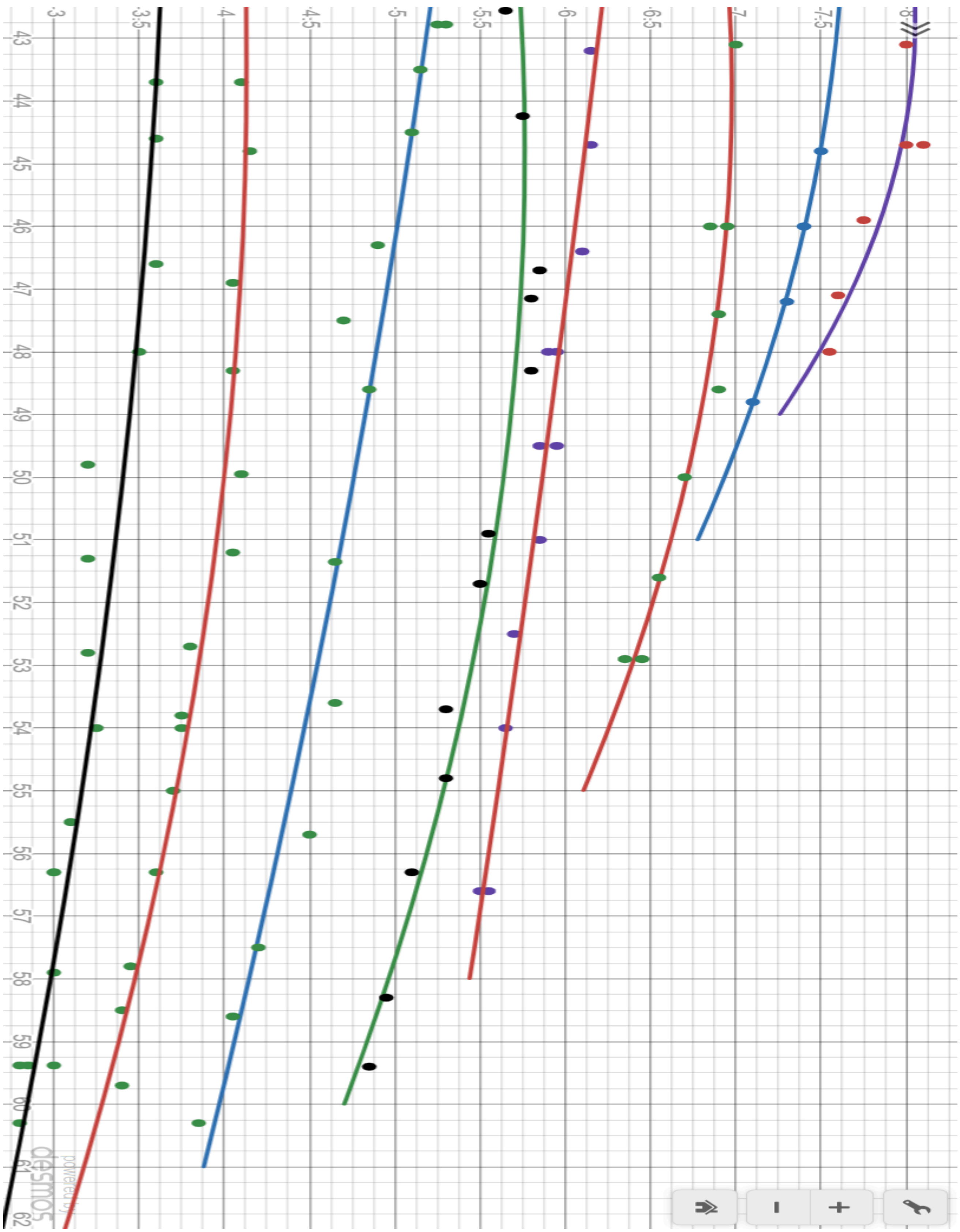
Laser holder was superglued onto the wood base under the launch tube to have a consist place to aim the laser

Protractor holder was superglued onto the launch tube, used to hold the electronic protractor that measures the angle of the launch tube.

Drop tube to tubing connector is superglued onto the drop tube and allows tubing to fit around it to minimize air loss.




First is the wood base. A 3d printed laser holder is super glued onto it to help consistently aim the laser in the same spot. A 6.5kg weight holds the device down to make sure it doesn't move much when the launch pin is pulled. A drop tube is also hot glued and taped onto the base. It's where the mass, made out of 3d printed PLA and weights and tape, will drop down onto the bit of air at the bottom of the tube when the pin is pulled, which will shoot into the launch pipe through the drop-tube-to-tubing connector and the tubing. A wood pillar and another piece of wood supports the launch tube. The clamp allows me to clamp the launch tube to the wood pillar to secure a consistent angle. Finally, there is a 3d printed protractor holder superglued to the top of the launch tube, which is used to hold the electronic protractor that measures the angle of the launch tube. During a launch, the pin is pulled, allowing the mass to drop onto the air at the bottom of the drop pipe. The air is pushed into the launch pipe, which contains a ping pong ball, shooting the ball to the target.




**Curve fits of data at each launch level**

**<u>Calibration Data</u> - Launch Angle (degrees) vs. launch distance of projectile (meters) at different drop levels**

Level 1
x1 - angle of launch tube (degrees)
y1 - launch distance of projectile (meters)

| $x_1$ | $y_1$ |
|---|---|
| 43.7 | 3.6 |
| 44.6 | 3.6 |
| 46.6 | 3.6 |
| 48 | 3.5 |
| 49.8 | 3.2 |
| 51.3 | 3.2 |
| 52.8 | 3.2 |
| 54 | 3.75 |
| 55.5 | 3.1 |
| 56.3 | 3.0 |
| 57.9 | 3.0 |
| 59.38 | 2.8 |
| 60.3 | 2.8 |
| 62.1 | 2.7 |
| 54 | 3.25 |
| 56.3 | 3.0 |
| 59.38 | 3 |
| 59.38 | 2.85 |

Level 2
x2 - angle of launch tube (degrees)
y2 - launch distance of projectile (meters)

| $x_2$ | $y_2$ |
|---|---|
| 43.7 | 4.1 |
| 44.8 | 4.15 |
| 46.9 | 4.05 |
| 48.3 | 4.05 |
| 49.95 | 4.10 |
| 51.2 | 4.05 |
| 52.7 | 3.8 |
| 53.8 | 3.75 |
| 55 | 3.7 |
| 56.3 | 3.6 |
| 57.8 | 3.45 |
| 58.5 | 3.4 |
| 59.7 | 3.4 |

Level 3
x3 - angle of launch tube (degrees)
y3 - launch distance of projectile (meters)

| $x_3$ | $y_3$ |
|---|---|
| 42.78 | 5.3 |
| 42.78 | 5.25 |
| 43.5 | 5.15 |
| 44.5 | 5.1 |
| 46.3 | 4.9 |
| 47.5 | 4.7 |
| 48.6 | 4.85 |
| 51.35 | 4.65 |
| 53.6 | 4.65 |
| 55.7 | 4.5 |
| 57.5 | 4.2 |
| 58.6 | 4.05 |
| 60.3 | 3.85 |

Level 4
x4 - angle of launch tube (degrees)
y4 - launch distance of projectile (meters)

| $x_4$ | $y_4$ |
|---|---|
| 42.56 | 5.65 |
| 44.24 | 5.75 |
| 46.7 | 5.85 |
| 47.15 | 5.8 |
| 48.3 | 5.8 |
| 50.9 | 5.55 |
| 51.7 | 5.5 |
| 53.7 | 5.3 |
| 54.8 | 5.3 |
| 56.3 | 5.1 |
| 58.3 | 4.95 |
| 59.4 | 4.85 |

# Example Calculations

1) **Near Target: 3m**

Find points on the line y=3 on the graph:
(57.9, 3), level 1
Adjust angle of launch tube to corresponding x value of coordinate (57.9 degrees), raise mass to corresponding level (level 1).

2) **Far Target: 7m forward, 1 meter right**

Use calculator to use pythagorean theorem to find straight line distance from device to center of target: sqrt(7^2+1^2) = 7.071
Find points on the line y=7.071 on the graph: (49.5, 7.071), level 8
Adjust angle of launch tube to corresponding x value of coordinate (49.5 degrees), raise mass to corresponding level (level 8).