Rocket Performance Analysis & Comparison Report

Canyon Natinsky · Liam West
PLTW Aerospace Engineering 3A · Mr. Dahl
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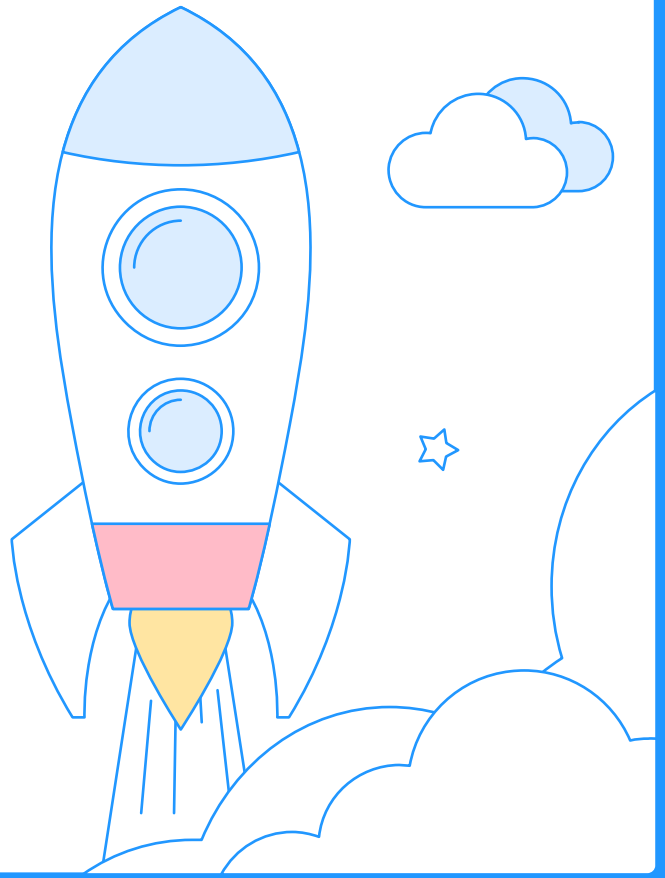


Comparison

	No need for air Intake	Works at any Speed	High Thrust-to-Weight Ratio
Propeller	✗	✗	✗
Gas Turbine	✗	✓	✓
Ramjet	✗	✗	✓
Rocket	✓	✓	✓

Advantages of Rocket Propulsion

Operates in Space – Unlike propellers, gas turbines, and ramjets, rockets carry their own oxidizer, allowing them to function in the vacuum of space.
No Air Intake Required – Rockets do not rely on atmospheric oxygen, making them effective at high altitudes and beyond Earth's atmosphere.
Works at Any Speed – While propellers and ramjets require specific speed ranges to operate efficiently, rockets generate thrust regardless of speed or external conditions.
High Thrust-to-Weight Ratio – Rockets produce significantly more thrust relative to their weight compared to other propulsion types, enabling rapid acceleration and heavy payload lifting.

Engine Test Procedure

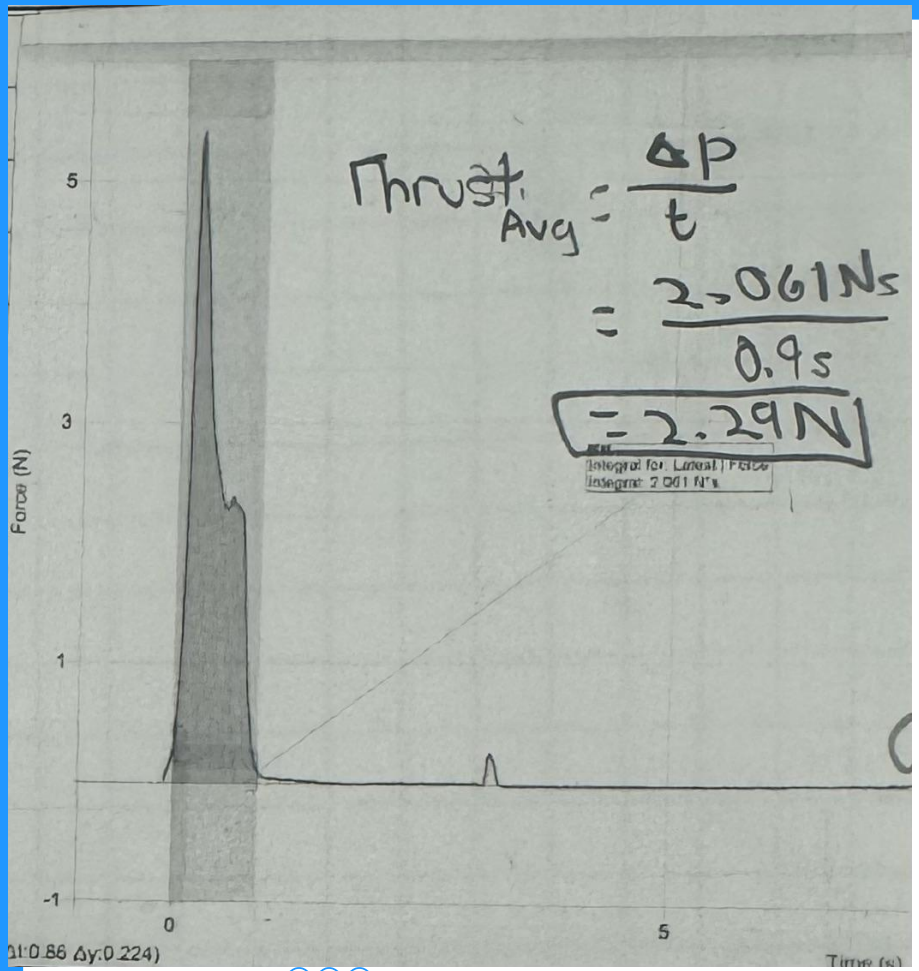
What Did We Do?

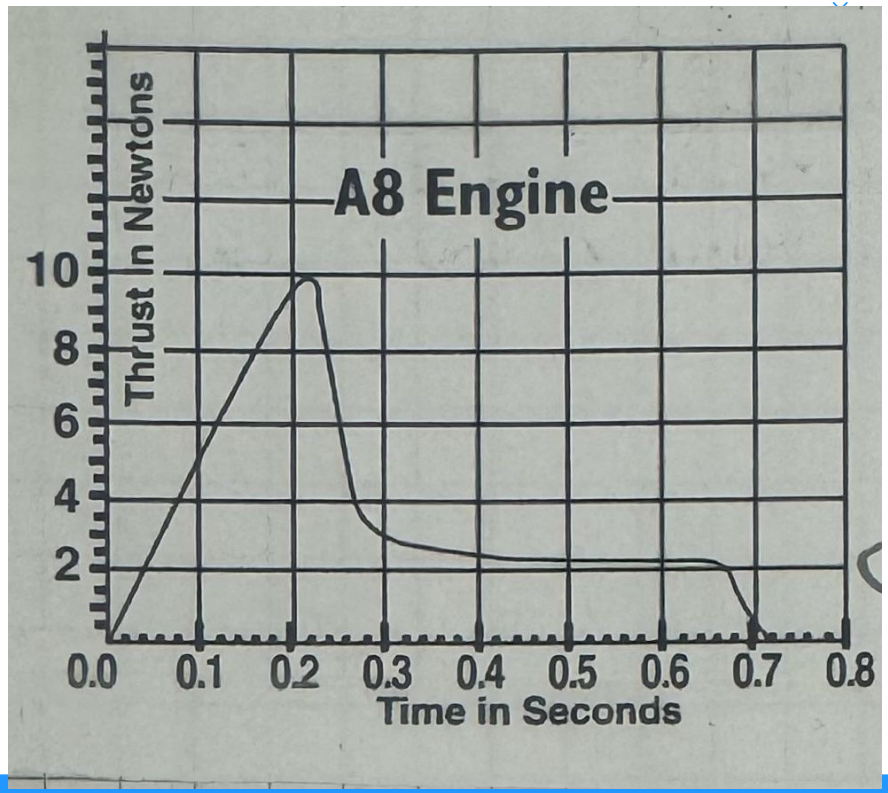
We tested different rocket engines using a force sensor to measure their thrust and determine which one best suits our launch scenario. The engines were fired under controlled conditions, and real-time thrust data was collected to compare their performance.

Why Did We Do It?

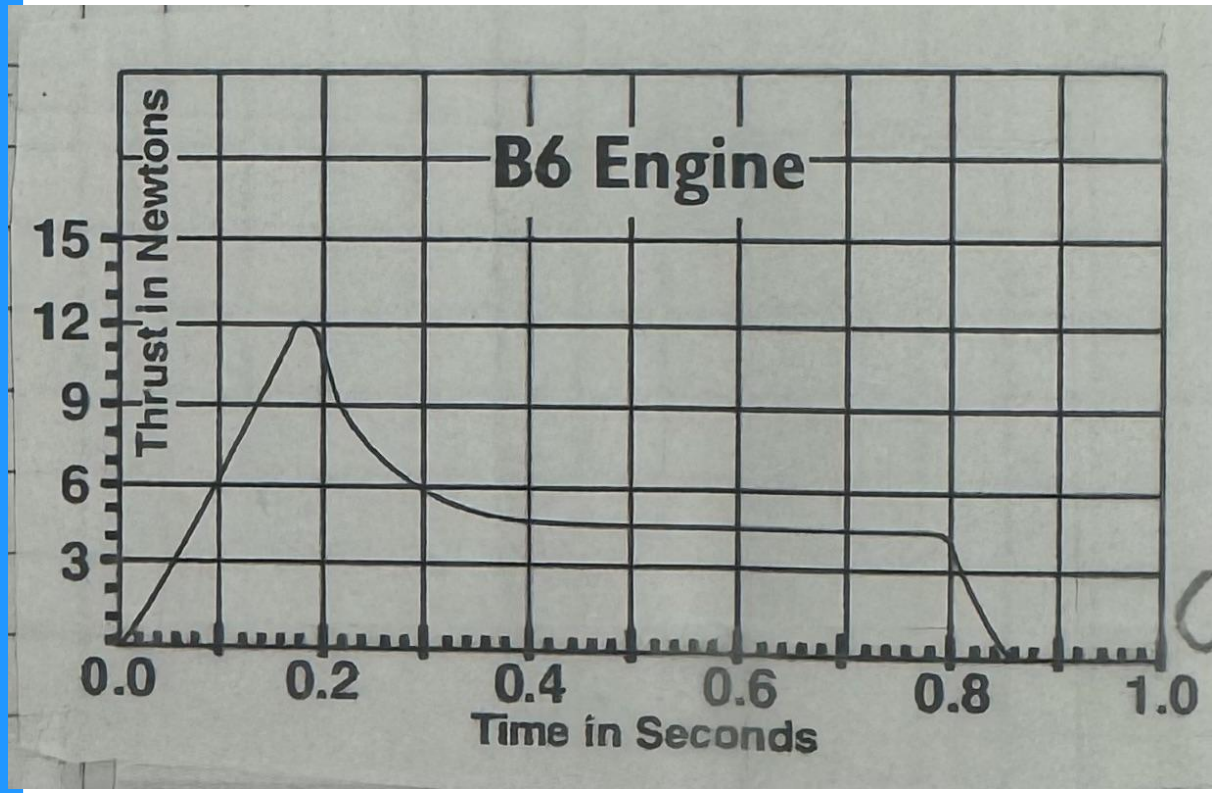
Our goal was to identify the most suitable engine for our launch area. The A8 engine produced the least thrust, making it the best choice since we didn't want the rocket to travel too far. By using a force sensor to measure thrust, we confirmed that higher-powered engines would have been excessive for our limited space.

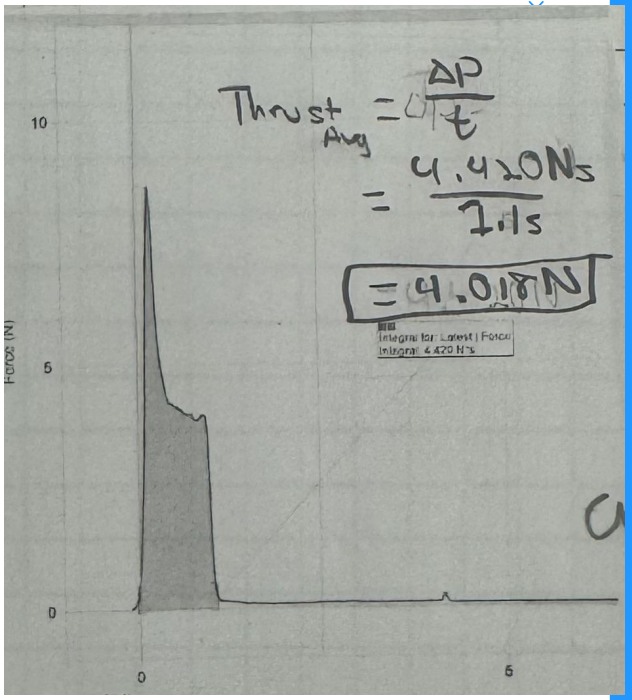
Results


Thrust Avg = Δp / t
= 2.061 Ns / 0.9s
= 2.29N
Force (N)
5
3
1
-1
0
5
Δy:0.224)

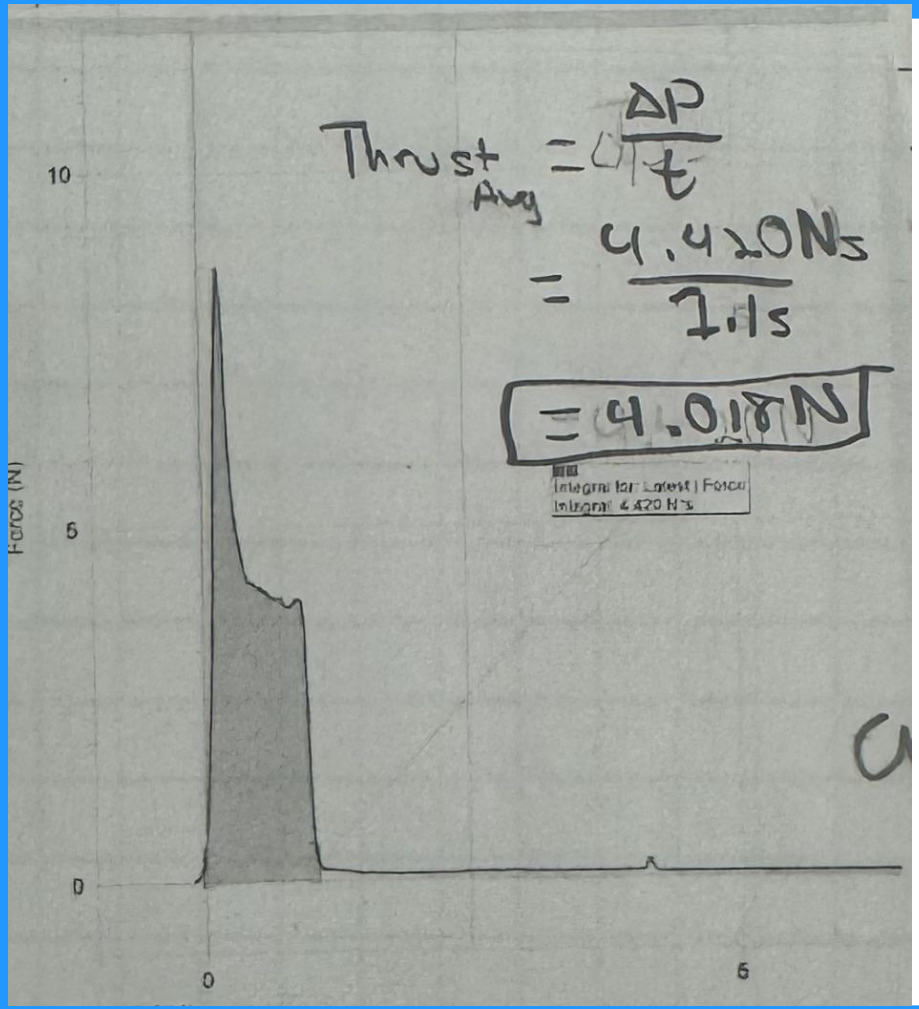

A8 Engine
Thrust in Newtons
10
8
6
4
2
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Time in Seconds

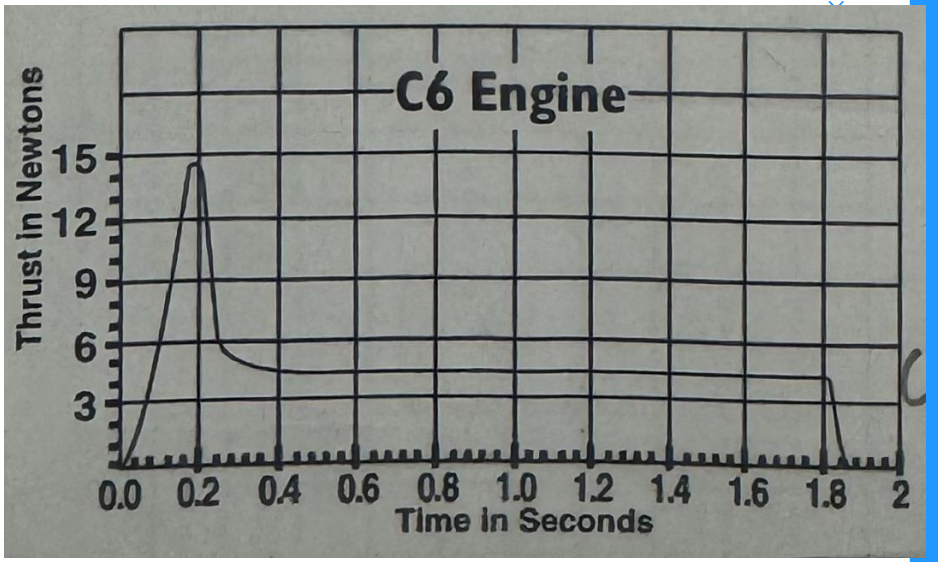
Results


B6 Engine
Thrust in Newtons
15
12
9
6
3
0.0
0.2
0.4
0.6
0.8
1.0
Time in Seconds


Thrust Avg = ΔP / t
= 4.420 Ns / 1.1s
= 4.018 N
10
5
0
0
5

Results


Thrust Avg = ΔP / t
= 4.420 Ns / 1.1s
= 4.018 N
10
5
0
0
5
Force (N)


C6 Engine
Thrust in Newtons
15
12
9
6
3
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2
Time in Seconds

Design & Simulate Using Open Rocket

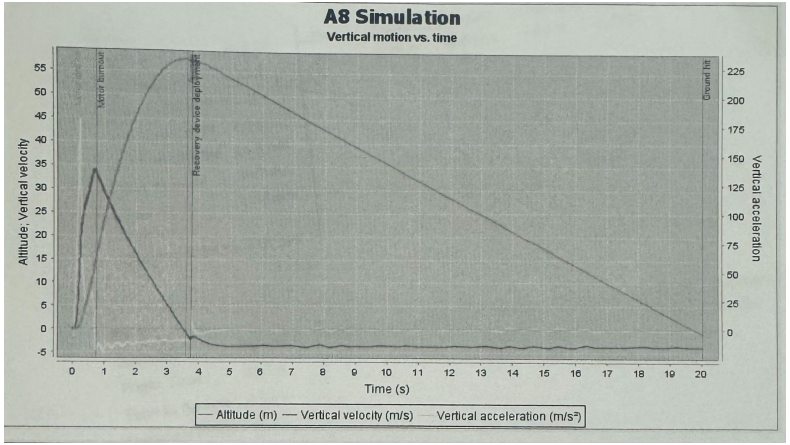
What Did We Do?

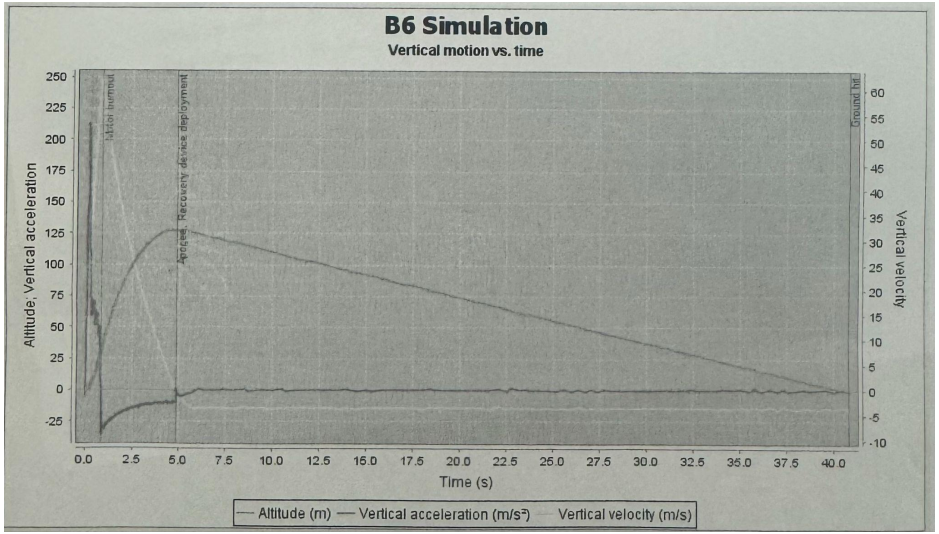
We used OpenRocket to simulate and compare the performance of three different engines, analyzing their thrust, altitude, and flight behavior. The simulations provided detailed data on how each engine would perform in our specific launch area.

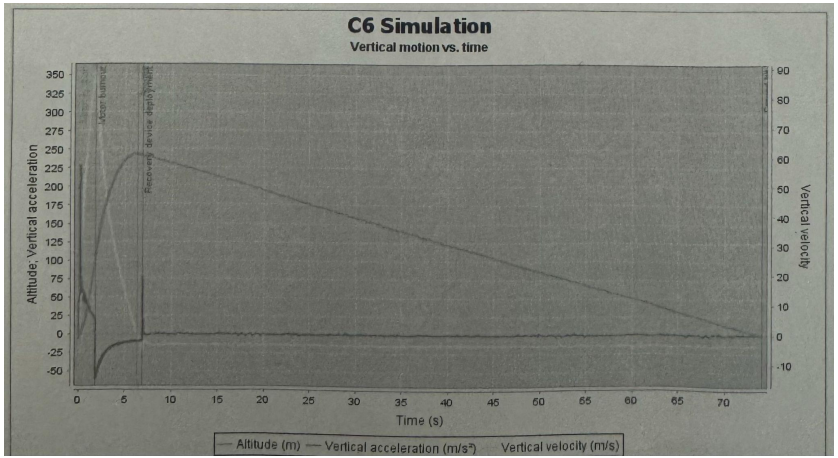
Why Did We Do It?

Our goal was to determine the best engine for our small launch area. The A8 engine had the lowest thrust and resulted in the shortest flight distance, making it the best choice.
Higher-powered engines would have caused the rocket to travel too far, which isn't ideal for our constraints.

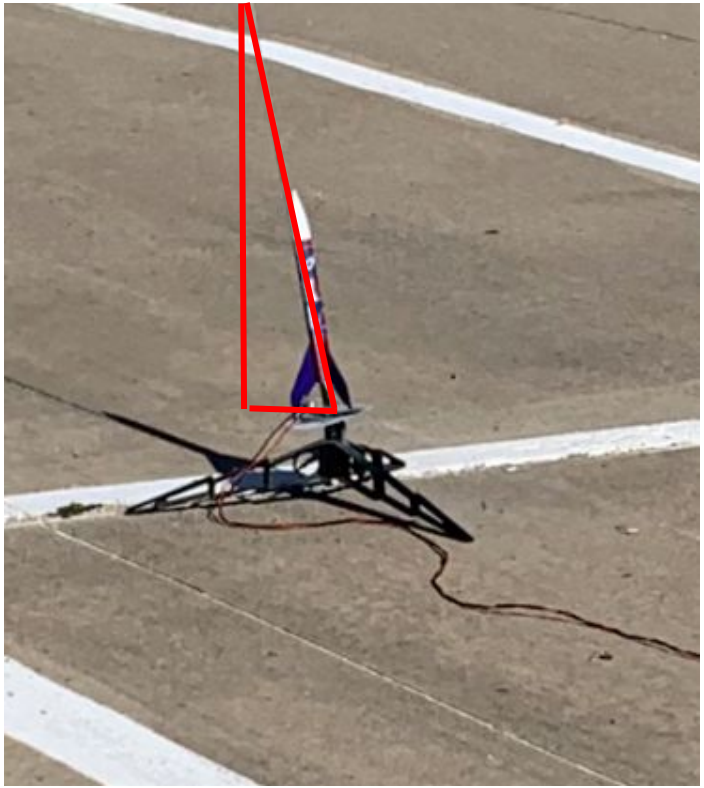
Results


A8 Simulation
Vertical motion vs. time
Altitude, Vertical velocity
Vertical acceleration
Time (s)
Altitude (m)
Vertical velocity (m/s)
Vertical acceleration (m/s²)


B6 Simulation
Vertical motion vs. time
Altitude, Vertical acceleration
Vertical velocity
Time (s)
Altitude (m)
Vertical acceleration (m/s²)
Vertical velocity (m/s)


C6 Simulation
Vertical motion vs. time
Altitude, Vertical acceleration
Vertical velocity
Time (s)
Altitude (m)
Vertical acceleration (m/s²)
Vertical velocity (m/s)

Launch & Performance Analysis

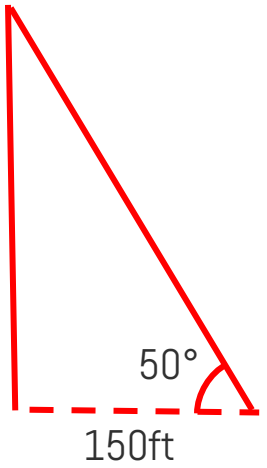


$$\tan(\theta) = \frac{\text{opposite}}{\text{adjacent}}$$

$$\tan(50^\circ) = \frac{\text{altitude}}{150}$$

$$x = 150 \times \tan(50^\circ)$$

$$x \approx 178.75 \text{ ft}$$



There is a difference between the value calculated in the simulation (58.6m) to our value (54.48m) because of external variables (like wind/air resistance) that aren't factored into an Open Rocket simulation.

Thank You