
ESTES
TRI-FLYER
STEM KIT
ACTIVITY BOOK

THE ULTIMATE ROCKET CHALLENGE

Shout out to all my rocketeers!

If you are in the market for an extreme model rocket competition, then the **Ultimate Rocket Challenge** is screaming your name! Use your most elite engineering skills to compete in five radical rocketry events. To enter, complete the challenges in this guide and fill out the **Qualifying Form** below to prove you have what it takes to compete in the Ultimate Rocket Challenge!

THE ULTIMATE ROCKET CHALLENGE

Qualifying Form

Your Name: _____

Rocket Name: _____

Which fins will you use for each event?

Event	Fin Type	Data
Sonic Speed		
Slow Burn		
Astonishing Altitude		
Savage Stunts		
Spot On Landing		

Good Luck, Rocketeers!

PREPARE FOR LAUNCH

Before you put your rocket together, create a device to measure the altitude of your rocket called an altimeter. You will need 2 feet of string, a protractor, straw, tape, and something to use as a weight, like a nut or washer.

1. **Tie** your string to the middle of the protractor.
2. **Secure** the knot with tape.
3. **Tie** a nut to the bottom of the string.
4. **Attach** the straw with tape to the straight edge of the protractor to use as the site.Be sure the straw is level.

Practice with your Altimeter! For this activity, you will need a tennis ball, a partner, and to be outside.

1. Look for tall objects in the distance like trees or tall buildings.
2. Measure and mark 92 meters from the object. This will be where you stand.
3. Hold the altimeter at arm's length and focus on the first object.
4. Be sure that the straw is on top, and the string is hanging down.
5. Align the straw site at the top of the object.
6. Wait for the weight to stop swinging.
7. Place your finger on the string to hold it in place.
8. Record the angle in degrees created with the string on your protractor.
9. Repeat with at least 2 other objects, or until you feel comfortable using the altimeter.

Now try a moving target! Time for the tennis ball!

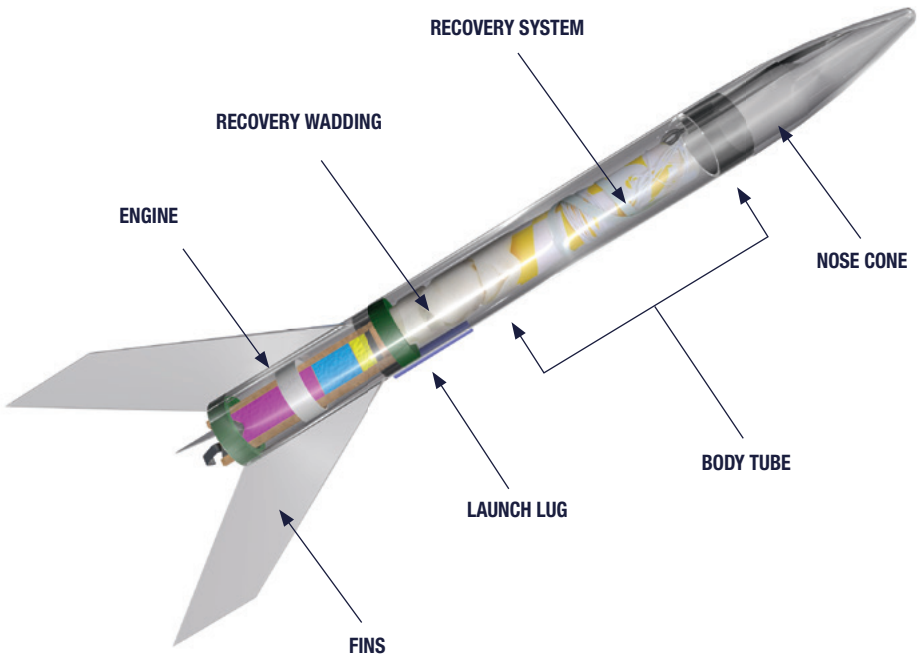
1. Have your partner toss the tennis ball straight up into the air.
2. Hold the Altimeter at arm's length and point it at the tennis ball.
3. Follow the ball with your arm as it goes up.
4. When it reaches the highest point, quickly put your finger on the string to hold it in place.
5. Record the angle (you will use this angle when calculating altitude in later activities).
6. Repeat until you are comfortable using the device.

PREPARE FOR LAUNCH

Prepare your rocket for flight and follow these steps:

Read through all the qualifying events first so you know what data to collect as you launch. You will launch your rocket at least twice, so you must decide which fins you want to test. Want to complete more launches? Order more engines at www.estesrockets.com.

1. **Unload** all the pieces of your rocket and follow the included instructions to build the rocket.
2. **Decide** which experiments from the following pages you are going to perform.
3. **Prep** your rocket for launch. Add recovery wadding and insert an engine.
4. **Attach** the set of blades that you wish to test.
5. **Look** over the safety guidelines and have an adult assist you with the launch.



SAFETY FIRST!

Review each of these regulations from the National Association of Rocketry before you launch and check off each box to show that you understand it.

www.nar.org/safety-information

Materials

- ☐ Only use materials provided in the rocket kit.
- ☐ Do not tamper with rocket engines in any way.

Launch Site

- ☐ Launch in an open outdoor area (A engines = 100 sq ft; B = 200 sq ft; C = 400 sq ft).
- ☐ Launch only in safe weather conditions (winds less than 20 mph).
- ☐ Be sure there is no dry grass near the launch pad.
- ☐ Do not launch at targets, into clouds, or near airplanes.

Launch

- ☐ Countdown before launch.
- ☐ Be sure everyone stands at least 15 feet away.
- ☐ Launch rod must be within 30 degrees of vertical.
- ☐ In case of misfire, wait 60 seconds before approaching the rocket.

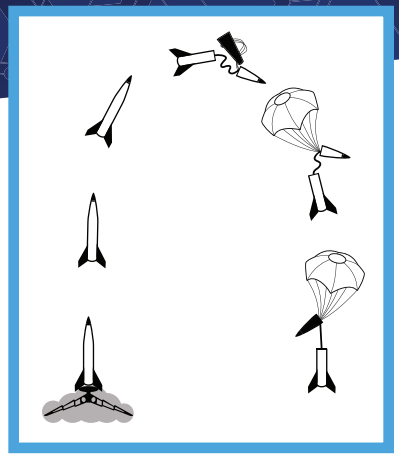
Recovery

- ☐ Do not attempt to recover rocket from tall trees, powerlines, or other dangerous places.

EVENT QUALIFIER #1

Sonic Speed

For this event you need to be faster than an asteroid racing through the sky! Choose the set of fins that has the fastest ascent time.



Equipment Needed: Stopwatch

Steps:

1. Launch your rocket and have a partner start the stopwatch when the rocket is launched.
2. Once the rocket reaches its apogee, or highest point, stop the stopwatch.
3. Record how long it takes for your rocket to go from the launch pad to apogee. Measure in seconds.
4. Repeat with the other fins.

Record your data:

Fin Type	Ascent Time

Choose which fins will work best for the Sonic Speed event based on the data you've collected. Report your data below and on your qualifying form (pg. 2).

Super Sonic Fins: _____

Time in Seconds: _____

Fins affect the drag of the rocket, which is the aerodynamic force that opposes the rocket's motion through the air and slows it down. What effect could the size or shape of fins have on drag?

Can you use this knowledge to explain which fins had the fastest time?

EVENT QUALIFIER #2

Slow Burn

Which set of fins will make your rocket the SLOWEST? Find out which fins are the most chill and have the slowest ascent time.

Steps:

1. Launch your rocket and have a partner start the stopwatch when the rocket is launched.
2. Once the rocket reaches its apogee, or highest point, stop the stopwatch.
3. Record how long it takes for your rocket to go from the launch pad to apogee. Measure in seconds.
4. Repeat with the other fins.

Record your data:

Fin Type	Ascent Time

Choose which fins will work best for the Slow Burn event based on the data you've collected. Report your data below and on your qualifying form (pg. 2).

Most Chill Fins: _____

Time in Seconds: _____

Why do you think these fins are the slowest?

What effect could drag have on the altitude, or height, of the rocket?

Real World Connections

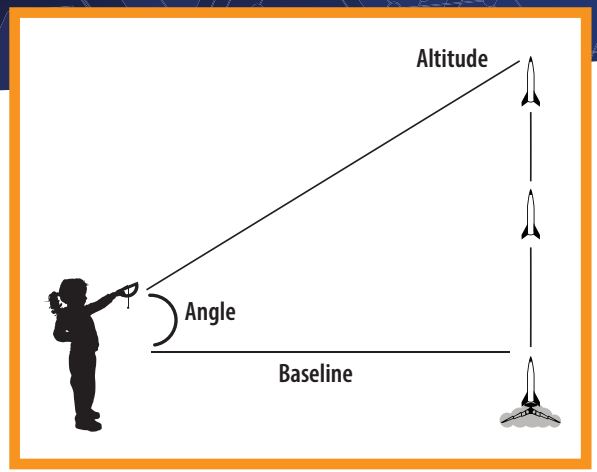
Fins are important to the flight of a rocket, but did you know they are also important in how a surfboard moves?

Fins can be set up differently on a surfboard to maximize speed or stability. Fins that have a greater cant, or angle, help the board move easier through turns and waves. Fins at less of an angle produce more speed since they cause the least amount of resistance to water flow. How do you think this relates to your rocket?

EVENT QUALIFIER #3

Astonishing Altitude

Which set of fins can get your rocket soaring to the stars? Find the fins that result in the highest altitude.



Equipment Needed: the new Altimeter you made

Steps:

1. Have a partner stand 92m away, hold the Altimeter at arm's length and point it at the rocket.
2. Launch your rocket.
3. As the rocket is launched, your partner will follow the rocket with their arm as it goes up.
4. When the rocket reaches the highest point, your partner will put their finger on the string to hold it in place.
5. Record the angle.
6. Use the instructions on the next page to calculate your altitude.
7. Repeat with the other fins.

Record your data:

Fin Type	Angle	Tangent	Altitude (tangent x baseline)

Angle	tan(a)	Angle	tan(a)	Angle	Tan(a)
25	.4663	47	1.0724	69	2.6051
26	.4877	48	1.1106	70	2.7475
27	.5095	49	1.1504	71	2.9042
28	.5317	50	1.1918	72	3.0777
29	.5543	51	1.2349	73	3.2709
30	.5773	52	1.2799	74	3.4874
31	.6009	53	1.3270	75	3.7321
32	.6249	54	1.3764	76	4.0108
33	.6494	55	1.4281	77	4.3315
34	.6745	56	1.4826	78	4.7046
35	.7002	57	1.5399	79	5.1446
36	.7265	58	1.6003	80	5.6713
37	.7535	59	1.6643	81	6.3138
38	.7813	60	1.7321	82	7.1154
39	.8098	61	1.8040	83	8.1443
40	.8391	62	1.8907	84	9.5144
41	.8693	63	1.9626	85	11.430
42	.9004	64	2.0503	86	14.301
43	.9325	65	2.1445	87	19.081
44	.9657	66	2.2460	88	28.636
45	1.000	67	2.3559	89	57.290
46	1.0355	68	2.4751	90	Infinite

What can I do with this angle?

Once you find the angle, go to the chart and find the tangent that corresponds with it. Then you'll need the baseline distance, which is how far away you were from the launch (at least 92 meters).
Next you will do some simple multiplication:

tangent x baseline = height (altitude)

For example, if your angle was 62 degrees, the equation would be...

1.8907 x 92 = 173.94 meters

Baseline	Angle	Tangent	Altitude
92 m	62	1.8907	173.94

Record your rocket's altitude with each set of fins. This measurement will be in meters.

Choose which fins will work best for the Astonishing Altitude event based on the data you've collected. Report your data below and on your qualifying form (pg. 2).

Sky High Fins: _____

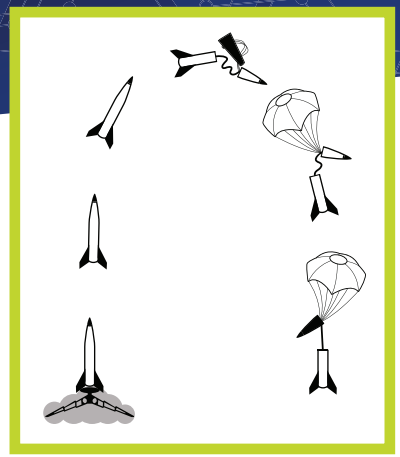
Altitude in Meters: _____

Based on your data, do you see a connection between ascent speed and altitude? How might this relate to drag?

EVENT QUALIFIER #4

Savage Stunts

Which fins give you the craziest flight path with spins and spirals? Fins help keep the rocket stable and create a smooth flight path. Changing the fin shape can change the rocket's stability or its path. Find the fins that result in the most unique flight path.



Steps:

1. Review the picture of the normal flight path of a rocket.
2. Launch your rocket and observe the flight path.
3. Draw it in the boxes below. Compare it to the picture.
4. Record your observations.
5. Repeat with the other fins.

1	2	3

Choose which fins will work best for the Savage Stunts event based on the data you've collected. Report your data below and on your qualifying form (pg. 2).

Fin Type	Qualitative Data (use words like straight, diagonal, spiral, etc.)

Most Savage Fins: _____

Flight Path: _____

What do you notice about the fins that caused the most unique flight path?

EVENT QUALIFIER #5

Spot Landing

Which set of fins land you closest to home? Find the fins that result in landing closest to the launch pad.

Equipment Needed: tape measure (or you can measure using your steps)

Steps:

1. Launch your rocket. Wait for it to land.
2. Walk to where your rocket is and measure the distance it landed from the launch pad using a measuring tape or count the number of steps (be sure your steps are as even as possible).
3. Record your distance.
4. Repeat with the other fins.

Record your data:

Fin Type	Distance from Launchpad

Choose which fins will work best for the Spot Landing event based on the data you've collected. Report your data below and on your qualifying form (pg. 2).

Closest Fins: _____

Distance in Meters or Steps: _____

Why are spot landings important?

Companies like Blue Origin must perfect spot landings so they can land their rocket boosters on landing pads. This allows them to reuse a rocket many times and is a great way to save resources!

Use all the information you just filled out and complete your Ultimate Rocket Challenge Qualifying Form at the front of this booklet!

Our Ultimate Rocket Challenge is not a real competition, but did you know that real rocketry competitions do exist? For information on how you can become a true competitor, check out this website!

https://rocketcontest.org/

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www.estesrockets.com