

**AMERICAN
ROCKETRY
CHALLENGE**

2023

Rocketry Starter Kit

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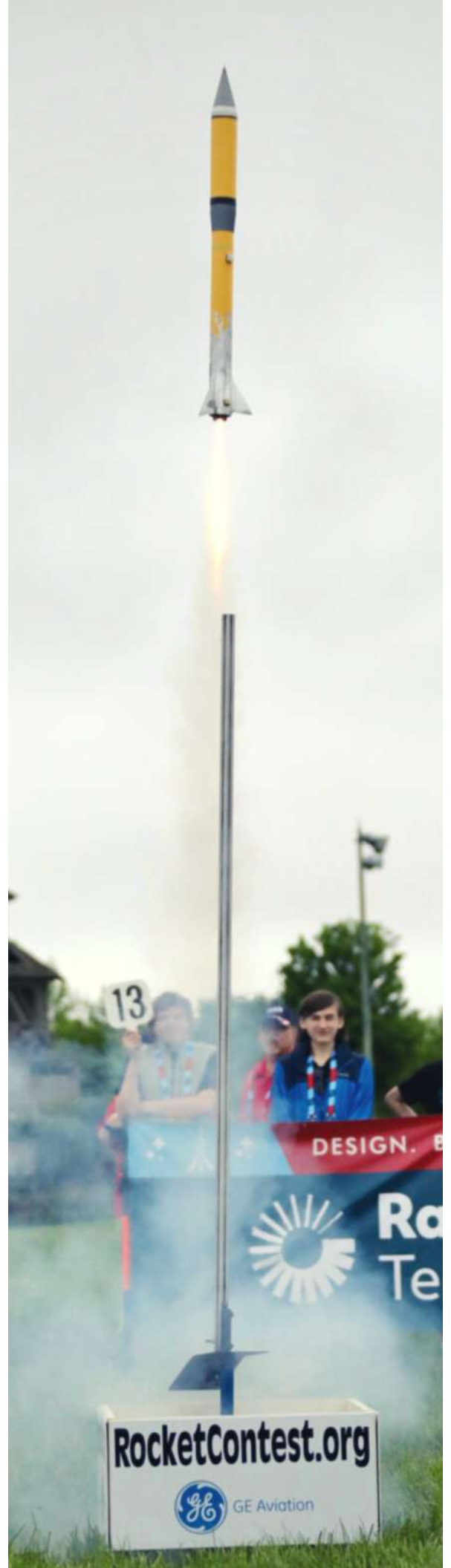
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AMERICAN ROCKETRY CHALLENGE

THE WORLD'S LARGEST STUDENT ROCKET CONTEST



The American Rocketry Challenge—now in its 21st year—is the world’s largest rocket contest, with nearly 5,000 students nationwide competing annually. The contest provides students in 6th – 12th grades the opportunity to design, build, and launch model rockets and gain hands-on experience solving engineering problems.

Sponsored by the Aerospace Industries Association, the National Association of Rocketry, and more than twenty aerospace industry partners, including NASA, the Federal Aviation Administration, and the Department of Defense, the challenge is the aerospace industry’s flagship program designed to encourage students to study science, technology, engineering and math.

WHAT WILL MY STUDENTS GAIN FROM PARTICIPATING IN THE CHALLENGE?

- Teamwork
- Leadership Skills
- Hands-on Engineering Experience
- Problem-Solving Skills

WHAT ARE THE RULES?

Teams are made up of 3 to 10 students between 6th and 12th grade, a supervisor, and an official Rocketry Challenge mentor.

The rules vary slightly each year to provide a new challenge to competitors. The [2023 rules](#) require teams to design, build, and launch a model rocket that carries one raw egg to an altitude of 850 feet, stays airborne for 42 - 45 seconds, and return the rocket to the ground safely with the egg intact.

WHAT IF I DON'T KNOW MUCH ABOUT ROCKETRY?

The American Rocketry Challenge features a nationwide network of aerospace professionals and rocketry experts from the National Association of Rocketry and the American Institute of Aeronautics and Astronautics who are willing and available to mentor your team. These mentors can help with the organizing, rocket building, and career pathway exploration.

WHAT ARE THE KEY DEADLINES?

- May 18, 2022 2023 Registration Opens
- Aug. 31, 2022 Early Bird Registration Ends
- Dec. 1, 2022 2023 Registration Closes
- April 3, 2023 Qualification Flight Scores Due
- April 12, 2023 Finalists Announced
- May 20, 2023 National Finals

WHAT HAPPENS WHEN WE WIN?

After official qualification flights are submitted, the top 100 teams are invited to attend the National Finals in Washington, D.C.

Teams competing at the Finals aim to capture their share of more than \$100,000 in cash prizes. There are also special awards for activities throughout the day.

The team that places first at the National Finals wins an all-expenses-paid trip to represent the United States in the International Rocketry Challenge, hosted at the Paris Air Show in Paris, France in June 2023. The United States Rocketry Team competes against the winning teams from Japan, the United Kingdom, and France.

Contact Program Director Katrina Hill at RocketContest@aia-aerospace.org or 703-358-1000.

Visit RocketContest.org to learn more.

  @RocketContest

American Rocketry Challenge 2023 Explained

The rocket must reach an altitude of 850 feet. Teams are penalized one point for every foot above or below the goal.

3

The two sections must separate after apogee and be recovered separately, with no harm to the egg, both by parachute.

4

Team must use two body sections, one containing a single raw egg and altimeter, and the second must contain the rocket motor(s).

2

The duration of the flight must be between 42 to 45 seconds. Teams are penalized by four points for each second outside that window.

5

650 millimeters

Teams of 3 to 10 students work together to design and construct a rocket. The overall length must be no less than 650mm and the weight must not exceed 650 grams.

1

At the National Finals, the rockets will be required to reach two new altitude goals of 825 or 875 feet within 41-44 seconds or 43-46 seconds respectively.

6

SCORING:

Teams are ranked on the combined score from their two best flights, the lower the better!

$$\text{SCORING FOR EACH FLIGHT} = \text{Unbroken Eggs} + \# \text{ of feet over/under} + \# \text{ of seconds over/under} \times 4$$

$$\text{FLIGHT 1} + \text{FLIGHT 2} = \text{TOTAL SCORE}$$



AMERICAN ROCKETRY CHALLENGE 2023

THE WEEK BY WEEK SUGGESTED SCHEDULE OF ACTIVITIES FOR TEAMS



This is a suggested schedule, teams will work at their own pace! Required deadlines are in blue.

WEEK OF OCTOBER 10, 2022

- Ensure all team information (school and teacher information, student information, parent consent forms, etc.) is entered in properly at rocketcontest.smapply.io.
- Your registration must be paid for and submitted no later than December 1, 2022.
- Early Bird Registration ends August 31, 2022. Registration fees will increase from \$125 to \$165.

WEEK OF OCTOBER 17, 2022

- Assign team responsibilities (such as project manager, airframe, propulsion & ignition, launch system, fundraising etc.).
- Get a mentor (see the list of available NAR/AIAA mentors at <https://rocketcontest.org/mentors/>)
- Watch the instructional video "How to Build and Fly a Model Rocket" on YouTube: <https://youtu.be/gYh1pWHoQXE>
- Review the Team Handbook, [2023 Rules](#), and the Frequently Asked Questions on rocketcontest.org/faq/
- Review the recommended rocket parts and our preferred vendors: <https://rocketcontest.org/wp-content/uploads/Parts-for-a-TARC-Rocket-1.pdf>
- Order one of the flight-simulation and rocket-design computer programs (RockSIM, SpaceCAD, or OpenRocket), at the official team discount price directly from the vendor after you have completed your 2023 registration.

WEEK OF OCTOBER 24, 2022

- Purchase an inexpensive, one-stage rocket kit to familiarize your team with rocket building & flying. Estes has a number of resources available for newcomers to rocketry, and Aerospace Specialty Products has a basic kit just for new teams.
- Locate a place to fly rockets (or a nearby NAR launch to attend and fly at, see the "Launch Windows" calendar at www.nar.org or contact the nearest NAR club or section).
- Develop a plan to raise money to purchase rocket supplies for two rockets and motors for at least 10 test and qualification flights. Your fundraising may also cover your travel to the Finals!

WEEK OF OCTOBER 31, 2022

- Buy a comprehensive book on model rocketry, such as G. Harry Stine's "Handbook of Model Rocketry" (available at <http://www.nar.org/nar-products/>).
- Load the rocket design and flight simulation computer program that you purchased.
- If you require "site owner" insurance for the place where you will be flying, have the teacher and at least three team members join the NAR, and order NAR site owner insurance.

WEEK OF NOVEMBER 7, 2022

- Fly a basic one-stage model rocket.
- Order your Perfectflite official altimeter with your discount code.

WEEK OF NOVEMBER 14, 2022

- Using the computer program and the knowledge gained from reading and from building basic rockets, develop a first rocket design for your entry.

WEEK OF NOVEMBER 28, 2022

- Using the computer program, conduct flight simulations of your design with various rocket motors on the approved motor list, to determine the best motor(s) to use.
- Locate sources for the materials needed to build your design (starting with the official vendors in the Official Handbook) and purchase required parts and rocket motors.

DECEMBER 1, 2022 – REGISTRATION CLOSES

WEEK OF DECEMBER 5, 2022

- Design and build (or purchase) the electrical launch system and the launch pad (preferably with a one-inch rail), if you do not have a local rocket club's system available for your use.

WEEK OF JANUARY 9, 2023

- Begin construction of your initial design for your entry.
- Locate a NAR Senior (adult) member who can serve as your official observer for your qualification flights, if you do not already have an NAR Mentor who will do this.

WEEK OF JANUARY 16, 2023

- Develop a pre-flight checklist for your flight and assign responsibility for each of the duties to a member of the flight team.
- Test your launch system by test-firing igniters without installing them in rocket motors.

WEEK OF JANUARY 23, 2023

- Weigh your completed rocket and re-run computer flight simulations with actual rocket weights.

BY FEBRUARY 1, 2023 YOU SHOULD (BUT ARE NOT REQUIRED TO):

- Test-fly your initial design (without altimeter), making sure that you leave time to redesign, rebuild, and re-fly by April 3 if this initial flight/design is not successful.
- If your first flight is fully successful, test-fly again with stopwatch timing and the altimeter installed. Repeat test flights until you hit the design targets.
- If your first flight is not successful, do post-flight failure analysis and re-design.

BY MARCH 1, 2023 YOU SHOULD (BUT ARE NOT REQUIRED TO):

- Make your first official qualification flight attempt in front of an NAR Senior member observer.

APRIL 3, 2022 – QUALIFICATION FLIGHTS DUE

BY APRIL 3, 2023 YOU MUST:

- Make your final official qualification flight attempt (of up to three permitted) in front of an NAR Senior member observer.
- Submit your qualification flight reports at rocketcontest.smapply.io or by email.

APRIL 12, 2022 – NATIONAL FINALISTS ANNOUNCED

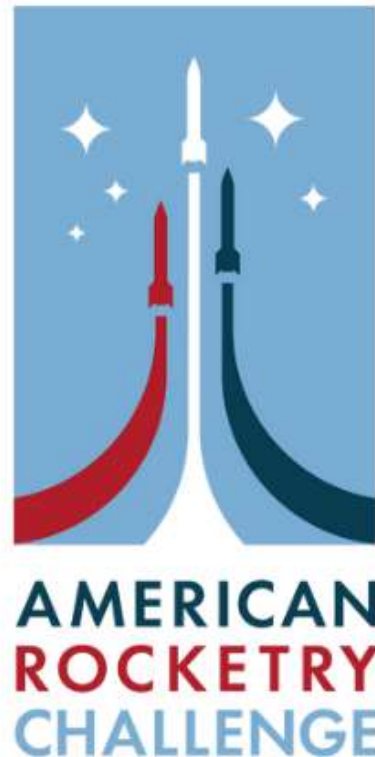
APRIL 12, 2023

- If notified of selection to attend the Finals, make reservations at one of the hotels identified by the organizers and conduct fundraising to cover travel and lodging.
- Continue test-flying to fine tune rocket design to both Finals target altitudes, 825 and 875 feet.
- If you plan to travel to the flyoff by airline, order rocket motors for flyoff to be shipped to the Finals receiving point at Aurora Flight Sciences or delivered on-site by a Finals vendor.

NO LATER THAN APRIL 30, 2023

- Complete and test-fly the actual rocket to be used in the Finals. This Finals rocket must have been test-flown before arrival at the flyoff, as there is no opportunity for test-flying at the flyoff site.

MAY 20, 2022 – NATIONAL FINALS



Visit RocketContest.org to learn more.



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Contact Program Director Katrina Hill at RocketContest@aia-aerospace.org or 703-358-1000.

National Association of Rocketry

SPORT ROCKETRY: AMERICA'S SAFE, EDUCATIONAL AEROSPACE HOBBY

WHAT IS SPORT ROCKETRY?

Sport rocketry is aerospace engineering in miniature. This popular hobby and educational tool was founded in 1957 to provide a safe and inexpensive way for young people to learn the principles of rocket flight. It has grown since then to a worldwide hobby with over 12 million flights per year, used in 25,000 schools around the U.S.

Its safety record is extraordinarily good, especially compared to most other outdoor activities. It is recognized and permitted under Federal and all 50 states' laws and regulations, and its safe and inexpensive products are available in toy and hobby stores nationwide. Sport rocketry has inspired two generations of America's young people to pursue careers in technology.

WHAT IS A SPORT ROCKET?

A sport rocket is a reusable, lightweight, non-metallic flight vehicle that is propelled vertically by an electrically-ignited, commercially-made, nationally-certified, and non-explosive solid fuel rocket motor. For safety reasons no rocket hobbyist is ever required or allowed to mix or load chemicals or raw propellant; all sport rocket motors are bought pre-made.

Sport rockets are always designed and built to be returned safely and gently to the ground with a recovery system such as a parachute. They are always designed to be recovered and flown many times, with the motor being replaced between flights. Sport rockets come in two size classes: MODEL rockets, which are under 3.3 pounds in weight, have less than 4.4 ounces of propellant, and are generally available to consumers of all ages; and HIGH-POWER rockets, which are larger, use motors larger than "G" power, and are available only to adults.

ARE THESE ROCKETS LEGAL?

Model rockets are legal under the laws and regulations of all 50 states and the Federal government, although some local jurisdictions may have ordinances restricting their use. Model rockets are regulated by the National Fire Protection Association (NFPA) Code 1122, which is adopted as law in most states. They are specifically exempted from Federal Aviation Administration (FAA) air traffic control by Part 101.1 of Federal Aviation Regulations (14 CFR 101.1) and may be flown anywhere without FAA clearance. They are permitted for sale to children by the Consumer Product Safety Commission under their regulations (16 CFR 1500.85 (a) (8)). They are permitted for shipping (with appropriate packaging and labeling) by the Department of Transportation and U.S. Postal Service. They are not subject to regulation or user licensing by the Bureau of Alcohol, Tobacco, Firearms & Explosives (BATFE). They are endorsed and used by the Boy Scouts, 4-H Clubs, the Civil Air Patrol, and NASA.

High power rockets are regulated under NFPA Code 1127. Because of their size and power they are not available to people younger than age 18. Their flights are subject to FAA air traffic regulations, and purchase of the larger motors for these rockets generally requires user certification by a national rocketry organization, plus BATFE licensing in some cases. Despite these greater legal restrictions, high power rockets are also very popular. They also have an outstanding safety record.

IS THIS HOBBY SAFE?

Over 500 million model rockets have been launched since the hobby's founding and our simple Safety Code procedures have almost totally eliminated accidents and injuries. Injuries are rare and generally minor. They are almost always the result of failure to follow the basic safety precautions and instructions provided by the manufacturers. Sport rocketry's record shows that it is safer than almost any sport or other outdoor physical activity.

The hobby operates under the simple and easy-to-follow Model Rocket and High-Power Rocket Safety Codes of the National Association of Rocketry, which have been fine-tuned by professional engineers and public safety officials over the past 50 years to maximize user and spectator safety. The foundations of these Safety Codes are that sport rockets must be electrically ignited from a safe distance with advance warning to all those nearby, must have recovery systems, must be flown vertically in a suitably-sized field with no aircraft in the vicinity, and must never be aimed at a target or used to carry a pyrotechnic payload.

All sport rocket motors are subjected to extensive safety and reliability certification testing to strict NFPA standards by the National Association of Rocketry or other national organizations before they are allowed to be sold in the U.S.

AREN'T THESE ROCKETS FIREWORKS?

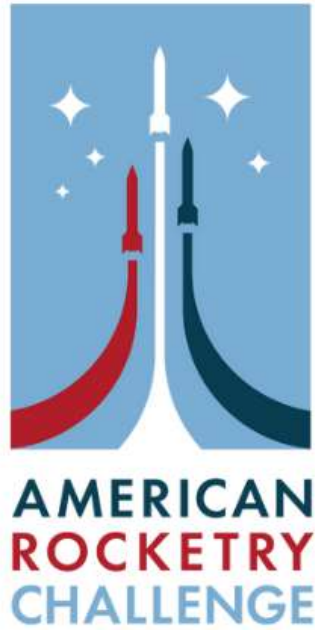
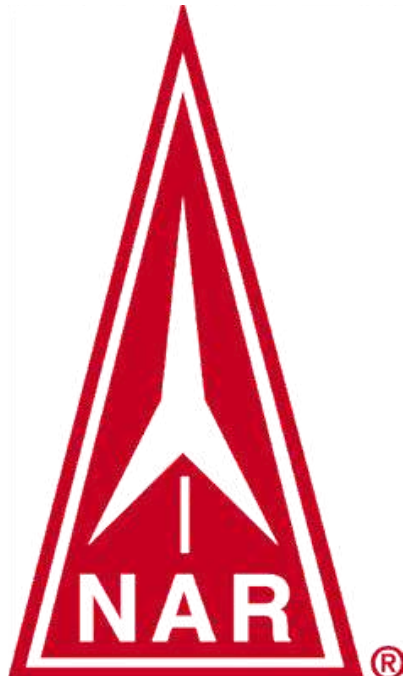
All Federal and state legal codes recognize sport rockets as different from fireworks. Fireworks are single-use recreational products designed solely to produce noise, smoke, or visual effect. They have few of the designed-in safety features or pre-consumer national safety testing of a reusable sport rocket, and none of the sport rocket's educational value. Fireworks are fuse-lit, an inherently dangerous ignition method that is specifically forbidden in the hobby of sport rocketry. Sport rockets are prohibited from carrying any form of pyrotechnic payload; their purpose is to demonstrate flight principles or carry educational payloads, not blow up, make noise, or emit a shower of sparks.

WHO ARE THE EXPERTS?

The oldest and largest organization of sport rocketeers in the U.S. is the National Association of Rocketry (NAR). This non-profit organization represents the hobby to public safety officials and federal agencies, and plays a key role in maintaining the safety of the hobby through rocket engine certification testing and safety code development. The NAR also publishes Sport Rocketry magazine, runs national sport rocketry events and competitions, and offers liability insurance coverage for sport rocketeers and launch site owners.

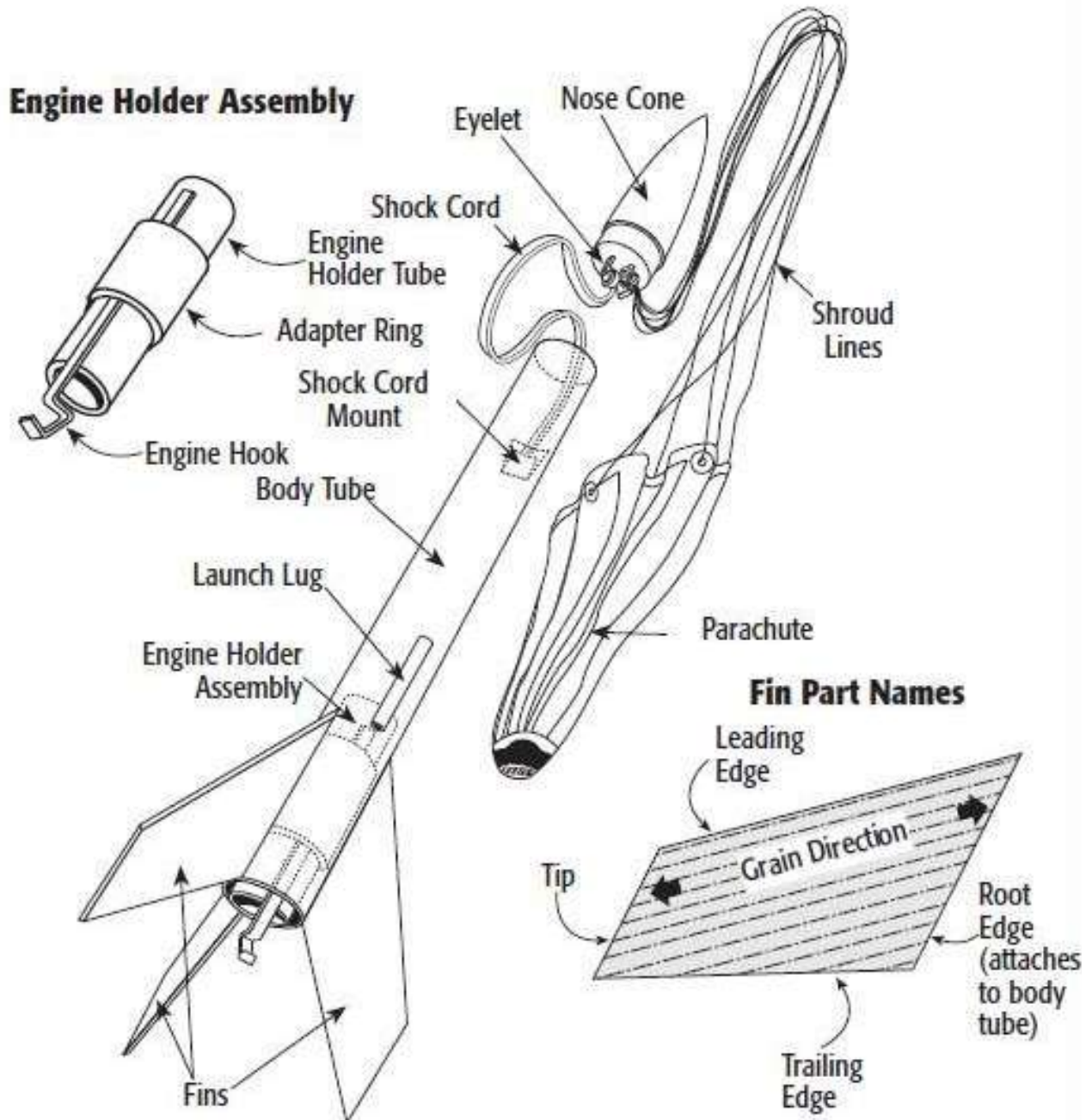
You may reach the NAR at:
National Association of Rocketry
Post Office Box 407
Marion, IA 52302
<http://www.nar.org>

You may purchase copies of the NFPA Codes 1122 or 1127 regulating sport rocketry from:
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269-9101
<http://www.nfpa.org>



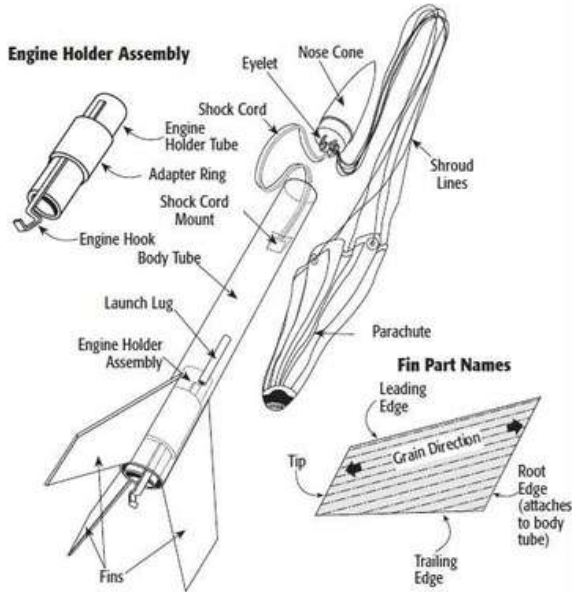
Typical Component Parts for a Rocket & Where to Find Them

Rocket Part Basics



Rocket Part Specifics

Model Rocket Nomenclature



www.
estes
rockets
.com

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Main Body Tube -typical choices are:

T-70/BT-70: 2.22 inch (56mm) outside diameter: Apogee (available with or without 3 fin slots); BMS (available with or without 4 fin slots); ASP (non-slotted); T-80/BT-80: 2.60 inch (66mm) outside diameter: Apogee (available with or without 3 fin slots); BMS (available with or without 4 fin slots); Estes or ASP (non-slotted)

Shock Cord: 2-foot "200-400-pound" (breaking strength) Kevlar cord

(available from Apogee, BMS, or eRockets) wrapped around engine mount, with 2-3 feet of 1/4 inch sewing elastic tied to the end which is then tied to a screw eye in the transition piece to the egg capsule

Parachute: typical choice is nylon cloth parachutes

Sunward brand from Apogee; Topflight brand from BMS, ASP, or eRockets; or Semrocbrand from eRockets

Parachute Protection:

9 x 9-inch reusable flameproof cloth blanket (Sunward, Madcowor Dinochutesbrands) (Apogee and eRockets); Topflight brand (ASP) Disposable flameproof paper wadding (Estes)

Nose Cone:

For T70 tubes: BNC70AJ or BNC70BB (BMS balsa); PNC-56A (Apogee plastic); or ASP (Balsa); For T80 tubes: BNC80BB (BMS balsa) or PNC80BB (BMS plastic); NC-80B (Estes plastic); PNC-66A (Apogee plastic); or ASP (balsa)

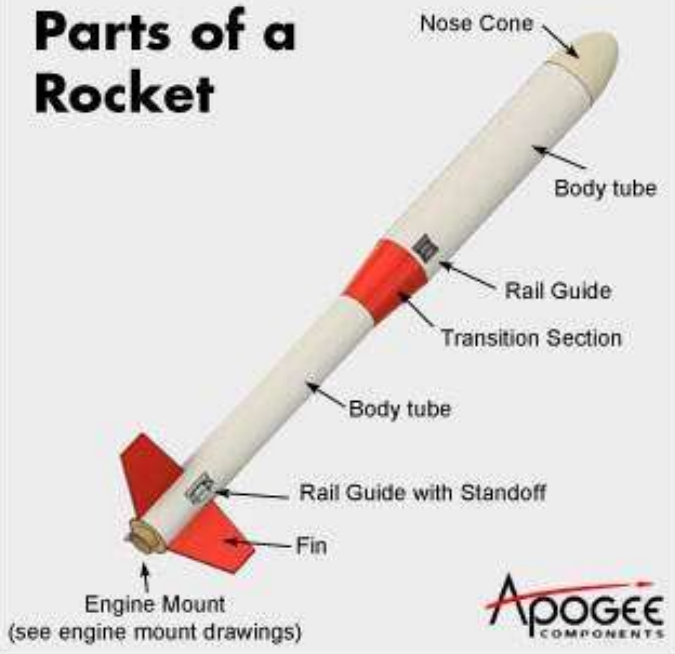
Transition Section:

If upper and lower body tubes are the same diameter, transition section is cylindrical: NB70 (for T70 tubes), NB80 (T80 tubes) (both BMS); "Semroc" brand balsa nose blocks (eRockets); balsa bulkheads (ASP) If one tube is T-80 and the other is T-70, transition section is conical: balsa TA7080 (BMS or ASP); blow mold plastic 70-80 transition (Apogee)

Fins: typical choices are 1/8-inch thickness balsa or 1/16 to 1/8 inch thickness plywood

Multiple precut shapes with through-the-wall tabs that fit in slotted body tubes (Apogee and BMS); or buy sheets of balsa at local craft store and cut your own

Parts of a Rocket



Rail Guide or Button: "1010" or "10/10" size

Buttons that screw on available from Apogee, ASP, BMS, or eRockets; glue-on rail guides available from Apogee

Centering rings (use plywood types):

For 24mm engines in T70: CR5070W (BMS); or from Apogee or ASP For 24mm engines in T80: CR5080W (BMS); or from Apogee or ASP For 29mm engines in T70: CR52H70W (BMS); or from Apogee or ASP For 29mm engines in T80: CR52H80W (BMS); or from Apogee or ASP For two 24mm engines clustered in T70: M2T5070W (BMS)

Engine Mount Tube:

For 24mm engines: T50 (BMS or ASP); BT-50 (Estes or Apogee) For 29mm engines: T52H (BMS); 29mm motor mount tube (Estes or Apogee); T-29 tube (ASP)

Engine Retainer:

Engine hook for Estes engines: 2.75" for D12, 3.75" for E12. Available from Apogee, BMS, or Estes. 4.9" for Estes 29mm engines available from ASP Screw-on cap type for Aerotech & Cesaroni engines: Estes 24mm or 29mm plastic retainer sets (Estes, Apogee, or eRockets)



Rocket Part Vendors:

Estes Industries: <https://estesrockets.com/product-category/accessories-parts/>

Apogee Rockets: <https://www.apogeerockets.com> (see the "TARC supplies" section)

Balsa Machining Service (BMS): <https://www.balsamachining.com> (see the "TARC parts" section)

Aerospace Specialty Products (ASP): <https://www.asp-rocketry.com>

Visit RocketContest.org to learn more.



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Contact Program Director Katrina Hill at RocketContest@aia-aerospace.org or 703-358-1000.

Sample Letter for Sponsors

Dear [NAME],

Our school is competing in the American Rocketry Challenge and could use your support! The American Rocketry Challenge is the world's largest student rocket contest. This year, nearly 5,000 students from across the country are competing for the chance to make the National Finals in Washington, D.C. Our team must design, build, and launch a rocket carrying one raw egg 850 feet into the air, and return to earth with the egg un-cracked, all within 42 to 45 seconds.

The top ten teams win a pool of over \$100,000 in cash and prizes, with the winning team going on to represent the United States in Paris against teams from around the world. But becoming national champions in rocketry doesn't happen overnight – that's why we need your help. This is our first year competing in the Rocketry Challenge, and your financial or material donation can help us succeed. [Information about your team]

We would be grateful if you were able to contribute and help our team reach the top! If you're interested in donating to our team, please speak with our teacher, [Teacher's Name] at [email address] or [phone number].

Thanks for your support,

[STUDENT SIGNATURES]

Visit RocketContest.org to learn more.



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