Team Amick Rocketry

Introduction to Model Rocketry Workshop (RW 101)

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Revised 7/2012

Amick Rocketry Workshops
Course 1: Introduction to Model Rocketry

Purpose: This is the first in a series of Workshops to inform and instruct attendees (parents and children) about the basics of the model rocketry hobby. The idea is to address any questions you may have about the hobby, and prepare you with a base of knowledge that will allow you to be an active participant in model rocketry.

At the end of this course you should have a basic understanding about the purpose of the hobby, safety, parts of a model rocket, choosing rockets based on skill level, construction tools, rocket engine designation and function, and the aspects of a rocket's flight.

You will also have the experience of constructing a model rocket under your belt, and hopefully this will encourage you to build others, and move forward with the Beginner level course.

Outline:

I. Introduction
II. Hobby history and the National Association of Rocketry (NAR)
III. What about safety?
IV. What are the parts of a model rocket?
V. What do I look for on the packaging?
VI. What are the Skill Levels?
VII. Where can I buy rockets and supplies?
VIII. What tools and materials do I need?
IX. How does a model rocket fly?
X. How do model rocket engines work?
XI. Where can we fly our rockets?
XII. Questions?
XIII. Let's Build a Rocket!
XIV. Closing

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 one pound in weight (3.3 pounds under some conditions), 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.

National Association of Rocketry

SPORT ROCKETRY: AMERICA'S SAFE, EDUCATIONAL AEROSPACE HOBBY

IS THIS HOBBY SAFE?

In well over 500 million flights since the founding of the hobby, there has never been a death caused by the flight of a sport rocket. 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 fust-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

NAR Model Rocket Safety Code

Approved March 2009

1. **Materials.** I will use only lightweight, non-metal parts for the nose, body, and fins of my rocket.

2. **Motors.** I will use only certified, commercially made model rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer.

3. **Ignition System.** I will launch my rockets with an electrical launch system and electrical motor igniters. My launch system will have a safety interlock in series with the launch switch, and will use a launch switch that returns to the "off" position when released.

4. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.

5. **Launch Safety.** I will use a countdown before launch, and will ensure that everyone is paying attention and is a safe distance of at least 15 feet away when I launch rockets with D motors or smaller, and 30 feet when I launch larger rockets. If I am uncertain about the safety or stability of an untested rocket, I will check the stability before flight and will fly it only after warning spectators and clearing them away to a safe distance.

6. **Launcher.** I will launch my rocket from a launch rod, tower, or rail that is pointed to within 30 degrees of the vertical to ensure that the rocket flies nearly straight up, and I will use a blast deflector to prevent the motor's exhaust from hitting the ground. To prevent accidental eye injury, I will place launchers so that the end of the launch rod is above eye level or will cap the end of the rod when it is not in use.

NAR Model Rocket Safety Code

Approved March 2009

7. **Size.** My model rocket will not weigh more than 1,500 grams (53 ounces) at liftoff and will not contain more than 125 grams (4.4 ounces) of propellant or 320 N-sec (71.9 pound-seconds) of total impulse.

8. **Flight Safety.** I will not launch my rocket at targets, into clouds, or near airplanes, and will not put any flammable or explosive payload in my rocket.

9. **Launch Site.** I will launch my rocket outdoors, in an open area at least as large as shown in the accompanying table, and in safe weather conditions with wind speeds no greater than 20 miles per hour. I will ensure that there is no dry grass close to the launch pad, and that the launch site does not present risk of grass fires.

10. **Recovery System.** I will use a recovery system such as a streamer or parachute in my rocket so that it returns safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.

11. **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places.

LAUNCH SITE DIMENSIONS

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Site Dimensions (ft.)
0.00--1.25	1/4A, 1/2A	50
1.26--2.50	A	100
2.51--5.00	B	200
5.01--10.00	C	400
10.01--20.00	D	500
20.01--40.00	E	1,000
40.01--80.00	F	1,000
80.01--160.00	G	1,000
160.01--320.00	Two Gs	1,500

What is model rocketry?

Model rocketry is a hobby that was founded in the 1950's when humans were actually building rockets to fly into space. Amateur “rocket scientists” began constructing their own models at home with parts available (See the move “October Sky”) and found that it wasn't the easiest (or safest) thing to do. Enterprising men in the aerospace and fireworks industries developed methods of building safe single-use rocket engines for modelers. Once engines were in mass-production, Verne Estes began making rocket kits and the hobby “took off”, so to speak.

Today there are a number of model rocket manufacturers, but Estes is still the biggest and most well-known. Model rocketry is a safe, fun, and inexpensive hobby thanks to people like Mr. Estes and the National Association of Rocketry (NAR), which is the leading scientific organization dedicated to safety, youth education, and technological advancement in the hobby. Most, if not all, of the products available for sport rocketry have been approved by the NAR.

What are the parts of a rocket and what do they do?

Model rockets share many common parts with their much bigger cousins that you see flown by the military or NASA. Attachment “A” is a diagram of a model rocket showing each of the components and their purpose.

Nose Cone: The front or top of the rocket. Makes the rocket aerodynamic so it will fly.

Body Tube (Airframe): Contains the Motor Mount, Recovery System, and is where the Fins are attached. The Nose Cone slides into the front of the Body Tube.

Fins: The Fins are attached to the Body Tube and help the rocket fly straight.

Engine: Propels the rocket up, makes a smoke trail for tracking, and ejects the Recovery System. “Booster” Engines can ignite other Engines in flight in multi-stage rockets.

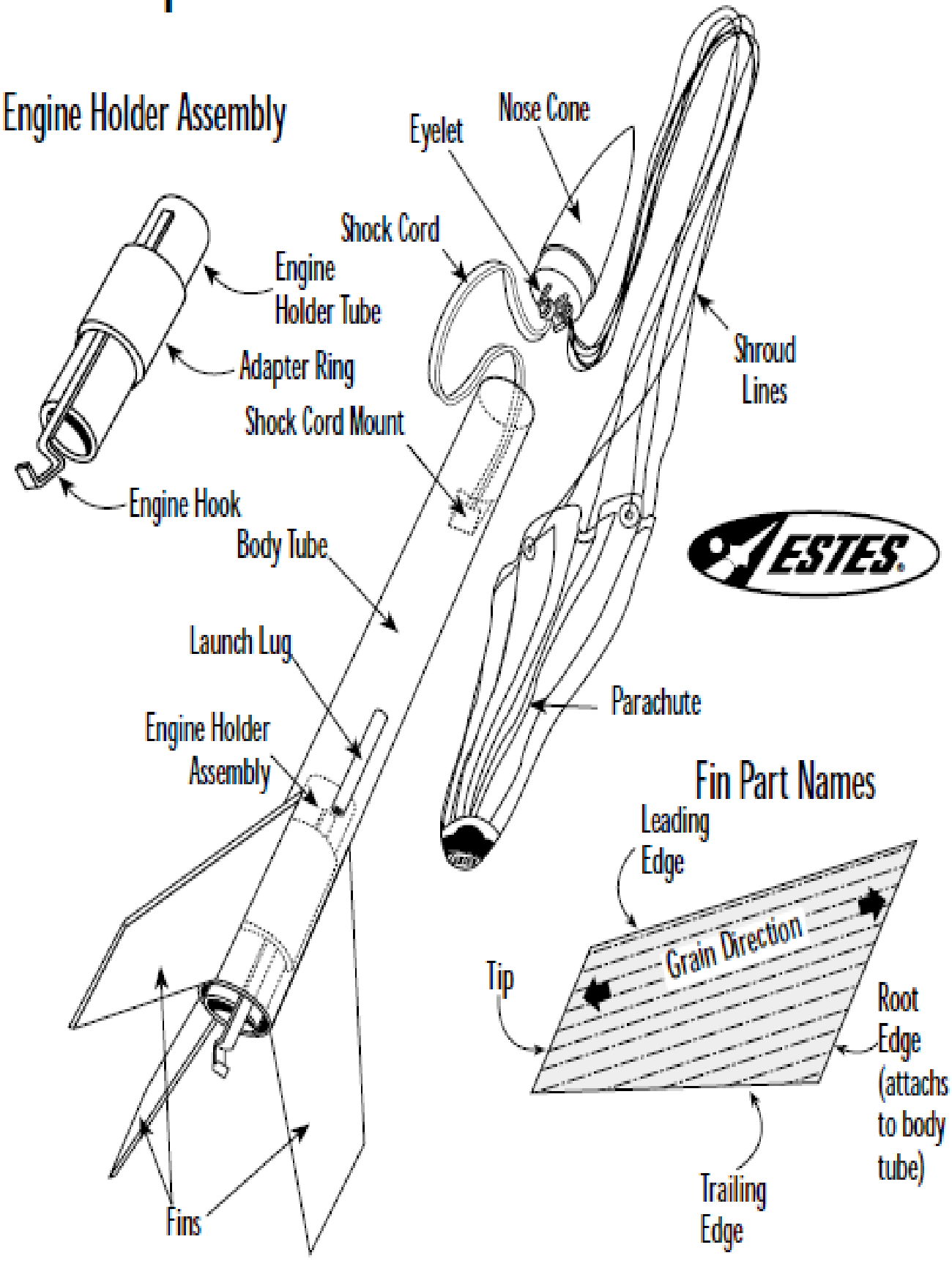
Engine Mount: Parts that secure the Engine in the rocket for a safe flight.

Recovery System: Typically a plastic streamer or parachute that slows the rocket for a safe landing so it can be used again. It is attached to the Nose Cone or Shock Cord.

Shock Cord: A rubber, elastic cord that holds the rocket together when the ejection charge pushes the Nose Cone and Recovery System out.

Launch Lug: Small tube(s) attached to the Body Tube that guides the rocket on the launch rod. This makes sure the rocket goes up when launched.

The Alpha Model Rocket Nomenclature



What should I look for when choosing a rocket kit?

Skill Level (1)
[Easy]
(Higher is harder)

Name
(This is the kit name. But you can name your rocket whatever you like.)

Max Altitude (575')
[On biggest engine]

Picture
(Gives idea of complexity of kit. This one has 4 fins & looks pretty simple.)

Engine Types
(eg: A83, B64, C65)
These are what to buy to fly the kit.

Specifications
(Height, weight, etc.)

Name
(This is a model of a real missile.)

Picture
(This kit has many fins and parts.)

Specifications

Engine Types
(Note kit uses 3 at a time)

Skill Level (4)
[Expert]

What are the Skill Levels of Model Rockets?

Most model rockets include a “Skill Level” to give and idea of how difficult the kit is to build. This is indicated on the package. Though it may seem simple enough I have found that different rocket manufacturers have different Skill Levels and they may not necessarily indicate how difficult the kit will be to build.

Estes uses a system that runs from E2X (Easiest) to Skill Level 5. Quest Aerospace has a similar system but they go from “Model Rocket Quick Kit” to Skill Level 3. Other manufacturers (Such as FlisKits) rate from 1 to 5 with .5 increments.

When first starting in the hobby, it is recommended that you start with a Skill Level E2X or 1 kit.

E2X kits may either snap together (See Estes' “Firestreak SST” - right) or require a minimal amount of construction experience. Typically you will need only Plastic Cement to assemble them. Their Fins come as a single-piece unit (called a “Fin Can”) or may slide and lock into a one or two-piece plastic Engine Mount. They are extremely lightweight, and may use a Streamer for recovery, or just tumble back to the ground. E2X kits do not require painting, and can take from 15-60 minutes to build.

Skill Level 1 kits are the first step toward real “Rocket Science” and the construction techniques will be similar all the way through high-power rockets. They are powered by either a 13mm or 18mm engine (½ “A” to “C” - see “Engines”) and may have a “Fin Can” or actual individual Fins to attach (See Estes' “Baby Bertha” - left). These kits will require some basic building materials (See: Building Supplies) such as wood glue, a hobby knife, and sandpaper. Construction will require some marking and measuring, but this is clearly explained in the instructions, and guides are included that can be cut out to ease the process.

Skill Level 1 kits will contain all the basic parts you will see going forward – a Engine Mount, which will have several parts including a Retainer Hook and Centering Rings; 3-5 pre-cut Fins that you will have to detach from either a cardstock or balsa wood sheet; a Body Tube, Shock Cord, and Nose Cone; and a Recovery System of either a Streamer or Parachute. These kits may come colored or may require painting, and may or may not have self-adhesive decals. There is an increased chance of making mistakes. If Fins are not properly aligned the result could be unusual flight behavior.

Skill Level 2 seems to be where different manufacturers go their own way regarding the actual difficulty rating of a kit. They build upon Skill Level 1 by having two or more Body Tubes that must be joined with a Coupler, and may add a 24mm Engine Mount (Estes' “D Region Tomahawk” or “Mean Machine”). Decals may be self-adhesive or waterslide (which are more difficult to work with, but ultimately not required to fly, nor will they affect the performance of the rocket). There is actually no more skill required to do this than in a level 1 kit – so these are a logical next step and reinforce what has already been learned and practiced.

However some fighter-like rockets – Estes' “Screaming Eagle” and Quest's “AeroSpace-1 Fighter” and “SHX Stilleto” are rated as Skill Level 2. These kits will require adding fairings, attaching multiple Fin pieces together, or adding pods to a Fin prior to attaching it to the Body Tube. Usually a pod consists of a small tube, nose cone and tail cone – adding three parts in the assembly process – and there tend to be multiple pods on the rocket.

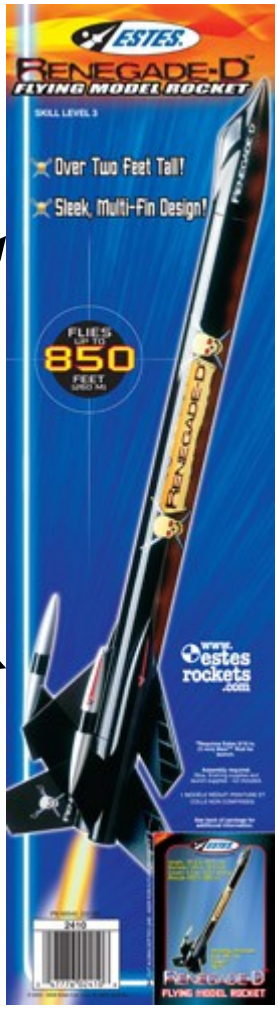
To give you a little more perspective on the difference in ratings by manufacturers, consider this: The Estes “Mean Machine” (left), a really tall but simple rocket at 79 inches length, is considered Skill Level 2, has about 22 parts, and flies on a “D” or “E” Engine. However, the Centuri “Draconian Marauder” (from the Buck Rogers TV series) is rated as a Skill Level 2, yet has over sixty (*60!)* parts and requires a LOT of detail. I've built the Marauder. It's no level 2 kit!

If you're not sure whether you're ready for a Skill Level 2 or 3 rocket yet, look at the picture on the package. If you see additional fins, fairings, and pods, you may want to wait until you have 3-4 builds under your belt and feel comfortable with your constuction skills before jumping into the fancy stuff. But to move into Skill Level 2, I recommend Quest kits such as the “Courier” (which carries an egg for a payload), “Gamma Ray”, “Superbird” or Estes' “Mega Mosquito”, “Maxi-Alpha-3”, or “Big Daddy”.

Estes' “Mega Mosquito”, “Screaming Eagle”, Quest's “AS-1”, Centuri “Draconian Marauder”

Skill Level 3 rockets, as mentioned previously, may (or may not) take the number of parts and degree of difficulty upward. For example, Estes' “Magician” rocket (below left) is still a very straight-forward build with a 24mm Engine Mount, 3 Fins, Body Tube(s), and a Nose Cone. In total there may be 22 parts. The only things I've found different than a level 2 kit is a Payload Bay and a Transition connecting it to the Body Tube, but there are level 2 kits with these features. In my opinion, this should be a level 2 kit.

If you look at the Estes “Renegade D” (right) you'll see about 35 parts total with multiple Fins and pods on the end of some. I can tell you from experience that it is a difficult build, but is a really cool-looking rocket once completed.



“Sleek, Multi-Fin Design!”
Means MORE DIFFICULT!

Both rockets pictured are Skill Level 3. Both fly on 24mm “D” or “E” engines. But you can clearly see the difference in difficulty.

Skill Level 4 and 5 kits just get that much harder. At this level you're really talking about craftsmanship in your work: measuring, cutting, and finishing parts that previously have been done for you. You should have the ability to build mid- and even high-power kits, and know tips and tricks to building better rockets.

At this point you may also want to try your hand at scratch-building a rocket.

The Launch Pad's “Rapier” (left) and the “QCC Explorer” from Estes (right) are both level 4 kits that require well-honed skills.

Where can I buy Model Rockets and Supplies?

Model rockets are available at most hobby shops. They can also be found at national chain hobby stores such as **Hobby Lobby** and **HobbyTown USA**. Hobby Lobby carries some of the Estes product line and motors. They also offer launch kits and recovery wadding. Recently, they added the Estes Pro-Series II rockets in stores, with a couple of mid-power kits and single-use mid-power engines available for purchase by those over 18.

$$ Note: Hobby Lobby frequently offers a 40% off coupon for a single item in the store, and occasionally has 30% off sale on all rocketry items. You can print the coupon or pull it up on your phone with the internet. See Hobbylobby.com for details.

HobbyTown USA carries most of the Estes product line, and may also have Quest and other model kits in stock, depending on the store. They will also carry the Estes engines, Pro-Series II engines, and other manufacturers.

You will also find mid-power kits from Aerotech, and possibly mid- and high-power kits from LOC Precision and Public Missiles Limited. They also carry Aerotech single-use and reloadable composite engine kits and casings.

You'll learn more about these in the Advanced Workshop.

$$ Note: Check with your hobby shop to see if they offer discounts to members of local rocketry clubs. Dallas Area Rocket Society (DARS) members receive a 10% price break on ALL rocket items at HobbyTown USA Dallas (NE corner of Walnut Hill and Central Expressway). HobbyTown USA in Plano (NE corner of Park and Tollway) offers DARS members 10% off rocket kits and parts. **R/C Zone** in Frisco (SW corner of Preston and Stonebrook) also offers a 10% discount to DARS members, and carries many Estes and some Quest kits and engines.

As for supplies to build and finish your model rockets, I suggest visiting your local Wal Mart for things like Carpenter's Wood Glue, Sandpaper (180, 220, 320, 400, and perhaps even 600 grit), and woven elastic (1/8, ¼, or 3/8 inch) to replace and lengthen stock shock cords. They also seem to have a wide variety of colors and the best price on primer and spray paint from Krylon, Rust Oleum, and other brands. You may also find stickers or other things to decorate rockets in the scrapbooking section of stores.

What tools/supplies do I need?

Most, if not all, model rocket will provide a list of tools/items you will need to build and finish the kit. You will be able to purchase these at a hobby store, retailer, or hardware/home-improvement store. I recommend purchasing the basic list, adding a few extra items, and getting a nice little container to store them in (some things may need to be stored vertically so they don't spill).

The basic list in most model rockets includes the following items:
Carpenter's Wood Glue
Hobby Knife (with X-Acto #11 blades)
Sandpaper (of various grits)
Masking tape
12”+ ruler
Pencil
Spray paint

Additional “basic” items I recommend include:
Plastic Model Cement (Testor's Blue-tube “Non-Toxic”)
Razor saw
Cutting mat (self-healing)

Adhesives

Different adhesives are used in building model rockets, with Wood Glue used most.

Cyanoacrylate or “CA”
(Similar to Super Glue. Fast-acting. Bonds ANYTHING!)

Carpenter's Wood Glue
(Stronger than white glue but just as safe)

Epoxy (Two-part mix)
(For super-strong bond)

Non-Toxic Plastic Model Cement
(Testor's Blue Tube)
(Bonds plastic and cardboard together)

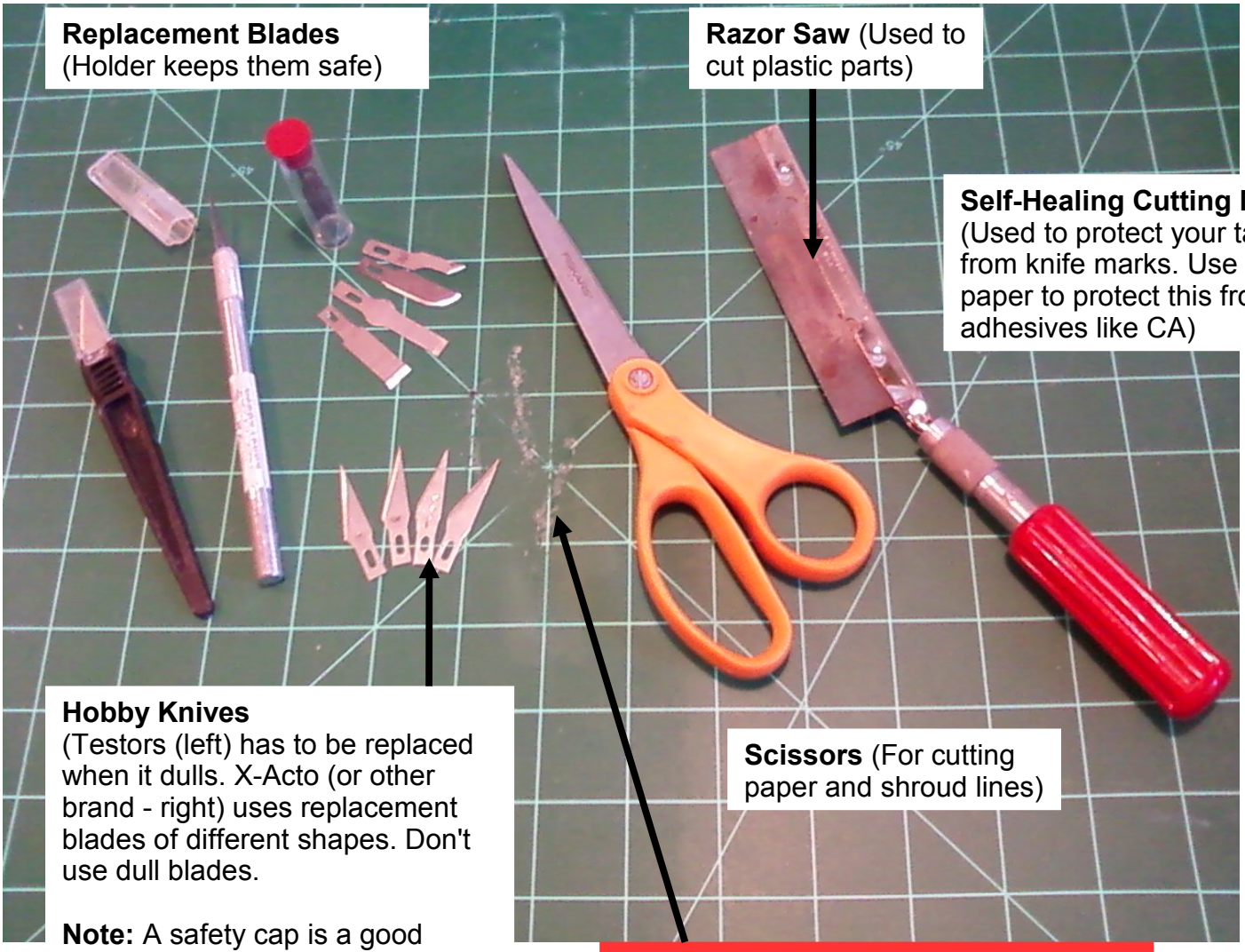
Acid Brushes
(Disposable. For applying nastier adhesives like CA and Epoxy)

What tools/supplies do I need?

Cutting Tools

The most commonly used cutting tool in model rocketry is the hobby knife (commonly called the X-Acto knife after the popular brand).

$$ Note: Scissors you may have, and perhaps an old cutting board. But make sure it isn't marred or rutted badly, or else it could cause problems when cutting precision parts or lines. Also, don't expose the rubber cutting mats to heat cycles (leave it in a car). It will warp and not lay flat. Further, when working with adhesives, lay down a sheet of wax paper to protect the mat from chemical-based agents like cement, CA, and epoxy. This will help keep the surface in good condition.



What tools/supplies do I need?

Finishing Supplies

Used to fill grain, seams, and holes and give your rocket a nice, smooth finish. Body Tubes have a spiral that can be sanded and filled to create a smooth tube. Balsa fins have a loose grain that can be sanded and filled with Filler or Primer to create a solid finish. Plastic nose cones and parts may have flaws from the molding process that can be filled with putty to make them “disappear” once painted.

$$ Note: The final quality of the finish is up to you. It is for appearance more than performance of the rocket. It can take several additional hours of work to create a high-quality model for competition (or pride) purposes. Don't worry about that with the first few rockets you build. The purpose here is to show what is available and those construction tips and techniques will be covered in another Workshop.

Sandpaper (Used to smooth fins, body tube, joints, and Primer.

Hint: Lower grit # is more coarse. 180 to 400 is good)

Wood Filler (Used to fill the “spiral” on the tube and wood grain in fins)

Primer (Creates an even color base for paint and prepares surface for a smooth finish.v

Hint: Use White for Bright and Gray as base for Dark colors)

Masking Tape (Blue Painter's Tape) Used to prevent paint overspray on parts [in addition to newspaper])

Note: Small pieces of tape are used to correct a loose-fitting Nose Cone

Model Putty (Used to fill seams and pits in plastic parts such as the Nose Cone)

Plastic Putty Knife (Used to apply filler or for scraping)

What tools/supplies do I need?

Other Tools

These are items that you may have around the house, or may want to add to your tool kit. You may or may not ever use them (such as the Milled Fiberglass) but they're handy to have around (such as the “Zap-It” brand CA de-bonder).

$$ Note: Of the items pictured, I recommend the ruler and cheap brushes to start. If you have a wood ruler with a metal edge that will suffice, and I imagine a house with students has plenty of pencils and a set of permanent markers around.

Milled Fiberglass (Used to strengthen Epoxy joints/fillets on mid- and high-power rockets)

Metal Ruler (Wood or plastic works too, but you can use this as a knife guide)

Easy Lift-Off (ELO) (Used to remove waterslide decals)

Debonder (Used to break CA bonds – such as on fingers)

Sanding Tee (block) (Used to back sandpaper. Helps for creating smooth, even finish)

Decal Set (Used to help waterslide decals stick)

Paint Brushes (Used to apply CA, Decal Set, or ELO. Also used to help position waterslide decals on rocket)

Pointed Tweezers (Used to handle and position small parts)

Pencils & Pens (Used for marking parts such as tubes and fins.)
Hint: Use pencils so you can erase lines. Dark lines or pens may show through paint.
Hint: Sharpie permanent markers can be used to color rockets or touch-up paint.

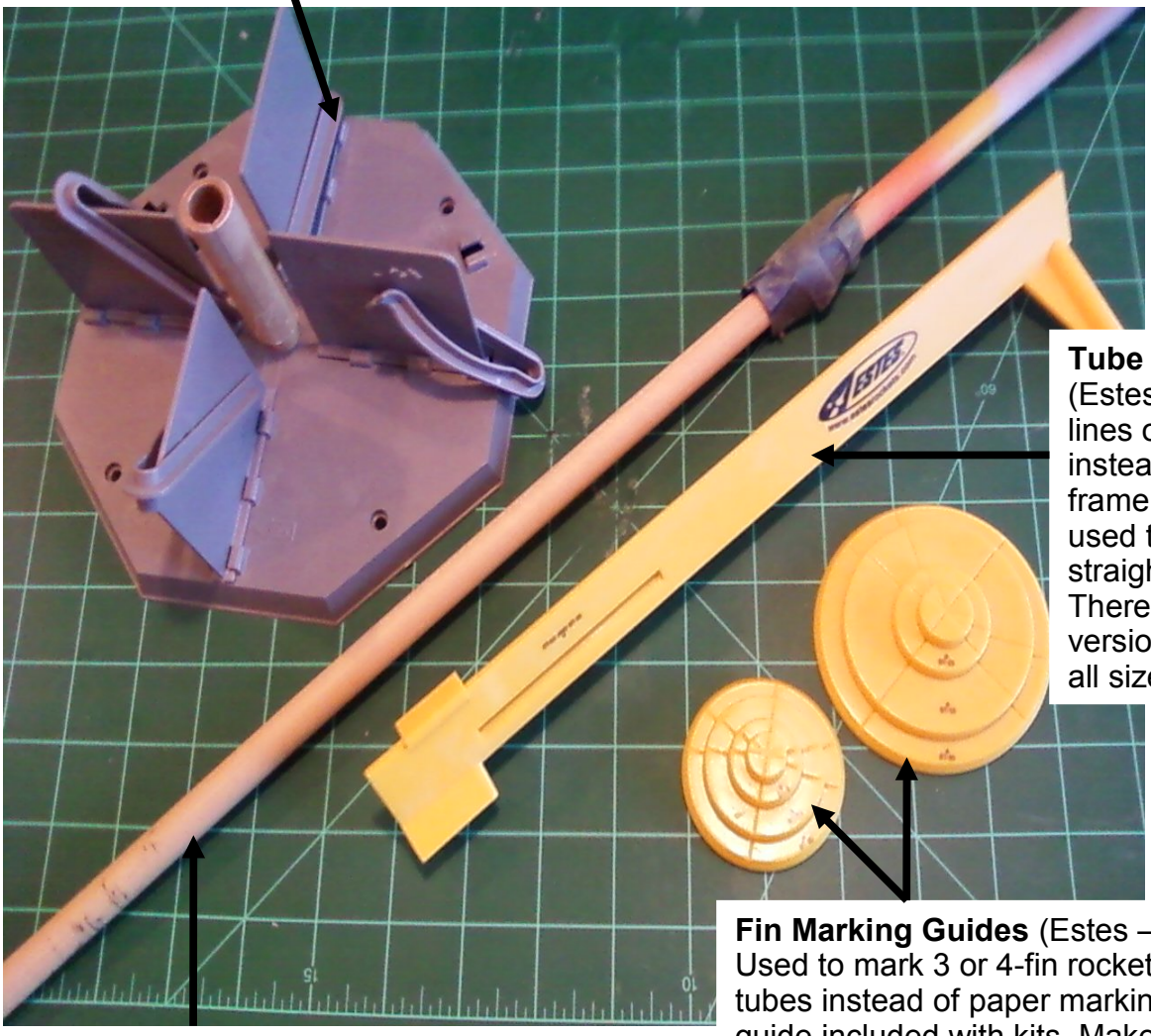
What tools/supplies do I need?

Construction Aids

Estes makes a number of tools intended to aid the model rocketeer in successfully building their rockets. These include marking guides, fin holders, and a new series of tools to help cutting body tubes. The tube-cutting guides are, in my opinion, somewhat unnecessary, as there are simpler and cheaper ways to cut Body Tubes. Also, this process is needed only for rocket repairs, or scratch-building, and will be covered in later worshops.

$$ Note: These tools/aids are all OPTIONAL and not required for construction.

Fin Alignment Guide (Estes – used to prop rocket in vertical position while glue holding fins dries. Ok for 3 or 4-fin kits, and 13-24mm motors. I prefer to eyeball and use a piece of paper with lines on it for reference)



Tube Marking Guide (Estes – Used to mark lines on body tubes, instead of using a door frame. Can also be used to hold fins straight while drying. There is a newer version of this tool for all size Estes tubes)

Fin Marking Guides (Estes – Used to mark 3 or 4-fin rocket tubes instead of paper marking guide included with kits. Make a good base for standing tubes vertical while working on the and for display)

3/8-inch Dowel (Used to hold rockets while painting and drying – better than rolled paper in my opinion)

What about launching rockets?

As mentioned previously, model rockets are legal in all 50 states. However, local city ordinances may affect where and when you can fly them. This is where knowing or belonging to a rocketry club comes in handy.

You can search the NAR website (NAR.org) to find a section near you. Most clubs have websites and will provide you information on when and where launches are, and if there is any cost involved.

For those in the Dallas / Ft. Worth Metroplex, the Dallas Area Rocket Society (DARS, NAR Section #308) flies in Frisco on the third Saturday of each month. Because the launch site is an undeveloped city park, there is no charge to come out and fly, even if you are not a member.

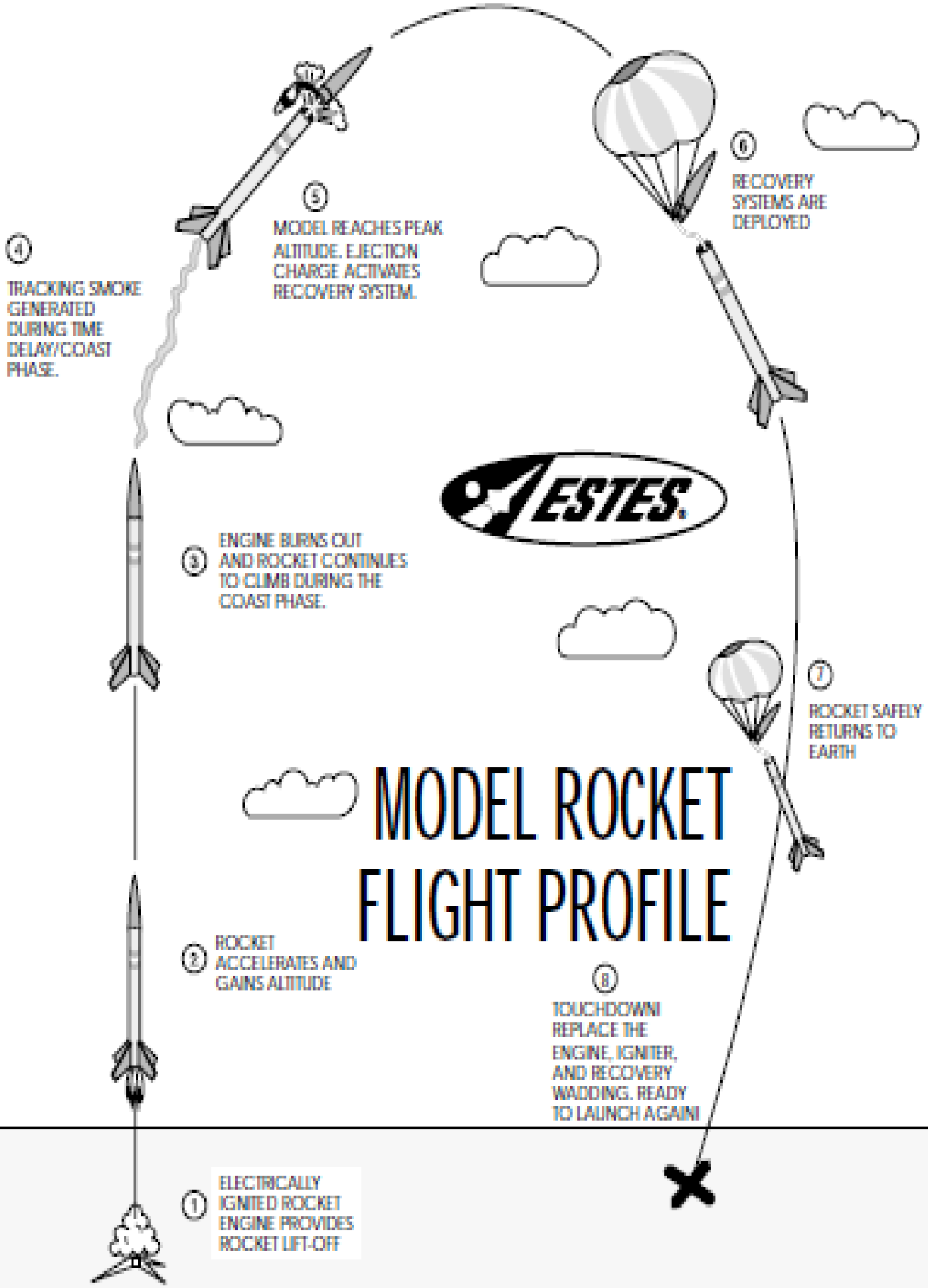
Joining a club gives you access not only to a wealth of knowledge and years of expertise, but also to organized launches that are safe and a great opportunity to get to know rocketeers big and small!

Web References

There is an enormous amount of information available on the internet about model rocketry; from organizations such as the NAR, to clubs, and individual web sites; many vendor sites that offer a multitude of products and kits; and videos such as how-to and launch footage.

I also suggest searching Ebay for Toys & Hobbies – Models & Kits – Rocketry. You will find thousands of items.

Below are a few key web sites to find more about model rocketry on the internet.
Www.NAR.org (National Association of Rocketry)
www.DARS.org (Dallas Area Rocketry Society)
www.hobbylobby.com (Hobby Lobby – So you can get the 40% off coupon)
www.estesrockets.com (Estes Company website)
www.questaerospace.com (Quest Company website)
Www.aerotech-rocketry.com (Aerotech Company website)
www.apogeerockets.com (Apogee is a vendor but has an ezine and help videos)



MODEL ROCKET FLIGHT PROFILE

Model Rocket Engines

ENGINE CODING FOR QUICK-N-EASY IDENTIFICATION

1. Label color indicates recommended use of the engine.

a. Green ..... Single Stage rockets
b. Purple ..... Upper Stage or Single Stage, if used in very light rockets
c. Red ..... *Booster and intermediate stages of multi-stage rockets
d. Black ..... *Special plugged engines for R/C gliders

*These contain no delay or ejection charge.

2. Code designation stamped on the engine gives useful and important information on its performance capabilities.

a. This portion indicates total impulse or total power produced by the engine.

b. This portion shows the engine's average thrust in Newtons and helps you choose the proper engine for your rocket's flight.

c. This number gives you the delay in seconds between burnout and ejection charge. It lets you choose the engine with the delay time you want for any flight.

TOTAL IMPULSE CLASSIFICATION

Code	Pound-Seconds	Newton-Seconds
1/2A	0.14 - 0.28	0.625 - 1.25
A	0.28 - 0.56	1.26 - 2.50
B	0.56 - 1.12	2.51 - 5.00
C	1.12 - 2.24	5.01 - 10.00
D	2.24 - 5.00	10.01 - 20.00

HOW HIGH WILL YOUR ROCKET GO?

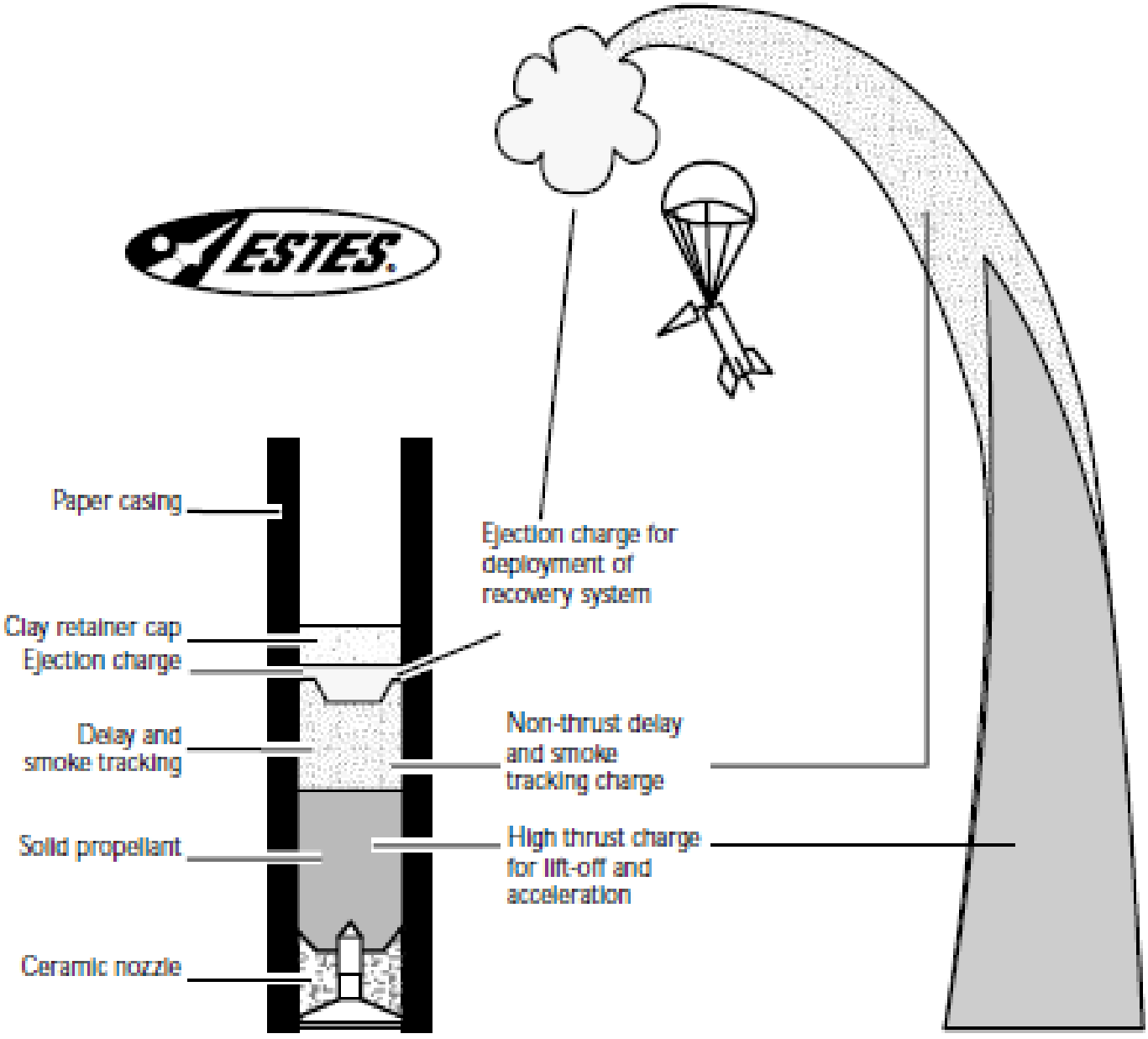
The chart below shows the approximate altitudes that can be achieved with single stage rockets.

Engine Size	Altitude Range (depending on rocket size and weight)	Approximate Altitude in a typical 1 oz. model
1/2A6-2	100' to 400'	190'
A8-3	200' to 650'	450'
B6-4	300' to 1000'	750'
C6-5	350' to 1500'	1000'

(Some high performance rockets will reach higher altitudes than shown above.)

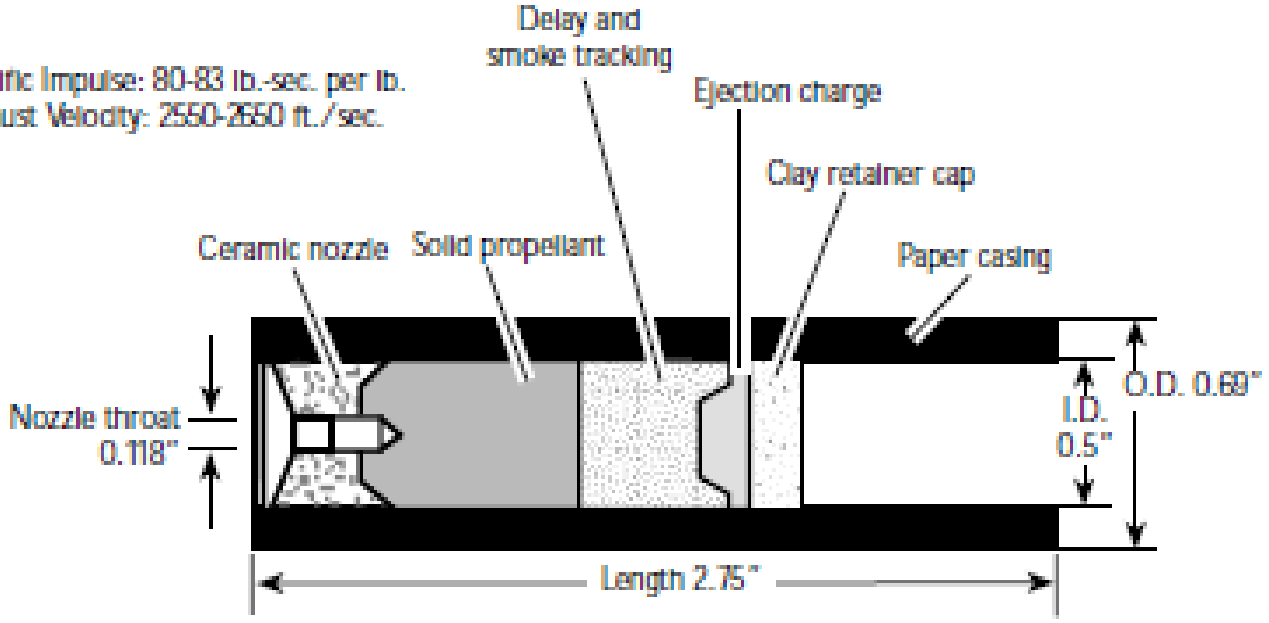
Model Rocket Engine Functions

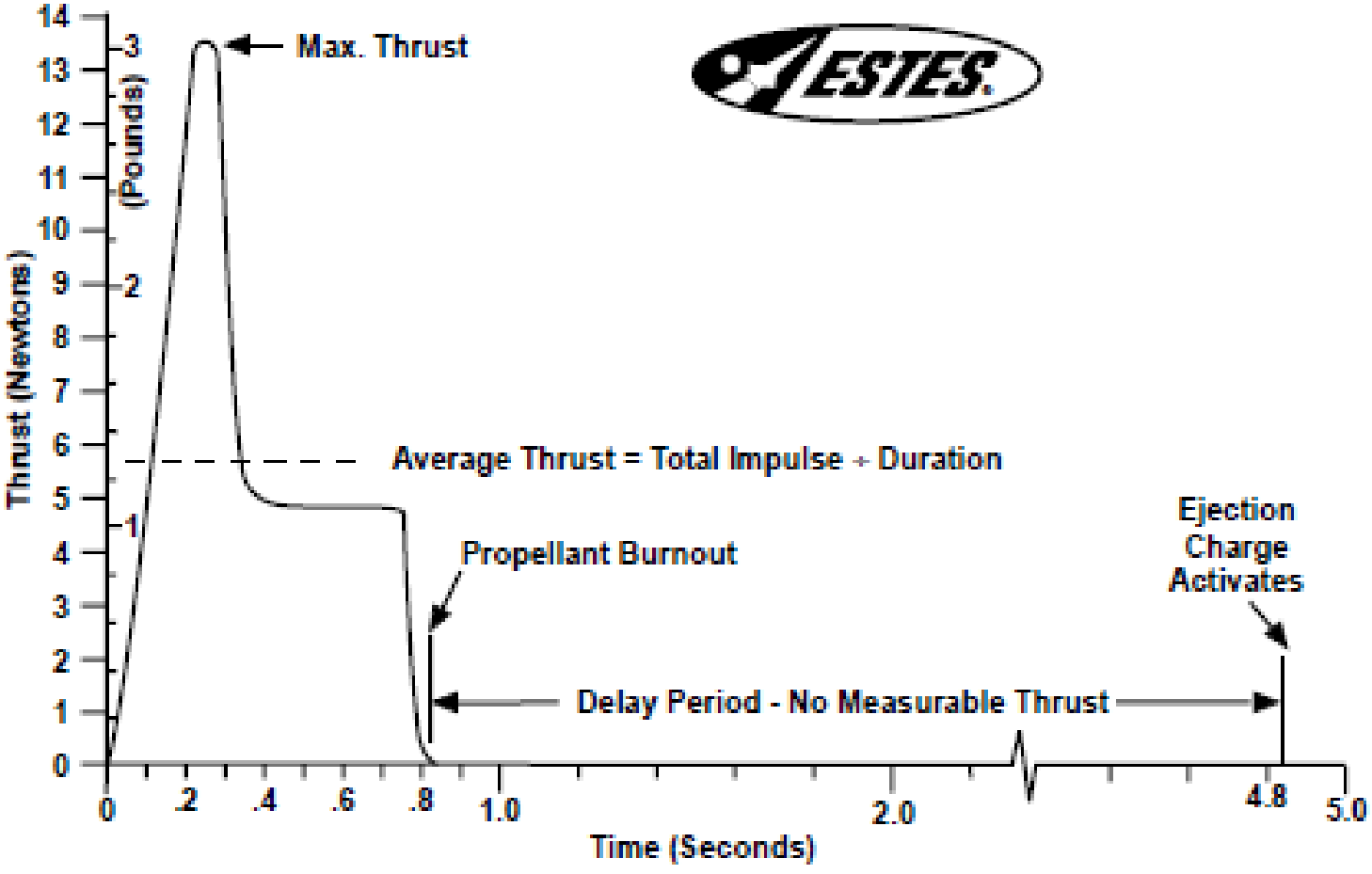
Graphic explanation of a rocket engine's fundamental construction and functions



Typical Time/Thrust Curve
B6-4 Model Rocket Engine

Specific Impulse: 80-83 lb.-sec. per lb.
Exhaust Velocity: 2550-2650 ft./sec.

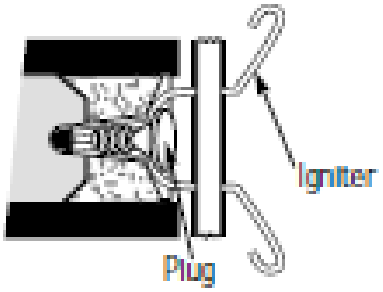




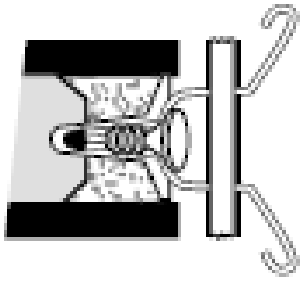
Igniter Installation

IGNITER TIP MUST **TOUCH** PROPELLANT!

GO



NO GO



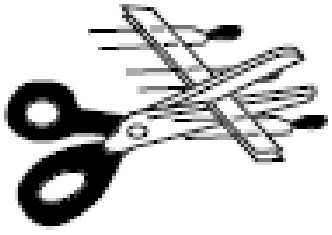
About 90% of all problems with engine ignition are caused by the igniter not being properly and securely held in place in the engine.

The igniter must **touch** the propellant at the moment the igniter is heated for ignition.

Attach micro-clips to igniter leads as close as possible to nozzle.

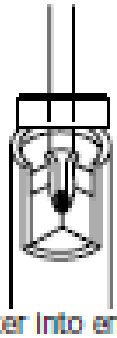
MODEL ROCKET IGNITER INSTALLATION

Always use electrical model rocket igniters with a model rocket launch controller.

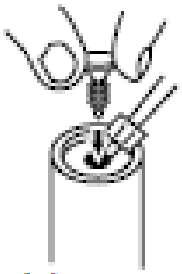


1. Cut tape separating igniters. Do not remove tape.

2. Separate plug from strip of plugs.

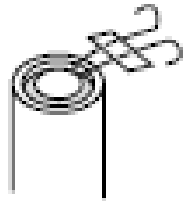


3. Insert igniter into engine. Igniter must touch propellant.

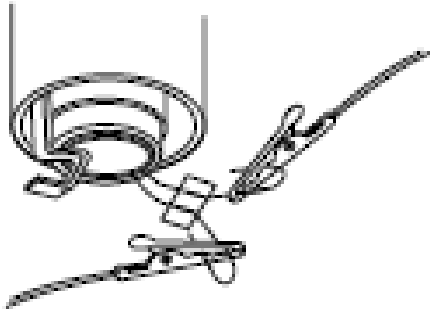


4. Insert plug into engine nozzle.

5. Push plug firmly into engine.



6. Bend igniter wires.



7. Attach one micro-clip to each lead of igniter. Clips must not touch each other or blast deflector and igniter leads must not cross.

ESTES

The Alpha
Model Rocket Nomenclature