This is Rocketry

Safe … Educational … Fun

National Association of Rocketry

www.nar.org

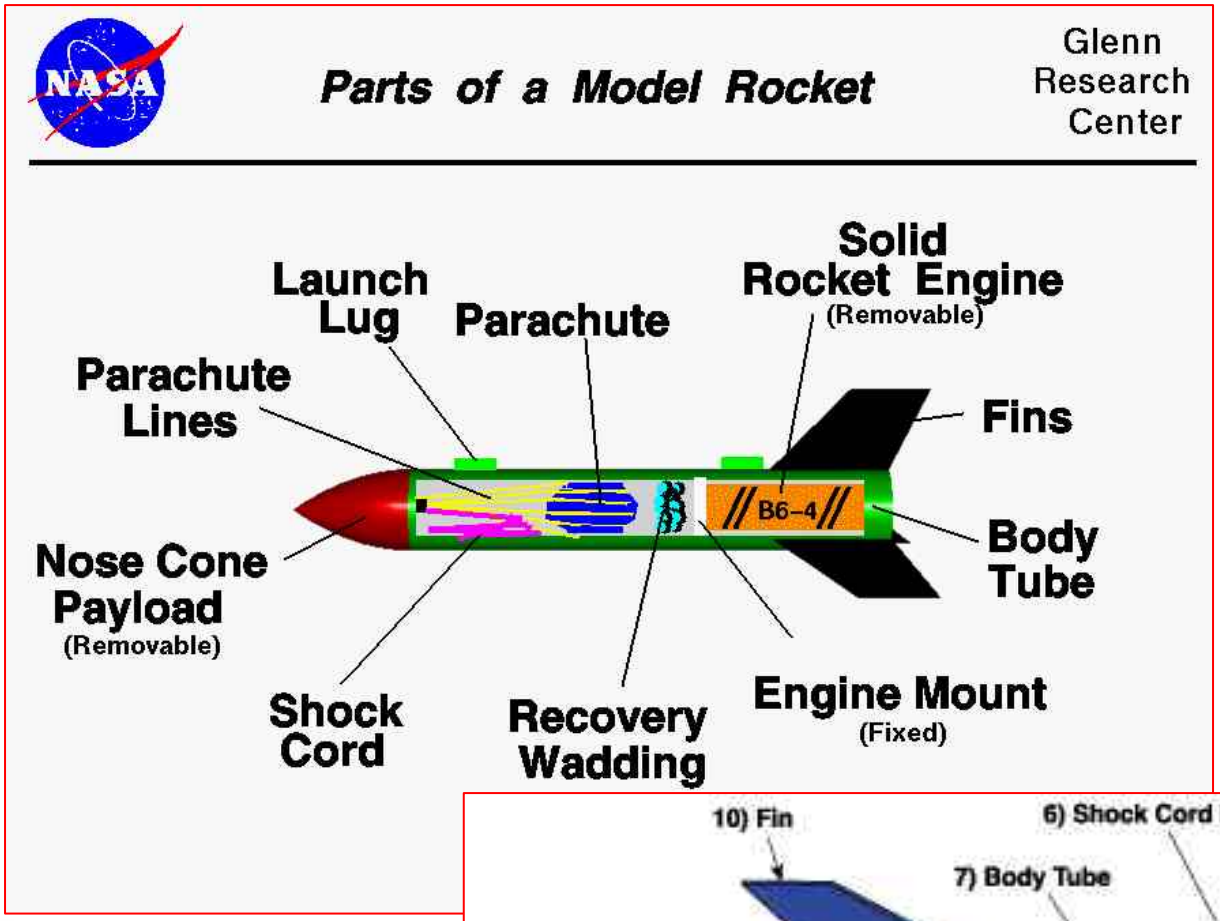
It Begins with Model Rocketry

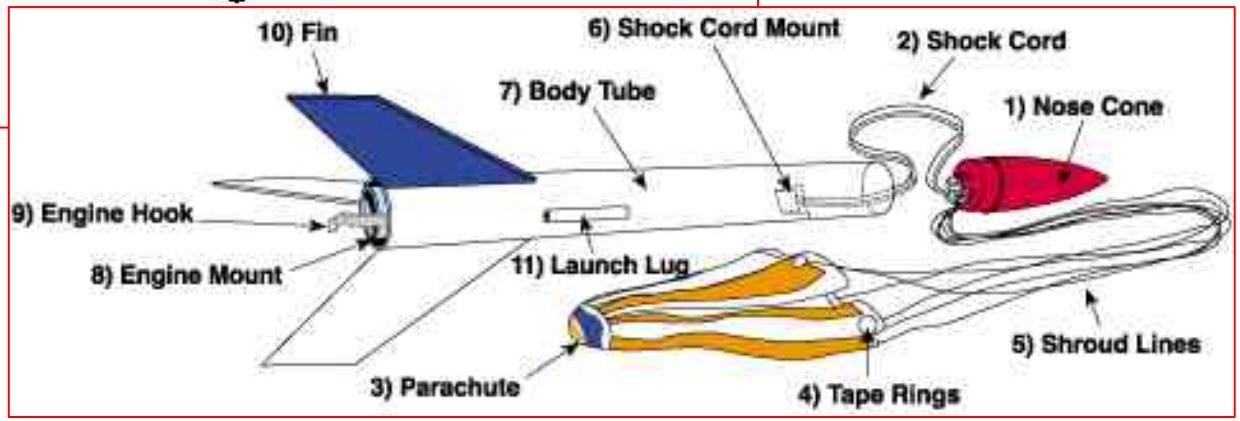
- Started in the US in 1957 to provide a safe way for consumers to build and fly rockets
- Models use light non-metal materials and safety-certified commercial solid-fuel motors
  - No more than 3.3 pounds and G size motors
  - Available in hobby and toy stores
- About 2 million model rocket fliers in the U.S. each year – of all ages
  - Legal in all states
  - Flying does not require licensing, NAR membership, or FAA approval

Are These Rockets Safe?

- **YES!** 500 million rockets launched over the hobby's 52 years – safely, with no flight fatalities
- Must use safety certified commercial rocket motors
- Model rockets must use paper, balsa, and plastic bodies – no metal
- Must have recovery devices and be reusable
- Must be ignited electrically from a safe distance and flown from a sturdy launcher with blast deflector
- Must be aimed straight up and not flown in high winds, dry grass, or near airplanes or power lines
- Exempt from FAA regulation until over 3.3 pounds

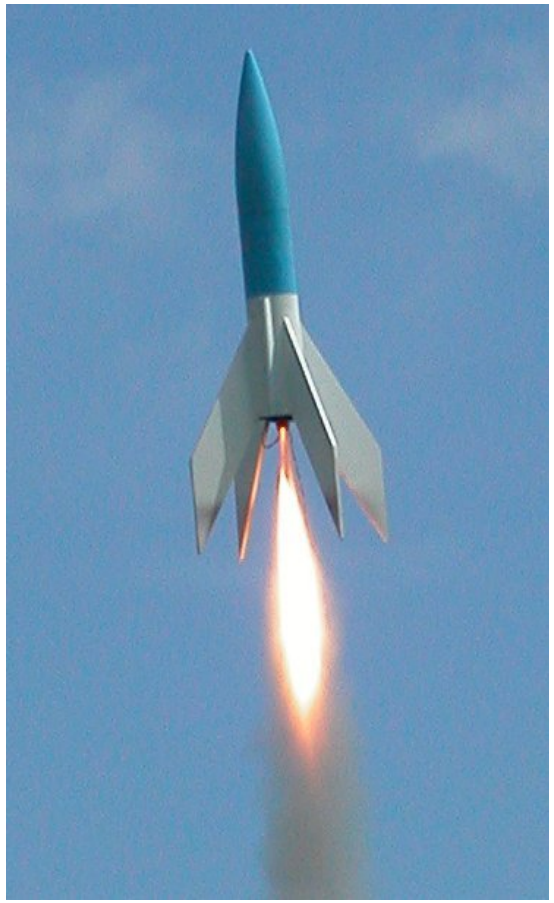
Parts of a Model Rocket

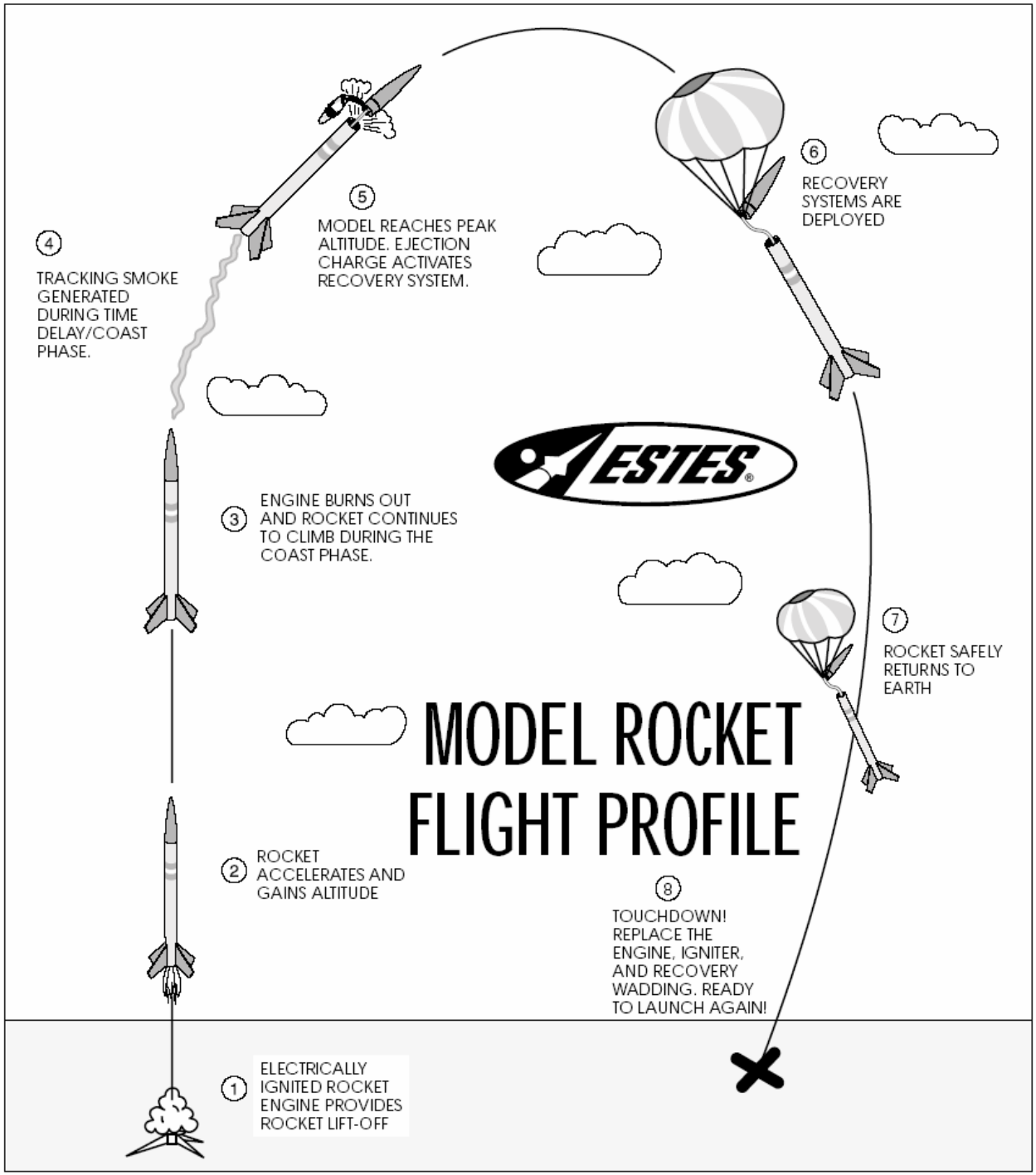




What Are The Parts For?

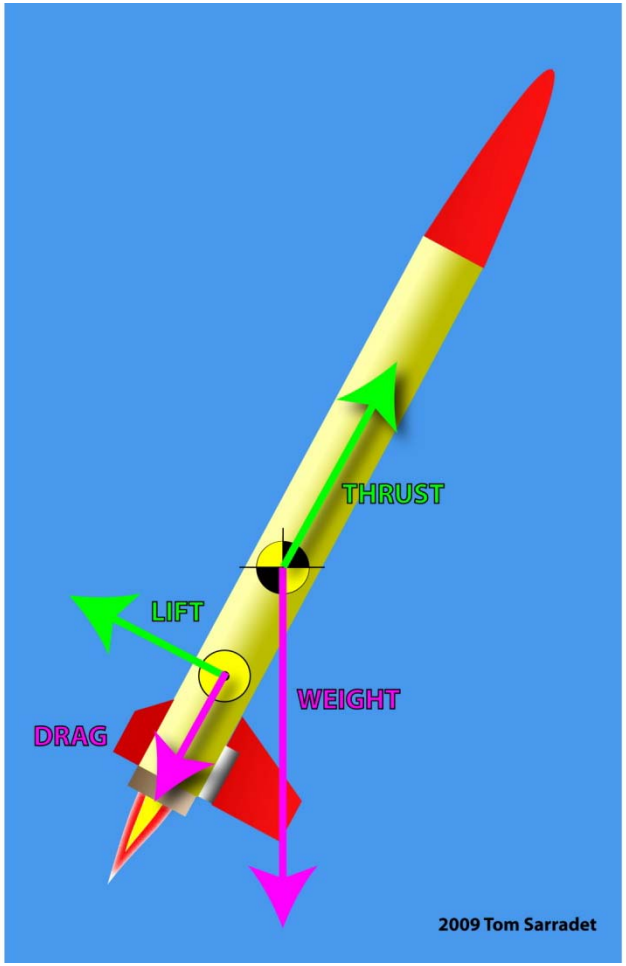
- The nose cone protects the payload and reduces drag
- The body tube holds the motor and recovery system
- The launch lug guides the rocket up the launch rod until it is flying fast enough for the fins to work
- The fins keep the rocket flying straight
- The rocket motor makes it go up
- The recovery system brings it down safely to earth




MODEL ROCKET
FLIGHT PROFILE
ESTES
1 ELECTRICALLY IGNITED ROCKET ENGINE PROVIDES ROCKET LIFT-OFF
2 ROCKET ACCELERATES AND GAINS ALTITUDE
3 ENGINE BURNS OUT AND ROCKET CONTINUES TO CLIMB DURING THE COAST PHASE.
4 TRACKING SMOKE GENERATED DURING TIME DELAY/COAST PHASE.
5 MODEL REACHES PEAK ALTITUDE. EJECTION CHARGE ACTIVATES RECOVERY SYSTEM.
6 RECOVERY SYSTEMS ARE DEPLOYED
7 ROCKET SAFELY RETURNS TO EARTH
8 TOUCHDOWN! REPLACE THE ENGINE, IGNITER, AND RECOVERY WADDING. READY TO LAUNCH AGAIN!

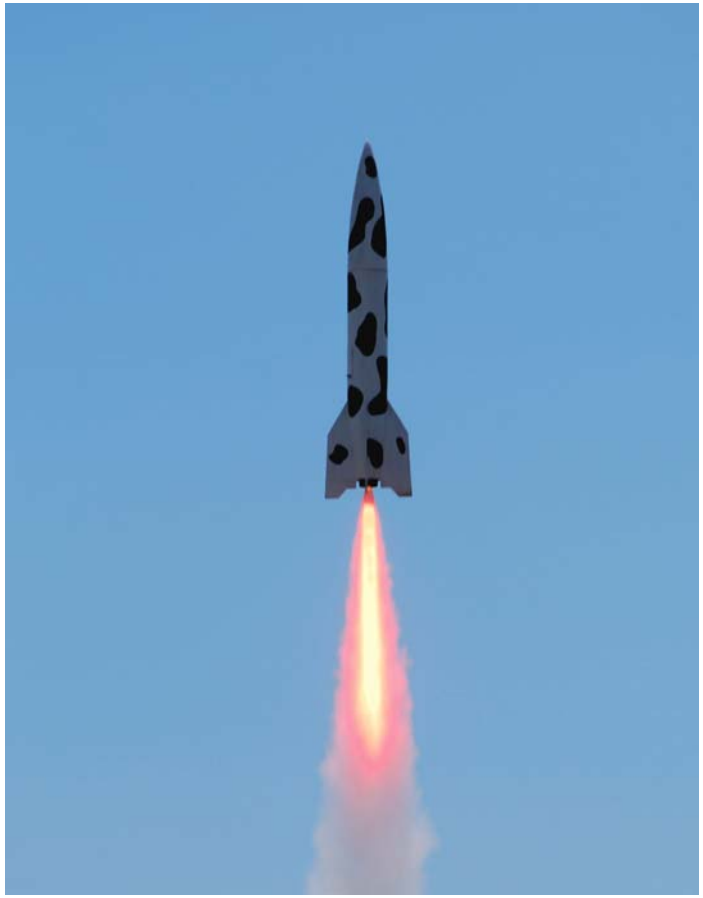
Forces Acting on a Rocket

- Thrust from the rocket motor
- Weight of the rocket
- Drag from the air as the rocket flies through it
- Lift from the fins as they stabilize the flight

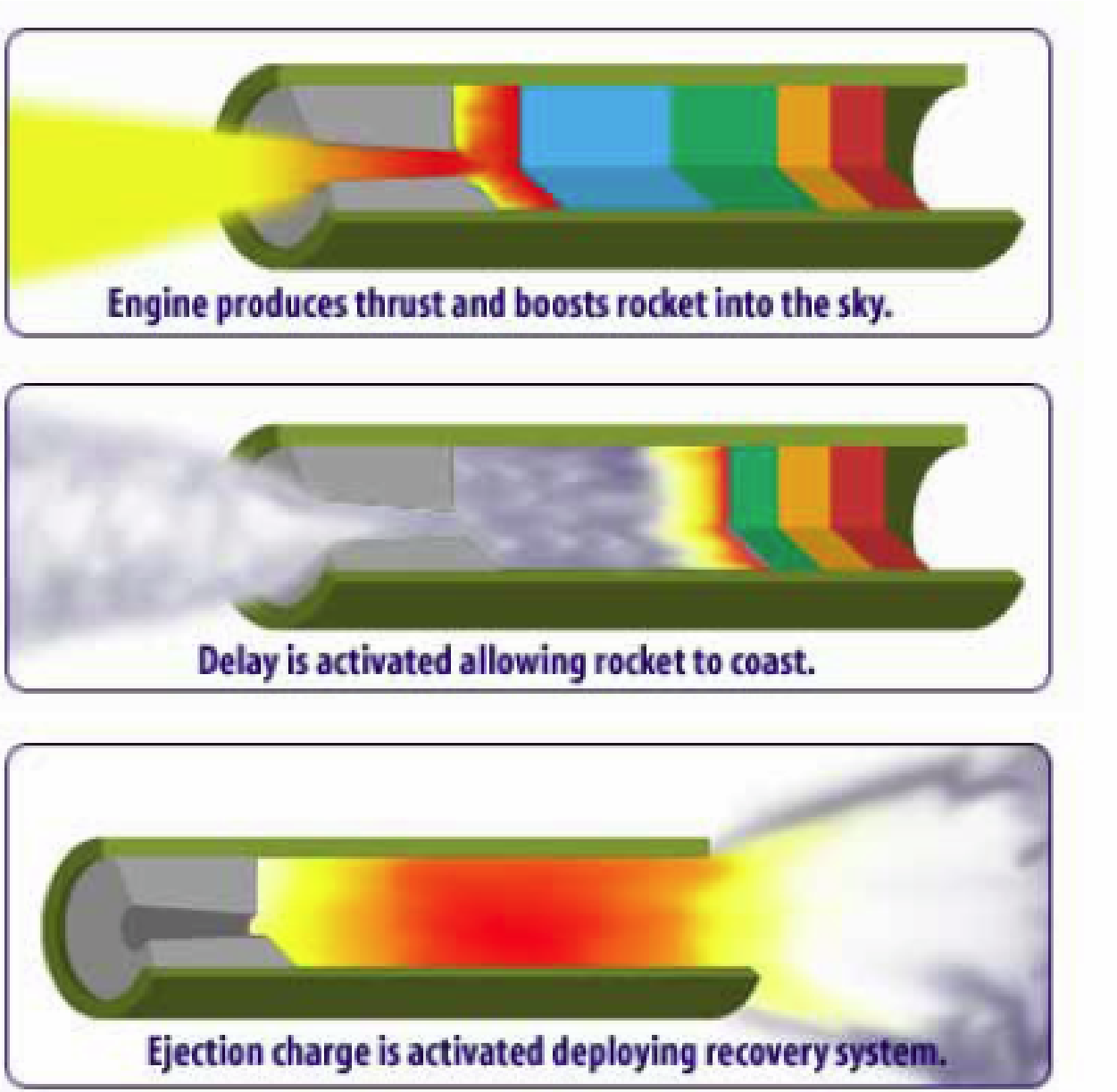


The Rocket Flies Higher When...

- The thrust is higher and lasts for longer
  - Motor has more total impulse
- The weight is low
- The drag is low
- It is stable and flies straight

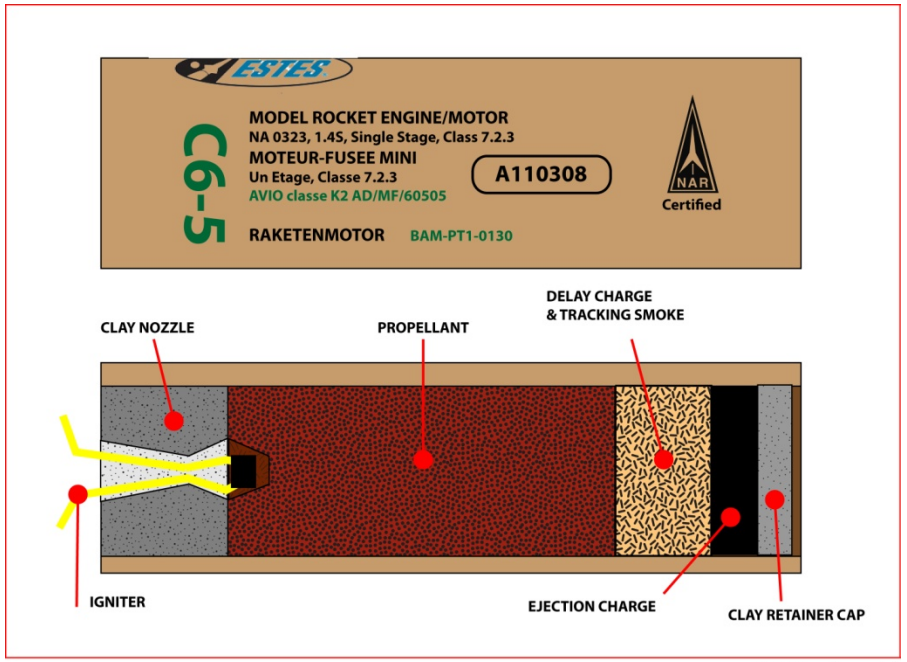


Rocket Thrust



Rocket Motors

- **A** – 2.5 N-sec
- **B** – 5 N-sec
- **C** – 10 N-sec
- **D** – 20 N-sec
- **G** – up to 160



- **B** – The letter indicates the **total impulse** (power) produced by the motor. Each letter increase represents doubling the power.
- **6** – The first number gives the **average thrust** of the motor in Newtons (a unit of force).
- **4** – The last number indicates the **delay seconds** between the end of thrust and the ejection charge.

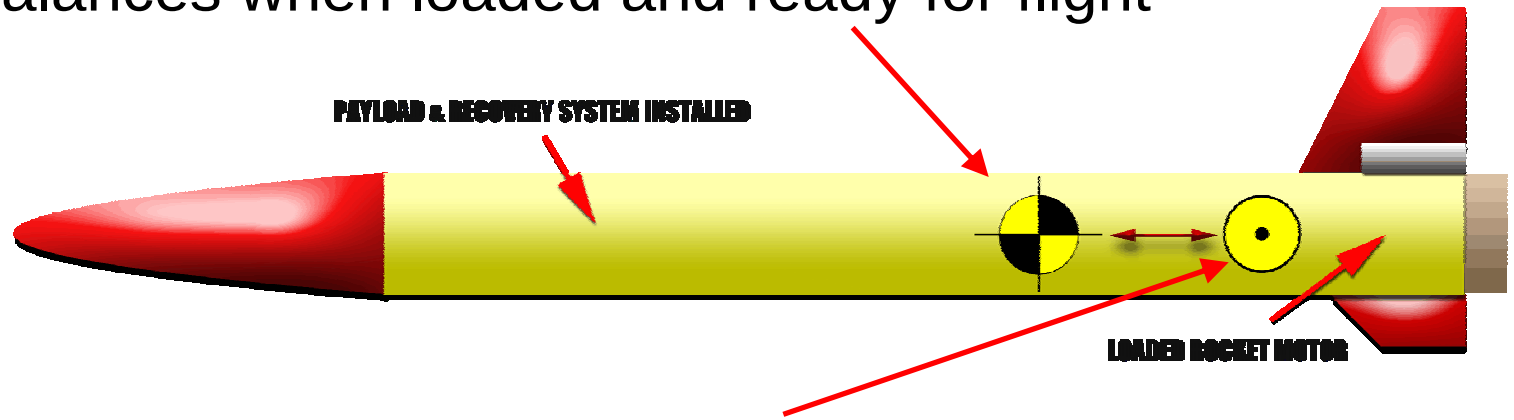
Rocket Weight

- Heavier rockets go lower with a given rocket motor than lighter rockets
- Rockets with too little motor power for their weight, or with excessively long delay times, will have bad flights

Motor Power Class	Typical Rocket Weight
1/2A	No more than 1 ounce
A	No more than 3 ounces
B	No more than 4 ounces
C	No more than 6 ounces
D	No more than 12 ounces
E	No more than 16 ounces
G	Up to 3 pounds

Rocket Stability

The **center of gravity (CG)** is where the rocket balances when loaded and ready for flight

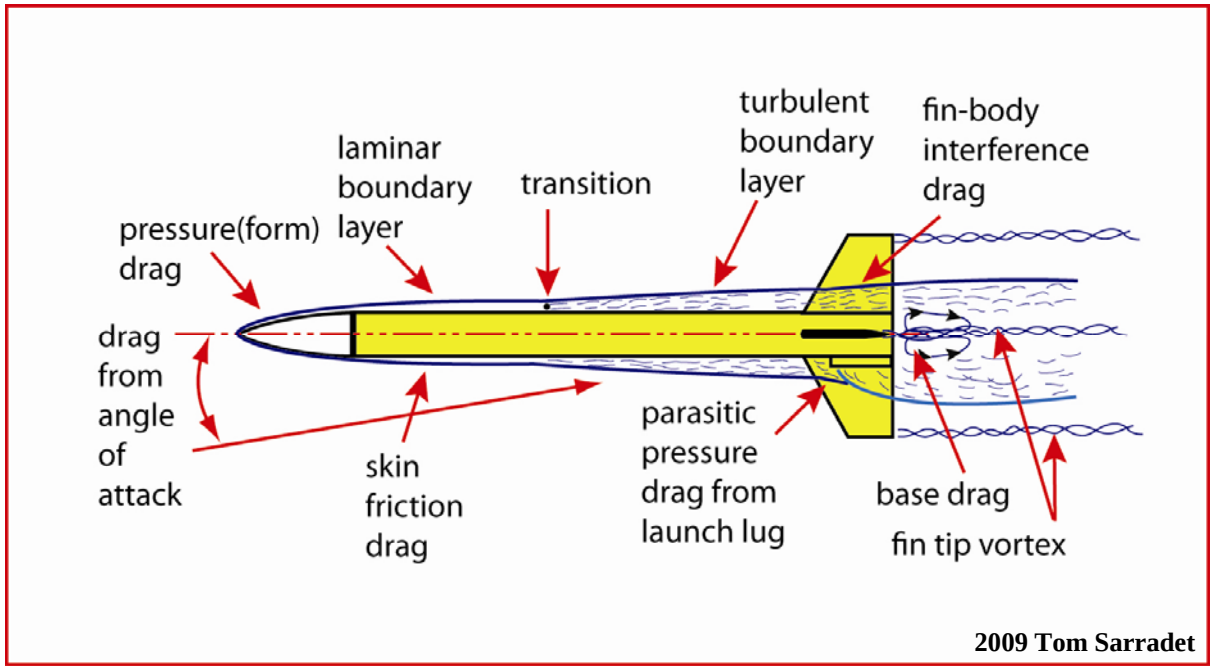


The average location of all the forces on the rocket from the passing air is called the **center of pressure (CP)**

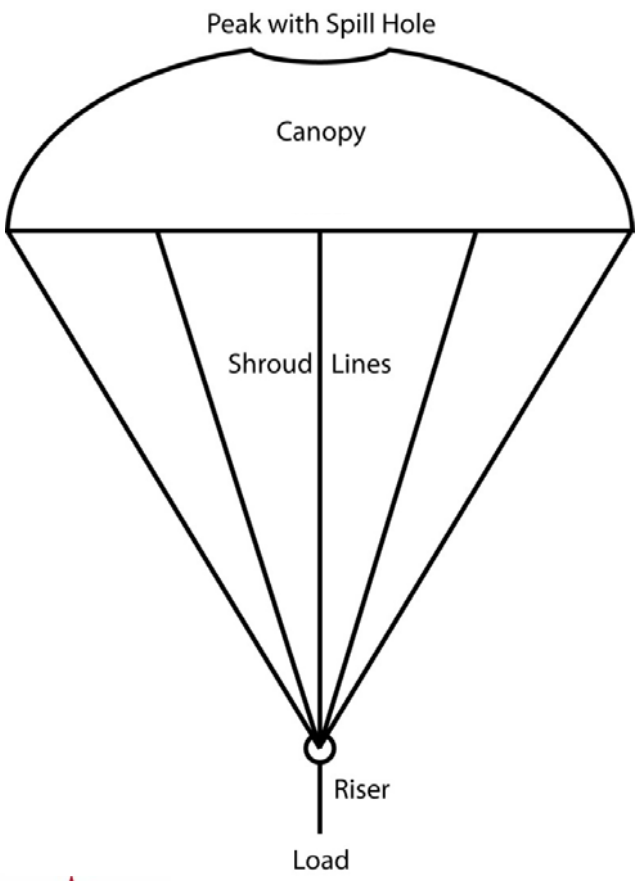
- The rocket will be stable when the CG is <u>at least</u> **one body tube diameter** in front of the CP
- To make a rocket stable use nose weight to move CG forward, or fin area to move CP back

Rocket Drag

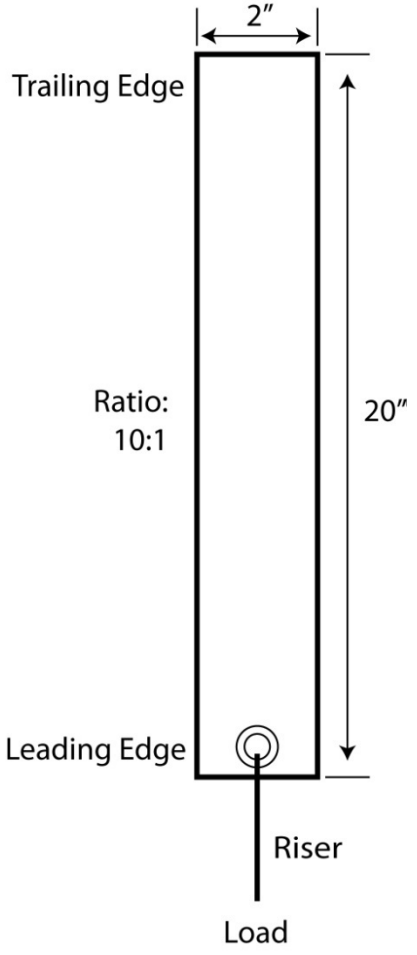
- Drag is aerodynamic friction from the flow of air over and past the surface of the moving rocket.
  - It slows the rocket down and reduces its altitude
  - It can be reduced with a smoother surface finish, smaller fins that are put on straighter, and a straight flight



Rocket Recovery



Parachute

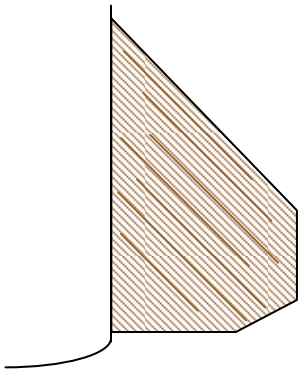


Streamer

- Rockets must have recovery devices to bring them down at safe speed
- Parachutes or streamers are usually used
- **Parachutes** are made of thin plastic; nylon cloth for heavy rockets
- **Streamers** are made of thicker plastic, or paper

Rocket Construction

- Made from paper body tubes, balsa fins, and plastic or balsa nose cones
- Building requires wood (yellow) glue, hobby (X-Acto) knives, fine sandpaper
- Wood grain and body tube spirals are filled with lightweight wood filler then sanded for surface smoothness
- Balsa wood fins must be cut with the wood grain oriented the right way
- If the fins and launch lug are glued on straight, the rocket will fly straight!



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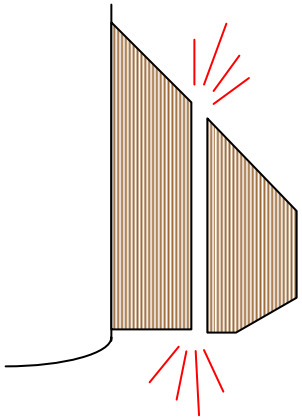
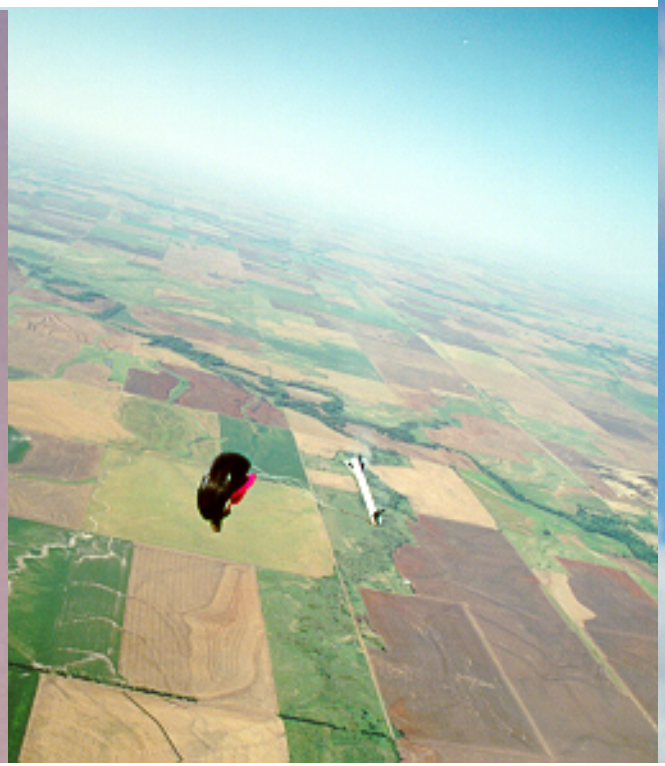


Not This...

Advanced Rocketry

- High power rockets
- Payloads
- Competition



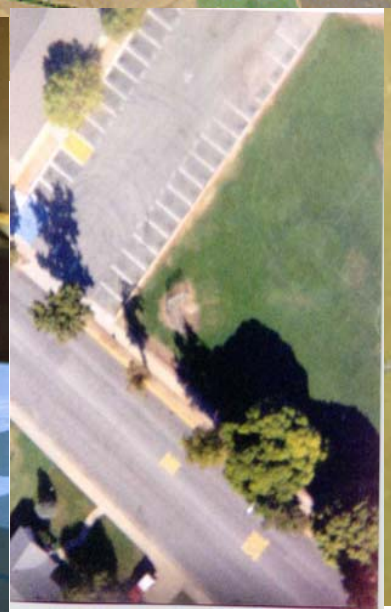
High Power Rockets

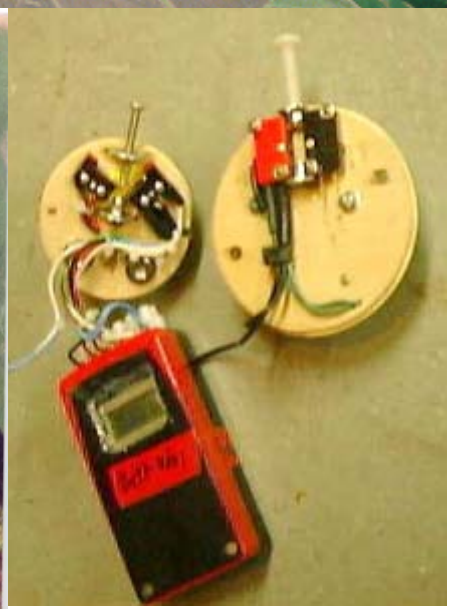
- Rockets that are over 3.3 pounds with “H” or above power class motors are called “high power”
- Requires NAR “high power user certification” and flight approval by the Federal Aviation Administration to fly
- NAR clubs provide launch sites, equipment, and insurance, and arrange FAA clearance
- These rockets are more complex and expensive
  - Fiberglass, plywood, and epoxy materials
  - Onboard flight control electronics
  - Large launchers
  - Payloads
  - Adults only

Payloads

Model or high power rockets can carry:

- Eggs
- Altimeters
- Data Recorders
- Cameras
- Video Downlinks
- RF or Audio Beacons





Competition

- NAR sponsors all US rocket competition
  - National
  - International
  - Model & high power classes
- Contests have multiple kinds of events and age divisions
- Goal is maximum performance within a given rocket power class
  - Duration (parachute, streamer, glider, helo)
  - Altitude
  - Egg-lofting
  - Scale
- Team America Rocketry Challenge
  - Annual national 7th-12th grade contest
  - $60,000 in prizes for top teams
  - See www.rocketcontest.org

National Association of Rocketry

- The oldest and largest organization for hobby rocket fliers in the world, founded in 1958
- Provides color magazine, $2M insurance, rocketry handbook, and high power certification to members
- Author of the hobby's Safety Codes
- Safety testing authority for consumer rocket engines
- Representative of the hobby to national agencies and organizations such as 4-H, FAA, and NFPA

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