# SPACE EXPLORATION

Jennifer F. Nemeth, Ph.D.
Pack 408, Troop 542
Merit Badge Counselor

Paul Schlosser
Troop 1
Merit Badge Counselor

https://blog.mendeley.com/2018/01/23/insights-into-the-national-aeronautics-and-space-administration-nasa-grant-research-funding/

# SESSION 2

# Reminders

- Website: https://troop541.com/spacex/index.html
  - If you have not done so, download the word.docx version from the website
- File format for anything you submit via the upload site on our website

# Poll:  Who was the first man on the moon?

# Poll:  What was the name of the first satellite launched into space?

Blue: Covered F2F
Green: Done on your own

# Requirements for the Space Exploration Merit Badge:

1.Tell the purpose of space exploration and include the following:
   a. Historical reasons,
   b. Immediate goals in terms of specific knowledge,
   c. Benefits related to Earth resources, technology, and new products,
   d. International relations and cooperation.

2.Design a collector's card, with a picture on the front and information on the back, about your favorite space pioneer. Share your card and discuss four other space pioneers with your counselor.

1.Build, launch, and recover a model rocket.* Make a second launch to accomplish a specific objective. (Rocket must be built to meet the safety code of the National Association of Rocketry. See the "Model Rocketry" chapter.)

Identify and explain the following rocket parts:
   a. Body tube
   b. Engine mount
   c. Fins
   d. Igniter
   e. Launch lug
   f. Nose cone
   g. Payload
   h. Recovery system
   i. Rocket engine

4.Discuss and demonstrate each of the following:
   b. The law of action-reaction
   c. How rocket engines work
   d. How satellites stay in orbit
   e. How satellite pictures of Earth and pictures of other planets are made and transmitted

5.Do TWO of the following:
   a. Discuss with your counselor a robotic space exploration mission and a historic crewed mission. Tell about each mission's major discoveries, its importance, and what was learned from it about the planets, moons, or regions of space explored.
   b. Using magazine photographs, news clippings, and electronic articles (such as from the Internet), make a scrapbook about a current planetary mission.
   c. Design a robotic mission to another planet, moon, comet, or asteroid that will return samples of its surface to Earth. Name the planet, moon, comet, or asteroid your spacecraft will visit. Show how your design will cope with the conditions of the environments of the planet, moon, comet, or asteroid.

6.Describe the purpose and operation of ONE of the following:
   a. Space shuttle or any other crewed orbital vehicle, whether government owned (U.S. or foreign) or commercial
   b. International Space Station

7.Design an inhabited base within our solar system, such as Titan, asteroids, or other locations that humans might want to explore in person. Make drawings or a model of your base. In your design, consider and plan for the following:
   a. Source of energy
   b. How it will be constructed
   c. Life-support system
   d. Purpose and function.

8.Discuss with your counselor two possible careers in space exploration that interest you. Find out the qualifications, education, and preparation required and discuss the major responsibilities of those positions.

*If local laws prohibit the launching of model rockets, do the following activity: Make a model of a NASA rocket. Explain the functions of the parts. Give the history of the rocket.

# REQUIREMENT #4: Physics of Space Exploration

4. Discuss and demonstrate each of the following:
    a. Newton's Laws of Motion
    b. How rocket engines work
    c. How satellites stay in orbit
    d. How satellite pictures of Earth and pictures of other planets are made and transmitted

# Poll:  How many laws of motion were conceived by Newton?

# Sir Isaac Newton’s Laws of Motion

**First Law:** An object in motion tends to stay in motion, and an object at rest tends to stay at rest, unless the object is acted upon by an outside unbalanced force.  Also known as “The law of inertia”

Newton's First Law of Motion - Video
By Kim Ristow

https://youtu.be/MFUkI8xD27k

4:00 min

# Sir Isacc Newton’s Laws of Motion

**Second Law:** Force equals mass times acceleration (F = m * a)


Ri{xsr+w$Wigsrh$
Pe{$sj$Q sxmsr$
F}Omg$Vmwxs{

https://youtu.be/QJTcgWTs9VE


3:00 min

# Sir Isaac Newton’s Laws of Motion

**Third Law:** For every action there is an equal and opposite reaction

Also known as “The law of action-reaction”


**Newton's Third Law of Motion**
By Kim Ristow

https://youtu.be/VHg6nSJh-ok

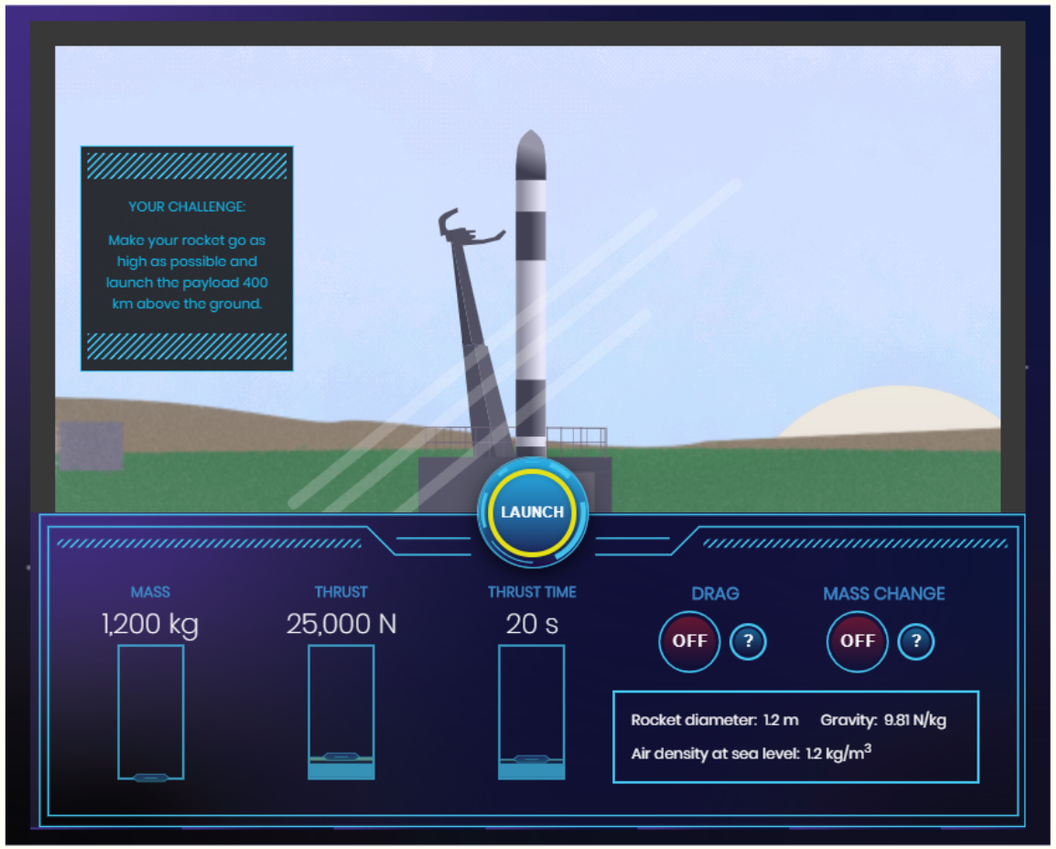
3:00 min

# POLL: READ THE EXAMPLE AND IDENTIFY NEWTON'S LAW

# Sir Isacc Newton’s Laws of Motion

**Third Law:** For every action there is an equal and opposite reaction

Also known as “The law of action-reaction”




https://www.sciencelearn.org.nz/embeds/132-rocket-launch-challenge

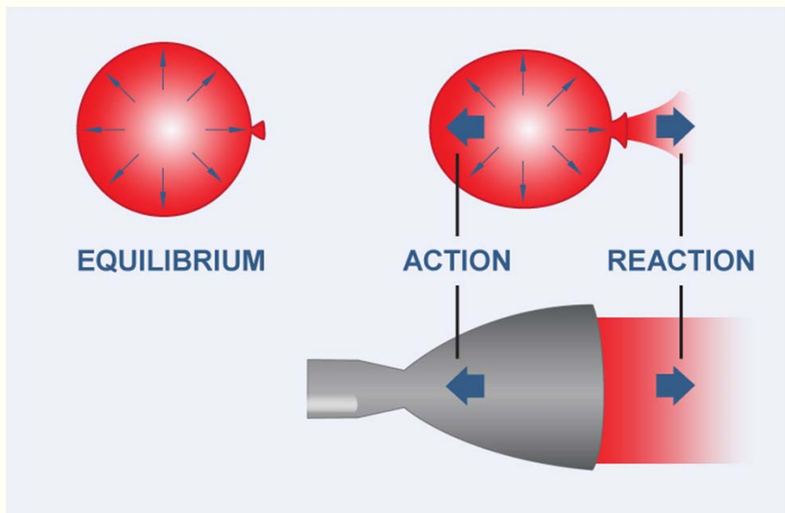
Activity: 10 min

# REQUIREMENT #4: Physics of Space Exploration

4. Discuss and demonstrate each of the following:
    a. Newton's Laws of Motion
    b. How rocket engines work
    c. How satellites stay in orbit
    d. How satellite pictures of Earth and pictures of other planets are made and transmitted

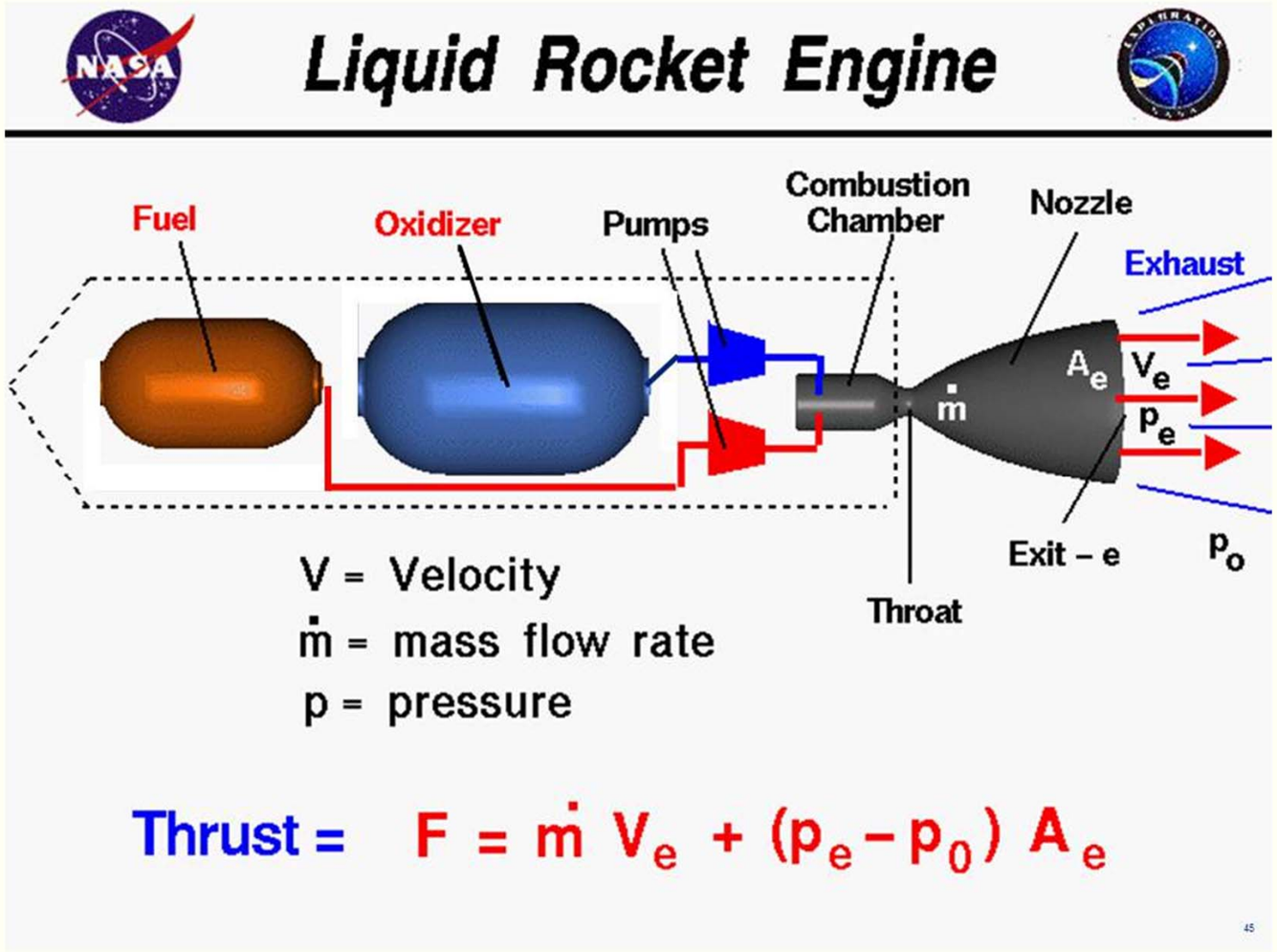
# How rocket engines work

- Rockets work much like a balloon filled with air.
  - If you fill a balloon with air and hold the neck closed…nothing happens…the gas stays in and the balloon does not move
  - If you release the neck of the balloon, the gas shoots out and the balloon takes off, until it runs out of gas.
- What does a rocket engine need:
  - Fuel and oxidizer
  - Mixing chamber
  - Generation of gas at high pressure and temperature
  - Nozzle
- Two types of rocket engines
  - Liquid Rocket Engines
  - Solid Rocket Engines



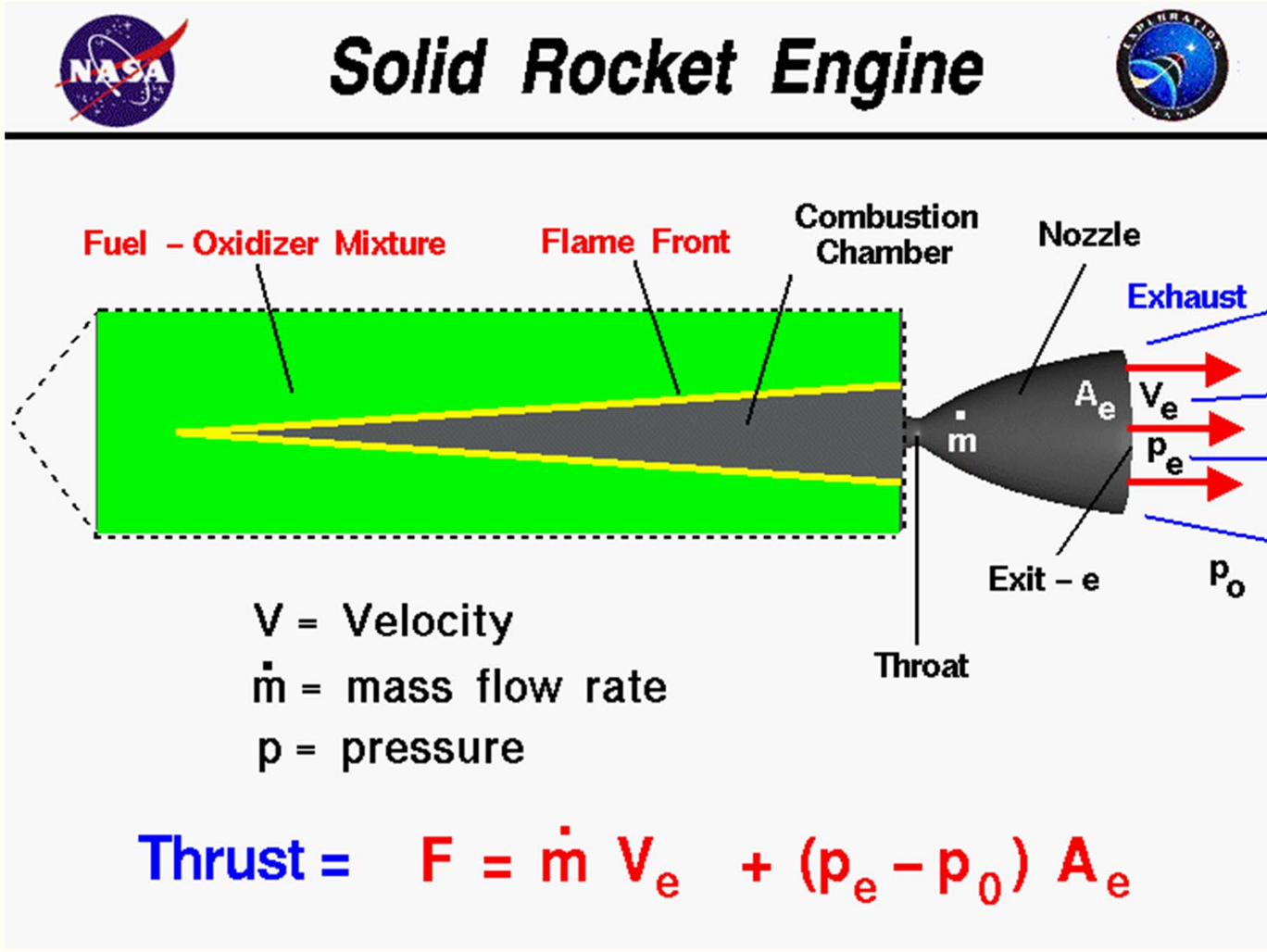

https://howthingsfly.si.edu/propulsion/rocket-propulsion

- **Liquid rocket engines**
  - Space Shuttle, SpaceX rockets
  - Many un-manned missiles to place satellites in orbit
  - Several high-speed research aircraft following World War II
- In a liquid rocket, stored **fuel and oxidizer** are pumped into a **combustion chamber** where they are mixed and burned.
- The combustion produces great amounts of exhaust gas at **high temperature and pressure**.
- The hot exhaust is passed through a **nozzle** which accelerates the flow.
- **Thrust** is then produced according to **Newton's third law of motion**.




https://www.grc.nasa.gov/www/k-12/rocket/lrockth.html

- **Solid rocket engines**
  - Air-to-air and air-to-ground missiles
  - Model rockets
  - Boosters for satellite launchers
- The **fuel and oxidizer** are mixed into a **solid propellant** and packed into a cylinder.
- A hole through the cylinder serves as a **combustion chamber**. When the mixture is ignited, combustion takes place on the surface of the propellant.
- A **flame front** is generated which burns into the mixture, combusts, and produces great amounts of exhaust gas at **high temperature and pressure**.
- The hot exhaust gas is passed through a **nozzle** which accelerates the flow.
- **Thrust** is then produced according to **Newton's third law of motion**.




https://www.grc.nasa.gov/www/k-12/rocket/srockth.html

# How rocket engines work


https://youtu.be/rt5dcrm8X1w

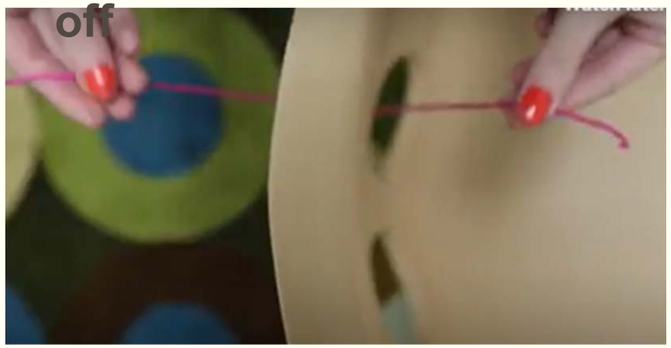
# Poll:  What are the critical components for a functioning rocket engine?

# Make a balloon rocket

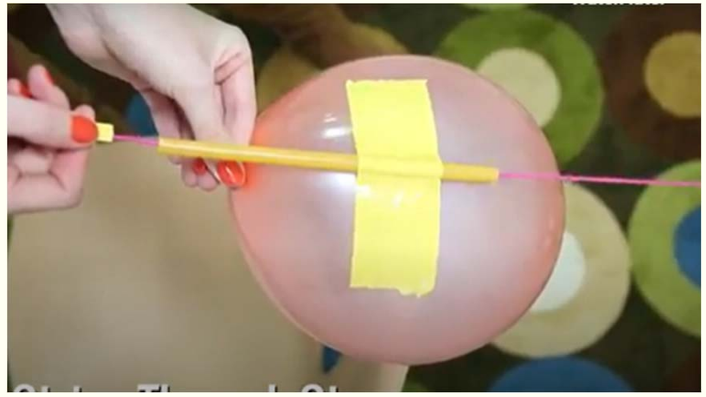
- What you need:
  - 1 balloon (uninflated)
  - 1 straw or other hollow tube
  - 1 piece of string ~ 6-10 feet long
  - One chair (that you can tie your string to)
  - Tape (packaging, duct)

- Directions
  - Tie your string to 1 of the chairs
  - Blow up your balloon but DO NOT knot it
  - Tape the straw to the balloon
  - Thread the other end of the string through the straw
  - Hold the string tight and let go of the balloon

**Step 1: Tie your string off**



**Step 2: Blow up balloon**
**Step 3: Tape straw to balloon**



**Step 4: Thread string through straw**

**Step 5: Launch**

Activity: 10 min

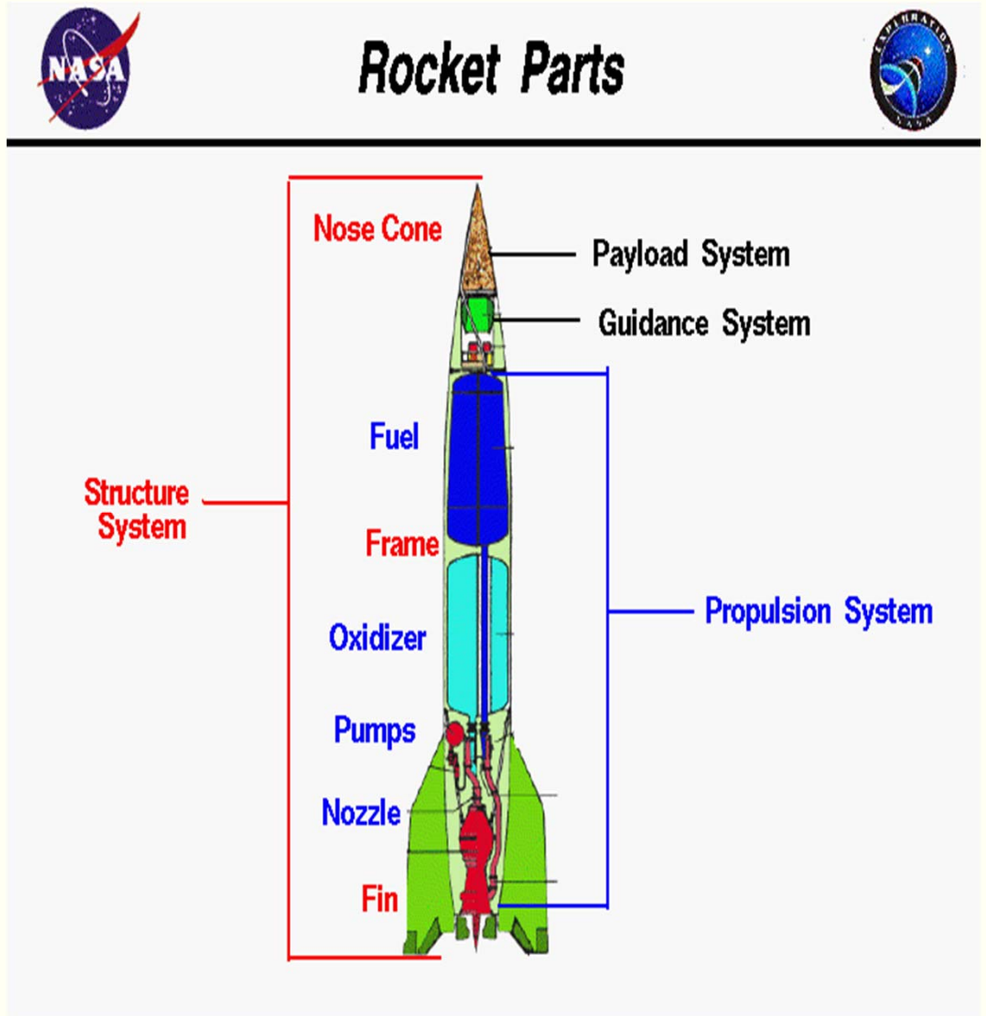
# Parts of a real rocket

a) **Nose cone** is attached at the top of the rocket, is tapered to cut through the air with minimal drag, and are typically attached to the rocket body tube by an elastic shock cord; when the rocket engine fires its ejection charge the shock cord keeps the nose cone with the rocket.

b) **Payload** depends on the rocket's mission. Examples include satellites, supplies for the international space station, repair equipment, scientific observatories (Hubble Telescope).

c) **Guidance System** of a rocket includes very sophisticated sensors, on-board computers, radars, and communication equipment to maneuver the rocket in flight. The guidance system must also provide some level of stability so that the rocket does not tumble in flight.

d) **Frame (Body tube)** is like the fuselage of an airplane. It is made from very strong, light weight materials, like titanium or aluminum, and usually employs long "stringers" which run from the top to the bottom which are connected to "hoops" which run around the circumference. The "skin" is then attached to the stringers and hoops to form the basic shape of the rocket. The skin may be coated with a thermal protection system to keep out the heat of air friction during flight and to keep in the cold temperatures needed for certain fuels and oxidizers.

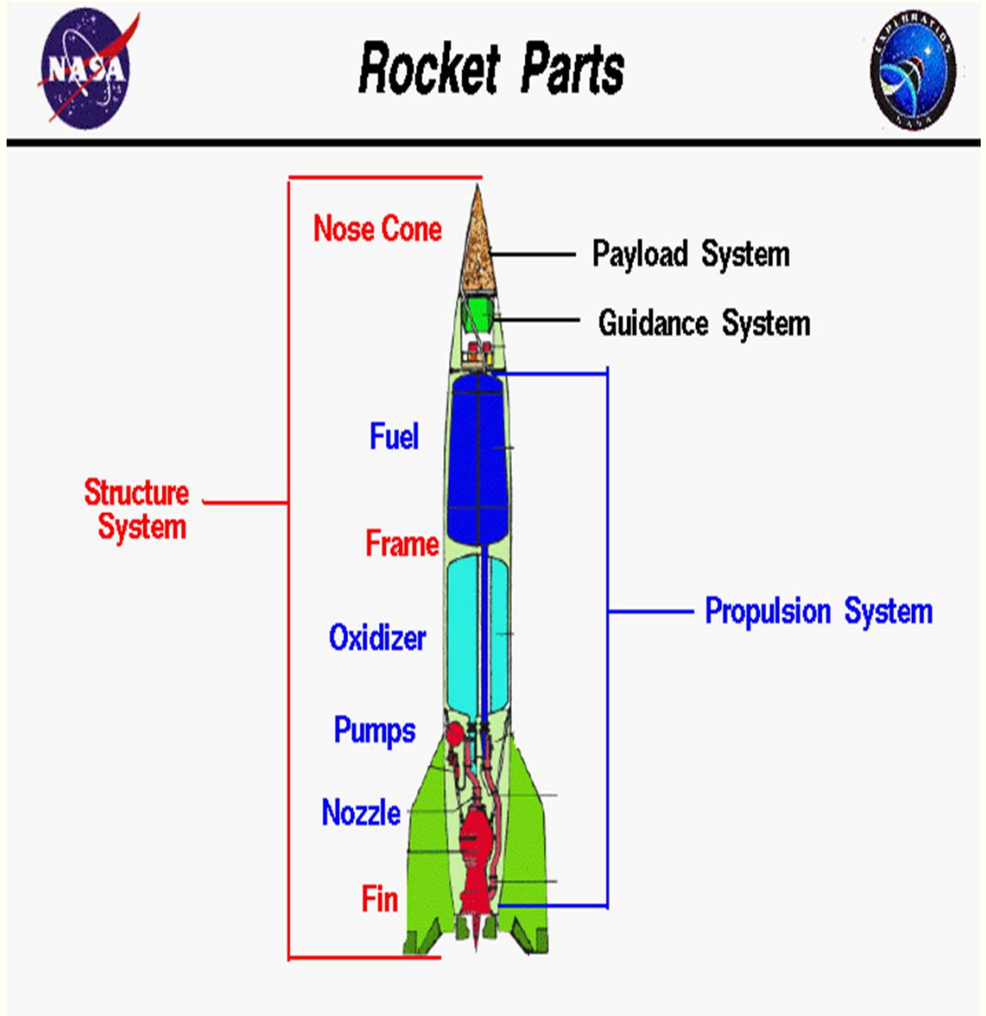



https://www.grc.nasa.gov/www/k-12/rocket/rockpart.html

# Parts of a real rocket designed for space flight

Identify and explain the following rocket parts:

a) **Fuels:** Refined kerosene, called RP-1, Liquid hydrogen
b) **Oxidizer:** Liquid oxygen (LOX), nitric acid, nitrogen tetroxide, and liquid fluorine
c) **Pumps**
d) **Nozzle** is used to expand and accelerate the combustion gases produced by burning propellants so that the exhaust gases exit the nozzle at hypersonic velocities
e) **Fins** are used for aerodynamic stability of the rocket. The fins are typically done in sets of three (the minimum required for stability) or four. The fins are placed on the body tube as close to the end with the rocket engine as possible, and often extend below the bottom of the body tube.




https://www.grc.nasa.gov/www/k-12/rocket/rockpart.html

# Space Shuttle Discovery Launch

https://youtu.be/OnoNITE-CLc



4:00 min

# REQUIREMENT #3, Option 1: Build and Launch a Model Rocket

- Build, launch, and recover a model rocket.*
- Make a second launch to accomplish a specific objective.
  - Ex) landing the rocket in a specific location/radius or launching a payload and recovering it safely



You will need to submit a video of your two launches

**Rocket construction is to be done on your own**
**We are working to arrange an organized launch**

# Parts of a model rocket

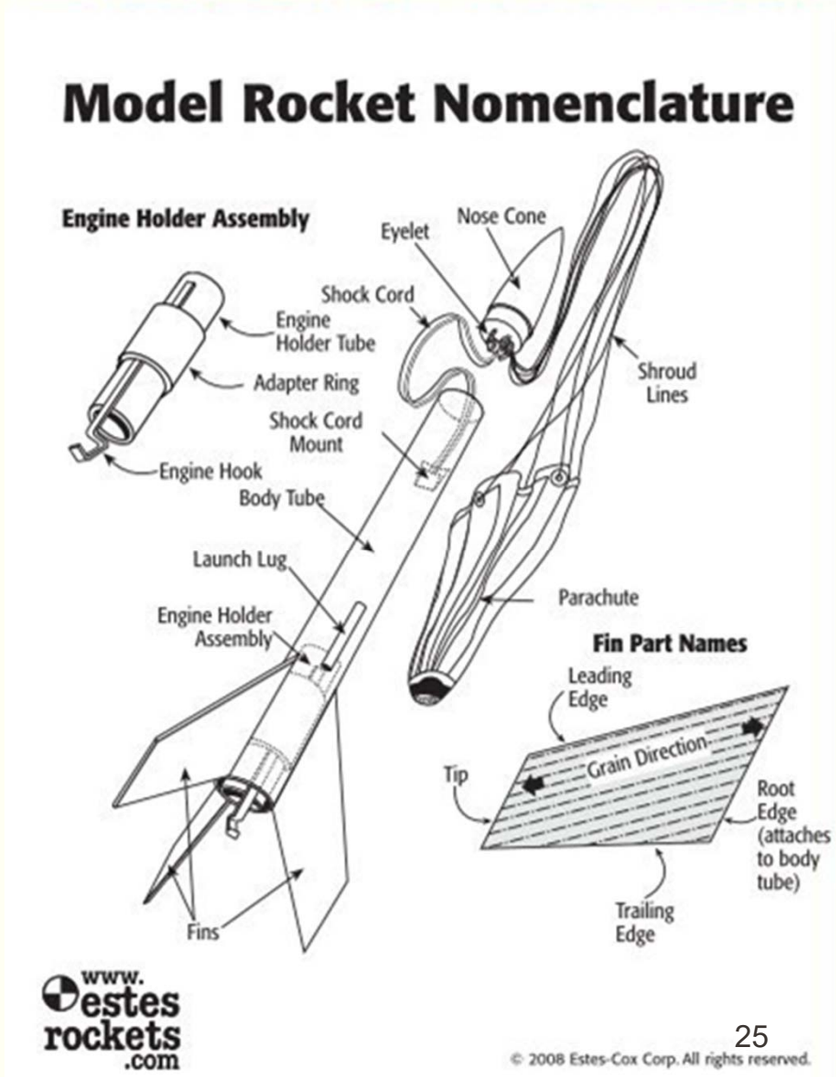
a) **Body tube** refers to the main cylindrical body of a rocket. Body tubes are typically made from lightweight wound cardboard tubing to keep the weight of the rocket down, since weight is the major factor limiting flight height.

b) **Nose cone** is attached at the top of the rocket, is tapered to cut through the air with minimal drag, and are typically attached to the rocket body tube by an elastic shock cord; when the rocket engine fires its ejection charge the shock cord keeps the nose cone with the rocket.

c) **Fins** are used for aerodynamic stability of the rocket. The fins are typically done in sets of three (the minimum required for stability) or four. The fins are placed on the body tube as close to the end with the rocket engine as possible, and often extend below the bottom of the body tube.

d) **Launch lug** is attached to the body tube near the center of gravity for the rocket.

e) **Payload** is the cargo that is launching with the rocket (optional).



# Parts of a model rocket

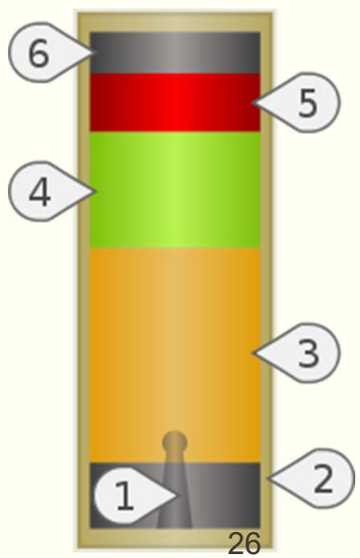
a) **Engine mount** is the portion of the model rocket that houses the engine. This can range from a simple engine hook to a full engine mount kit.
   a) The engine tube which houses the engine.
   b) The engine hook keeps the engine in place.

b) **Rocket engine** is an example of a solid rocket engine and consists of the motor casing, used to hold the engine together; the solid propellent which provides the thrust through the nozzle; and a delay mechanism which is used to time the ignition of the ejection charge to deploy the recovery system.

a) **Igniter** are small wires inserted into the nozzle of the rocket engine and are used to deliver an electrical charge to ignite the engine.

a) **Recovery system** is typically a parachute or streamer attached to the nose cone. When the nose cone is ejected, it pulls the recovery system out of the rocket to allow it to deploy. The nose cone must fit into the rocket tube body rather loosely or the recovery system will not deploy.

**Rocket Engine**
1 : Nozzle
2 : Casing
3 : Propellant
4 : Delay Charge
5 : Ejection Charge
6 : End Cap



# How to prepare and launch a model rocket

https://youtu.be/-6WnAY9Qego


8:00 min

# Rocket Launch Safety Code

- MODEL ROCKET SAFETY CODE
- EFFECTIVE AUGUST 2012

- **Materials.** I will use only lightweight, non-metal parts for the nose, body, and fins of my rocket.
- **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.
- **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.
- **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.
- **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. When conducting a simultaneous launch of more than ten rockets I will observe a safe distance of 1.5 times the maximum expected altitude of any launched rocket.
- **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.
- **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.
- **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.
- **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.
- **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.
- **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places.


Adobe Acrobat Document

Revision of August 2012.

https://www.nar.org/safety-information/model-rocket-safety-code/

# REQUIREMENT #3, Option 2: Build a Historical Rocket

- Do one of the following: (1) Build a historical model rocket (purchased or built with materials at home) or (2) draw and color a historical rocket.
- Explain the function of the main parts of the rocket.
- Give the history of the rocket.

Saturn V


Mercury Redstone

Space Shuttle with Rocket Boosters


Titan III

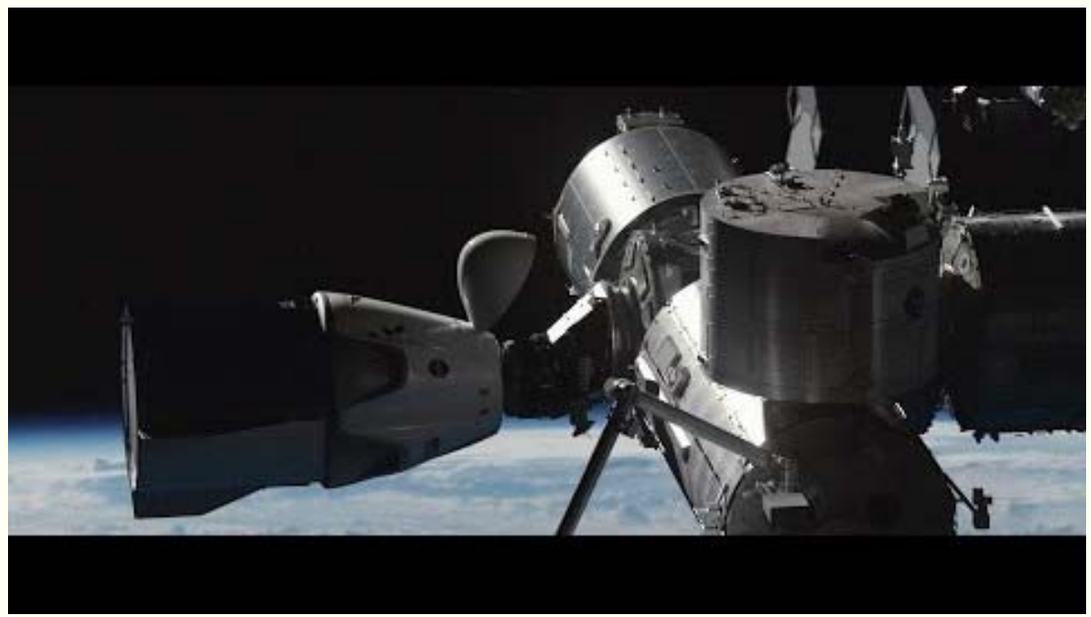
- **Rocket construction and write-up is to be done on your own. Provide photos of your construction.**
- **Submit write-ups for credit.**

# SpaceX Manned Launch Schedule for May 27, 2020

- SpaceX and NASA are targeting May 27 for Falcon 9's launch of Crew Dragon's second demonstration mission (Demo-2)
  - NASA astronauts Bob Behnken and Doug Hurley will be the first two NASA astronauts to fly onboard the Dragon spacecraft as part of the Demo-2 mission
  - They will go to and from the International Space Station
  - This mission will return human spaceflight to the United States since the Space Shuttle Program was retired in 2011.

Our Next Meeting is May 27

- Zoom Meeting will start at 4 PM
- Launch is planned for 4:34



https://www.spacex.com/news/2020/04/17/crew-demo-2-mission

# DESIGN YOUR MANNED BASE

Break-out sessions

# Design Teams & Objectives

**Eagle 14**

- Joseph Raggi
- Charlie Morris
- Henry Hunsicker
- Lance Yang
- Caleb Martin
- Liam MacIntyre

**Moderators**
Schlosser
Gregg

**Project Supernova**

- Austin Graffam
- Kevin Derr
- Gavin Fountain
- Colin Pennington
- Tyler Pennington

**Moderators**
Fountain
Pennington

**Spatius Explorationis**

- Robert Raggi
- Michael Cooper
- Jonah Gallagher
- Kiran Mahnkopf

**Moderators**
Myers
Cooper

**Space Scouts**

- Jacob Christ
- Connor Seay
- Joshua Spaar
- Gabriel Eastman
- Dylan Nemeth

**Moderators**
Nemeth-Seay
Christ

## Goals for today's Break-Out

- Select one of the four **destinations** for your manned base
- **Review** the destination info sheet for your selected destination
- Determine the **purpose** of your manned base
- Start Base design in the PPT file