Space Exploration

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How Do We Explore Space?

Human

Apollo 12

Shuttle

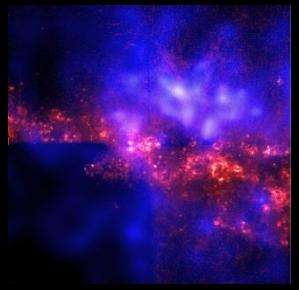
ISS

Mars

Robotic

Deep Space

Hubble



Chandra

Kepler

Up Close

Galileo

Curiosity

OSIRIS-REx

From Earth

VERITAS Cosmic Radiation

Particles

LIGO Gravitational Waves

Waves

Chile Observatory

Optical

Why Explore Space?

Newrange Passage Tomb may be the first structure with known astronomical significance. It was built around 3,200 B.C. in Ireland. It's central passage allows light end-to-end for about 2 weeks around winter solstice.

Citation: Corel Photography and Windows to the Universe

The Sun, Moon, Planets, and Stars held significance in early times due to the seasons, significance for food crops, and mythology.

The Greek may be among the first to pursue analytical interpretations of what they saw in the sky. In about 280 B.C. *Aristarchus* suggested Earth revolves around the Sun and estimated the distance between. Around 130 B.C. *Hipparchus* developed the first accurate star map.

By Raphael - Personal gift, Public Domain, https://commons.wikimedia.org/w/index.php?curid=44583579

Today still seek to understand how the universe formed and how we came to be & are we alone?

Today's NASA Goals for Space Exploration: *Inward Looking*

- Understanding the causes and consequences of climate change using advanced space missions with major Earth science and applications research.
- Fire the public imagination and inspire students to pursue STEM fields. Train college and graduate students to create a U.S. technical workforce with employees that embody the values of competence, innovation, and service.
- Drive the technical innovations that enable exploration and become the engine of National economic growth.
- Partner domestically and internationally to leverage resources to extend the reach of research.

Today's NASA Goals for Space Exploration: *Outward Looking*

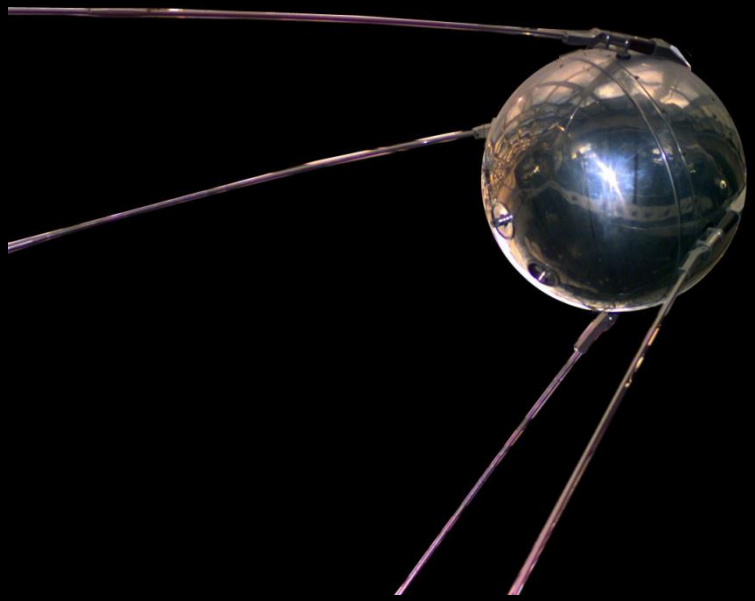
- This is NASA's science vision: using the vantage point of space to achieve, with the science community and our partners, a deep scientific understanding of our planet, other planets and solar system bodies, the interplanetary environment, the Sun and its effects on the solar system, and the universe beyond.
- Utilize ISS for: basic research; proving new insights into problems affecting people on the Earth; and understand and develop the systems and protocols necessary for humans to venture beyond low Earth orbit for extended durations.
- Send humans to Mars through a series of technology and experience building steps that will sustain future and deeper space exploration.

A Brief History of Rockets

- 300 B.C.E. Archytas the Greek flew model pigeon propelled by water vapor
- 100 C.E. Chinese filled hollow pieces of bamboo with gunpowder
- 1232 Chinese used rockets as weapons
- 1898 Konstantin Tsiolkovsky proposed idea of exploring space using rockets
- 1903 Tsiolkovsky published *Exploration of the Universe with Rocket Propelled Vehicles;* Wernher von Braun read Tsiolkovsky
- 1926 Robert Goddard successfully launched a **liquid-fueled** rocket
- 1940s Wernher von Braun used the V-2 rocket in warfare against England

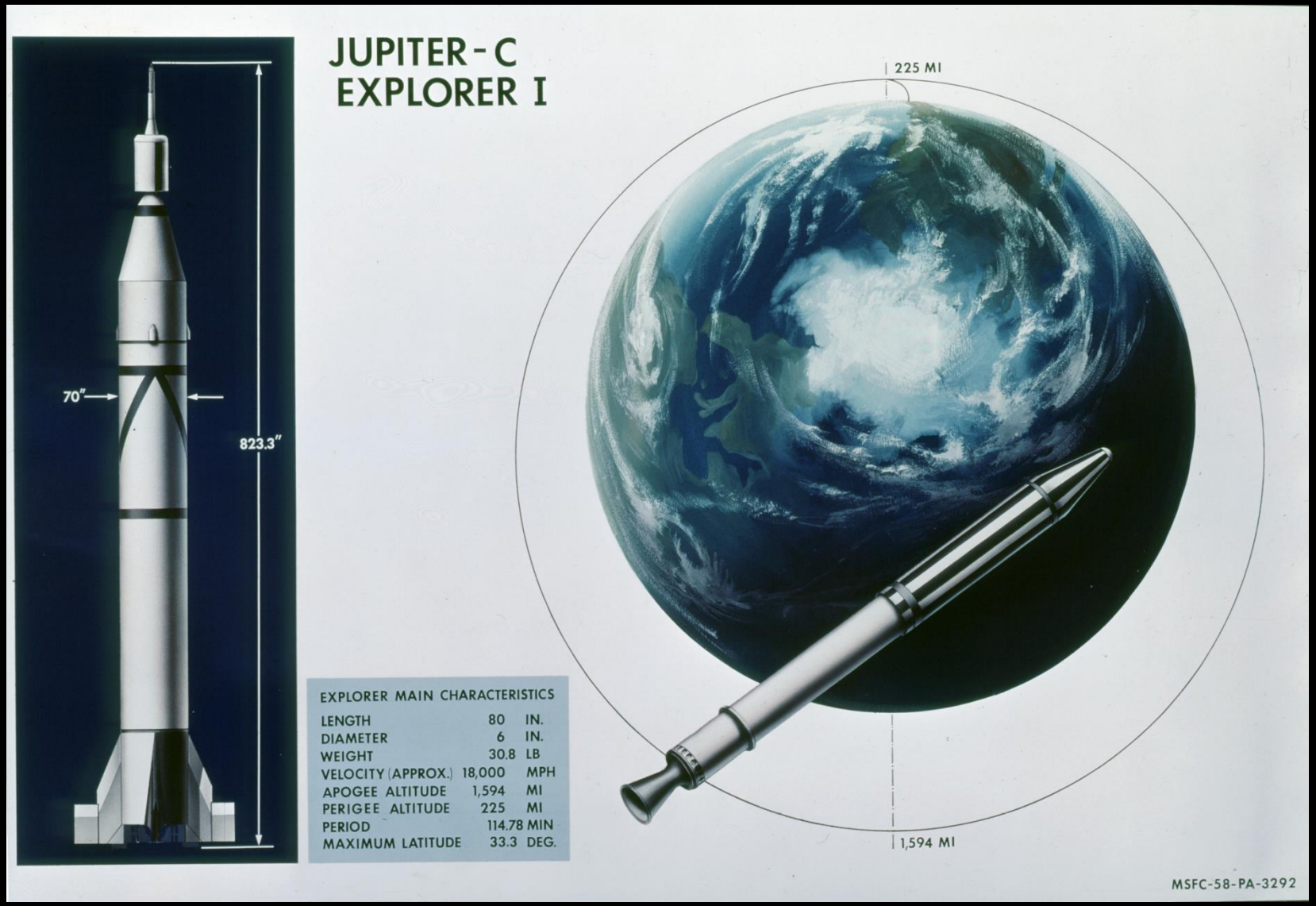
A Brief History -- Continued

- October 4, 1957 -- Sputnik I launched, 83.6 kg (I am about 50 kg)

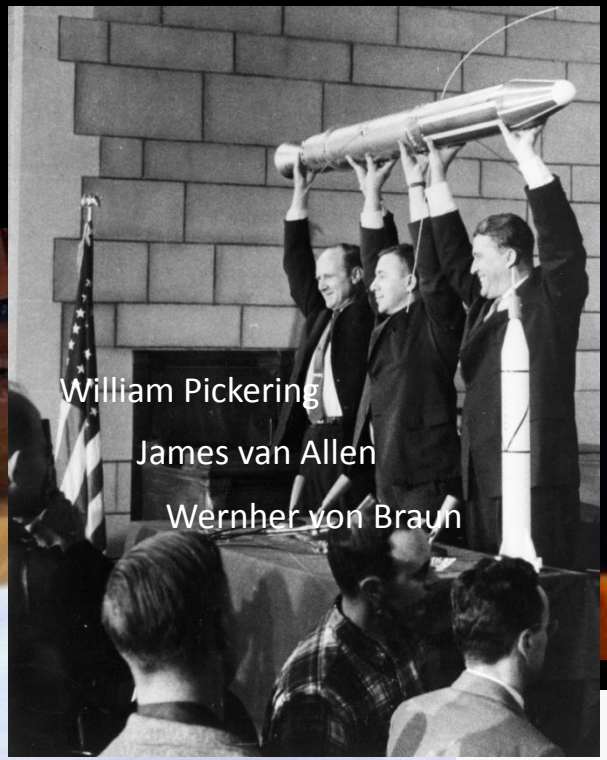


- Scientific Purpose: Measure atmospheric density and propagation of radio waves in ionosphere

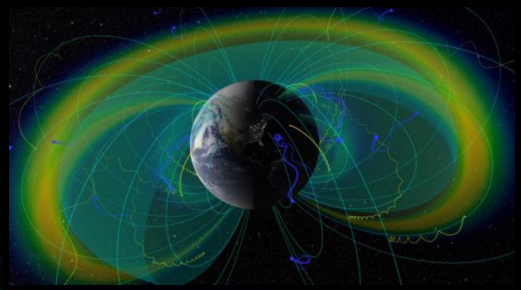
The U.S. Responds to Sputnik
Launches Explorer I on January 22, 1958

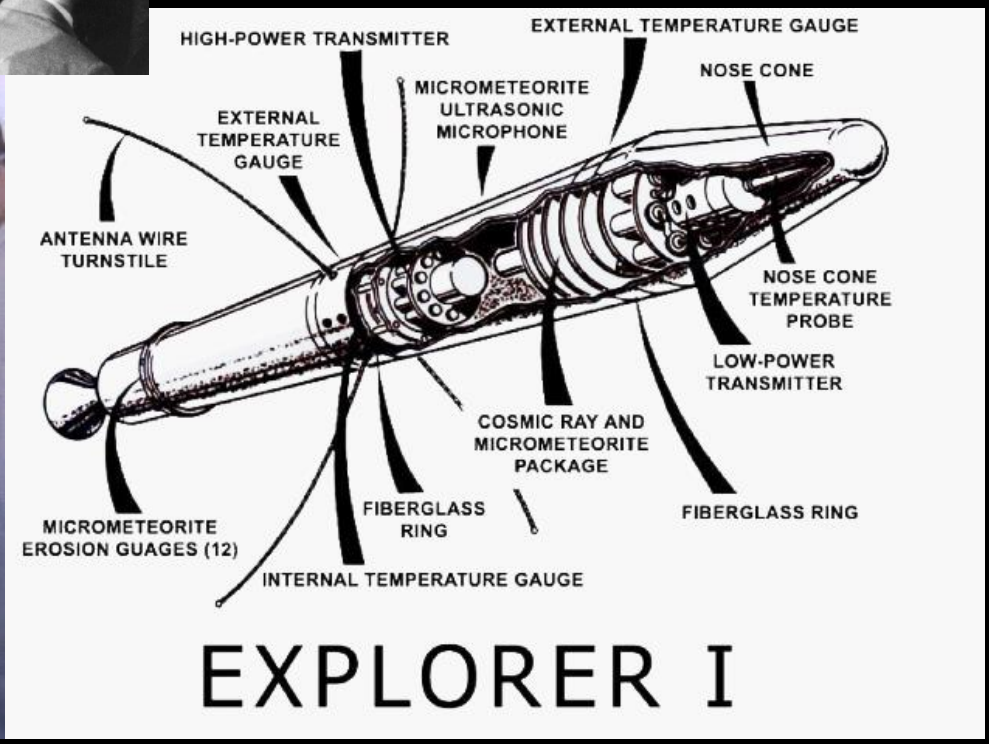


Explorer 1 (continued)



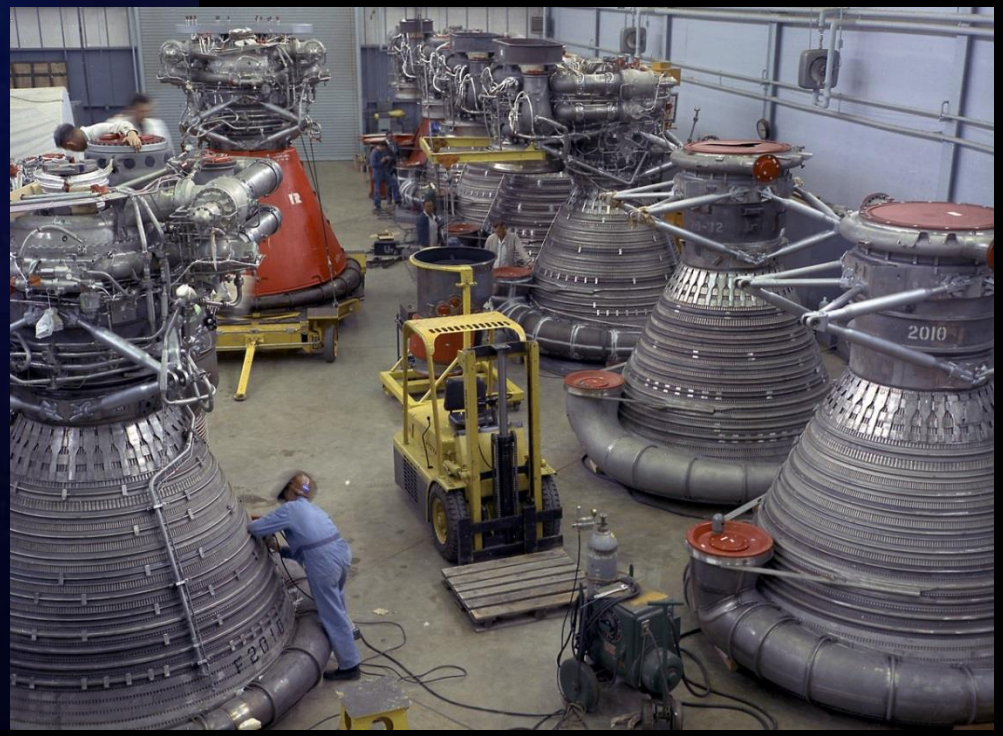
Discovery: Van Allen Radiation Belts



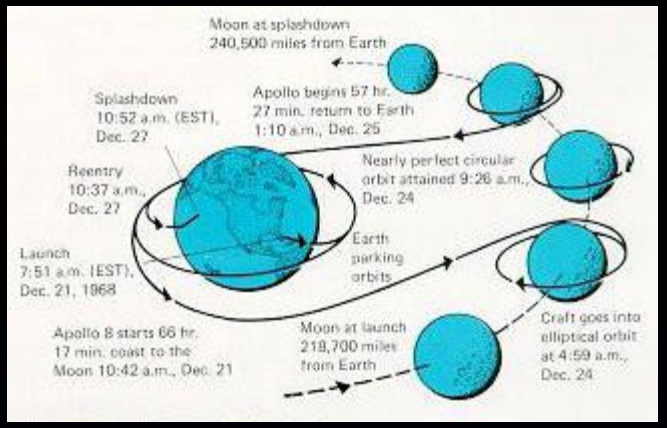


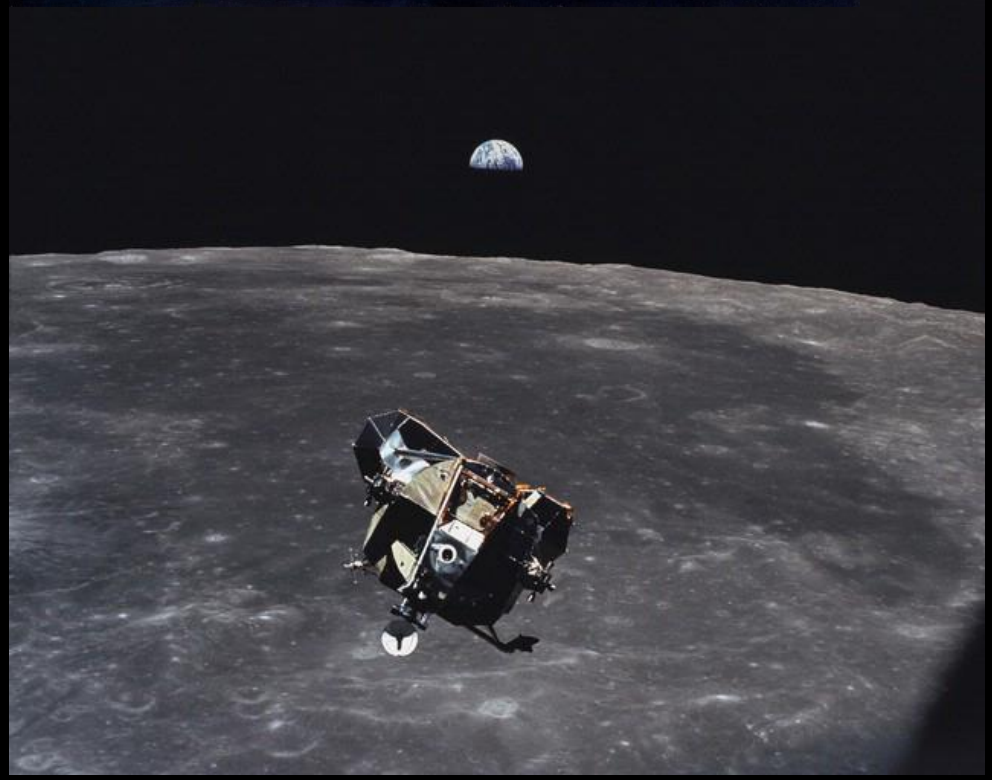
From the Explorer Science Missions to the Moon!

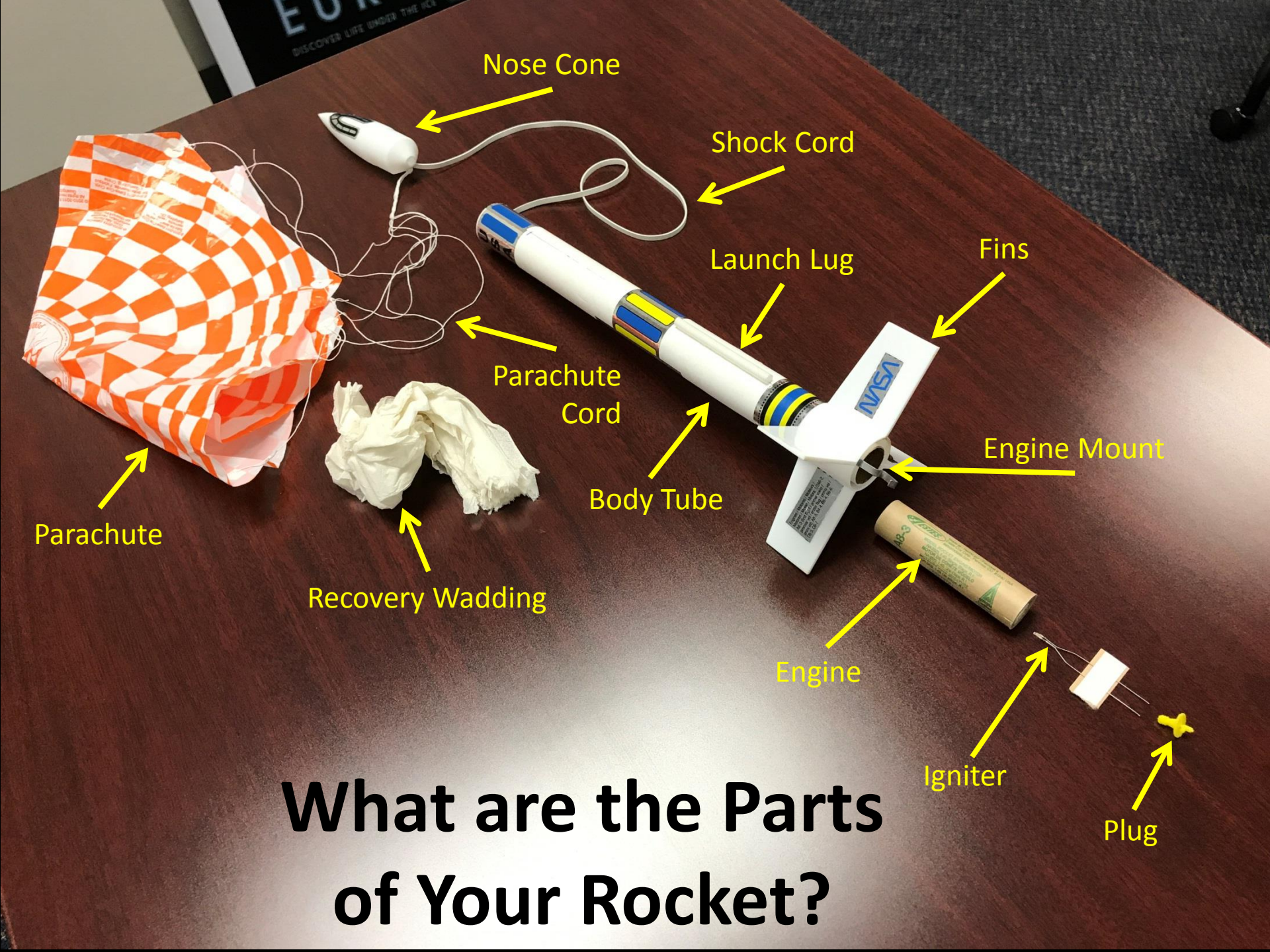
- 111 meters (363 Feet) Tall
- Five F1 engines (first stage)
- First stage lifted the vehicle to 68 km (48 mi)
- Generated 34.5 million N (7.6 million lbs) thrust
- Second stage carried it almost to orbit
- Third stage boosted to orbit and onto Moon
- Apollo 8-10 tested systems
- Apollo 11, 12, 14-17 landed on Moon



Gettng there and back is complicated.






Nose Cone
Shock Cord
Launch Lug
Fins
Parachute Cord
Engine Mount
Body Tube
Parachute
Recovery Wadding
Engine
Igniter
Plug
What are the Parts of Your Rocket?

Newton's Laws of Motion

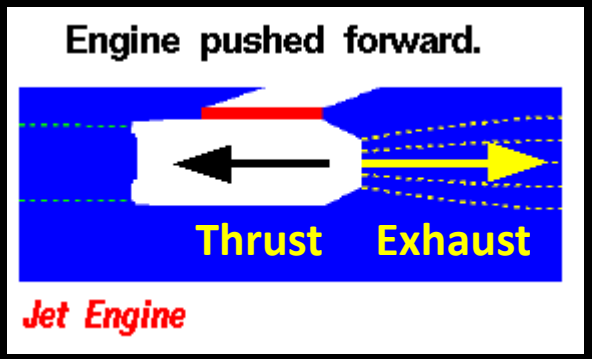
1690 Sir Isaac Newton composed the three laws of physics that quantify how and why rockets work.

1) An object in motion will stay in motion unless acted on by an unbalanced force. An object at rest will stay at rest unless acted on by an unbalanced force. Law of Inertia
2) Acceleration is produced when a force acts on a mass. a=F/m
3) For every action there is an equal and opposite reaction.

1

2

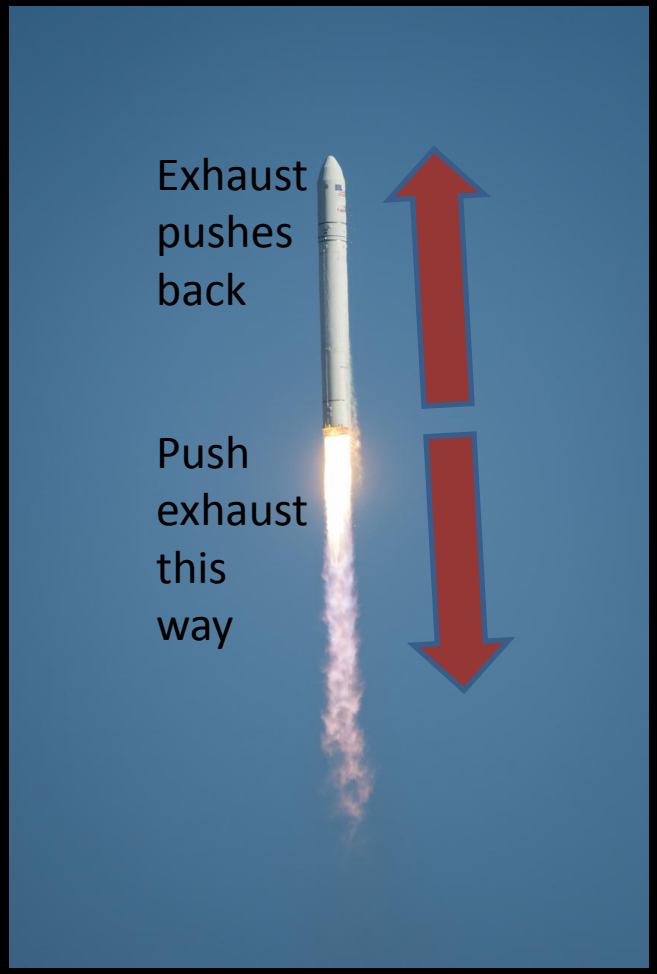
3

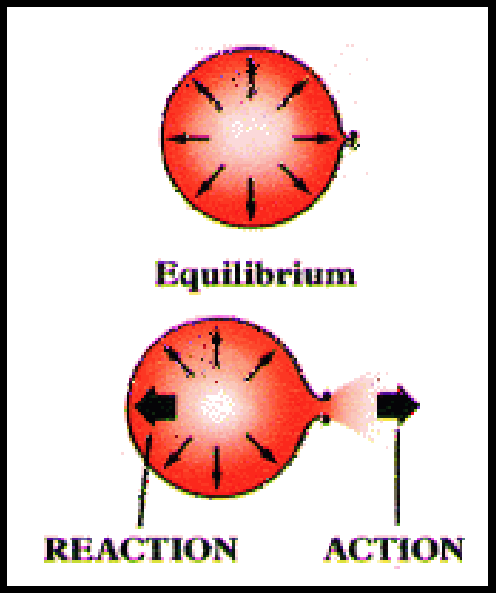


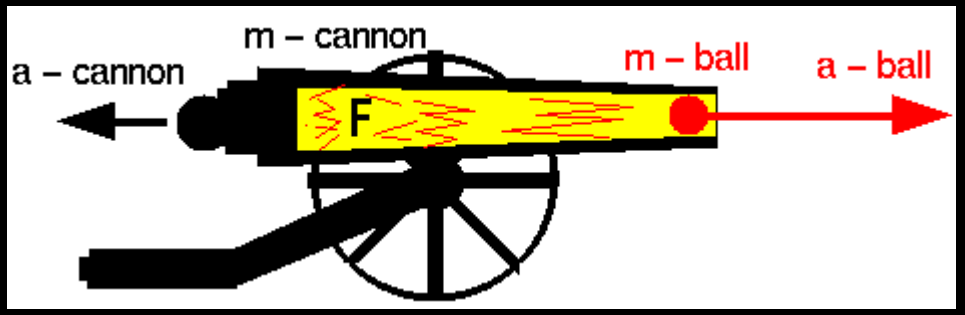
How Do Rockets Work?

Rockets use Newton's Third law of motion:

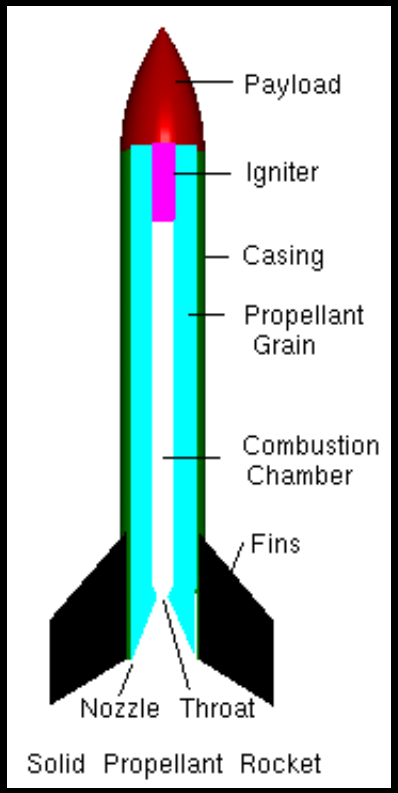
When one body exerts a force on a second body, the second body exerts a force equal in magnitude and opposite in direction on the first body.







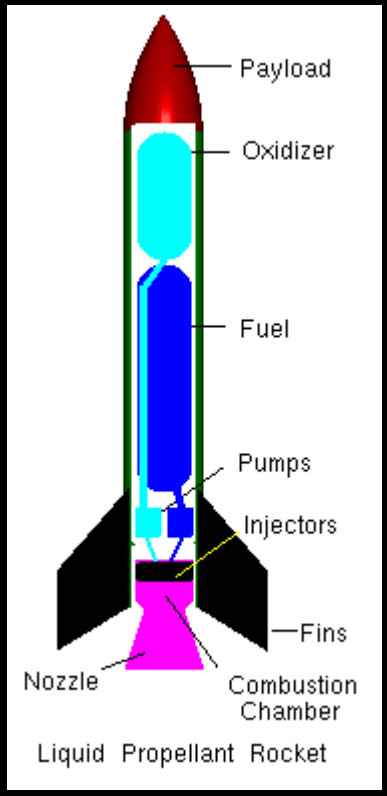
How Do Rocket Engines Work?



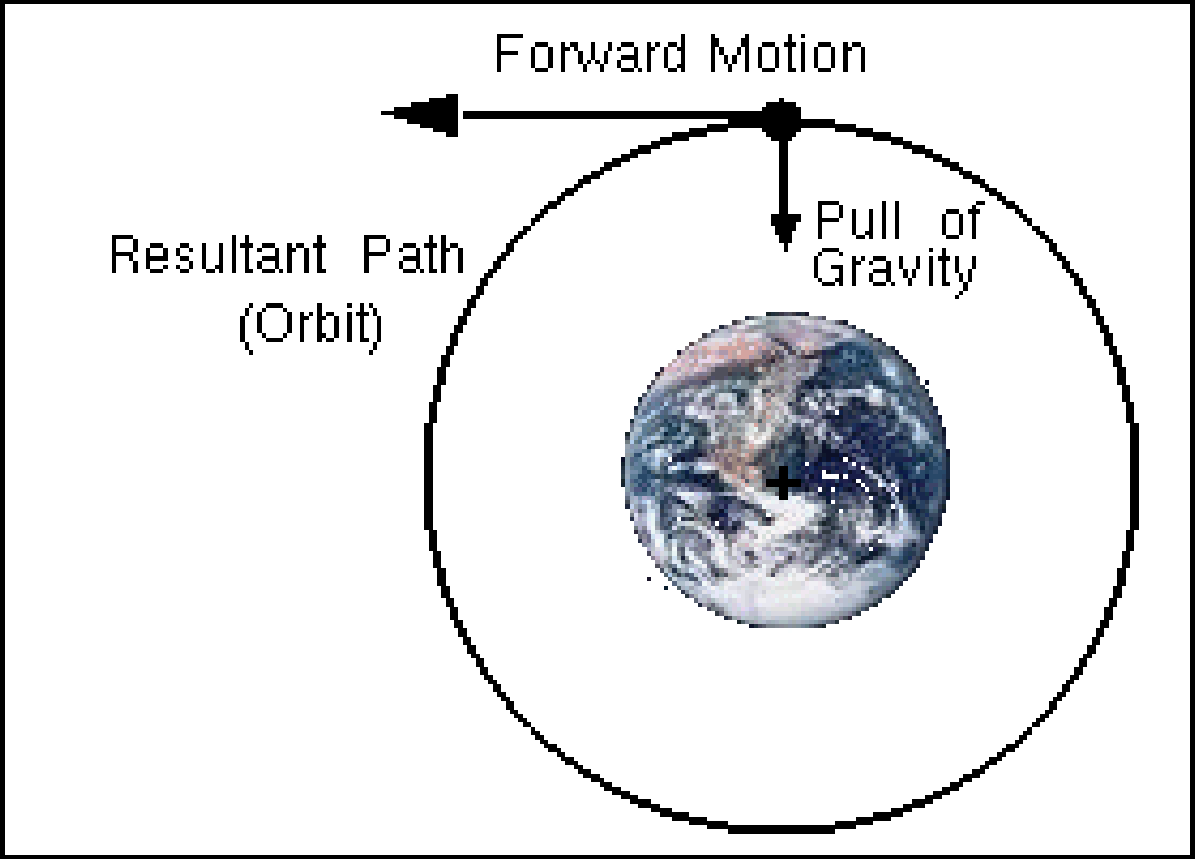
All rocket engines must send its fuel out one end very rapidly in order to create thrust for the rocket to move in the opposite direction.

That can be made to happen by heating the fuel or by explosion and, for the solid rocket on the left and liquid fuel rocket on the right, by passing the heated gas through the throat of a nozzle.

These engines use the energy of chemical reactions to create hot gas at high pressure for thrust. Other engines can use nuclear reactions to create heat, while ion engines make elementary particles go extremely fast just using electrical energy.



How Do Satellites Stay in Orbit?



Earth's gravity pulls objects toward Earth's center. If the rocket goes fast enough and in a direction parallel to Earth's surface, then its path can be a circle or ellipse. The satellite is always "falling" toward the Earth, but is moving fast enough forward to fall around the Earth instead of into it.

Your Rocket Launches

As part of the merit badge requirements you are required to carry out two rocket launches.

1) Build, launch, and recover a model rocket.

2) Make a second launch to accomplish a specific objective. What might that be?

Rocket launch safety:

- Use only prepackaged engines
- No metal in your rocket
- Only use approved launch ignition
- Have room to fly safely
- Launch controller must be disabled and untouched until launch
- Announce/count-down launch