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ADVANCEMENTS IN ROCKET TECHNOLOGY

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Credits: NASA
https://www.nasa.gov/exploration/systems/sls/overview.html

I. HISTORY OF ROCKETRY

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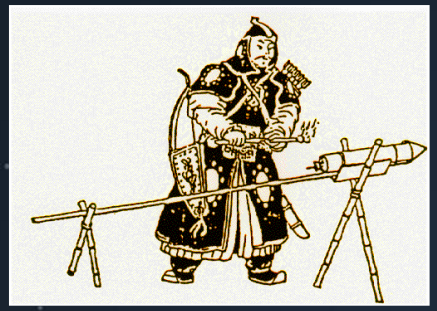
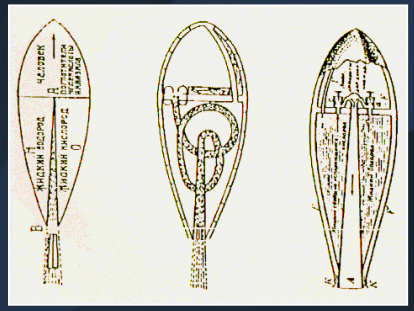
Ancient Rockets

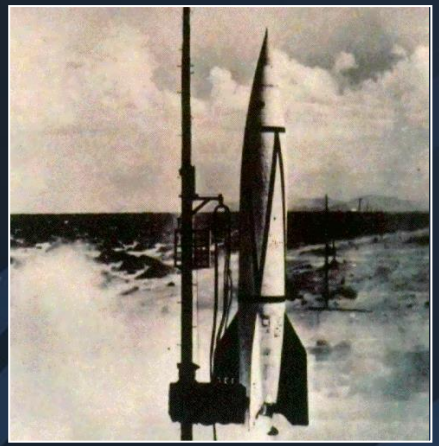


Rockets for Warfare

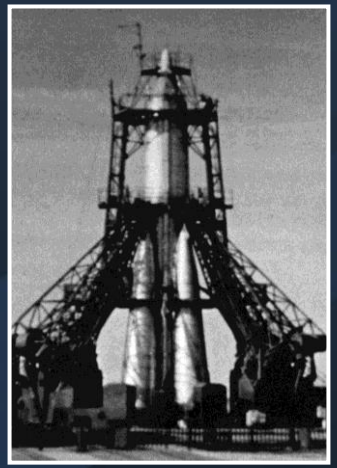
Rockets as Inventions



Early - Mid 20th Century Rockets



Space Race Rockets



Future Rockets

Space Launch System (SLS) Overview

NASA's Space Launch System, or **SLS**, is an advanced launch vehicle that provides the foundation for human exploration beyond Earth's orbit.

Credits: NASA
https://www.nasa.gov/sites/default/files/atoms/files/0080_sls_fact_sheet_10162019a_final_508.pdf

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THE POWER TO EXPLORE BEYOND EARTH'S ORBIT

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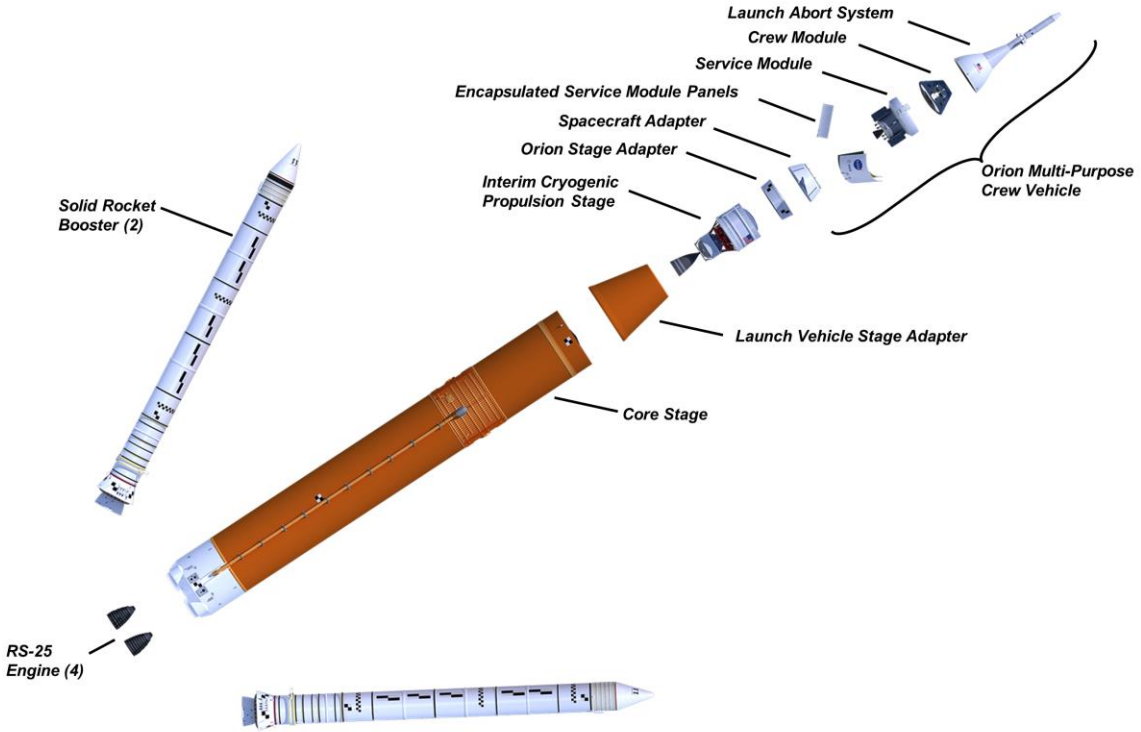
To fill America's future needs for deep space missions, SLS will evolve into increasingly more powerful configurations.

The first SLS vehicle, called Block 1, was able to send more than 26 metric tons (t) or 57,000 pounds (lbs.) to orbits beyond the Moon.

https://www.nasa.gov/exploration/systems/sls/overview.html

BLOCK I - INITIAL SLS CONFIGURATION



Block 1 - Initial SLS Configuration
Credits: NASA

QUESTION

What is SpaceX?

SpaceX headquarters in December 2017; plumes from a flight of a Falcon 9 rocket are visible overhead

Spaceflight Industries will carry and launch a cluster of Kleos satellites on the SpaceX Falcon 9 scheduled for launch mid 2021.

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Space Exploration Technologies Corp., trading as SpaceX, is an American **aerospace manufacturer** and **space transportation** services company headquartered in Hawthorne, California, which was founded in 2002 by **Elon Mask**.

An Airbus A321 on final assembly line 3 in the Airbus plant at Hamburg Finkenwerder Airport

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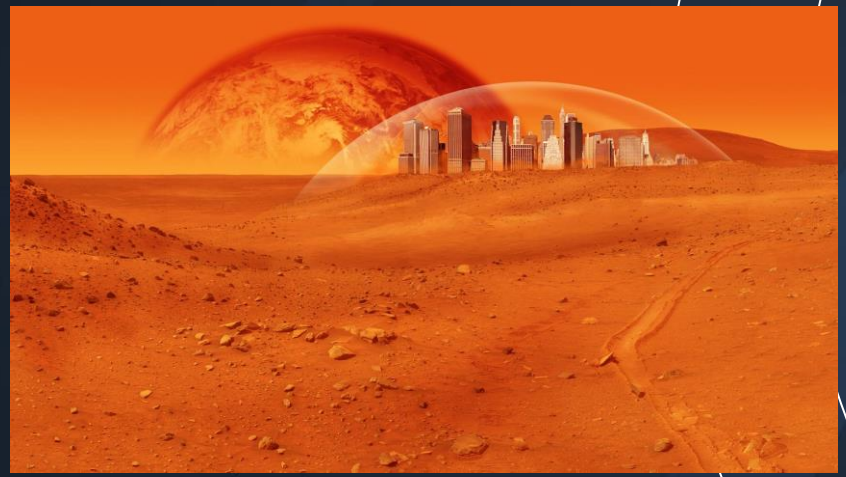
MAIN IMPORTANT EVENTS

An artist's conception of a human Mars habitat, with a 3D-printed dome made of water ice, an air lock, and a pressurized Mars rover

The goal was reducing space transportation costs to enable the colonization of Mars.

SpaceX has developed several launch vehicles, the **Starlink** satellite constellation, the **Dragon** cargo spacecraft, and flown humans to the International Space Station on the **Crew Dragon Demo-2**.



Credits to twitter.com
Mars Oasis on Twitter

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In 2001, Elon Musk conceptualized **Mars Oasis**, a project to land a miniature experimental **greenhouse** and grow plants on Mars. He announced that **"This would be the furthest that life's ever traveled"** in an attempt to regain public interest. Its major competitors are **Arianespace**, **United Launch Alliance**, and **International Launch Services.**

MAIN ACHIEVEMENTS

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- The first privately funded **liquid-fueled rocket** to reach orbit **(Falcon 1 flight 4 on September 28, 2008)**
- The first privately developed liquid-fueled rocket to **put a commercial satellite in orbit (RazakSAT on Falcon 1 flight 5 on July 14, 2009)**
- The first private company to successfully launch, orbit, and **recover a spacecraft (SpaceX Dragon on COTS Demo Flight 1 on December 9, 2010)**
- The first private company to **send a spacecraft to the International Space Station (Dragon C2+ on May 25, 2012)**
- And many more achievements...

2. TRADITIONAL ROCKET PROPULSION

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- A **rocket** is a container enclosing a gas under pressure.
- A small opening at one end of the container allows the gas to escape in one direction. That provides **thrust** that propels the rocket in the opposite direction.

What is Propulsion ?

- **Propulsion** is the act of moving or pushing an object forward.

- The word is derived from two Latin words: pro, meaning before or forward, and pellere, meaning to drive.

- A **propulsion** system is an engine that produces thrust to push an object.

Example 1

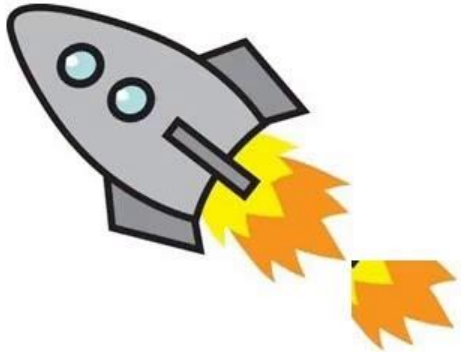
Variable Mass System

Conservation of Momentum

At time t

$M\Delta v = U\,\Delta m$

After time $t + \Delta t$



$$M\frac{\Delta v}{\Delta t} = U\frac{\Delta m}{\Delta t}$$

Force on Rocket = Upthurst by propulsion

$$M.a = U.m$$

Propulsion

Speed of Propulsion w.r.t Rocket — U m/s

Rate of Propulsion — m Kg/s

ROCKET PROPELLANT

- INTRODUCTION

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- Propellant is the chemical mixture burned to produce thrust in rockets and consists of a fuel and an oxidizer.

- A fuel is a substance which burns when combined with oxygen producing gas for propulsion.

- An oxidizer is an agent that releases oxygen for combination with a fuel.

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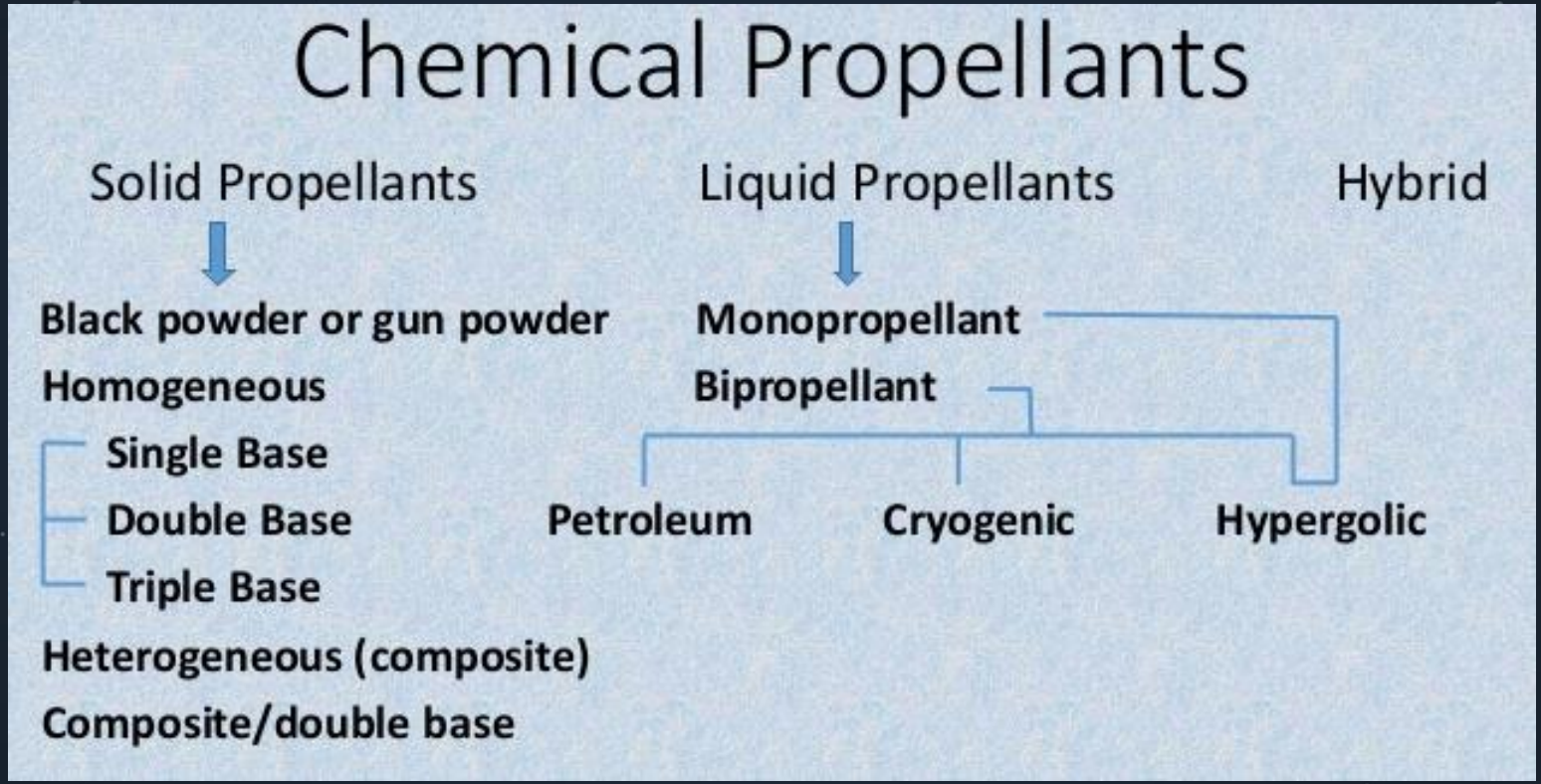
Chemical Propellants



TYPES OF ROCKET ENGINES

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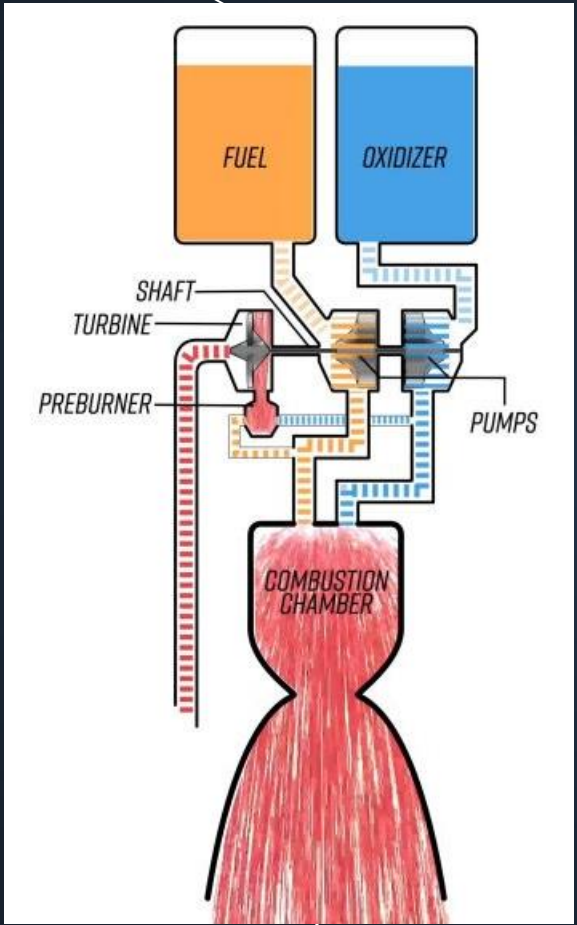
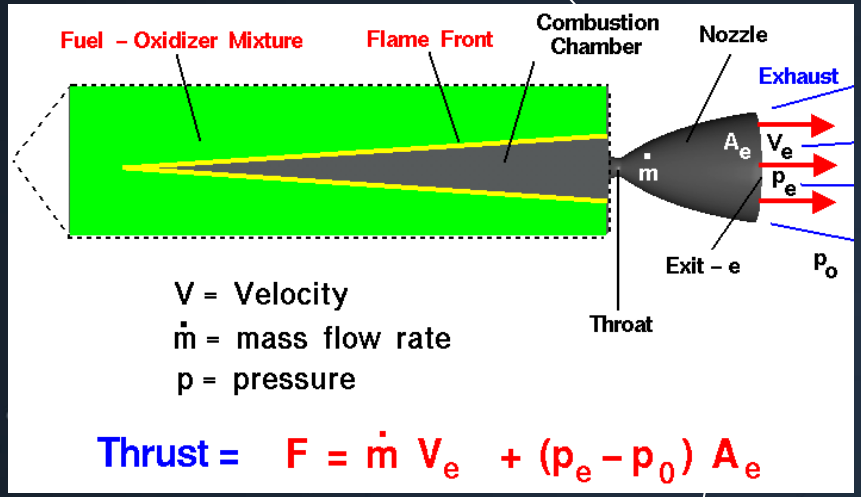


Rocket engines are distinguished by the type of mechanism used to produce **exhaust material**. The simplest "engine" is a compressed air bottle attached to a **nozzle**.

The most common rocket engine is the chemical type in which **hot exhaust gases** are produced by **chemical combustion**. The chemicals or propellants, are of two types, fuel and oxidizer.

TYPES OF ROCKET ENGINES



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

The exit pressure is only equal to free stream pressure at some design condition.

The working fluid may be converted to a hot gas for ejection by the addition of heat from a nuclear reactor or some other energy source.

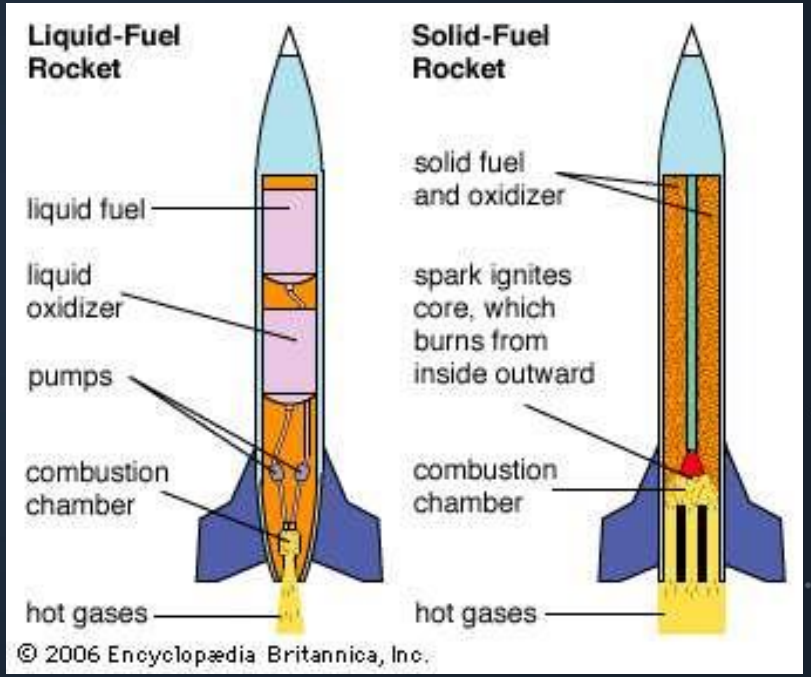
These and other variations of the rocket engine are discussed below.

SOLID-PROPELLANT ROCKET

In the solid-chemical rocket, the fuel and oxidizer are intimately mixed together and cast into a solid mass.

ROCKET ENGINES

Since the founding of SpaceX in 2002, the company has developed three families of rocket engines—Merlin. **SpaceX** is currently developing two further rocket engines: **SuperDraco** and Raptor.



LIQUID BIPROPELLANT CHEMICAL ROCKETS

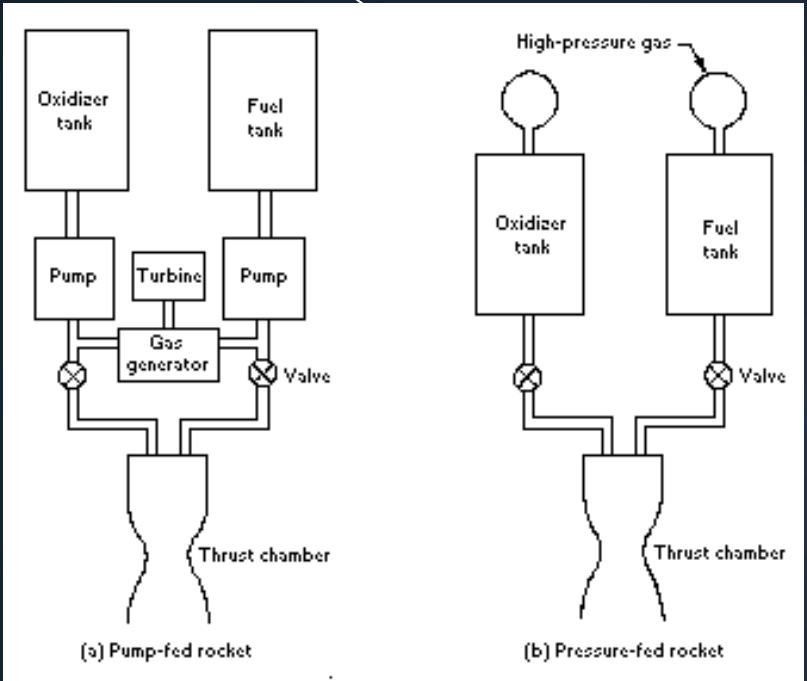


Fig. Schematic of liquid-propellant rocket

Propellant **flow rates** must be extremely large for **high-thrust engines**, often hundreds of gallons per second. Pump-fed systems may require engines delivering several thousand horsepower to drive the **pumps**. This **power** is usually developed by a **hot gas turbine**.

LIQUID MONOPROPELLANT ROCKET

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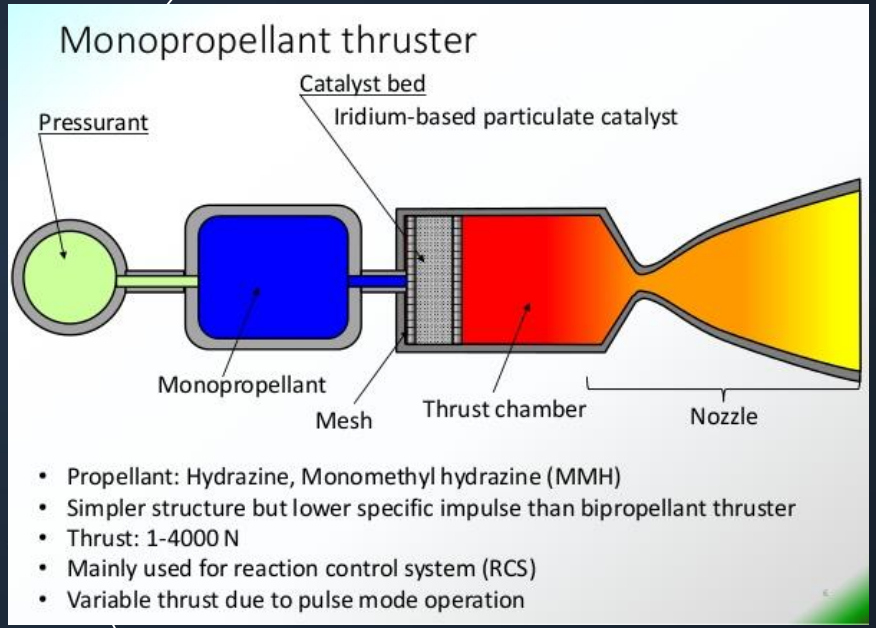
Certain liquid chemicals can be made to form **hot gas** for thrust production by decomposition in a rocket chamber. The most common such monopropellant is hydrogen peroxide.



NUCLEAR ROCKETS

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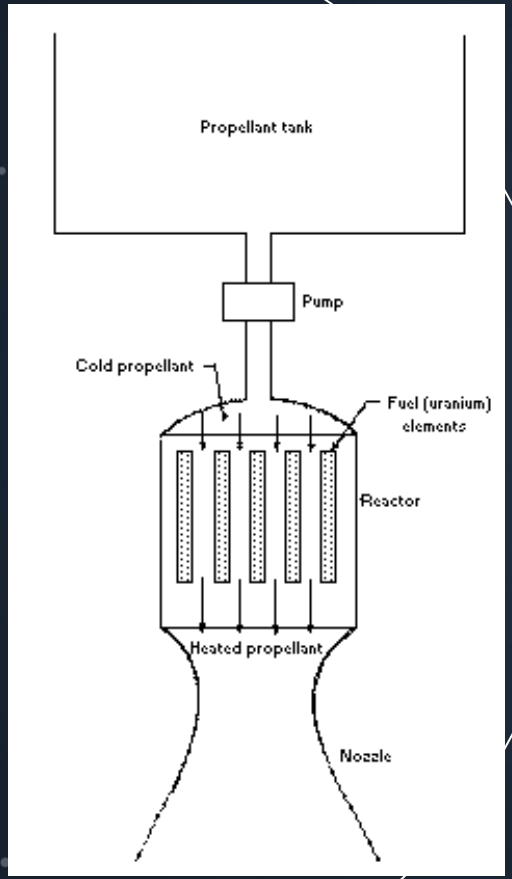
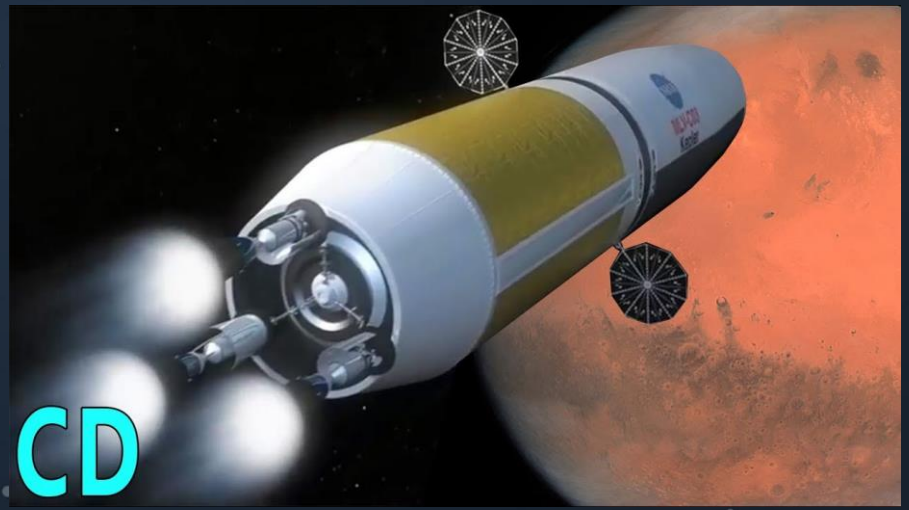
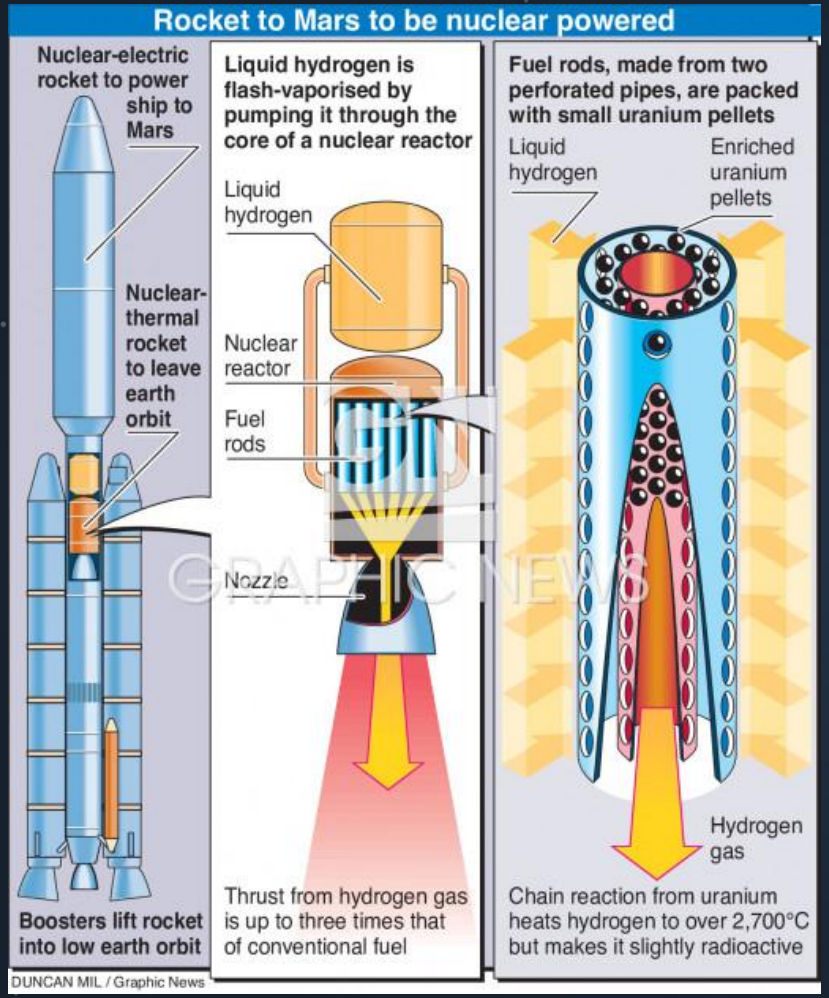
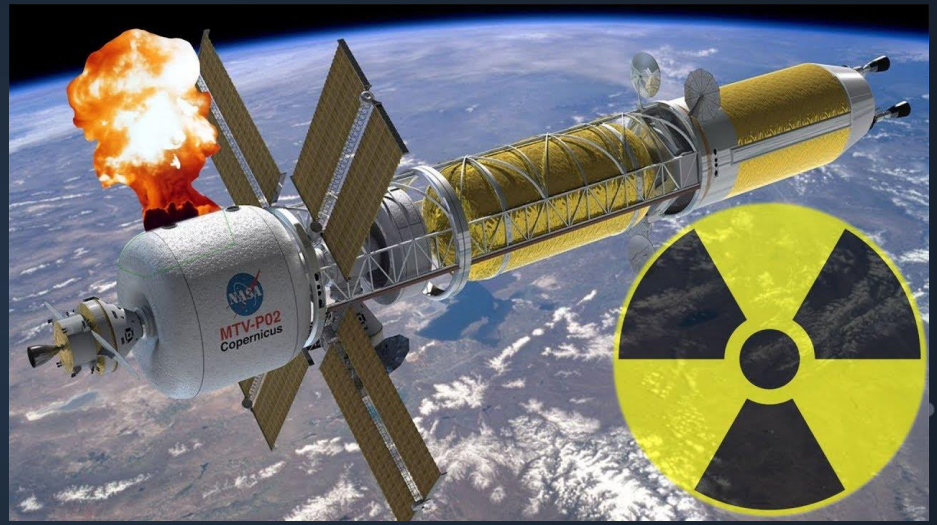


Research and development on the use of a nuclear reactor as a rocks energy source is currently being carried out in Project Rover. The nuclear rocket does not utilize any combustion process.



NASA's Nuclear Rocket





Credits to RumbleLab, Jun 9, 2019
NASA

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QUESTIONS?

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THANKS!

Do you have any questions?

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