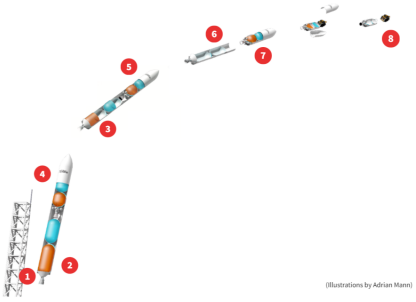
How rockets work: A complete guide

Link: [How rockets work: A complete guide | Space]

- At high altitudes, the Earth's atmosphere rapidly becomes thing → challenge
- Rockets solve the problem of generating force without using surrounding air/materials
    - Generate force in one direction = thrust (principle of action & reaction)
- Oxidant → chemical that performs similarly to oxygen in Earth's air, enables fuel to combust
- The launch is the most difficult part
    - Weight is at its maximum, and need a lot of thrust to move
    - Most efficient setup = vertically launched vehicle with different stages
    - 

- Generates thrust through a controlled explosion, as the fuel and oxidant go through a "violent" chemical reaction
    - Expanding gases from explosion are released through a part of the rocket called the nozzle (in the back)
- As rocket gains speed, it's very important to make sure the direction of motion is closely aligned with the direction of thrust

How Rockets Work

Link: [Rockets Guide - How Rockets Work (nasa.gov)]

- Air pressure plays an essential role while the rocket is still in the atmosphere
- As the rocket goes higher into space: ambient pressure decreases, atmosphere thins, engine thrust increases

    - And combustion products get ejected by the engine, so the rocket's total mass decreases, its inertia decreases, and upward acceleration increases

What kind of Visual Sensors are employed aboard Rockets?

Link: [camera - What kind of Visual Sensors are employed aboard Rockets? - Space Exploration Stack Exchange]

- SpaceX uses GoPro cameras
    - Ex: used inside a fairing on Falcon 9 flight (monitors recovery attempts) → real time footage
- NASA JPL
    - Boom holding camera
    - GoPro microphone picks up sound in real time
    - As altitude increases, sound goes down → lower densities = lower sound transmission

BYU: Cameras for Our Builds

Link: [Cameras for Our Builds - BYU Rocketry - Student led organization geared towards creating the next generation of leaders in engineering]

- Different cameras are used to record rocket manufacturing, testing, and launching
- On-board cameras → evaluating payload, airbrake, and general rocket performance post-flight
- In high-speed rockets, a common challenge is fin flutter
    - Used CCTV camera to help avoid this
- Cameras mid flight → confirmparachute deployment, allow manual overrides and backups to ensure successful recovery

Space Communications: 7 Things You Need to Know

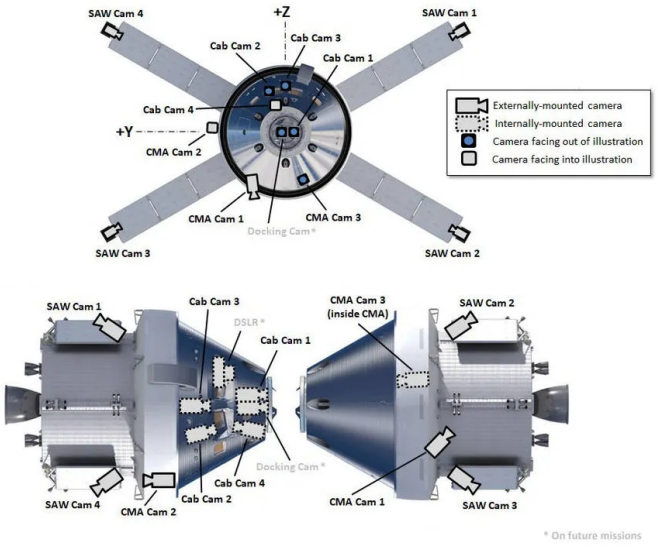
Link: [Space Communications: 7 Things You Need to Know - NASA]

- NASA's SCaN program enables communication to and from space

- Space communications relies on two things: a transmitter and a receiver
    - Transmitter: used modulation to represent encoded messages onto electromagnetic waves (modulation changes wave properties to represent data)
    - Waves flow through space towards receiver
    - Receiver collects waves and demodulates them (aka decoding message from sender)
- NASA has an extensive network of antennas all over the world → receives transmissions from spacecrafts
    - Network engineers plan communications and make sure antennas are prepared to receive data as spacecrafts pass overhead (communication between ground stations and missions)
    - Ground station antennas → range from small, high frequency antennas to massive ones that can communicate with super far away missions
- Relay satellites → NASA missions rely on these to get their data to the ground
- Various bands of electromagnetic frequencies → have different capabilities
    - Higher bandwidth = carry more data per second = spacelink can downlink data more quickly
    - NASA currently uses radio waves for communications, but working on using infrared lasers
- Communications are not instantaneous bc bound by universal speed limit: speed of light
    - Closer to Earth = less of a time delay
    - Farther from Earth = higher communication latency
- Traveling longer distances = quality of data deteriorates
    - There can be interference from radiation from other missions, the Sun, other celestial bodies, etc.
    - NASA uses methods of error detection and correction to receive accurate data

NASA adapted consumer cameras for amazing Artemis 1 space mission

Link: [NASA adapted consumer cameras for amazing Artemis 1 space mission | Digital Camera World]

- Artemis 1 mission → 24 cameras on board
    - Document landings, takeoffs and the external condition of the rocket
    - Also perspectives of the earth and moon
- Each camera designed to capture certain activities and positioned accordingly for them
    - 4 cameras attached on each solar array wings → monitor solar array deployment & overall spacecraft condition
    - 4 cameras attached to the engine facing up to the Orion spacecraft
        - 2 cameras capture boosters sequence separation
        - 2 cameras attached to the launch vehicle adapter record the core separation
    - "These eight cameras will be carefully preprogrammed with a set sequence and used during launch and ascent"
    - 

- Each of the 24 cameras powered by solar energy collected by the arrays
- Can capture still images, but also record 4k video
- Wireless cameras inside the spacecraft → see what the astronauts see while on the missions