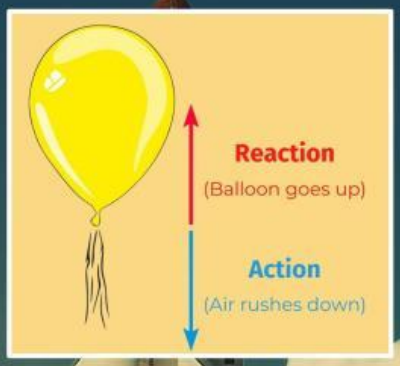
Warm Up

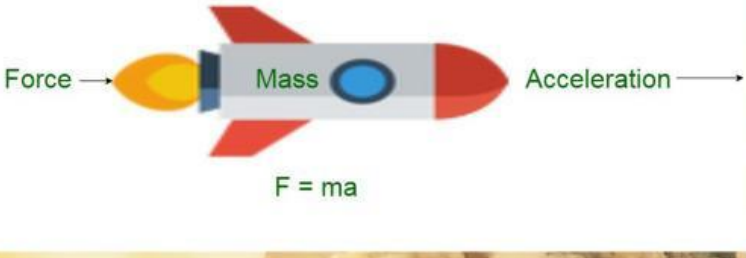
1. Watch the Video
   a. Explain how rockets work.
   b. What are some of the core components of a rocket?


How Rockets Work
USA
LIVEWORKSHEETS

Basics of Rocket Propulsion

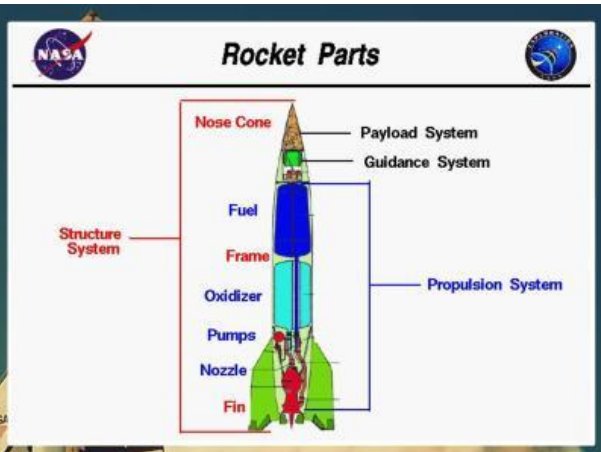
- Rocket propulsion relies on Newton's third law of motion: for every action, there is an equal and opposite reaction.
- Rockets work by expelling mass in one direction, which generates thrust in the opposite direction.
    - Force = Mass **x** Acceleration (F=MA)
- The mass expelled, known as propellant, is accelerated through the rocket engine nozzle, converting chemical energy into kinetic energy.
- Two main types of rocket engines are used: liquid-fueled engines, which use liquid propellants, and solid-fueled engines, which use solid propellants.
- Thrust is produced as the high-speed exhaust gases exit the engine nozzle, propelling the rocket forward.

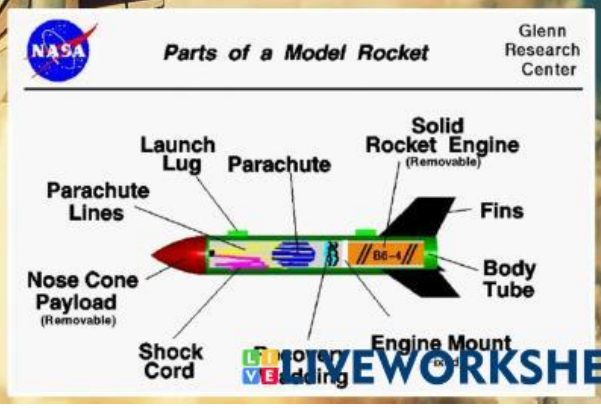


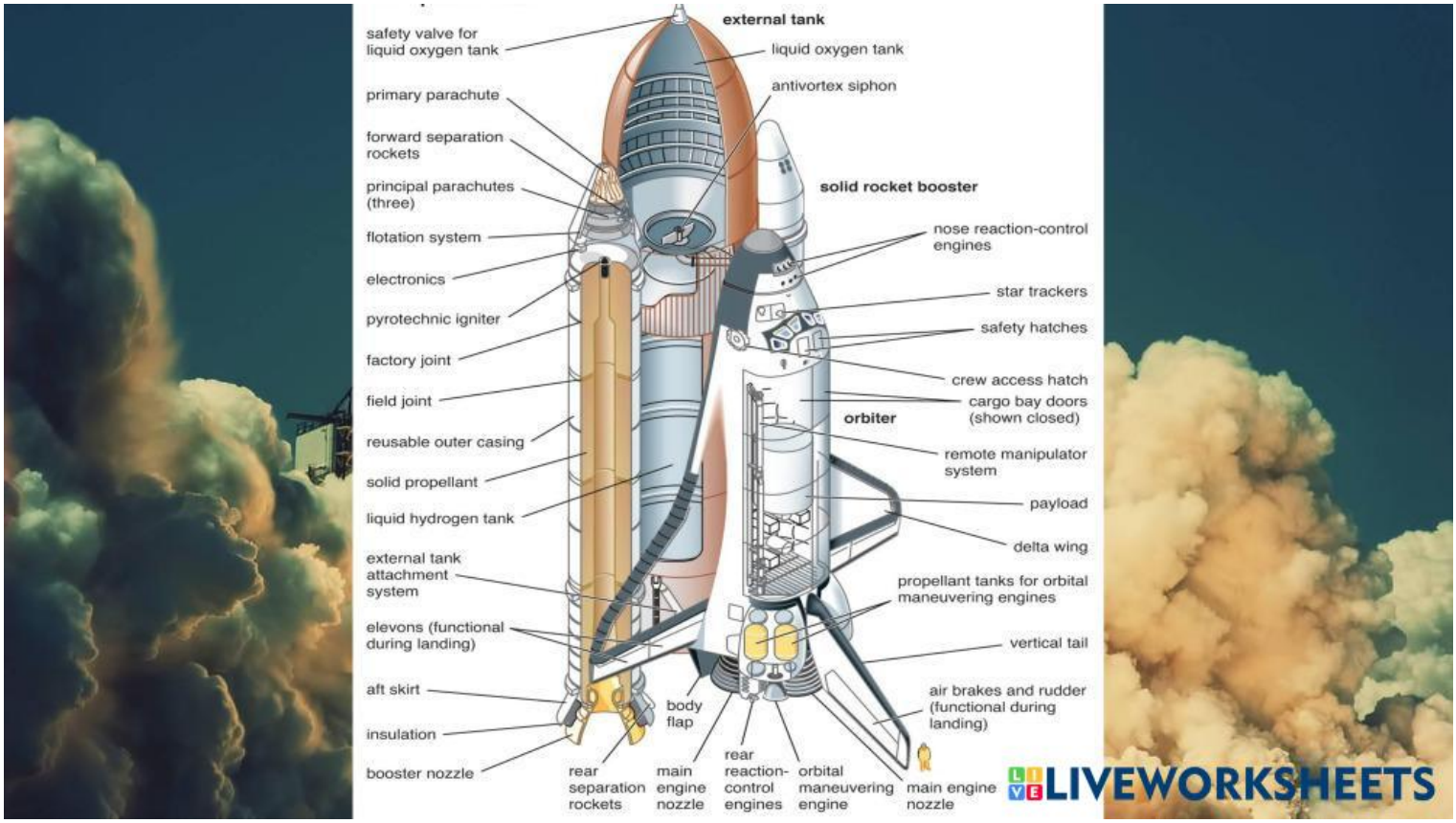


Components of a Rocket

- **Propellant Tanks:** Store the fuel and oxidizer needed for combustion.
- **Rocket Engine:** Converts chemical energy from the propellants into thrust.
- **Nozzle:** Controls the flow and direction of the exhaust gases, accelerating them to high speeds.
- **Payload:** Carries the cargo, such as satellites, spacecraft, or scientific instruments.
- **Structural Components:** Provide support and structural integrity to the rocket, including the fuselage, fins, and payload fairing.
- **Guidance System:** Controls the rocket's trajectory and orientation during flight, ensuring it reaches its intended destination accurately.

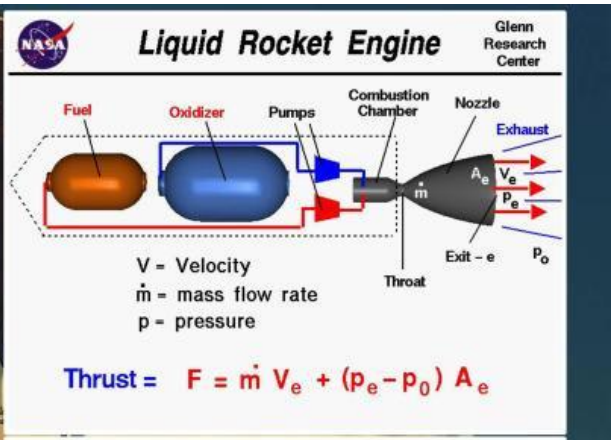


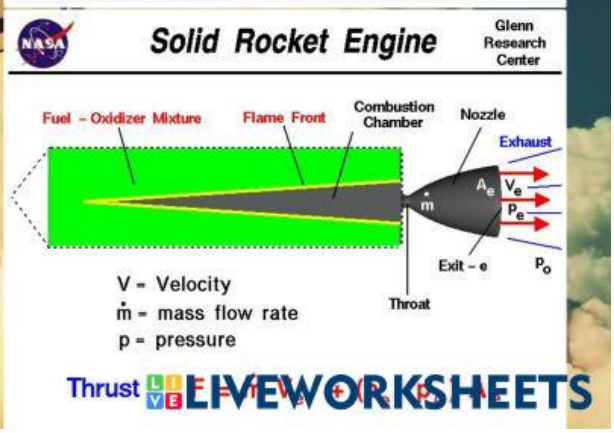




Types of Rocket Engines

- Liquid Fuel Engines:
  - Use liquid propellants, typically consisting of a fuel (such as liquid hydrogen) and an oxidizer (such as liquid oxygen).
  - Components include separate tanks for fuel and oxidizer, combustion chamber, and turbopumps to feed propellants into the combustion chamber.
  - Provide precise control over thrust and engine performance, allowing for throttling and shutdown.
- Solid Fuel Engines:
  - Use solid propellant composed of a mixture of fuel and oxidizer in a solid form.
  - Components include a solid rocket motor casing, propellant grain, and igniter.
  - Offer simplicity and reliability, but cannot be throttled or shut down once ignited.



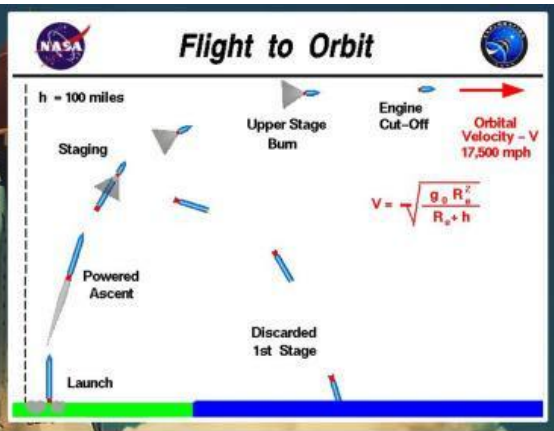


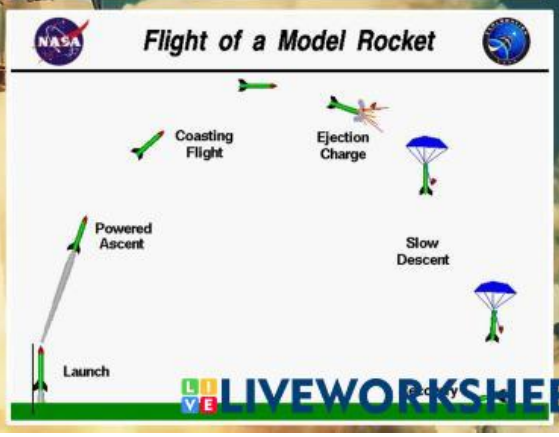
Liquid Fueled Rocket

https://youtube.com/watch?v=9Y3fG-YrIII

Stages of Rocket Flight

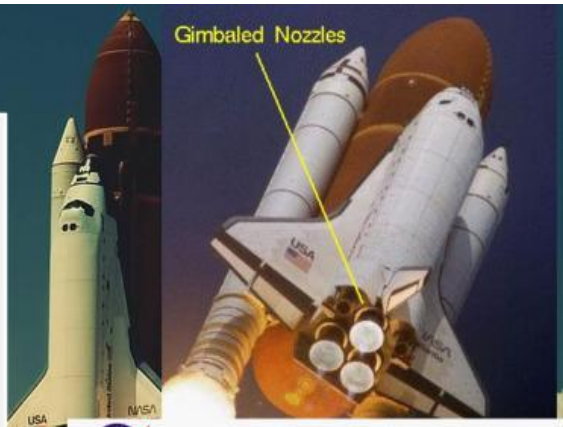
- **Launch**: Rocket engines ignite, generating thrust to lift the rocket vertically off the launch pad, beginning its ascent through the atmosphere.
- **Ascent**: Rocket continues to gain altitude and velocity, gradually leaving Earth's atmosphere. Atmospheric pressure decreases, allowing the rocket to accelerate to higher speeds as it ascends.
- **Orbit Insertion**: The rocket's engines perform a burn to accelerate the spacecraft to orbital velocity. Involves precise trajectory adjustments to enter a stable orbit.
- **Re-entry**: Rocket slows down and safely descending through the atmosphere. Thermal protection systems shield the spacecraft from the intense heat generated during atmospheric re-entry.
- **Landing or Impact**: The rocket may execute a controlled landing, or the payload may impact the surface.

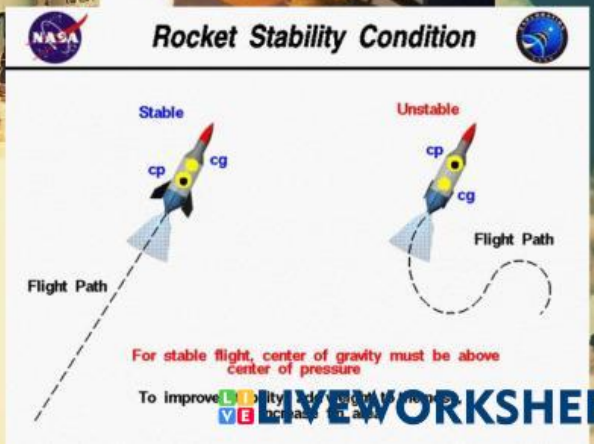




Guidance and Control

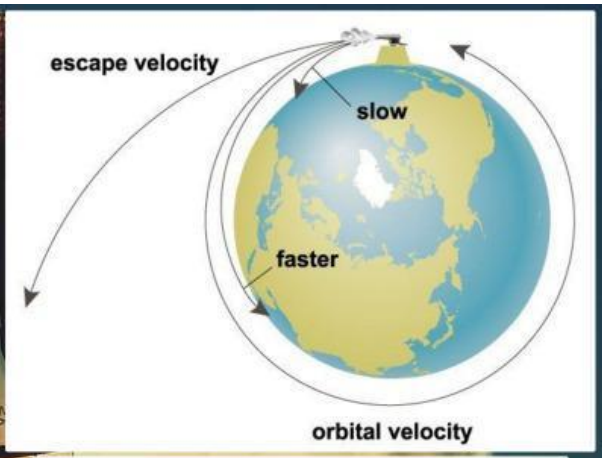
- Guidance systems provide real-time control and adjustment of rocket trajectory.
- Utilize sensors, computers, GPS etc. to analyze flight data and make corrections for precise positioning.
- Guidance systems ensure accurate flight path adherence despite external factors, and adjust direction and velocity to maintain course integrity.
- Stability During Flight is crucial for control and preventing deviation from intended path.
- It's achieved through aerodynamic design and control surfaces.
- Ultimately ensures safe and precise mission accomplishment.





Challenges and Solutions

- **Overcoming Gravitational Forces:**
  - Rockets must generate enough thrust to ascend against Earth's gravity.
  - Higher thrust-to-weight ratios aid in lifting off from the Earth's surface, and multistage rockets discard spent stages to reduce mass and increase efficiency.
  - Achieving escape velocity allows rockets to overcome Earth's gravitational pull and enter space.
- **Dealing with Air Resistance and Atmospheric Conditions:**
  - Rockets encounter air resistance, or drag, during ascent through the atmosphere.
  - Streamlining rocket shapes and minimizing frontal area reduces air resistance.
  - Ascending quickly to higher altitudes, where air density is lower, decreases drag, and igniting rocket engines at higher altitudes further minimizes atmospheric drag.

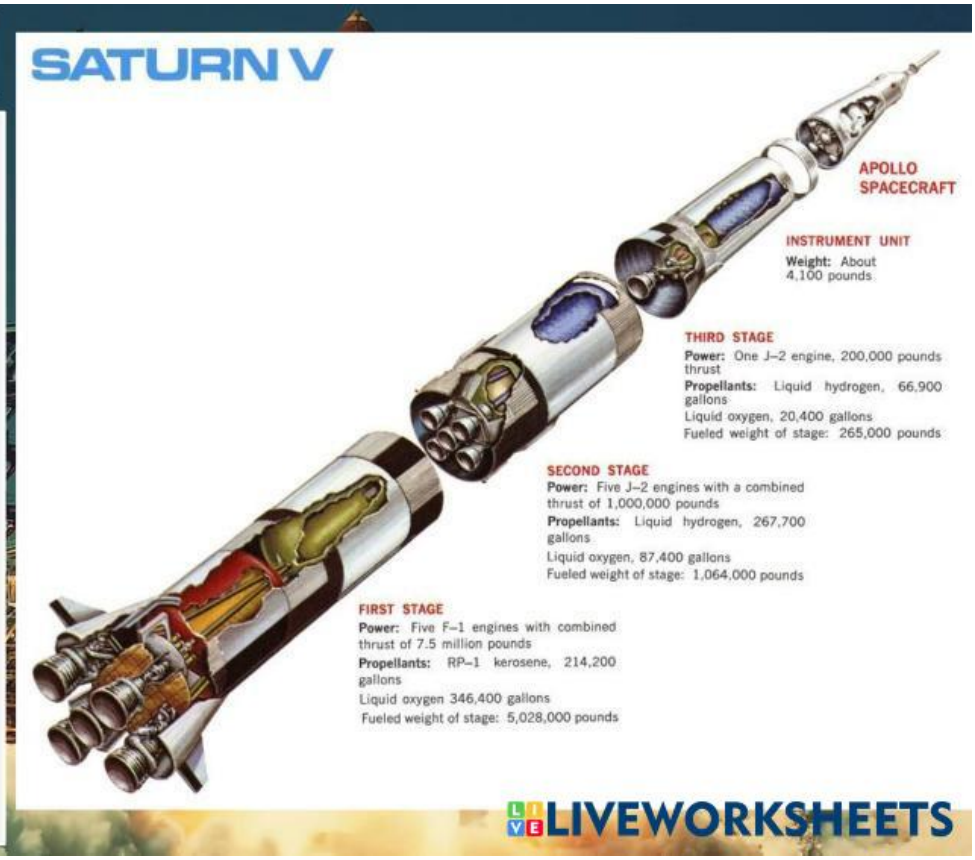


Launching Things into Space

https://www.youtube.com/watch?v=o2FFtPPM3iY

Famous - Saturn V

- The **Saturn V Rocket** was developed by NASA during the Apollo program in the 1960s.
- Notable missions include the Apollo 11 moon landing in 1969, the first crewed mission to land on the Moon.
- Saturn V remains the largest rocket ever flown, capable of carrying heavy payloads to the Moon and beyond.
- Its success demonstrated the feasibility of crewed lunar exploration and cemented NASA's leadership in space exploration.
- The Apollo missions paved the way for advancements in rocket technology and inspired future space exploration efforts.

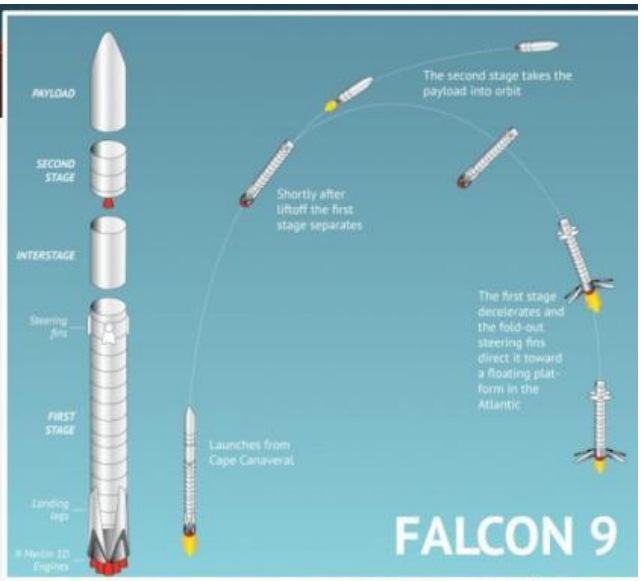


Saturn V Rocket

https://www.youtube.com/watch?v=WF06IhEUDfI

Famous - Falcon 9

- Developed by SpaceX, founded by Elon Musk, the Falcon 9 is a reusable rocket.
- Notable missions include the first commercial spacecraft rendezvous and docking with the International Space Station (ISS) in 2012.
- Falcon 9 made history in 2020 by launching the Crew Dragon spacecraft with NASA astronauts on board, marking the first crewed orbital flight from US soil since the Space Shuttle program ended in 2011.
- Falcon 9's reusability significantly reduces the cost of space launches.
- Demonstrated the viability of private spaceflight companies and stimulated competition and innovation in the aerospace sector.
- The rocket's versatility and reliability have made it a workhorse for a wide range of missions, including satellite deployments, cargo resupply missions to the ISS, and crewed spaceflights.



Falcon 9 Rocket

https://www.youtube.com/watch?v=Z4TXCZG_NEY