Society for Space Education Research & Development

Rocketry

Basic knowledge

Rockets?

•A rocket is a space craft, missile, or an aircraft which obtains thrust from a rocket engine

•Thrust is force that helps rocket lift itself by pushing massive amount of high energy gas to the ground.

HOW DOES A ROCKET FLY?

Newton's Laws of Motion

1. 1st Law
2. 2nd Law
3. 3rd law

Society for Space Education Research & Development

1ST LAW

An object at rest will remain at rest

Unless an external unbalanced force is applied

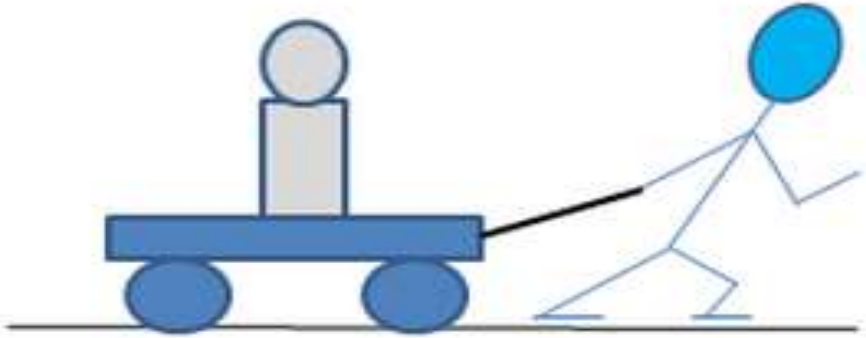
An object at motion will continue with constant speed and direction

Unless acted on by an unbalanced force

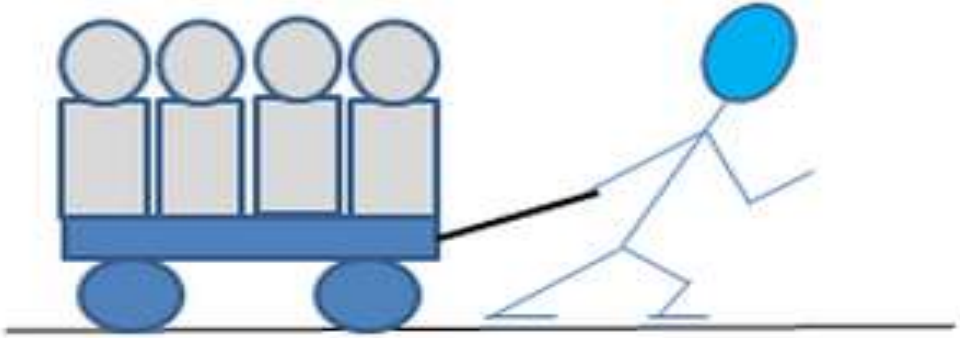
2ND LAW

The acceleration of an object produced by net force is directly proportional to the magnitude of the force applied is inversely proportional to the mass of the object

To get the wagon to *accelerate*, you have to apply a PULL (Force).



If the MASS of the wagon increases, a greater PULL is necessary to accelerate it.



3RD LAW

T (Thrust from the rocket engine)

Weight of the rocket

Every action has an equal and opposite reaction

Law of conservation of momentum

Formula for Momentum

Momentum = (mass) x (velocity)

$$\vec{p} = m\vec{v}$$

Momentum

Mass

Velocity

DESIGN

FUEL+
OXIDEIZER

+

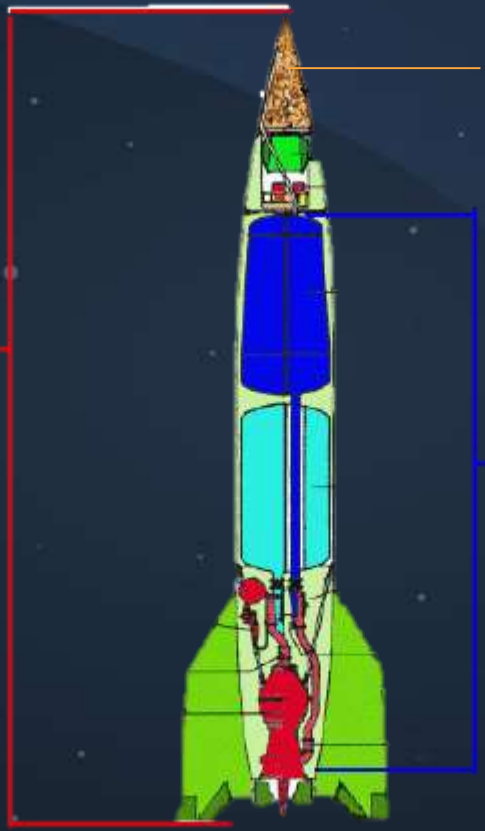
HEAT

=

THRUST

Society for Space Education Research & Development

BASICS DESIGN



Nose cone or payload

structure

Propulsion system

PROPULSION

✓It is an act of pushing an object forward

✓A propulsion system is an engine which provides the required thrust to push a rocket or an airplane forwards

✓**Propellant** is a chemical mixture which are burned to produce required thrust in rockets

ROCKET ENGINES AND PROPELLANTS

Classification of engines based on propellants

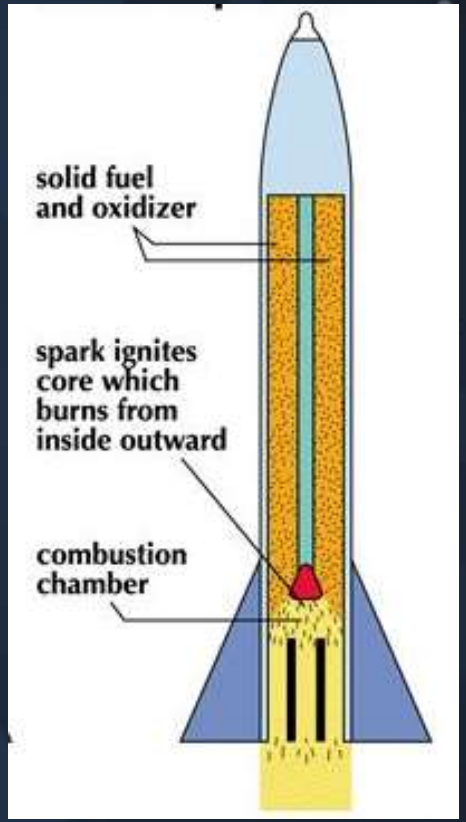
Society for Space Education Research & Development

Engines

- SOLID
- LIQUID
- HYBRID

SOLID PROPELLANT

- Contains both fuel and oxidizer combined together.
- Usually fuel is made up of hydrogen and carbon compounds and oxygen as an oxidizer.



Society for Space Education Research & Development

SOLID ROCKET GRAIN (GVG / PD)

WHY IS IT STAR SHAPED?

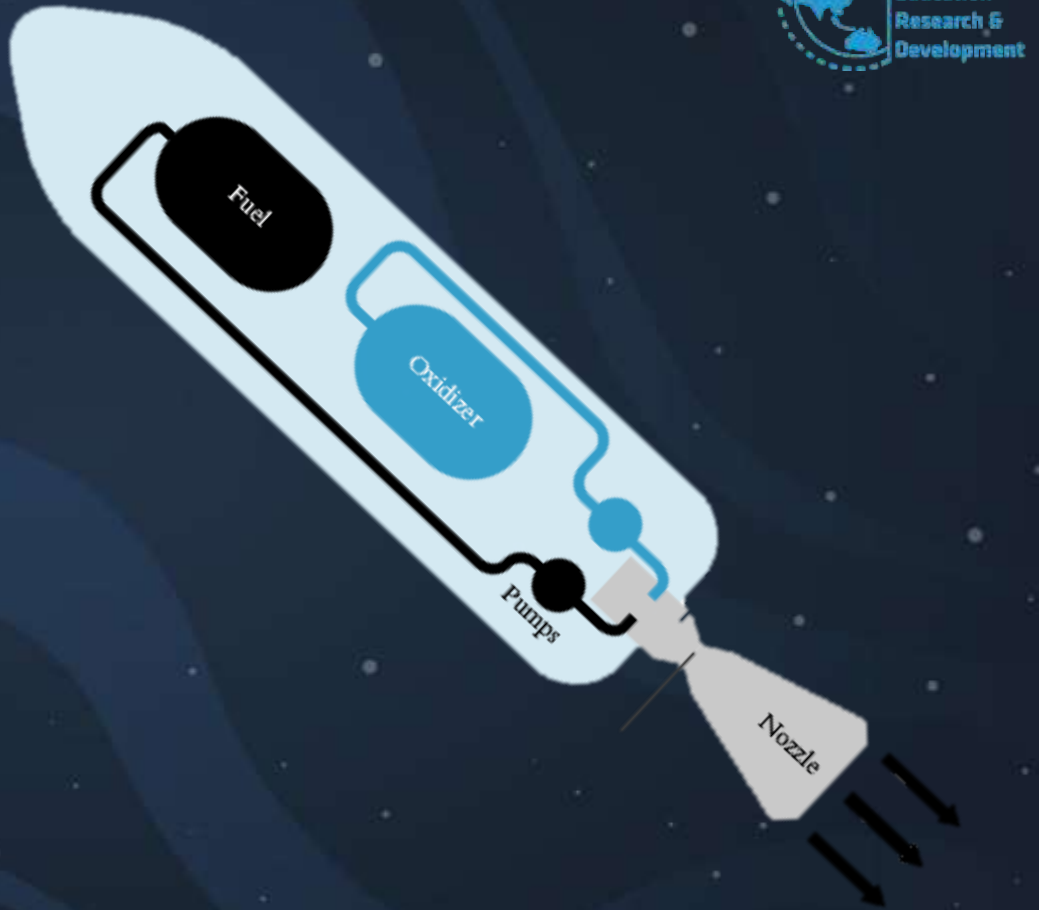
It increases the area of burning providing more thrust

Society for Space Education Research & Development

Society for Space Education Research & Development

LIQUID PROPELLANT

- Contains fuel and oxidizer in separate tanks which are then pumped into combustion chamber to obtain required thrust.

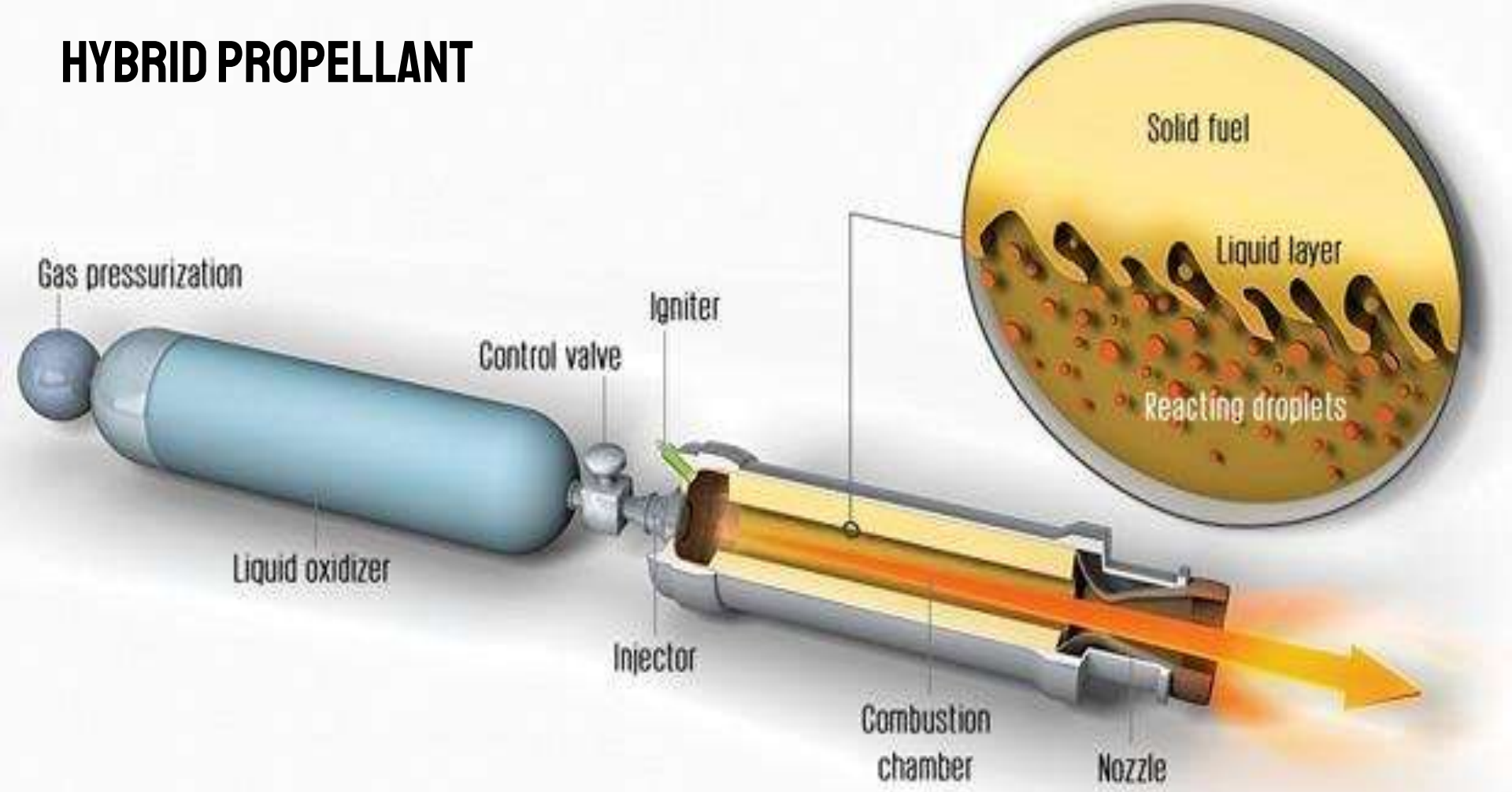


Society for Space Education Research & Development

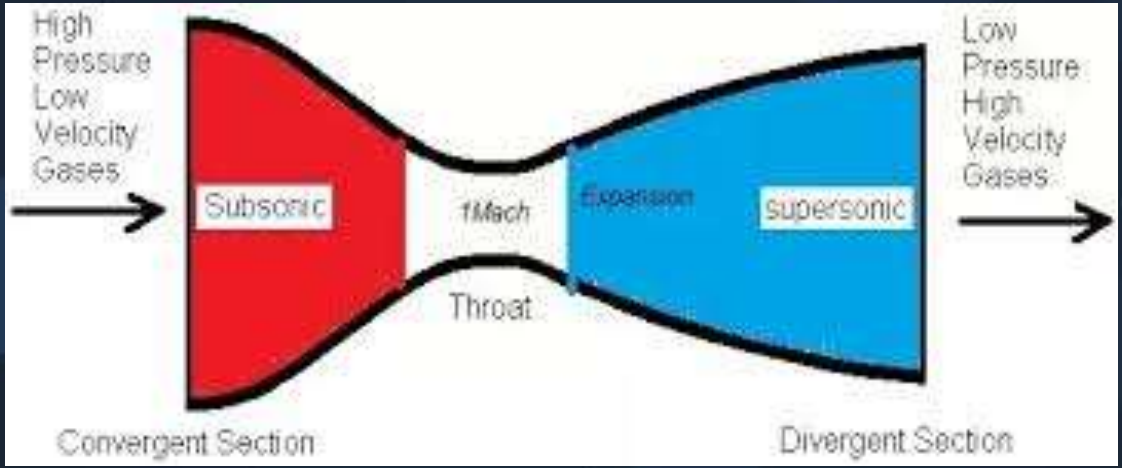
F1 liquid fueled rocket engine

viking_5C_rocket engine

HYBRID PROPELLANT



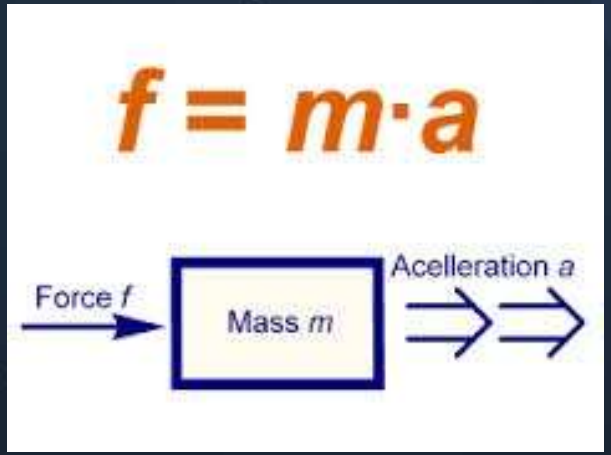
THE NOZZLE


High
Pressure
Low
Velocity
Gases
Subsonic
1Mach
Throat
Expansion
supersonic
Low
Pressure
High
Velocity
Gases
Convergent Section
Divergent Section

QUESTION TIME

WHY DO ROCKETS SHRED THEIR PARTS ?

- The operative principle behind rocket stages is that you need a certain amount of thrust to get above the atmosphere, and then further thrust to accelerate to a speed fast enough to stay in orbit around Earth

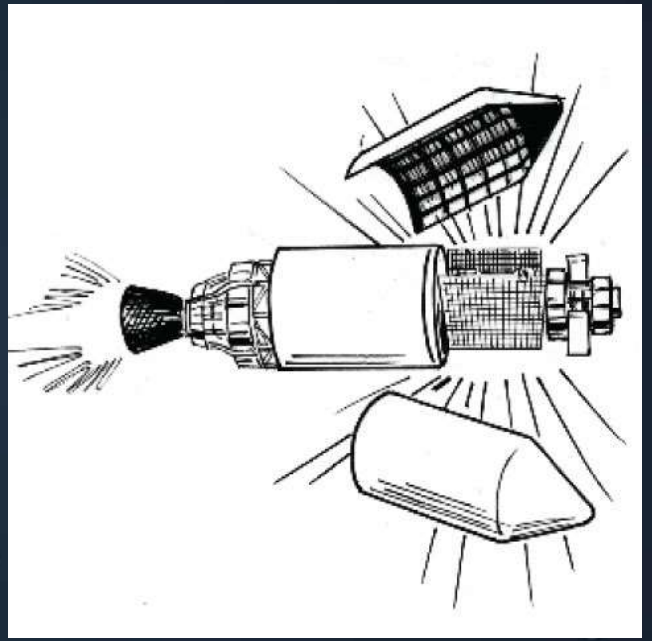


- Today's large, space bound rockets consists of at least two stages. Each stage has its own engines, which can vary in numbers.

- A rockets 1st stage gets the rocket out of the thick, lower atmosphere, sometimes with the help of side boosters.

- Once the 1st stage has done its job the rocket drops that portion and ignites the 2nd stage.

- As the 2nd stage has a lot less to transport, and it doesn't have to fight through the thick layer of atmosphere it usually has one engine.



SATURN V

Society for Space Education Research & Development

Saturn V was an American super heavy-lift launch vehicle certified for human-rating used by NASA between 1967 and 1973. It consisted of three stages, each fueled by liquid propellants.

Quincunx

HEIGHT = 363 FT.
APOLLO / SATURN V
SPACE VEHICLE

HEIGHT = 305 FT.
STATUE OF
LIBERTY

MSFC 67 PA 117

Society for Space Education Research & Development

Society for Space Education Research & Development

QUESTION TIME

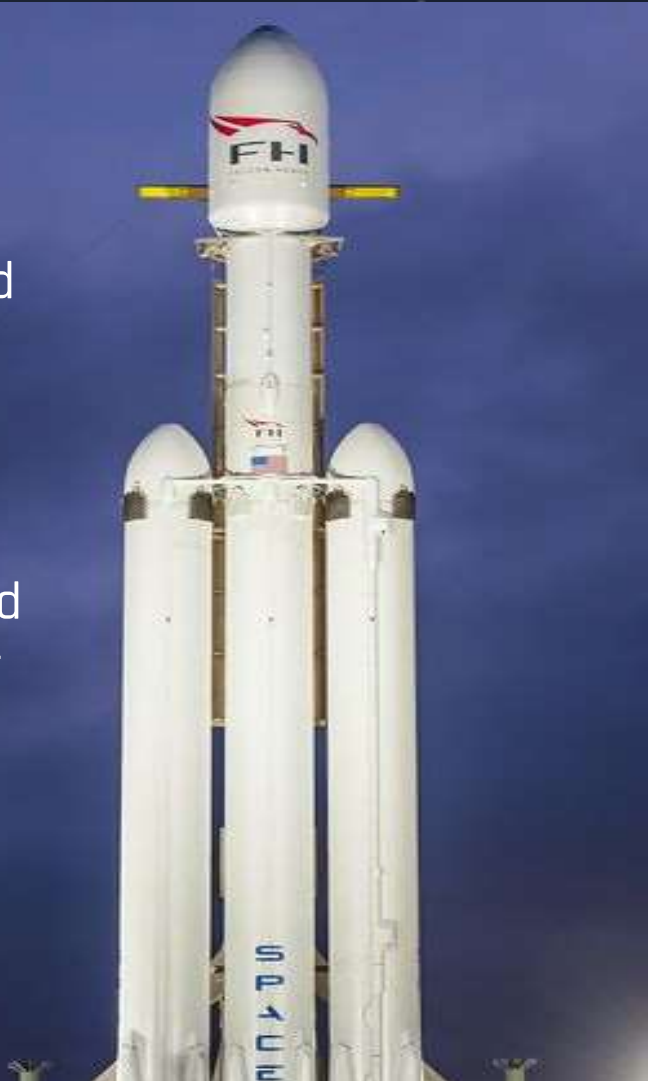
WHICH WAS THE WORLD IST REUSABLE ROCKET ?

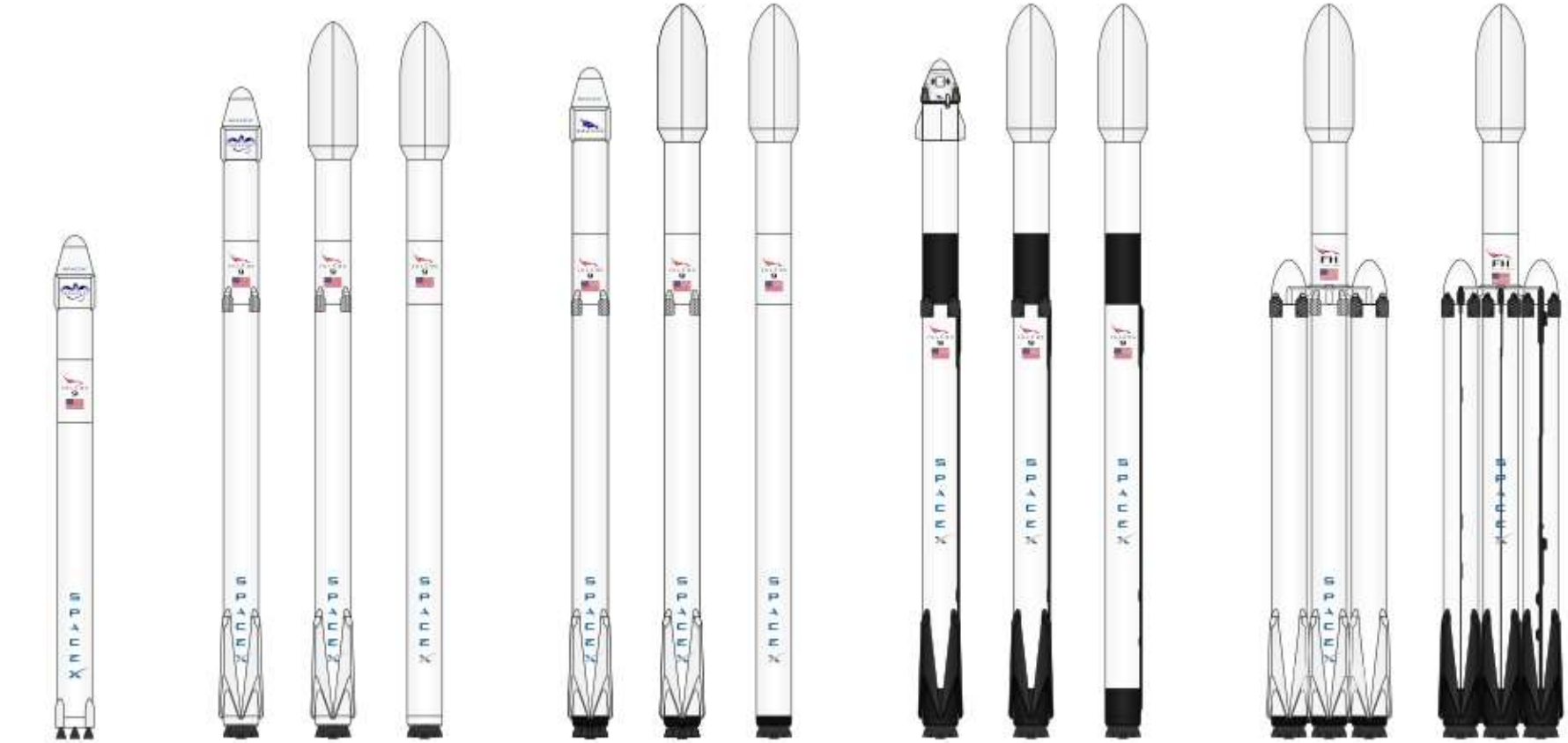
FALCON FAMILY

- Falcon family launch vehicles are manufactured by spaceX.

FUN FACT:

Elon Musk, CEO of spaceX, has stated that the Falcon1, 9, and heavy are named after the **Millennium Falcon** from **Star Wars** film series.




Falcon 9 v1.0
Falcon 9 v1.1
Falcon 9 v1.2 (FT)
Falcon 9 Block 5
Falcon Heavy
FH B5

FALCON 9

•**Falcon 9** is a partially reusable two-stage launch vehicle designed and manufactured by SpaceX.

•Engine - Merlin engines (most efficient engine ever built).

•Fuels - cryogenic liquid oxygen and kerosene (RP-1) as propellants

• The first stage engines are arranged in a structural form SpaceX calls "Octaweb".

•Payload capacity - 1. to LEO – 22800kg
2. to GEO – 8300kg
3. to mars – 4020kg

FALCON HEAVY

•. The **Falcon Heavy** is a partially reusable heavy-lift launch vehicle designed and manufactured by SpaceX. It is derived from the Falcon 9 vehicle and consists of a strengthened Falcon 9 first stage as the center core with two additional Falcon 9-like first stages as strap-on boosters.

•Fuels - cryogenic liquid oxygen and kerosene (RP-1) as propellants

•Payload capacity - 1. to LEO – 54,400kg
2. to GEO – 37,000 kg
3. to Mars –16,800

CAPABILITIES & SERVICES

SpaceX offers open and fixed pricing for its Falcon 9 and Falcon Heavy launch services. Modest discounts are available, for contractually committed, multi-launch purchases. SpaceX can also offer crew transportation services to commercial customers seeking to transport astronauts to alternate LEO destinations.

PRICE	FALCON 9	FALCON HEAVY
STANDARD PAYMENT PLAN (2018 LAUNCH)	$62M Up to 5.5 mT to GTO	$90M Up to 8.0 mT to GTO

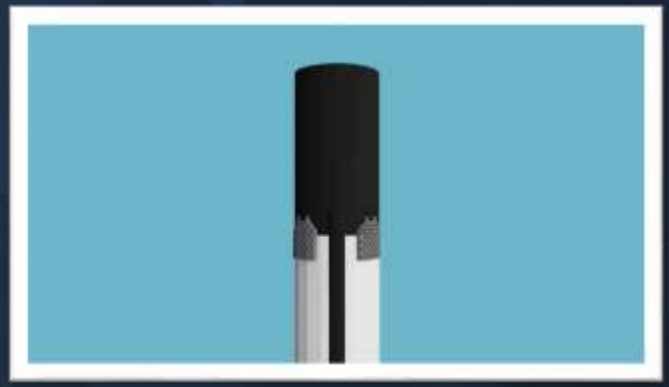
DESTINATION	*PERFORMANCE**	*PERFORMANCE**
LOW EARTH ORBIT (LEO)	22,800 kg 50,265 lbs	54,400 kg 119,930 lbs
GEOSYNCHRONOUS TRANSFER ORBIT (GTO)	8,300 kg 18,300 lbs	22,200 kg 48,940 lbs
PAYLOAD TO MARS	4,020 kg 8,860 lbs	13,600 kg 29,980 lbs

*Performance represents max capability on fully expendable vehicle

Inclination: LEO = 28.5°, GTO = 27°

HOW DOES THE RELENDING OF IST STAGE POSSIBLE ?

- After releasing the pay load, special 8 cold nitrogen gas thrustors are activated which flip the rockets and engine is again fired and are guided back to earth.

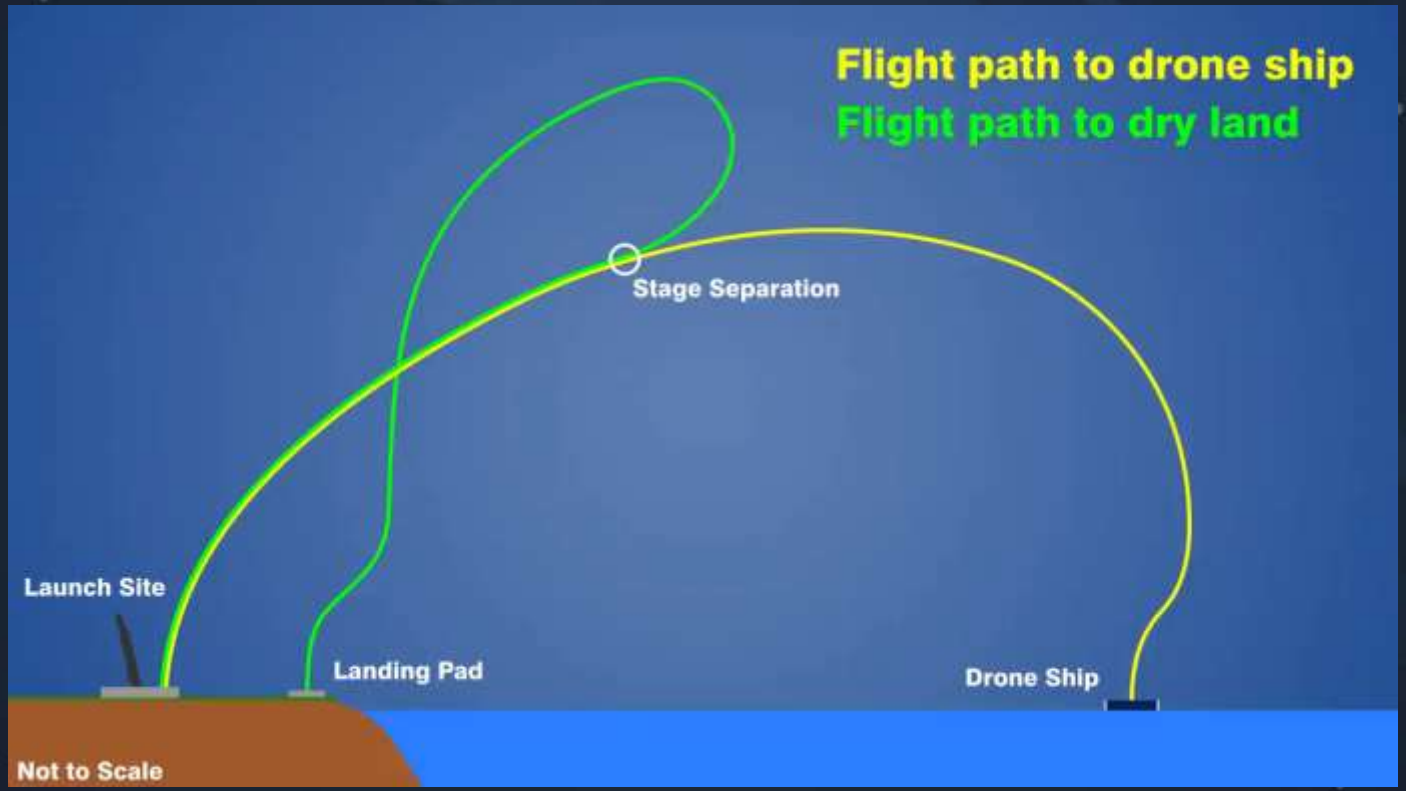


https://youtu.be/J1f-MXMASkE

Credit: Questn
https://youtu.be/apKOg2XLCCc

- To aid them with the re-entry hypersonic grid fins are used which guides them for the landing.

LANDING PATH




SPACEX
STARSHIP

- The **SpaceX Starship** is a fully reusable super heavy-lift launch vehicle under development by SpaceX since 2012

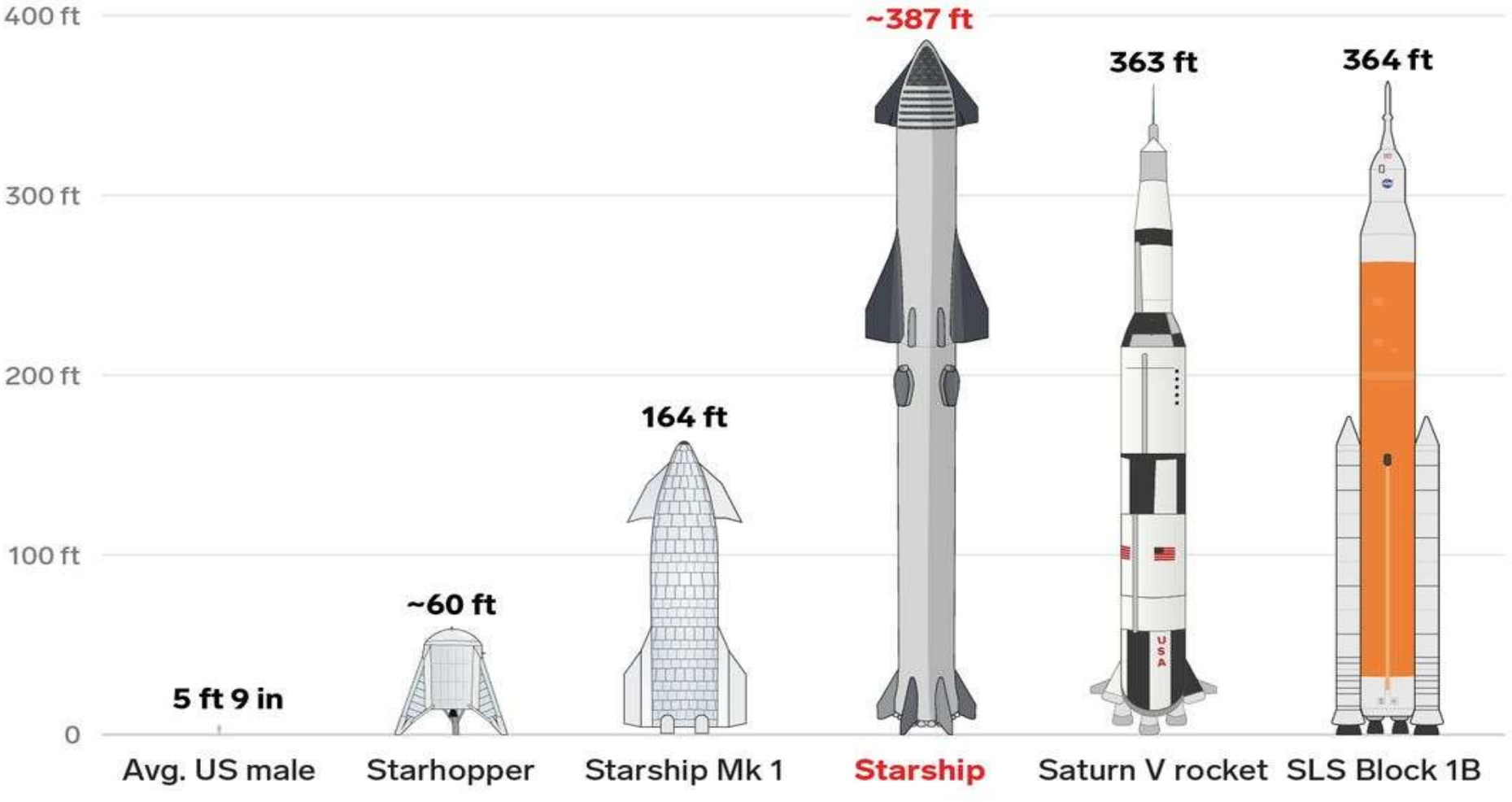
- It mainly contains 2 parts **Super Heavy** and **Starship**

- Super heavy is the 1st stage rocket which delivers the Starship

- After the 1st stage separation, the super heavy booster land in the same way as falcon boosters does.

Society for Space Education Research & Development

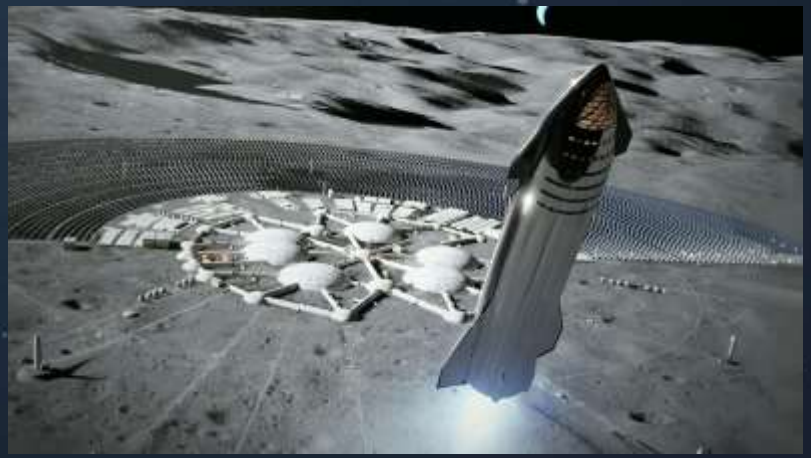
- Both super heavy and starship are powered by raptor engines.
- Height – 122m
- Diameter – 9m
- Total mass (with payload) – 5,000,000 kg
- Payload capacity – 100,000 kg


400 ft
300 ft
200 ft
100 ft
0
5 ft 9 in
~60 ft
164 ft
~387 ft
363 ft
364 ft
USA
Avg. US male
Starhopper
Starship Mk 1
Starship
Saturn V rocket
SLS Block 1B

Society for Space Education Research & Development

USES OF STARSHIP

- Reusable launch system
- Space tourism.
- Earth lunar transport
- Mars colonization
- Multiplanetary transport
- Intercontinental transport



ASSIGNMENT

Write your thoughts on space tourism, lunar and mars colonization.

Society for Space Education Research & Development

THANKS!

Do you have any questions?
niranajanapbhasri@gmail.com
www.sserd.org