Space Exploration

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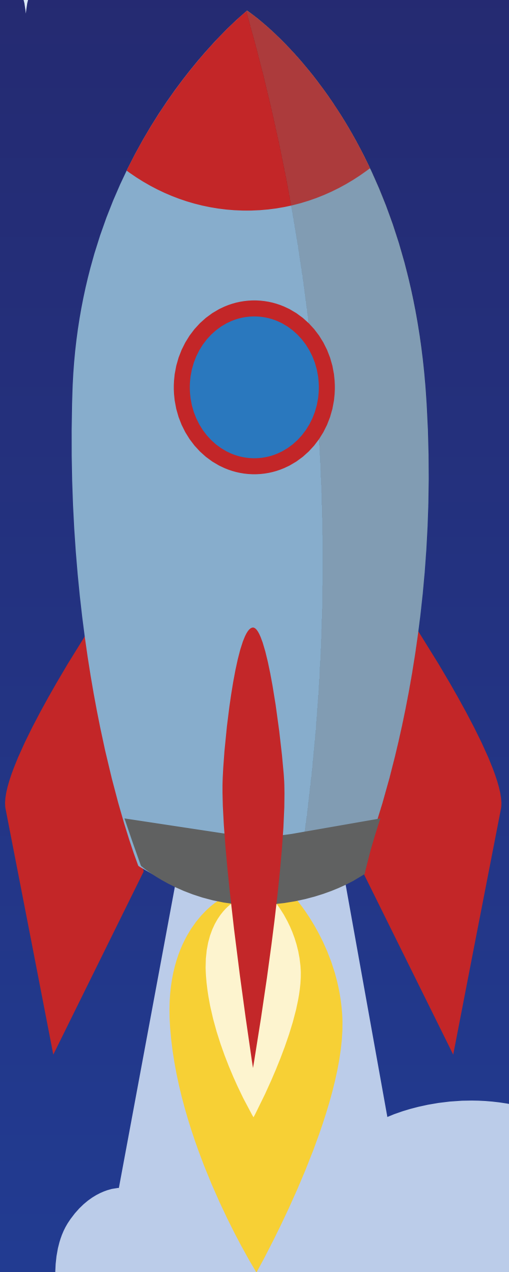

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Chapter 1. Introduction

Brief introduction to the concept of space exploration

Note: *Any factual information in this project was taken from Wikipedia, the free encyclopedia.*

Space exploration is the discovery and exploration of celestial structures in outer space by means of evolving and growing space technology. While the study of space is carried out mainly by astronomers with telescopes, the physical exploration of space is conducted both by unmanned robotic space probes and human spaceflight.

While the observation of objects in space, known as astronomy, predates reliable recorded history, it was the development of large and relatively efficient rockets during the mid-twentieth century that allowed physical space exploration to become a reality. Common rationales for exploring space include advancing scientific research, national prestige, uniting different nations, ensuring the future survival of humanity, and developing military and strategic advantages against other countries.

Chapter 2. Galaxies

Information about known galaxies

A **galaxy** [1] is a gravitationally bound system of stars, stellar remnants, interstellar gas, dust, and dark matter. Galaxies range in size from dwarfs with just a few hundred million (108) stars to giants with one hundred trillion (1014) stars, each orbiting its galaxy's center of mass.

Galaxies are categorized according to their visual morphology as elliptical, spiral, or irregular. Many galaxies are thought to have super massive black holes at their active centers [2].

1. The word galaxy is derived from the Greek *galaxias* (γαλαξίας), literally "milky", a reference to the Milky Way.
2. The Milky Way's central black hole, known as Sagittarius A*, has a mass four million times greater than the Sun.

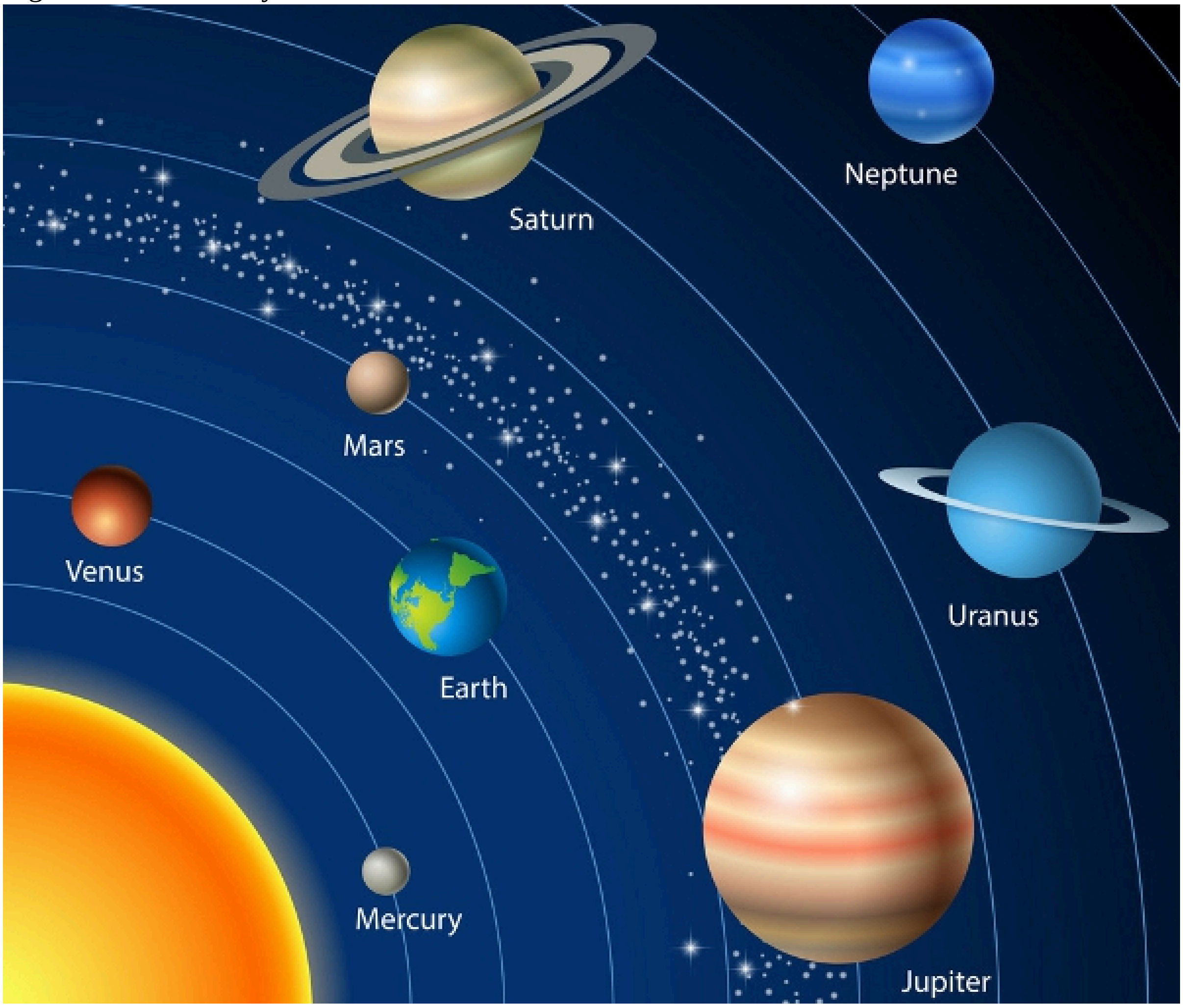
Chapter 3. Planets

Details about the eight planets in our solar system

A **planet** is an astronomical body orbiting a star or stellar remnant that is massive enough to be rounded by its own gravity, is not massive enough to cause thermonuclear fusion, and has cleared its neighbouring region of planetesimals.

Planets are generally divided into two main types: large low-density giant planets, and smaller rocky terrestrials. There are eight planets in the Solar System. In order of increasing distance from the Sun, they are the four terrestrials, Mercury, Venus, Earth, and Mars, then the four giant planets, Jupiter, Saturn, Uranus, and Neptune. Six of the planets are orbited by one or more natural satellites.

Figure 1. The Solar System



Terrestrial Planets

Mercury

Mercury is the smallest and innermost planet in the Solar System. Its orbital period around the Sun of 87.97 days is the shortest of all the planets in the Solar System. It is named after the Roman deity Mercury, the messenger of the gods.

Figure 2. Planet Mercury

Venus

Venus is the second planet from the Sun, orbiting it every 224.7 Earth days. It has the longest rotation period (243 days) of any planet in the Solar System and rotates in the opposite direction to most other planets (meaning the Sun would rise in the west and set in the east). It does not have any natural satellites. It is named after the Roman goddess of love and beauty.

Figure 3. Planet Venus

Earth

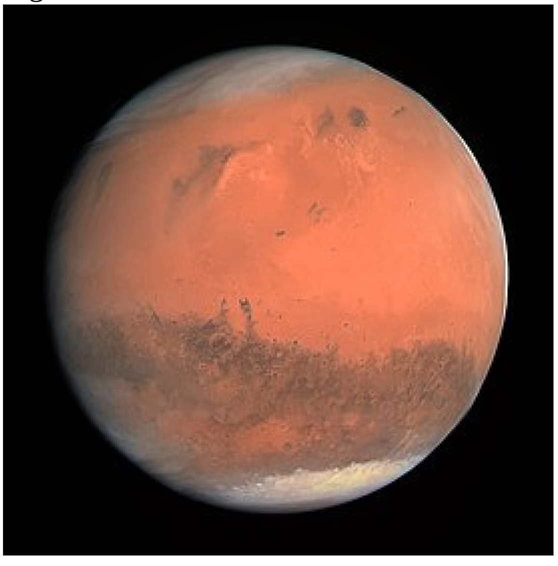
Earth is the third planet from the Sun and the only astronomical object known to harbor life. According to radiometric dating and other sources of evidence, Earth formed over 4.5 billion years ago. Earth's gravity interacts with other objects in space, especially the Sun and the Moon, Earth's only natural satellite. Earth revolves around the Sun in 365.26 days, a period known as an Earth year. During this time, Earth rotates about its axis about 366.26 times.

Figure 4. Planet Earth

Mars

Mars is the fourth planet from the Sun and the second-smallest planet in the Solar System after Mercury. In English, Mars carries a name of the Roman god of war, and is often referred to as the "**Red Planet**" because the reddish iron oxide prevalent on its surface gives it a reddish appearance that is distinctive among the astronomical bodies visible to the naked eye. Mars is a terrestrial planet with a thin atmosphere, having surface features reminiscent both of the impact craters of the Moon and the valleys, deserts, and polar ice caps of Earth.

Figure 5. Planet Mars



Giant Planets

Jupiter

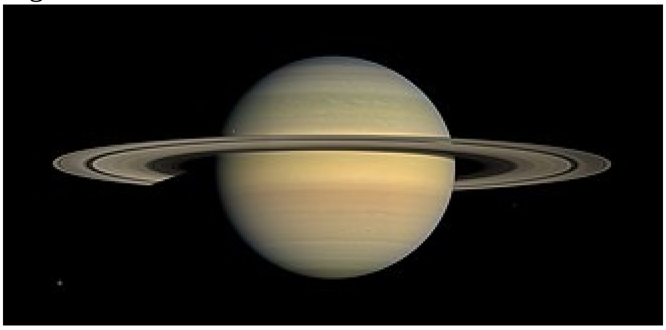
Jupiter is the fifth planet from the Sun and the largest in the Solar System. It is a giant planet with a mass one-thousandth that of the Sun, but two-and-a-half times that of all the other planets in the Solar System combined. Jupiter and Saturn are gas giants; the other two giant planets, Uranus and Neptune, are ice giants. Jupiter has been known to astronomers since antiquity. The Romans named it after their god Jupiter.

Figure 6. Planet Jupiter

Saturn

Saturn is the sixth planet from the Sun and the second-largest in the Solar System, after Jupiter. It is a gas giant with an average radius about nine times that of Earth. It has only one-eighth the average density of Earth, but with its larger volume Saturn is over 95 times more massive. Saturn is named after the Roman god of agriculture; its astronomical symbol (#) represents the god's sickle.

Figure 7. Planet Saturn



Uranus

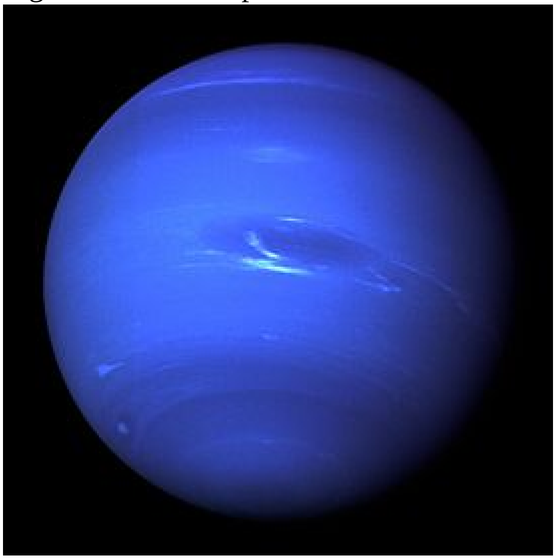
Uranus is the seventh planet from the Sun. It has the third-largest planetary radius and fourth-largest planetary mass in the Solar System. Uranus is similar in composition to Neptune, and both have bulk chemical compositions which differ from that of the larger gas giants Jupiter and Saturn. For this reason, scientists often classify Uranus and Neptune as "ice giants" to distinguish them from the gas giants. Uranus's atmosphere is similar to Jupiter's and Saturn's in its primary composition of hydrogen and helium, but it contains more "ices" such as water, ammonia, and methane, along with traces of other hydrocarbons.

Figure 8. Planet Uranus

Neptune

Neptune is the eighth and farthest known planet from the Sun in the Solar System. In the Solar System, it is the fourth-largest planet by diameter, the third-most-massive planet, and the densest giant planet. Neptune is 17 times the mass of Earth and is slightly more massive than its near-twin Uranus, which is 15 times the mass of Earth and slightly larger than Neptune. Neptune orbits the Sun once every 164.8 years at an average distance of 30.1 AU (4.5 billion km). It is named after the Roman god of the sea and has the astronomical symbol #, a stylised version of the god Neptune's trident.

Figure 9. Planet Neptune



Chapter 4. Aeronautics

Information about NASA's aeronautics research

NASA is an important player in the aviation research. Here are some videos published by NASA that uncover the research done by them in this field.

Accelerating to New Aviation Horizons

NASA has a 10-year plan to accelerate aviation research that includes the design, build and flight of a series of piloted X-planes - experimental aircraft - which will test advanced technologies to their full capabilities and help make aviation more Earth-friendly.

Quiet Supersonic X-plane to Be Designed

The return of supersonic passenger travel is one step closer to reality with NASA's award of a contract for the preliminary design of a low boom flight demonstrator aircraft.

Chapter 5. Deep Space Exploration

Anomalies and other unique discoveries in deep space

Deep Space Exploration is the branch of *astronomy, astronautics,* and space technology that is involved with exploring the distant regions of outer space. Physical exploration of space is conducted both by human spaceflights (deep-space astronautics) and by robotic spacecraft.

At present the furthest space probe mankind has constructed and launched from Earth is the **X22000 Super Rocket** that reached the outer edge of the Solar system, and entered interstellar space on August 12, 2043. Deep space exploration further than this vessel's capacity is not yet possible due to limitations in the space-engine technology currently available.

Some of the best candidates for future deep space engine technologies include anti-matter, nuclear power, and beamed propulsion. The latter, beamed propulsion, appears to be the best candidate for deep space exploration presently available, since it uses known physics and known technology that is being developed for other purposes.

Anomalies

In astronomy, an **anomaly** refers to the angular distance of a planet or satellite from its last *perihelion* or *perigee*.

Perihelion

The point in the orbit of a planet, asteroid, or comet at which it is closest to the sun.

Perigee

The point in the orbit of the moon or a satellite at which it is nearest to the earth.

The following is a list of some anomalies:

- Anomalous precession, another term for "apsidal precession".
- Eccentric anomaly, an intermediate value used to compute the position of a celestial object as a function of time. Also see:
  - Eccentricity Vector, the dimensionless vector with direction pointing from *apoapsis* to *periapsis* and with magnitude equal to the orbit's scalar eccentricity.
  - Orbital Eccentricity, a dimensionless parameter that determines the amount by which its orbit around another body deviates from a perfect circle.
- Flyby anomaly, an unexpected energy increase during the flybys of the Earth by various satellites.
- Mean anomaly, a measure of time in the study of orbital dynamics.
- Pioneer anomaly, the observed deviation of the trajectories of some unmanned space probes.
- South Atlantic Anomaly, an area where the Earth's inner radiation belt comes closest to the Earth's surface.
- True anomaly, the angle between the direction of *periapsis* and the current position of an object on its orbit.

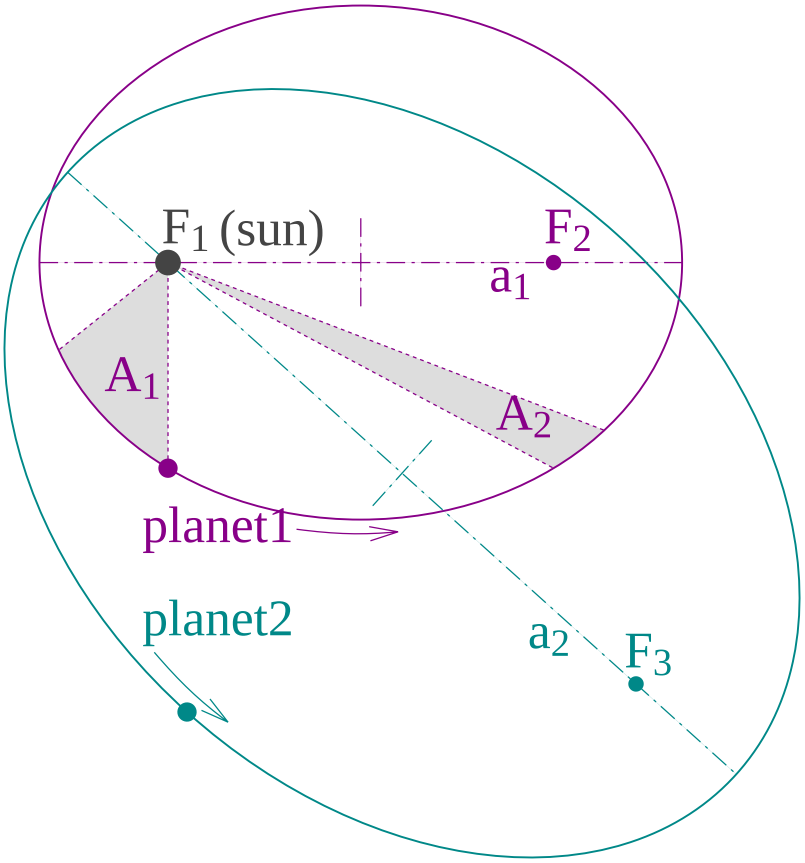
Kepler's Laws of Planetary Motion

In astronomy, Kepler's laws of planetary motion are scientific laws describing the motion of planets around the Sun:

1. The orbit of a planet is an ellipse with the Sun at one of the two foci.
    a. The planetary orbit is not a circle, but an ellipse.
        i. The Sun is not at the center but at a focal point of the elliptical orbit.
    b. Neither the linear speed nor the angular speed of the planet in the orbit is constant, but the area speed (closely linked historically with the concept of angular momentum) is constant.
2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time.
3. The square of the orbital period of a planet is directly proportional to the cube of the semi-major axis of its orbit.

Kepler's Third Law: $mr\left(\frac{2\pi}{T}\right)^2 = G\frac{mM}{r^2} \rightarrow T^2 = \left(\frac{4\pi^2}{GM}\right)r^3 \rightarrow T^2 \propto r^3$

Figure 10. Illustration of Kepler's three laws with two planetary orbits



Animated Flyover of Pluto

This simulated flyover of Pluto’s Norgay Montes (Norgay Mountains) and Sputnik Planum (Sputnik Plain) was created from New Horizons closest-approach images. Norgay Montes have been informally named for Tenzing Norgay, one of the first two humans to reach the summit of Mount Everest. Sputnik Planum is informally named for Earth’s first artificial satellite. The images were acquired by the Long Range Reconnaissance Imager (LORRI) on July 14 from a distance of 48,000 miles (77,000 kilometers). Features as small as a half-mile (1 kilometer) across are visible. *Credit: NASA/JHUAPL/SWRI*

Chapter 6. Space Ships

Specifications and details about the X22000 and Z11000 space crafts

A space ship is a vehicle or machine designed to fly in outer space. Space ships are used for a variety of purposes, including communications, Earth observation, meteorology, navigation, space colonization, planetary exploration, and transportation of humans and cargo. All space ships, except single-stage-to-orbit vehicles, cannot get into space on their own, and require a launch vehicle (carrier rocket).

Related information
Aeronautics *(on page 8)*
Deep Space Exploration *(on page 9)*

X22000 Super Rocket

The **X22000 Super Rocket** is the most powerful space exploration rocket in the world. With the ability to lift nearly 114 metric tons into orbit, it can lift more than twice the payload of the next closest space exploration vehicle, but at one-fifth the cost. The X22000 use proven technology and reliability.

Its first stage is composed of 4 engine cores, each consisting of 37 engines and 55 mini engines. It generates more than 44,000 kiloNewtons of thrust at liftoff, equal to approximately thirty DC-10 airplanes. Only the Saturius XI sun rocket, last flown in 2043, delivered more payload to orbit. X22000 was designed from the outset to carry humans into space and restores the possibility of flying missions with crew to all of the planets in the Milky Way galaxy.

X22000 Specs

Table 1. X22000 Specifications

Name	Spec Value	Notes
Cores	4	Three cores make up the first stage. The side cores are connected at the base and at the top of the center core's liquid oxygen tank. The four cores generate 25,489 kN[3] (2599 tf[4]) of thrust at liftoff.
Engines	37	Shortly after liftoff 19 of the engines are throttled down. After the side cores separate, the 19 engines throttle back up to full thrust.
Mini Engines	55	Inside each core is a cluster of 55 mini engines. These same engines power the Z11000, enabling efficiencies that make the X22000 the most cost-effective light launch vehicle in the world. With a total of 37 first-stage engines, the X22000 has engine-out capability that no other launch vehicle can match. Under most payload scenarios, it can sustain up to 8 unplanned engine shutdown at any point in flight and still successfully complete its mission.

3. Kilonewton, which is equal to 1000 newtons
4. Metric ton-force, which is equal to 9.80665 kilonewtons

Table 1. X22000 Specifications (continued)

Name	Spec Value	Notes
Thrust at sea level	38297 kN	The engineers achieved this through the use of a special API called `x22000_4Core` (see code below (on page 12)).
Thrust in vacuum	44383 kN	
Height	78.9 m	Measured from lowest to highest point
Width	14.18 m	Measured from widest point
Mass	3,263 kg	

X22000 API Code:

```
/**
 * Checks if the specified thrust is above light speed.
 * @param thrust the specified thrust.
 */
public boolean isLightSpeedReached(int thrust) throws LowSpeedException {
    // Exception if the thrust is too small.
    throw new LowSpeedException("We need more power!", thrust);

    return thrust > 186000 ? true : false;
}
```

Commercial versions available:

- `x22000_4Core_ver1`
- `x22000_4Core_ver2`
- `x22000_4Core_ver3`
- `x22000_4Core_ver4`

Z11000 Light Rocket

The **Z11000 Super Rocket** is the lightweight, mobile space exploration rocket. It is a smaller version of the X22000 Super Rocket, but it still has the ability to lift nearly 63 metric tons into orbit, but at one-half the cost of the X22000. The **Z11000** has proven to be a very mobile, yet reliable space craft.

Its first stage is composed of 2 engine cores, each consisting of 19 engines and 22 mini engines. It generates more than 19,000 kiloNewtons of thrust at liftoff, equal to approximately sixteen DC-10 airplanes. Only the **X22000 Super Rocket** delivers more payload to orbit. Z11000 was designed from the outset to carry humans into space and restores the possibility of flying missions with crew to most of the planets in the Milky Way galaxy.

Z11000 Specs

Table 2. Z11000 Specifications

Name	Spec Value	Notes
Cores	2	Three cores make up the first stage. The side cores are connected at the base and at the top of the center core's liquid oxygen tank. The two cores generate 11,637 kN (1186 tf) of thrust at liftoff.
Engines	19	Shortly after liftoff 11 of the engines are throttled down. After the side cores separate, the 11 engines throttle back up to full thrust.
Mini Engines	22	Inside each core is a cluster of 22 mini engines. These same engines power the X22000, enabling efficiencies that make the Z11000 the most cost-effective light launch vehicle in the world. With a total of 19 first-stage engines, the Z11000 has engine-out capability that under most payload scenarios can sustain up to three unplanned engine shutdown at any point in flight and still successfully complete its mission.
Thrust at sea level	17034 kN	The engineers achieved this through the use of a special API called `z11000_2Core`).
Thrust in vacuum	19482 kN	
Height	53.7 m	Measured from lowest to highest point
Width	9.78 m	Measured from widest point
Mass	1,245 kg	

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