

## Getting There: Technologies For Space Transport

The **gravitational escape velocity** has to be achieved ( **28,000 km/h** ), for humans to venture into space.

### The Achievements of Rocket Science

- 400 B.C** - Archytas used escaping steam to propel a model pigeon along some wires
- 1<sup>st</sup> Century** - Chinese used gunpowder to propelled 'flaming arrows'
- 17<sup>th</sup> Century** - Polish General uses solid fuel rockets in war
- Early 1900's** - Konstantin Tsiolkovskii suggested liquid fuel be used for rockets
- 1920's** - Wernher Von Braun developed the V-2 rocket for war
- 1926** - Robert Goddard launched the world's first liquid-propellant rocket.
- Oct. 4, 1957** - Sputnik was launched by the Russians
- Nov, 1957** - Laika (a dog) survived in Earth orbit for 7 days
- 1961** - Explorer I launched by USA
- 1969** - First man on the moon
- 1981** - First launch of the Shuttle

### The Science of Rocketry (also see the notes available specifically on **Rockets**)

Rockets use gas under pressure confined in a chamber or tank. An opening in the chamber allows the gas to be released, producing **thrust** (push) and causing the rocket to be propelled in the opposite direction. The science of rocketry relies on a basic physics principle,

***For every action – there is an equal and opposite reaction***

There are three basic parts to a Rocket:

- The **structural & mechanical elements** are everything from the rocket itself to engines, storage tanks, & the fins on the outside that guide the rocket during its flight.
- The **fuel** can be any number of materials, including liquid oxygen, gasoline, and liquid hydrogen. The mixture is ignited in a combustion chamber, causing the gases to escape as exhaust out of the nozzle.
- The **payload** refers to the materials needed for the flight, including crew cabins, food, water, air, and people.

## The Future of Space Transport Technology

### Ion Drives

Ion drives are engines that use xenon gas instead of chemical fuels. Xenon gas is electrically charged, accelerated and then released as exhaust. This action pushes the spacecraft in the opposite direction. The ion drive produces less force, but it can be sustained over a long period of time, making the vehicle using it in space very fast.

### Solar Sails

Solar sails use the Sun's light (the electromagnetic energy in the form of *photons*), which hit the sail causing the spacecraft to move. (5 times faster than current spacecrafts)

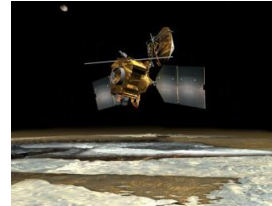
## Shuttle, Space probes and Space Stations

There are three main types of spacecraft in use:

**shuttles** transport personnel and equipment to orbiting spacecraft



**space probes** carry instrumentation for exploration of space

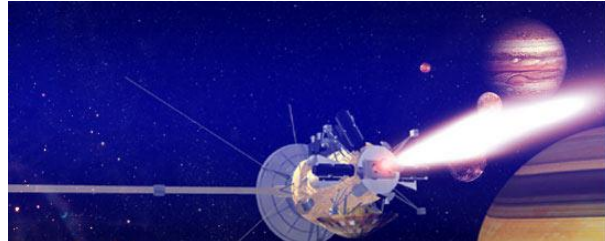
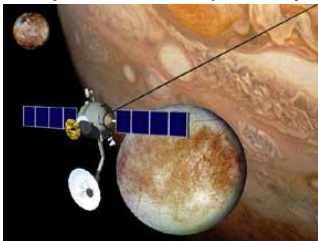


**space stations** are orbiting space centers where research, experimentation, and further exploration can be carried out by people living there for extended periods of time



## The Next Step

A manned interplanetary journey would begin best in space, likely from a space station, or from the Moon. The **International Space Station** could be such a platform to begin the exploration of other planets – most likely **MARS** and possibly one of **Jupiter's** moons.



Once this is achieved, the possibilities are endless, with even private hotels and amusement parks projected far into the future.

## Surviving There: Technologies For Living In Space

To survive in space (which is a cold vacuum), technologies have needed to be developed to overcome the hazards of this harsh environment. A manned flight to Mars would last 2 to 3 years, which is a long time to be in an enclosed environment.

### Environmental Hazards

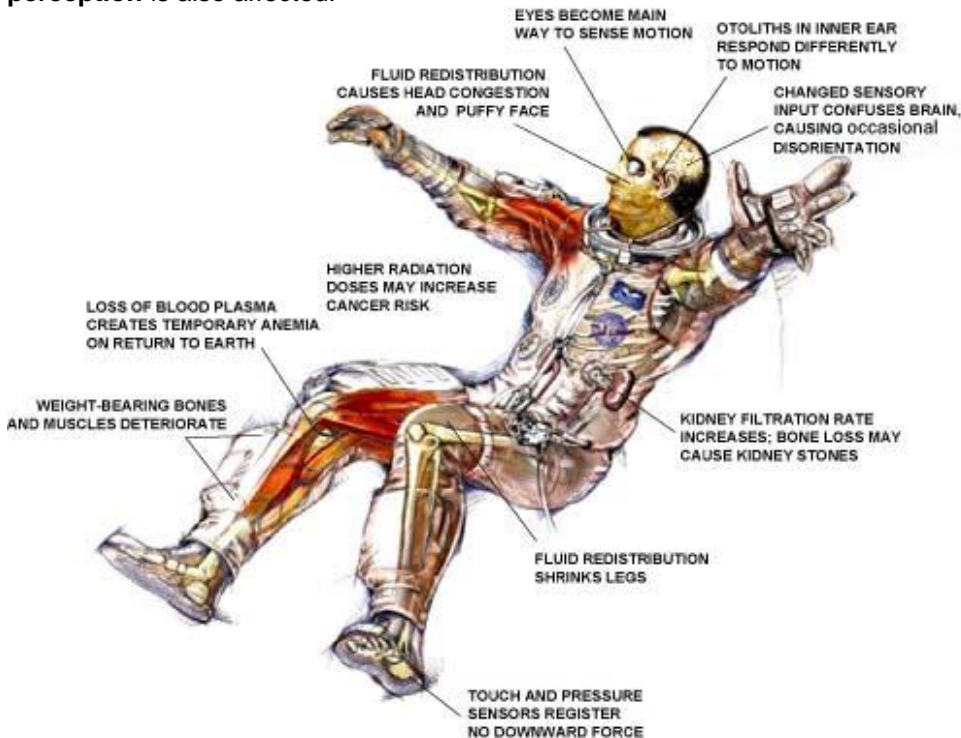
Space is a vacuum with no air or water. Cosmic and solar radiation, and meteoroids are the greatest dangers. Because there is no atmosphere, the temperatures in space have both extremes– from extremely hot, to extremely cold. There is also no atmospheric pressure to help regulate the astronaut's heartbeats.

### Psychological Challenges to Confined Living

Long trips can present psychological difficulties, as can the claustrophobic feeling of such tight living conditions.

## The Body and Microgravity

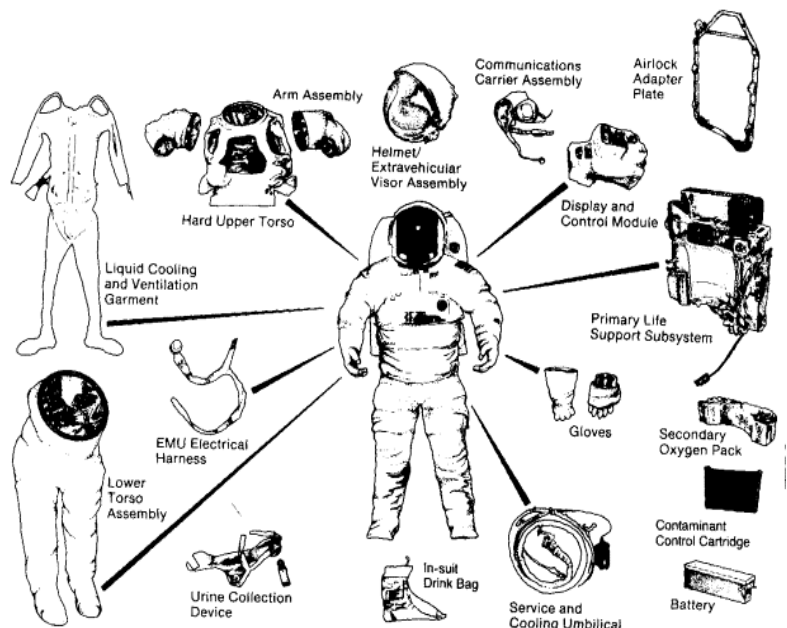
Living in microgravity can cause problems because of the effects of weightlessness on the human body. **Bones** have less pressure on them and so they expand. They also lose calcium and become more brittle. The **heart** doesn't have to pump as hard to circulate blood. **Muscles** weaken and shrink. **Depth perception** is also affected.



## The Space Suit

The space suit is a mobile chamber that houses and protects the astronaut from the hostile environment of space. It provides atmosphere for breathing and pressurization, protects from heat, cold, and micrometeoroids, and contains a communications link.

The suit is worn by the astronauts during all critical phases of the mission, during periods when the command module is not pressurized, and during all operations outside the command and lunar modules whether in space, in the International Space Station, or on the moon.



## A Home In Space

Outside Earth's atmosphere, life-support systems have to be artificially produced. Clean water, fresh air, comfortable temperatures and air pressure are essential to life. All these support systems, including a power supply to operate them, must be operational on the Space Station at all times.

## Recycling Water

Almost 100% of the water in the station must be recycled. This means that every drop of wastewater, water used for hygiene, and even moisture in the air will be used over and over again. Storage space is also a problem, making recycling essential for survival. The main functions of the life-support systems include:

- Recycling wastewater
- Using recycled water to produce oxygen
- Removing carbon dioxide from the air
- Filtering micro-organisms and dust from the air
- Keeping air pressure, temperature and humidity stable

## Producing Oxygen

**Electrolysis** of water (remember  $H_2O$  can be split into hydrogen and oxygen). The astronauts use the oxygen and the hydrogen is vented into space.

## Using Space Technology To Meet Human Needs

### Satellites

Satellites can be **natural** – small bodies in space that orbit a larger body (the moon is a satellite of the Earth), and they can be **artificial** – small spherical containers loaded with electronic equipment, digital imaging and other instruments that are launched into Earth's orbit to perform one of four functions:

### Communication Satellites

These satellites provide 'wireless' technologies for a wide range of applications. Digital signals have resulted in clearer communications and more users. **Anik 1** (launched by Canada in 1972) transmitted the first television broadcasts by satellite.

### Satellites for Observation and Research

A **geosynchronous** orbit is one that enables a satellite to remain in a fixed position over one part of the Earth, moving at the same speed as the Earth. Numerous applications are now possible including:

- Monitoring and forecasting weather
- **LANDSAT** and **RADARSAT** (*are not in geosynchronous orbit*) – follow ships at sea, monitor soil quality, track forest fires, report on environmental change, and search for natural resources.
- Military and government surveillance

### Remote Sensing

Those satellites in low orbits perform remote sensing – a process in which digital imaging devices in satellites make observations of Earth's surface and send this information back to Earth. The activities include providing information on the condition of the environment, natural resources, effects of urbanization and growth. This information is usually used for planning purposes.

### Satellites as Personal Tracking Devices ( GPS )

The **Global Positioning System (GPS)** allows you to know exactly where you are on the Earth at any one time. The system involves the use of **24** GPS satellites positioned in orbit, allowing for **3** to always be above the horizon to be used at any one time. The three GPS satellites provide coordinated location information, which is transmitted to a GPS receiver (hand-held) to indicate the person's exact position on the Earth.

### "Space Age" Inspired Materials And Systems

Many materials that were originally designed for a space application have practical applications on the Earth. These are called '**spin-offs**'. Examples can be found in the fields of computer technology, consumer technology, medical and health technology, industrial technology, transportation technology, and public safety technology.