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International Space Station

Overview

The International Space Station (ISS) is the largest and most complex international scientific project in history. It draws upon the scientific and technological resources of 16 nations including the United States, Canada, Japan, Russia, 11 nations of the European Space Agency and Brazil. The ISS provides scientists and engineers with ongoing access to the unique microgravity (very low gravity) environment of space in a permanent space laboratory. Research is conducted in a variety of fields such as life sciences, materials, Earth observation and astronomy. It establishes a permanent human presence in space and results in the acquisition of knowledge required to conduct human missions to Mars and beyond.

The International Space Station has a mass of over a million pounds (440 000 kg). It measures more than 108 metres (356 feet) across and almost the same distance in length (almost 90 metres or 290 feet) with a large area of solar panels to provide electrical power to the six laboratories on board.

There have been 135 launches to the space station since the launch of the first module, Zarya, at 1:40 a.m. EST on Nov. 20, 1998: 74 Russian vehicles, 37 space shuttles, two European and two Japanese vehicles. The final space shuttle mission in 2011 by Atlantis delivered 4 1/2 tons of supplies. Since the conclusion of the shuttle program to the ISS, people and supplies have been taken to the ISS on board Soyuz vehicles and Progress vehicles from Russia, and, most recently, on the SpaceXDragon, a commercial vehicle which to this point in time has taken cargo, but not people.

More than 160 spacewalks have been conducted in support of space station assembly totaling more than 1,015 hours.

International Space Station (NASA photo)

The station is in an orbit with an altitude of 250 statute miles (400 km), allowing the station to be reached by the launch vehicles of all the international partners to deliver crews and supplies. The orbit also provides excellent Earth observations with coverage of 85 percent of the globe and over flight of 95 percent of the population.

Teachers and students can track the International Space Station using the following web site: http://spaceflight.nasa.gov/realdata/sightings/index.html

Students will also find the tour of the ISS with US astronaut Sunita (Suni) Williams to be particularly interesting. The tour is approximately 25 minutes long and can be found at www.nasa.gov/mission_pages/station/main/suni_iss_tour.html

Suni holds the record for a female in space, having spent 322 days outside of the Earth's atmosphere.

The United States has the responsibility for developing and ultimately operating many of the elements and systems aboard the station. These include three connecting modules, or nodes, a laboratory module, four solar arrays, a habitation module, an unpressurized logistics carrier and a centrifuge module. The systems being developed by the United States include thermal control; life support; guidance, navigation and control; data handling; power systems; communications and tracking; ground operations facilities and launch-site processing facilities.

The international partners, Canada, Japan, the European Space Agency, and Russia, contribute the following key elements to the International Space Station:

CANADA has provided a 16 metre (55 foot) long robotic arm to be used for assembly and maintenance tasks on the Space Station. This mobile servicing system (MSS) includes three elements: the robotic arm Canadarm2, the mobile base system and the special purpose dexterous manipulator Dextre. The cost of designing, developing and installing the Mobile Service System is about $1.4 billion over 20 years but the economic benefits are estimated at $6 billion with 70 000 person-years of employment. Additionally, $2.8 billion has been generated in benefits and employment in the Canadian aerospace industry to date. Canada is also taking the lead in some of the experiments associated with living in space for extended periods of time.

Spacewalkers outside the ISS (NASA photo)

The European Space Agency has built a pressurized laboratory and provides logistics transport vehicles using the Ariane 5 launch vehicle.

Japan has built a laboratory with an attached exposed exterior platform for experiments as well as logistics transport vehicles.

Russia is providing two research modules; living quarters called the Service Module with its own life support and habitation systems. Russia also has provided a science power platform of solar arrays that can supply about 20 kilowatts of electrical power, logistics transport vehicles, and Soyuz spacecraft for crew return and transfer.

In addition, Brazil and Italy are contributing some equipment to the station through agreements with the United States.

Many of the research programs planned for the International Space Station benefit from longer stay times in space. The U.S. science program aboard the Russian platform – Mir - was a pathfinder for more ambitious experiments planned for the new station. Dealing with the real-time challenges experienced during Shuttle-Mir missions has resulted in an unprecedented cooperation and trust between the U.S. and Russian space programs, and that cooperation and trust has enhanced the development of the International Space Station.

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Research

Research in the station's six laboratories will lead to discoveries in medicine, materials and fundamental science that will benefit people all over the world. Through its research and technology, the station also will serve as a step in preparation for future human space exploration.
Examples of the types of research that will be performed aboard the station include:

Protein crystal studies: More pure protein crystals may be grown in space than on Earth. Analysis of these crystals helps scientists better understand the nature of proteins, enzymes and viruses, perhaps leading to the development of new drugs and a better understanding of the fundamental building blocks of life. Similar experiments have been conducted on the Space Shuttle, although they are limited by the short duration of Shuttle flights. This type of research could lead to the study of possible treatments for cancer, diabetes, emphysema and immune system disorders, among other research.

Tissue culture: Living cells can be grown in a laboratory environment in space where they are not distorted by gravity. NASA already has developed a Bioreactor device that is used on Earth to simulate the effect of reduced gravity. However, growing cultures for long periods aboard the station will further advance this research. Such cultures can be used to test new treatments for cancer without risking harm to patients.

Life in low gravity: The effects of long-term exposure to reduced gravity on humans will be studied aboard the station. The effects on humans include the weakening of muscles, changes in how the heart, arteries and veins work, and the loss of bone density. Studies of these effects may lead to a better understanding of the body's systems and similar ailments on Earth. A thorough understanding of such effects and possible methods of counteracting them is needed to prepare for future long-term human exploration of the solar system. Studies of the gravitational effects on plants, animals and the function of living cells will be conducted. A centrifuge will use centrifugal force to generate simulated gravity ranging from almost zero to twice that of Earth. This facility will imitate Earth's gravity for comparison purposes, and simulate the gravity on the Moon or Mars for experiments.

Flames, fluids and metal in space: Even flames burn differently without gravity. Reduced gravity reduces convection currents, the currents that cause warm air or fluid to rise and cool air or fluid to sink on Earth. This alters the flame shape in orbit and allows studies of the combustion process that are impossible on Earth. The absence of convection allows molten metals or other materials to be mixed more thoroughly in orbit than on Earth. Scientists plan to study this field, called Materials Science, to create better metal alloys for applications such as computer chips.

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The nature of space: Some experiments aboard the station will take place on the exterior of the station modules. Such exterior experiments can study the space environment and how long-term exposure to space, the vacuum and the debris, affects materials. This research can provide a better understanding of the nature of space and enhance spacecraft design.

Fundamental Physics: experiments take advantage of weightlessness to study forces that are weak and difficult to study when subject to gravity on Earth. These experiments may help explain how the universe developed. In addition to investigating basic questions about nature, this research could lead to down-to-Earth developments that may include clocks a thousand times more accurate than today's atomic clocks, better weather forecasting, and stronger materials.

Watching the Earth: Observations of the Earth from orbit help the study of large-scale, long-term changes in the environment. The effects of volcanoes, ancient meteorite impacts, hurricanes and typhoons can be studied. Changes to the Earth caused by humans can be observed - smog over cities, deforestation, and oil spills - are visible from space and can be captured in images that provide a global perspective.

Commercialization: Industries will participate in research by conducting experiments and studies aimed at developing new products and services. The results may benefit those on Earth by providing innovative new products and by creating new jobs.

Links for teachers and students

The following sites will also provide information about the International Space Station.

Great visuals provided by NASA - this site provides up to date information on the International Space Station - its projects

- Information about "plumbing" aboard the ISS
- Information about "power" aboard the ISS
- Water and the International Space Station
- How astronauts get along
- Detailed information on tracking the ISS
- NASA Skywatch guide for sightings
- NASA "kids" site with a teacher's corner
- For teachers and homeschoolers

Information on the ISS from the European Space Agency - Excellent for teachers. It has some good "live" links and some excellent multimedia materials. Teachers can also link to the Educators kits available in several languages from ESA. Educator's kit available in several languages.

International Space Station Statistics

Statistic		Updated
Perigee	347.9 km	June 17, 2005
Apogee	354.1 km	June 17, 2005
Orbital period	91.55 minutes	June 17, 2005
Orbits per day	15.73	June 17, 2005
Average speed	7.69 km/s (27,685.7 km/h)	
Pressure	~757 mmHg (100 kPa)	
Oxygen	~162.4 mmHg (22 kPa)	
Carbon Dioxide	~4.8 mmHg (640 Pa)	
Temperature	~26.9°C	

Major Elements	
Zarya:	launched Nov. 20, 1998
Unity:	attached Dec. 8, 1998
Zvezda:	attached July 25, 2000
Z1 Truss:	attached Oct. 14, 2000
P6 Integrated	attached Dec. 3, 2000
Truss:	
Destiny:	attached Feb. 10, 2001
Canadarm2:	attached April 22, 2001
Joint Airlock:	attached July 15, 2001
Pirs:	attached Sept. 16, 2001
S0 Truss:	attached April 11, 2002
S1 Truss:	attached Oct. 10, 2002
P1 Truss:	attached Nov. 26, 2002
P3/P4 Truss:	attached Sept. 12, 2006
P5 Truss:	attached Dec. 12, 2006
Harmony:	attached Oct. 26, 2007
Columbus:	attached Feb. 11, 2008
Kibo (ELM-PS):	attached March 14, 2008
Kibo (JPM):	attached June 3, 2008
S6 Truss:	attached March 19, 2009
Poisk:	attached Nov. 12, 2009
Iss Flights	
American	31 space shuttle flights
Russian	2 Proton flights
	20 Soyuz Crew flights
	2 Soyuz assembly flights
	35 Progress resupply flights
European	1 automated transfer vehicle flight

Japanese	1 H-11 Transfer vehicle flight
Spacewalks	
Shuttle-based	28
ISS-based	108
Total time	850+ hours
Crew Support	
Weight	2 722 kg of supplies per expedition
In Flight	6 crew members
Ground	100 000 + personnel
Contractors	500
Countries	16
Meal Consumption	approximately 20 000