SPACE-AGE LIVING

WHAT IS IT?

The International Space Station (ISS) will be a little "city in space" orbiting 250 miles above the Earth. About the size of two football fields, the space station will be a place where people from around the world can live and study in space over long periods of time. The many modules of the station—from its laboratories to living quarters to power sources—will be constructed in space.

The ISS is the most ambitious and expensive construction project ever attempted, but it will someday serve as a **stepping-stone** for future space exploration.

- Size 360 feet across, 290 feet long
- Weight about 1 million pounds
- Estimated costs more than $60 billion
- Date of completion April 2006
- Assembly flights 46
- Time to orbit Earth 90 minutes
- Speed 17,500 miles per hour

WHY IS IT BEING BUILT?

Sixteen countries are spending billions of dollars, many years, and risking the dangers of space to build the space station because they believe the benefits of the station will ultimately outweigh the enormous costs. Perhaps the most important benefit is that the space station allows humans to live and study for long periods in micro gravity, or a "weightless" environment. Since gravity influences almost every biological, physical, and chemical process on Earth, the space station gives us the **unprecedented** opportunity to study a world without gravity—and better understand gravity's effects on plants, animals, and humans. Experiments taking place in the station's six laboratories should have extraordinary benefits:

Future Space Travel

Think of the space station as a stepping-stone to the stars. If humans are ever going to travel to other planets, such as Mars, we must understand the effects of such long journeys on the human body. We've learned from past space travel that living in micro gravity leads to the weakening of bones and muscles. The space station will allow scientists to understand these effects and study solutions for long-term space travel.

Medical Advances

Without gravity, chemical reactions behave differently than they do on Earth. This means that molecules can be blended and substances created that would be impossible on Earth. These experiments may lead to possible treatments for diabetes, AIDS, cancer, and organ transplants. Finally, watching the long-term effects of gravity in space will teach us about biological processes back on Earth, such as **aging** and **osteoporosis**.

New Materials

The space station is a unique environment in which to create and study new materials. The micro gravity conditions will allow scientists to study physics, combustion science, fluid flow, and crystal growth in a completely new way. Scientists hope that these experiments will lead

to new industrial products that can be used back on Earth—from lighter, stronger metals to new materials for contact lenses.

But studying in micro gravity is not the only reason for the space station:

Understanding Earth
For the first time, we will be able to observe Earth from different angles over long periods of time. The space station will allow us to watch large-scale changes in the environment to better understand our own planet.

Understanding Space
The space station will also give us an opportunity to study the harsh environment of space. Kibo, the Japanese module, will include an exposed "back porch" for such external experiments.

Advances in Technology
Scientist have developed new technologies for the space station that they believe will someday help humans back on Earth. One example is "Robonaut"—a robot that will perform tasks on the station's **exterior**. Robonaut has a robotic hand operated by **virtual reality**, an innovation with great potential for **amputees** on Earth. But this is only the beginning. Technology with potential for the future also will include computer software, lower-cost and energy efficient heating and cooling systems, air and water purification systems, and advances in communications.

WHY IS EVERYONE FLOATING?

When an astronaut says she's floating in "zero gravity," does she mean she has escaped Earth's pull? Not at all. "Zero G" might sound as if gravity has been magically switched off, but what she's referring to is the effect of weightlessness caused by a constant state of free fall around the Earth.

To visualize this, imagine riding in the world's tallest elevator. If the elevator is allowed to drop freely, then under the influence of gravity, it and everyone inside will fall at the same rate. Falling in an elevator is the same feeling as falling outside an elevator, except there's no wind. Of course, the elevator can't fall forever—at some moment, it will hit the ground unless we put on the brakes. Like the elevator, astronauts are also in free fall, but there are no cables or brakes to slow them down. So how do they stay in orbit so long without falling all the way to the ground? The space station is moving fast enough and high enough to avoid drag from the atmosphere and to remain in orbit. That's how objects in orbit remain in orbit so long—everything in orbit must travel at high speeds. In the case of the space station—about 17,500 miles per hour!

WHO IS BUILDING IT?

Sixteen countries from around the world are collaborating on the International Space Station. These international partners are as follows:

- United States
- Russia
- Canada
- Japan

- Brazil
- European Space Agency (Belgium, Britain, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, and Switzerland)

The United States and Russia are leading the effort—an incredible partnership considering that until a decade ago, these countries were bitter rivals in space exploration. But every country is making a unique contribution to the ISS—from the laboratories where cutting-edge research will be conducted to the robotic "arm" that will help **assemble** and maintain the exterior of the station.

Once the components are launched into orbit, the real builders are the astronauts and cosmonauts who are risking their lives to complete the assembly in space. After new modules are docked with the space station, crewmembers will perform dangerous space walks on the exterior of the station to connect wires, deploy antennas, and complete other maintenance tasks. In the hostile environment of space, one mistake could be deadly. For every hour spent on a space walk, the astronauts have trained 10 hours underwater—the closest thing on Earth to a weightless environment.

The first full-time crew moved into the space station on November 2, 2000. For the next few years, three-person crews will be living aboard the Zvezda module. But a larger component for living quarters, the U.S. habitation module, is scheduled for 2005. Once this module is connected with the station, a crew of up to seven people can live and work aboard the station at one time.

WHEN WILL IT BE COMPLETE?
The first piece of the space station was Zarya, the Russian control module that was launched into orbit November 20, 1998. A few weeks later, on December 4, 1998, the U.S. module Unity was launched into space. On December 7, 1998, the two modules were connected. This assembly in space was an amazing feat, but it is just the beginning. More than 100 pieces must be connected before the station is complete. The final components are scheduled for 2006—but with all the challenges and dangers ahead, the station may be completed even later than that.

Why does it take so long? Well, consider that the space station assembly will require at least the following:

Forty-six space missions: 37 by U.S. space shuttles, 9 by Russian launch vehicles.
One hundred sixty space walks: It will take astronauts 1,900 man-hours to assemble the station, risking the dangers of the hostile space environment.
One hundred components: over 1 million pounds of hardware.

WHERE IS IT NOW?
The space station travels at an incredible 17,500 miles per hour, orbiting the Earth every 90 minutes—that's 16 times a day!

HOW WILL ASTRONAUTS LIVE THERE?
Life in space will certainly take some getting used to! But the space station has been designed to keep the astronauts as comfortable as possible—the modules are roomy, bright, and kept at a constant 70 degrees Fahrenheit. It's important the crewmembers are comfortable because they'll be busy aboard the station. In a typical workday, crewmembers will spend 14 hours

working and exercising, 1.5 hours preparing and eating meals, and 8.5 hours sleeping. Here are some other fun facts about life aboard the station:

Food
Come mealtime, astronauts will have a special dining galley. Space food just keeps getting better—and more like food we enjoy here on Earth. In early space missions, astronauts could eat only freeze-dried food that didn't require any preparation. But the space station is equipped with water, microwave ovens, and refrigerators, allowing the folks on board to eat more "normal" types of food, including fruit, vegetables, and ice cream!

Sleep
Each crewmember has a private room, or "galley." With no gravity, they'll need to be anchored down in the their beds so they don't float away! That might sound like a strange way to catch some z's, but astronauts from past space missions report that sleeping in space is actually pretty great!

Exercise
You might not think it, but exercise is even more important on the station than it is on Earth. In micro gravity, muscles and bones atrophy—and this muscle and bone loss can be dangerous back on Earth. To fight this, astronauts on the station will exercise on bikes, rowing machines, and other equipment about two hours every day.

Clothing
Astronauts will have to wear special space suits while travelling aboard the U.S. shuttle or Russian rockets. But once they're safe inside the space station, crewmembers can wear regular clothing. Of course, a specially designed, pressurized space suit is required for space walks. It has to withstand flying debris and protect the astronauts from dramatic temperature changes. It can range from 120 degrees below Fahrenheit in the shadow of the station to 250 degrees in the hot sun.

Personal Hygiene
Simple tasks like brushing your teeth can be challenging in a weightless environment. A little water doesn't trickle in a stream—it suspends in a bubble! Astronauts will use a freshwater hose to take showers, shampoo, and rinse off—then a second vacuum hose to suction off the dirty water. And how do you go to the bathroom in space? With a special "air toilet" that uses flowing air instead of water to dispose of waste.