10.5 The Future of Space Exploration

Figure 1 Mars will be a prime destination for future astronauts.

Space exploration is relatively new. Before the 1950s, information about space was obtained only through telescopes. However, in the past 50 years, humans have visited the Moon, sent robots to distant planets, invented the first space plane, and lived and worked in orbit aboard space stations.

What do you think will be the next steps for space exploration? The next two decades may see human expeditions going out into the Solar System. Can you imagine humans establishing a colony on the Moon or landing on Mars (Figure 1)? Will we have faster, cheaper ways to travel in space? Will people vacation on other planets? These are only a few of the possible innovations in space exploration.

After the Space Shuttle

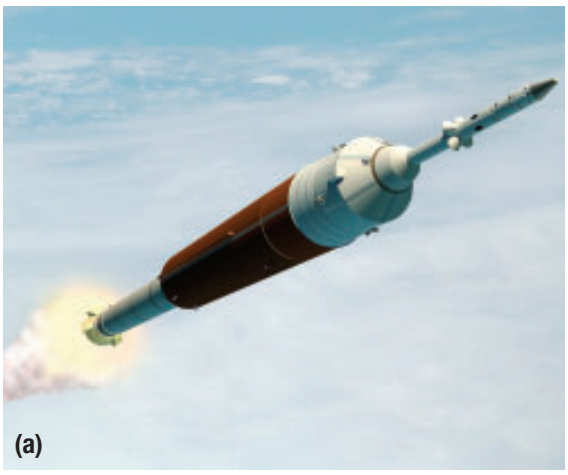
The space shuttle is the main vehicle used by astronauts to go into space. Flying since 1981, all three remaining shuttles are scheduled for retirement in 2010 after they haul the last component up to the International Space Station to finish its construction.

LEARNING TIP

***Ares* Series**

Ares is named after the Greek god of war, the god associated with the planet Mars. The *Ares* spacecraft is designed to take humans beyond Earth orbit, hopefully all the way to Mars and back.

To replace the space shuttle system, NASA is in the early stages of developing a pair of new reusable launch vehicles. NASA's *Ares* rockets, named for the Greek god associated with Mars, will return humans to the moon and later take them to Mars and other destinations. The crew launch vehicle will be a smaller rocket called *Ares I* (Figure 2(a)). The cargo launch vehicle will be a large rocket booster called *Ares V* (Figure 2(b)). *Ares V* will carry many tonnes of cargo into low Earth orbit using the old space shuttle launcher design: fuel tank and solid rocket boosters. Both new launch rockets are going to be based on parts of the current space shuttle launch vehicle. Once the boosters have lifted their cargo into orbit, they will re-enter the atmosphere and use parachutes to land in the ocean for collection. Sitting atop the *Ares I* booster will be a crew capsule called *Orion* (Figure 2(c)). The first human mission aboard the *Orion–Ares* launch system is scheduled for 2014, in preparation for the first mission to the Moon since the *Apollo* program in the late 1960s.



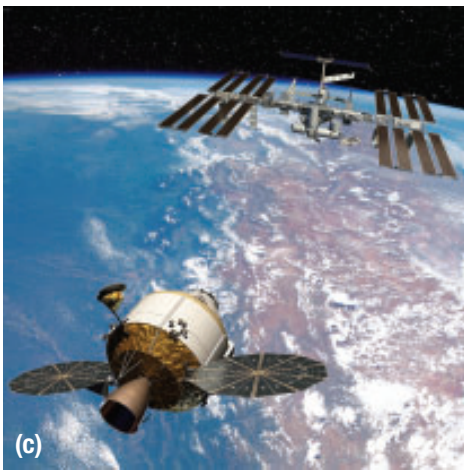


Figure 2 (a) The *Ares I* crew launcher is designed to carry humans and cargo into space. (b) The *Ares V* will lift heavy cargo into low Earth orbit. (c) The *Orion* crew exploration vehicle is capable of carrying as many as six astronauts.

The Moon: A Testing Ground for Mars Exploration

Some scientists are planning to send a human-occupied spacecraft to Mars to explore its surface. They also intend to set up a base station there, where astronauts can live for extended periods of time. To reach this goal, astronauts will first travel to the Moon, where they will live and train for their eventual mission to Mars. Current plans call for humans to return to the surface of the Moon by 2020. Crews of three to six will stay as long as two weeks, conducting experiments and testing technologies in preparation for the longer and more dangerous journey to Mars (Figure 3).

READING TIP

Using Graphs and Illustrations
Graphs, tables, and images can help you to visualize the main idea of a text. For example, the images of the *Ares* boosters and *Orion* spacecraft can help you synthesize what you are reading with what you have already learned about the space shuttle, *Apollo*, and the *Saturn V* rocket. This synthesis will help you understand how future space missions will differ from past missions.

Figure 3 Long-term plans call for building permanently occupied international science bases on the Moon, as is done in Antarctica.

The Moon has been chosen as a testing ground for future Mars exploration because it is closer to Earth and has characteristics similar to those of Mars. For example, both the Moon and Mars are much colder than Earth and are blanketed by a fine layer of silt-like dust particles. They also both have less gravity than Earth does. However, the Moon can be reached by spacecraft in less than four days, whereas travelling to Mars takes six to ten months. Sending equipment and people to Mars is far more time consuming and risky than a trip to the Moon.

Challenges and Dangers of Exploring the Moon and Mars

The fine layer of dust blanketing the Moon and Mars may be 10 m deep in places. This presents challenges for exploration. Because the dust is so fine, it can filter into the living spaces of the astronauts and irritate their skin, eyes, and lungs. It can also damage scientific equipment and spacesuits. Landing rockets will stir up the dust, creating clouds of dust on the surface of the planet or the Moon, and surface vehicles will need special tires that do not sink into the deep layers of dust.

Other challenges for humans colonizing the Moon and Mars include the difficulties in obtaining a constant supply of water, oxygen, and food.

Figure 4 U.S. billionaire Dennis Tito received technical and safety training as an astronaut for six months to prepare for his ride into space.

Protection from the cold and the Sun's ultraviolet and X-ray radiation will also be necessary. Heated houses might melt the surface on which they are built, causing the ground to collapse. These types of potential dangers will be checked first by robotic explorers. Plans are already underway to send robots on reconnaissance missions to both the Moon and Mars over the course of the next decade to lay the foundation for the safest possible human missions.

Space Tourism

Travelling beyond Earth's gravity and into space has captured the imagination of generations of people. However, until recently, only a select few—specialized military or highly trained astronauts—have had a chance to travel into space. In 2001, U.S. businessman Dennis Tito became the world's first space tourist when he blasted into orbit aboard a Russian rocket (Figure 4). He stayed aboard the ISS for one week. As of spring 2009, six individuals who are not professional astronauts have paid to go into space. The 2009 price tag for a week-long trip into space was around $30 million.

Although space tourism opportunities today are limited and expensive, companies in Canada, the United States, and England are working on building and flying low-cost rockets to take tourists on a more affordable, 2.5 hour suborbital trip (Figure 5). Passengers will be able to experience free fall for a few minutes when they fly to an altitude of 100 km—the official boundary between Earth's atmosphere and outer space. The space flight ends with the vehicle gliding back down to Earth.

Figure 5 British company Virgin Galactic has already flown a prototype of its suborbital space plane and plans to fly its first space tourists in 2010.

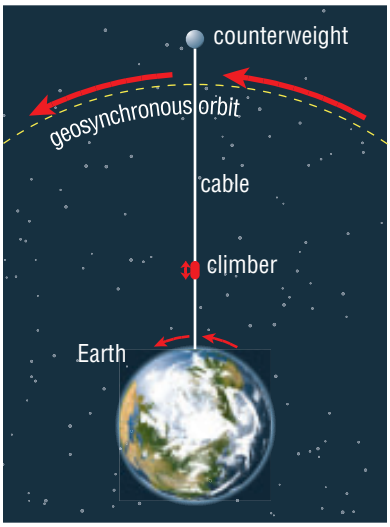


Figure 6 Concepts call for the elevator to rise vertically along a cable to Earth orbit.

The Space Elevator

Scientists in Canada and around the world are competing to develop the first elevator to space. Elevators in buildings on Earth consist of

- a compartment or car for people or cargo
- a steel cable or tether anchored to the bottom and top of an elevator shaft
- a counterweight

An ordinary elevator car is powered by electricity. It is raised and lowered by traction. The counterweight, which weighs about the same as the car, makes it possible to raise and lower the elevator using less energy.

Similarly, the design of a space elevator consists of a very long cable or tether anchored from a location on Earth's surface and extending 36 000 km into space (Figure 6).

This tether will be anchored by an ocean ship and attached to a counterweight in space (Figure 7(a)). Earth's rotation and the counterweight in space will keep the cable taut. (The counterweight is always pulling upward on the ocean ship, much like a pail of water at the end of a rope pulls against your hand if you whirl it around in a circle.) The space elevator's car is called a climber. Powered by laser or light energy, the climber is used to move cargo—satellites or people—to Earth orbit. Once the cargo reaches orbit, it can be launched beyond Earth (Figure 7(b)).

The benefits of space elevators are many. The propulsion technology used today to launch spacecraft is expensive. The estimated cost to build a space elevator is $10 billion. This is much less than the cost of the ISS and space shuttle systems. The space elevator is operated from Earth and not from space, which may also lower costs.

However, the technology to make a fully functional space elevator does not yet exist. Currently, no material is strong enough and light enough to make the cable stretch from Earth into space. Scientists have also not figured out how to provide the climber with enough energy to climb up the cable against Earth's gravity all the way to space.

Figure 7 (a) Current designs call for a ship to anchor the space elevator tether to Earth and house the laser to power it. (b) The elevator rises vertically to Earth orbit with its cargo and people.

UNIT TASK Bookmark

You can apply what you have learned about space tourism and the challenges and dangers of space exploration to the Unit Task described on page 446.

IN SUMMARY

- New vehicles and methods are being designed to shuttle people and materials into space.
- Space travel is dangerous and very expensive.
- Tourists have begun to travel into space for pleasure and might continue to do so in the future.

CHECK YOUR LEARNING

1. Compare and contrast the *Ares V* spacecraft with the *Ares I* spacecraft. K/U
2. Why is the Moon a suitable testing ground for Mars exploration? T/I
3. Descibe NASA's plans to replace the space shuttle. K/U
4. There are many challenges to space exploration. Rank the following criteria from most important (1) to least important (7). Explain your reasoning in two to three sentences. T/I
   - constant supply of water
   - protection from dust storms on Mars
   - constant supply of oxygen
   - constant supply of food
   - dealing with feelings of isolation and claustrophobia
   - protection from the cold
   - protection from the Sun's radiation
5. How long does it take to get to the Moon compared with the time it takes to get to Mars? K/U
6. Why does the dust on the Moon and Mars make colonization and exploration more difficult? K/U A
7. Who was the first person to travel into space as a tourist, and how much did he pay for this privilege? K/U
8. Summarize the future plans to create journeys into space for tourists. K/U
9. What are the components of the proposed space elevator? Explain the purpose of the elevator with the use of a diagram. K/U C
10. What are the benefits of space elevators? What are the drawbacks of space elevators? K/U A