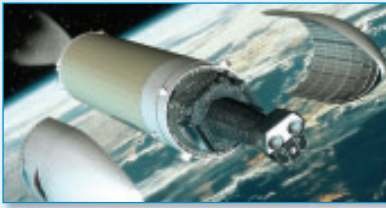
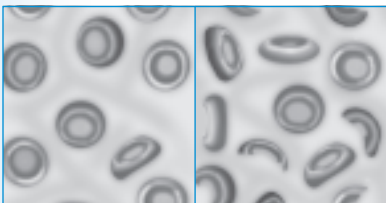


KEY CONCEPTS SUMMARY



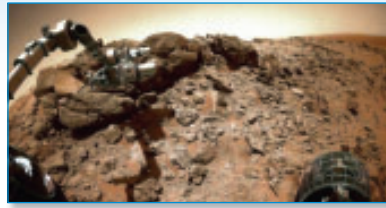
Humans use telescopes that gather energy from the entire EM spectrum to learn about objects in the Universe.

- Galileo first used a refracting telescope to gather and focus light 400 years ago. (10.1)
- Astronomers use radio telescopes to collect radio waves emitted from distant stars and galaxies. (10.1)
- High-energy EM radiation, such as gamma rays and X-rays, are being collected by the Chandra, INTEGRAL, and SWIFT space telescopes. (10.1)



The environment in space is hostile to living things.

- Astronauts in the ISS exercise to keep their bones and muscles strong. (10.2)
- Scientists are always working on ways to protect astronauts from radiation, cold temperatures, and hostile environments in space. (10.2, 10.5)
- Humans need oxygen, food, and water to survive in space, so they must either take them with them or manufacture them on the way. (10.5)
- When astronauts live and work in space, they are in continuous free fall around Earth. (10.2)



Humans use space probes to learn more about the Solar System.

- Rovers have been exploring the surface of Mars and sending back information on Martian climate and geology since 2004. (10.1)
- The *Cassini* spacecraft reached Saturn in 2004. (10.1)
- Space probes have travelled to all of the planets in the Solar System, giving us valuable information about their composition. (10.1)



New technologies and information from the space program have benefited our everyday lives.

- Space technologies have led to advances in medical science. (10.3)
- Consumer products have been improved with the aid of space program technologies. (10.3)
- GPS satellites are used in conjunction with cellphones, computers, GPS receivers in vehicles, and many other applications. (10.3)
- Weather satellites are continuously monitoring Earth's environment. (10.3)



Canada is a world leader in developing technology for space exploration.

- Canada is partnering with many countries on projects such as the *Mars Phoenix* meteorological station, the ISS, the Square Kilometre Array telescope, and others. (10.1, 10.4)
- The Canadarm2 and DEXTRE are used on the space shuttle and the ISS to move things around in space. (10.1)
- RADARSAT-1 and RADARSAT-2 satellites track features and climate change on Earth. (10.3)



Space exploration is technically challenging and expensive.

- NASA, the CSA, and the European Space Agency have spent billions of dollars on space exploration. (10.1, 10.4, 10.5)
- Spacecraft designers must address many challenges to safely take humans to their celestial destinations and back. (10.2)
- Any new spacecraft launches must be calculated to avoid the thousands of pieces of space debris orbiting Earth. (10.2)

WHAT DO YOU THINK NOW?

You thought about the following statements at the beginning of the chapter. You may have encountered these ideas in school, at home, or in the world around you. Consider them again and decide whether you agree or disagree with each one.



- 1** Sending humans into space is important for research and discovery.
Agree/disagree?



- 4** Spending billions of dollars on robots that explore the surface of Mars is worthwhile.
Agree/disagree?



- 2** All celestial objects can be viewed from Earth using a telescope.
Agree/disagree?



- 5** Technology developed for space exploration has many practical uses here on Earth.
Agree/disagree?



- 3** Space exploration encourages international cooperation and understanding.
Agree/disagree?



- 6** Astronauts “float” in space because there is no gravity.
Agree/disagree?

How have your answers changed since then?
What new understanding do you have?

Vocabulary

refracting telescope (p. 410)
reflecting telescope (p. 410)
spacecraft (p. 411)
space probe (p. 415)
microgravity environment (p. 421)
space junk (p. 424)
spinoff (p. 426)

BIG Ideas

- Different types of celestial objects in the Solar System and Universe have distinct properties that can be investigated and quantified.
- People use observational evidence of the properties of the Solar System and the Universe to develop theories to explain their formation and evolution.
- ✓ Space exploration has generated valuable knowledge but at enormous cost.