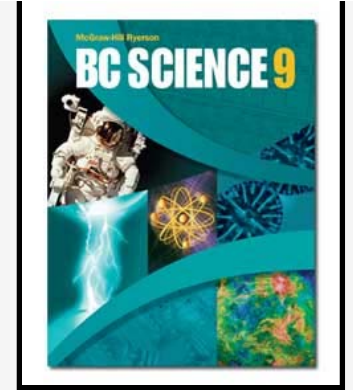
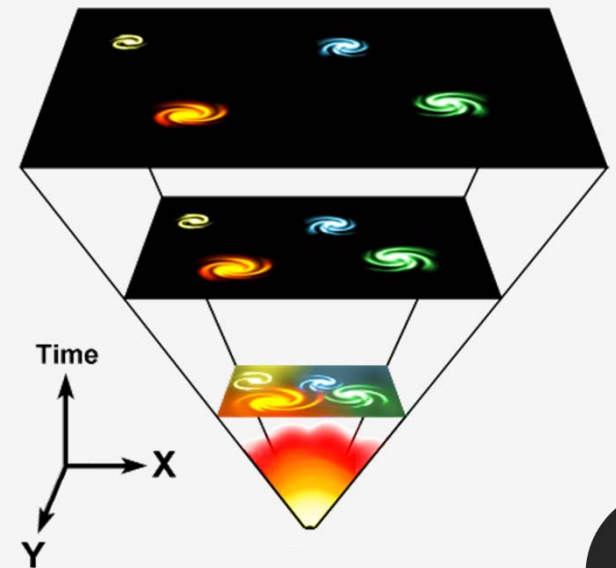


# 10.1 The Early Universe

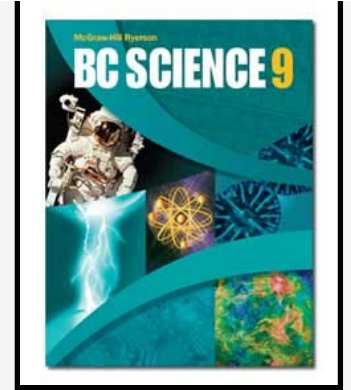


- Until 100 years ago, scientists believed nothing ever changed in outer space.
  - Using powerful telescopes, astronomers like Edwin Hubble discovered many new celestial bodies, and observed that everything in the universe was moving further apart.
  - The universe expands like baking bread; galaxies and other celestial objects are like raisins in the dough, moving apart as the bread bakes.

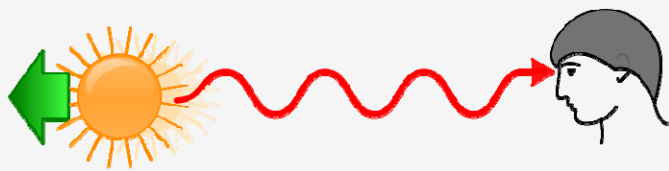


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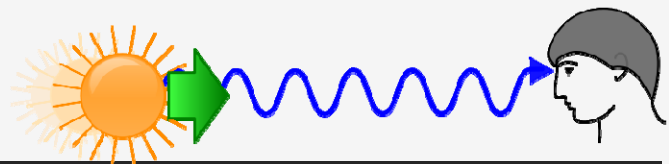
# Red Shift Analysis



- By examining the light from distant stars, astronomers can estimate the speed and directions the star is traveling.
  - Light, like all forms of electromagnetic radiation, travels in waves. Objects in space give off many different forms of radiation.
  - Like the sound of a ambulance siren changes as it passes you, light from stars exhibits red-shift, indicating speed and direction of motion.
  - A spectroscope analyzes the unique spectrum of a star, which astronomers can analyze to discover the direction and amount the light has shifted.

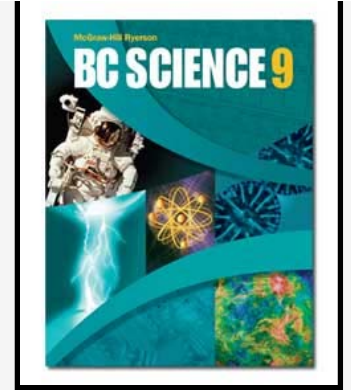


- *A red shift means the wavelength is getting longer, and the star is moving away from us.*

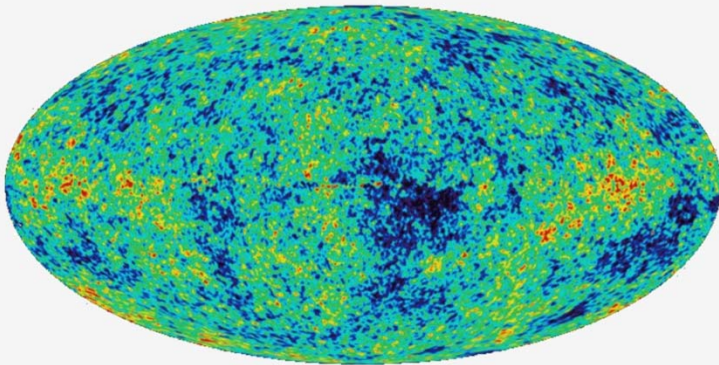


- *Blue shift is the opposite; the star is getting closer.*

# *The Big Bang Theory*



- Once astronomers realized everything was moving away from everything else, they realized the universe might have originated from a single point.
  - The Big Bang theory suggests that everything in the universe came from a single starting point, approximately 13.7 billion years ago.



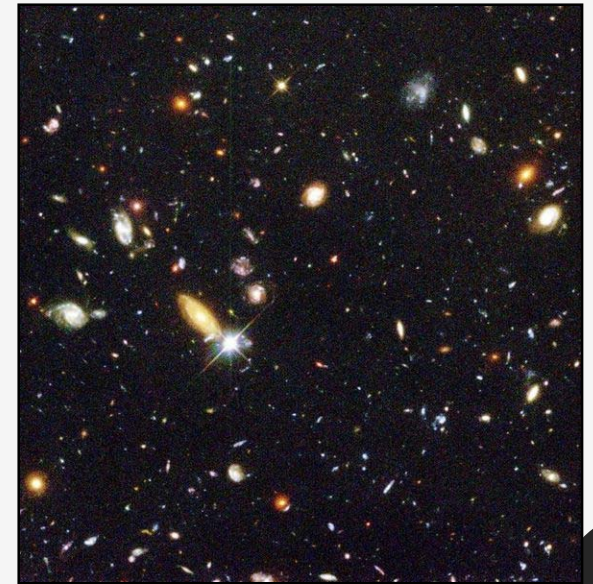
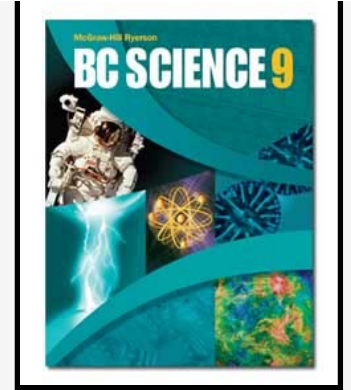
- Although there are other theories about the beginning of the universe, much scientific evidence supports the Big Bang theory.
- The Big Bang is also supported by the presence of cosmic background radiation, which is the energy left over from the Big Bang.
- This radiation was mapped by the COBE and WMAP explorations.

[Take the Section 10.1 Quiz](#)

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# 10.2 Galaxies

- Our star, the sun, is one of 100 million stars in the Milky Way galaxy - and there are 125 billion galaxies in the universe!
  - A galaxy is a large group of stars. A nebula is a cloud of gas and dust in space that is often produces a new star, or is the remains of an old star.

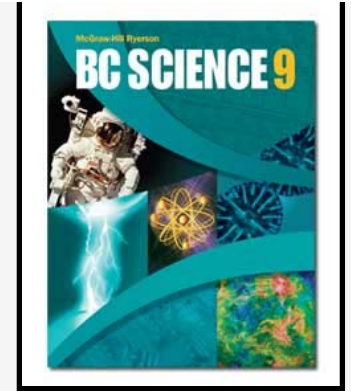


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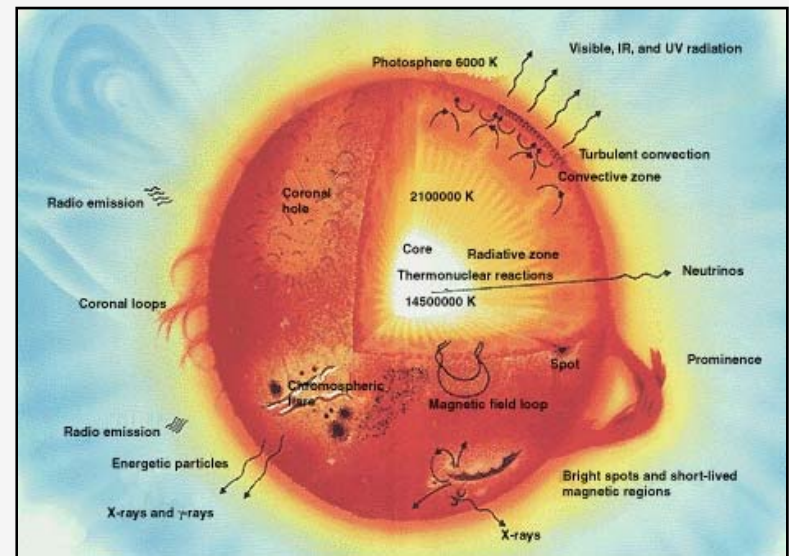
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# 11.1 Stars



- A star is a massive sphere of gases with a core like a thermonuclear reactor.
  - The most common celestial bodies in the universe are stars.
  - It is estimated there are more stars in the universe than there are grains of sand on all the beaches on Earth.
  - By peering through the interstellar matter (dust and gases), astronomers can observe the birth of stars.

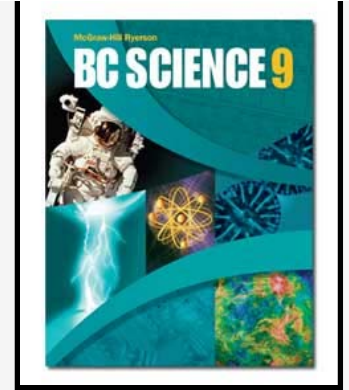


**\*\*You do not need to know parts of the sun \*\***

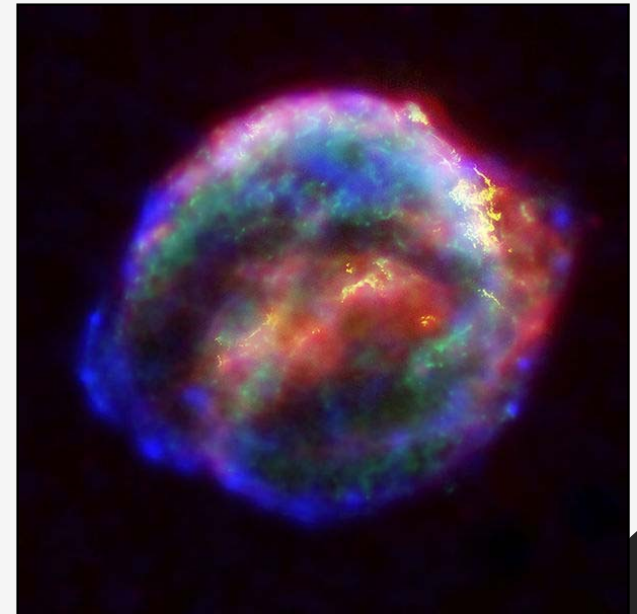
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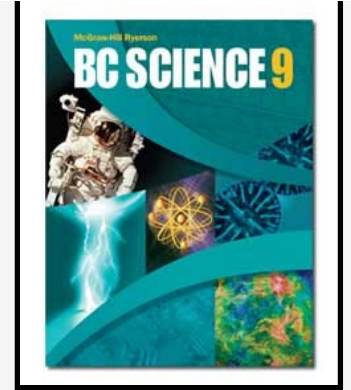
# *The Birth and Life of Stars*



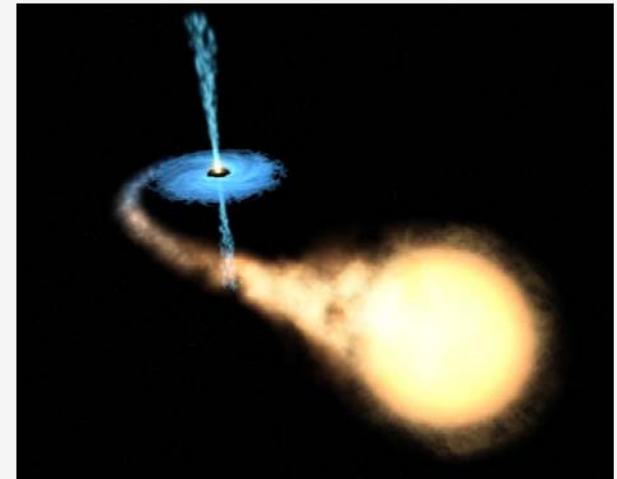
- Stars form from the dust and gases found in a nebula, when enough gravity causes all the molecules to collapse in on themselves.
  - If enough matter gathers, the gravity becomes so massive that hydrogen atoms join to form helium atoms, producing huge amounts of energy through the process of fusion.
    - It is the energy given off by fusion that causes stars to glow.
  - The life cycle of a star: nebula, low mass star, intermediate mass star (like our Sun), high mass star. Large high mass stars often explode as supernovas, spreading elements throughout the universe.



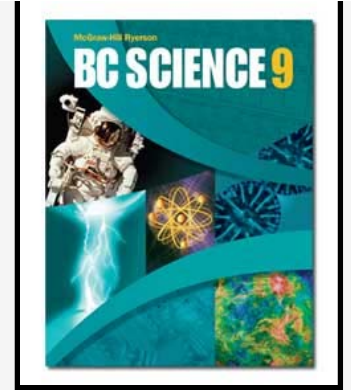
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- Stars 12 - 15 times more massive than our Sun can end as neutron stars after going supernova. These superheated, super massive dead stars can take trillions of years to cool.
- Stars 25 times as massive as our Sun can become black holes instead of neutron stars. The same process that produces a neutron star produces an area so massive and yet so small that the gravity it produces traps everything - even light!
- Stars can vary greatly in size. Although our Sun is an average size, many of the stars we see in the night sky are up to 3000 times as large as the Sun.



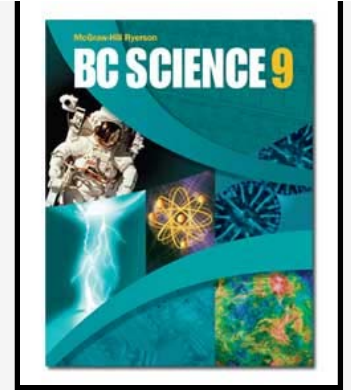
# 11.2 *The Sun and the Planets*



- Our Sun, an average star in the universe, is the center of our solar system.
  - Our solar system is full of planets, moons, asteroids and comets, all of which revolve around the Sun at the center.
  - When a star forms from a nebula, gravity pulls most of the material into the new star, but some may also clump together to form objects in a solar system.
    - A planet is a celestial body that orbits one or more stars.
    - Each planet may also spin on its axis (rotates) while it orbits the Sun (revolves).
  - Our solar system formed approximately 4.5 billion years ago. The four inner, rocky planets in the first 100 million years on the Sun's existence, while the outer, gaseous planets formed later from the remnants of the Sun's original nebula.



# The Planets

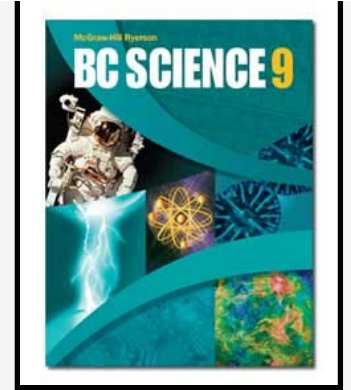


- To be considered a planet, a body must orbit one or more stars, be large enough that its own gravity holds it in a spherical shape, and be the only body occupying the orbital path.
  - Distances between planets in the solar system are measured in astronomical units (AU). One AU = the average distance from the Sun to the Earth.
  - The inner planets are relatively close to the center of the solar system - Mars is 1.52 AU from the Sun. The next planet, Jupiter, an outer planet, is 5.27 AU from the Sun. The most distant planet, Neptune, is 30.06 AU from the Sun.

Inner, rocky planets		Outer, gaseous planets	
Mercury	Smallest planet	Jupiter	Largest planet
Venus	Earth's sister	Saturn	Rings + many moons
Earth	Only life in universe	Uranus	Methane gas planet
Mars	The red planet	Neptune	Outermost planet

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# *Other Solar System Bodies*



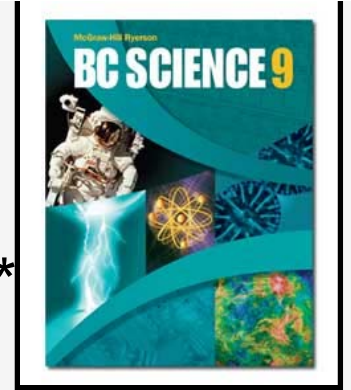
- There are also numerous celestial bodies smaller than planets in our solar system.
  - Moons are found around all planets except Mercury and Venus.
  - Asteroids are found mostly between Mars and Jupiter in the asteroid belt. It is thought these are 'leftovers' from the formation of the solar system.
  - Comets (sometimes called "dirty snowballs") are actually rocky travelers, following huge orbits far outside the planets in the Oort Cloud.
  - Trans-neptunian objects refer to objects outside Neptune's orbit, including ex-planet Pluto (now referred to as a dwarf planet). These objects orbit the Sun in a large area known as the Kuiper Belt.
  - The Oort Cloud is at the farthest reaches of the Sun's gravitational pull, almost 25% of the way to the next nearest star, Proxima Centauri.

[Take the Section 11.2 Quiz](#)

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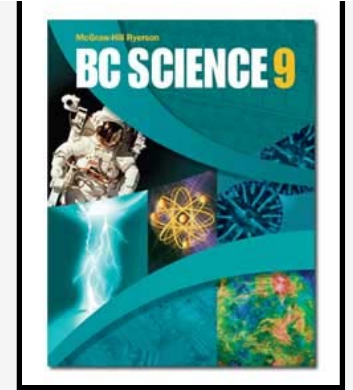
## 12.1 *Earth, Moon and Sun Interactions*

**\*\*You do not need to know this slide but interesting information \*\***

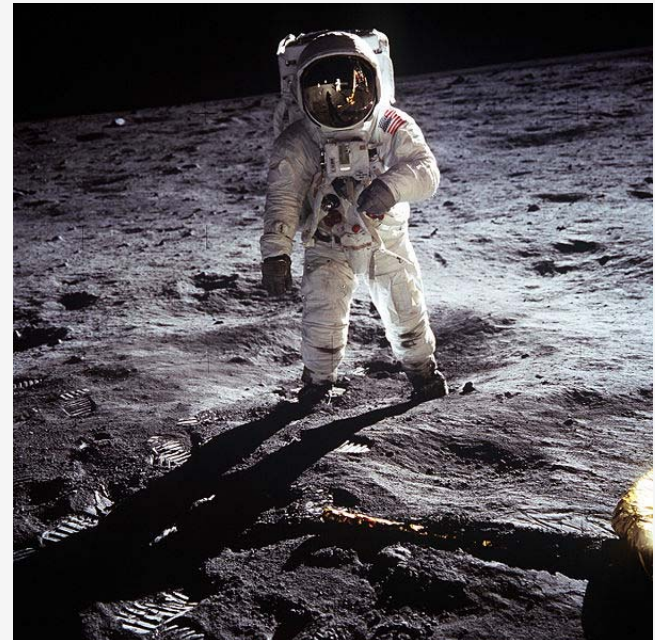


- Humans have been aware of the relationships between the Earth, Sun and Moon for thousands of years, but only recently have we begun to better understand the true nature of these relationships.
  - Ancient civilizations used the seasons, months, position of stars and other astronomical information in many parts of their lives.
  - Until the past few hundred years, humans believed the Earth was the center of the universe (the geocentric model).
    - The geocentric model was based on the work of the ancient Greek philosopher Ptolemy
  - We now observe the heliocentric model, where the Sun is the center of the solar system, and the universe expands outward.
    - The heliocentric model is based on the observations of Copernicus and Galileo.

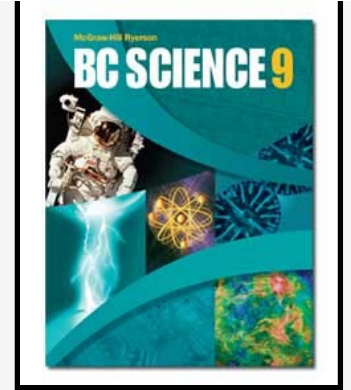
# *The Moon*



- Earth's nearest neighbour in space is the Moon, a natural satellite that most likely formed from a collision between the Earth and a Mars-sized planet during the formation of the solar system.



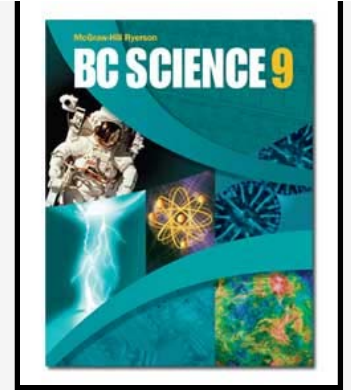
# *Phases of the Moon*



- The Moon, reflecting light from the Sun, appears to change in size and shape as it rotates on its axis and revolves around the Earth.
  - It takes the Moon 29.5 days to make a complete orbit around the Earth. During this time, different portions of the Moon can be viewed as the changing phases.
    - Interestingly, the Moon rotates at almost the same rate as it revolves, meaning that the same surface of the Moon (the “near” side) always faces the Earth. The “far” side is always facing away from the Earth!
    - What we see as the changing phases are actually just different viewing points of the Moon’s “daylight”, time periods when the Sun shines on the Moon.
  - The Moon’s gravity pulls on the oceans on Earth to create tides.

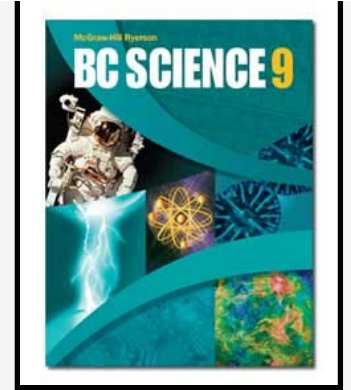


# *The Earth's Rotation and Tilt*



- The time it takes the Earth to revolve around the Sun is 365 days (one year). Every 23 hours and 56 minutes (one day), the Earth rotates on its axis. The tilt of the Earth's axis gives us seasons.
  - As the Earth rotates, it is tilted at  $23.5^{\circ}$  from vertical. Depending on what part of the year (orbit around the Sun) and which hemisphere (North or South) you are at, your location will either be tilted toward the Sun (summer) or away (winter).
  - At the equator, the Sun's energy strikes the Earth the same all year long - in other words, there are no seasons!
  - It is this tilt that also changes the length of the daylight hours each part of the Earth receives.
  - The shortest day (Winter solstice) occurs when we are tilted the most away from the Sun, while the longest day (Summer solstice) occur when the tilt is closest to the Sun.
  - The Spring and Autumnal equinoxes occur when the number of hours of light and dark are equal.

## 12.3 Exploring Space: Past, Present and Future



- Until the invention of the telescope, knowledge of space was very weak, and mythology and speculation were the rule.
  - The telescope was invented in the 17th century by the Dutch eyeglass maker Lippershey.
  - There are two main types of optical (light) telescopes: refracting and reflecting.

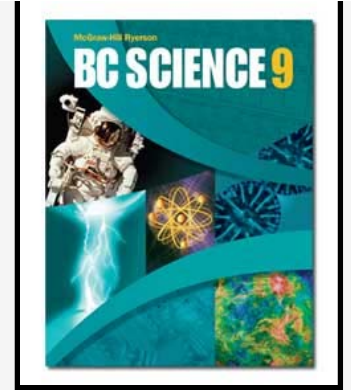
**\*\*You do not need to know this\*\***

- Refracting telescopes use lenses to gather and focus light
- Reflecting telescopes use mirrors to collect light and project it onto an eyepiece.

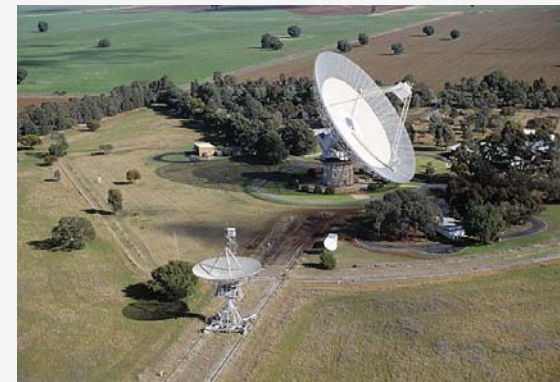


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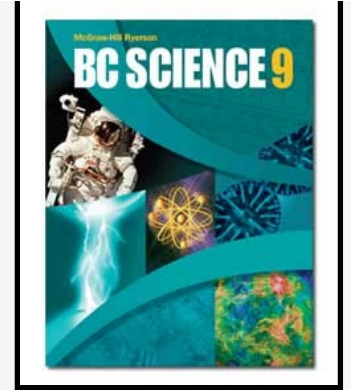
# *Non-Optical Telescopes*



- Early optical telescopes improved viewing of space greatly, but other electromagnetic waves could also be used to gather information about space.
  - X-rays, gamma rays and radio waves can all be gathered and analyzed to learn about space.
  - Radio telescopes look like satellite dishes.
  - By joining radio telescopes together in a network, results can be obtained as though one very large telescope was being used.



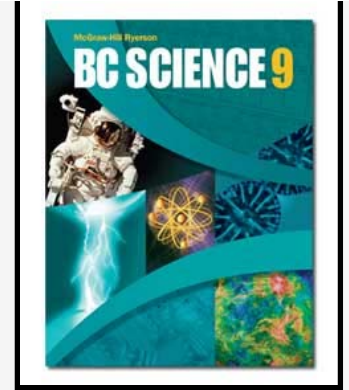
# *Space-based Observation*



- As good as many of the telescopes on Earth are, by moving outside the atmosphere, space-based observation has become our most powerful method of space observation.
  - Satellites launched from Earth provide us with communication and safety every day.
    - Geosynchronous satellites orbit at the same rate as the Earth rotates, and stay above one point.
  - Probes launched from Earth have visited Venus, Mars and Saturn's moon Titan, and have traveled through space to the far reaches of our solar system.
  - Rovers are used to maneuver scientific equipment after landing on planets and moons.



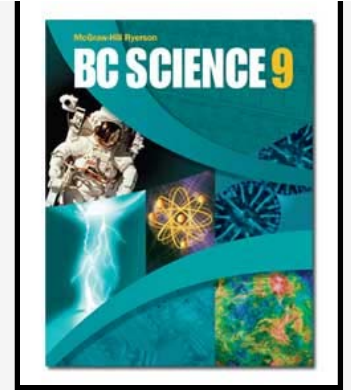
# *The Technology of Space Travel*



- The challenge of using rockets to launch scientific equipment - and astronauts - into space now sees us attempting to establish colonies in space.
  - A rocket is used whenever we want to get something - called a payload - into space.
    - The rocket has a large amount of thrust, and very little drag, in order to break through the Earth's atmosphere.
  - The space shuttle program also uses rockets for launch, but also relies on having the equipment return to Earth safely for return trips.
  - The International Space Station is an attempt to provide a location in space from which to operate without needing to always use rockets to get there.

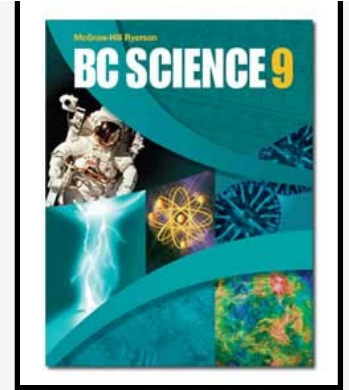


# *Space Travel*



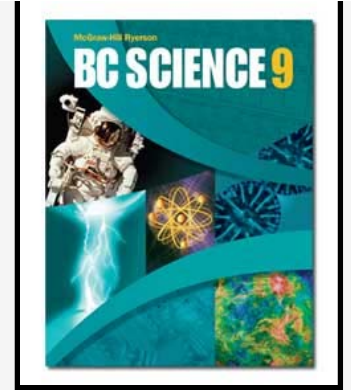
- Early attempts at space travel were unmanned, or carried animals. In the past 40 years, we have sent humans into space, as well as having them return safely.
  - International collaboration promotes friendly politics.
  - Canadians have aided in space travel by contributing to the development of the International Space Station, as well as work on the Canadarm system for the Space Shuttle, as well as sending astronauts on space missions.
  - Many technological advancements have occurred due to research done for space travel.
  - Soon, average citizens may be able to afford to travel into space for recreational purposes.
  - Terraforming is a process where previously uninhabitable locations, such as the Moon or Mars, would be changed to look and function as Earth does.

# *The Risks of Space Travel*



- Perhaps more than in any other area, space travelers rely heavily on the equipment used for travel to provide safety.
  - Two shuttle failures have resulted in the loss of several astronauts.
  - Our equipment is very sensitive to the debris found in space, from large fuel tanks to small flecks of paint.
    - Sometimes, this debris can also re-enter the Earth's atmosphere and threaten us on the surface.
  - Space poses a huge advantages to those who control it, and have access to its resources.
    - Environmental, safety and political concerns can arise if we do not use space ethically.

# *New Ideas for Interplanetary Travel*



- To reach farther into space, particularly for manned missions, new methods of transportation will be necessary.
  - Our current space travel technology uses very large amounts of fuel to travel relatively short distances with very few passengers.
  - The 'space sled' uses magnetic technology to help propel a small craft without the use of much fuel.
  - A 'space elevator' would be very useful for moving people and materials into space without the constant use of rockets.

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[Take the Section 12.3 Quiz](#)

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