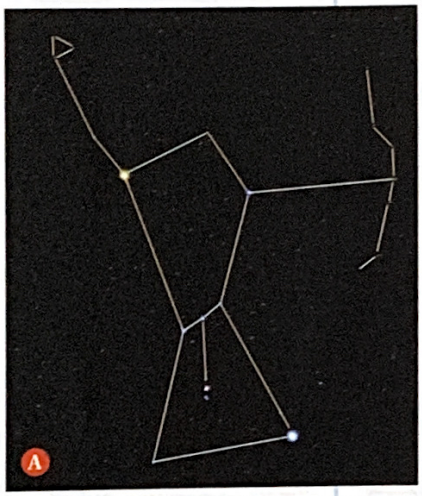
CONCEPT 2

The appearance and motions of the objects we see can be described using a model called the celestial sphere.

Imagine you are a hunter thousands of years ago. You know the patterns of the night sky the way you know the land on which you live and the habits of the plants and animals that sustain you. On this day, you have followed the trail of animals to a place that is unfamiliar to you. As night approaches, you locate a safe spot, unfurl your bed roll, and lie back to stare up at the sky. Though the land on which you rest is new to you, the star-scape that twinkles down at you is much like what you know. The stars will guide you when is it time to return home. For now, their familiar patterns provide comfort. Beneath this sky you know, your sense of place, of home, is reinforced.

Many peoples, both past and present, connect objects and events on Earth with objects and events in the sky. For example, many First Peoples noted that the appearance of certain patterns of stars and certain "faces" of the Moon marked the changing seasons. This helped them know when to plant and harvest crops, perform ceremonies, and carry out other aspects of life.

Stars were also used for navigation. People living in places surrounded by water had no land to use as a reference point, so stars were used as familiar "landmarks." Polynesians, for example, navigated the vast expanses between Pacific islands because of their understanding of stars, as well as of tides and currents.



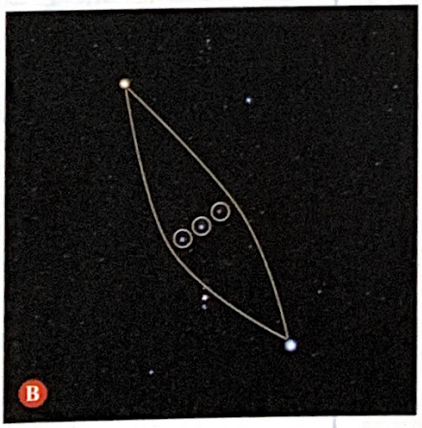


Figure 4.8 The stars that make up the constellation officially named Orion are shown in A. In B, the same stars are shown in the shape of a canoe.

Constellations

Over millennia, many cultures have observed that some stars in the night sky appear to form shapes. They named these shapes after heroes, animals, tricksters, and objects from their land, life, and stories. Today we call them **constellations**.

People used their imaginations to link up the stars like a huge connect-the-dots puzzle. Different cultures linked up the stars in different ways. For instance, ancient Greek skywatchers saw the stars in **Figure 4.8A** as making up the shape of Orion, a mighty hunter from their stories; the three stars at his waist are his belt. Some First Peoples saw in that same constellation and three-star grouping the shape of a canoe (**Figure 4.8B**). In southern Mexico, the Maya of a great city-state, Palenque, saw a turtle with the three stars forming part of its shell pattern. In the north the Inuit saw, instead, a bear chased by four hunters. The topmost star is the bear escaping by climbing high in the sky. Three hunters are in pursuit. The fourth hunter returned to Earth to retrieve a dropped mitten and remained to tell the story of the constellation.

constellation group of stars that form a pattern in the sky

Activity

Construct a Model Constellation

In the sky, the stars of a constellation look like they are all close to each other and at exactly the same distance from Earth. In fact, stars are separated from us and from each other by very large distances. Design a model to show how this is possible. Your model could be 3D, or you could render it on paper or digitally.

The International Astronomical Union lists 88 constellations. Orion is one of them. Smaller groups of stars that form shapes within the constellations are called *asterisms*, from the Greek word for star: *aster*. An example is one of the most famous and visible star patterns in the northern sky, the Big Dipper. The two end stars in its bowl are called "pointer stars", because they point toward the North Star, Polaris (**Figure 4.9**). Long before the invention of the compass, people used the North Star to tell direction.

Here in Canada, we cannot see all 88 constellations. There are about 20 that never rise above our horizon. These 20 can be seen only by people who live (or visit) south of the equator. Use **Figure 4.9** to figure out why.

When European explorers of the 15th century first sailed around the world and travelled to places like Australia and South America, they saw these stars for the first time. The explorers imagined new constellations out of these stars, and they chose objects that were important to their lives, such as a ship, a clock, a microscope, and a compass.

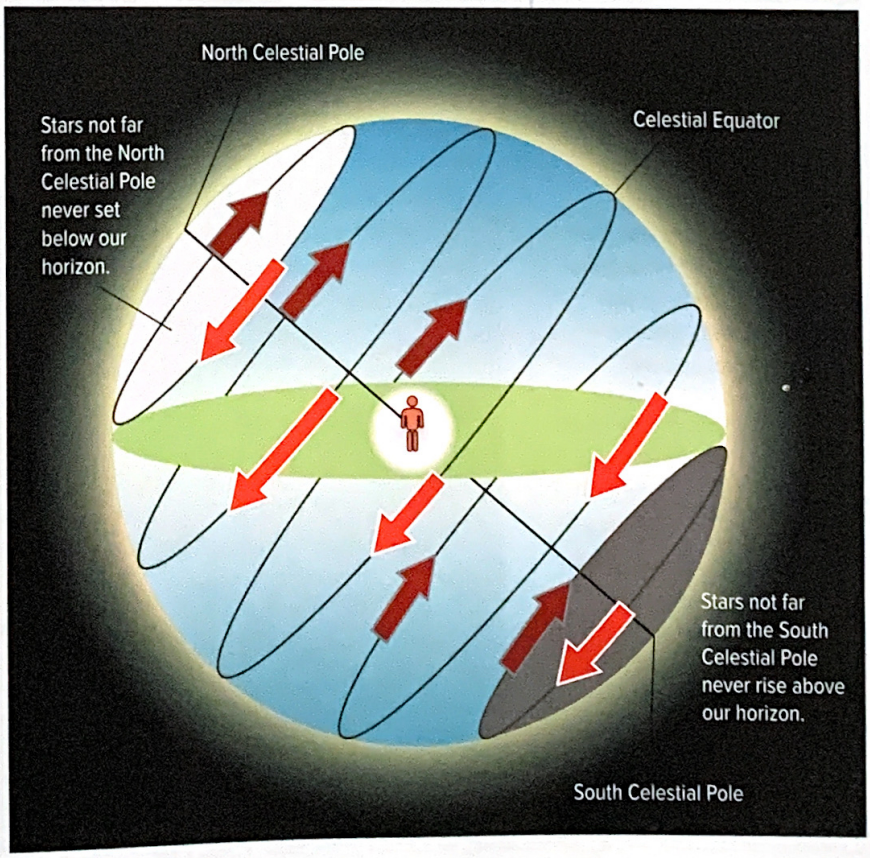


Figure 4.9 Imagine standing on flat land at night. As Earth turns, the stars appear to be on the inside surface of a sphere that moves slowly around Polaris, the North Star. You see stars in the sky above you. **Inferring: Can you see the stars in the grey area? Why or why not?**

The Celestial Sphere

From Earth, we observe the sky as it appears, not as it is. For millennia, people believed the sky to be a solid sphere with celestial objects in fixed positions. This imaginary sphere onto which all celestial objects are projected is called the **celestial sphere**. Today, we know that it is Earth that rotates, and not the sky. The celestial sphere extends around Earth. However, an observer on Earth can only see half of the sphere, the same way you can only see what is in front of you, and not behind (Figure 4.10).

celestial sphere an imaginary, rotating sphere on which lie all objects of the night sky

The celestial sphere is divided into northern and southern hemispheres by the celestial equator, which is an imaginary extension of Earth's equator projected into space. Astronomers mark the position of stars and other objects in the sky of each hemisphere using a grid system similar to latitude and longitude used on Earth. The North and South Celestial Poles are the imaginary points where Earth's axis of rotation extends out onto the celestial sphere above the North and South Poles on Earth. For observers in the northern hemisphere, the North Celestial Pole points very close to Polaris, the North Star. Even today, celestial navigation is widely used by sailors (Figure 4.11).

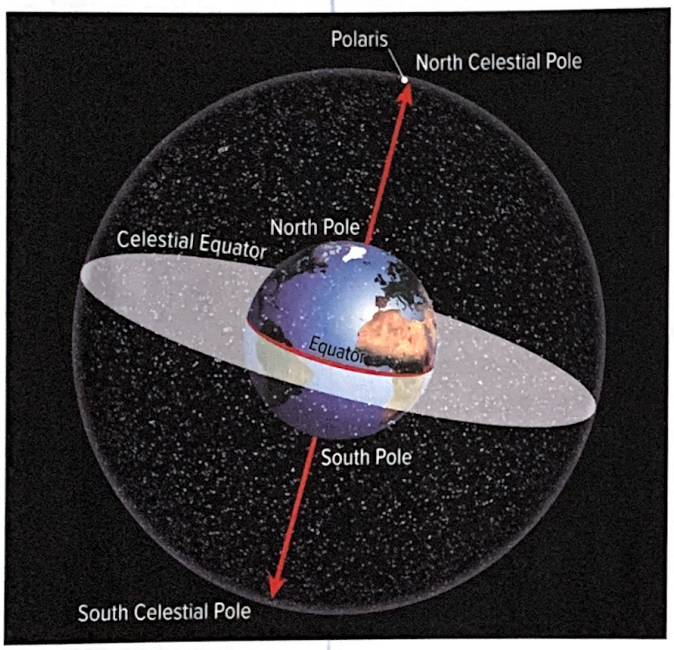


Figure 4.10 The celestial sphere **Analyzing: How does this diagram compare with Figure 4.9? How does examining each help you understand the concept of the celestial sphere?**

Figure 4.11 Modern technologies are widely used to navigate ships at sea. But batteries can run out, and GPS can malfunction. As a result, many navies and coast guards around the world have resumed learning the ancient art of celestial navigation, using an angle-measuring device called a sextant.

NEL

The Ecliptic

Over one year, the Sun seems to move against the constellations of the celestial sphere. The Sun's path across the celestial sphere is called the **ecliptic**, and is caused by Earth's orbit around the Sun. The ecliptic is best observed looking up at the sky toward the southern horizon (Figure 4.12).

ecliptic path the Sun and some other sky objects appear to take across the celestial sphere

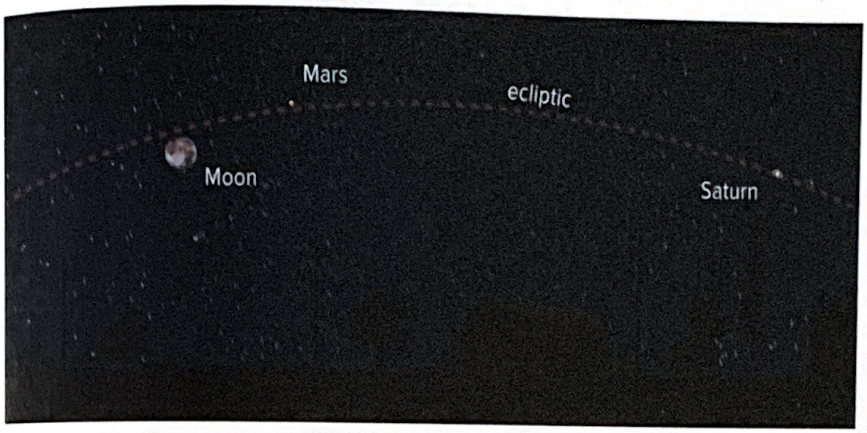


Figure 4.12 The ecliptic is an important reference pathway that helps us locate the positions of the Sun, Moon, planets, and constellations. (The ecliptic gets its name from the similar-looking word, eclipse. Eclipses of the Sun and Moon occur along or near the ecliptic.)

Changing Views of the Night Sky

You know that Earth's rotation causes celestial objects to appear to move across the sky from east to west. The distance of celestial objects can also play a role in how they are observed from Earth. For example, because the planets are much closer to Earth than the stars, their path along the ecliptic over time appears to change with respect to the constellations. A planet can be distinguished from a star in the night sky by observing its motion over weeks or months.

In addition, our view of the night sky changes with each passing season due to Earth's revolution around the Sun. For example, if we observe the northern hemisphere's night sky in winter we see stars that are opposite the Sun. The stars that are in the same direction as the Sun will only be in the northern hemisphere's sky during the day and will not be visible (Figure 4.13). Therefore, the constellations we see in the night sky are not the same at all times of the year.

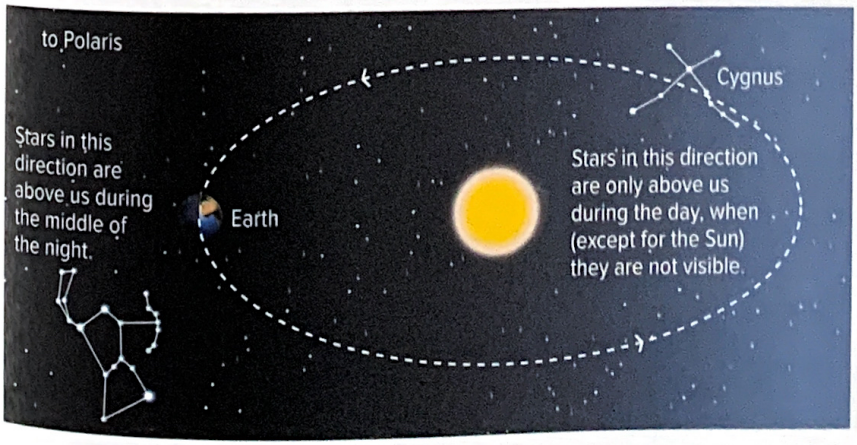


Figure 4.13 Orion is visible in the northern winter sky because it is opposite the Sun during that time. However, Cygnus is in the northern winter sky during the day, so it cannot be seen.