# Modeling the Night Sky

**National Science Education Standards**

- Content Standard in K-4 Earth and Space Science (Changes in Earth and sky, Objects in the sky)
- Content Standard in 5-8 Earth and Space Sciences (Earth in the solar system)
- Content Standard in K-4 Physical Science (Position and motion of objects)

*This activity extends "Shadow Play" (page 6) to include more solar system objects and to examine their motions.*

## Preparation

Each individual or group needs one copy of the constellation strip on page 9. The teacher needs individual constellation pictures and cards with the names or pictures of the following objects: Sun, Earth, Mercury, Mars, and Jupiter. Allow each group of 2-3 students to glue or tape the strips together to form a loop with the constellations in this order: Scorpius, Libra, Pisces, Aquarius, Capricornus, Gemini, Taurus, Aries, Virgo, Leo, Cancer, and Sagittarius. Ask students if they recognize any of the pictures. Some students may wish to color the pictures.

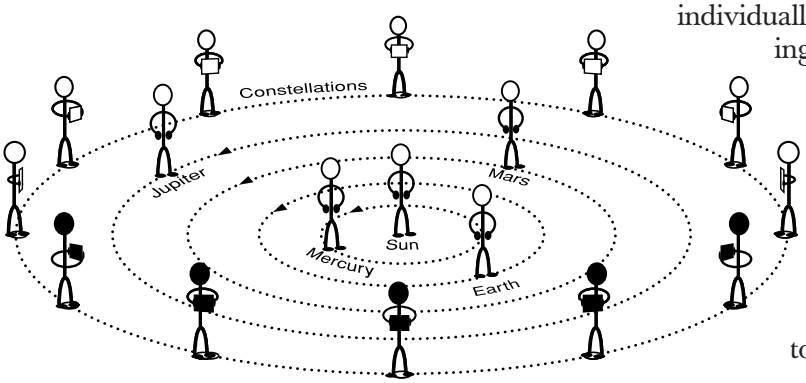
## Activity 1

Place the loop so that the pictures face inward. Distribute two small balls (such as clay or marbles). Ask the students to place one ball to represent the position of the Sun in relation to the constellations. Then ask them to place the other ball where they think Earth should be in relation to the Sun and the constellations and to explain to their partners why they chose that position. Ask the students to identify which side of Earth will be day and which side will be night. When the Sun is "in" a certain constellation (that is, standing on Earth if you had the ability to see stars in the daytime, which constellation would be behind the Sun), what constellation is seen at midnight? Your interactions will depend upon the student responses. If they place Earth rather than the Sun in the center, ask them to explain. For now, accept all answers.

Ancient peoples tracked which constellation was in the direction of the Sun. They usually watched the sky near sunrise. When the model is correct, the Sun is in the middle and Earth goes around it (counterclockwise as seen from the north pole). The constellations are very distant compared to the Earth-Sun distance.

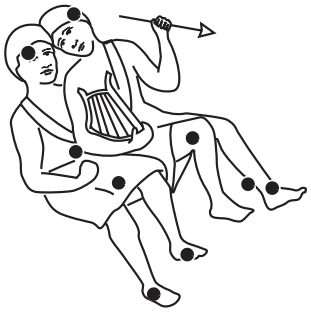
## Activity 2

Cut each figure out of one strip and paste it on an individual card. Pass the cards out to 12 students, who stand in a circle facing inward. (For a small group, post the cards on backs of chairs to make a circle.) Make sure they follow the same order as the loop. Choose one student to be the Sun and stand in the middle of the circle. Allow another student to individually model Earth's motion throughout the year, recalling that the direction of rotation and revolution are the same. For Earth, one turn around the Sun takes one year. (Although rotation can be considered simultaneously, remember that Earth rotates in 24 hours, and anyone who spins 365 times as they "orbit" the Sun will become dizzy!) As an extension, you may wish to include Earth's tilt. Choose a spot above Gemini on a distant wall to be Polaris and tell "Earth" to always bend in that direction as it orbits the Sun.

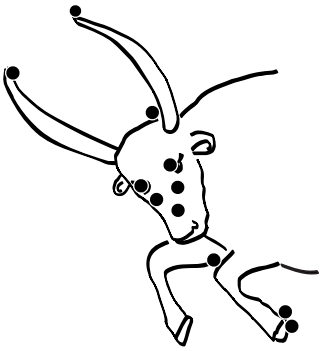



We see different stars at different times of year because Earth orbits (revolves around) the Sun. It takes about one month for the Sun to move from one constellation to another.

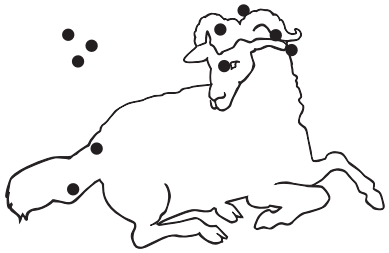
A



GEMINI



TAURUS

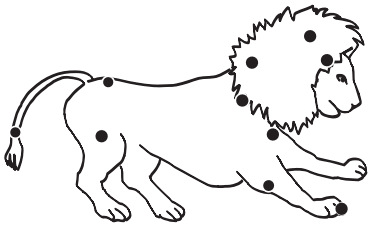


ARIES

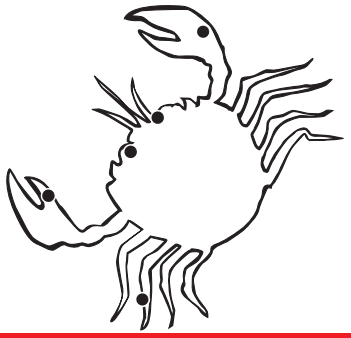
D

B

VIRGO



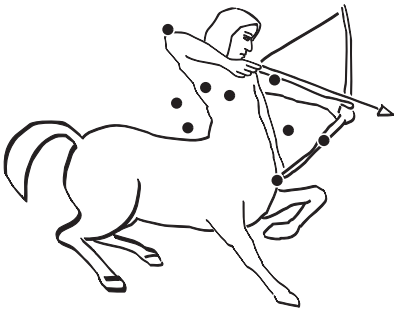
LEO



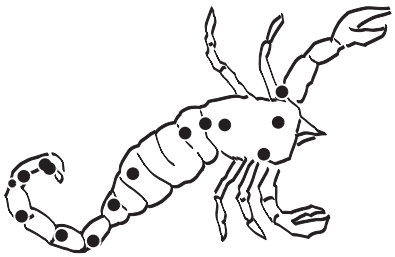
CANCER

A

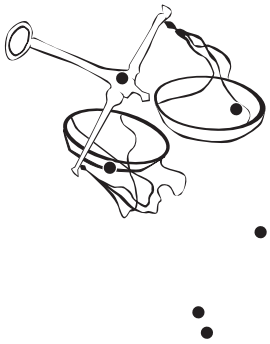
C



SAGITTARIUS



SCORPIUS

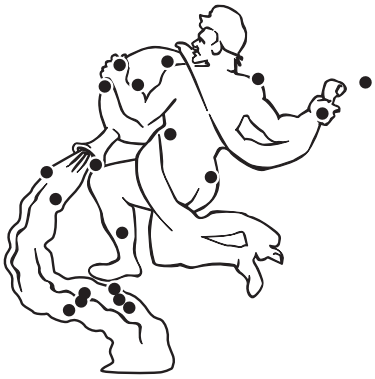


LIBRA

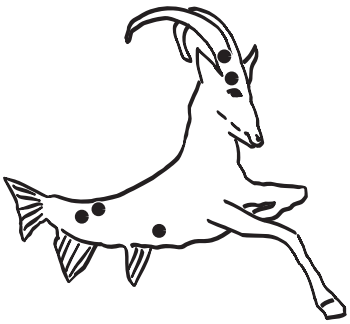
B

D

PISCES



AQUARIUS



CAPRICORNUS

C

## The Journey Begins

Spring begins in the northern hemisphere this morning as the Sun crosses the equator heading north. For many of us in modern times, this event, called the spring equinox, is little more than a note on the calendar. But to many older cultures, the equinox was a time for celebration, as the Sun warmed the Earth and banished the long winter nights.

The Lakota of the Great Plains celebrated the beginning of a new year around the equinox. They commemorated the event with the start of a sacred journey across the Black Hills. Sometimes, only medicine men or tribal elders made the trek; at other times, entire tribes were involved. The Lakota have recently revived the custom, which they say may have started more than 2,000 years ago.

The spring journey celebrated a connection between the stars and the land. Several Lakota constellations represented prominent features in the Black Hills. In fact, one *large* constellation represented the *entire* Black Hills; more on that tomorrow.

Spring journey began when the Sun entered the Lakota constellation Cansasa Ipusye, the Dried Willow, which includes stars of Aries and Triangulum. It culminated at Mato Tipi La Paha — the Hill of the Bear's Lodge, a tower of volcanic rock in Wyoming that's also known as Devils Tower. It's represented in the sky by the stars of Gemini. Sun Dance ceremonies there affirmed the connection between the people and the sky, and celebrated the completion of one full circle of life — and the beginning of another.

Add more celestial objects to your model by handing planet cards to more students. These objects orbit the Sun like Earth, but at different rates. This works best if they come in one at a time, each with their own rate of orbiting the Sun. The following table recommends some approximations to use, along with the exact values, for periods of revolution (the time it takes for the object to revolve around the Sun one time). Remember that distance scales are not preserved in this activity. For example, tell them that Mercury orbits the Sun four times in one Earth year. So the person who represents "Mercury" has to race around the Sun four times while Earth goes around only once. Some students will count this out. For younger students, drawing the circles on the floor helps them keep at the proper distances. Stop occasionally to ask, "If you are on Earth, where or when can you see that object?" Add more or fewer objects depending upon the age of the group. For older students, model sunrise/sunset and ask what objects are visible in the sky at various times of day (just after sunset or at midnight, for example) and in which constellations they appear. If you have already studied phases of the Moon (see "Observing the Moon," page 11), it can be inserted into this model, orbiting Earth in about one month while Earth orbits the Sun in one year.

| Object | Approximate period | Actual period |
|---|---|---|
| Mercury | 1/4 year | 0.24 year = 88 days |
| Earth | 1 year | 1.00 year = 365.25 days |
| Moon | 1 month | 27.3 days |
| Mars | 2 years | 1.88 years |
| Jupiter | 12 years | 11.86 years |

### Evaluate

- The asteroid Ceres has a period of 4.6 years. Where would it go in this scheme? (Answer: between Mars and Jupiter.)
- Why did we not include Venus (0.61 year), Saturn (29.42 years), Uranus (83.75 years), Neptune (163.73 years), or Pluto (248 years)? (Answer: 0.61 years would be difficult to model and adding Venus would make it crowded. The other planets orbit so slowly that they would barely move!)
- Place a plain piece of paper under the loop and sketch the number of orbits (or partial orbits) for Earth and two other objects.

**Teaching note**: Although this activity does not indicate relative distances, it is correct that all of the planets orbit the Sun in approximately the same plane. That is why we can limit ourselves to just the constellations that form one great circle on the celestial sphere.