Modeling the Night Sky

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

Although Ophiuchus (oh-fee-YOO'-kus) is not a traditional constellation of the zodiac, the Sun passes through its borders in December. In one year, the Sun passes through 13 constellations. In classical mythology, Ophiuchus was known as the serpent bearer.

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, matching the letters on the edges of each strip, A:A, B:B, C:C, and D:D. That will form a loop with the constellations in this order: Gemini, Taurus, Aries, Pisces, Aquarius, Capricornus, Sagittarius, Ophiuchus, Scorpius, Libra, Virgo, Leo, and Cancer. Ask students if they recognize any of the pictures. Some students may wish to color the pictures.
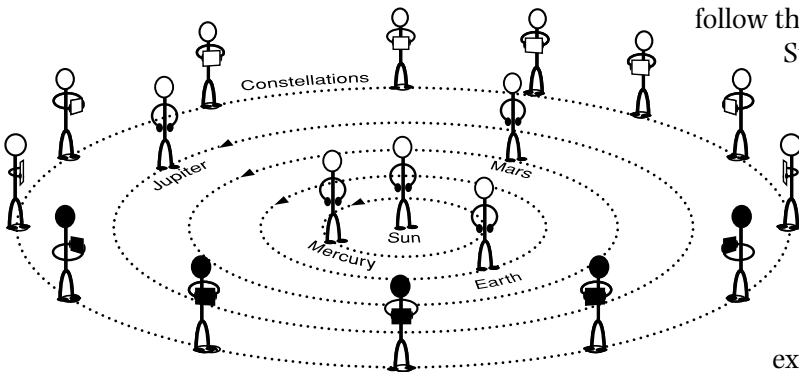
ACTIVITY 1

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 constellations appeared in the direction of the Sun. They usually watched the sky near sunrise. For this model, the Sun is in the middle and Earth goes around it (counterclockwise as seen from the north pole). The stars 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 13 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.
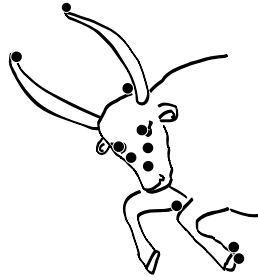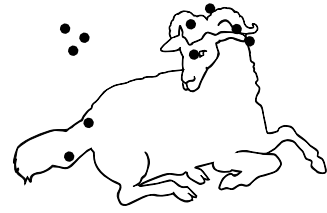
A ——— ——— ———
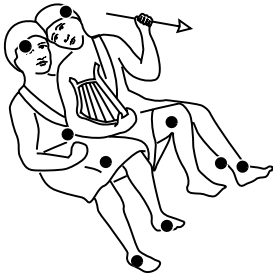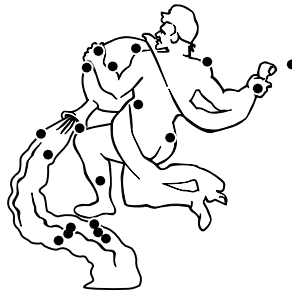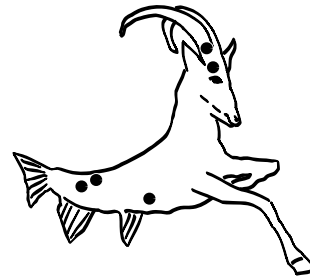
D ———

| GEMINI | TAURUS | ARIES |

D ——— ———

C ———

| PISCES | AQUARIUS | CAPRICORNUS |

C ——— ———

B ———

| SAGITTARIUS | OPHIUCHUS | SCORPIUS | LIBRA |

B ——— ———

A ———

| VIRGO | LEO | CANCER |

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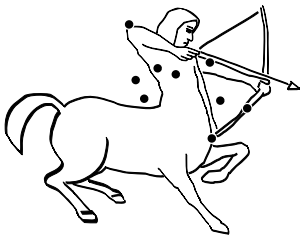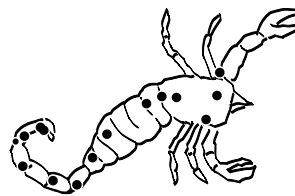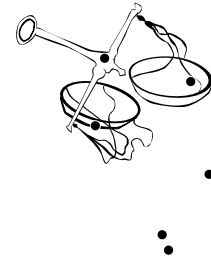
Ophiuchus and Serpens

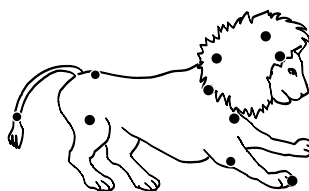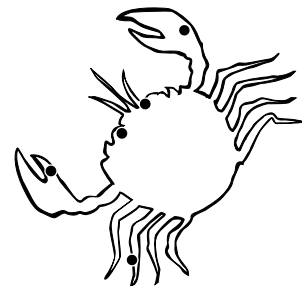Two constellations that don't get a lot of respect are in the southwest this evening, above the Moon and the bright planet Jupiter. One of them is slighted by anyone who can name the 12 signs of the zodiac. The other was slighted by the people who established the constellation boundaries: they chopped out its middle.

The constellations are Ophiuchus, the serpent bearer, and Serpens, the serpent.

Ophiuchus is one of the largest constellations. More important, it lies along the ecliptic — the Sun's path across the sky. The constellations along this path form the zodiac. But Ophiuchus isn't included in the lineup, even though the Sun spends more time inside its borders than in Scorpius, which is next door.

Ophiuchus represents the founder of medicine. In myth, he was such a good healer that he even brought the dead back to life. That was reminiscent of the powers of a snake: It can kill, but it also rejuvenates itself every year when it sheds its skin. So in the sky, the physician is also known as the serpent bearer.

Appropriately enough, he's holding on to Serpens. The serpent's head is to the west of Ophiuchus, with the tail to the east — severed by the body of Ophiuchus.

Serpens and Ophiuchus are well up in the southwest at nightfall. Look for the crescent Moon quite low in the sky, with brilliant Jupiter and the bright orange star Antares to its upper left. Ophiuchus and Serpens stretch out above this bright trio.

We see different stars at different times of year because Earth orbits (revolves around) the Sun. Some constellations are small, while others are large. The Sun appears to move from one constellation to another in as few as 6 days or as many as 43.

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). Distance scales are not preserved in this activity. For example, tell the students 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 maintain 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 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), or Neptune (163.73 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.