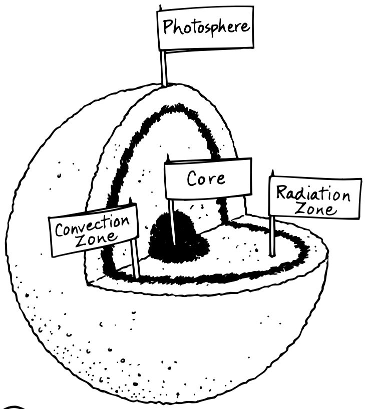
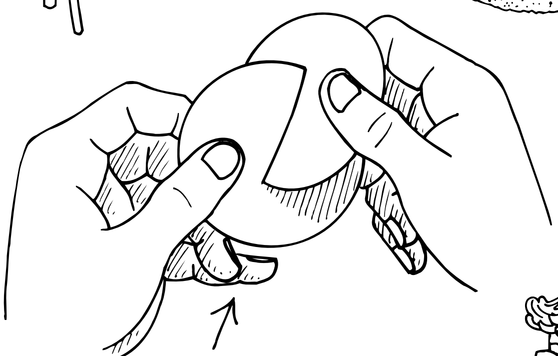
# I

# Astronomy



# 1. More or Less

**Purpose** To determine how the masses of other planets compare to the mass of Earth.

**Materials** pen, ruler, sheet of white copy paper, calculator

**Procedure**

1. Use the pen, ruler, and paper to make a table like the one shown here.

**MASS RATIOS OF THE PLANETS TO EARTH**

| Planet | Mass (trillion trillion kg) | Mass Ratio (planet/Earth) |
|---|---|---|
| Mercury | 0.33 | 0.06/1 |
| Venus | 4.87 | |
| Earth | 5.986 | |
| Mars | 0.64 | |
| Jupiter | 1,899.0 | |
| Saturn | 569.0 | |
| Uranus | 86.9 | |
| Neptune | 103.0 | |
| Pluto | 0.012 | |

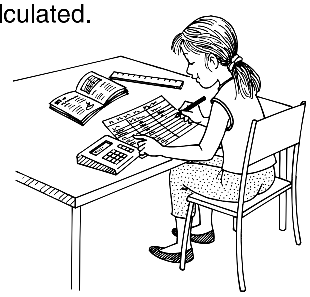
2. Complete the table by calculating each planet's mass ratio, which is the ratio of a planet's mass to the mass of Earth.

*NOTE: The mass of planets is measured in trillion trillion kilograms. For example, the mass ratio of Mercury is:*

mass ratio = planet's mass ÷ Earth's mass
= 0.33 ÷ 5.986
= 0.06/1

*Mercury's mass ratio is 0.06/1, which means that Mercury's mass is 0.06 times that of Earth.*

**Results** The mass ratio of each planet to Earth in the solar system is calculated.



**Why?** **Matter** is anything that takes up space and has mass. **Mass** is the amount of substance in a material. The term **mass ratio,** as used in this book, is a number indicating how many times as massive an object is as compared to another object.

Matter in the **universe** is made up of all the natural objects in space including Earth and other planets. **Planets** are celestial bodies that travel in an **orbit** (curved path of one celestial body about another) around the Sun. **Celestial bodies** are natural objects in the sky, such as stars, suns, moons, and planets. The nine planets listed in the table are part of our **solar system** (a group of celestial bodies that move in a curved path about a star called a sun). The mass ratio of each of the planets in our solar system compared to Earth is calculated by dividing the mass of a planet by the mass of Earth.

# 2. Sunrise-Sunset

**Purpose** To model the Sun's apparent daily motion.

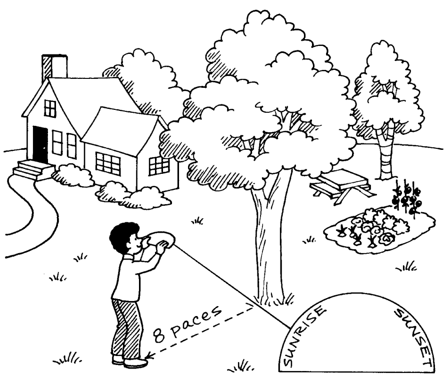
**Materials** marker
scissors
22-by-28-inch (55-by-70-cm) piece of poster board
tree

**Procedure**

1. Use the marker to draw the largest semicircle possible on the poster board. Cut out the semicircle.
2. Label the left side of the semicircle "Sunrise" and the right side "Sunset."
3. Holding the semicircle, stand with your back near the tree.
4. Walk eight paces away from the tree. Then turn and face the tree.
5. Hold the poster board parallel with the ground so that the center of the straight edge of the board is near but not touching your eyes.
6. Turn so that the tree is in line with the left (sunrise) side of the poster board.
7. Slowly turn your body counterclockwise until the tree is in line with the right (sunset) side of the poster board. As you turn, watch the tree while also observing objects in the background.

**Results** The tree appears to move from one side of the poster board to the other, but does not move in relation to objects in the background.

**Why?** The apparent motion of the tree from one side of the paper to the other is due to your body turning. The apparent motion of the Sun is also, like the tree, due to your body turning. But for the Sun's motion, instead of you turning your own body, the Earth you stand on turns, or **rotates,** about its **axis** (an imaginary line through the center of an object), taking your body with it. The Sun's daily path is generally from east to west. **Sunrise** is the apparent rising of the Sun above the eastern **horizon** (an imaginary line where the sky and Earth appear to meet). **Sunset** is the apparent setting of the Sun below the western horizon.



# 3. Sun Path

**Purpose** To demonstrate the Sun's apparent motion.

**Materials** tree

**Procedure**

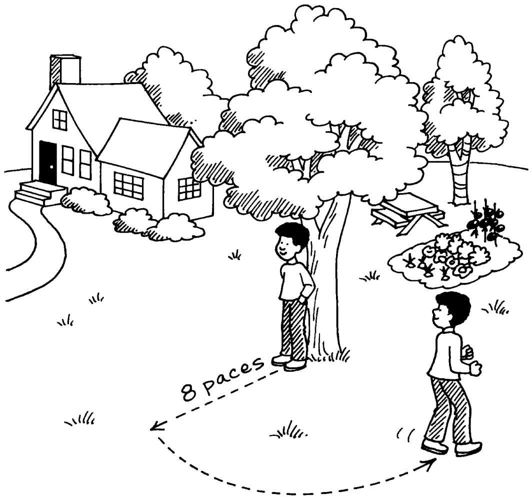
1. Stand with your back near the tree.
2. Walk eight paces away from the tree.
3. Turn and slowly walk counterclockwise halfway around the tree.
4. As you walk, watch the tree trunk while also observing objects in the background.

**Results** The tree appears to move slowly against a background of stationary (unmoving) objects.

**Why?** Just as the tree appeared to move against objects in the background, to observers on Earth, the Sun appears to move eastward among the stars. The apparent path the sun moves in is called the **ecliptic.** The ecliptic runs through a band of **constellations** (groups of stars that appear to make patterns in the sky). This band is called the **zodiac,** and the constellations along the band are called **zodiac constellations.** In ancient times, sky watchers divided this band into 12 segments, each about 30° wide, with a constellation in each segment. About every 30 days, a different segment appears in the daytime sky.

As seen from Earth, the zodiac constellations are the background against which the Sun apparently moves. At specified times, the Sun is said to be "in" a given constellation. So even during the daytime, when the Sun is too bright for the stars to be visible, the constellations around the Sun are known.

In this experiment, you represent the Earth, the tree represents the Sun, and the objects beyond the tree represent the zodiac constellations. The path you walked represents Earth's orbit. The apparent motion of the tree is due to your motion around it. This is also true for the apparent annual movement of the Sun, which is due to Earth **revolving** (moving about a central point) about the Sun. As Earth revolves about the Sun, the zodiac constellation that appears behind the Sun changes throughout the year.




# 4. Time

**Purpose** To study the relationship between the apparent motion of the Sun and time.

**Materials**

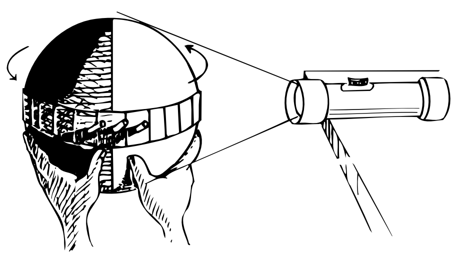
| | |
|---|---|
| scissors | transparent tape |
| butcher paper | straw |
| ruler | modeling clay |
| basketball | flashlight |
| marking pen | |

**Procedure**

1. Cut a strip of paper 4 inches (10 cm) wide and long enough to wrap around the basketball.
2. Fold the strip into three equal sections. Then fold it in half three times to make 24 equal sections.
3. Unfold the strip and draw a line on each fold.
4. Wrap the strip around the basketball and secure the ends together with a piece of tape.
5. Cut three 2-inch (5-cm) pieces from the straw. Use three dabs of clay to stand the straw pieces on three consecutive sections of the strip.
6. Turn on the flashlight and lay it on the edge of a table with the bulb facing outward.
7. Darken the room. Then stand with the flashlight to your right, holding the basketball so that it is about 6 inches (15 cm) away from the bulb and the first straw points straight toward you.
8. Observe the length of the shadows of the straws on the paper. Continue to observe the shadows as you slowly rotate the ball counterclockwise. Stop when the first straw points directly at the light.

**Results** Shadows are cast by the straws. Straws closer to the light have shorter shadows.

**Why?** As the straws get closer to the light, their shadows shorten until no shadow is cast by the straw pointing directly at the light. This is a simulation of Earth rotating on its axis toward the Sun, with each of the 24 sections on the paper representing one time zone. A time zone is any of 24 geographic areas into which the Earth is divided. Clocks within a given time zone are set to the same time. The difference in the shadows indicates a difference in distance from the zone beneath the noonday Sun, when the Sun is at its greatest **altitude** (angular distance above the horizon), and thus a difference in time.



# 5. Saving Time

**Purpose** To determine if there is extra sunlight because of daylight saving time.

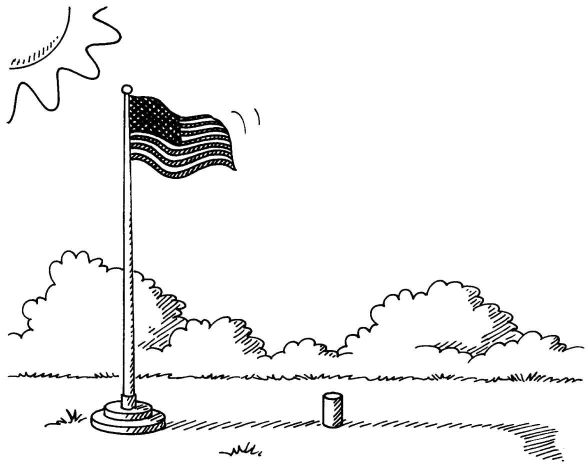
**Materials** watch or clock
empty soup can (or can of comparable size)
thin pole, such as a flagpole (a thin tree will work)

**Procedure**

1. Set the watch to correct standard time, which is 1 hour earlier than daylight saving time. (If you are performing this experiment during daylight saving time, set the watch back 1 hour.)
2. On a sunny day, take the can outdoors about 5 minutes before 10:00 A.M. (or any convenient hour).
3. Locate the shadow of the pole.
4. At 10:00 A.M., push the can into the ground in the center of the pole's shadow.
5. Before the following day, set the watch to daylight saving time (set the watch ahead 1 hour).
6. On the following day, at 10:00 A.M. daylight saving time, observe the pole's shadow. Compare the location of the shadow to the location of the can. Continue to observe the shadow periodically and make note of the time when the can is in the center of the shadow as on the previous day.

**Results** The can was in the pole's shadow 1 hour later when the watch was set to daylight saving time.

**Why?** **Daylight saving time (DST)** is the time from late spring to early autumn when clocks are set forward 1 hour so that there are more usable hours of daylight in the evening. **Standard time (ST)** is the time during the rest of the year. During daylight saving time, nothing changes except the position of the hour hand on the watch. The shadow on the can would have indicated the same standard time of 10:00 A.M. each day. Your watch showed the shadow to be on the can at 11:00 A.M. instead of 10:00 A.M. because you set your watch ahead 1 hour. Dawn and sunset both occur 1 hour later during daylight saving time, so no extra hours of daylight are really available from the time change.



# 6. Longer

**Purpose** To determine how the Sun's altitude affects shadow length.

**Materials** sheet of unruled paper
pen
ruler
grape-size piece of modeling clay
pencil
flashlight

**Procedure**

1. Lay the paper on a table. Use the pen and ruler to draw two perpendicular lines across the center of the paper.
2. Print the compass directions—N, E, S, W—at the ends of the lines as shown.
3. Use the clay to stand the pencil in the center of the paper where the lines cross.
4. In a darkened room, hold the flashlight on the east side and about 6 inches (15 cm) away from the pencil. The light should be pointed toward the side of the pencil. Observe the length of the shadow.
5. Slowly move the flashlight over the pencil in a semicircle to the west side. Observe the length of the shadow during this movement.

**Results** The length of the shadow decreases as the flashlight is raised and increases as the flashlight is lowered.

**Why?** Because of the rotation of the Earth, the Sun appears to move across the sky from east to west. In the morning, when the Sun rises in the east and is at a low altitude, shadows are long. As the altitude of the Sun increases, shadows decrease in length. Shadows are shortest when the Sun is at its highest altitude. This occurs at what is called **solar noon,** which is at or near 12:00 P.M. standard time. After solar noon, the Sun's altitude decreases and shadows increase in length and are longest at sunset. Before solar noon, shadows are cast toward the west, but after solar noon, shadows are cast toward the east.