For all parts of this activity, it is helpful to imagine that the stars are so bright (or our Sun so dim) that the stars can be seen during the day so that your sky might appear as in Figure 1.

Part I: Daily Motion

On December 1, at noon, you are looking toward the south and see the Sun among the stars of the constellation Scorpius as shown in Figure 1.

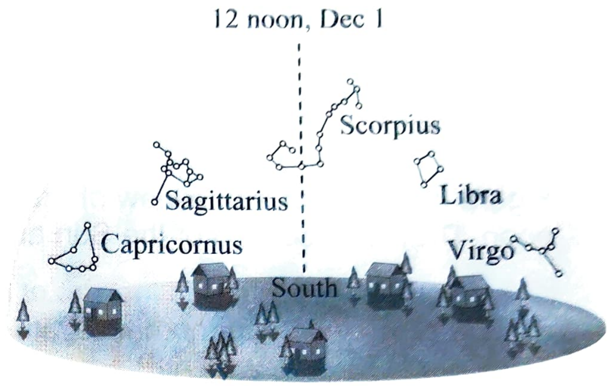


Figure 1

1) At 3 P.M. that afternoon, will the Sun appear among the stars of the constellation Capricornus, Sagittarius, Scorpius, Libra, or Virgo?

2) Two students are discussing their answers to Question 1.

Student 1: *The Sun moves from the east through the southern part of the sky and then to the west. By 3 P.M. it will have moved from being high in the southern sky to the west into the constellation Libra.*

Student 2: *You're forgetting that stars and constellations, like those in Figure 1, will rise in the east, move through the southern sky, and then set in the west just like the Sun. So the Sun will still be in Scorpius at 3 P.M.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

Recall that in the celestial sphere model, the stars' daily motions result from the rotation of the celestial sphere.

3) Is it reasonable to account for the Sun's **daily motion** by assuming that the Sun is at a fixed position on the celestial sphere (in this case in the location of the constellation Scorpius) and is carried along its path across the sky by the sphere's rotation? Explain why or why not.

Part II: Monthly Changes

By careful observation of the Sun's position in the sky throughout the year, we find that the celestial sphere rotates slightly more than 360° every 24 hours. Figure 2 shows the same view of the sky (as Figure 1) but on December 2 at noon. For comparison, the view from the previous day at the same time is also shown in gray.

4) Draw the location of the Sun as accurately as possible in Figure 2.

5) Figure 3 shows the same view of the sky (as Figure 1) one month later on January 1 at noon. Draw the location of the Sun as accurately as possible in this figure.

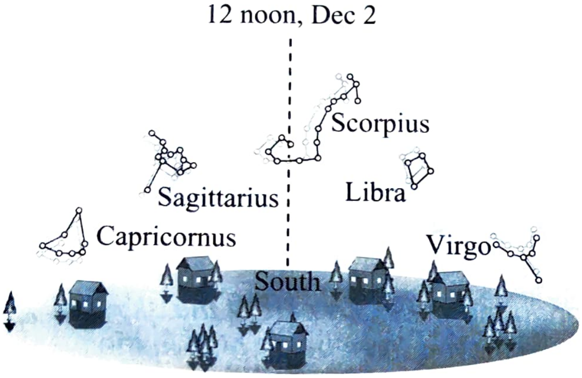


Figure 2

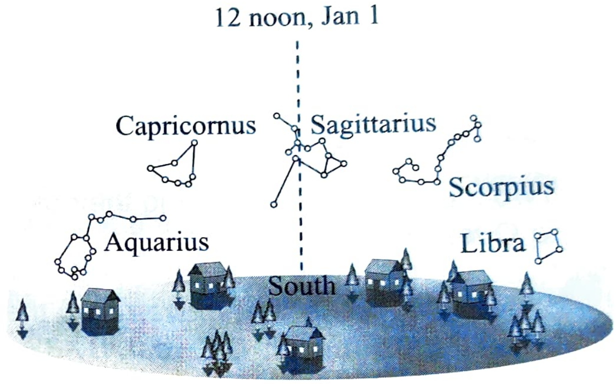


Figure 3

6) Two students are discussing their answers to Questions 4 and 5.

Student 1: *The Sun will always lie along the dotted line in the figures when it's noon.*
Student 2: *But, we saw in Question 3 that the Sun's motion can be modeled by assuming it is stuck to the celestial sphere. The Sun must, therefore, stay in Scorpius.*
Student 1: *If that were true, then by March the Sun would be setting at noon. The Sun must shift a little along the celestial sphere each day so that in 30 days it has moved toward the east into the next constellation.*

Do you agree or disagree with either or both of the students? Explain your reasoning.

7) Why is it reasonable to think of the Sun as attached to the celestial sphere over the course of a single day, as suggested in Question 3, even though we know from Questions 5 and 6 that the Sun's position is not truly fixed on the celestial sphere?

Part III: The Ecliptic

The zodiacal constellations were of special interest to ancient astronomers because these are the constellations through which the Sun moves throughout the year. This was incorporated into their celestial sphere model by having the Sun loosely fixed to the celestial sphere but allowing it to slip a small amount each day. The Sun's position on the celestial sphere (among the stars in the constellation Scorpius) on December 1 is shown in Figure 4.

Figure 4

8) On Figure 4, draw where the Sun will be located on the celestial sphere on January 1. Label this position "Jan 1."

9) On Figure 4, for the other constellations, draw in the Sun and label the constellation with the approximate date that the Sun will be located there.

The line drawn through these constellations, tracing out the Sun's annual path, is called the **ecliptic.**

10) Label the ecliptic in Figure 4.

11) About how many times does the celestial sphere rotate in the time it takes the Sun to move between two adjacent constellations (i.e., 1/12 of the way around) along the ecliptic?

12) How long does it take the Sun to make one complete trip around the ecliptic (i.e., from Scorpius to Scorpius)?

Part IV: Wrap-Up

It is important to realize that the ecliptic represents an *annual* drift of the Sun and does not represent the daily path of the Sun. Instead, the rotation of the celestial sphere is responsible for the Sun's daily motion through the sky. Also, since the ecliptic is tilted with respect to the rotation axis of the celestial sphere, the ecliptic slowly "wobbles" as the celestial sphere rotates. The Sun's position on the ecliptic is only important in deciding whether the Sun's daily path will carry it high in the sky (summer) or low in the sky (winter). In Figure 5a, the Sun's position along the ecliptic and its path for one day (dashed line) are shown for two different dates: December 1 (in Scorpius) and June 1 (in Taurus). Figures 5b, 5c, and 5d show the path of the Sun and the wobble of the ecliptic at six-hour intervals as the celestial sphere rotates. Study these figures, carefully noting that the ecliptic and Sun are both carried by the celestial sphere.

13) On Figure 5d, label the ecliptic (Sun's annual path) and the Sun's daily path for December 1 and June 1.

14) Which Figure (5a, 5b, 5c, or 5d) shows the Sun at noon, low in the southern sky, when it would be among the stars of the constellation Scorpius?

15) Which Figure (5a, 5b, 5c, or 5d) shows the Sun at noon, high in the southern sky, when it would be among the stars of the constellation Taurus?

December 1 (Sun in Scorpius)
and
June 1 (Sun in Taurus)

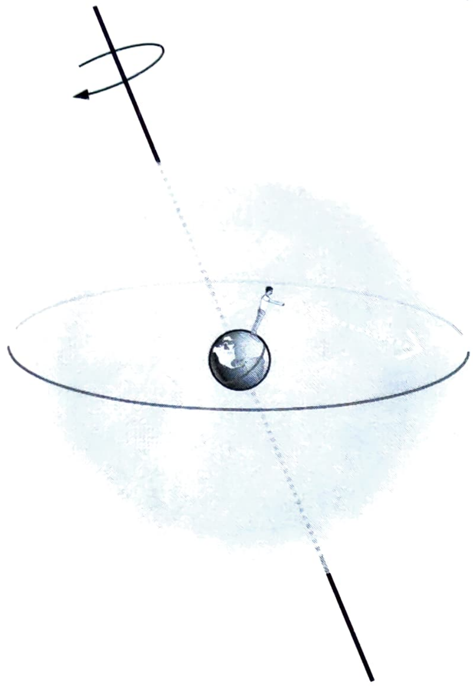
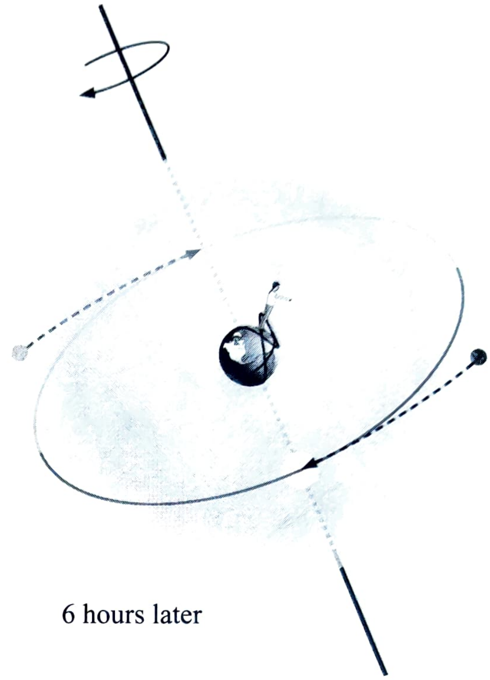
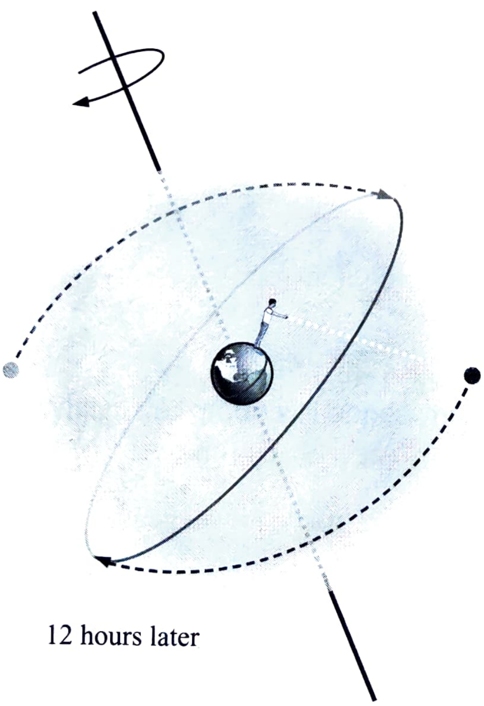


Figure 5a



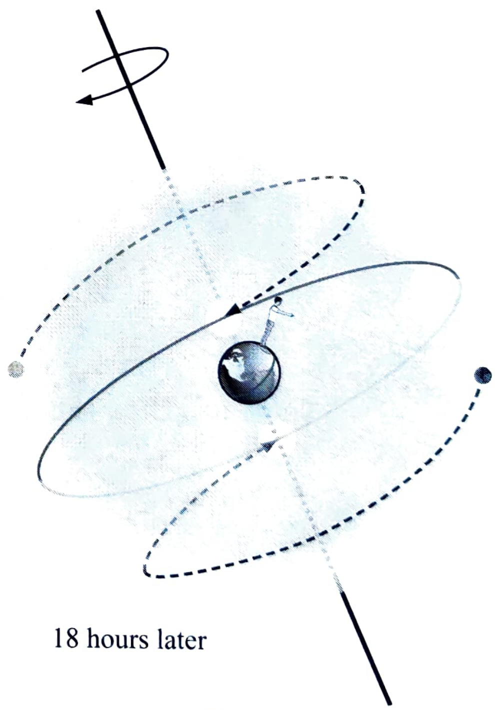
6 hours later

Figure 5b



12 hours later

Figure 5c



18 hours later

Figure 5d