



Stars and Constellations: The Big Dipper—Guide to the Sky

Stars are scattered across the nighttime sky in a way that can be bewildering to a person who is unfamiliar with the patterns that are formed. However, the sky is like any unfamiliar location—once you are able to recognize a few prominent landmarks, you can begin to find your way around with relative ease, and filling in the areas between the landmarks can be quite enjoyable. The landmarks in the sky are the brightest stars and the constellations.

This exercise is designed to familiarize you with several of the major constellations and bright stars that can be seen from mid-northern latitudes on the Earth. Once you know these patterns and can find them in the nighttime sky, you can use them as landmarks or direction finders to locate other stars and constellations and, with practice, you can become an expert at finding your way around the sky.

In history, the constellations were groups of stars, which outlined in crude, formed a familiar object or pattern. In modern astronomy, the constellations are 88 “officially designated” areas of sky, covering the entire celestial sphere with no gaps between them (Section 2-2 of Kaufmann & Freedman, *Universe*, Fifth Ed). However, most people, including most astronomers, think of a constellation more often in terms of the historical star pattern than as a set of invisible boundary lines dividing the sky into sections.

There are other patterns of stars called “asterisms,” which are useful to know, even though they are not constellations. Some of these asterisms are part of a larger constellation; for example, the Big Dipper is part of the constellation Ursa Major, or the Big Bear. Other asterisms, such as the Summer Triangle (Figure 2-8, *Universe*), extend over several constellations.

It is important to note that, at any given time of the night, not all of the stars and constellations described in this exercise will be visible. You should be able to find some of them, but others will be below the horizon and therefore hidden from view. To see these constellations, you need to try again at a different time of night (e.g., before dawn) or at a different time of the year. The changing appearance of the night sky is described in Section 2-3 of *Universe*.

Since the purpose of this exercise is for you to become familiar with the nighttime sky, we will first set up the screen to show only stars and constellations, eliminating distractions such as the horizon and daylight, and the Sun, Moon and planets. We will also select a mid-northern latitude on the Earth—New York City, at about 40° north latitude—to allow a clear view of the parts of the sky in which we are most interested, and we will begin by facing north. This flexibility is possible through the magic of a computer!

In this exercise, Part 1 leads you through the steps needed to set up the screen, and Part 2 then guides you to the stars and constellations that can be found by using stars in the Big Dipper as pointers. Some of these alignments are also described in Section 2-3 and Figure 2-6 of *Universe*.

Starting the Program

Start the program by clicking the mouse on the “Starry Night™, Freeman Edition” icon on the “Windows” screen or by running the “Starry Night™ Freeman Edition” program from the location where it was initially installed (e.g., C:\Program Files\Sienna\Starry Night™ Freeman Edition\).

The **initial set-up** of this program is for the “present” time (i.e., Now) at the default location, which is most likely your present location. Each of these parameters can easily be adjusted at any time.

The default function for the mouse is the **Grabber Tool**, whose mouse icon is a hand. The Grabber Tool can be used to change the observer's viewing direction by clicking and holding the left mouse button while the icon is "dragged" anywhere on the screen. To activate the Grabber Tool if it is not already activated, first click Window in the menu bar and look to see if the menu says "Show Floating Palettes" or "Hide Floating Palettes." Click on "Show Floating Palettes" if this is what the menu says, and you should see the icon/location box appear on the screen. You can recognize this box by the four icon buttons in a square at the top of the box. One of these four icons should be the Grabber Tool, which can be activated by clicking on this button. (If the Window menu says "Hide Floating Palettes," then the icon/location box should already be visible on the screen.) Alternatively, you can activate the Grabber Tool by pressing the F4 key.

The Grabber Tool is one of four tools that can be used for various purposes within the program. The other screen tools can be activated by clicking on the appropriate icon in the icon/location box or by using the correct F key. They each have a different mouse icon. The **Object Selection Tool** (click on the arrow icon or press F3) can be used to identify any object on the screen by pointing the arrow icon at the object in question and clicking the left mouse button. The third tool, the **Constellation Selection Tool** (click on the line-shape-and-arrow icon or press F5), can be used to identify the constellation in which the mouse icon has been placed. The fourth tool, the **Magnification Tool** (click on the magnifying glass icon or press F8), can be used to zoom in on a particular region of the sky around the mouse position, the extent of the region being shown by its width in degrees in the box at the bottom of the icon/location box. The magnification can be reversed by clicking the left mouse button while holding down the Control (CTRL) key. The screen icon will change to a minus sign at this time to indicate this "zoom-out" function.

PART 1: Screen Set-up

1. Switch off daylight. You can do this by clicking on Daylight in the Display menu. Or, instead, you can simply press CTRL+D; that is, holding down the CTRL key while you press D.
2. Similarly, switch off the horizon either by clicking on Horizon in the Display menu or by pressing CTRL+H.

3. Switch off the planets by clicking on Planets in the Display menu.
4. Set your location to New York. You can do this by following these steps:
 - a. Click on Viewing Location in the Settings menu. A new screen should appear, displaying a map of the world and a list of continents.
 - b. Click on the small triangle next to the words “North America” in the list of continents, then click on the triangle next to the words “United States.” A list of U.S. cities should appear.
 - c. Go to the lower-right-hand corner of the list of cities, and click the down arrow (little black triangle) several times until you can see New York in the list of cities. Click on New York to highlight it.
 - d. Click on the Set Location button, which is located to the lower right of the world map.
5. Set the date to 1/01/1999 AD using the following steps:
 - a. Go to the Window menu and look to see if Time has a check mark beside it. If it does not, then click Time to activate the date/time box. If there is already a check mark there, then this box should already be activated. You can recognize the date/time box by the button in it, which says “Now.” (Alternatively, you can activate the date/time box by pressing CTRL+T.)
 - b. There is a row of buttons in the date/time box, one of which has a black square on it. This is the time-stop button. If this button is not already highlighted, then click on it to stop the progress of time.
 - c. Today’s date is shown in date/time box in the form MONTH/DAY/YEAR AD (e.g., 10/23/1998 AD). Change the date to 1/01/1999 AD. To do this, click on the number corresponding to the MONTH, then type the number 1 (e.g., if the date is 10/23/1998 then click on the 10 and type 1). This will replace the 10 with the number 01. Next, click on the DAY (e.g., 23) and type 1; and finally click on the YEAR (e.g., 1998), and type 1999.
6. Directly below the date in the date/time box, you should see

the time in the form HOURS:MINUTES:SECONDS, followed by AM or PM. Change the time to 12:30:00 PM, just after midday. You can do this the same way that you changed the date in step 5b, above. If the time shown is AM, do not forget to change it to PM (click on AM, then type P).

7. Look near the bottom of the icon/location box and check that the Viewing Elevation is 3 m. If the elevation is any other number of meters, click on the button with the little house on it in this box. The buttons with the rising and falling rockets on them can be used to increase or decrease your elevation; clicking on the house button gets you back to the default value of 3 m.
8. Look again near the bottom of the icon/location box and check that the Field of View is 100°. The plus and minus symbols inside little magnifying glasses can be used to change the field of view, while the third button in the same row resets the field of view to the default value of 100°.
9. Finally, change your viewing location to North. To do this, go to the Window menu and see if Toolbar has a check mark beside it. If it does not, then click on Toolbar. You should now see a row of buttons on the screen, four of which should say N, S, E, and W. Click once on the N button, and you should see the stars move across the screen until you are facing directly north.

If you are familiar with the Big Dipper, you should now see it near the upper-left-hand corner of the screen.

PART 2: Using the Big Dipper as a Guide to the Sky

1. Find the Big Dipper. This asterism, part of the constellation **Ursa Major**, or the Big Bear, consists of seven moderately bright stars that form the shape of a dipper that you might use to scoop water out of a bucket. It should be on the left-hand or upper-left-hand side of the screen. The bowl of the Big Dipper consists of four stars forming a slightly skewed rectangle, and the handle consists of three stars forming an arc extending toward the left (or upper left) in the orientation on your screen. In the actual sky the Big Dipper can have any ori-

entation, such as upside down or hanging downward from its handle, depending on the time of night and the time of year. This is because these stars, and indeed all stars, appear to rotate around the North Pole position in our sky.

You can check that you have found the correct pattern of stars by clicking Constellations in the Guides menu to display a set of connecting lines that outline the patterns of stars. You *might* be able to make out the shape of a bear in this, the constellation Ursa Major or the Big Bear! At any rate, you will see this name identifying the group of stars near the upper-left-hand corner of the screen. Click Guides/Constellations a second time to switch the constellations off again; leaving the lines on will create confusion. Since the real sky has no lines in it, it is important to become familiar with finding your way around the sky using only the stars.

2. The Big Dipper is one of the most important constellations to know in the sky because the stars in it can be used as pointers to find many other stars and constellations, particularly the North Pole Star.

We will need to define two words: “upward” and “downward,” relative to the Big Dipper. First tilt your head, or imagine that you have tilted your head, so that the dipper is horizontal with the handle to your left and the bowl opening upward. This defines “upward” relative to the Big Dipper. “Downward” is the opposite direction—the direction in which water would drip if the bowl leaked. For example, if in the real sky the Big Dipper is standing vertically on its handle (bowl above the handle), then upward from the bowl would be toward the left in the sky, and downward from the bowl would be toward the right.

3. Now use the Big Dipper to find the North Star, **Polaris**. To do this, first find the two stars that are on the end of the bowl farthest from the handle. These are often called the “pointer stars.” Start from the bottom star (the star at the bottom of the bowl farthest from the handle), and extend an imaginary straight line upward through the top star (at the top of the bowl). If you continue to extend this line upward a total distance approximately equal to 5 times the spacing of these pointer stars, you should

find a moderately bright star. This is Polaris, the North Star. (The North Star is *not* a really bright star—it is actually slightly fainter than the brightest stars in the Big Dipper—but it *is* the brightest star in that little patch of sky.)

If you have found the correct star, then you should see a line of four stars on the screen, curving away from Polaris in an arc toward the handle of the Big Dipper. The first three of these stars are fainter than Polaris and the fourth is about equal in brightness to Polaris. These stars are part of the Little Dipper, which consists of the brightest stars in the constellation Ursa Minor, or the Little Bear.

Click on Guides/Constellations to bring up the constellation lines and names, and check that you have found Ursa Minor correctly; then click the constellation lines off again.

Notice that the two stars in the bowl of the Little Dipper furthest from the North Star (i.e., closest to the Big Dipper’s handle) are brighter than all the other stars in the Little Dipper except Polaris. These two stars are often called the “Guardians” because, as the sky turns, they always remain between the Big Dipper and Polaris and “guard” Polaris from the Big Dipper (or from the Great Bear). In a city, with its light pollution, you might find when you look at the real sky that the only stars of the Little Dipper that you can see are Polaris and the two Guardians.

In clicking the constellation lines on and off again, you may find that one of the four stars in the bowl of the Little Dipper is “missing.” It is visible in the real sky if the sky is very dark, with no bright moonlight, city lights, or other light pollution. If it is missing from your screen, this is caused by its being fainter than the lowest brightness limit of the stars in the program.

The **brightness**, or “magnitude,” of the stars that appear in the sky view in this program can easily be changed to match the expected sky conditions at any site. To do this, simply click on Magnitudes in the Settings menu. A slider control can be adjusted with the mouse to change the star brightness. A particular setting can be tried by using the Apply command. Clicking on OK will then return you to the screen. The stars

shown in this program are limited to a sub-set of the stars in the real sky, those that are brighter than a certain limit. Thus, using this “brightness” facility will merely brighten or darken those that are visible but will not bring fainter stars into view.

With the constellation lines turned off, check again that you can find the pointer stars in the Big Dipper and that you can use them to find Polaris. Then check that you can see the Little Dipper, with its two Guardian stars, hanging downward in an arc toward the handle of the Big Dipper.

5. Now, with the constellation lines clicked off, locate the constellation **Cassiopeia** (the Queen of Ethiopia). To do this, start at the handle of the Big Dipper and imagine a straight line drawn from this position through the North Star to approximately an equal distance beyond it. The end of this line should place you in a group of stars shaped like a W. In the orientation on your screen at this time, the right side of the W should be tilted upward. (At other times and in other orientations, it may look more like an M, depending on which side is facing down.)

Click the constellation lines on to check that you have found Cassiopeia correctly, then click them off again.

If you look carefully, you may see a faint band of brighter sky on your screen, running downward through Cassiopeia. This band of light depicts the **Milky Way**, made up in the real sky of countless faint stars. Most of these stars are too faint to be seen individually with the unaided eye, but their collective light contributes to a faint glow in the sky.

With the constellation lines clicked off, check again that you can find Cassiopeia using the handle of the Big Dipper and Polaris.

6. Now find the star **Capella**. To do this, first find the two stars on the top of the bowl of the Big Dipper. One of these two stars marks the point where the handle joins the bowl, and the other is across the top of the bowl from the first star.

Draw an imaginary straight line through these two stars, starting where the handle joins the bowl, and extend it a long way across the sky (toward the lower right of your screen). The first *really* bright star that you come to is Capella, in the con-

stellation **Auriga**, the Charioteer. (When you look at Capella in the real sky, you may notice that it has a slightly yellowish tint because it is roughly the same temperature as the Sun. However, our Sun is a dwarf star and Capella is a supergiant, so they are very different from each other in size.)

Click the constellation lines on again to check that you have found the constellation Auriga correctly, then click them off again. Capella is the brightest star in Auriga.

You can check that you have located the correct star by using the Object Selection Tool, described above. Click on the arrow icon at the top of the icon/location box, or press the F3 key. The cursor will now be an arrow. Click on the mouse with the arrow adjacent to the chosen star and its name will appear on the screen. To remove this name, click the mouse with the cursor on blank sky. Return to the Grabber Tool by clicking the mouse on the hand icon at the top of the icon/location box, or press the F4 key.

7. To find the next set of stars and constellations, you will have to change your **viewpoint**, or the direction in which you are facing in the sky. To do this, place the cursor hand of the Grabber Tool somewhere on the Big Dipper, then press the left mouse button. KEEP HOLDING THIS BUTTON DOWN and use the mouse to move the hand slowly toward the right across the screen, as explained earlier. The hand drags the sky with it across the screen. Use this action to place the Big Dipper on the right-hand side of the screen, about halfway down from the top of the screen. Make sure that the Big Dipper is close to the right edge of the screen, with all of its stars visible (move the sky back to the left again a little if necessary).
8. Now find the star **Arcturus**. To do this, look at the handle of the Big Dipper. Notice that the handle is curved and forms an arc in the sky. Imagine this arc extended through the sky in the direction away from the bowl (toward the left and somewhat down on your screen). Then you should find that it passes more or less through a bright star near the center of the screen. This star is Arcturus. (A good way to remember how to find this star is, "Follow the arc to Arcturus.")

Use the Object Selection Tool to confirm your identification of

Arcturus by clicking on the arrow button in the icon/location box, and then clicking the mouse with the arrow icon placed close to the chosen star. The name of the star will be displayed. Click the mouse again with the icon on blank sky to remove the name, then return to the Grabber Tool.

Arcturus is the brightest star in the constellation **Bootes**, the hunter. (The two o's in Bootes are pronounced separately: "Bootes"; to show this, it is often spelled Boötes.) If you look toward the upper right from Arcturus on your screen, you should see a pentagon of five stars with a fainter sixth one just above them. If you ignore the sixth one, then Arcturus plus the other five form a kite-shape or an ice-cream cone in the sky. In the real sky, the whole constellation of Bootes is quite large, and the kite or ice-cream cone forms the most easily seen part of it. The orientation of Bootes in the real sky may be different than on your screen, depending on the time of year and time of night. However, the shape will always be the same, and the brightest star in this constellation can always be found by starting from the Big Dipper and "following the arc to Arcturus."

In the real sky, Arcturus has a yellowish or even slightly orange tint because it is slightly cooler than the Sun.

9. Bootes is hunting the Great Bear—as the sky turns counter-clockwise around the North Star, Bootes follows the Great Bear around the sky. If you look below the handle of the Big Dipper on your screen, you should see Bootes' hunting dogs, two relatively faint stars that form the constellation **Canes Venatici** (Latin for "dogs of the hunter"). These two dogs nip at the heels of the Great Bear as it circles the North Star, trying to get away from Bootes.

Another interesting constellation to find before leaving Bootes is Corona Borealis (the Northern Crown). This is the semicircular arc of stars next to Bootes' shoulder (to the left of the top of the kite or ice-cream cone on your screen).

Click the constellation lines on to see the full extent of the constellation Bootes and the smaller constellation Canes Venatici, then click them off again.

10. To find the next set of stars, you need to adjust the screen

again. The Big Dipper should still be where you set it in step 7, on the right-hand side of the screen about halfway down from the top. The adjustment you need to make is to move the Big Dipper upward, to the upper-right-hand corner of the screen. Do so by following the instructions in step 7. Place the cursor hand on the Big Dipper, hold the left mouse button down, and drag the sky upward. Place the Big Dipper close to the corner, but make sure that all seven stars are still visible.

11. The next star to find is **Spica**. To do so, start with the handle of the Big Dipper and “follow the arc to Arcturus.” Then continue this arc to Spica, a relatively bright star. You should find Spica in the bottom left portion of your screen, roughly the same distance past Arcturus that Arcturus is from the handle of the Big Dipper. Spica is considerably hotter than the Sun and has a whitish or even slightly bluish tint when you look at it in the sky.

Spica is the brightest star in the constellation Virgo, the Virgin. You can check that you have found Virgo correctly by clicking the constellations on and looking for the name “Virgo”; then click them off again. You can also check that you have found the star Spica correctly, using the Object Selection Tool as described above.

12. Now find the star **Regulus**. To do this, go back to the Big Dipper, and use the pointer stars in reverse—instead of pointing upward to find the North Star, point downward from them a distance somewhat greater than the total length of the Big Dipper, or about nine times the spacing of the pointer stars. You should find two moderately bright stars. The one that is farther from the Big Dipper (lower on your screen) and somewhat brighter than the other is the star Regulus, the brightest star in the constellation **Leo**, the Lion. Click the constellations on and off again to check that you have found Leo, and use the Object Location Tool to be certain that you have located Regulus.

To find the star pattern making up the constellation Leo, first look for a line of stars running from Regulus through the other bright star and forming the shape of a backward question mark. This forms the head and front legs of the lion. Then look for a triangle of stars that forms the hind end and tail of the lion.

(Clicking the constellation lines on and off will help you pick out these patterns.) In the sky, the backward question mark and the triangle form the most easily seen parts of the constellation.

Like Spica, Regulus is much hotter than the Sun and has a whitish or even slightly bluish tint when you look at it in the sky.

You have now explored the northern sky, identifying several constellations and bright stars while becoming familiar with the Starry Night™ program and many of its features. If the opportunity arises, you should attempt to explore the real sky and identify these features from your home location. You can use Starry Night™ to show which stars and constellations are visible from your own location at any time by simply placing yourself at your home location and using the Now button in the date/time box, or entering a suitable time such as 10:00 tonight.

If you want to save this configuration for future reference, you can use the “Save as” command in the File menu, giving the configuration a name and saving it in a convenient location. You can then return to it merely by opening this file.