Guide to Using Starry Night Enthusiast

With Questions

Initial View

When you first start “Starry Night Enthusiast” you will see a view of the sky, looking South. You may find that you are looking at the starry night, or at the bright afternoon sky. This will depend upon your location on the surface of the Earth. You will see the horizon with some trees, representing the Earth’s surface. You will notice direction markers along the bottom of your screen. [Click on the “Full Screen” button in the top right-hand corner of the screen, so that the program screen completely fills the computer screen.]

There will be a “display” area along the top of your viewing screen with display windows showing some useful information. The settings of this box will determine your view of the sky. We will discuss these settings in more detail as we go. In addition, you will notice a menu bar across the top of these display windows. When referring to the items in this menu bar, bold print will be used. For example, if you are to click on the “Options” menu and then click on “Viewing Location” that will be expressed as: “Options - Viewing Location”. There will appear a number of tabs along the left side of your viewing screen. More about these later.

Above the right side of your viewing screen there are two “view” windows which indicate the direction you are looking and the angular size of your viewing window. Below these two windows, you will see five direction indicators: North, East, South, West, and Up (toward the zenith). By clicking on one of these direction indicators, the viewing direction will be changed to that setting. Try these at this time. Notice that when you click on the zenith direction, you will look up into the sky. If you click on the screen, you will see a “zenith” indicator which looks like circular arrows). The “plus” and “minus” buttons are like zoom buttons (the wheel on the mouse will also allow you to zoom in and out). Reset the direction to South before continuing.

Setting Home Location

Before we get started, you will need to set up your home location. To accomplish this, go to “Options – Viewing Location”. Find Searcy, AR in the list of locations and select this as your home location. Once this is done, you can move to your home location by simply clicking on the “Home” button at the top of your viewing screen (beneath the “Viewing Location” window). Do that now so that your view of the sky will correspond to the actual view of the sky at your location. Remember, you can always return to your home location by clicking on the “Home” button.

Changing the Time and Clock Rate

On the menu bar you will see a “clock” window indicating the time and date. The current date and time should be displayed in this clock window. By clicking on this clock window you can change the time and date of your observations. Below this window, you will find a “Now” button, and “Sunrise-Sunset” buttons. By clicking on these you can move to the current time, or the sunrise or sunset for the particular day you have selected. The next indicator window is the “Time Flow Rate” window (this indicates the rate at which your time changes on the display screen). Below this are
buttons that let you move forward or backward in time at a continuous rate (right and left triangles), or in single steps (triangles with a bar). There is also a “Stop” button (square). The default setting is “1x” meaning “real time”. You can click on the window and change the rate arbitrarily, or you can use the drop-down menu (downward pointing triangle) to get a list of common flow-rate values. You will notice that you can change from seconds to minutes, to hours, days, or even years! You can always get back to the current time by clicking on the “Now” button, which also resets the time flow rate to real time.

To see how all this works, we will first “turn off” the daylight glow of the atmosphere so we can see the stars. To do this go to “View – Hide Daylight”. Notice that there is a shortcut key combination Ctrl+D which accomplishes the same thing. Since the earth rotates very slowly, you will not immediately notice any change in the location of the stars. This is because the clock is running in “realtime”.

To see what would happen if time were to flow faster, click on the “1x” showing in the “Time Flow Rate” window and change to setting to 300x. Next, click on the drop-down arrow to the right of this window and select 3000x. You can also chose different time units, such as seconds, minutes, days, etc. Play around with this a little to see the effect of changing the time rate. Remember the “one-step” button that looks like an arrow and a vertical line. This button allows you to take only one step at a time.

Now change the time to “Now”, the time unit to “sidereal day”, and start the clock.

1. How do the stars appear to move as the time changes in sidereal day units?
   a. from East to West   b. from West to East   c. from North to South   d. from South to North   e. they remain fixed

2. Now change the date to 2/4/2001 and turn off the daylight. With the time-step setting on sidereal day, you will notice some objects move through the background stars. What are these objects (be specific)? (You can identify them by pointing your finger (or the arrow cursor) at the object when the timer is stopped.)

3. In what direction do they move, approximately, relative to the background stars?
   a. from East to West   b. from West to East   c. from North to South   d. from South to North   e. they remain fixed

The definition of a sidereal day is the time required for the Earth to complete one rotation relative to the stars, whereas a solar day is the time required for the Earth to complete one rotation relative to the sun. There are about four minutes difference between a sidereal day and a solar day. By observing the sky in periods of sidereal days, you can see how the sun and the planets (as well as the moon) move through the stars from day to day. Before moving on, change the time-step to a solar day (just “day”) to see how the position of the stars appear to change from one solar day to another.
4. From one solar day to another the background stars appear to move
a. from East to West  b. from West to East  c. from North to South  d. from South to North  e. they remain fixed

Before continuing, click on the “Stop” button and the “Now” button to return to the present.

Star Identification, and Apparent Motion during the Night

To see how the stars move during the night, we will begin by looking toward the North. Set your time to Now and set the time rate to 3 minutes. Be sure that “daylight” is turned on (use the Ctrl+D toggle). Start the clock.

You will notice that the sky begins to darken, and the stars begin to “come out”. You can identify individual stars by positioning the arrow cursor over the star of interest (you can also do this by placing the index finger of the “hand” cursor over the star of interest). [Note: If you click on an object (e.g., a star), an identification symbol will be attached to that object and you can watch how that object moves through the sky.] Additional information about a star is also given. After a stars name you will see: 1) the apparent magnitude, 2) the constellation in which the star resides, 3) its position in the night sky in Right Ascension and Declination (this will be described later), and 4) its distance from the Sun in light years.

Now, change your position by looking East, then South, then West, to see how the stars appear to move through the night sky.

5. The stars appear to rotate around a single star, visible in the night sky, when looking
   a. North  b. South  c. East  d. West  e. directly upward

6. The name of the star about which the others appear to move is __________.

7. This star is ________ light years from the Sun.
   a. 44.9  b. 2.35  c. 432  d. 126.7

8. When looking ________ the stars appear to rise from the horizon,
   a. North  b. South  c. East  d. West  e. directly upward

9. and these stars appear to move at a slight angle toward the ________.
   a. North  b. South  c. East  d. West  e. directly upward

10. When looking ________ the stars appear to set (i.e., move down below the horizon).
    a. North  b. South  c. East  d. West  e. directly upward

The star in the center of the field of view – the one that appears to remain at rest – when looking North is often called the North Star. This star is significant because, since
it does not appear to move during the night, it gives navigators a “fixed” navigational point that never changes (although it cannot be seen during the daytime).

Move your viewing position back to the North, and see if you can identify the Big Dipper and the Little Dipper (you may want to turn off the daylight). To help you find these click on the “Options” tab on the left of your screen and then click on the + button beside the “Constellations” tab. Here you can select “Boundaries” and “Labels” to see the constellations. You can also choose “Stick Figures (Asterisms)”, which may help you in identifying some of the constellations. An asterism is often a subset of a constellation. The Big Dipper, for example, is an asterism – a subset of the larger constellation Ursa Major, the Big Bear. If you compare the constellations represented in this program with other drawings of constellations, you will notice that different people (books) represent the constellations in very different ways. However, the constellations are associated with regions of the sky that have been very precisely defined by the astronomical community. You can see how the sky is divided up into the different constellation regions by selecting “Boundaries”.

While looking North, click on the “Options” tab and then click on the + button beside the “Guides” tab, and select “Celestial Grid” and “Celestial Poles”. You will see that the North Star is very nearly located on the North celestial pole. Just like we define latitude and longitude lines on the Earth, we can define latitude and longitude lines associated with the “celestial sphere”. This is similar to a projection of the latitude and longitude lines of the earth outward onto the stars. It is much like standing in the center of a huge sphere with stars painted on the sphere. We define the point directly over the Earth’s north pole as the celestial north pole. In addition, the line in the sky associated with the Earth’s equator is the celestial equator. However, on the celestial sphere the lines that are similar to latitude lines (measuring angles from the equator toward the North or South) measure what is called the “declination” angle (starting from zero at the celestial equator). Likewise, the lines that are similar to the longitude lines on the Earth (lines going from the North pole to the South pole) are called “right ascension” and are measured in hour-angles (or hours). There are 24 hours in a solar day (the time for the Earth to rotate around once) and each hour is approximately 15 degrees, giving 360 degrees in the circle of the celestial sphere. The zero point for the right ascension is a special place on the celestial sphere – that place where the ecliptic (the path of the Sun through the stars) passes through the celestial equator. It is near the constellation Pegasus. The only thing you need to remember about this is that the right ascension and declination for a given star is always the same and can be used to locate a particular star in the night sky. The points on the celestial sphere can, therefore, be thought of as attached to the stars.

11. Locate the constellation Cepheus (it looks something like a stick house). Find the star Er Rai. This star is ______ ly from the Sun,
   a. 14.8    b. 2.35    c. 142.7    d. 44.9

12. The apparent magnitude of Er Rai is ________.
   a. 3.8    b. 3.18    c. –2.5    d. 5.6    e. 12.2
The constellations have not changed their appearance significantly in the last 1000 years. To see this look toward the north and set the clock time step on 10 years. Be sure the constellation boundaries have been selected, and the celestial grid and poles have been selected. Now watch the constellations for about a 1000 year period. You will notice that the big dipper still “points” toward the little dipper, and that the basic shapes of the constellations have not appreciably changed. You will notice, however, that the north star moves away from the celestial north pole over time. If you continue to watch the progression of the stars over time (put the time step on 100 years) you will observe the shape of some of the constellations change – in particular you should pay attention to the little dipper. You may lose the little dipper as the stars go around and around, so change the date to about 28,000 AD and you will see the north star is again near the celestial pole – but the shape of the little dipper has changed significantly. This is because the stars actually do move relative to one another – just over long periods of time – and some move faster than others.

**Motion of the Sun**

To observe the motion of the Sun throughout the day click “Now” and “Home”, make sure the time step is on 3 minutes, and that daylight is “on”. (You may want to turn the constellations off as well.) Change your viewing position to West, and start the clock. After the sun goes down, change your viewing position to East and watch the Sun come up.

13. Where, in relation to due West, does the Sun set?  
   a. North of West  b. South of West  c. Due West

14. Where, in relation to due East, does the Sun rise?  
   a. North of East  b. South of East  c. Due East

Now, let’s see how the sun’s position along the horizon changes with seasons. To do this, click “Now” and “Home”, make sure your viewing position is due East, and change the time to 7:00 am. Now click on the month part of the date in the time window and use the arrow keys to increase the month in one-month increments. Observe the position of the sun as you do this. Now change the time to 8:00 am, and repeat this process throughout a year's time.

Now, change your viewing position to due West and the time to about 5:00 or 6:00 pm, and repeat this process.

15. The sun rises and sets at different times during the year. What is the position of the sun relative to due East when it rises at different times during the year?
16. What is the position of the sun relative to due West when it sets at different times during the year?

Now change your viewing position to due South, and change the time to 1:00 pm. Again, click on the month on the time window and use the arrow key to increase the month in one-month increments.

17. Describe how the position of the Sun at (or near) noon changes from month to month during the year.

**Motion of the Moon**

To observe the motion of the moon throughout the day click “Home”, make sure the time step is on 3 minutes, and that daylight is “on”. Change the date to July 4, 2001. Change your viewing position to East, and start the clock. You will notice that the moon rises in the East just at sunset. Now change the viewing position to South. When the moon is approximately centered in your screen (left to right) stop the clock. (You can let it cycle through another day if you missed it.) Now change the time step to 1 solar day, and observe how the moon moves through the background stars. To do this you will need to use the “one-step” button – the right arrow with a vertical line after it. This button allows you to take only one step at a time.

18. From night to night, the moon moves relative to the fixed stars.
   a. from East to West   b. from West to East   c. from North to South
   d. from South to North   e. none

19. Does the appearance of the moon change from night to night? Describe this change.

Watch carefully the way the moon moves and changes its phases using this planetarium program, and attempt to answer the following questions.

20. What time will the moon rise when the moon is full?
21. What time is it when the full moon is directly overhead?

22. What time is it when a new moon sets?

Changing Your Point of View

Sometimes it is desirable to change your point of view, so that you can see different things – just like looking upward in the night sky. A simple way to do this is to make use of the “hand cursor”. Move the cursor to some point on your screen, hold down the left mouse button, and move the sky. What you are actually doing is changing your viewing orientation (although not your location). This is like looking up and down, or rotating around. Much like real life, if you look upward, you can only go so far (you neck stops you from going further), but then you can rotate around and remain looking upward.

To try this out, go back to your “Home” location, and the present time, “Now”. Be sure the time flow is stopped. You may want to turn off the constellations and the equatorial guides. Now use the hand cursor to “look around”, both with daylight on and with daylight off. (Note: Another “Guide” that is sometimes useful, is the “local grid” This can be selected from the “Guides” tab.)

Another way to change your viewpoint is to move some distance above the surface of the earth (much like blasting off on a spaceship). This can be accomplished by using the “ascend” and “descend” buttons (up and down arrows), found just below the “Viewing Location” window.

As an example, go back to your “Home” location and click “Now”, and then click on the “ascend” button until you are at a distance of approximately 24,000 km above the Earth. Now, using the hand cursor, move the viewing position so that you are looking “down” (you do this by grabbing the screen and moving it upwards). Eventually you will see the “nadir” indicator (the nadir is opposite the zenith). The nadir position is your original location on the Earth’s surface. You should see the Earth below you, and you may see the moon as well. The Earth may look “upside-down” to you, so you may need to rotate your observing position. To do this with the hand cursor, move off to the side (off the Earth) and grab the viewing area to move it around rotating the Earth until North America is “up”. If you place the hand cursor on the Earth and move it you will actually change your location on the surface of the Earth.

Now, make sure the time step is set to 1 solar day, click on the forward time button and watch what happens. You will see the Earth move through the stars, and you may see the moon move into or out of your field of view. You will also see the region of the Earth in daylight change with time. Change the time-step to 5 minutes and watch for long enough that you see the moon pass through your field of view. [Note: If you set the
time step on one sidereal day, the Earth does not appear to move through the stars, so be sure you have it set on solar days.]

Now let’s change our location on the surface of the Earth, so that we are looking down onto the North pole. One way of accomplishing this is to click on “Options-Viewing Location” and then select the “Map” tab. Move your cursor to the top, center of the map and click on that spot. You will see a dim red cross, indicating your location. You can also do this by clicking on the “Latitude/Longitude” tab and entering 90 degrees North for the Latitude. Set the time flow rate to 5 minutes and you will see the stars appear to circle the Earth. The moon also does, but is so far away from the Earth that it is not visible within our field of view. You can use your “ascend” and “descend” buttons to change the distance from your observation point to the Earth’s surface. Move away from the Earth until you see the Moon moving around the Earth.

23. What do you notice about the North Pole? Is it always in the sunlight?

Now we are going to change our viewing position again. Click on “Now” and then go to “Options-Viewing Location” and select “View from: the center of Earth at the top of this window. In order to keep yourself oriented, you will need to turn on the Celestial Grid and the Ecliptic (by clicking on the “Options” tab, and then the “Guides” button and selecting the Celestial grid and poles and the Ecliptic). Now change your viewing position by using the up and down arrow keys. If you change your viewing direction upward, you will eventually come to the North Celestial pole. Now move your viewing position so that you are looking at the Celestial Equator (you will be able to see 15 degrees North and 15 degrees South). Now use the left and right arrow keys (Shift-left and Shift-right) to move around until you see the Sun. Move until the Sun is in the middle of the screen from left to right (don’t change the up – down position).

Now, set the time-step to one sidereal day and watch the motion of the Sun and planets through the stars. Using the left and right arrow keys, change your viewing position so that you can watch how the Sun and planets move along the Celestial sphere.

24. The Sun appears to
   a. move along a constant declination angle
   b. move around a circular path, with slight up and down motion between a little over 20 degrees North to a little over 20 degrees South
   c. remain fixed among the stars
   d. move randomly among the stars
   e. remain approximately fixed on the computer screen, except for an up and down motion

25. Many planets appear to
   a. remain fairly close to the Sun, sometimes moving forward faster than the Sun, sometimes moving slower than the Sun.
   b. maintain a constant distance from the Sun
c. move across the sky at very different angles from the Sun’s motion

26. The Moon appears to move approximately along the same path as the Sun.
   a. True
   b. False

   You were able to see some planets orbiting the Sun. Let’s identify these planets. To do this, click on the “Find” tab on the left of your screen. You will see a list of planets (those with moons have an additional menu that can be selected using the + button) with check boxes. If you check the box to the left of the planet name, the planet will be identified by the label on the viewing screen. If you check the box to the right of the planet name, you will be able to see the path of the planets orbit traced out among the stars. Be sure you turn these orbit indicators off again before continuing.

Exploring the Night Sky

Before answering the questions in this section, you must select the date (as indicated in Starry Night) on which these observations are made: You are to make all observations on the date 7/04/02.

Now we want to explore the night sky and to see what is visible on this date from here in Searcy. Stop the progression of time and go back to your home location. Put in the date indicated above. Also turn off all guides, and planet orbits, and make sure daylight is on. Change your viewing position to the East and set the time-step to 5 minutes. As you approach twilight, you may want to progress one step at a time, or slow down the time progression by decreasing the time-step.

27. What is the first “star” you see as the sun begins to go down?

Identify some of the brighter objects in the night sky. In particular, watch for the Moon to see if and when it will rise on this date, and/or any of the planets.

28. About what time will the moon rise tonight, if at all?

As you watch through the night, you will eventually see the night sky begin to lighten (as the Sun comes up).

29. What is the last “star” that you see before the Sun completely dominates the daytime sky on the day following your assigned evening of observation?
Now go back to the assigned date and look to the West and watch the motion of the stars throughout the night (watch with a time-step of 3 minutes). Look at the brightest objects in the night sky and see if these are planets or bright stars.

30. What planets are visible in the night sky on the assigned night as you look West? When would be the best time to observe this planet?

Now look North and do the same thing.

31. What planets are visible in the night sky on the assigned night as you look North? When would be the best time to observe this planet?

Watching the Change in Seasons

Begin by freezing time, and going to your home location. Change your viewing position to the East and set the time-step to 5 minutes. To help you get a better “feel” for what you are observing, turn on the Celestial Grid and Pole indicators. Now watch as the Sun progresses through the day and night. Pay particular attention to where the Sun rises relative to due East. [Note: You may want to use the single step button to see precisely what is happening]. Notice how the latitude and longitude lines on the Celestial Sphere move with time.

Now change the time to 6:00 am and the date to June 22 and turn off daylight (Ctrl+D). Notice where the Sun is. Now change the time in one-hour steps, one step at a time. Notice that the Sun’s position relative to a particular Celestial latitude remains basically fixed and that the Celestial sphere rotates through one “hour” each hour. Notice in particular that if you know where the Sun is at 8:00 am in the sky (relative to the Celestial grid) then you can tell where the Sun will be at 6:00 am when it rises – you just move along the celestial sphere at the same declination. Now change the time to 8:00 am and change the date in one month intervals. This is most easily done by putting your cursor on the month in the “Time and Date” window and using the up and down arrow keys to change the month in one month intervals. From what you observe, you should be able to predict where the Sun will rise on the 22nd of each month.

32. On about the 22nd day of what month(s) does the Sun rise farthest North?
33. On about the 22\textsuperscript{nd} day of what month(s) does the Sun rise farthest South?

34. On about the 22\textsuperscript{nd} day of what month(s) does the Sun rise due East?

You can also change your point of view to look West and try this same sequence to see when and where the Sun sets along the Western horizon.

35. On about the 22\textsuperscript{nd} day of what month(s) does the Sun set farthest North?

36. On about the 22\textsuperscript{nd} day of what month(s) does the Sun set farthest South?

37. On about the 22\textsuperscript{nd} day of what month(s) does the Sun set due West?