Are You Ready to Explore the Skies?

This kit will give you tips and tricks to find your way easily around the nighttime sky, helping you find constellations, features on the moon, and other interesting targets.

You won’t need anything fancy like a telescope to see what is in this kit, everything can be seen with just your eyes. If you have a pair of binoculars at home, feel free to take them out for a better view of the moon, planets or other interesting sights. Modern binoculars are more powerful than the telescopes that were used to find the moons around Jupiter so they can show you a lot of detail!

This guide doesn’t cover all the constellations you can see, but it does give you a quick tour of the sky using a few easy tricks you can learn.

Useful Tools

Included with this kit is a planisphere, basically a map of the nighttime sky you can adjust to match the time and date you’re going out observing. To make your planisphere, you’ll need some paper, scissors, and tape. Check out this video to learn how to put your planisphere together. (Plastic sheet and brass fastener are optional)

There are a lot of mobile apps that can show you around the sky. One free app with a lot of features is Stellarium. This app is available for both Android and iOS. For the more adventurous, Stellarium also offers a free desktop version that allows you to see the sky from any time and any place in the world.

Wishing you clear skies and happy observing!
**What are Constellations?**

Constellations are the shapes, or patterns that we make out of the stars. There are thousands of constellations from cultures around the world and throughout history. With the increasing pace of scientific discoveries, there emerged a need to have a standardized group of constellations to help identify discoveries made by scientists around the world. In the 1930s, the International Astronomical Union compiled a list of 88 constellations we currently use to locate objects in the sky. Though we use these 88 constellations, they are no more important than any others. If you have the Stellarium app, you can switch the constellations shown to one of the many different cultures around the world!

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**Where do you Start?**

Often, one of the first shapes we learn to recognize in the sky, one you might even remember, is the Big Dipper. It stands out in the sky and its dipper, or bowl shape is easy for us to remember.

Surprisingly, the Big Dipper isn’t a constellation on its own, it is part of a larger constellation called Ursa Major, or the Big Bear. You can almost see the shape of the bears, where the handle of the dipper is the tail and the lines stretch down to mark out the bear’s feet!

The Big Dipper is an important marker to find in the sky because it can lead you to find lots of other constellations. Something else the Big Dipper is helpful for is trying to orient yourself. See how you can find directions using the Big Dipper on the next page!

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*The shape we call the Big Dipper has many names around the world including The Plough and The Wagon!*

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Using the Stars to Find Directions

For ancient peoples around the world, observing the sun and the stars were an important part of navigating from place to place and was especially important when trying to guide ships across oceans. With satellites and instant GPS navigation, we rarely look up at the stars to guide us anymore, but that doesn’t mean they can no longer help you find your way. One of the first things even seasoned astronomers do when they go outside is find which direction is north, and it is simple to do as long as you can find one of the best-known shapes in the sky, the Big Dipper.

Use the Big Dipper to Find North

In a simple three step process, you can easily draw lines between stars to find north.

1. Find the Big Dipper in the sky. Look for 7 bright stars. Depending on the time of year it can be directly overhead, or low to the ground, so look all over the sky until you see its familiar shape.

2. Take the two stars from the bowl of the dipper and draw a line between them. Extend that line across the sky until you run into another bright star. This is Polaris, but you might know it better by its other name, the North Star.

3. The final step is to draw a line from Polaris, the North Star, straight down to the ground. Since Polaris is the only star in the sky that doesn’t move, it will always point you to the direction north.

With three steps, you’ve just found north! But does it stop there? No! Once you know which direction is north, you can figure out all the other directions too. The area directly opposite north is south, and in between you’ll have east and west.

So, remember if you ever need to, you can find your way around at night simply by using the stars and it is even faster than trying to use a compass or unlocking your phone!
Star Hopping

Star hopping is an easy way to move across the sky from one constellation to another, or to find important markers in the sky. It is kind of like using the stars to play a giant game of connect the dots. If you already found north by jumping from the Big Dipper to Polaris, you’ve already tried star hopping! In the following pages, I’ll introduce new star hopping cheats because it is an easy way to hop your way from constellation to constellation and is a technique even seasoned astronomers still use when they go stargazing.

Some stars and constellations stay in our skies all year round, so you can use this star-hopping trick any time of the year to find two year-round constellations.

This star hop takes us across a big part of the sky, but if you break it down into two sections, it is a lot easier.

1. **Finding Ursa Minor – The Little Bear** - This is one you may have already done if you tried to find which direction is north. Take the two stars from the front of the bowl of the Big Dipper and draw a line to the next bright star, Polaris. Polaris is part of the constellation Ursa Minor, also known as the Little Dipper.

2. **Finding Cassiopeia – The Queen** - Once you’ve found Polaris, you can continue across the sky in a pretty much straight line until you see a “W” in the sky. The stars are bright and located along the bright band of the Milky Way. The “W” marks out the constellation of Cassiopeia, The Queen.

Congratulations! You’ve just found two constellations just by hopping from the Big Dipper!

Now that you’ve found Cassiopeia, you might want to look for one of the best sights in the nighttime sky, the **Andromeda Galaxy**.

One way to find Andromeda is to use Cassiopeia to point in the direction of Andromeda. Follow the arrow made of stars and you’ll see a fuzzy patch in the sky, that’s the Andromeda Galaxy located 2.5 million light years away!
As the seasons change, we’re able to see new stars and new constellations in our skies. Spring is a time we really look forward to seeing new constellations appear because it signals that winter is coming to an end. There are two easy star-hops you can use to find the spring constellations of Leo, Boötes, and Virgo and they both start from the Big Dipper!

**Star Hop From the Big Dipper!**

**Finding Leo – The Lion** -
Take the two stars from the front of the bowl of the Big Dipper (remember the Big Dipper is part of Ursa Major) and draw a line down through them. This time you’re not looking for a specific star, but rather a shape. Look for a backwards shaped question mark (?) and you’ve found Leo the Lion’s mane!

**Arc to Arcturus!**

**Finding Boötes – The Hunter** -
This time look at the handle of the Big Dipper. Follow the curve, or the arc of the stars until you come to a bright star called Arcturus. There’s a saying to help remember this, “Arc to Arcturus!”

**Finding Virgo – The Maiden** -
Once you’ve found your way to Arcturus, you can “Speed on to Spica!” Draw a straight line from Arcturus and you’ll find the brightest star in Virgo, Spica.

So just remember to “arc to Arcturus, then speed on to Spica.”
Standing out even along the bright band of the Milky Way, you’ll can see the brilliant stars making up the shape we call the Summer Triangle. Shining through even the glare from bright city lights, these stars are easy to spot and stay high in the sky for months. If you can find the Summer Triangle, you’ll have just found three new constellations!

Vega, Altair and Deneb are three of the brightest stars in the entire sky and each mark out a different constellation. They appear in spring and stay high in the sky until late fall, giving you plenty of time to track them down.

**Finding Cygnus – The Swan** – After finding Deneb, look for a cross shape making up the body and wings of the swan. This cross hidden in Cygnus is often called the “Northern Cross.”

**Finding Aquila – The Eagle** – The bright star Altair marks out the head of Aquila. Similar in shape to Cygnus, Aquila also appears as a cross in the sky, but it is smaller, and the intersecting lines form a much sharper angle than Cygnus.

**Finding Lyra – The Harp** – Lyra is a small constellation, but it is easily found because Vega is one of the brightest in the sky. Look for a diamond shape below Vega that makes up the rest of the constellation.
Just like summer, fall has a shape we can look for in the sky. The Square of Pegasus shows up in our skies in late summer and stands out well against the background of dim stars. If you can locate the square, you’ll be able to spot the constellations surrounding it!

**Finding Pegasus – The Horse** – First, find the 4 bright stars making up the “Square of Pegasus.” Once you’ve found the square that makes up the horse’s body, you can find the rest of the constellation as long as you Pegasus is upside down, the horse’s head is nearest the ground while its feet are in the pointing upwards. From the corners of the square, you can trace the head and front legs of the horse.

**Finding Andromeda – The Princess** - The Andromeda constellation is connected to the square of Pegasus, almost forming the back legs of the horse. If you can find Andromeda, you can follow the stars until you reach the fuzzy light of the Andromeda Galaxy (circled).
Though winter gives us bitterly cold nights, those same clear nights are also some of the best conditions to view the stars. The winter constellations contain brilliant stars and bright nebulae. Don’t be afraid to bundle up and head outside even for a few minutes to catch what Winter has to offer!

**Finding Orion – The Hunter** - Just like the Big Dipper, Orion is a major starting point in finding other constellations. To find Orion, look for the three bright stars close together that make up Orion’s Belt (highlighted in blue).

If you look just below the bright stars from the belt, you might notice an area that looks brighter than the rest of the sky. This area is a mass of gas being lit up by stars forming in the Orion Nebula. If you set up your camera or phone on a steady surface and take a time lapse of this region, you’ll see how much of the sky this nebula takes up!

Also, make sure to find two other bright stars in Orion, Rigel (a bright blue star) and Betelgeuse (a bright red star). Finding these two stars will help you find our next constellation.

**Finding Gemini – The Twins** – Starting from Rigel, the bright blue star at the bottom of Orion, draw a line through the red star Betelgeuse and across the sky until you see two bright stars that are very close together. These two stars, Castor and Pollux, mark the heads of the Gemini twins.
Winter Continued

Drawing a line through the stars of Orion’s belt can lead you to two different constellations depending on which way you decide to go.

Finding Taurus – The Bull – Starting out on the left, draw a line through Orion’s belt going to the right and keep going until you find yourself at a bright red star named Aldebaran.

Finding Canis Major – The Big Dog – Draw a line through Orion’s belt from right to left and you’ll find the brightest star in the sky, Sirius.

If you’ve found Taurus, you’re able to find one of the best star clusters in the sky, the Pleiades. The bright cluster is also known as the Seven Sisters because under good conditions, you can make out 6-7 bright stars. This is a great target for binoculars!

The Pleiades cluster in Taurus – Image made with Stellarium

Draw through Orion’s Belt to the right to find Aldebaran – Image made with Stellarium

Draw through Orion’s Belt to the left to find Sirius – Image made with Stellarium
Lunar Targets

Use this map or whatever app/website works best for you to find lunar features. Mare are labelled in **blue** and craters are labelled in **red**.

**Mare/Maria** - The term mare (or maria) is left over from when we didn’t understand the makeup of the moon very well. For a long time, people thought that the dark patches on the moon were seas and named them mare (Latin for seas). We eventually discovered these dark regions were ancient lava flows and not oceans, but the names stuck.

**Impact Crater** - Impact craters are formed when the surface of a planet or moon is hit by, for example, an asteroid or a meteor. While the object that caused the impact might not be very large, it can leave behind basins with shock rings stretching out hundreds of kilometers from the site of impact. Impact craters on the moon are named after famous scientists.

**Lunar Phase** – The appearance of the moon changes throughout the month as the amount of light reaching its surface changes to create patterns we call phases. It takes 28 days, roughly a month, for the moon to cycle through all its phases. To find out the phase each night, check out timeanddate.com/moon/phases
Meteor Showers

Meteor / Meteor Shower: Meteors are rocks or dust in space that enter our atmosphere, slowing down and creating brief, bright streaks of light as the air around them heats up, you’ve probably heard them called “shooting stars.” Meteor showers occur when the earth moves through the path of dust left behind by a comet, causing many meteors to happen in a small amount of time. Since we know where the path of the comet and earth meet, we can predict when these showers will occur each year. Below are the peak dates for a few meteor showers throughout the year, these are the nights you’ll see the most meteors per hour. You can usually see meteors from a meteor shower a week or so before and after the peak date, so don’t worry if it is cloudy or you miss the peak date.

<table>
<thead>
<tr>
<th>Peak dates</th>
<th>Meteor Shower</th>
<th>Meteors/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 3-4</td>
<td>Quadrantids</td>
<td>40/hr</td>
</tr>
<tr>
<td>April 22-23</td>
<td>Lyrids</td>
<td>20/hr</td>
</tr>
<tr>
<td>May 6-7</td>
<td>Eta Aquarids</td>
<td>30/hr</td>
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<tr>
<td>July 28-29</td>
<td>Delta Aquarids</td>
<td>20/hr</td>
</tr>
<tr>
<td>August 12-13</td>
<td>Perseids</td>
<td>60/hr</td>
</tr>
<tr>
<td>October 7</td>
<td>Draconids</td>
<td>10/hr</td>
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<tr>
<td>October 21-22</td>
<td>Orionids</td>
<td>20/hr</td>
</tr>
<tr>
<td>November 4-5</td>
<td>Taurids</td>
<td>5-10/hr</td>
</tr>
<tr>
<td>November 17-18</td>
<td>Leonids</td>
<td>15/hr</td>
</tr>
<tr>
<td>December 12-13</td>
<td>Geminids</td>
<td>120/hr</td>
</tr>
<tr>
<td>December 22-23</td>
<td>Ursids</td>
<td>5-10/hr</td>
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Eclipses

Eclipses happen when planets, moons, or even the sun line up. You may have heard of eclipses before, such as a solar eclipse or lunar eclipse.

Solar Eclipse – Solar eclipses occur when the moon’s path takes it in front of the sun partially, or even completely blocking it.

Lunar Eclipse – Lunar eclipses happen when the moon slowly moves into earth’s shadow. Over the course of a few hours the moon is slowly covered in shadow, eventually turning red when the eclipse is at its maximum.

Upcoming Eclipses

- May 15/16, 2022: Lunar Eclipse
- November 8, 2022: Lunar Eclipse
- October 14, 2023: Partial Solar Eclipse
- March 24/25, 2024: Penumbral Lunar Eclipse
- April 8, 2024: Partial Solar Eclipse
- September 17/18, 2024: Partial Lunar Eclipse
- March 13/14, 2025: Total Lunar Eclipse
- March 2/3, 2026: Total Lunar Eclipse
- August 12, 2026: Total Solar Eclipse
- August 27/28, 2026: Partial Lunar Eclipse
Northern Lights

The Northern Lights, or Aurora Borealis, can be seen all year round even though we associate it most with winter. In southern Manitoba you can see the Northern Lights, on average, one in every five days while in northern Manitoba that number goes up to one in every three.

If you would like to check your chances of seeing the Northern Lights, check out auroraforecast.com. When the green oval is over your location, you have the best chance of seeing the Aurora.

Viewing Planets

Planets are constantly moving in our solar system, their position in the sky changing night by night. To see which planets are visible timeanddate.com/astronomy/night can tell you the planets and the times you’ll be able to see them.

You should be able to see Mercury, Venus, Mars, Jupiter and Saturn with just your eyes but if you want to see Neptune or Uranus, you’ll need a telescope.

One tip to remember when hunting for planets, stars twinkle, planets don’t.

Taking Pictures

With the number of phone settings and apps available, you can take a pretty good picture of the stars with your phone if you know how to set it up. All phones are different, and it will take time and patience to find the right settings for your camera and your location. Here are just a few tips:

- Open the Pro mode of your camera or wherever you can access settings such as exposure length and ISO.
- Find the exposure setting and change it to a few seconds or longer depending on the type of picture you’re wanting
- Increase the ISO so the camera will be more sensitive to light
- Use a tripod or prop your phone up so it won’t move while taking a long exposure picture
- Use a timer. Any motion from tapping the screen can cause a blurry picture.
- Try out one of the many paid/free apps available for night photograph or astronomy photography (these will automatically adjust your phone’s settings for optimal photos)
- Use imaging software to adjust your photos and stack images

The following pages are planisphere instructions and components © Dominic Ford. Visit in-the-sky.org for other versions and detailed instructions or watch this helpful Video on youtube.
Make your own planisphere

Dominic Ford

2014–2021

A planisphere is a simple hand-held device which shows a map of which stars are visible in the night sky at any particular time. By rotating a wheel, it shows how stars move across the sky through the night, and how different constellations are visible at different times of year.

Here, I present a kit which you can download and print to make your own planisphere out of paper or cardboard.

The design of a planisphere depends on the geographic location where it is to be used, since different stars are visible from different places. I have created kits for use at a wide range of latitudes, which you can download from

https://in-the-sky.org/planisphere/

The planisphere presented in this document is designed for use at a latitude of 55°N.

What you need

- Two sheets of A4 paper, or preferably thin card.
- Scissors.
- A split-pin fastener.
- Optional: one sheet of transparent plastic, e.g. acetate designed for use with overhead projectors.
- Optional: A little glue.

Assembly instructions

Step 1 – Planispheres look slightly different depending on where you live. The planisphere prepared in this document is designed for use anywhere on Earth which is within a few degrees of latitude 55°N. If you live elsewhere, you should download an alternative kit from

https://in-the-sky.org/planisphere/

Step 2 – Print the pages at the back of this PDF file, showing the star wheel and the body of the planisphere, onto two separate sheets of paper, or more preferably onto thin card.
Step 3 – Carefully cut out the star wheel and the body of the planisphere. Also cut out the shaded grey area of the planisphere’s body, and if you have it, the grid of lines which you have printed onto transparent plastic. If you are using cardboard, you may wish to carefully score the body of the planisphere along the dotted line to make it easier to fold it along this line later.

Step 4 – The star wheel has a small circle at its center, and the planisphere’s body has a matching small circle at the bottom. Make a small hole (about 2mm across) in each. If a paper drill is to hand, these are ideal, otherwise use a compass point and enlarge the hole by turning in a circular motion.

Step 5 – Slot a split-pin fastener through the middle of the star wheel, with the head of the fastener against the printed side of the star wheel. Then slot the body of the planisphere onto the same fastener, with the printed side facing the back of the fastener. Fold the fastener down to secure the two sheets of cardboard together.

Step 6 (Optional) – If you printed the final page of the PDF file onto a sheet of plastic, you should now stick this grid of lines over the viewing window which you cut out from the body of the planisphere.

Step 7 – Fold the body of the planisphere along the dotted line, so that the front of the star wheel shows through the window which you cut in the body.

Congratulations, your planisphere is now ready for use!

How to use your planisphere

Turn the star wheel until you find the point around its edge where today’s date is marked, and line this point up with the current time. The viewing window now shows all of the constellations that are visible in the sky.

Go outside and face north. Holding the planisphere up to the sky, the stars marked at the bottom of the viewing window should match up with those that you see in the sky in front of you.

Turn to face east or west, and rotate the planisphere so that the word “East” or “West” is at the bottom of the window. Once again, the stars at the bottom of the viewing window should match up with those that you see in the sky in front of you.

If you printed the grid of altitude and azimuth lines onto transparent plastic, these lines let you work out how high objects will appear in the sky, and in which direction. The circles are drawn at altitudes of 10, 20, 30, ..., 80 degrees above the horizon. For reference, a distance of ten degrees roughly equates to a hand-span at arm’s length. The curved lines are vertical lines connecting points on the horizon up to the point immediately above your head. They are drawn in the cardinal directions S, SSE, SE, ESE, E, etc.

Customised planispheres

This planisphere kit was designed using a collection of Python scripts and the pycairo graphics library. If you would like to customise your planisphere, you are welcome
to download the scripts from my GitHub account and modify them, providing you credit the source:

https://github.com/dcf21/planisphere

License

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The planisphere's central star wheel, which should be sandwiched inside the folded holder.
Cut out this shaded area with scissors.

It will become a viewing window through which to look at the star wheel behind.

**PLANISPHERE 55°N**

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For more information, see https://in-the-sky.org/planisphere © Dominic Ford 2021.
This grid of lines can optionally be printed onto transparent plastic and glued into the cut out window in the planisphere’s body to show the altitudes of objects in the sky, and their directions.