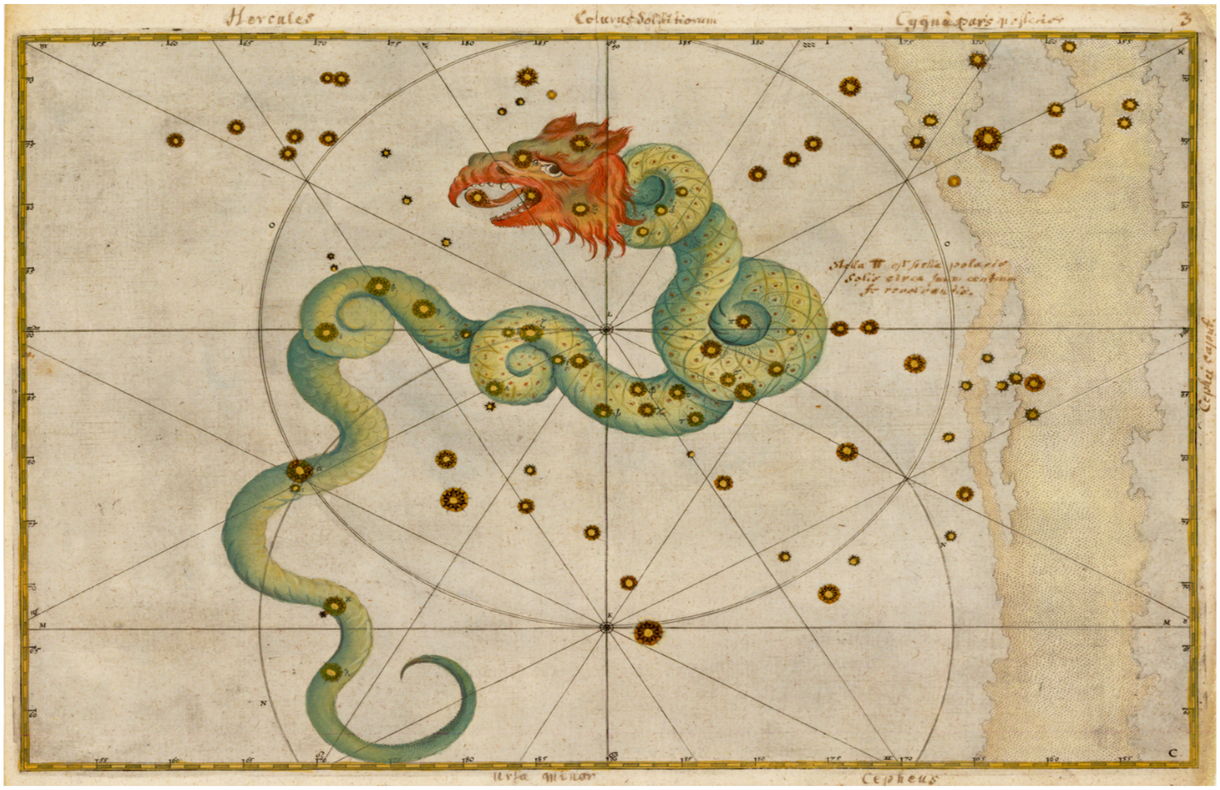
A Naked-eye Guide to the Night Sky
Time in the Eye of the Dragon



Draco, the Dragon, from Johann Bayer's Uranometria, 1661

We're all aware of the connection between the Sun and timekeeping: we know that the Sun rises in the morning and sets in the evening, and somewhere between-times the noon hour happens. If we're lucky enough to have a sundial, we can be more precise, marking hours and the minutes within them according to a shadow cast on the face of the dial. But once the Sun goes down and the skies go dark, how are we to tell the hour without a clock or watch in hand?

In the same way that daytime hours are marked by the Sun, nighttime hours can be read in the stars if we know where to look. The activity that follows will introduce you to a method for telling time according to the position of **Eltanin** – a prominent star in the figure of **Draco** the **Dragon**. It works for any night of the year, and from any location in the Northern Hemisphere – very handy when you're waiting in the dark for the next camel caravan!

The Eyes of the Dragon

To find the time of night by the method that follows, you'll have to know where to find the figure of Draco, the Dragon, in the northern sky.

Begin by locating the **"Big Dipper."** It's comprised of seven prominent stars, relatively equal in brightness, and probably the most widely recognized figure in the sky. End-to-end, the Dipper measures about a hand-span, viewed at arm's length with fingers splayed wide. It's visible every night of the year from any location in the Northern Hemisphere, though its orientation changes over time - hour by hour and night by night it circles the northern skies, sometimes appearing "right-side-up," and other times spilling its contents. These changes, of course, are due to Earth's movements through space. Nevertheless, face the Big Dipper and you know you're looking north*ish*.

Next, find the stars **Merak** and **Dubhe** at the end of the Dipper's bowl. These stars are known as "the pointers," because a line drawn through them points to the North Star, Polaris – the one star that stays put, no matter the hour of night or the time of year. Face Polaris, and you're looking north – not just north*ish*, but the *Real Deal*.

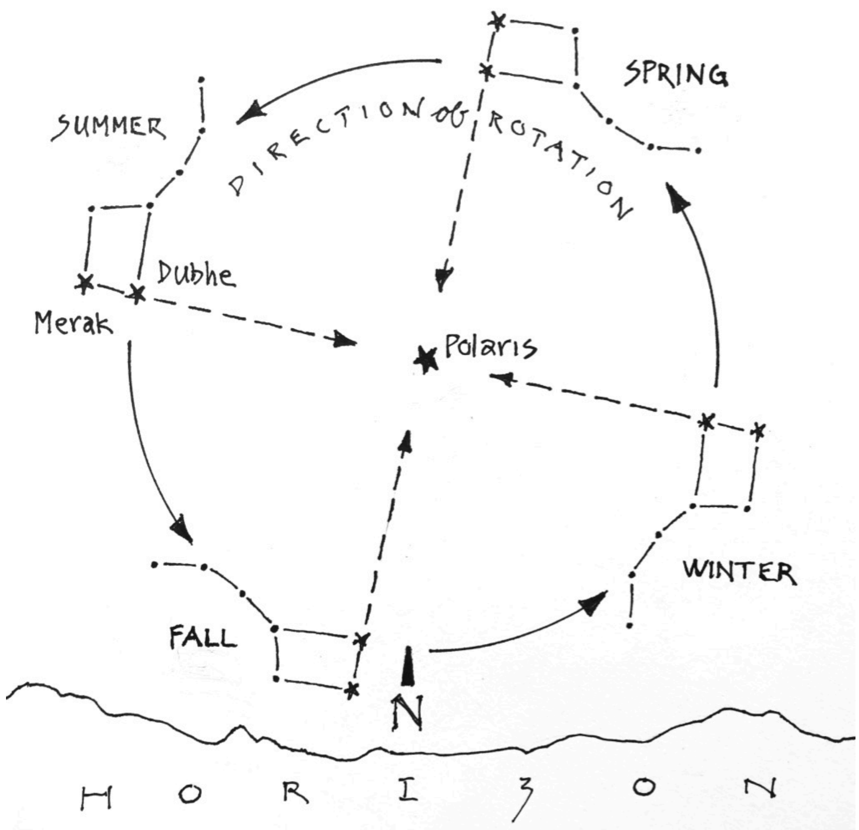


Figure 1: Finding North by the Big Dipper.
Merak and Dubhe point the way to the North Star, Polaris.
The diagram shows the approximate position of the Big Dipper,
season by season, in the hours shortly after sunset.

Now, attached to Polaris, look for the stars of the **"Little Dipper".** Like its larger counterpart, the Little Dipper is comprised of seven stars, though most are dimmer by comparison. They, too, rotate around Polaris through the hours of the night and the seasons of the year, always visible in the northern skies.

Once you've located the Little Dipper, you're ready to search for **Draco, the Dragon**. You'll find it wrapped around the Little Dipper – a long, backwards S-curve of dim stars, ending in a group of four that marks the Dragon's head. Look there for the two stars known as "the Eyes of the Dragon" - the brighter of the two is Eltanin, as shown in **Figure 2**.

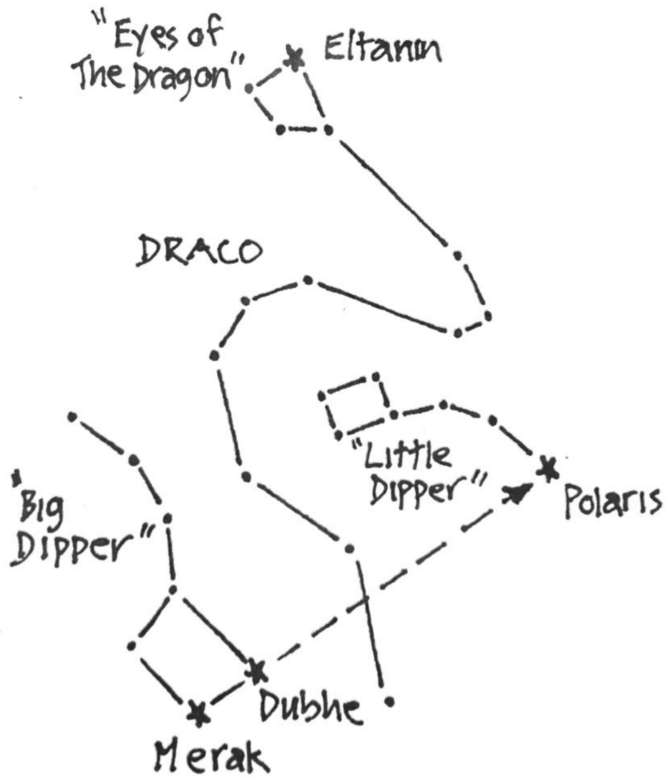


Figure 2: The Dippers and Draco, the Dragon
Shown as they appear shortly after sunset in Fall's northern sky.

The stars and figures described above are *circumpolar* – that is, they rotate around Polaris through the hours and seasons, but remain visible at any hour on any night of the year. Like the hands on a clock, these stars and their rotations can be used to mark the hour.

The 24 Hour Clock

To tell the hour by the stars, you'll need to envision the northern sky as a clock face, with Polaris at its center. But this clock face has its quirks: First, it's a *24-hour clock,* marked with 24 hours around its rim, starting with the zero hour of midnight. Second, the clock turns *backwards,* because the stars we'll use to mark the time appear to rotate counterclockwise as we face North. **Figure 3** illustrates the concept of a 24-hour clock face centered on Polaris:

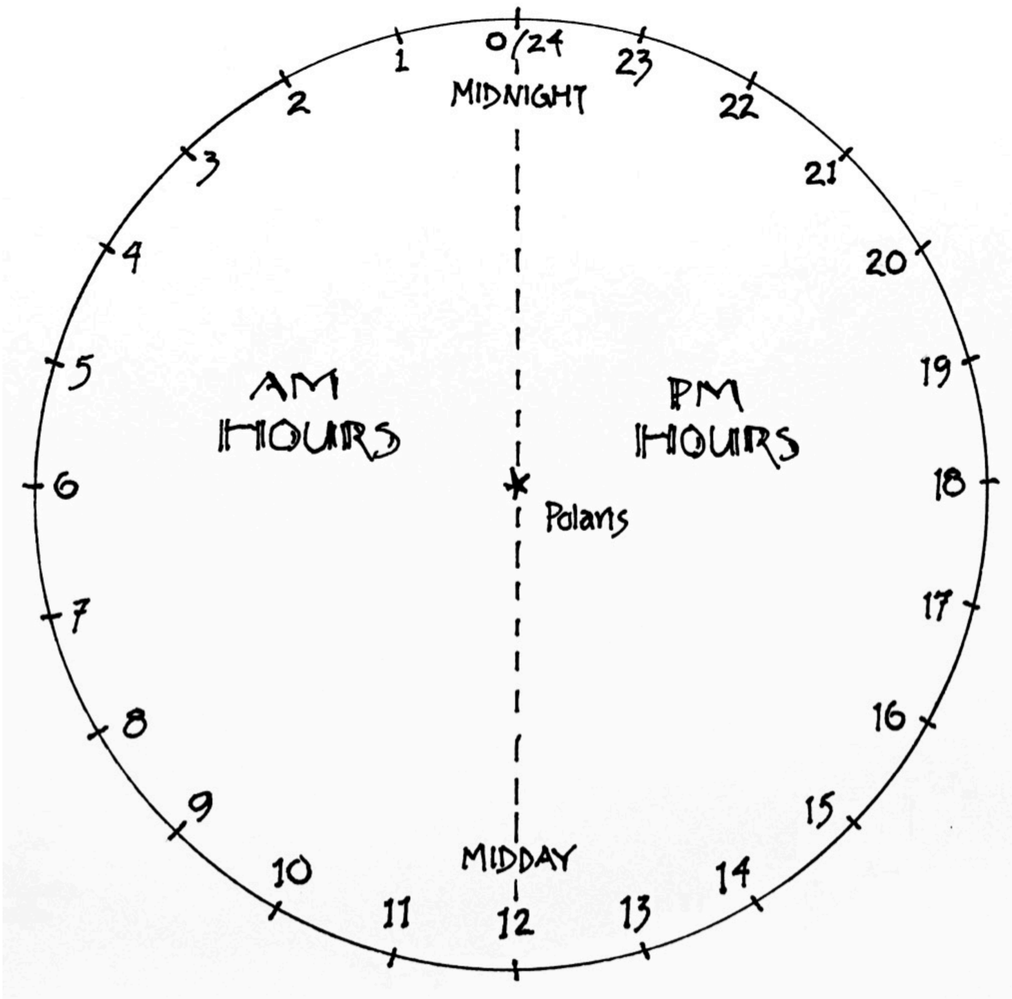


Figure 3: The 24-hour Clock

Polaris at the center, and 24 hours marked around the rim.
Stars in the northern sky appear to rotate counterclockwise through the hours of the night.

On the 24-hour clock, **am** hours are numbered 0 – 11, and **pm** hours are numbered 12 – 23. Once you have this nailed down, you're ready to tell time by the Eye of the Dragon!

Procedure:

1) Step outside after dark and see if you can spot Eltanin. Remember that it's in the figure of Draco the Dragon, which wraps around the Little Dipper. The Little Dipper is attached to Polaris, the North Star, which you can find from the pointers in the Big Dipper.

2) Picture the 24-hour clock centered on Polaris. Next, imagine that Eltanin is attached to an hour hand on the clock. By your best estimation, to what hour on the clock does Eltanin correspond? Fractions of hours count, if you want to be really accurate: for example, is the Eye of the Dragon at seven hours, or closer to seven and a half…? Keep your number in mind as you move on to the next step.

3) Now, some calculation: How many months will pass before the next Summer Solstice? The Solstice occurs on the 21st or 22nd of June – so, how many months away is it? Again, fractions count here: Is the Solstice six months away, or closer to five and three quarters…? Here are some friendly fractions of a month for you to consider:

- 15 days is half of a month (.5)
- 10 days is a third of a month (.33)
- 7 days is a quarter of a month (.25)

4) Take the number of months from step 3 and multiply it by 2. Again, some help with the maths:

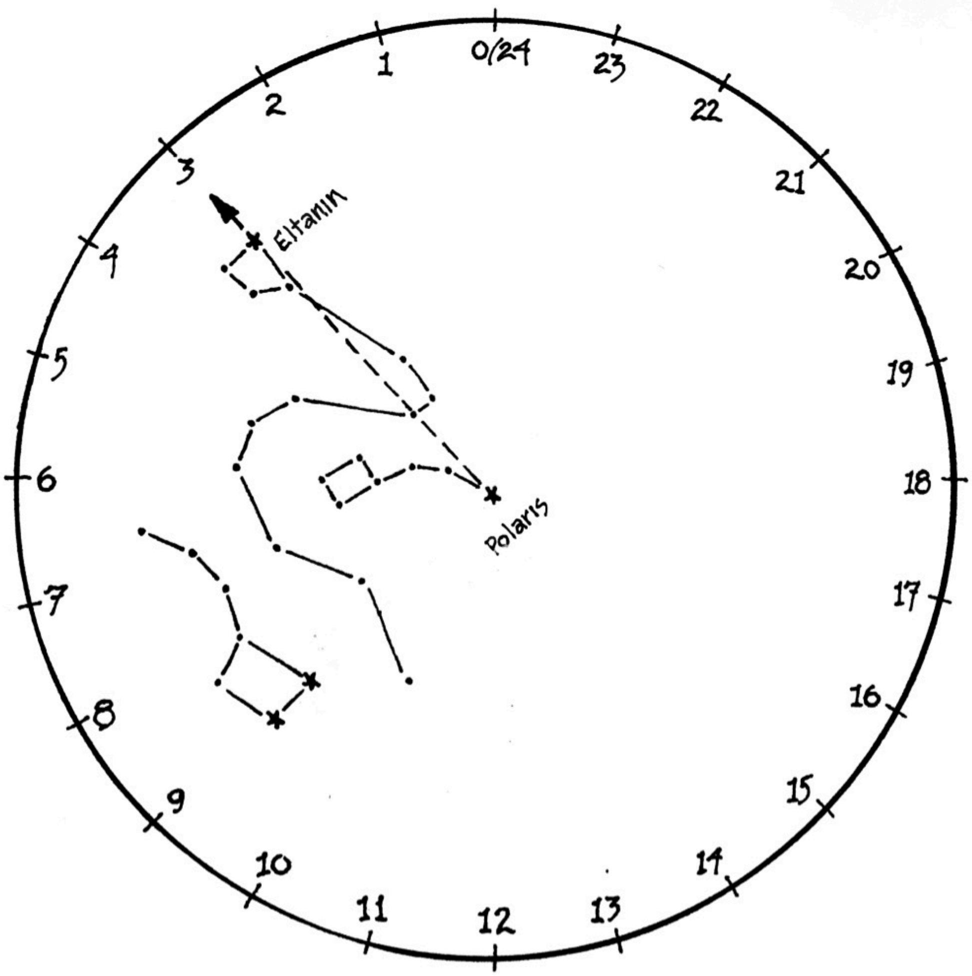
- 2 x a half = 1
- 2 x a third = 2/3 (or roughly .7)
- 2 x a quarter = 1/2 (or .5)

5) Now add the number you got from step 4 to the hour number you got from step 2. If the sum is *less than 24,* you can leave it alone. If the sum is *greater than 24,* subtract 24. In either case, the number you end up with is the actual clock time, as measured on a 24-hour scale. From there, you can convert your answer to a 12-hour scale if that makes more sense to you. But take note: *The hours derived by this method are in Standard Time. For Daylight Saving Time, you'll need to add an hour to your results.* It may seem like a lot of work, but a little practice makes all the difference.

A few examples follow…

Example 1:

1) It's the night of October 20th. Here's the position of Eltanin in the Northern sky, imagined on the face of a 24-hour clock. Remember, the clock is centered on Polaris, the North Star.



2) Eltanin is pointing to about 3 hours on the clock.

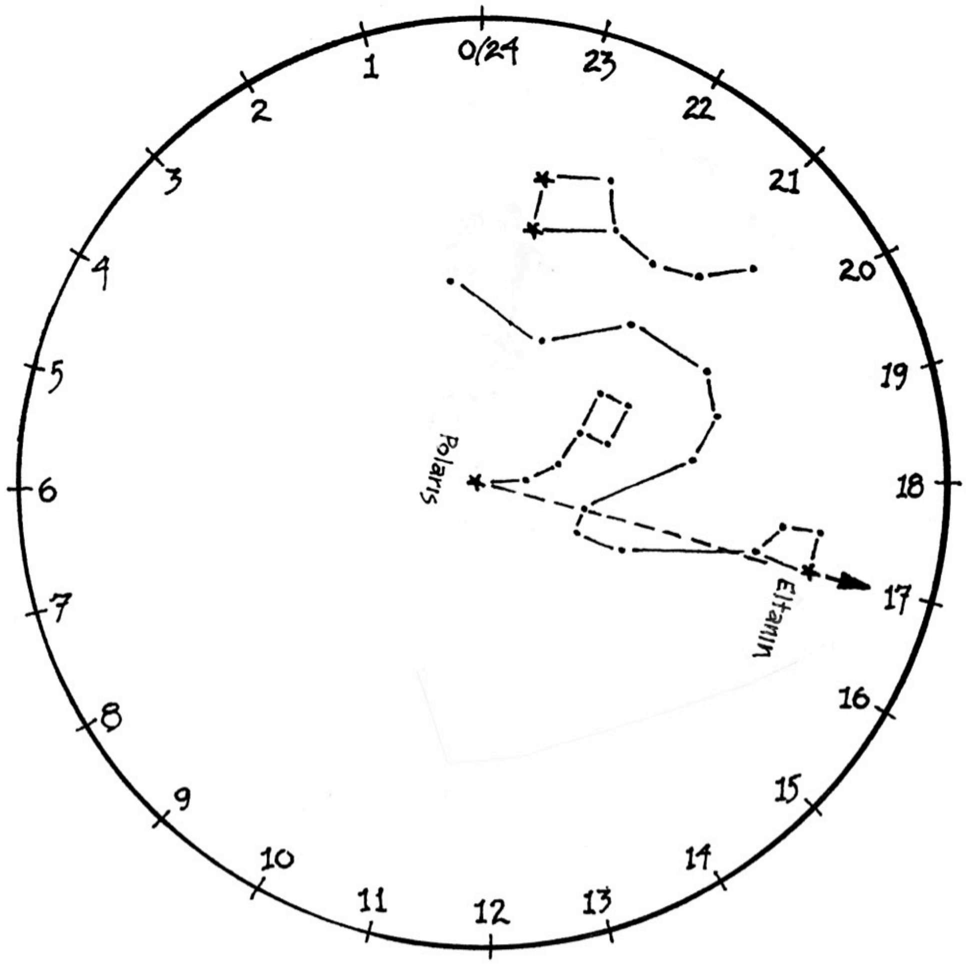
3) October 20th is about 8 months from the next Summer Solstice.

4) Multiply: 8 x 2 = 16

5) Add: 3 hours + 16 = 19 hours
The time is 19 hours on the 24-hour clock, or 7 pm.

Example 2:

1) It's the night of March 25th. Here's the position of Eltanin in the northern sky, imagined on the face of a 24-hour clock. Remember, the clock is centered on Polaris, the North Star.



2) Eltanin is pointing to about 17 hours on the clock.

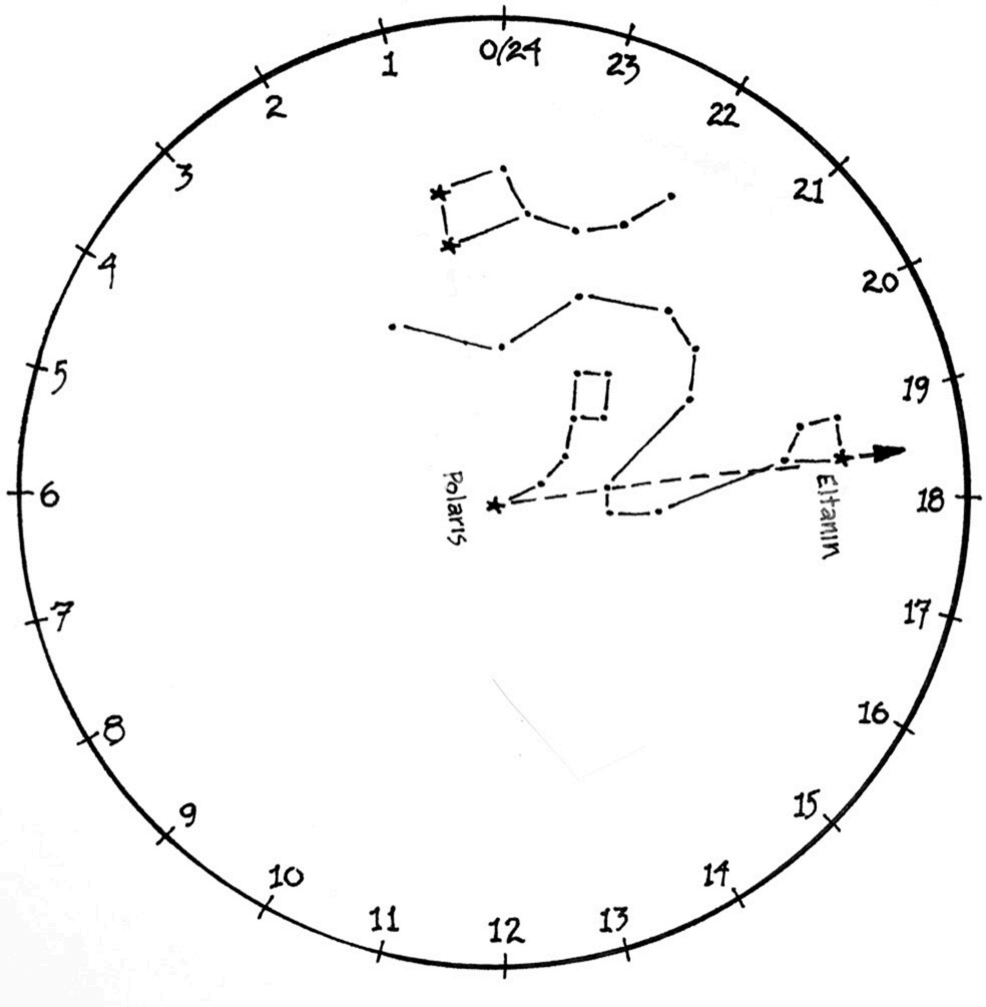
3) March 25th is about 3 months from the next Summer Solstice.

4) Multiply: $3 \times 2 = 6$

5) Add: 17 hours + 6 = 23 hours
The time is 23 hours on the 24-hour clock, or 11 pm.

Example 3:

1) It's the night of March 5th. Here's the position of Eltanin in the Northern sky, imagined on the face of a 24-hour clock:



2) Eltanin is pointing to about 18 and 1/2 (18.5) hours on the clock.

3) March 5 is about 3 and 1/2 (3.5) months from the next Summer Solstice.

4) Multiply: 3.5 x 2 = 7

5) Add: 18.5 hours + 7 = 25.5 hours
25.5 is greater than 24, so subtract: 25.5 hours – 24 = 1.5 hours
The time is 1.5 hours on the 24-hour clock, or 1:30 am.

So far, so good....

But it's fair to wonder: What happens if the Eye of the Dragon is obscured by clouds, or something looming on the horizon? In that event, it helps to have a back-up plan – specifically, another point of reference. There are plenty of options, as numerous as stars in the sky – but an especially useful one is Errai, in the figure of **Cepheus** the **King**.

You can find Errai by extending that line from the pointers *past* Polaris to the next star you see. The figure of the King resembles the shape of a house you might have drawn as a five-year-old, but like the Dippers and the Dragon it tumbles around Polaris through the hours of the night and the seasons of the year. Errai is at the peak of the house. Elsewhere in the figure you'll find a trio of dim stars known as "the flock." Long before its coronation as King, Cepheus was recognized more humbly as a shepherd - in fact, Errai is Arabic for "shepherd." Ever mindful of the Dragon, it watches over the flock through the hours of the night.

Figure 4 shows that a line drawn from Polaris to Errai forms a 90-degree angle with a similar line drawn to the Eye of the Dragon.

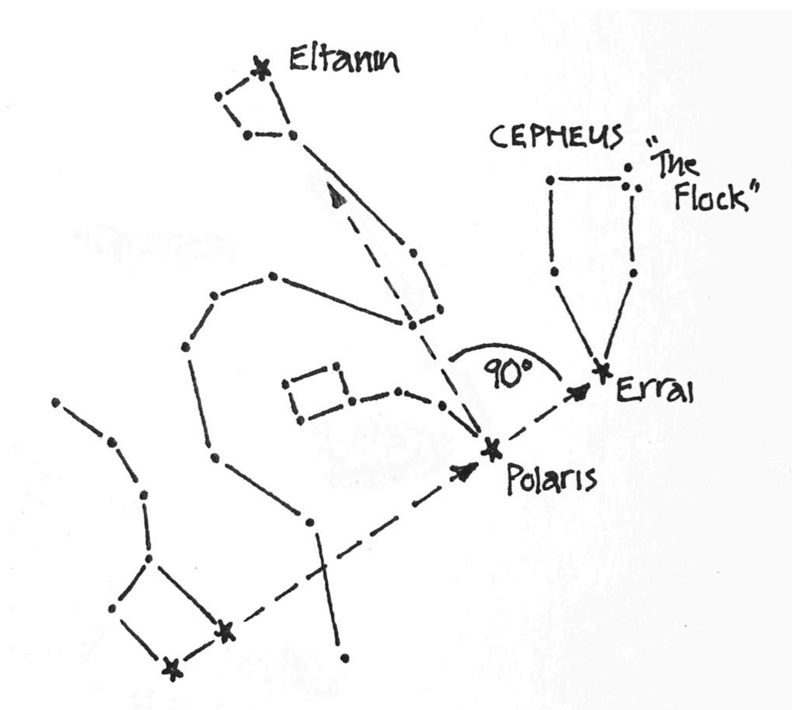
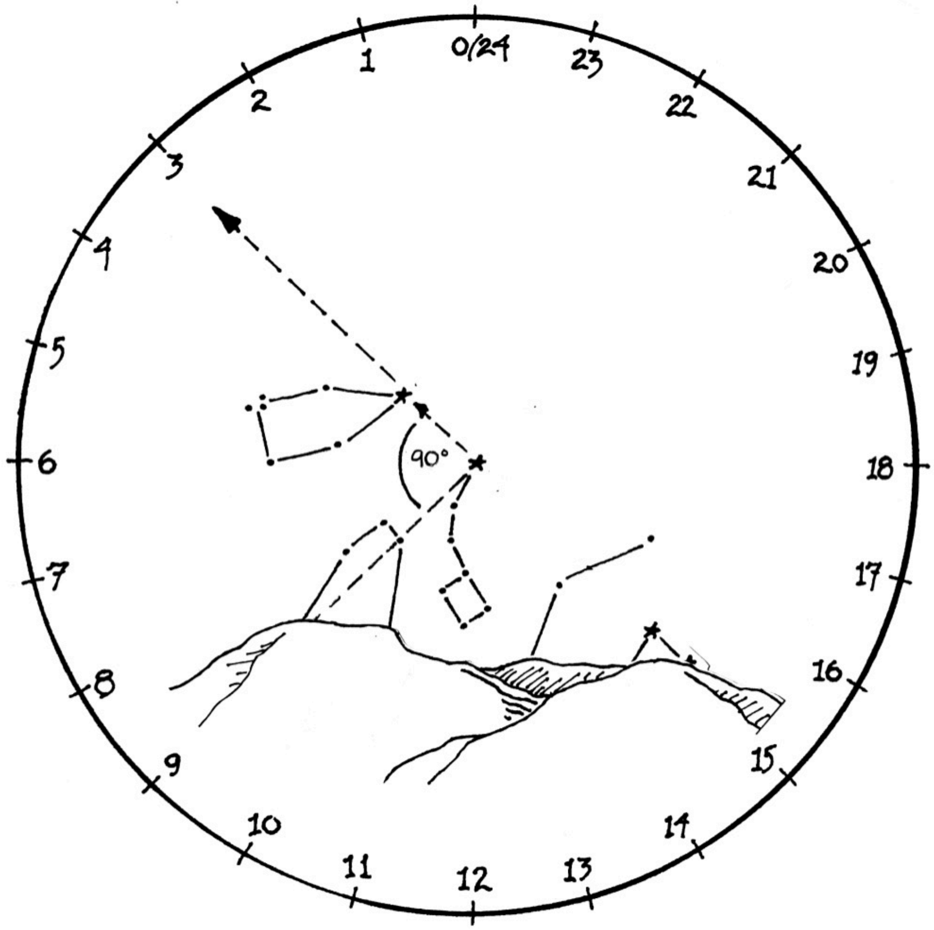


Figure 4: Cepheus the King
Errai the Shepherd forms a 90 degree angle with Eltanin, as measured from Polaris.

That 90-degree angle amounts to a quarter circle – or, six hours on the 24-hour clock face. Stated another way, the Shepherd is *six hours behind* the Eye of the Dragon. Knowing this comes in handy when the Dragon's eye is hiding and we want to find the time. Examples follow....

Example 4:

1) It's the night of November 5th. The Eyes of the Dragon are hidden behind some hills in the North, but Errai, the ever-wary Shepherd, knows where the threat to his flock is lurking! Recall that Errai forms a 90 degree angle with respect to the Eye of the Dragon, so Eltanin is a quarter circle – 6 hours – *ahead* of the shepherd....



2) Errai, the Shepherd, is at 3 hours on the 24h-hour clock, so Eltanin must be hiding at about 9 hours.

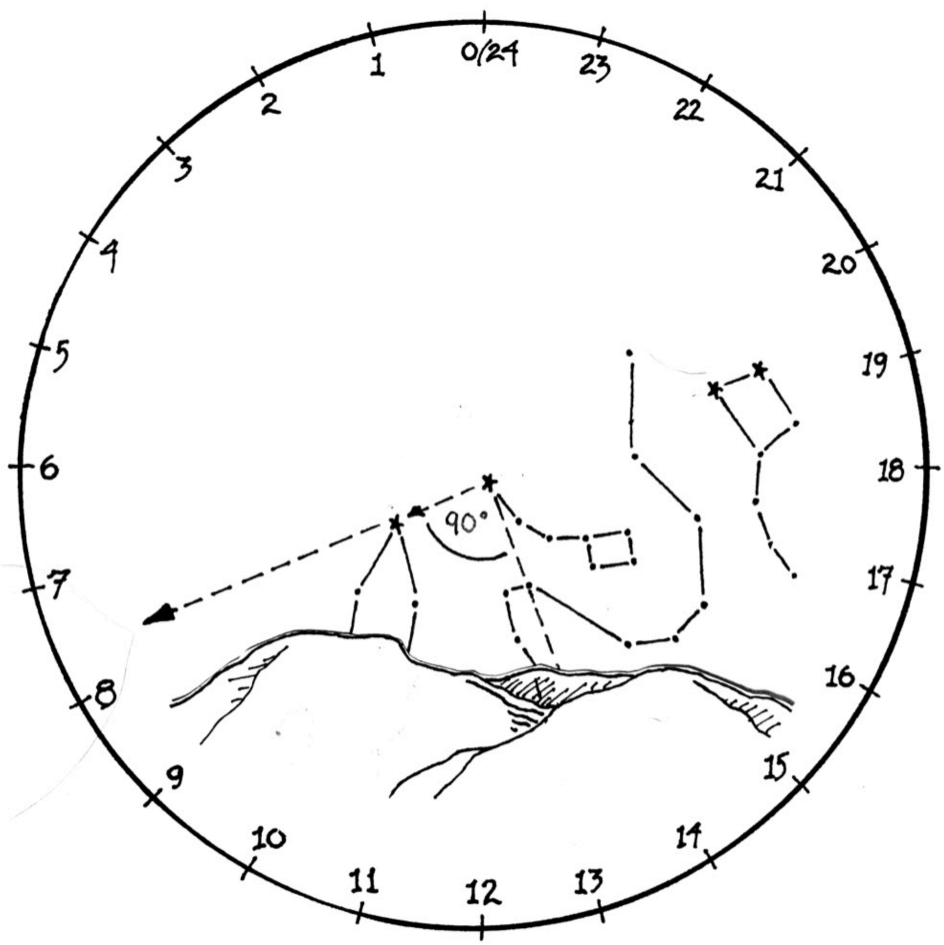
3) September 5th is about 9 and 1/2 (9.5) months from the next Summer Solstice.

4) Multiply: $9.5 \times 2 = 19$

5) Add: 9 hours + 19 = 28 hours
28 is greater than 24, so subtract: 28 hours – 24 = 4 hours
The time is 4 hours on the 24-hour clock, or 4 am.

Example 5:

1) It's the night of December 14th. Eltanin, the Eye of the Dragon, is hiding behind hills in the north, but Errai the Shepherd, knows where to find it. Errai is visible to the left and a bit below Polaris. Here's the scene, imagined on a 24-hour clock face:



2) Errai is at about 7 and 1/2 hours on the clock face. Eltanin, then, must be 90 degrees (a quarter circle, or 6 hours) *ahead* at 13 1/2 (13.5) hours.

3) December 14th is about 6 and 1/4 (6.25) months from the next Summer Solstice.

4) Multiply: 6.25 x 2 = 12.5 hours

5) Add: 13.5 hours + 12.5 hours = 26 hours
26 is greater than 24, so subtract: 26 – 24 = 2
The time is 2 hours on the 24-hour clock, or 2 am.

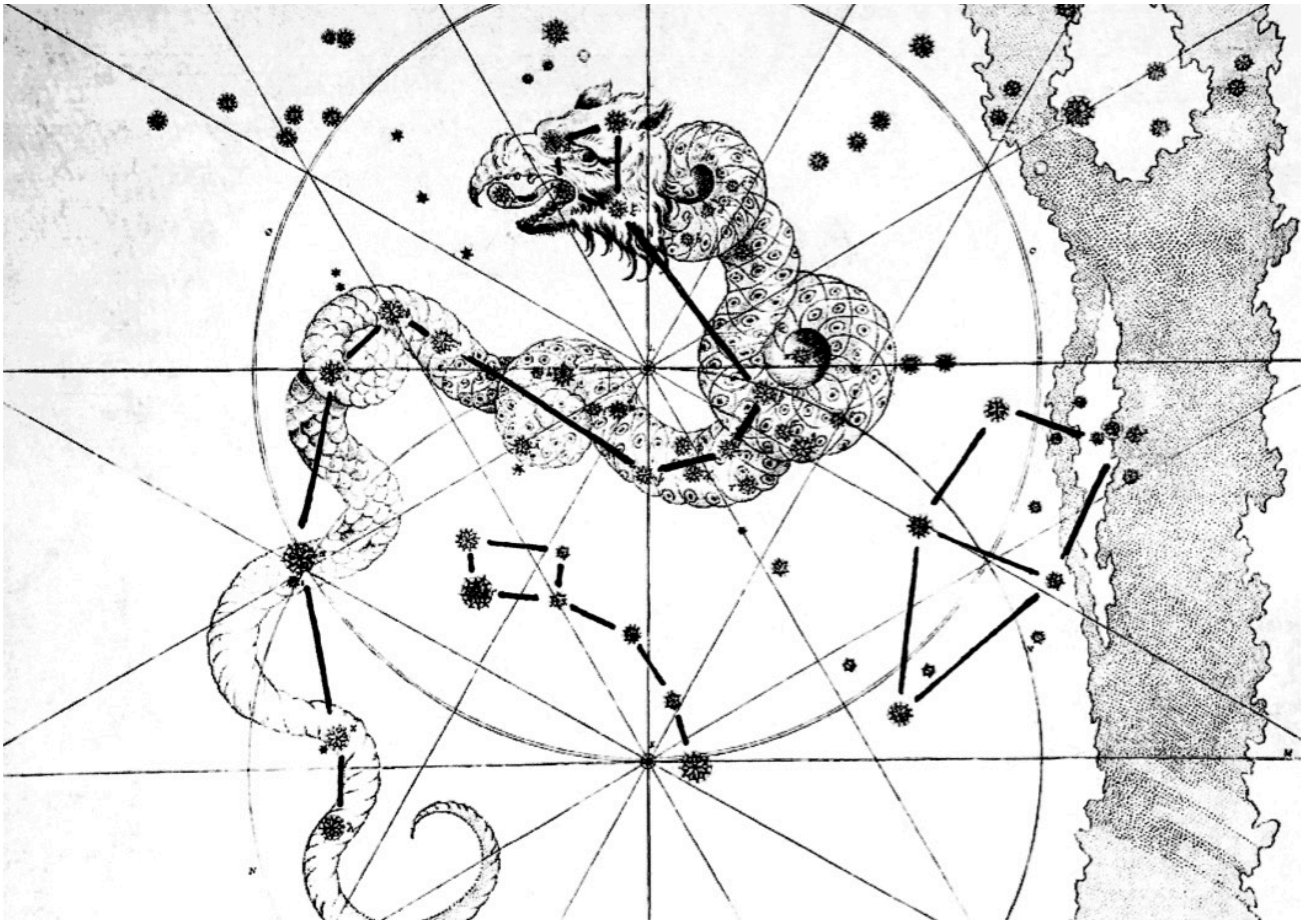
So Why Does Any of This Work?

Our measurement of time is based on movements of our planet through space. In particular, the *spin* of the planet marks hours and days, while the *orbit* of the planet around the Sun marks the passage of months and years. And because these movements are regular and predictable, so too are the movements of stars as they pass into and out of view over time. Some, like the Sun, cross the sky in broad arcs from east*ish* to west*ish*. Others, like the star Eltanin, move in tighter arcs or circles around the North Star, Polaris. In every case, however, these motions are *illusions* – it's not the stars that are moving, but rather the Earth itself.

Predictability of the illusions is at play when we're telling the time by the stars - the appearances and disappearances of the Sun and stars enable us to gauge and measure time here on the planet we call home. Any star will do, so long as we know with certainty where and *when* it will appear in the sky.

The activity presented above focuses on Eltanin for two reasons: The first is that Eltanin is *circumpolar* – meaning that for most observers in the Northern Hemisphere it never sets. If we want a reliable method for telling time at *any* hour of *any* night of the year, we need a star that's visible whenever when we need it.

Secondly, and equally important, we want a star whose position at a notable point in time and space can serve as a reference for marking other times throughout the year – a starting point, as it were, to set clock and calendar in motion. Any number of stars, brighter and better-known than Eltanin, could be used as a referent. But It so happens that the Eye of the Dragon stands directly above Polaris at midnight on the Summer Solstice - right up there at the top of our imagined 24-hour clock face, on one of the most celebrated nights on the calendar. What better star (and from what better moment?) to mark the passage of time through the hours and nights of the coming year?



Draco, the Dragon

Adapted from Uranometria, by Johannes Bayer, 1661.
The Dragon rears its head at midnight on the Summer Solstice.
Eltanin, the Dragon's eye, is directly above Polaris - and so the clock is set.