Star Clocks

Activity F1

Grade Level: 5–12

Source: This activity was first developed for *Astro Adventures*, by Dennis Schatz, Paul Allan, and Doug Cooper. Copyright ©2003 by The Pacific Science Center. It was adapted for the *Astronomy from the Ground Up* program at the Astronomical Society of the Pacific, by Andrew Fraknoi and Anna Hurst. This version is © copyright 2006 Astronomical Society of the Pacific. www.astrosociety.org

What's This Activity About?

Before humans had watches with luminous dials or digital clocks, people used the stars to tell the time at night. This activity will teach students how the Big Dipper can be used as a clock to tell the approximate local time.

What Will Students Do?

Students construct a northern-hemisphere star clock and learn to set the clock based on the position of the Big Dipper. Students use the position of the Big Dipper to tell the time. They also can predict where the Big Dipper will be at a given time and month.

Tips and Suggestions

- The activity describes using a Star Finder which students make in the activity "Star Finding with a Star Finder" in this section. This activity can be done quite successfully before students create the more elaborate Star Finder.

What Will Students Learn?

Concepts

- Motions of the northern constellations
- Rotation of the Earth

Inquiry Skills

- Observing
- Predicting
- Visualizing

Big Ideas

- Patterns of Change
- Models

ASTRONOMY from the GROUND UP
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Big Dipper Star Clock
Activity Guide

Originally developed by Dennis Schatz and Andrew Fraknoi for Family ASTRO. The Star Clock pattern was adapted from the book Astro Adventures by Dennis Schatz and Doug Cooper, © 1994 by the Pacific Science Center

Adapted by Anna Hurst

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Type of Activity:	Indoor/outdoor classroom or drop-in station, facilitated
Set up Time:	10 minutes
Time to Do:	30 minutes
Audience age:	8 years and older
Group size:	various

What's This Activity About?

You don't need a watch to tell what time it is at night as long as you can find the Big Dipper. Long before digital watches or even grandfather clocks, people used the sky to tell time at night. We'll follow their example and build a star clock that you can use to tell time by the stars.

Materials

- Star Clock patterns
- Scissors
- Brass prong fasteners
- Single hole punch, push pin or sharp pencil to make hole in center of star wheel

Setting Up the Activity

You will need to copy the Star Clock patterns onto cardstock. Each participant should receive one each of the inner and outer wheels. Each participant will also need a brass fastener and access to a pair of scissors and a tool to make holes in the center of the star wheels.

Suggestions for Introducing the Activity

Have a discussion about time measurement. What are the different ways that we mark the passage of time? What are some units of time? How long is one day? How did we decide on 24 hours for the length of a day? What happens in the course of one day? Bring your discussion to the movement of the Earth and thus the apparent movement of the Sun and stars in the sky - the most basic way of measuring time.

If you have already tried the Pocket Sun Clock, you may have already had a similar discussion about the movement of the Sun through the sky. The Sun is just one of many stars in the sky, except that it is much closer and so looks much brighter. But the other stars appear to move through the sky as well, rising in the east and setting in the west just like the Sun. Only the circumpolar stars do not rise and set; they instead move in circles around Polaris, the North Star. These are the stars we will use to tell time with our Big Dipper Star Clocks.

If you have tried the Sky Time lesson from Kinesthetic Astronomy, you can use it to help participants visualize the movement of the Earth and thus the apparent motion of the stars. As the rotate on their axis, pointing toward Polaris, have them observe the constellations of the zodiac and notice how they rise and set (i.e. move in and out of view). Meanwhile, they should always be able to see Polaris (if they are truly able to bend their bodies and keep their "north poles" pointed at it). This could also be demonstrated by having a participant sit on a spinning stool and watching the walls and then a spot on the ceiling directly overhead, as explained in the "Wrap-up" section below.

For further background information and ideas for introducing the activity in more depth, see the "Wrap-up" section below.

Doing the Activity

Making the Star Clock

1. Carefully cut out the 2 circles from the patterns
2. Punch a hole in the middle of each circle.
3. Put a brass fastener through the two holes. The black circle with the notch and the words "THE TIME IS" should be on top.
4. Make sure the wheels can turn smoothly around the fastener. You may have to make your holes a little bigger if they don't.

Using the Star Clock

Do this when the sky is pretty clear. On a cloudy night, crucial stars often hide behind some cloud and the constellation patterns are easy to miss. First, help participants find which way is north. For example, if you know where the Sun set this evening, that's roughly west. If you are facing west, north will be in the direction of your right shoulder. Landmarks can also help find direction. For example, in San Francisco, the bay is to the east and the ocean to the west. Or, you could show participants how to find north using a compass.

Have participants face north and see if they can find the pattern of seven stars that make up the Big Dipper or the five that make up Cassiopeia. They can look at the star clock to see how this group of stars looks. (See also the section on "Finding the Big Dipper," in the "Wrap-up" section below.) Show them how to use the Big Dipper's pointer stars to find and face the North Star.

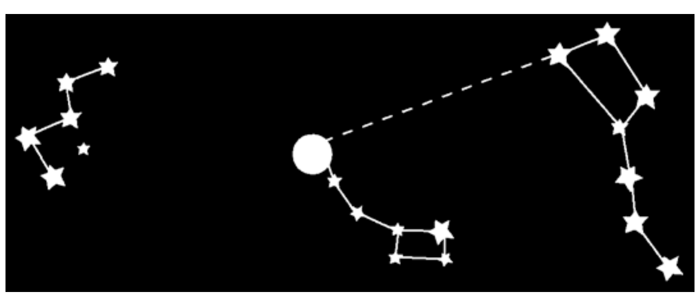
Participants should then go through the following steps to read the time:

1. Turn the outer circle of the Star Clock so that the current month is on top.
2. Turn the inner circle until the picture of the Big Dipper on the star clock lines up with the Big Dipper in the real sky. To check if you are right, see if the Little Dipper and Cassiopeia are lined up the right way too.
3. Now read the time in the window. That's roughly the time, provided that you are on standard time. If you are on daylight savings time when you are making the observation, add an hour.
4. Check your "star time" against a modern watch or clock. How close did you come?

HINT: If you are going to use the star clocks in a dark place, take a small flashlight with you. Red light is better because it doesn't disturb your night vision as much. You can cover the flashlight with red cellophane, a thin red cloth, a red balloon, or even a thin brown paper bag. Attach them to the flashlight with a rubber band.

Finding the Big Dipper

The Big Dipper is a seven-star pattern that looks like a big soup ladle or cooking pot with a long bent handle and is visible in the night sky all night long and all year long in the Northern Hemisphere. In the summer, the Big Dipper is high overhead in the evening sky. In the fall you can see it toward the northwest after the Sun has set (and it seems to be upside down). In the winter, it is low on the northern horizon and somewhat harder to see in the evening (especially if hills, buildings or trees block your view of the horizon). In the spring, you can see it standing on end toward the northeast in the evening sky. (If you have trouble finding the Dipper, you might want to use a rotating starfinder, such as the planisphere you can make in another AFGU activity, *Making a Star Finder*.)



Practicing the use of the Star Clock indoors

If you do this activity inside and/or during the daytime, participants can still practice the use of their star clocks. Copy the pattern of stars from the above image or from the Star Clock itself onto a large piece of paper or, for something more permanent, onto a circle of plywood. Rotate this large diagram to a certain position and hang it on the wall at the front of the room. Have participants practice using the star clocks using the process outlined above. Stress that this is not the actual time, and just a way to practice. Encourage them to go outside at night to try out their Star Clocks with the real stars. If you have a planetarium, you could also have them practice there.

Wrap-up

Remind participants once more how to use their Star Clocks and encourage them to try it on their own at different times of night and different times of year. Suggest that they keep a log comparing the actual time to the time shown on the Star Clock. Why might these times differ?

You may also want to discuss in greater depth the Big Dipper and how the Star Clock works.

Why Does the Star Clock Work?

Because planet Earth turns once every 24 hours, the sky appears to turn above our heads during that time. When we look out of the window of a moving train, we see the scenery moving backwards. In the same way, from the turning Earth, we see the sky turn – and all the stars and planets turn with it. Try seeing this for yourself when you go camping or have a chance to watch the sky for a long time. Star patterns in the night sky seem to move slowly around the sky as the hours of the night go on. And we can use the turning constellations as a rough clock, just like the ancients did. In the Northern Hemisphere, the easiest star group to use for telling time is the Big Dipper. The outer edge of the Dipper (the side away from the handle) consists of two pointer stars that direct you toward the North Star. This star is the one around which the sky in the Northern Hemisphere appears to turn (see “What’s Up with the Big Dipper” for further explanation).

People long ago noticed that the North Star acted like the anchor of the sky – the still point around which everything else turned. The Big Dipper swung around the North Star in a circle – just like the hands of an old-fashioned clock. Polaris (the official name for the North Star) is the brightest star in the star group called the Little Dipper, which is much like a smaller version of the Big Dipper. (Its stars are fainter and thus harder to make out, so don’t get discouraged if you can’t find it.) It always looks like the Big Dipper is pouring some soup or punch into the Little Dipper (or vice versa). Another star group that’s easy to find near the Big Dipper is Cassiopeia (pronounced “Cass’ee o pee a”), which consists of 5 stars and looks like a big “W” or “M”, depending on the time of year. Follow the pointer stars of the Big Dipper to the North Star and keep going (curving just a bit away from the handle of the Big Dipper). You should soon come to a W or M shape of stars. On the star clock, you can use the position of Cassiopeia to check if you’ve oriented the star clock right.

What’s Up with the Big Dipper?

Why does the Big Dipper turn around the North Star? The Earth spins on its axis – an imaginary stick, poking through the Earth’s north and south poles. The stick itself doesn’t turn – the Earth turns around it, like a roasting pig on a spit. You can visualize this by poking a chopstick or other stick through something soft, like an orange or a ball of clay. Then slowly turn the ball around the axis of the stick. Notice that as the ball turns, the axis stick just sits there. The same is true on Earth. Our imaginary axis just sits there and the Earth turns around it. A point exactly on the axis, like the North Pole, would not turn at all.

Now let's think about watching the sky: as we said earlier, it doesn't really turn. We see it turn because the Earth turns. A fun way to show this is to use a piano stool or a desk chair that swivels all the way around. Have a participant sit under a spot on the ceiling. Have another participant slowly turn the first one. He or she should note that the walls of the room (and all the furniture) seem to move around when spinning in the chair, but that the special spot on the ceiling right overhead just sits there and doesn't turn. The Sky Time lesson from Kinesthetic Astronomy is another way to demonstrate this, as described above in the section "Suggestions for Introducing the Activity." Now pose the following question: What point on the sky will not be seen to turn as the Earth turns? Give participants a moment to consider this. The answer is that a point in the sky right above the North Pole of the Earth would be sitting still, just like the North Pole does. By a wonderful coincidence, there happens to be a star almost exactly above the North Pole of the Earth – it is Polaris, the North Star.

If you lived at the North Pole (a pretty cold place to have a home), you would see the North Star right overhead. But most of us live far away from the North Pole and so the North Star is not exactly at the top of the sky, but just in the northern direction. The Big Dipper, being close to the North Star, turns in a small circle around it and is therefore a good turning "clock hand" for our Star Clock.

In general, stars near the North Star just go around it in small circles and are visible in the sky all night long. Stars farther from the North Star will go around in bigger circles, parts of which will be below the horizon. We say that these stars rise and set. In the Southern Hemisphere, by the way, the South Pole plays the same role. The spot in the sky directly above the South Pole does not "turn." Not far from the "South Pole" of the sky, there is a small group of stars that looks like a kite — it's called the Southern Cross, but there is no bright star marking the spot in the sky where the South Pole points. There is no "South Star."

Complimentary activities:

- Pocket Sun Clocks
- Kinesthetic Astronomy
- Making a Star Finder

Star Clock Inner Wheel

Star Clock Outer Wheel