The Big Dipper Star Clock

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Your students can tell what time it is at night if they can find the Big Dipper—as Isaac Newton used to do, back before people had wristwatches. Let's build a star clock that you or they can use to tell time by the stars.

Making the Star Clock

Materials You'll Need: Scissors, paper fastener (with two prongs that spread apart), and a printout of the star-clock patterns that come with this activity.

1. Cut out the 2 circles carefully.
2. Punch a hole in the middle of each circle.
3. Put a paper 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

1. Do this activity when the sky is pretty clear. On a cloudy night, crucial stars often hide behind some clouds and the constellation patterns are easy to miss.
2. Find North. If you know where the Sun set this evening, that's roughly west, and if you are facing west, north will be in the direction of your right shoulder. Or use a compass.
3. Face north and see if you can find the pattern of seven stars that make up the Big Dipper. See the star clock for what this group of stars looks like. (See also the section on "Finding the Big Dipper," below.)
4. Use the Big Dipper's pointer stars to find the North Star. Then face the North Star.
5. Turn the outer circle of the Star Clock so that the current month is on top.
6. 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.
7. 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 one hour. Check your "star time" against a modern watch or clock. How close did you come?

HINT: If you are going to use the star clock 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. Hold them on 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. From North America it is visible in the night sky all night long throughout the year. 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 sets (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, trees, or chubby neighbors block your view of the horizon). In the spring, you can see it toward the northeast in the evening sky. (If you have trouble finding the Dipper, use the *Your Sky Tonight* star chart on the *Seeing in the Dark* website.)

Star Clock Challenge

- Use the Star Clock to dial up where the Big Dipper will be three hours from now. Where will Cassiopeia be then?
- Where will the two star groups be six hours from now? Which way is the sky turning?
- North to South? South to North? East to West? West to East? Toward which compass direction *must the Earth be turning?*

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 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 a fuller 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. The official name of the North Star is *Polaris,* the pole star. Polaris is the brightest star in the star group called the Little Dipper, 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 five stars that 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. Your students can visualize this by poking a chop stick or other stick through something soft, like an orange or a ball of clay. Then ask them to slowly turn the ball around the axis of the sticks. 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. The sky doesn't really turn, but *seems* to 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 student sit under a spot on the ceiling (or a wad of gum you allow an honor student to shoot up there temporarily). Have someone turn the student slowly. Have the student describe how the walls of the room (and all the furniture) seem to move around you as he or she spins in the chair.

Now ask the student to look carefully as she turns at that special spot on the ceiling right above her head. It just sits there and doesn't turn. Then ask students to answer the following question: What point on the sky will not be seen to turn as the Earth turns? Have them take a minute to think about this before you read the answer.

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. And 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 rather 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 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.*

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