Astrology: Fact or Fiction?
50-60 minutes, for 9th-12th grades

Notice

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Objectives

Students will learn:
- What the ecliptic is;
- That the zodiac constellations lie along the ecliptic;
- That the location of the sun determined the original dates of the 12 zodiac constellations;
- That the original dates of the zodiac constellations are no longer accurate because of precession;
- Basic requirements for something to be a science; and
- That astrology is a pseudoscience, not a science.

Materials required

- Flashlight
- Light and laser pointers
- Three to five sample horoscopes *(Watch out for sign-specific references, such as, 'You'll be particularly bull-headed today.' Try to get horoscopes from within the past week so that students are able to recall the day in question.)*
- Earth on a stick (globe with handles at north and south poles to represent axis)
- Stick pin with a flag attached

I. Introduction *(10 minutes)*

A) Inform students that you'll be exploring a topic that many of them have probably heard of—astrology. Ask students what astrology is ***[****the idea that the positions of astronomical bodies at the time of birth influence people's personalities, events in people's lives, etc****.]*****.** What is the zodiac? ***[****12 constellations that lie along the ecliptic. Be sure to define what the ecliptic is. To be perfectly accurate, there are actually 13 constellations on the ecliptic, but Ophiuchus has been left out of the zodiac for some reason****.]***

Each constellation occupies a sign. A sign is a patch of sky 30 degrees long and 18 degrees tall--nine degrees above the ecliptic and nine degrees below. Inform students that they'll have a chance to see the 12 zodiac constellations and the ecliptic when they go inside the planetarium.

B) How many of you know what a 'sun sign' or 'birth sign' is? ***[****The sign of the zodiac the sun was 'in' when an individual was born****.]*** This means that your 'birth sign' is the one constellation that you cannot see on your birthday. How many of them read the horoscope for their 'sun sign' at least once per month? once per week? every day?

Inform students that you'll read some sample horoscopes for _____ ***[****whatever day the horoscopes are for****]***. You won't be telling the students which 'sun sign' each horoscope you read is for; if they think they hear their own, they'll be able to guess later. ***[****Read the horoscopes.****]*** Does anyone think they heard the horoscope for their 'sun sign?' ***[****Discuss whether or not they were right about their horoscopes.****]*** Did any of them feel like more than one horoscope was written for their sign? Why do the students think horoscopes are written so vaguely?

C) Review rules and expectations for the planetarium, then enter.
NOTE: Bring the Earth on a stick into the planetarium with you!

II. Introduction to the night sky and ecliptic *(10 minutes)*

A) ***[****When all are in and seated, darken the planetarium so that students can better view the night sky****.]*** Inform students that they are looking at the sky as it would appear at about ___ p.m./a.m. today/early tomorrow. Are they familiar with any of the zodiac constellations? There are some they've probably seen before—Taurus, Scorpius, Gemini, and Leo. Do they see any of these in the current night sky? ***[****If so, allow a student to use a LIGHT pointer to show the constellations****.]***

B) It will be helpful if we have a general idea of where to look for the zodiac constellations. What is the name of the path that the sun appears to travel along? Right, the ecliptic. In here we can project a line for the ecliptic ***[****turn it on****]***. Along this line is where we'll look for the zodiac constellations. Does anyone see any zodiac constellations now? ***[****If so, allow a student to use a LIGHT pointer to show them; if not, point out those currently visible and turn on the line drawings or constellation art after connecting the stars with your laser pointer.****]***

III. 'Sun sign,' precession *(15 minutes)*

A) Who can remind us what a 'sun sign' is? Right, it's the sign of the zodiac that the sun is in on your birthday, the one sign that you cannot see on your birthday. Are we going to be able to tell what the current 'sun sign' is at night? No, we'll have to travel forward or backward to daytime ***[****advance or regress in time to approximately noon the following or preceding day****]***.

In here we can turn off Earth's atmosphere. What does Earth's atmosphere do? Among other things, it scatters sunlight, which makes the sky look blue. Now that the atmosphere is off, we can see which constellation the sun is currently in. Does anyone know offhand what that sign should be?

B) But wait a minute, the sun isn't actually in ____ ***[****whatever the 'sun sign' is supposed to be****]***. This is ___ ***[****point out the stars for whatever the 'Sun sign' is supposed to be****]***, so the sun should be over here. What's going on? Actually a lot is going on. Earth is not perfectly spherical; it bulges a little bit around the equator. The gravity of the sun and the moon try to draw this equatorial bulge toward themselves. This leads to something called 'precession.' Does anyone know what precession is? Right, it's the wobble of Earth's axis ***[****demonstrate this with the earth on a stick****]***, and it's caused by the sun and moon pulling on that equatorial bulge. It's like a top as it starts slowing down.

It takes about 26,000 years for Earth's axis to go through one complete wobble. Does anyone know what star the earth's northern axis currently points to? Right, Polaris, which is also called the north star. It's right here in the sky ***[****point to it with your laser pointer****]***.

Because Earth's axis is tilted toward Polaris ***[****model this with the earth on a stick****]***, we can use Polaris to find our directions. Review the directions, then turn on the cardinal points. Polaris hasn't always been our pole star, nor will it always be: about 14,000 years ago our pole star was Vega. ***[****Point out Vega if it is visible in the daytime sky; otherwise tell students that you'll show them Vega when you speed up time and it becomes visible.****]*** Vega, Polaris, and another star called Thuban ***[****point out Thuban in Draco****]*** take turns being the northern pole star throughout one cycle of precession. ***[****If time allows, go backward or forward in*

*time several thousand years to show how the pole star changes. Use the equatorial grid—which is currently centered on Polaris—to make the change obvious.**]***

So, to make a long story short, when these constellations were designed and assigned dates, the sun actually was in them. But now, thousands of years later, things have changed because of precession. Do you think astrologers take this into account? Most of them don't even mention it.

C) Let's take a look now at how the sun seems to travel through these constellations. ***[****Turn on the constellation line drawings and move forward in time week by week so that students can see the sun move against the background of stars.**]***

IV. Science in astrology *(5 minutes)*

A) Okay, by now you should have figured out that I don't believe in astrology's ability to predict the future or tell me anything about my personality. However, I do believe that there is some science in astrology. What makes something a science anyway? ***[****According to Philip Plait, author of* *Bad Astronomy,* *'Scientists look for causes and use them to make specific predictions about future events. If the theory fails, it either gets modified and retested or it gets junked.'**]*** Do astrologers junk their theories? No, they just make vague predictions that can be later modified to fit the actual occurrence. Well then, where's the science in astrology? We'll have to look back in history...

B) The early astrologers were actually doing a fair amount of science: they made careful observations of the planets, the moon, and the sun, and they checked these observations over a long period of time. Their observations were accurate enough for these early astrologers to assign dates to the sun's appearance in a certain constellation, even when that constellation was hidden by the glare of the sun. The ancient Mesopotamians knew as early as 687 BCE which sets of stars the sun traveled through and when. They'd observed the planets long enough to determine when each 'wanderer' would reappear. They knew that the moon made its trip around the ecliptic in about 27 days, while it took the planets much longer.

All this is good science: making a theory, testing that theory, and then modifying the theory as needed; that's what they did when they were figuring out the dates for the moon's and planets' reappearances. However, the leaps that have been made from these observations—that you can predict a person's fate and personality based on the positions of celestial bodies at the time of his/her birth, etc.—are not science. Why not? ***[****They don't stand up to testing.**]***

C) To go back to the science the early astrologers were doing, how do you think they determined which constellation the sun was in during the day without one of these nifty projectors? We'll take a look at how they did that outside the dome.

D) Exit the planetarium.

V. Determining the position of the Sun *(10 minutes)*

A) Who can remind us one more time what's special about your birth sign? Right, it's the sign that the sun was 'in' when you were born, and that means you can't see your birth sign on your birthday. Let's model how the early astrologers determined birth signs. We're going to make this simpler by using only four signs instead of 12.

- First I need someone to represent the sun, someone who believes the world revolves around him or her...
- Now I need someone to be the earth. Earth, we're going to imagine that we're all sitting on your nose. So whenever the tip of your nose is pointing directly toward the sun, what time of day is it? Right, it's high noon. To start out, we'll ignore Earth's axial tilt. We'll add that in later, if there's time.
- Now I'll need a volunteer to represent one zodiac constellation. ***[****Position the volunteer across the circle from the 'earth,' so that the 'earth' must look past the 'sun' to see the zodiac volunteer.****]***
- Ask the zodiac volunteer, What's one of your hobbies? ***[****Have the volunteer freeze in some position representing that hobby. We'll use stamp collecting as an example.****]*** So right here we have the constellation 'Stamp Collector.' Earth, could you see 'Stamp Collector' right now? No, because the light of the sun would block it out. So those of us born at this time of year would be which sign? Right, 'Stamp Collector,' since that's the one sign we can't see. Okay, let's move on...
- ***[****Move the 'earth' counterclockwise one-fourth of the way around the sun.****]*** Ask for a second zodiac volunteer, and position that volunteer across the circle from the 'earth,' behind the sun. Ask this second volunteer, 'What's a sport you like to play?' ***[****Have this volunteer freeze in a position that represents that sport. We'll use soccer as an example.****]*** Here we have the constellation, 'Soccer Player.' Earth, can you see 'Soccer Player' right now? No, because it's hidden by the sun. Can you now see 'The Stamp Collector?' Yes, though only for a short time at dusk. ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'The Stamp Collector.****]*** Those of us born at this time of year would be which sign? Right, 'Soccer Player,' since we can't see it. Let's move on...
- ***[****Move the 'earth' another fourth of the way around the sun. Position the 'earth' between the sun and the Stamp Collector.****]*** Choose a third zodiac volunteer, and position the third zodiac volunteer across the circle from the 'earth,' behind the sun. Ask this third zodiac volunteer, 'What's a breakfast food you enjoy?'

[*Have the volunteer freeze in a pose representing that food, cooking it or eating it. We'll use scrambled eggs as an example.****]*** So here we have the constellation 'Scrambled Egg Cooker.' Earth, can you now see 'Scrambled Egg Cooker?' No, it's hidden by the light of the sun. How about 'Soccer Player?' ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'Soccer Player.'****]*** Yep, but only at dusk. How about 'Stamp Collector?' ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'The Stamp Collector.'****]*** You sure can! It'll be high in the sky at midnight. Those of us born at this time of year would be which sign? Right, 'Scrambled Egg Cooker.' Why is that? Because it's the one sign we can't see. One more...

- ***[****Choose a fourth zodiac volunteer, and position him/her in the last open space. Now the 'earth' will be standing in front of the 'Soccer Player' looking across the circle at the fourth volunteer.****]*** Ask the fourth zodiac volunteer, 'What's a movie or cartoon that you like?' ***[****Have this volunteer freeze in a position that represents that movie or cartoon. We'll use 'Lord of the Rings' as an example.****]*** Okay, Earth, could you see the constellation 'Hobbit' right now? No. Why not? Right, because it's blocked by the light of the sun. Could you see 'Scrambled Egg Cooker?' ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'Scrambled Egg Cooker.****]*** When? *At dusk.* Could you see 'Soccer Player?' ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'Soccer Player.'****]*** When? *It'll be high in the sky at midnight.* How about 'Stamp Collector?' ***[****Rotate the 'earth' on his/her axis until his/her nose is pointing at 'The Stamp Collector.****]*** When? *At dawn.* So those of us born at this time of year would be which sign? Right, 'Hobbit.'

You can either end here after doing a quick review, or make it more scientifically accurate by doing the following:

- We can figure out which season each of these constellations represents by making our model more accurate. Who can tell us what causes the seasons on Earth? Right, Earth's axial tilt of about 23.5 degrees. We talked briefly in the planetarium about how Earth is tilted toward the north star. Does anyone know which direction is north in here? ***[****If possible, use the 'real' north; if not, choose north at random.****]***
- Okay, Earth, we're going to get off your nose now and onto this globe. ***[****Put a stick pin into the approximate location of the students' town, then give the Earth volunteer the Earth on a stick.****]*** Your northern axis needs to tilt about 23.5 degrees toward the north star. Now you need to maintain that tilt as we travel around the sun.
- When our town is angled toward the sun ***[****move the volunteer into position to demonstrate this****],*** what season are we experiencing? Yep, summer. When our town is tilted away from the sun ***[****move the volunteer to demonstrate this****]***, what season is it? Right, winter. And on one side of winter is autumn ***[****move the volunteer clockwise from winter****]***, and on the other is spring ***[****move the*

*volunteer to the position opposite autumn in the circle**].*** Earth, let's go.

- Start with the same constellation as for the first part, which in this example is 'Stamp Collector.' Use the axial tilt to figure out which season corresponds to which sign.

VI. Conclusion *(2 to 5 minutes)*

A) Ask students what they have learned today. What is the ecliptic? The zodiac? Precession? What are some of the inconsistencies with 'sun signs' and other astrological beliefs?