

TIME STALKERS

An Original Taylor Planetarium Production

EDUCATOR GUIDE

MUSEUM^{OF} THE ROCKIES

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Dear Educator,

Thank you for choosing to bring your students to the Taylor Planetarium at the Museum of the Rockies (MOR), where our mission is to inspire visitors to explore the rich natural and cultural history of America's Northern Rocky Mountains. A planetarium show is a great way to help your students visualize concepts and spark their curiosity about a new topic.

Studies have shown that learning in museums is not limited to the time spent within their walls, but is heavily influenced by prior knowledge and experiences and continues long after the visit has ended. For these reasons, preparing your students for their planetarium visit and then extending their experience afterward will enhance the educational aspect of the field trip experience.

To aid you in linking this planetarium show to your curriculum, the Museum of the Rockies' Education Department has created this guide. Inside, you will find details on the *Time Stalkers* planetarium show, including vocabulary and state science standards addressed. We have also assembled complementary classroom activities for various grade levels. We hope that these resources will help you prepare pre- and post-visit activities for your students that tie into your curriculum.

MOR is committed to providing the richest possible learning experience for your students and welcomes your questions and feedback. We look forward to seeing you at the Taylor Planetarium at the Museum of the Rockies soon!

Sincerely,

Claire Thoma
Astronomy Education Intern
Museum of the Rockies

Angie Hewitt
Education Director, Early & Elementary Programs
Museum of the Rockies

OVERVIEW

Grades: 6th–12th

Length: 30 minutes

Show Brief: What do clocks have to do with the sky? A detective and his client take a romp through time to uncover the astronomical legacy of the clocks and calendars we use every day, culminating with a space-age view of time in relation to one's frame of reference.

Themes: calendars, clocks, natural cycles (day/night, seasons, lunar)

Program Description:

In this detective novel-style planetarium show, Tess Chronological recruits Sam Stopwatch to help her understand what time is all about. The pair travels through history, discovering how astronomy has shaped time keeping throughout the ages. Historic characters include a caveman, an ancient Egyptian sundial maker, a medieval cleric, an 18th-century astronomer, a modern scientist, and a future space explorer. Time-related topics covered include lunar and solar calendars, sundials, water clocks, stellar transits, standard time and time zones, atomic clocks, and the relative nature of time based on the observer's frame of reference. No matter how sophisticated the timekeeping device, all calendars and clocks are originally based on the spinning earth and cycles in the sky.

Vocabulary:

astronomy	pendulum	meridian	cesium atoms
calendar	atomic clock	Greenwich Mean	microwaves
phases of the	rotation	Time	oscillation
moon/moon cycle	orbit	time zone	frequency
sundial	leap year	Daylight Savings	leap second
water clock	transit	Time	

OBJECTIVES

Students will:

1. Explain how the motions of the sky produce the systems of timekeeping that we observe today.
2. Explain how our timekeeping devices and units of time have been influenced by the ancient Egyptians, Babylonians, and Greeks.
3. Explain the challenges of timekeeping that humans have faced over the millennia.

MONTANA SCIENCE STANDARDS ADDRESSED

End of Grade 8

- 4.5 Describe and model the motion and tilt of Earth in relation to the sun, and explain the concepts of day, night, seasons, year, and climate changes.
- 5.1 Describe the specific fields of science and technology as they relate to occupations within those fields.
- 5.2 Apply scientific knowledge and process skills to understand issues and everyday events.
- 6.1 Give examples of scientific discoveries and describe the interrelationship between technological advances and scientific understanding.
- 6.2 Identify major milestones in science that have impacted science, technology, and society.
- 6.3 Describe and explain science as a human endeavor and an ongoing process.

End of Grade 12

- 5.1 Predict how key factors affect the development and acceptance of scientific thought.
- 5.2 Give examples of scientific innovation challenging commonly held perceptions.
- 5.3 Evaluate the ongoing, collaborative scientific process by gathering and critiquing information.
- 6.1 Analyze and illustrate the historical impact of scientific and technological advances.
- 6.2 Trace developments that demonstrate scientific knowledge is subject to change as new evidence becomes available.
- 6.3 Describe, explain, and analyze science as a human endeavor and an ongoing process.

INTRODUCTION TO CLOCKS

Grades 6–8

BOZEMAN SCIENCE CURRICULUM STANDARDS ADDRESSED:

8th Grade

El.5.1 Students model and explain the motion and tilt of the Earth relative to the Sun, including the concepts of day, night, seasons, and year.

RESOURCES AND MATERIALS:

Activity 1

- Plunger or stick about 10 inches tall
- White poster paper
- Marker

Activity 2

- 1 copy of sun watch template on cardstock for each student
- String

Activity 3

- 2-liter plastic bottle
- Pin, nail, or tack
- Bowl to catch dripping water
- Stopwatch
- Water

PURPOSE:

This discovery exploration lesson allows students to chart the course of the sun over a day to build a sundial and experiment with building an accurate water clock.

OBJECTIVES:

1. Students will observe the movement of the sun over the course of one day.
2. Students will develop or learn to use a sundial.
3. Students will be able to explain how a water clock keeps track of time.
4. Students will be able to discuss pros and cons of using sundials and water clocks.

ACTIVITY 1 – TELLING TIME BY THE SUN: MOVING SHADOW

Attach a plunger or stick about 10 inches tall to a piece of white poster paper so that it is sticking up perpendicular to the plane of the poster. Place the poster and stick somewhere outside where there is sunlight all day long. Do not move it again.

Visit the place five or six different times during the day (once every hour is preferable). Mark the stick's shadow on the piece of paper on each visit, captioning it with the time and being careful not to move the stick or the piece of paper.

The complete observations produce a poster (which can be used as clock in the following days) showing that the length of the shadow and its direction vary as the day goes by. At 12 noon, the shadow will be shorter, and at the beginning or at the end of the day the shadow will be longer. Draw a line, which follows the various registered points.

Lead students in a discussion addressing the following questions: "What produced the stick's shadow?" or "Why did the shadow move?" or "What time was the shadow shorter?"

ACTIVITY 2 – TELLING TIME BY THE SUN: POCKET SUN WATCH

This alternative to the Moving Shadow activity is from the Pacific Science Center's Astro Adventures (Lesson 4: Making a Sun Clock) available at:

http://eu.montana.edu/pdf/outreach/spacescience/astro_ad_sun_clock.pdf

Students make sundials out of cardstock and string and then take them outside to learn how to use them, rather than observing the sun's movement and building a sundial from scratch.

After completing either activity, ask students what they think the advantages and drawbacks to keeping time using a sundial would be. (Some advantages are that a sundial never runs out of batteries or breaks.

As long as the sun is visible, it will cast a shadow on the sundial. Some disadvantages are that the sundial cannot be used when it is cloudy or dark. Sundials do not go on Daylight Savings Time. Days are longer in the summer and shorter in the winter, which might be confusing when reading the sundial.)

ACTIVITY 3 - BUILD A WATER CLOCK

You can find instructions for building a water clock out of a 2-liter bottle online at Science NetLinks available at:

<http://www.sciencenetlinks.com/lessons.php?DocID=2>

Explain that a water clock provides an alternative method of keeping track of time that does not require the sun. This activity may be a demonstration/large group activity or a challenge for small groups of students to engineer the most accurate water clock. After students have explored water clocks, discuss the advantages and drawbacks of this type of timekeeping device.

TYING IT ALL TOGETHER:

Keeping track of time is harder than it seems. Ancient peoples used both sundials and water clocks to keep track of time, but there were challenges involved with using both. How did we get from sundials to digital watches? The *Time Stalkers* planetarium show discusses these and other early methods of keeping track of time and explains how timekeeping methods advanced to those we use today.

SKY TIME

Grades: 6 – 12

**BOZEMAN SCIENCE
CURRICULUM STANDARDS
ADDRESSED:**8th Grade

El.5.1 Students model and explain the motion and tilt of the Earth relative to the Sun, including the concepts of day, night, seasons, and year.

RESOURCES AND MATERIALS:

Email MOR

(visitmor@montana.edu) for a complete list of materials

- Signs of the zodiac
- Sign for Polaris
- East/West cards for each student
- Earth t-shirts/vests/sandwich boards (optional)

PURPOSE:

These lessons will help students understand the motions of the earth that account for the day/night cycle and the seasons.

OBJECTIVE:

Students will embody the earth and learn about earth and sky motions kinesthetically.

ACTIVITY:

Email MOR (visitmor@montana.edu) to obtain a copy of this unit on earth movement and its relationship to units of time. The unit can be completed in full, or specific parts may be selected.

TYING IT ALL TOGETHER:

As discussed in the *Time Stalkers* planetarium show, the day/night cycle and the yearly cycle of seasons form the basis of all calendars and timekeeping devices.

REASONS FOR THE SEASONS

Grades 6–10

BOZEMAN SCIENCE CURRICULUM STANDARDS

ADDRESSED:

8th Grade

El.5.1 Students model and explain the motion and tilt of the Earth relative to the Sun, including the concepts of day, night, seasons, and year.

High School

El.1.0 Students explore the climate and seasons on the Earth and other planets in the Solar System.

RESOURCES AND MATERIALS:

Email MOR

(visitmor@montana.edu) to obtain a complete list of materials

- Copies of worksheets for each student
- 3-inch Styrofoam ball on a stick with a pin stuck in at latitude 45 for each student
- Lamp with a white light bulb
- Flashlights

PURPOSE:

This lesson will help students gain an understanding of how the tilt of the earth's axis causes seasons.

OBJECTIVE:

Students will be able to explain that seasons are caused by the tilt of the earth resulting in longer or shorter days and more or less direct sunlight hitting the surface of the earth.

ACTIVITY

Email MOR (visitmor@montana.edu) to obtain a copy of this lesson that teaches students why we experience seasons on Earth and dispels the misconception that seasons are caused by the Earth moving closer and farther from the Sun. Students will chart the position of the sun at sunrise, noon, and sunset for each season, use Styrofoam balls to model the seasons on earth, and demonstrate how angle of incidence affects the intensity of sunlight.

TYING IT ALL TOGETHER:

As discussed in the *Time Stalkers* planetarium show, the day/night cycle and the yearly cycle of seasons forms the basis of all calendars and timekeeping devices.

HOW MANY DAYS ARE IN A YEAR?

Grades 9-12

BOZEMAN SCIENCE CURRICULUM STANDARDS

ADDRESSED:

High School

HT.3.0 Students describe a scientific or technological innovation that impacts communities, cultures, and societies.

HI.1.0 Students identify scientific contributions made by different cultures. Students identify how scientific developments have impacted human activity and culture.

RESOURCES AND MATERIALS:

Email MOR

(visitmor@montana.edu) to obtain a complete list of materials

- Copies of worksheet for each student

PURPOSE:

Students will gain an understanding of why leap years are used in calendars and how they are calculated.

OBJECTIVE:

Students will calculate how often a leap year is necessary for another planet's calendar by comparing its revolutionary and orbital periods.

ACTIVITY

Email MOR (visitmor@montana.edu) to obtain a copy of this lesson.

After students have viewed the planetarium show and been introduced to the history and purpose of leap years, this math-based activity challenges them to create accurate calendars for imaginary planets.

TYING IT ALL TOGETHER:

In the *Time Stalkers* planetarium show, the historical difficulty of creating an accurate calendar is explored. It is found to be due to the fact that one Earth year is not divisible by an equal number of Earth days, but it took centuries for humans to design a calendar with the proper number of leap years.

FEEDBACK

Please contact the Education Department with any questions, comments or suggestions regarding this curriculum.

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