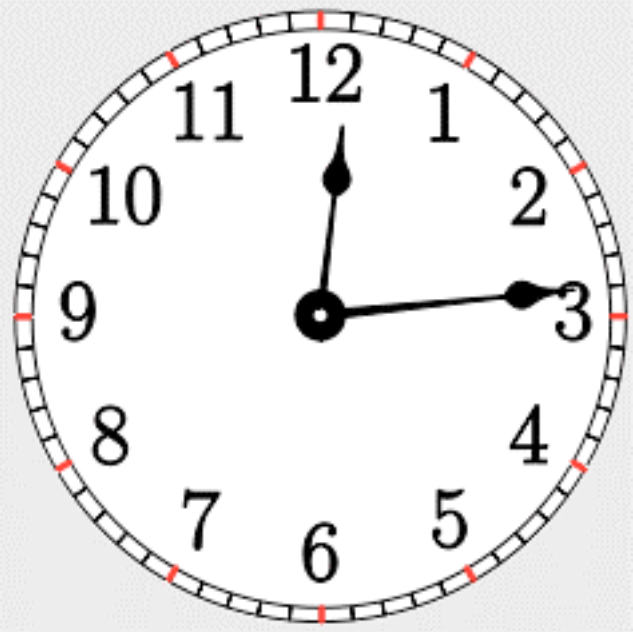
JOURNEY NORTH

A Global Study of Wildlife Migration and Seasonal Change

Mystery Class

Planning Packet #2



Discovering

Time Clues

Teacher's Practice Packet #2:

Discovering Time Clues

Includes:

Overview and Essential Question

As the spring equinox approaches, students will begin to explore information that will help them estimate where Mystery Classes are located east and west of the Prime Meridian. Using clues that focus on sunrise times in Universal Time, students estimate longitude degrees for each Mystery Class. Through this hunt for longitude locations, students gain a greater understanding about the Earth's daily and seasonal cycles.

Teacher Practice Packet#2 includes background information that will help you understand the science and math behind longitude clues, student worksheets that give step-by-step instructions for working with time clues, sample worksheets to use for reference, and the map used for plotting the east/west locations of Mystery Classes. With the information and worksheets you will be able to:

- **Build your understanding** about how students discover information about the Earth's daily and seasonal cycles when they are tracking down the east/west longitude locations of Mystery Classes.
- **Practice the math calculations** students will do to estimate longitudes of Mystery Classes.
- **Examine the data** to find connections and make predictions.
- **Reflect** on questions and prepare for teaching using the Mystery Class journal.

Essential Question

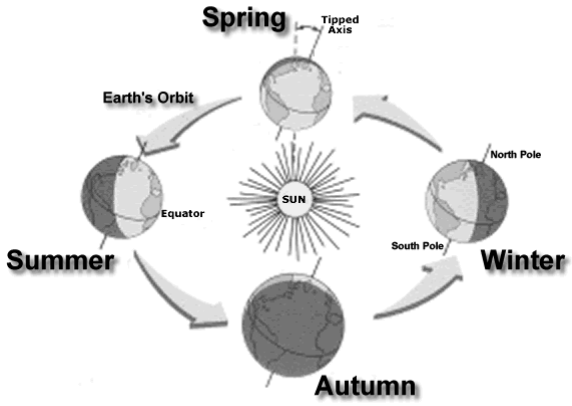
How does Universal Time reveal clues about a location's longitude?

Teacher Background Information
The Science Behind the Time Clues

The following concepts are key to understanding how sunlight clues on the Equinox can reveal information about the longitude of locations on Earth.

Earth's Seasons: Caused by Earth's Tilt on its Axis

The sun stays in its position at the center of our solar system and the Earth revolves around the sun. Seasons occur because the Earth is tilted on its axis. If the Earth were not tilted on its axis, we would not have seasons. The tilt causes sunlight to strike the Earth for different lengths of time at different times of the year. In the Northern Hemisphere, the Earth's axis is tilted away from the sun between our fall equinox and our spring equinox. The axis is tilted toward the sun between our spring equinox and fall equinox. At the time of the equinox (spring and fall), the Earth's axis is **not** tilted toward or away from the sun. At those two times of year only, all places on earth have daylight for equal lengths of time.

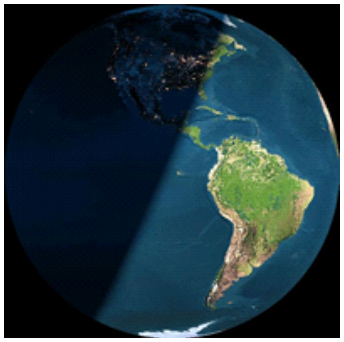


How Longitude is Related to Seasons and Sunlight

The satellite images below depict the Earth at sunrise at two different times of year, on the spring equinox and the winter solstice. Look carefully at the angle of the line between light and darkness.

Spring Equinox

On the spring equinox (March) locations at the same longitude experience sunrise at the same time.



Winter Solstice

On the winter solstice (December) locations at the same longitude **do not** have sunrise at the same time. In this image, notice how much earlier sunrise occurred in the Southern Hemisphere on this winter day! This is because the Northern Hemisphere was tilted away from the sun.

Teacher Background Information:
The Math Behind the Time Clues

How Sunrise Times are Used to Estimate Longitude

Local Time is the time people see on their clocks. Local time is based on the sun's day/night cycle in each of the world's 24 different time zones.

Universal Time (UT) is a measure of world time. It is based on the local time at the Prime Meridian in Greenwich, England (at zero degrees longitude). Universal Time and Greenwich Mean Time (GMT) can be used interchangeably. Universal Time is an international time-keeping standard. We use it to communicate about events that occur at a specific moment. In Universal Time, it is the same time everywhere on Earth.

Time Clues

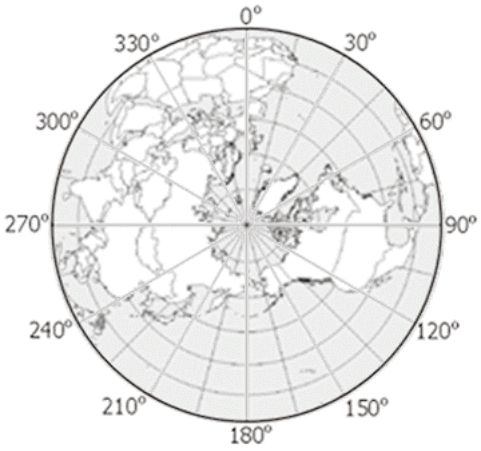
Students will use UT as they ESTIMATE the longitude of the Mystery Classes. On the spring equinox, each Mystery Class will reveal their time of sunrise in Universal Time. Students calculate how long the Earth spins between the time of sunrise at a Mystery Class location and the time of sunrise at Greenwich. The Time Clues Worksheet (pg. 7) helps them walk through the calculations to estimate the longitude locations of Mystery Classes.

Sunrise and Degrees

Think about this: In order for sunrise to occur every place on Earth each day, the Earth must spin 360 degrees every 24 hours. If you hold your globe with the North Pole on top, you can see that the vertical longitude lines (called "meridians") add up to 360 degrees.

Using the following equation, you can figure out how many degrees longitude the Earth turns each hour:

360 degrees divided by 24 hours = 15 degrees longitude per hour.



The Earth spins 360 degrees in 24 hours.

Using a division equation again, you can also figure out how many minutes it takes for the Earth to spin 1 degree longitude:

60 minutes divided by 15 degrees = 4 minutes per degree longitude.

Read through the Time Clues Worksheet (pg 7.) to practice math calculations, using the two samples provided (pg. 8 and 9) as models.

The Mystery Class Journal: Reflecting on the Data

Use your practice experience to prepare for teaching.

We encourage you to capture your thoughts as you explore the longitude information and worksheets in this practice packet. What observations, questions, discoveries, and teaching ideas did you make as you calculated, recorded, graphed, and examined the data? Think about ways to share your "captured thoughts" with students to model and guide their investigation.

- Jot down possible journal questions you would use to encourage thoughtful reflection.
- Explore Mystery Class Journal pages: http://www.learner.org/jnorth/tm/mclass/JournalSpring.html

Mystery Class Journals for Students

When longitude clues for this year's Mystery Classes are revealed at the time of the spring equinox (March 20), students will be asked to make connections to how the clues reveal information about the Earth's daily and seasonal cycles. Examining and reflecting on the data is essential. Watch for journal questions specific to time clues in Mystery Class updates. The journal questions invite students to identify patterns, make predictions, compare/contrast findings, and pose possible explanations for results. Mystery Class journals work side-by-side with your students' worksheets filled with time clues and data. Helpful tip: when possible encourage students to view satellite images of the rotating Earth as you work on Longitude Clues worksheets and journal pages.

Sample Journal Questions

- Why are the time clues revealed at the time of the spring equinox? (Posing explanations)
- How are time clues connected to the vernal equinox? (Posing explanations)
- Which sites have similar photoperiods during the spring equinox? (Comparing/contrasting)
- Which sites are located east of the Prime Meridian? What data reveals which Mystery Classes are east and west of the Prime Meridian? (Identifying patterns and analyzing data)
- How do you think the hours of daylight will change in the next couple of weeks? (Making predictions)
- What information/data/results surprised you this week? (Posing explanations for unexpected results)

Time Clues: **Equinox Sunrise Table**

Mystery Class 2009

Sunrise on the Equinox

The sunrise times below are a clue to the **approximate longitude** of each Mystery Class site. Print this page and use with the **Map (pg. 10)** and **Time Clues Worksheet (pg. 7).**

Mystery Class	**Time (and Date) of Sunrise** Universal Time
# 1	**05:25 (March 20)**
# 2	**05:37 (March 20)**
# 3	**22:02 (March 19)**
# 4	**03:53 (March 20)**
# 5	**16:06 (March 20)**
# 6	**21:06 (March 19)**
# 7	**08:34 (March 20)**
# 8	**23:05 (March 19)**
# 9	**20:48 (March 19)**
# 10	**12:09 (March 20)**

Time Clues Worksheet 2009

Mystery Class #_____ Name: _____

1. **FACT: Greenwich, England is at 0 degrees longitude.**
Mark the location of Greenwich, England on the map.

2. **FACT: The sunrise time is 06:03 A.M. (UT) in Greenwich, England on the spring equinox** (March 20, 2009). Write the sunrise time beside 0 degrees longitude on the map.

3. The sunrise time is _____(UT) on _____ (date) at this Mystery Class location on the spring equinox. (See Equinox Sunrise Table, pg 6.)

4. The difference between UT sunrise time at this Mystery Class and UT sunrise time at Greenwich, England is _____ hours and _____ minute(s).
(**CAUTION!** Remember that hours and minutes are not in decimal form, and pay attention to the date of the UT sunrise time too. This may not be a simple subtraction or addition equation for your Mystery Class site. Think about your answer!)

5. **FACT: The Earth turns to the east as it spins.**
The Earth will spin for _____ minutes between the sunrise time at Greenwich and the sunrise time at this Mystery Class location.
(Clue: convert your answer in #4 above to minutes.)

6. **FACT: The Earth spins 1 degree longitude every 4 minutes.**
I estimate the longitude of this Mystery Class to be _____degrees away from Greenwich.

7. This Mystery Class is _____ (East or West) of Greenwich.

Sample #1

Time Clues Worksheet 2009

Mystery Class #3 Name: Sample Number One

1. **FACT: Greenwich, England is at 0 degrees longitude.**
Mark the location of Greenwich, England on the map.

2. **FACT: The sunrise time is 06:03 A.M. (UT) in Greenwich, England on the spring equinox** (March 20, 2009). Write the sunrise time beside 0 degrees longitude on the map.

3. The sunrise time is 22:02 (UT) on March 19 (date) at this Mystery Class location on the spring equinox. (See Equinox Sunrise Table, pg 6.)

4. The difference between UT sunrise time at this Mystery Class and UT sunrise time at Greenwich, England is 8 hours and 1 minute(s).

(**CAUTION!** Remember that hours and minutes are not in decimal form, and pay attention to the date of the UT sunrise time too. This may not be a simple subtraction or addition equation for your Mystery Class site. Think about your answer!)

5. **FACT: The Earth turns to the east as it spins.**
The Earth will spin for 481 minutes between the sunrise time at Greenwich and the sunrise time at this Mystery Class location. (Clue: convert your answer in #4 above to minutes.)

6. **FACT: The Earth spins 1 degree longitude every 4 minutes.**
I estimate the longitude of this Mystery Class to be 120.25 degrees away from Greenwich. (481 minutes/4 minutes per degree = 120.25 degrees.)

7. This Mystery Class is East (East or West) of Greenwich.

Sample #2

Time Clues Worksheet 2009

Mystery Class #10 Name: Sample Number Two

1. **FACT: Greenwich, England is at 0 degrees longitude.**
Mark the location of Greenwich, England on the map.

2. **FACT: The sunrise time is 06:03 A.M. (UT) in Greenwich, England on the spring equinox** (March 20, 2009). Write the sunrise time beside 0 degrees longitude on the map.

3. The sunrise time is 12:09 (UT) on March 20 (date) at this Mystery Class location on the Spring Equinox. (See Equinox Sunrise Table, pg 6.)

4. The difference between UT sunrise time at this Mystery Class and UT sunrise time at Greenwich, England is 6 hours and 06 minute(s).

(**CAUTION!** Remember that hours and minutes are not in decimal form, and pay attention to the date of the UT sunrise time too. This may not be a simple subtraction or addition equation for your Mystery Class site. Think about your answer!)

5. **FACT: The Earth turns to the east as it spins.**
The Earth will spin for 366 minutes between the sunrise time at Greenwich and the sunrise time at this Mystery Class location. (Clue: convert your answer in #4 above to minutes.)

6. **FACT: The Earth spins 1 degree longitude every 4 minutes.**
I estimate the longitude of this Mystery Class to be 91.5 degrees away from Greenwich. (366 minutes/4 minutes per degree = 91.5 degrees.)

7. This Mystery Class is West (East or West) of Greenwich.

Map for Plotting Mystery Class Longitude Estimates