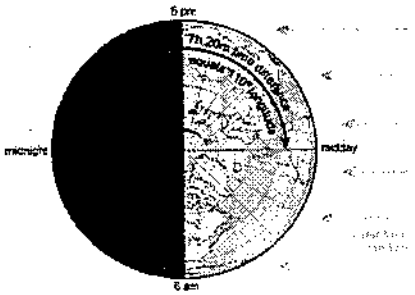

TIME EQUALS LONGITUDE

AIM: What causes time to be different in various locations around the world?

How do longitude and time work together?

Introduction

Imagine you are a ship at sea, miles from any land that would help you get a reference point. In the Northern Hemisphere, early mariners used the North Star, Polaris, to find their way. Observing Polaris in the night sky helped them find the direction north or south. Finding longitude, or how far you are east or west of a known point, is a far more complicated process. Solving the longitude problem was possibly the greatest scientific challenge of the 17th and 18th centuries. It was vitally important that mariners could find their way safely across the oceans. Many sailors lost their lives when their captain was unable to correctly locate where they were on a map. This caused ocean voyages to take longer than their supplies of food and water lasted. In other cases, ships ran aground and sunk when land suddenly appeared that was not expected.

INSTRUCTIONS

1. Look at **Side A** of the sheet (pasted on cardboard or Plexiglas.) You should see a polar view of the Earth with the hours of the day spiraling around it.

2. Place the globe on the Plexiglas or cardboard sheet over the center of the polar view map of the world (**Side A**). The polar view diagram shows Earth as seen from above the North Pole. The curved arrows show the direction of Earth's motion – west to east (counterclockwise). The shaded portion represents the nighttime side of the Earth. The lines you see radiating out from the center (like spokes on a bicycle wheel) are lines of **LONGITUDE**.

3. Cut out 4 paper figures. On the globe provided:
   a. Attach 1 figure on Greenwich, England (51° N, 0°) **This person is located on the PRIME MERIDIAN**
   b. Attach 1 figure on New York, NY (40° N, 75° W)
   c. Attach 1 figure on Bogotá, Colombia (4° 38' N, 75° W)
      These 2 people are located on the same line of longitude
   d. Attach 1 figure on San Francisco, CA (38° N, 120° W)

4. Orient the person on the Prime Meridian with the 12:00 a.m. line on the sheet. This line is in the nighttime side of the Earth.

5. Turn on your flashlight (aka sun's rays). The person at Greenwich, England on the Prime Meridian is probably sleeping at midnight.

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6. Rotate your Earth counterclockwise until your person has experienced one complete day on Earth.

7. What hour should your person end up on in order to complete a one day trip?_____

8. How many degrees do you have to rotate the Earth in order to complete a one day cycle?_____ (think circle/sphere geometry here!)

9. How many total hours does it take for a person to make a one day trip?_____ (think of the number of hours in a day)

10. Using the values from questions 8 & 9, what is the rate of change of the Earth's rotation? (in degrees per hour.)

a. Write the Rate of Change formula (pg 1 ESRT):

Rate of Change = _____

b. Plug in your numbers from 8 & 9 into the formula above:

Rate of Change = _____

c. Calculate the rate of change and write the proper units:

11. Now we will check our answer in #10. You will be provided with a protractor. Use it to measure the angle between any two lines of longitude on your ditto of the Earth's polar view (side A.)

How many degrees did you measure?_____

12. Notice that this measurement covers 2 hours of time.
Now calculate: one hour = how many degrees of longitude?_____

13. If you have done your measurements and math correctly, your answer in #12 should match the answer you have in #10. Does it?

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PART 2

Use your globe, flashlight, and figures on it to answer the following questions.

What time is it when a line of longitude (and the figure on it):

1. Is directly facing the rays of the Sun?_____
2. Is directly opposite the rays of the Sun?_____
3. Is first starting to turn into the rays of the Sun? (this is sunrise)_____
4. Is first starting to turn away from the rays of the Sun? (this is sunset)_____

Rotate your globe so that the figure in Greenwich, England is at the sunrise position.

5. Has sunrise occurred yet for the New York and San Francisco figures?_____

6. Who will experience sunrise after Greenwich England? New York or San Francisco?

_____

7. Who will experience sunset last? Greenwich, NY, or San Francisco?_____
Why is this the case?_____

Put your NY figure at the 12 noon location (and imagine this person is eating lunch then.)

8. Name 2 countries where a person might be having a midnight snack at the same time as the New Yorker is having lunch:

_____ and _____

These are also countries that are experiencing sunrise while NY is experiencing

_____

How many degrees apart is NY and these countries?_____

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PART 3

Orient your globe so that the person in Greenwich is experiencing midnight.

Slowly turn your globe counterclockwise until the person is on the 2:00 a.m. line.

1. How many hours have passed since 12:00 a.m.? _____
How many degrees has the earth rotated since 12:00 a.m.?
(15° of longitude = 1 hour) _____

2. Continue to turn your globe until the Greenwich person is on the 6:00 a.m. line.
How many hours have passed since 12:00 a.m.? _____
How many degrees has the earth rotated? _____

3. New York and Bogotá, Colombia are on the same line of longitude. Keeping your eyes on New York and Bogotá, continue to slowly turn your globe. What observations can you make about persons on the same line of longitude? _____
_____

4 Based on your observations is the following statement true or false?
Cities located on the same longitude must have the same solar time.

5 Remove the globe from the diagram. Notice Point A and Point B on the polar view diagram. Point A's position is on the 12:00 p.m. noon line. Point B is on the 4:00 p.m. line. You can calculate the longitude difference between the 2 points if you know the local time at both locations. Your longitude will be this time difference multiplied by 15° per hour.
Calculate the difference in longitude between Point A and B _____

Part 4

1. Turn over your Plexiglas sheet. (Diagram is below also)
This diagram shows Earth as seen from above the North Pole. The curved arrows show the direction of Earth's motion – west to east (counterclockwise). The shaded portion represents the nighttime side of the Earth. Some of the latitude and longitude lines have been labeled. Points A and B represent locations on Earth's surface.

What is Point A's location? (latitude and longitude) _____
What is Point B's location? (latitude and longitude) _____

Does latitude determine time? (yes or no)
If we are asked to determine the time at Point A and Point B, does it matter that one location is at different latitude than the other? yes or no

Remember TIME = LONGITUDE

2. What is difference in longitude between the 2 points? _____

3. What is the time difference in hours between the 2 points? _____

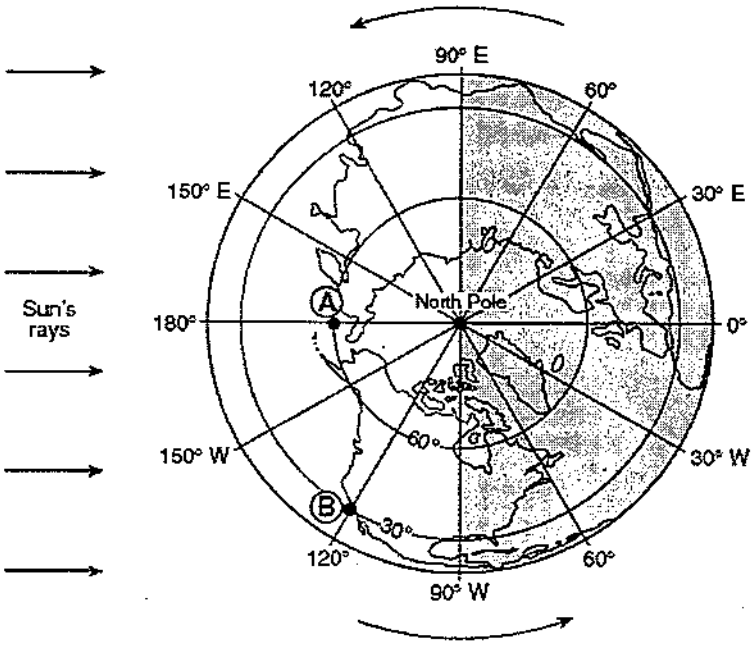
4. If it is 1 p.m. at Point A, what time is it at Point B? Earth rotates west to east. Time in the east will be ahead of the time in the west.
EAST – INCREASE (time is later)
WEST – LESS (time is earlier)

Is Point B west or east of Point A? _____

Do you add or subtract the time difference in hours you calculated in question 2?

_____

Point A's time is 1:00 p.m. Point B's time is _____



Challenge: (are you up to it?)

Point A's time is 11:00 p.m. Point B's time is 3:00 am
Point B's time is 3:00 a.m. Point A's time is 11:00 pm
Point A's time is 8:00 p.m. Point B's time is 12 am
Point B's time is 1:00 a.m. Point A's time is 9:00 pm