

I. Objectives

1. Use the functions of a software geochron, *Home Planet*.
2. Compare the number of hours of daylight and darkness in the northern and southern hemispheres on the equinoxes and solstices.
3. Calculate the number of hours of daylight and darkness at your location today and on the equinoxes and solstices.
4. Estimate sunrise and sunset locations and meridian transit altitude.

II. Introduction

The word geochron is a combination of "geo," meaning earth and "chron," meaning time. A geochron is an instrument that simultaneously displays a map showing the time and the extent of daylight and darkness throughout the world. Using the geochron we can trace the apparent path of the Sun as it moves across the sky at any time of the year.

III. Materials

Home Planet software

IV. Theory and Calculations

1. The number of hours of daylight received at a particular location on Earth can be calculated from:

$$\text{hours of daylight} = 12 + \sin^{-1}(\tan d \tan \varphi)$$

where d is the declination of the Sun and φ is the observer's latitude. We will use this formula to calculate the number of hours of daylight today and on the equinoxes and solstices.

2. The Sun is not circumpolar. We can calculate where it rises, its meridian transit altitude and where it sets using following information:
 - if $d = 0^\circ$ then it is on the celestial equator, rises directly east, crosses the meridian at an altitude of $90^\circ - \varphi$, and sets directly west;
 - if $d > 0^\circ$ then it rises north of east, and sets north of west;
 - if $d < 0^\circ$ then it rises south of east, and sets south of west.
3. At your latitude the sun reaches meridian transit at an altitude of $90^\circ - \varphi + d$.

V. Prelab Definitions

1. geometry
2. geology
3. geography
4. chronology
5. chronograph
6. chronometer
7. circumpolar
8. equinox
9. solstice
10. meridian transit
11. latitude
12. altitude

VI. Prelab Questions

1. On which date is the spring equinox this year?
2. On which date is the summer solstice this year?
3. On which date is the autumnal equinox this year?
4. On which date is the winter solstice this year?

VII. Lab Procedure

1. Write the dates for spring equinox, summer solstice, autumnal equinox and winter solstice for this year in row A of the *Daylight Calculation Results for Equinoxes, Solstices, and Today* table.
2. Write today's date in the last column of row A.
3. Start up the *Home Planet* software. Click on Edit, then click on Set Observer's location. Use the mouse to scroll the box until your location appears. Click on your location. Click OK.
4. Estimate the amount of daylight and darkness in the northern and southern hemispheres for the equinox and solstice dates and today's date, and enter your estimates in row B.
4. Click on Edit, then click on Set Universal Time. Enter the current year, press the tab key, click on the down arrow, enter the date and time for the spring equinox, click OK. Note the amount of daylight and darkness in the northern and southern hemispheres, and enter it in the table in the estimated daylight hours in row B.
5. Follow the instructions in step 4 and set *Home Planet* for the date and time of the summer solstice. Observe the amount of daylight and darkness in the northern and southern hemispheres.
6. Follow the instructions in step 4 and set *Home Planet* for the date and time of the autumnal equinox. Observe the amount of daylight and darkness in the northern and southern hemispheres.
7. Follow the instructions in step 4 and set *Home Planet* for the date and time of the winter solstice. Observe the amount of daylight and darkness in the northern and southern hemispheres.
8. Make sure your calculator is set to degrees, not radians. You can check by calculating $\sin 45$. If the calculator displays an answer of approximately 0.707 then your calculator is set to degrees and you need not change the setting. If the calculator gives you an answer of approximately 0.850 then it is set to radians and you will need to change the setting to degrees.
9. Your instructor will provide you with the declination of the Sun for today's date. Write it in the last column of row D.
10. Calculate the values for rows E, F, G, H, I, J, K, and L.
11. Determine sunrise location for each date and complete row M. The possible answers are directly east, north of east, or south of east.

12. Determine meridian transit altitude for each date and complete row N using the information provided in the Theory and Calculations section of this lab.
13. Determine sunset location for each date and complete row O. The possible answers are directly west, north of west, or south of west.

Daylight Calculation Results for Equinoxes, Solstices, and Today

		Spring equinox date:	Summer solstice date:	Fall Equinox date:	Winter solstice date:	Today's date:
A	equinox and solstice dates	March 21	June 21	Sept. 23	Dec. 22	
B	estimated daylight hours					
C	latitude ϕ in decimal degrees					
D	solar declination d in decimal degrees	0°	23.5°	0°	-23.5°	
E	$\tan d$					
F	$\tan \phi$					
G	E x F					
H	$\sin^{-1}(G)$					
I	$H \times \frac{\pi}{180}$					
J	$I \times \frac{24}{\pi}$					
K	hours of daylight = J + 12					
L	hours of daylight in h m					
M	sunrise location					
N	meridian transit altitude					
O	sunset location					

VIII. Lab Discussion

1. Explain why all points on Earth don't receive the same number of hours of daylight during the day.

2. Explain why all points on Earth don't receive the same number of hours of daylight during the year.

3. Why might astronomers need to know how many hours of daylight there are on a certain date? How might this affect their observing activities?

4. Who else might need to know how many hours of daylight there are on a certain day? Why?

5. Explain why there is a difference in the meridian transit altitude of the Sun at different times of the year.

6. When are the meridian transit altitudes the same? Explain why this situation occurs.

7. Which location receives more daylight on the summer solstice, your location or Alaska?

8. Which location receives more daylight on the winter solstice, your location or Alaska?