Participants: _____ and _____

The Analemma

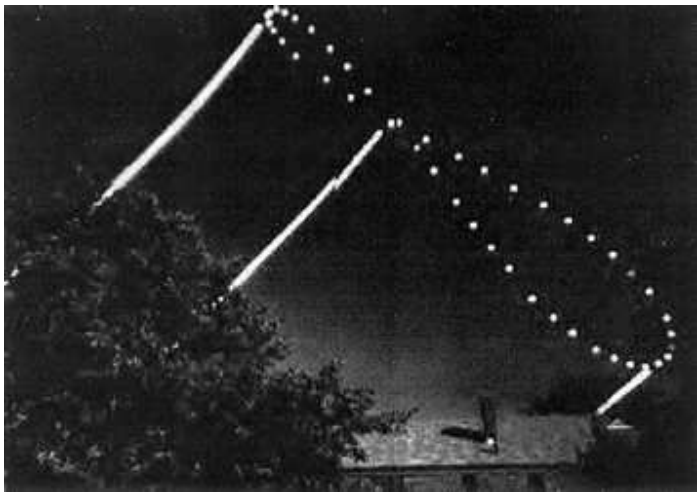

Photo Credit: Dennis di Cicco

By this point in your life, you have most likely noticed the Sun slowly and continuously changing its position in the sky throughout the year. The very unusual photo of the Sun was created by exposing a single piece of film a total of forty-five times throughout the course of a year. This "Figure 8" shape, referred to as an analemma, was traditionally included on older globes of the world, positioned directly between latitude +23.5° and –23.5°. This pattern is a result of the tilt of the ecliptic to the equator and the Earth's elliptical orbit about the Sun.

The course of the Sun during a period of one full year has been plotted onto the grid in Figure 1. The actual dates represented by the dots appear in Table I found on page 3. The vertical, indexed line represents the meridian, an imaginary line stretching from pole to pole crossing directly above the observer's head.

The Earth actually changes speed as it orbits the Sun, whereas clock time remains constant. The values appearing on the horizontal, indexed line at the center reflect the number of minutes the sun is either ahead or lagging behind the time indicated on one's watch or clock.

Unlike the analemma appearing in Figure 1, analemma nearly always include the dates. The Sun's declination may be estimated for any given day of the year using the analemma as a miniature almanac. The number of minutes the sun lags behind or is ahead of clock time may also be determined using the analemma.

Note: The dates on this grid refer to the analemma as it appears in the sky, not as it would appear using a stick and shadow observation.

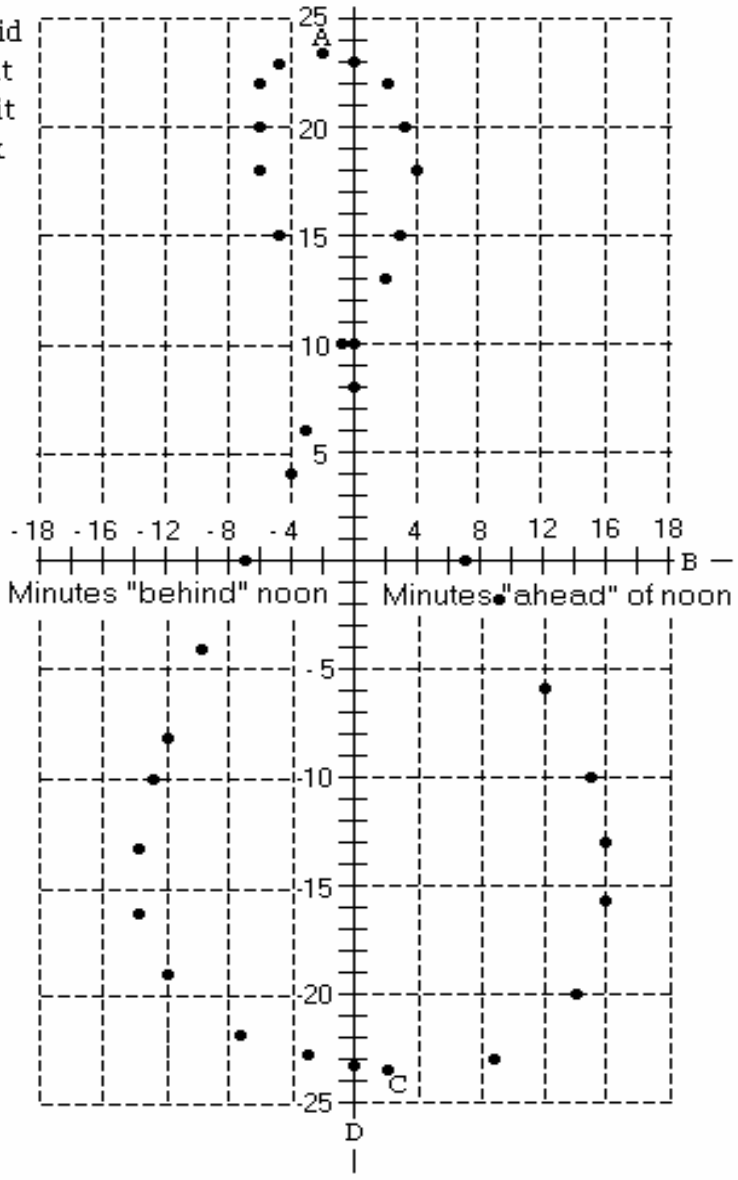

Figure 1: The Sun's Declination vs. Time

Data Source for this page and Table I on Page 3: *Astronomy for All Ages: Discovering the Universe through Activities for Children and Adults* by Philip Harrington and Edward Pascuzzi. The Globe Pequot Press. [A few dates were modified.]

Table I

DATE	MINUTES THE SUN IS AHEAD OR BEHIND +/-	DECLINATION
January 1	-3	-23°
January 10	-7	-22°
January 25	-12	-19°
February 4	-14	-16°
February 14	-14	-13°
February 24	-13	-10°
March 1	-12	-8°
March 11	-10	-4°
March 21	**-7**	**0°**
March 31	-4	4°
April 5	-3	6°
April 15	**0**	**10°**
April 25	2	13°
May 1	3	15°
May 11	4	18°
May 21	3	20°
June 1	2	22°
June 15	**0**	**23°**
June 22	**-2**	**23.5°**
July 7	-5	23°
July 13	-6	22°
July 23	-6	20°
August 2	-6	18°
August 13	-5	15°
August 28	-1	10°
September 3	**0**	**8°**
September 21	**7**	**0°**
September 28	9	-2°
October 8	12	-6°
October 19	15	-10°
October 29	16	-13°
November 8	16	-16°
November 22	14	-20°
December 7	9	-23°
December 22	**2**	**-23.5°**
December 27	**0**	**-23.25°**

1. Connect the dots in Figure 1 to form the pattern created by the Sun's apparent path across the sky throughout the year. Your figure will be similar to the photo on page 1.
2. Consult Table I on page 3 of this activity to assist in identifying and labeling the dots appearing on the analemma with the following dates: 6/15, 9/21, 3/21, 12/27, 4/15, 6/22, 9/3 and 12/22. These particular dates have been **highlighted** on Table I.
3. On the line you have drawn, place arrowheads at six widely separated intervals [your choice] to indicate the direction of the Sun's apparent motion across the sky.
4. With you finger, trace the figure you have drawn. How often during the course of each year are the Sun and time keeping devices in sync [perfectly matched]? _____
5. On the line preceding the description, enter the **month and day** [m/d] on which each of the special events occurs. Dates may be used more than once.

   _____ All dates when the Sun and time keeping devices <u>are in sync</u>

   _____ Summer solstice

   _____ Fall equinox

   _____ Day with the **most** hours of sunlight in the Northern Hemisphere

   _____ Winter solstice

   _____ Spring equinox

   _____ Day with the **least** hours of sunlight in Northern Hemisphere
6. Identify the points labeled A, B and C on the analemma matching the positions of their corresponding lines on globes of the world. Also identify the point labeled "D" whose position is referenced to the point located directly above the observer's head.

   A _____ C _____

   B _____ D _____