Lab A-3: Orbit of the Earth

Purpose: 1. To plot the orbit of Earth around the sun.
2. To calculate some orbital data for the Earth.

Discussion: In order for Kepler to determine the orbit of Mars, he had to first reconcile the orbit of the earth. He used some observational data of Mars and the sun to make triangulations to find the orbit of the earth. He could not calculate the actual distance to the sun, but he could find relative positions. In this lab, you will follow along the spirit of what Kepler did and make a plot of the orbit of the earth around the sun. In the next lab, you will make a plot of the orbit of Mars around the sun.

It takes Mars 687 days to go around the sun exactly one time. This means that every 687 days, Mars is in the same place. If we take readings of the sun and mars over a long series of observations, each 687 days from the previous, we can triangulate the earth's position from these "fixed" points.

Procedure:
Use a pencil to do this! Part of your grade is the neatness of your orbit!

1. The data for October 2, 1950 was used to create the separate handout on which you will draw your orbit. On that date, Mars was in opposition with the sun. Since we know where the sun is on that date, we know the direction to Mars on that date, but not its actual distance from the earth. It will allow us to set up an arbitrary scaled orbit of the earth however.
2. Use the rest of the data to triangulate from the sun and Mars to find successive positions of the earth. Clearly mark each position of the earth. Leave the triangulation lines on the paper. Write the date (not including year) next to each earth position. (Note: there is no data on April 9 because Mars is too close to the sun to accurately measure its position.)
3. When you have plotted all your positions, use a compass to sketch in the best circle for the orbit. The center will not be exactly on the sun – put an X where you find the center.
4. **On your plot, use a ruler to draw in the major axis. Mark and label the following on the orbit: major axis, sun, mars, perihelion, aphelion, and each earth position. Calculate the perihelion and aphelion distance in AU and the eccentricity of the orbit.**

Data:

Date	*Position of Sun (longitude degrees)*	*Position of Mars (longitude degrees)*
10/2/50	189°	9°
8/19/52	146°	56°
7/6/54	104°	47°
5/23/56	61°	30°
4/9/58	*no data*	*no data*
2/25/60	336°	355.5°
1/11/62	291°	338°
11/29/63	247°	326°
10/15/65	202°	342°
9/1/67	159°	53°

Conclusions: *(Do these right on your plot.)*

1. What does it mean when a planet is in opposition with the sun?
2. Why are the readings every 687 days?
3. How did Kepler know that it took Mars 687 days to go around the sun? (Also show the appropriate calculation.)
4. Why do you think there is no data for April 9, 1958?