



For every 15° Earth moves  
Mars moves 8°

Fill in positions  
4-14.

More West →

← More East

# Retrograde Motion Construction

## *Copernican, Sun-Centered Understanding*

Ptolemy's Almagest used epicycles and his understanding was the dominant understanding from his lifetime (100-170) until past Copernicus (1473-1543) when Galileo (1564-1642) settled the issue with telescopic observations. In this construction, you will discover how the Copernican model accounts for retrograde motion. Kepler (1571-1630) massively improved on Copernicus by realizing that the planets followed ellipses, but you can understand retrograde motion with circles.

### Directions:

1. Mars: On the attached sheet, **carefully** mark equally-spaced movements for Mars. Mars goes about  $8^\circ$  around the Sun every two weeks. You need to measure the spacings and then make more equal spacings. M1 and M2 were done by computer. M3 shows how to continue by hand. You do M4-M14.
2. Earth: **Carefully** mark equally-spaced — but larger — movements for Earth. Earth goes further around the Sun every two weeks. It's about  $15^\circ$ . By computer, E1 and E2 have been marked. E3 shows how to continue by hand. You do E4-E14.
3. For steps 1 and 2, the most important thing to get right is equal spacings for each Mars movement and the equal but larger spacings for each Earth movement.
4. The next part of the geometrical construction is to see where Mars appears to be in front of the distant stars. By computer I have shown P1, which is where M1 appears to be in the stars when Earth is at E1, and P2, which is where M2 appears to be when Earth is at E2. Using a straight edge, I have shown P3, which is where M3 appears to be when Earth is at E3.
5. You continue by showing P4-P14, which is where M4-M14 appear to be when Earth is at E4-E14.
6. Do you see and understand retrograde motion from your diagram? If not, compare your diagram with a classmate who does claim to see and understand it.
7. Hold the construction up so that the stars are along the ecliptic. I will demonstrate what I mean by this.
8. Using your construction, and holding it up as demonstrated, answer the following questions. Most of the time Mars moves \_\_\_\_\_ through the stars, and this is called prograde motion.
9. For a brief time, Mars moves \_\_\_\_\_ through the stars, and this is called retrograde motion.
10. Each step in the construction represents two weeks, so Mars is retrograde for about \_\_\_\_\_ weeks.