

Retrograde Motion of Mars

Activity: plotting the path of Mars through the constellations

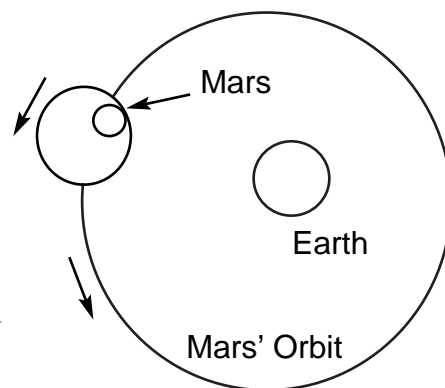
Materials: Mars Motion in 1971 and Explaining Retrograde Motion of Mars (pages 69 and 70)

Background

Ancient astronomers (astrologers) mapped the positions of planets moving gradually through zodiac constellations. They saw that planets moved across the sky from east to west each day. However, they also slipped eastward throughout the year. Since astronomers believed the planets were traveling around Earth, they assumed the paths would always move eastward, like the sun. What they observed was very different. The planets did move eastward, but from time to time they would slow down, stop, and then begin moving westward. Gradually, they would slow down again until they stopped and resumed their eastward motion again. Thus, they appeared to be making loops in their paths. The loops varied in size with each planet, and not every planet was looping at the same time. This was finally explained by the theory that the planets were traveling around Earth within their own circular orbits, called *epicycles*.

Later, it was proved that the planets revolve around the sun, not Earth. Now, a different explanation for this backwards, or *retrograde*, motion was needed.

Mars will be used as the example in this activity to show students what the retrograde loop looks like when plotted against the constellations and why we see this happening.



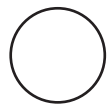
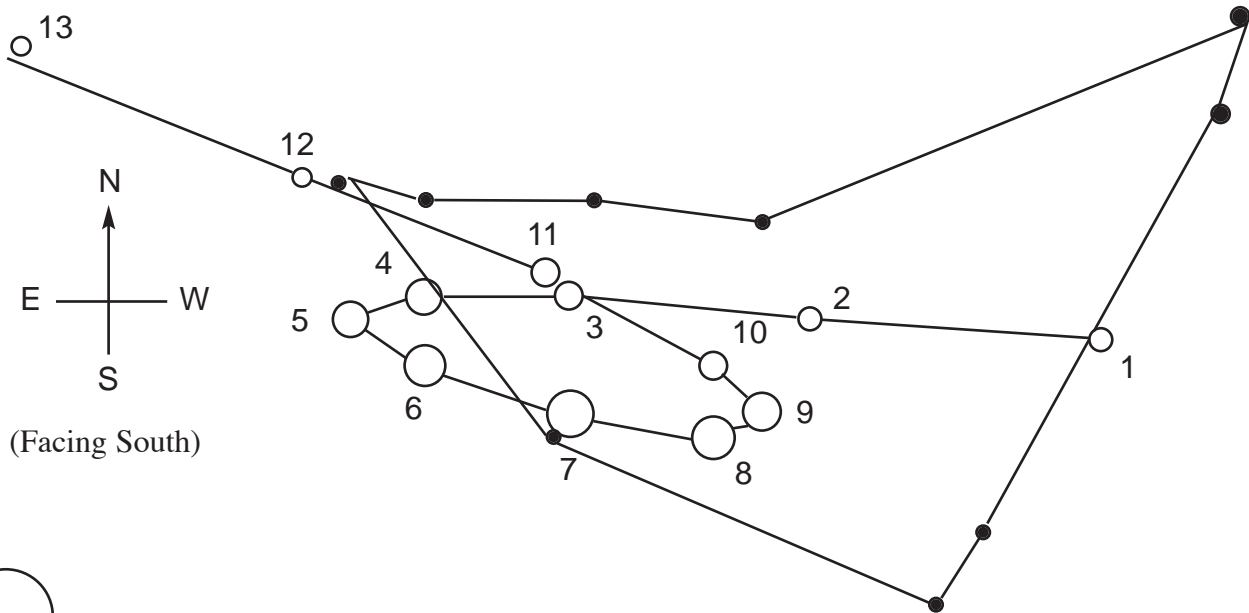
- Make transparencies of Mars Motion in 1971 and Explaining Retrograde Motion. Cut and assemble the latter according to the instructions.
- Show the transparency of Mars Motion in 1971. Read the information about the diagram.
- Have students refer to drawing and chart to answer the following:
 1. (*Trace the path of Mars from #1 to #13.*) Look at the path. What is the direction of Mars from #1 position to #4? (*eastward*)
 2. Describe what happened after that. (*The planet began to move westward after #5 until #9 when it began to move eastward again.*)
 3. Was there any change in Mars' appearance at this time? (*Yes, it increased in size from #1 to its largest size on August 11 at position #7. It then began to become smaller*)
 4. What happened to its brightness? (*Mars became brighter as it grew in size and then dimmer as it reduced in size.*)
 5. Why would Mars change in size and brightness? (*As it gets closer to Earth, it would appear to increase in size and brightness.*)
- Show the students the transparency of Explaining Retrograde Motion of Mars. Point out the orbits of Mars and Earth are not centered on the sun. Show that Mars takes longer than 12 months to make one complete trip around the sun. Place a finger from each hand on the position 1 for both planets. Rotate Earth's orbit, keeping your fingers moving to 2. As you do this for all positions, pause to analyze the distances and direction of Mars. Notice that Mars appears to lag behind Earth (retrograde) from 4 until 10, after which Mars begins to catch up with Earth again.

Have the students find where Mars appears brightest (4 or 5). Dimmest (12).

Mars Motion in 1971

During the summer of 1971, Earth passed closer to Mars than it had since 1924. Not until 2003 will our planet be closer to Mars than it was in August 1971.

CAPRICORNUS



Open circles show the positions of Mars in the constellation Capricornus, beginning May 13, 1971. Stars are solid black circles; their sizes indicate their brightness.

Sizes of the open circles indicate the changing size of Mars as seen through a telescope. Mars also became brighter as it increased in size. The numbers by or in the circles correspond to the dates listed below.

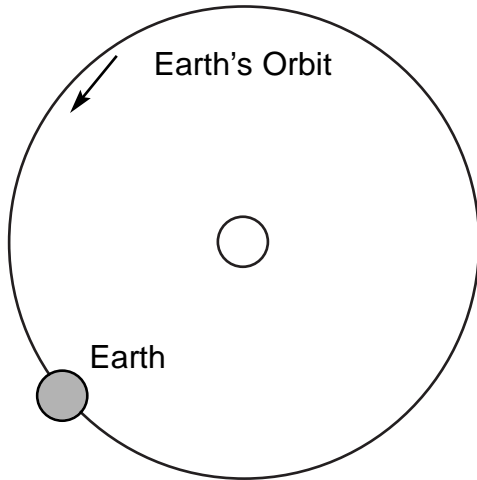
Number	Date	Distance from Earth	Apparent Magnitude (*Brightness)
1	May 13	75 million miles	-0.4
2	May 28	64	-0.7
3	June 12	55	-1.2
4	June 27	47	-1.6
5	July 12	41	2.1
6	July 27	36	-2.4
7	August 11	35	-2.6
8	August 26	36	-2.4
9	September 10	40	-2.1
10	September 25	46	-1.6
11	October 10	54	-1.2
12	October 23	63	-0.6
13	November 9	72	-0.5

*The higher the negative number, the brighter Mars appeared.

Explaining Retrograde Motion of Mars

Instructions

1. Make a transparency of this page.
2. Cut along the dotted line.
3. Cut out Earth's orbit, being sure not to cut away the circle or the planet.
4. Superimpose the circle in the center of Earth's orbit over the sun. Use tape to hold the two images in this position.
5. Place the transparencies over the hole of a tape dispenser so the dots are in the center of the hole.
6. Push the awl through the dots to make a hole large enough to insert the snap. Be sure there is enough clearance so that Earth's orbit can be turned freely around the sun.



Cut along this line.

Retrograde Motion of Mars as Seen from Earth

