Name _____ Date _____

Chapter 27 Lab Activity

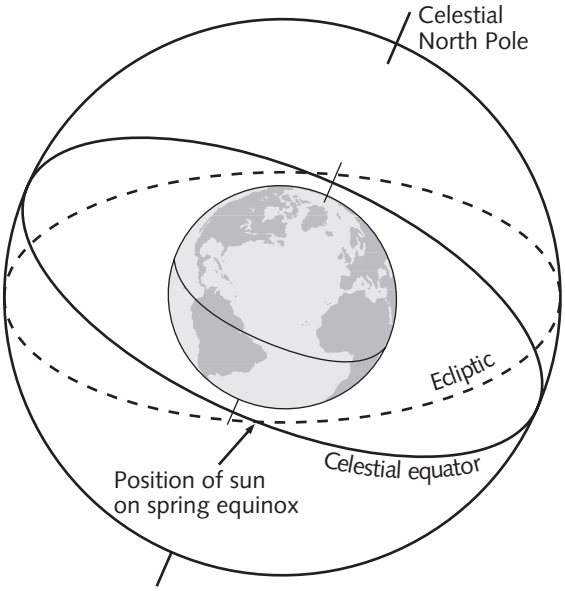
Retrograde Motion of Mars

The **celestial sphere** is the imaginary dome of the sky on which the sun, stars, and other objects appear to be located. Like objects on Earth's surface, locations of objects on the celestial sphere are described using imaginary lines and points. The celestial equator is a circle in the sky directly above Earth's equator. The celestial poles are the points in the sky directly above Earth's North and South poles.

Declination is celestial latitude. Values for declination range from 0° to +90° for locations between the celestial equator and the North Pole, and from 0° to −90° between the celestial equator and the South Pole. Right ascension is celestial longitude. It is marked off in units called hours and minutes. The starting point for right ascension is the point at which the sun crosses the celestial equator on the spring equinox; right ascension is measured eastward from this point.

The right ascension and declination of an object in the sky do not change unless the object changes its position on the celestial sphere. The sun, the moon, and the planets do change their positions on the celestial sphere. The apparent path of the sun across the celestial sphere is called the ecliptic. The circle of the ecliptic corresponds to the plane in which most planetary orbits lie, as shown in the figure below.

For thousands of years, observers of the sky have noticed that certain objects behaved differently than most stars. These objects moved against the stellar background, never twinkled, and sometimes even reversed their direction of movement. The word *planet* is derived from an ancient Greek verb which means "to wander," and so the planets are celestial wanderers. In this activity, you will focus on one celestial wanderer, Mars, and examine its path across the celestial sphere during a certain period of retrograde motion.



Lab Skills and Objectives

- ***Graph*** **part of the celestial sphere.**
- ***Interpret*** **data on the motion of Mars across the celestial sphere.**
- ***Predict*** **the motions of other planets.**

Materials

- **colored pencils**

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Procedure

1. Answer Analysis and Conclusions Questions 1–4.
2. This activity will focus on a specific region of the celestial sphere represented by the Retrograde Motion of Mars grid on the following page. The data in the Background Stars and Magnitudes data table represents the 14 brightest background stars in the selected region of the celestial sphere. These stars are all visible to the naked eye.
3. Refer to the data table. Use a non-red colored pencil to plot the third-magnitude stars (stars with magnitudes from 3.0 to 3.9) with a small star (*) on the Retrograde Motion of Mars grid. Plot the second-magnitude stars (magnitudes from 2.0 to 2.9) with a somewhat larger star (⁎). Plot the two first-magnitude stars with an even larger star (⁎). This star field represents the stationary part of the celestial sphere.
4. Using the same colored pencil as you used in Step 3, plot the points listed on the Selected Points on the Ecliptic data table on the Retrograde Motion of Mars grid with a small dot (.). Connect the points with a smooth curve. The ecliptic represents the changing motion of the sun along the surface of the celestial sphere. However, the ecliptic itself changes very little from year to year and can be considered stationary.
5. Now use a red colored pencil to plot the positions of Mars on the grid with a solid circle (•), using the Observations of Mars data table. Label each circle with the month in which Mars had that position. Draw a solid line connecting the positions in chronological order. The line traces the path of Mars across the celestial sphere during an 11-month period that the data represents. Answer Questions 5–10.

Analysis and Conclusions

1. Polaris, the North Star, is located directly over Earth's North Pole. What is the declination of Polaris on the celestial sphere?

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2. There are 24 hours of right ascension on the celestial sphere. There are 360° in a circle. How many degrees of a circle would be equal to one hour of right ascension? Show your work.

_____

3. As Earth revolves around the sun, the sun appears to be located at different points on the celestial sphere. The ecliptic is the sun's path against the celestial sphere. The sun makes one complete trip around the path of the ecliptic in one year, or 365.25 days. To the nearest tenth of a degree, approximately how many degrees along the ecliptic does the sun move each day? Show your work.

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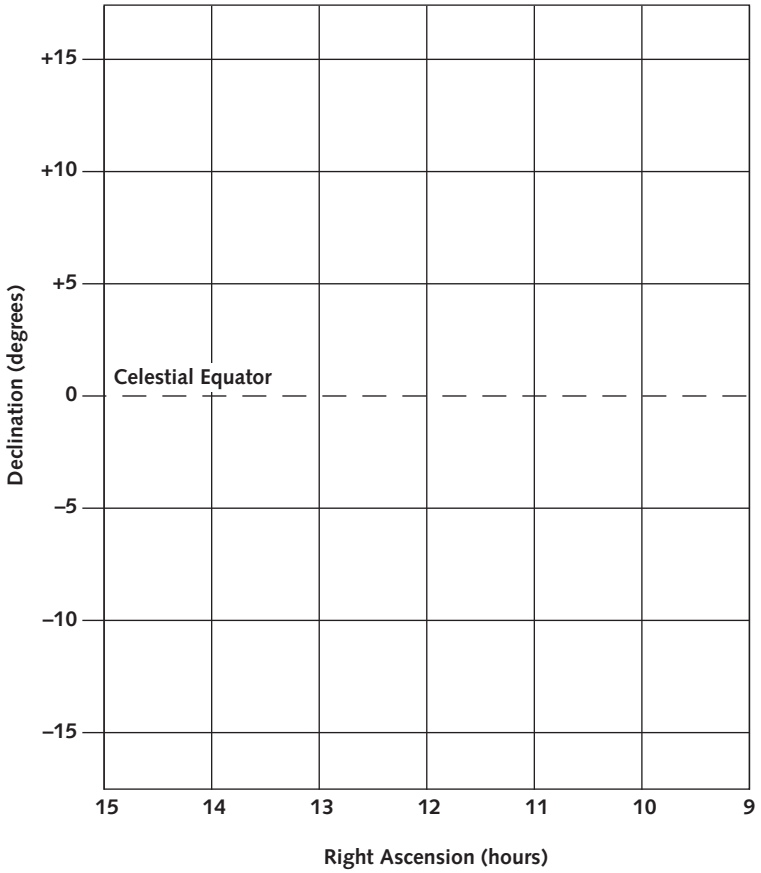
Name _____ Date _____

RETROGRADE MOTION OF MARS



Selected Positions on the Celestial Sphere							
Background Stars and Magnitudes			Selected Points on the Ecliptic		Observations of Mars		
Right Ascension (hr)	Declination (degrees)	Apparent Magnitude	Right Ascension (hr)	Declination (degrees)	Month	Right Ascension (hr)	Declination (degrees)
11.4	+10.8	3.9	9.0	+16.6	OCT	10.0	+13.8
12.3	−0.4	3.9	10.0	+11.8	NOV	11.1	+7.7
14.7	−5.4	3.9	11.0	+6.1	DEC	12.1	+2.0
9.6	−0.9	3.9	12.0	0	JAN	12.8	−2.6
10.5	+9.6	3.8	13.0	−6.1	FEB	13.3	−4.6
10.1	−12.1	3.6	14.0	−11.8	MAR	13.1	−3.7
9.6	+10.1	3.5	15.0	−16.6	APR	12.4	+0.4
12.9	+3.7	3.4			MAY	12.1	+0.9
13.5	−0.3	3.4			JUN	13.4	−2.7
12.7	−1.2	2.8			JUL	13.3	−8.4
11.8	+14.9	2.1			AUG	14.3	−14.8
9.4	−8.4	2.0					
10.1	+12.2	1.4					
13.4	−10.9	1.0					

4. What are the maximum and minimum values of declination for points on the ecliptic? How do you know?

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_____

5. During which months was Mars in retrograde motion?

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6. Given that Earth revolves around the sun in a counterclockwise motion, use your graph to determine the direction Mars revolves around the sun. Explain your reasoning.

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7. Besides the motion of Mars through the sky, list two ways you can tell by observing Mars in the sky that it is a planet and not a star.

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8. Compare the path of Mars through the stars with the sun's path through the stars (the ecliptic). Where are the paths relative to each other?

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9. How would the paths through the stars of the other planets compare with the paths of Mars and of the sun? How do you know?

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_____

10. Jupiter is farther than Mars is from Earth and farther than Mars is from the sun. How would you expect Jupiter's motion in the sky to be different from that of Mars? Explain.

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