

The Planets

In this activity we will examine the motions of the five objects other than the Sun and Moon that move relative to the stars in our night sky: Mercury, Venus, Mars, Jupiter, and Saturn.

1. Go to a computer and launch Stellarium. Make sure the location is set to your actual location on Earth.
2. Stop the flow of time (7) and set time to now (8).
3. Turn off the atmosphere (a), fog (f), and ground (g).
4. Turn on the equatorial grid (e), the ecliptic (.), and the equator (.).
5. Open the Search window (magnifying glass on left) and type in Venus. Hit return. This should center Venus in your view and label it for you. Track (t) Venus.
6. Advance time by days (either sidereal or solar) to see how Venus moves against the stars. The easiest way to do this is to hold down the Add 1 Solar Day (=) key. Watch the motion of Venus for a while. Remember that we are watching how Venus moves *relative to the background stars*. Don't forget that Venus, along with the background stars and everything else up there, participates in the daily rotation of the Celestial Sphere.
7. Most of the time Venus moves _____.
 - (a) Westward, staying close to the Ecliptic
 - (b) Eastward, staying close to the Ecliptic (like the Sun and Moon)
 - (c) along a path that does not stay close to the Ecliptic
8. Make sure you watch Venus' motion until it does something unusual. In what important way is the motion of Venus different from that of the Sun and Moon?
9. When Venus moves Westward relative to the fixed stars it is said to exhibit *retrograde* motion. The time between consecutive retrograde motions is called the planet's *synodic period*. Determine the approximate (to the nearest month) synodic period of Venus (by finding the difference between the time when it just starts retrograde motion and the next time it just starts retrograde motion) and record the result below.
10. When Venus undergoes retrograde motion it is in _____.
 - (a) Eastern quadrature
 - (b) conjunction
 - (c) Western quadrature
 - (d) opposition

11. Now measure the time from the point when Venus is in retrograde and in conjunction with the Sun, until the next time it is in retrograde conjunction. Does this give you the same result as measuring the synodic period using the method described above? In practice it is much easier to tell when Venus is in conjunction than to tell when it is starting retrograde motion.

12. Does the path of Venus repeat? In particular, when Venus undergoes a retrograde loop does this loop look the same each time? You may want to watch Venus do a few more loops to see.

13. The time it takes for a planet to go completely around the sky (i.e. all the way around the Celestial Sphere) is known as its *zodiacal period* (for reasons that will become clear next class). Determine the approximate zodiacal period of Venus by finding the difference between a time when it crosses the Celestial Meridian ($RA=0^h$) and the next time it crosses that line.¹ Record your result below.

14. Throughout Venus' motion relative to the stars, does it ever get very far away from the Sun?

15. Now go back to Search window and find Mercury. Track Mercury and advance time by days. Watch the motion of Mercury for a while. Does Mercury also exhibit retrograde motion?

16. Does Mercury stay close to the Sun like Venus? The angular distance between the Sun and a planet is known as the planet's *elongation*. Is Mercury's maximum elongation less than, greater than, or equal to that of Venus?

17. Determine the approximate synodic period (using either method described above, although one is much easier) of Mercury. Record your answer in the space below.

¹Because of the occasional retrograde motion, the zodiacal period varies from one cycle to the next. The real definition of the zodiacal period involves averaging over many cycles.

18. Determine the approximate zodiacal period (time to go around the Celestial Sphere) of Mercury. Record your answer in the space below.
19. Now find Mars and watch its motion for a while. Does Mars exhibit retrograde motion?
20. Does Mars stay close to the Sun? What is the maximum elongation of Mars?
21. When Mars undergoes retrograde motion it is in _____. (See p. 23 in the text for explanations of these terms.)
- (a) Eastern quadrature
 - (b) conjunction
 - (c) Western quadrature
 - (d) opposition
22. Determine the approximate synodic period of Mars by measuring from the time it starts retrograde motion until the next time it starts to retrograde. Write your result below.
23. Now determine the synodic period of Mars by measuring the time from when Mars is in conjunction with the Sun until the next time it is in conjunction. Does your answer agree with your previous measurement? Again, it is much easier to tell when Mars is in conjunction than to tell when it is starting to retrograde (or even when it is in opposition).
24. Determine the approximate zodiacal period of Mars and write your result below.
25. Watch the motion of Mars again and this time pay close attention to how the brightness of Mars changes. When is Mars the brightest?

26. Now find Jupiter and watch its motion. Does Jupiter exhibit retrograde motion?

27. Does Jupiter stay close to the Sun?

28. Determine the approximate synodic period of Jupiter and write your result below.

29. Determine the approximate zodiacal period of Jupiter and write your result below. For this measurement you may want to speed up the simulation (for example, you could advance time by solar weeks using the] key).

30. Now find Saturn and watch its motion. Does Saturn exhibit retrograde motion?

31. Does Saturn stay close to the Sun?

32. Determine the approximate synodic period of Saturn and write your result below.

33. Determine the approximate zodiacal period of Saturn and write your result below.