ScienceNews

Activity Guide for Students: Lunar Orbit

Directions:

After a class discussion covering the general information about the moon's orbit, look at Table 1 and answer the questions that follow. When needed, use additional resources to find background information.

Table 1

Apogee — 2019		Perigee — 2019	
Date	**Distance (km)**	**Date**	**Distance (km)**
January 8	406,117	January 21	357,342
February 5	406,555	February 19	356,761
March 4	406,391	March 19	359,377
March 31	405,577	April 16	364,205
April 28	404,582	May 13	369,009
May 26	404,138	June 7	368,504
June 23	404,548	July 4	363,726
July 20	405,481	August 2	359,398
August 17	406,377	August 30	357,176
September 13	406,377	September 27	357,802
October 10	405,899	October 26	361,311
November 7	405,058	November 22	366,716
December 4	404,446	December 18	370,265

Source: https://www.timeanddate.com/astronomy/moon/distance.html?year=2019&n=59

Background questions

1. The moon's orbit around Earth is elliptical. Explain what this means.

2. The equation that follows describes the eccentricity of the moon's orbit — how much the orbit varies from being a perfect circle. In this equation for eccentricity (e), a is apogee distance and p is perigee distance.

$$e = 1 - \frac{2}{\frac{a}{p} + 1}$$

When a and p are approximately equal, what is the rough value of e? What happens to e as a becomes much larger than p? How does the value of e affect the shape of the ellipse?

3. In which month is the moon's closest approach (perigee)? In which month is its farthest approach (apogee)? What do you notice? Describe your observations.

4. In which month is the farthest perigee? In which month is the closest apogee? How does this compare with the closest perigee and farthest apogee?

5. What is the average distance for perigee? What is the average distance for apogee?

6. If the moon continues moving away from Earth at the rate indicated in the article, 3.8 centimeters per year, how long will it take the moon to move one kilometer away?

7. If the radius of the moon's orbit did increase by one kilometer but the moon still traveled along its path at the same speed, how would the length of the lunar month change?

Use the base distance of 398,304 km and the equation:

$$P^2 = \frac{4\pi^2 a^3}{G(M_1 + M_2)}$$

In this equation, a is the average distance of the moon in meters, P is measured in Earth seconds and M_1 and M_2 are measured in solar masses.

8. How far would the moon have to move away from Earth to change the moon's orbit by one day?

Data analysis and graphing

9. Use graph paper, a computer or a calculator to graph the data for both perigee and apogee on the same set of axes to trace the path of the moon's orbit. What type of graph might you use?

10. What does the shape of the graph tell you about the moon's orbit around Earth?

11. Where on the graph is the difference between perigee and apogee distance the greatest? During what month is the difference least? Calculate the rough eccentricity for these months.

12. How did your calculations of the two eccentricities compare? What does that tell you about the shape of the moon's orbit?

13. If the eccentricity of the moon's orbit were to double, how would the ratio of a to p be affected?

14. What causes variations in the moon's eccentricity?

15. How do the variations in the moon's eccentricity affect Earth?

16. With the moon slowly moving away from Earth, how might the eccentricity of the moon's orbit be affected?

Bonus questions

17. Humans have known since ancient times that we can only see one side of the moon from Earth. Why do we only see one side of the moon?

18. The phases of the moon are caused by the orientations of Earth, the moon and the sun. Sketch and label what phases of the moon will occur at the various positions on the moon's orbit around Earth.

19. If a solar eclipse occurs when the moon comes between the sun and Earth, why don't eclipses occur every month? What is the difference between a total and partial eclipse?

20. Using your knowledge of the moon's orbit, can you explain what a "super moon" is?