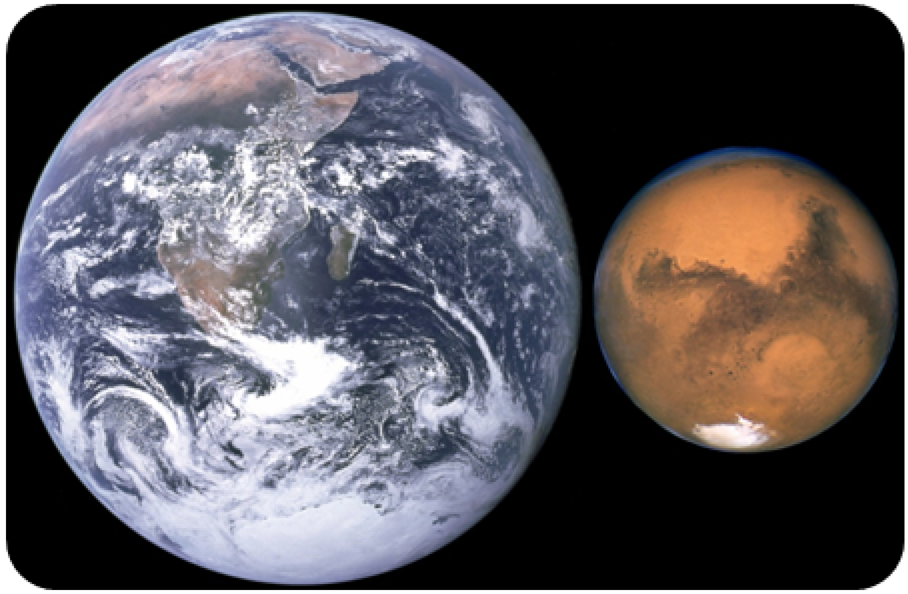
Exploring the Orbits of Earth and Mars

Introduction: On May 25th, 1961, President John F. Kennedy presented to congress his plan to have a man successfully landed on the moon and be returned safely to Earth before the end of the decade. The Apollo program successfully met this ambitious goal on July 20th, 1969 when Neil Armstrong and Buzz Aldrin were the first humans to step onto the lunar surface. In the years since the first lunar landing we have looked deeper into our solar neighborhood and set our sights on Mars.



The manned exploration and colonization of mars is the next frontier for our species, and comes with a wide array of challenges we are still working to overcome. One of the key aspects of any manned or unmanned mission to Mars is mastering the precise movements of these celestial bodies. A slight miscalculation on the projected movement of Mars or the Earth could result in a catastrophic failure of any mission. In today's lab investigation you will determine the eccentricity and circumference of each planet's elliptical orbit, and determine their average orbital velocity. This data is critical in beginning to understand the challenges of launching a successful mission towards the red planet.

Objective: At the end of this lab you should be able to describe the motions of Earth and Mars relative to the Sun and each other, calculate eccentricity, and discuss the challenges in manned missions to mars.

Hypothesis # 1: If the Earth's foci are … than the foci of Mars's, then the Earth's eccentricity will be ...

Hypothesis # 2: If the Earth's orbit is closer to the sun then Mars's orbit, then the Earth's orbital velocity will be …. than Mar's orbital velocity.

Procedure:

1. **Determine the eccentricity of orbit for Earth and Mars, on Appendix A**
    a. Determine aphelion (the point in the orbit of a planet at which it is furthest from the sun) in cm for the Earth's orbit. Record this in Data Table # 1.
    b. Determine perihelion (the point in the orbit of a planet at which it is closest to the sun) in cm for the Earth's orbit. Record this in Data Table # 1.
    c. Repeat steps a-b for Mar's orbit.
    d. Determine the distance between foci for Earth's orbit in cm. Record your results in Data Table 1.
    e. Determine the length of major axis for Earth's orbit in cm. Record your results in Data Table # 1.
    f. Repeat steps e-f for Mar's orbit.
    g. Calculate the eccentricity of orbit for Earth and Mars using the following formula; record both values in Data Table # 1:

$$Eccentricity = \frac{Distance\ between\ Foci}{Length\ of\ Major\ Axis}$$

h. Using the Solar System Data Table from your Earth Science Reference Tables, record the accepted eccentricity for both Earth and Mars in Data Table # 1.

i. Determine the % error of your eccentricity calculations using the following formula; record both values in Data Table # 1:

$$\%\ Error = \frac{Measured\ Value - Accepted\ Value}{Accepted\ Value} \times 100$$

2. Determine the Circumference of the orbits of Earth and Mars, and each planet's Orbital Velocity

a. Record the period of Revolution in days for both Earth and Mars using Page 15 of your ESRT.

b. Convert the period of revolution from days to hours by using the following formula.

$$Period\ of\ Revolution_{\ hours} = Period\ of\ Revolution_{\ days} \times 24\ hours$$

c. Convert the period of revolution from hours to seconds by using the following formula.

$$Period\ of\ Revolution_{\ seconds} = Period\ of\ Revolution_{\ hours} \times 3{,}600\ seconds$$

d. Convert the Length of Major Axis for both planets in cm to km using the scale from Earth - Mars Orbit Diagram.

e. Calculate the circumference of orbit in km for both Earth and Mars using the following formula; record both values in Data Table # 2:

$$Circumference\ of\ Orbit_{\ km} = \pi \times Length\ of\ Major\ Axis_{\ km}$$

f. Convert the circumference of orbit in km to miles for both Earth and Mars using the following formula:

$$Circumference\ of\ Orbit_{\ miles} = Circumference\ of\ Orbit_{\ km} \times 0.6214\ miles$$

g. Calculate the Orbital Velocity in km/s for both Earth and Mars using the following formula:

$$Orbital\ Velocity_{\ km/s} = \frac{Circumference\ of\ Orbit_{\ km}}{Period\ of\ Revolution_{\ seconds}}$$

h. Calculate the Orbital Velocity in km/s for both Earth and Mars using the following formula:

$$Orbital\ Velocity_{\ miles/hour} = \frac{Circumference\ of\ Orbit_{\ miles}}{Period\ of\ Revolution_{\ hours}}$$

i. Mark with an x on Appendix A where you would find the greatest orbital velocity for both planets in their respective orbits

3. Construct the elliptical orbits of unknown asteroid A and B

a. Place a pushpin into each foci of Unknown Asteroid A

b. Loop the provided string loop around the pins and use your pencil to construct an ellipse

c. Determine distance between foci and length of major axis for the ellipse; record in Data Table 3.

d. Calculate the eccentricity of your constructed ellipse using the eccentricity formula.

e. Repeat steps 3a through 3d for Unknown Asteroid B.