Orbit of Jupiter

OrbitOfJupiter.tns

Name _____

Class _____

Problem 1 – A Cartesian Model

On page 1.2, play the animation of Jupiter orbiting around the sun. What shape is the orbit? In what direction does Jupiter move?

Building the Cartesian Model

aphelion = 5.455 A.U. perihelion = 4.952 A.U.

- Go to **MENU > View > Show Axes** to display the coordinate axes. What are the coordinates of the center of the ellipse?

- What are the coordinates of the point representing the sun? Do not use the **Coordinates and Equations** tool.

- The sun is one focus of the ellipse. Use the **Reflection** tool (**MENU > Geometry > Transformations**) to draw the other. What are its coordinates?

- What is the value of *a* (the semimajor axis) for this ellipse? (Hint: what is 2*a*?)

- Plot one of the points where the ellipse intersects the *y*-axis ($x = 0$). Label it *P*. Draw line segments from *P* to each of the foci. These line segments have length *a*. Explain why.

- Use the Pythagorean Theorem to solve for *b*, the distance from the origin to point *P*.

- Write the equation for the elliptical orbit of Jupiter in the form $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

- Graph your ellipse equation using the ellipse template by pressing **MENU > Graph Entry/Edit > Equation > Ellipse**.

Evaluating the Cartesian Model

- Describe the way a point on the curves would move. Does it look like Jupiter's orbit? Explain why or why not.

- List some of the shortcomings of this model.

Problem 2 – A Parametric Model

Exploring Coordinate Equations

Use the graph on page 2.3 to answer the following questions.

- How does Jupiter move as t increases from 0 to 2π?
- Complete the description of how the horizontal distance between Jupiter and the center of its orbit (represented by the origin) changes as Jupiter orbits the sun:
  The distance starts out at the maximum, a = 5.2035,
  decreases to 0,
  decreases further to $-a$,

  _____,

  _____,
  and then this pattern repeats as Jupiter orbits the sun again.
- Describe how the vertical distance between Jupiter and the center of its orbit changes as Jupiter orbits the sun.

Plot of x-values vs. t-values

- What is the shape of the graph?

- What are the maximum and minimum values? Where have you seen these numbers before?

- Write a function $x(t)$ for this data. Graph it over the data to check. (Go to **MENU > Analyze > Plot Function**.)

Plot of y-values vs. t-values

- What is the shape of the graph? What function does it show?

- What are the maximum and minimum values? Where have you seen these numbers before?

- Write a function $y(t)$ for this data. Graph it over the data to check. (Go to **MENU > Analyze > Plot Function**.)

Problem 3 – Parametric Model of Jupiter's Orbit

Checking the Coordinate Equations

These two functions are the coordinate equations of the ellipse. They are usually written:

$$x(t) = a\cos(t)$$

$$y(t) = b\sin(t)$$

- Substitute these equations into the general equation for an ellipse centered at (0, 0), $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, to check.

- Write the coordinate equations for Jupiter's orbit by substituting the values for a and b.

$x(t) =$ _____

$y(t) =$ _____

A Better Model of Jupiter's Orbit

Enter the coordinate equations for Jupiter's orbit in X1(T) and Y1(T) on page 3.2. Graph them as an animated point on the curve.