Name ________________________

Class ________________________

Part 1 – Parametric Equations – Kinematics

In this part, you will explore parametric equations and describe the relationship between the position, velocity, and acceleration of an object.

Press N , select the *Text Editor* application, and open *param1*. Press ƒ to execute each command line and read the instructions.

The script plots two points that have horizontal movement. The points are modeled by two different parametric equations $x(t)$ for $0 \le t \le 10$. Both equations are plotted at the same time.. You can press ƒ to regraph the equations and study the movement.

1. Do the two points seem to start out at the same location? Do they seem to end at the same location? Which point is furthest from the origin when the time is 10? If this were a race, do you think there is ever a time between 0 and 10 that the points would be neck and neck? If you knew the equations for $x(t)$, how could you find out when and where they were at the same location?

2. The parametric equations are defined as follows:

$\mathbf{x1}(t) = t - 7\sin(t)$ and $\mathbf{x2}(t) = 0.05t^3 - 0.2t^2 - 0.5t - 5$

Which equation models the movement of the lower point and which models the movement of the upper point?

3. Find the velocity of each point at $t = 3.5$ and $t = 8$. Show your work.

a. When the time is 3.5, which point is moving faster?

b. When the time is 8, which point is moving faster?

4. Find the acceleration for both objects at $t = 3.5$ and $t = 8$.

5. Using calculus terms, explain what the sign of the answers in Exercises 3 and 4 implies for the motion.

Part 2 – Parametric Equations – Slope

Press N , select the *Text Editor* application, and open *param2*. Press ƒ to execute each command line and read the instructions.

6. The parametric equations $x(t) = 4\sin(t) - 2\sin(2t)$ and $y(t) = 4\cos(t) + 2\cos(2t)$ are plotted over a time domain of $0 \le t \le 2\pi$. At what values of t does the graph form a cusp? What is the derivative at a cusp?

7. What are the x- and y-coordinates where the slope is zero?

To find the slope of a tangent, we want to find $\frac{dy}{dx}$:

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{y'(t)}{x'(t)}$$

8. Using calculus, how would you find where the slope is zero?

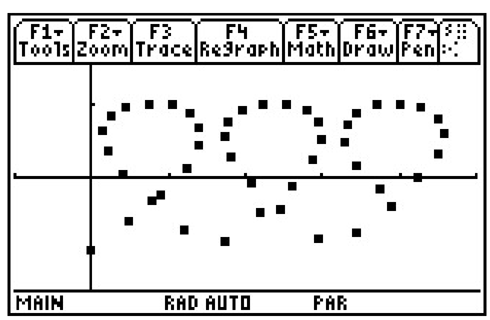
9. Use calculus to find when $\frac{dy}{dx} = 1$. Show your work.

Part 3 – Homework/Extension

Try to graph a set of parametric equations that match the scatter plot shown at right.

The window values are **xmin** = –1, **xmax** = 5, **ymin** = –1.5, and **ymax** = 1.5. The values of t are between 0 and 9.

If you create your own new graph, use calculus to find the horizontal and vertical tangent.



Write your parametric equations and show some work to demonstrate understanding of slopes of parametric equations.

