1. Show the limit below does not exist.

\[ \lim_{(x,y) \to (0,0)} \frac{x^2y}{x^3 + y^3} \]

2. Consider the equation \( x^2 + 4y^2 - z^2 = 1 \) and its graph.

(a) Identify the graph by name.

(b) Which of the three x-axis, y-axis or z-axis does not intersect the graph?

(c) Carefully do a 2D plot of the \( z = 0 \) contour of this equation (in the \( xy \)-plane).

(d) Carefully do a 2D plot of the \( y = 0 \) section of this equation (in the \( xz \)-plane).

(e) Carefully do a 2D plot of the \( z = \sqrt{3} \) contour of this equation (in the \( xy \)-plane).

3. A particle moves at a constant speed along a line from the point \( P = (1, -1, 2) \) to the point \( Q = (5, 3, 0) \). Find the parametric equation of the line if

(a) It takes five seconds to go from \( P \) to \( Q \).

(b) The speed of the particle is 5 units per second.

4. Consider the following equations in polar coordinates.

(I) \( r = 2 \) (II) \( r = 2 \sec \theta \) (III) \( r = 2 \sin \theta \) (IV) \( r = 2 \csc \theta \) and (V) \( r = \tan \theta \sec \theta \).

Match the equations above with five of the equations in rectangular coordinates below.

(A) \( y = 2 \) (B) \( x^2 = y \) (C) \( x^2 - 2x + y^2 = 0 \) (D) \( x^2 + y^2 = 2 \)

(E) \( x^2 + y^2 = 4 \) (F) \( y^2 = x \) (G) \( x = 2 \) (H) \( x^2 - 2y + y^3 = 0 \)

5. Consider the parametric equation \( \vec{r}(t) = (t \cos t, t \sin t, t) \) whose graph is pictured below.

(a) Compute the velocity (by hand).

(b) Compute and simplify the speed (by hand). [All the trig functions will conveniently disappear.]

(c) Use the TI-89 to find the exact arclength of the curve from \( t = 0 \) to \( t = 1 \).

(d) Find parametric equations of the tangent line to the curve at \( t = 1 \).

(e) Show each point of our curve is on the cone \( x^2 + y^2 = z^2 \).