Problem 1. (3 points) Sketch the curve given by the vector function
\[ \vec{r}(t) = \langle \cos t, t, \sin t \rangle \]
and indicate the direction in which \( t \) increases.

Note that the projection onto the \( xy \)-plane is a circle and as \( t \) increases (\( \cos t, \sin t \)) is moving counterclockwise.

Problem 2. (4 points) Let \( f(x) = \frac{x^2}{2} \).

A) Find the curvature of \( f(x) \) and sketch both \( \kappa(x) \) and \( f(x) \) in the same coordinate system.

B) What happens with curvature as \( |x| \to \infty \)?

\[ \kappa(x) = \frac{|F''|}{(1 + (F'(x))^2)^{3/2}} = \frac{1}{(1 + x^2)^{3/2}} \]

\[ \lim_{x \to \infty} \kappa(x) = 0 \]
Problem 3. (4 points) Reparametrize the curve \( \mathbf{r}(t) = < 2t, 2t, t > \) with respect to arc length measured from \((0, 0, 0)\) in the direction of increasing \( t \).

Extra Credit. (2 points) Suppose \( \mathbf{r}(t) \) is a differentiable vector function satisfying \( |\mathbf{r}(t)| = 1 \) for all \( t \) (note that it means that the curve described by the function lies on the sphere of radius 1). Show that \( \mathbf{r}(t) \cdot \mathbf{r}'(t) = 0 \).