1. Find the limit

\[ \lim_{t \to \infty} \left( \frac{1 + t^3}{2 - t^3}, te^{-t}, \tan^{-1} t \right) \]

2. Sketch \( \mathbf{r}(t) = (t^3, t^4) \).
3. At what point(s) does the helix \( \mathbf{r}(t) = \langle 2 \sin t, 2 \cos t, t \rangle \) intersect the cone \( z = x^2 + y^2 \)?

4. Find a vector function for the curve of intersection of the paraboloid
\[ z = x^2 + 4y^2 \]
and the parabolic cylinder \( x = y^2 \).
1. Sketch the plane curve \((1 + \cos t)i + (2 - \sin t)j\). Find the unit tangent at \(t = 3\pi/4\).

2. Find the unit tangent vector \(\mathbf{T}\) for the curve \(\mathbf{r}(t) = (t^4 + 3t, t^2 + 1, 3t + 4)\) at the point \(t = 1\).
3. Find expression for
\[ \frac{d}{dt} (A(t) \times B(t)) \cdot C(t) \]

4. Evaluate
\[ \int_0^1 \left( \frac{1}{1+t^2} \mathbf{i} + \frac{2t}{1+t^2} \mathbf{k} \right) dt \]
1. Let $p(x) = x^4 + x^3$ and let $\kappa(x)$ be the curvature of $p(x)$.

(a) What is $\kappa(0)$?

(b) Is $\kappa(x)$ continuous at $x = 0$? Justify your answer.

(c) Is $\kappa(x)$ differentiable at $x = 0$? Justify your answer.
2. Find the length of the curve \( \mathbf{r}(t) = \langle 2t, t^2, \frac{1}{3}t^3 \rangle \) for \( 0 \leq t \leq 1 \).

3. Calculate \( \mathbf{r}'(t) \), \( \mathbf{r}''(t) \), and the curvature, for \( \mathbf{r} = t \mathbf{i} + t^2 \mathbf{j} + e^{-t} \mathbf{k} \).
1. The position function is given by \( \langle t^2, 5t, t^2 - 16t \rangle \). When is the speed a minimum?
2. Find the position vector of a particle given that \( \mathbf{a}(t) = t \mathbf{i} + \sin t \mathbf{j} + e^{-t} \mathbf{k} \) with \( \mathbf{v}(0) = \mathbf{k} \) and \( \mathbf{r}(0) = \mathbf{j} - \mathbf{k} \).