1. Compute the derivatives of the following functions. You do not need to simplify your answers.

   (a) \( \frac{2x + 5}{\sqrt{x^4 + 3}} \)
   (b) \( e^{3x+1} \ln(x^2 + 1) \)
   (c) \( \tan(\cos x + \sin x) \)
   (d) \( \sin^{-1} \left( \sqrt{2x} \right) \)

2. Evaluate the following limits or say if they do not exist (using any method you want):

   (a) \( \lim_{x \to 0} \frac{1 - \cos(2x)}{xe^x - x} \)
   (b) \( \lim_{x \to 0} \left\{ \sin x \left[ \frac{1}{x} - \frac{1}{\sin(2x)} \right] \right\} \)
   (c) \( \lim_{x \to \infty} (\ln x e^{-x}) \)
   (d) \( \lim_{x \to 1} \frac{\sin x}{x} \).

3. A 15 ft ladder is leaning against a wall. If the base of the ladder is pushed toward the wall at a speed of 2 ft/sec, at what speed is the top of the ladder moving up the wall when the base of the ladder is 6 ft from the wall?

4. A pile of sand in the shape of a cone whose radius is twice its height is growing at a rate of 5 cubic meters per second. How fast is its height increasing when the radius is 20 meters? **HINT.** The volume of a cone of radius \( r \) and height \( h \) is \( V = \frac{1}{3} \pi r^2 h \).

5. State the natural domain of the function

\[ y = \frac{\ln x}{x^2}. \]
Sketch the graph, identify where the graph is increasing/decreasing, the local extrema, where the graph is concave up/concave down, and the inflection points.

6. A cricket ball is projected directly upward from the ground with an initial velocity of 112 ft/s. Assuming that the acceleration due to gravity is 32 ft/sec², derive an equation for the height \( s(t) \) of the ball above the ground after \( t \) seconds. When does the ball hit the ground?

7. A one meter high fence is eight meters in front of a high wall. Find the minimum length of a ladder resting on the fence whose foot is in front of the fence and whose top reaches the wall.

8. Define a function \( f(x) \) with domain \((-\infty, \infty)\) by

\[
f(x) = \begin{cases} 
  x^2 & \text{if } x \leq 1 \\
  Ax + B & \text{if } 1 < x < 2 \\
  -2x^2 & \text{if } x \geq 2.
\end{cases}
\]

(a) Determine the constants \( A \) and \( B \) so that \( f(x) \) is continuous everywhere.
(b) Is this function differentiable everywhere?
(c) Sketch the graph \( y = f(x) \) in that case and determine the range of \( f \).

9. Find the equation of the tangent line to the curve

\[(x - y)^3 = x^2 - y^2 - 2\]

at the point \((2, 1)\). At which point does this tangent line cross the \( x \)-axis and at what angle?