1. Given \( y = f(x) \), where

\[
f(x) = -12x^2 + 48x + 24,
\]

compute the instantaneous rate of change of \( y \) with respect to \( x \), or \( dy/dx \), at the point \( x = 3 \).
2. Given

\[ f(x) = (x - 1)^3, \]

compute the function \( f'(x) \) using the definition of the derivative. **Note:** you may **not** use differentiation rules.
3. Differentiate the function

\[ f(x) = \frac{(x + 1)^2(x + 2)^2}{x^3 - 3x^2 + 3x - 1}. \]
4. Differentiate the function

\[ f(x) = \frac{\cos x \csc x}{\sec x}. \]
5. Differentiate the function

\[ f(x) = \cos(\sec^3(x^4)). \]
6. Given

\[ y^2(y^2 - 7) = x^2(x^2 + 5), \]

compute the equation of the tangent line to the curve described by this equation at the point \((2, 3)\).
7. Recall the equation from Problem 6,

\[ y^2(y^2 - 7) = x^2(x^2 + 5). \]

Compute \( y'' \).
8. Given \( f(x) = x \cos^2(2x), \)

compute \( f''(\pi). \)
9. Suppose that the radius \( r \) of a cylinder is increasing at a constant rate of 2 cm/s, while its height \( h \) is decreasing at a constant rate of 1 cm/s. Determine the rate at which the volume \( V \) of the cylinder is changing when \( r = 5 \) cm and \( h = 100 \) cm.
10. Compute

\[
\lim_{x \to 0^-} \left( \frac{1}{2} \right)^{1/x}.
\]
Possibly Useful Formulas

\[
\frac{d}{dx}[f(x) + g(x)] = \frac{d}{dx}[f(x)] + \frac{d}{dx}[g(x)]
\]

\[
\frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}[f(x)] - \frac{d}{dx}[g(x)]
\]

\[
\frac{d}{dx}[cf(x)] = c \frac{d}{dx}[f(x)]
\]

\[
\frac{d}{dx}[f(x)g(x)] = g(x) \frac{d}{dx}[f(x)] + f(x) \frac{d}{dx}[g(x)]
\]

\[
\frac{d}{dx}[x^n] = nx^{n-1}
\]

\[
\frac{d}{dx}[(f(x))^n] = n[f(x)]^{n-1} \frac{d}{dx}[f(x)]
\]

\[
\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x) \frac{d}{dx}[f(x)] - f(x) \frac{d}{dx}[g(x)]}{[g(x)]^2}
\]

\[
\frac{d}{dx}[\sin x] = \cos x
\]

\[
\frac{d}{dx}[\cos x] = -\sin x
\]

\[
\frac{d}{dx}[\tan x] = \sec^2 x
\]

\[
\frac{d}{dx}[\cot x] = -\csc^2 x
\]

\[
\frac{d}{dx}[\sec x] = \sec x \tan x
\]

\[
\frac{d}{dx}[\csc x] = -\csc x \cot x
\]

\[
\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)
\]

The equation of a line with slope \(m\) passing through the point \((x_0, y_0)\) has the equation given by the **point-slope form**

\[ y - y_0 = m(x - x_0). \]