1. Find $\frac{dy}{dx}$ for each of the following. Simplify your answers.

   a) $y = \frac{4xe^{2x}}{x^2 + 1}$

   b) $y = \left[ \frac{\tan (5x)}{1 + \sec (5x)} \right]^2$

   c) $y = \cos \left( \frac{1}{x} \right) + \sin^{-1} \left( \frac{1}{x} \right)$

   d) $\cos \left( y^2 \right) + x = e^{xy}$

2. Use logarithmic differentiation to find $f''(x)$: $f(x) = \left(1 + \frac{1}{x} \right)^{2x}$

3. Compute $h'(2)$ if $h(x) = \frac{x^2f(x)}{f(x) + g(x)}$, and $f(2) = 1$, $f'(2) = 2$, $g(2) = 3$, and $g'(2) = 4$.

4. Find $\frac{d^2y}{dx^2}$ for $y = \tan^{-1}(e^{2x})$

5. Find the equation of the tangent line in slope-intercept form to the graph of $x^3 + y^3 = 2xy$ at the point $(1, 1)$.

6. The graph of $f$ is given below. Sketch the graph of $f''$ in the same coordinate system. (8 pt)
7. Suppose the position function \( s(t) = (t^2 + 3)^2 (2t + 1)^3 \) represents the position of a particle in meters at \( t \) seconds.

a) Find the velocity function \( v(t) \). Simplify your answer.

b) Find the velocity at 1 second. Give appropriate units.

8. Sand falls from a conveyor belt onto a conical pile at a rate of 1 cm\(^3\)/min. The radius of the base of the pile is always equal to twice its height. How fast is the height of the pile increasing when the pile is 4 cm high?

Give appropriate units. \( V = \frac{1}{3} \pi r^2 h \)

9. A balloon rises at the rate of 8 feet per second from a point on the ground 60 feet from an observer. Find the rate of change of the angle of elevation when the balloon is 30 feet above the ground. Give appropriate units.