1. Find $\frac{dy}{dx}$ of $y = x^2 + 4x + 3$ using the definition of the derivative.

2. Given the following graph, answer the following questions. Each tick mark represents 1 unit.

   (a) For which $x$-values does the derivative, $f'(x)$, not exist?

   (b) Which points on the graph of $f(x)$ are continuous?
3. Find the derivative of the following functions:

(a) \( r = \left( \frac{\sin \theta}{\cos \theta - 1} \right)^2 \)

(b) \( y = x^3 + 2x^4 + 3x \)
(c) \( s = (\sec t + \tan t)^5 \)

(d) \( y = \frac{\sqrt{t}}{1 + \sqrt{t}} \)
4. Sand falls from a conveyor belt at the rate of 20 m³/min onto the top of a conical pile. The height of the pile is always three-eighths of the base diameter. The volume of a cone is \( V = \frac{1}{3}\pi r^2 h \). Answer the following in cm per minute.

(a) How fast is the height of the pile changing when the pile is 4 m high?

(b) How fast is the radius changing when the pile is 4 m high?
5. Given \( f(x) = (1 + x)^k \),

(a) Show that the linearization of \( f(x) \) at \( x = 0 \) is

\[
L(x) = 1 + kx.
\]

(b) Estimate \( (1.00006)^{55} \) using the linearization of \( f(x) \). Compare to \( (1.00006)^{55} \).

6. Find \( y'' \) if \( y = \sec x \). Express your answer using only \( \sec x \) and \( \tan x \).
7. The accompanying figure shows the velocity $v = \frac{ds}{dt} = f(t)$ (m/sec) of a body moving along a coordinate line.

(a) When does the body reverse direction?

(b) When is the body moving at constant speed?

(c) Where defined, graph the acceleration of the body.

8. Derive the formula for the derivative of $\tan x$ by using the quotient rule.
9. Find an equation for the line tangent to the curve at the point defined by $t = \frac{\pi}{4}$, for the parametric equation

$$x = 2 \cos t, \quad y = 4 \sin t.$$ 

In addition, find the value of $\frac{d^2y}{dx^2}$ at $t = \frac{\pi}{4}$. 

10. Use implicit differentiation to find \( \frac{dy}{dx} \) for

\[
y \sin \left( \frac{1}{y} \right) = 1 - xy.
\]