1. Work out the derivative of each function using the limit definition of the derivative.

\[ a) \quad f(x) = \sqrt{x} \quad b) \quad f(x) = \sqrt{7x^2 + 5} \]

\[ c) \quad f(x) = \frac{1}{x} \quad d) \quad f(x) = \frac{1}{x^2 + 4} \]

Check your answers using derivative rules.

2. Find the equation of the tangent line to the given function at the given x-value.

\[ a) \quad f(x) = 5x^2 + 10x + 3 \quad @ \quad x = 1 \]

\[ b) \quad f(x) = \frac{x^2 - 4x + 32}{\sqrt{x}} \quad @ \quad x = 4 \]

\[ c) \quad f(x) = xe^x \quad @ \quad x = 0 \]

\[ d) \quad f(x) = \tan x \quad @ \quad x = \pi/4 \]

\[ e) \quad f(x) = \sec x \quad @ \quad x = \pi/4 \]

\[ f) \quad f(x) = \ln\left(\frac{x^2 + 1}{2x}\right) \quad @ \quad x = 2 \]

3. Find all values of x at which f is not differentiable. Look for discontinuities, vertical tangents, corners, cusps.

\[ a) \quad f(x) = \begin{cases} 
    x^2 & x < 3 \\
    6x - 9 & 3 \leq x < 5 \\
    \sqrt{9 - x + 19} & 5 \leq x \leq 9 
\end{cases} \]

\[ b) \quad f(x) = \begin{cases} 
    12x^{1/3} & x < 8 \\
    5 & x = 8 \\
    24|x - 9| & 8 \leq x 
\end{cases} \]

\[ c) \quad f(x) = (x^2 - 16)^{1/5} \]
4. A person travels from home along a straight line. His velocity at time \( t \) is given by

\[ v(t) = t^3 - 7t^2 + 10t \text{ mph for } 0 \leq t \leq 8 \]

a) When does the position function have a local min? a local max?

b) When is his eastward velocity the greatest? (using east as the positive direction)

c) When is his westward velocity the greatest?

d) What occurs in the graph of his position function, \( s(t) \), at each of the times you found in b and c?

5. a) The tangent line to \( f(x) \) at \((3, f(3))\) is \( y = 4x - 7 \). Find \( f(3) \) and \( f'(3) \).

b) The tangent line to \( f(x) \) at \((5, f(5))\) is \( y = 15 \). Find \( f(5) \) and \( f'(5) \).

c) The tangent line to \( f(x) \) at \( x = 2 \) is the vertical line \( x = 2 \). What can you say about the derivative of \( f \) at \( x = 2 \)? Can \( f(2) \) be determined?

6. The tangent line to \( f(u) \) at \( u = 2 \) is \( y = 3u - 6 \). The tangent line to \( g(x) \) at \( x = 1 \) is \( y = -4x + 6 \). Find the tangent line to \( f(g(x)) \) at \( x = 1 \).

7. Find each derivative.

a) \[ \frac{d}{dt} (1000 e^{0.6t}) \]

b) \[ \frac{d}{dx} \ln \left( \frac{x^5}{\sqrt{x^4 + 1}} \right) \text{ Use logarithm rules before differentiating!} \]

c) \[ \frac{d}{dx} (x^2 \cos^2 x) \]

d) \[ \frac{d}{dx} (e^x \sin^2 x) \]
e) \( \frac{d}{dx} (e^{x^3 - 5x}) \)

f) \( \frac{e^{x^2}}{\tan x + 4} \)

8. Approximate using the tangent line of a function or using differentials.

a) \( \sqrt[4]{15} \)  
b) \( \sqrt[4]{17} \)

9. The volume of a sphere of radius \( r \) is given by

\[ V = \frac{4}{3} \pi r^3 \]

a) Approximate the change in the volume if the radius increases from 5 cm to 5.02 cm. (Use a differential.)

b) Approximate the % change in \( V \) in \( r \) increases by 15%.

10. Shown is the graph of the derivative of \( f(x) \).

At what \( x \)-values does \( f(x) \) have a local min? a local max? an inflection point?

On what interval(s) is \( f(x) \): increasing? decreasing? concave up? concave down?