1. (a) The rocket’s airtime corresponds to the time until its height is zero, or when \( s(t) = 0 \). So solve:

\[
0 = s(t) = 80t - 16t^2 = t(80 - 16t)
\]

\[
t = 0 \text{ and } t = \frac{80}{16} = 5
\]

Thus the rocket lands after 5 seconds.

(b) This now means we have to find \( v(5) \), recalling that \( v(t) = s'(t) \):

\[
s'(t) = 80 - 32t; \quad s'(5) = 80 - 32 \cdot 5 = 80 - 160 = -80
\]

So, the rocket’s velocity is \(-80 \text{ feet per second, or 80 feet per second downward.}\)

2. (a) To find this limit, we need to work with a common denominator, which in this case means \( 5 \cdot (5 + h) \).

\[
\lim_{h \to 0} \frac{\frac{5}{5} - \frac{1}{5 + h}}{h} = \lim_{h \to 0} \frac{\frac{5}{5} - \frac{(5+h)}{5(5+h)}}{h} = \lim_{h \to 0} \frac{\frac{5-5-h}{5(5+h)}}{h} = \lim_{h \to 0} \frac{-1}{h} = -\frac{1}{25}
\]

(b) This limit is of a rational function, so we should try to factor and look for common factors that may cancel each other out:

\[
\lim_{x \to 2} \frac{2x^2 - 8}{2 - x} = \lim_{x \to 2} \frac{2(x^2 - 4)}{2 - x} = \lim_{x \to 2} \frac{2(x + 2)(x - 2)}{-(x - 2)} = \lim_{x \to 2} \frac{2(x + 2)}{-1} = -8
\]

3. To find the equation of the tangent line, you are given the point \((0, 1)\), so we first find the slope (namely the value of the derivative at the \( x \)-value), and then use that along with the point-slope formula to find the equation:

\[
f'(x) = 2e^{2x} + 2
\]

\[
f'(0) = 2 + 2 = 4
\]

\[
y - 1 = 4 \cdot (x - 0)
\]

\[
y = 4x + 1
\]

4. (a) \( g(t) = \pi \sin^{-1}(t) \)

\[
g'(t) = \frac{\pi}{\sqrt{1 - x^2}}
\]

(b) \( y = 4x^\pi - x \)

\[
\frac{dy}{dx} = 4\pi x^{\pi - 1} - 1
\]

(c) \( h(x) = \frac{1}{x} + \frac{2}{x^2} \)

\[
h'(x) = -x^{-2} - 4x^{-3}
\]

5. (a) \( \frac{d}{dx} [(e^x + x) \sin(2x)] \) [product rule]

\[
(e^x + 1)(\sin(2x)) + (e^x + x)(2\cos(2x))
\]

(b) \( \frac{d}{dt} \left[ \frac{t^2 - 2t + 1}{t^2 + t^4 + 1} \right] \) [quotient rule]

\[
\frac{(2t - 2)(t^7 + t^4 + 1) - (t^2 - 2t + 1)(7t^6 + 4t^3)}{(t^7 + t^4 + 1)^2}
\]
(c) \( \frac{d^2}{dx^2} [\sin(x) \cos(x)] \) [product rule, twice]

\[
\frac{dy}{dx} = \cos^2(x) - \sin^2(x)
\]

\[
\frac{d^2y}{dx^2} = -2\cos(x) \sin(x) - 2\sin(x) \cos(x) = -4\sin(x) \cos(x)
\]

6. Using implicit differentiation:

\[
ye^{-y} - x = 1 - x^2
\]

\[
\frac{dy}{dx} e^y + y \frac{dy}{dx} e^y - 1 = -2x
\]

\[
\frac{dy}{dx} = \frac{-2x + 1}{e^y(y + 1)}
\]

7. (a) Domain of \( f(x) = \mathbb{R} \). Range of \( f(x) = [-4, \infty) \).
    Domain of \( g(x) = (-8, \infty) \). Range of \( g(x) = [0, \infty) \).
    (b) \((g \circ f)(x) = \sqrt{x^2 - 4} + 8 = \sqrt{x^2 + 4}\), so the domain is \( \mathbb{R} \), and the range is \([2, \infty)\).

8. (a) \( \lim_{x \to 0} f(x) = 2 \)  
    (b) \( \lim_{x \to 2^-} f(x) = 1 \)  
    (c) \( \lim_{x \to -2} f(x) \) DNE

9. (a) \( \frac{d}{dx} \left[ \cos (x^4 - e^x) \right] \) [Chain rule]
    \[
    \frac{dy}{dx} = (4x^3 - e^x) (-\sin(x^4 - e^x))
    \]
    (b) Find \( \frac{d}{dt} \left[ \ln (\cos^2 (t)) \right] \) [Chain rule]
    \[
    \frac{dy}{dt} = \frac{-2 \cos(t) \sin(t)}{\cos^2(t)} = -2 \frac{\sin(t)}{\cos(t)} = -2 \tan(t)
    \]

10. Any parabola facing up with a vertex at \( x=1 \) would do here. (Try looking at the graph of \( y = x^2 - 2x + 1 \), for instance.)

BONUS If \( f(x) \) and \( f'(x) \) both pass through \((\pi, 2)\), then \( f(\pi) = 2 \) and \( f'(\pi) = 2 \). Thus the equation of the tangent line is gotten by:
    \[
    y - 2 = 2(x - \pi)
    \]
    \[
    y = 2x - 2\pi + 2
    \]