1. Note that the value of $y' = f'(x)$ is the corresponding value of the slope of $y = f(x)$. So we have

2. Recall that if $f(x)$ is differentiable at some point $x = a$, then $f(x)$ is continuous at $x = a$, i.e., continuity is the necessary condition of differentiability.

   But conversely, continuity is not sufficient. A classical case is the 'sharp corner'. Think about $y = |x|$ at $x = 0$.

   a. In $[-2, -1), (-1, 0), (0, 2), (2, 3)$
   b. $x = -1$. 'Sharp corner'
   c. $x = 0$ and $x = 2$. 
3. Suppose it does, and it is tangent to \( y = \sqrt{x} \) at \((a, \sqrt{a})\).

At this point, \( y' = \frac{1}{2} a^{-\frac{1}{2}} \). So the tangent line is

\[
y - \sqrt{a} = \frac{1}{2} a^{-\frac{1}{2}} (x - a).
\]

We need it cross \((-1,0)\). So

\[
o - \sqrt{a} = \frac{1}{2} a^{-\frac{1}{2}} (-1 - a).
\]

Solving it gives \(a=1\).

So, \( y-1 = \frac{1}{2} (x-1) \) is the line; \((1,1)\) is the point.

4. \( y' = x^2 + x - e^{-x} \); \( y'' = 2x + 1 + e^{-x} \)

5. \[
y' = \frac{(2x+3e^x)(2e^x-x)-(x^2+3e^x)(2e^x-1)}{(2e^x-x)^2} = \frac{xe^x-x^2-2e^x e^x + 3e^x}{(2e^x-x)^2}
\]

6. The bullet going aloft means \( s>0 \). So, we need to solve \( s = 832t - 2.6t^2 = 0 \) and \( s = 832t - 16t^2 = 0 \). The first gives \( t=0 \) or \( 320 \); the second \( t=0 \) or \( 52 \).

So, 320 sec on the moon; 52 sec on the Earth.

Since \( s \) is a quadratic function w.r.t \( t \), it suffices to find the peak of \( s \), which attains at the middle points of two solutions. So, plugging in 160, we have \( S_{\text{moon}} = 66,560 \text{ ft} \); plugging in 26, \( S_{\text{Earth}} = 10,816 \text{ ft} \).
7.

a. \( x(0) = 3 \cos(0) + 4 \sin(0) = 3 \text{ ft} \)
\( x(\pi/2) = 4 \text{ ft} \)
\( x(\pi) = -3 \text{ ft} \)

b. \( x'(t) = -3 \sin t + 4 \cos t \). So
\( x'(0) = v(0) = 4 \text{ ft/s} \)
\( v(\pi/2) = -3 \text{ ft/s} \)
\( v(\pi) = -4 \text{ ft/s} \)

8.

\( y = f(u) = \sqrt{u} \), where \( u = g(x) = 3x^2 - 4x + 6 \).

\[
\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx} = \frac{1}{2} u^{-\frac{1}{2}} \cdot (6x-4) = \frac{1}{2} (3x^2-4x+6)^{\frac{1}{2}} (6x-4)
\]

\[
= (3x^2-4x+6)^{-\frac{1}{2}} (3x-2)
\]

9.

\( y = f(u) = e^u \), where \( u = 4\sqrt{x} + x^2 \).

\[
\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx} = e^u \left( 2 \cdot x^{\frac{1}{2}} + 2x \right) = 2e^{(4\sqrt{x} + x^2)} (x^{\frac{1}{2}} + x)
\]

10.

\( y' = 9 \sec^2 \left( \frac{x}{3} \right) \cdot \frac{1}{3} = 3 \sec^2 \left( \frac{x}{3} \right) \).

\( y' = 3 \cdot 2 \sec \left( \frac{x}{3} \right) \cdot [\sec \left( \frac{x}{3} \right)]' \)
\[
= 6 \sec \left( \frac{x}{3} \right) \cdot \sec \left( \frac{x}{3} \right) \cdot \tan \left( \frac{x}{3} \right) \cdot \frac{1}{3}
\]
\[
= 2 \sec \left( \frac{x}{3} \right) \cdot \tan \left( \frac{x}{3} \right)
\]