1. \[ \lim_{x \to \frac{\pi}{2}^-} \frac{2}{1 + e^{\tan x}} = 0 \]

since as \( x \to \frac{\pi}{2}^- \) we have that \( \tan(x) \to \infty \). Thimeans that \( 1 + e^{\tan x} \to \infty \).

2. Find \( \frac{dy}{dx} \) for these functions.

   (a) \( y = e^{x^2+5x}e^{7-x^2} \)
   simplify first. \( y = e^{x^2+5x+7-x^2} = e^{7+5x} \)
   \( y' = 5e^{7+5x} \)

   (b) \( y = \tan(e^{3x^2+4}) \)
   \( y' = \sec^2(e^{3x^2+4}) \cdot 6xe^{3x^2+4} \)

   (c) \( x = e^t + \sec(t^2) \)
   \( y = t^4 + 1 \)
   \[ \frac{dy}{dx} = \frac{dy}{dt} \frac{dt}{dx} = \frac{et^{4-1} + 4t^3}{e^t + 2t \sec(t^2) \tan(t^2)} \]

3. Find the tangent line at the point \((0, 2)\) for \( 2e^{xy} = x^2 + y \)

   \[ 2e^{xy} \cdot (1 * y + x * y') = 2x + y' \]

   now you have two choices: 1) solve for \( y' \) and then plug in the values for \( x \) and \( y \), or 2) plug in the values for \( x \) and \( y \) and then solve for \( y' \). I'm going to do the second choice since it is a bit easier.

   \[ 2e^0 \cdot (2 + 0) = 0 + y' \]
   \[ 4 = y' \]
   Answer: \( y - 2 = 4(x - 0) \)

4. Find all the points where the tangent line is vertical or horizontal.

   \( x = t^3 - 3t^2 + 5 \)
   \( y = 2t^2 + t \)

   If a tangent line is horizontal then the slope of the tangent line is zero. Since \( \frac{dy}{dx} = \frac{dy}{dt} \frac{dx}{dt} \), this means we are looking for \( \frac{dy}{dt} = 0 \)

   \[ \frac{dy}{dt} = 4t + 1 \]
   \[ 0 = 4t + 1 \]
   \[ t = -\frac{1}{4} \]

   Since the problem asks for points, plug the value of \( t \) back into the parametric formulas and solve for \( x \) and \( y \).

   Answer: at the point \((4.796875, -0.125)\) or in fraction form \( \left( \frac{307}{64}, \frac{-1}{8} \right) \)

   If the tangent line is vertical then the slope of the tangent line is undefined. That happens when \( \frac{dx}{dt} = 0 \)
\[
\frac{dx}{dt} = 3t^2 - 6t
\]

0 = 3t(t - 2)

so \( t = 0 \) or \( t = 2 \)

Answers: at the point (5, 0) and at the point (1, 10)

5. Find the equation of the tangent line at the point (3, 1) for the curve

\[
x = t^2 + 2t \\
y = t^3 - t + 1
\]

If this is the point, that means that \( x = 3 \) and \( y = 1 \). We to know the value of \( t \) that makes this happen.

\[
3 = t^2 + 2t \\
0 = t^2 + 2t - 3 \\
0 = (t + 3)(t - 1)
\]

\[
t = -3 \text{ or } t = 1
\]

The only value of \( t \) that works for both \( x \) and \( y \) is \( t = 1 \).

\[
\frac{dy}{dx} \bigg|_{t=1} = \frac{3 - 1}{2 + 2} = \frac{2}{4}
\]

Answer: \( y - 1 = \frac{2}{4}(x - 3) \)