1) a) $x = -\frac{1}{2}, -2, 1$ (where tangent line is horizontal)
b) $-2 < x < 1$ (where tangent line slopes upward)
c) $f(-1)$ (it looks like tangent line is steeper than at $x = 0$)
d) $-1$, since graph looks like $x = -1$ for $x > 3$

2) $\lim_{x \to 1} \frac{\sin(2x) - \sin(x)}{x-1} = \lim_{x \to 1} \frac{2\sin(x)\cos(x) - \sin(x)}{x-1}$
   $= \lim_{x \to 1} \frac{\sin(x)(2\cos(x) - 1)}{x-1}$
   $= \frac{\sin(1)(2\cos(1) - 1)}{0}$
   $= \frac{0}{0}$ (indeterminate)
Since this is an indeterminate form, we can use L'Hopital's Rule.

3) $V(t) = 5\sin(t) - e^{-\frac{t}{2}}\cos(t)$
   $V'(t) = 5\cos(t) + e^{-\frac{t}{2}}\sin(t)$
   The point is moving right since its velocity is always positive.

4) To show $e^x$ is on the graph, check that $e = e^x$.
   $e^x = (e^x)^x = e^{(e^x-x)} = e^x = e$. So, $(e, e)$ is on the graph. The derivative of $e^x$ is $e^x \ln(e)$, so the slope of the tangent line at $x = e$ is $e^x \ln(e) = e^x$. The tangent line has slope 1 and contains $(e, e)$ so has equation $y = e^{x}(x-e)$.

5) $\frac{d}{dx} e^{2x} = 2e^{2x}$
   $= 2e^{2x}$.
   $\frac{d}{dx} e^{x^2} = \frac{d}{dx} \left( e^{x^2} \right) = e^{x^2} \cdot 2x$.
   $= e^{x^2} \cdot 2x$.

6) $F''(x) = \frac{d}{dx} F'(x) = \frac{d}{dx} (-x^2) = -2x$.
   $F'(x) = \frac{d}{dx} F(x) = \frac{d}{dx} e^{-x^2} = -2xe^{-x^2}$.

7) An inverse function of a function $f(x)$ is a function $g(x)$ such that $f(g(x)) = x$ for all $x$ in the domain of $g$, and $g(f(x)) = x$ for all $x$ in the domain of $f$. For example, $\ln(x)$ is an inverse function for $e^x$ because $\ln(e^x) = x$ and $e^{\ln(x)} = x$ for $x > 0$.

8) When a quantity $B$ is determined by a quantity $A$, we can speak about the rate at which $B$ changes as $A$ changes. An average rate of change would be given by $\frac{B - B_0}{A - A_0}$, where $A_0$ represents some change in the value of $A$ and $\Delta B$ represents the resulting change in the value of $B$. Taking a limit as $\Delta A \to 0$ gives the derivative $\frac{dB}{dA}$ as an exact rate of change. [Often, $A$ represents time]
\[ \frac{d}{dy} (\ln(y^2+1))^{100} = 100 \left( \frac{1}{y^2+1} \right)^9 \cdot \frac{d}{dy} \ln(y^2+1) \]
\[ = 100 \cdot \left( \frac{1}{y^2+1} \right)^9 \cdot \frac{1}{2y} \]

10. (a) \[ \frac{d}{dx} \left( \frac{1}{y} \right) = \frac{d}{dx} \left( \frac{1}{\tan^{-1}(x)} \right) = -\frac{1}{x^2 + 1} \cdot \frac{d}{dx} \tan^{-1}(x) \]
\[ = -\frac{1}{x^2 + 1} \cdot \frac{1}{x^2 + 1} \cdot 2x \]

(b) \[ \frac{d}{dt} \left( \tan(t^2) + t^2 \cot(t) \right) = \frac{d}{dt} \tan(t^2) + t^2 \frac{d}{dt} \cot(t) \]
\[ = \sec^2(t^2) \cdot 2t \cdot \frac{d}{dt}(t^2) + t^2 \frac{d}{dt} \cot(t) + \cot(t) \cdot 2t \]
\[ = \sec^2(t^2) \cdot 2t + t^2 \cdot (-\csc^2(t^2)) + \cot(t) \cdot 2t \]

(c) \[ \frac{d}{dx} \sin^{-1}(2x) = \frac{1}{\sqrt{1-(2x)^2}} \cdot \frac{d}{dx} 2x \]
\[ = \frac{1}{\sqrt{1-4x^2}} \cdot 2x \cdot \ln(2) \]

11. \[ \frac{d}{dx} e^{\pi x} \cdot \pi^{\pi x} \cdot \pi^{\pi^{\pi x}} = e^{\pi x} \cdot \frac{d}{dx} (\pi^{\pi x} \cdot \pi^{\pi^{\pi x}}) \]
\[ = e^{\pi x} \cdot \left( \pi^{\pi x} \frac{d}{dx} \pi^{\pi x} + \pi^{\pi^{\pi x}} \frac{d}{dx} \pi^{\pi x} \right) \]
\[ = e^{\pi x} \cdot \left( \pi^{\pi x} \cdot \pi x + \pi^{\pi^{\pi x}} \cdot \pi^{\pi^{\pi x}} \cdot \ln(\pi) \right) \]

12. The limit is \( f'(2) \) when \( f(x) = \sqrt{5-x^2} \).
\[ f'(x) = \frac{1}{2\sqrt{5-x^2}} \cdot \frac{d}{dx} (5-x^2) = \frac{-x}{\sqrt{5-x^2}} \]
\[ f'(2) = \frac{-2}{\sqrt{5-2^2}} = \frac{-2}{\sqrt{1}} = -2 \]

13. \[ \sin(\sin^{-1}(x)) = x \quad \text{and} \quad \cos(\sin^{-1}(x)) = \frac{1}{\sqrt{1-x^2}} \]
So \( \sin(\sin^{-1}(x)) + \cos(\sin^{-1}(x)) = x + \sqrt{1-x^2} \).