Out of 8 - Parts (a) and (b) each out of 4.

(a) (i)
\[ f(x) = \log_e[x(x^2 + 1)^2] \]
\[ \Rightarrow f'(x) = \frac{1}{x(x^2 + 1)^2} \cdot \frac{d}{dx}[x(x^2 + 1)^2] \]
\[ = \frac{1}{x(x^2 + 1)^2} \cdot ((x^2 + 1)^2 + x \cdot 2(x^2 + 1) \cdot 2x) \]
\[ = \frac{1}{x} + \frac{4x}{x^2 + 1} \]

(ii)
\[ f(x) = e^{2x}(x^3 + 3x + 1) \]
\[ \Rightarrow f'(x) = 2e^{2x}(x^3 + 3x + 1) + e^{2x}(3x^2 + 3) \]
\[ = e^{2x}(2x^3 + 3x^2 + 6x + 5) \]

(iii)
\[ f(x) = (1 + x^3)^{1/2} \]
\[ \Rightarrow f'(x) = \frac{1}{2}(1 + x^3)^{1/2-1} \cdot 3x^2 \]
\[ = \frac{3x^2}{2\sqrt{1 + x^3}} \]

(b) Let \( L, W, P \) (in inches) denote the length, width and perimeter of the rectangle, respectively. Let \( A \) (in square inches) be the area of the rectangle. Let \( t \) denote time (in seconds). Then
\[ P = 2L + 2W, \quad A = LW, \]
and we are told
\[ \frac{dL}{dt} = 3 . \]

(i) The given condition says
\[ A = LW = 16 \quad \Rightarrow \quad W = \frac{16}{L} , \]
and we want to find \( \frac{dP}{dt} \). We have
\[ P = 2L + 2W = 2L + 2 \cdot \frac{16}{L} = 2L + \frac{32}{L} , \]
so by the chain rule
\[
\frac{dP}{dt} = \frac{dP}{dL} \frac{dL}{dt} = \left(2 - \frac{32}{L^2}\right) \cdot 3 = 6 - \frac{96}{L^2}.
\]

When \(L = 5\) we have
\[
\frac{dP}{dt} = 6 - \frac{96}{25} = \frac{54}{25},
\]
so the perimeter is changing at a rate of \(\frac{54}{25} = 2.16\) inches per second when \(L = 5\).

(ii) The given condition says
\[
P = 2L + 2W = 16 \quad \Rightarrow \quad W = \frac{1}{2}(16 - 2L),
\]
and we want to find \(\frac{dA}{dt}\). We have
\[
A = LW = L \cdot \frac{1}{2}(16 - 2L) = 8L - L^2,
\]
so by the chain rule
\[
\frac{dA}{dt} = \frac{dA}{dL} \frac{dL}{dt} = (8 - 2L) \cdot 3 = 24 - 6L.
\]

When the rectangle is a square, the length and width are equal at 4 inches, so
\[
\frac{dA}{dt} = 24 - 6(4) = 0,
\]
and the area is not changing (or changing at a rate of 0 inches per second) when the rectangle is a square.