1. Find \( \frac{d}{dx} \left( x^3 e^{4x} + \sqrt{2x-5} \right)^{10} \). Do not simplify.

\[
L = 10 \left( x^3 e^{4x} + \sqrt{2x-6} \right)^9 \left( 3x^2 e^{4x} + 3x e^{4x} + \frac{2}{2 \sqrt{2x-6}} \right)
\]

2. Find \( \frac{d}{dx} \left( \frac{\ln(2x^4 + 5x)}{3x+2} \right) \). Do not simplify.

\[
L = \frac{8x^3 + 5}{(3x+2) \cdot 2x^4 + 5x} - \ln \left( \frac{2x^4 + 5x}{3x+2} \right) \cdot 3
\]
3. (a) Solve for \( x \): \( 4 \cdot 3^{x+1} = 17 \)

\[ 4 \cdot 3^{x+1} = 17 \]
\[ 3^{x+1} = \frac{17}{4} \]
\[ \ln 3^{x+1} = \ln \frac{17}{4} \]
\[ (x+1) \ln 3 = \ln \frac{17}{4} \]
\[ x+1 = \frac{\ln \frac{17}{4}}{\ln 3} \]
\[ x = -1 + \frac{\ln \frac{17}{4}}{\ln 3} \]

(b) \( 5e^{2x-1} = 13 \)

\[ e^{2x-1} = \frac{13}{5} \]
\[ \ln e^{2x-1} = \ln \frac{13}{5} \]
\[ 2x-1 = \ln \frac{13}{5} \]
\[ x = 1 + \frac{\ln \frac{13}{5}}{2} \]

4. Let \( f(x) = x^3 - 3x^2 - 24x + 12 \). Find and classify the critical values.

\[ f'(x) = 3x^2 - 6x - 24 = 3(x^2 - 2x - 8) = 0 \text{ for C.P.} \]

\[ x^2 - 2x - 8 = 0 \]
\[ (x - 4)(x + 2) = 0 \]
\[ x = 4, -2 \]

\[ \begin{array}{c|c|c}
  & + & - \\
\hline
-2 & 1 & + \\
4 & & \\
\end{array} \]

\[ \text{max at } x = -2, \text{ min at } x = 4. \]

OR

\[ f''(x) = 6x - 6 \]

\[ f''(-2) = -18 < 0 \Rightarrow \text{max at } x = -2 \]
\[ f''(4) = 18 > 0 \Rightarrow \text{min at } x = 4. \]
5. Find the equation of the tangent line to \( f(x) = x^3 \ln x \) at \( x = e \).

\[
y(e) = e^3 \ln e = e^3
\]

\[
f'(x) = x^3 \cdot \frac{1}{x} + 3x^2 \ln x
\]

\[
\text{Slope } = f'(e) = e^2 + 3e^2 \ln e = 4e^2
\]

\[
y - e^3 = 4e^2 (x - e) = 4e^2 x - 4e^3
\]

\[
y = 4e^2 x - 3e^3
\]

6. Let \( f(x) = x^5 - 15x^4 + 12 \). (a) Find the inflection points. (b) Specify where \( f \) is concave up and where it is concave down.

\[
f' = 5x^4 - 60x^3
\]

\[
f'' = 20x^3 - 180x^2 = 20x^2 (x - 9) = 0 \text{ at } x = 0, 9
\]

\[
f''
\]

\[
\begin{array}{c|c|c|c}
& - & + \\
0 & 9 & \\
\end{array}
\]

\[
\text{Sign Change:}
\]

\[
\text{Change for } f'' \]

\[
\text{so } x = 0 \text{ is}
\]

\[
\text{NOT an infl. pt.}
\]

\[
\text{(b) } f \text{ is CC↓ for } x < 9 \text{ CC↑ for } x > 9
\]
A rectangular area along a river is to be fenced on three sides with fencing costing $8 per foot and subdivided into three smaller rectangular areas with interior fencing costing $2 per foot. The total area is 160 square feet. Find the dimensions $x, y$ for smallest cost.

$$A = xy = 160$$

$$y = \frac{160}{x}$$

$$C = 8x + 8y + 2y + 2y$$

$$= 8x + 20y$$

$$= 8x + \frac{3200}{x}$$

$$= 8x + 3200 \cdot x^{-1}$$

$$C' = 8 - 3200x^{-2} = 0$$

$$8 = \frac{3200}{x^2} \quad \Rightarrow \quad x = \frac{3200}{8} = 400$$

<table>
<thead>
<tr>
<th>X = 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y = 160</td>
</tr>
<tr>
<td>80'</td>
</tr>
</tbody>
</table>

8. A particle moves from the origin to the right along the $x$-axis according to $s(t) = t^3 - t^4$, $0 \leq t \leq 1$, where $s$ is measured in meters and $t$ in seconds. (a) Find the time when the velocity is zero. (b) Find the maximum distance the particle is from the origin.

(a) $v = s' = 3t^2 - 4t^3 = t^2 (3 - 4t) = 0$ for $t = 0, 3/4$ sec.

(b) $s(0) = 0$

$s(3/4) = (\frac{3}{4})^3 - (\frac{3}{4})^4 = (\frac{3}{4})^3 (1 - \frac{3}{4}) = \frac{27}{64} \cdot \frac{1}{4} = \frac{27}{256}$ ft

$s(1) = 0$

Do max s is 27/256 ft.
9. Let \( f(x) = x^4 - 4x^2 \). Find the absolute maximum and absolute minimum of \( f \) on the interval \([-1, 2]\).

\[
f'(x) = 4x^3 - 8x = 4x(x^2 - 2) = 0 \text{ at } x = -\sqrt{2} \text{ and } +\sqrt{2} \text{ and } x = 0
\]

<table>
<thead>
<tr>
<th>( x )</th>
<th>( f(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( \sqrt{2} )</td>
<td>( 2^2 - 4 \cdot 2 = -4 )</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

\(-4 = \text{ min value} \)

\(0 = \text{ max value} \)

10. Suppose \( f(x) \) is a function such that \( f'(x) = (x + 3)^3 (x - 2)^2 (13 - 4x)^5 \). Find and classify the critical values.

(a) \( x = -3, 2, \frac{13}{4} \)

\[
\begin{array}{c|c|c|c}
\text{ } & -3 & 2 & \frac{13}{4} \\
\hline
f' & - & + & + & - & - \text{ out here} \\
\hline
& \sqrt{\ } & / & \backslash & \text{Min} & \text{neither} & \text{Max} \text{X-3 > 0} \\
& & & & x-2 > 0 & \text{but } 13-4x < 0 & \end{array}
\]