I. Find the derivative. **DO NOT SIMPLIFY** your answer.

1. $y = x^4 + x^e + x^\pi + e^x + e^\pi + \ln x + \ln 5$

$y' = 4x^3 + ex^{e-1} + \pi x^{\pi-1} + e^x + 0 + \frac{1}{x} + 0$

2. $y = xe^{3x+5}$ $\boxed{y' = x \cdot e^{3x+5} \cdot 3 + e^{3x+5}(1)}$

copy erule inside copy deriv. of x

3. $y = \ln\left(2x^3 + \sqrt{x}\right) = \ln(2x^3 + x^{\frac{1}{2}})$ those parentheses are important!

$\boxed{y' = \frac{1}{2x^3 + x^{\frac{1}{2}}} \cdot (6x^2 + \frac{1}{2}x^{-\frac{1}{2}})}$

4. $y = \frac{e^{4x^2+1}}{13x-8}$ $\boxed{y' = \frac{(13x-8)e^{4x^2+1} \cdot 8x - e^{4x^2+1}(13)}{(13x-8)^2}}$

5. $y = 5e^{\sqrt[3]{2x^7-5x+3}} = 5e^{(2x^7-5x+3)^{\frac{1}{3}}}$

$\boxed{y' = 5e^{(2x^7-5x+3)^{\frac{1}{3}}} \cdot \frac{1}{3}(2x^7-5x+3)^{-2/3} \cdot (14x^6-5)}$

e rule power rule inside

II. Find the **second derivative,** $\frac{d^2y}{dx^2}$. You should simplify the first derivative a bit before you differentiate again, but do not simplify the second derivative.

6. $y = (e^{2x}+8)^7$ $y' = 7(e^{2x}+8)^6 \cdot e^{2x} \cdot 2 = 14e^{2x}(e^{2x}+8)^6$

$\boxed{y'' = 14e^{2x} \cdot 6(e^{2x}+8)^5 \cdot e^{2x} \cdot 2 + (e^{2x}+8)^6 \cdot 14e^{2x} \cdot 2}$

copy power erule inside copy erule inside

7. $y = \ln(3x+1)$ $y' = \frac{1}{3x+1} \cdot 3 = 3(3x+1)^{-1}$

$\boxed{y'' = -3(3x+1)^{-2} \cdot 3}$

III. **Abstract Functions.**

8. Suppose $h(x)=\ln(f(x))$, and the equation of the tangent line to $f(x)$ at $x=2$ is given by $y=30x-55$. Find $h'(2)$.

$h'(x) = \frac{1}{f(x)} \cdot f'(x)$ So $h'(2) = \frac{f'(2)}{f(2)}$.

$f'(2) = 30$. $f(2) = 30(2)-55 = 5$.

So $h'(2) = \frac{30}{5} = \boxed{6}$

9. Suppose f and g are differentiable functions which have the following values

a. Find $h'(1)$ if $h(x)=f(\ln x)+\ln(g(x))$

x	$f(x)$	$g(x)$	$f'(x)$	$g'(x)$
0	16	-9	8	14
1	5	3	7	-6

$h'(x) = f'(\ln x) \cdot \frac{1}{x} + \frac{1}{g(x)} \cdot g'(x)$

$h'(1) = \frac{f'(\ln 1)}{1} + \frac{g'(1)}{g(1)} = \frac{f'(0)}{1} + \frac{-6}{3} = 8-2 = \boxed{6}$

b. Find $h'(1)$ if $h(x)=x^2e^{f(x)}$

$h'(x) = x^2 \cdot e^{f(x)} \cdot f'(x) + e^{f(x)} \cdot 2x$

$h'(1) = 1^2 \cdot e^{f(1)} \cdot f'(1) + e^{f(1)} \cdot 2$

$= e^5 \cdot 7 + e^5 \cdot 2$

$= \boxed{9e^5}$