# Chain Rule

**Def** $y = f(g(x))$

$y' = f'(g(x)) \cdot g'(x)$

Ex) $f(x) = (x^2+1)^5$

$f'(x) = 5(x^2+1)^4 \cdot (2x)$

$f'(x) = 10x(x^2+1)^4$

Ex) $f(x) = \sqrt{2x+1}$

$f(x) = (2x+1)^{1/2}$

$f'(x) = \frac{1}{2}(2x+1)^{-1/2} \cdot (2)$

$f'(x) = \frac{1}{2(2x+1)^{1/2}} \cdot \cancel{2} = \frac{1}{(2x+1)^{1/2}}$ or $\frac{1}{\sqrt{2x+1}}$

Ex) $f(x) = \sqrt{4x^2+7}$

$f(x) = (4x^2+7)^{1/2}$

$f'(x) = \frac{1}{2}(4x^2+7)^{-1/2} \cdot 8x$

$f'(x) = \frac{8x}{2(4x^2+7)^{1/2}} = \boxed{\frac{4x}{\sqrt{4x^2+7}}}$

Ex) $f(x) = e^{(4x^3+2x+1)}$

$e^{\text{something}}$

$f'(x) = e^{(4x^3+2x+1)} \cdot (12x^2+2)$ ✓

$\boxed{f'(x) = (12x^2+2)\, e^{(4x^3+2x+1)}}$

Ex) $f(x) = \ln(3x^3+4)$

$f'(x) = \frac{1}{(3x^3+4)} \cdot (9x^2)$

Ex) $f(x) = \underbrace{3x}_{\downarrow 3} \cdot \underbrace{(x^2+2)^4}_{\downarrow 4(x^2+2)^3 \cdot 2x}$

$8x(x^2+2)^3$

$f'(x) = 3x(8x(x^2+2)^3) + (3)(x^2+2)^4$

$f'(x) = 24x^2(x^2+2)^3 + 3(x^2+2)^4$