Find tangent line to $f(x)=x^2$ that goes through (1,-1).

Point of tangency is at

(A) $(1+\sqrt{2}, 3-2\sqrt{2})$

(B) $(1+\sqrt{2}, 3+2\sqrt{2})$

(C) (1, -1)

(D) $(1-\sqrt{2}, 3-2\sqrt{2})$

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(A) $(1+\sqrt{2}, 3-2\sqrt{2})$

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Power rule

$$f(x) = x^2$$

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Find f′ at x=2 (using the definition of the derivative).

Power rule

$$f(x) = x^2$$

$$f'(2) = \lim_{h \to 0} \frac{(2+h)^2 - 2^2}{h}$$

Power rule

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$$= \lim_{h \to 0} \frac{4 + 4h + h^2 - 4}{h}$$

Power rule

$$f(x) = x^2$$

$$f'(2) = \lim_{h \to 0} \frac{(2+h)^2 - 2^2}{h}$$

$$= \lim_{h \to 0} \frac{4 + 4h + h^2 - 4}{h}$$

$$= \lim_{h \to 0} \frac{4h + h^2}{h}$$

Power rule

$$f(x) = x^2$$

$$f'(2) = \lim_{h \to 0} \frac{(2+h)^2 - 2^2}{h}$$

$$= \lim_{h \to 0} \frac{4 + 4h + h^2 - 4}{h}$$

$$= \lim_{h \to 0} \frac{4\cancel{h} + h^{\cancel{2}}}{\cancel{h}}$$

Power rule

$$f(x) = x^2$$

$$f'(2) = \lim_{h \to 0} \frac{(2+h)^2 - 2^2}{h}$$

$$= \lim_{h \to 0} \frac{4 + 4h + h^2 - 4}{h}$$

$$= \lim_{h \to 0} \frac{4\cancel{h} + h^{\cancel{2}}}{\cancel{h}} = 4$$

Power rule

$$f(x) = x^2$$

Power rule

$$f(x) = x^2$$

Find f′ at all points x at the same time

Power rule

$$f(x) = x^2$$

$$f'(x) = \lim_{h \to 0} \frac{(x+h)^2 - x^2}{h}$$

Power rule

$$f(x) = x^2$$

$$f'(x) = \lim_{h \to 0} \frac{(x+h)^2 - x^2}{h}$$

$$= \lim_{h \to 0} \frac{x^2 + 2hx + h^2 - x^2}{h}$$

Power rule

$$f(x) = x^2$$

$$f'(x) = \lim_{h \to 0} \frac{(x+h)^2 - x^2}{h}$$

$$= \lim_{h \to 0} \frac{x^2 + 2hx + h^2 - x^2}{h}$$

$$= \lim_{h \to 0} \frac{2hx + h^2}{h}$$

Power rule

$$f(x) = x^2$$

$$f'(x) = \lim_{h\to 0} \frac{(x+h)^2 - x^2}{h}$$

$$= \lim_{h\to 0} \frac{x^2 + 2hx + h^2 - x^2}{h}$$

$$= \lim_{h\to 0} \frac{2\cancel{h}x + h^{\cancel{2}}}{\cancel{h}}$$

Power rule

$$f(x) = x^2$$

$$f'(x) = \lim_{h \to 0} \frac{(x+h)^2 - x^2}{h}$$

$$= \lim_{h \to 0} \frac{x^2 + 2hx + h^2 - x^2}{h}$$

$$= \lim_{h \to 0} \frac{2\cancel{h}x + h^{\cancel{2}}}{\cancel{h}} = 2x$$

Power rule

$$f(x) = x^3$$

$$f'(x) = \lim_{h \to 0} \frac{(x+h)^3 - x^3}{h}$$

$$= \lim_{h \to 0} \frac{\cancel{x^3} + 3\cancel{h}x^2 + 3h^{\cancel{2}}x + h^{\cancel{3}\,2} - \cancel{x^3}}{\cancel{h}}$$

$$= 3x^2$$

Power rule

$$f(x) = x^n$$

$$f'(x) = nx^{n-1}$$

Derivative properties

$$\frac{d}{dx}(f(x) + g(x)) = \frac{df}{dx} + \frac{dg}{dx} \quad (4.1)$$

$$\frac{d}{dx}Cf(x) = C\frac{df}{dx} \quad (4.2)$$

Derivative properties

$$\frac{d}{dx}\left(f(x)+g(x)\right)=\frac{df}{dx}+\frac{dg}{dx} \tag{4.1}$$

$$\frac{d}{dx}Cf(x)=C\frac{df}{dx} \tag{4.2}$$

- Notation:

$$y = f(x)$$

Leibniz → $\frac{dy}{dx} = f'(x)$ ← Newton