What you'll Learn About

- How to find the derivative of:
- Functions with positive and negative integer powers
- Functions with products and quotients

A) Using a definition of the derivative find the derivative of $y = x^2$ at $x = a$

B) Using a definition of the derivative find the derivative of $y = x^3$ at $x = a$

C) Using a definition of the derivative find the derivative of $y = x^2 + 4$ at $x = a$

Find the derivative using the power rule

D) $f(x) = 3 + x^2 - x^3 + x^5$

E) $y = \frac{x^4}{5} + 3x^7$

F) $y = x^{-3}$

G) $y = \frac{x^{-5}}{3} + \frac{x^{-3}}{4} - \frac{1}{x}$

H) $f(x) = 4\sqrt{x} - \frac{1}{x} + \frac{2}{\sqrt{x}}$

Find the Horizontal Tangents of each curve

I) $x^3 + 2x^2 = 0$

J) $\frac{2}{3}x^3 - \frac{5}{2}x^2 - 3x = 0$

Using Algebra and the Product Rule to take a derivative

J) $y = (x^2 + 3)(x^3 - x)$

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Using Algebra and the Quotient Rule to take a derivative

K) $f(x) = \frac{x^3 + 9}{x}$

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Take the Derivative of the function

L) $y = (x^2 + x + 2)(x^5 + x^3 + 5x)$

Take the Derivative of the function

M) $f(x)=\dfrac{x^4}{2-x^2}$

N) $f(x)=\left(5-x^2\right)\left(3-x\right)^{-1}$

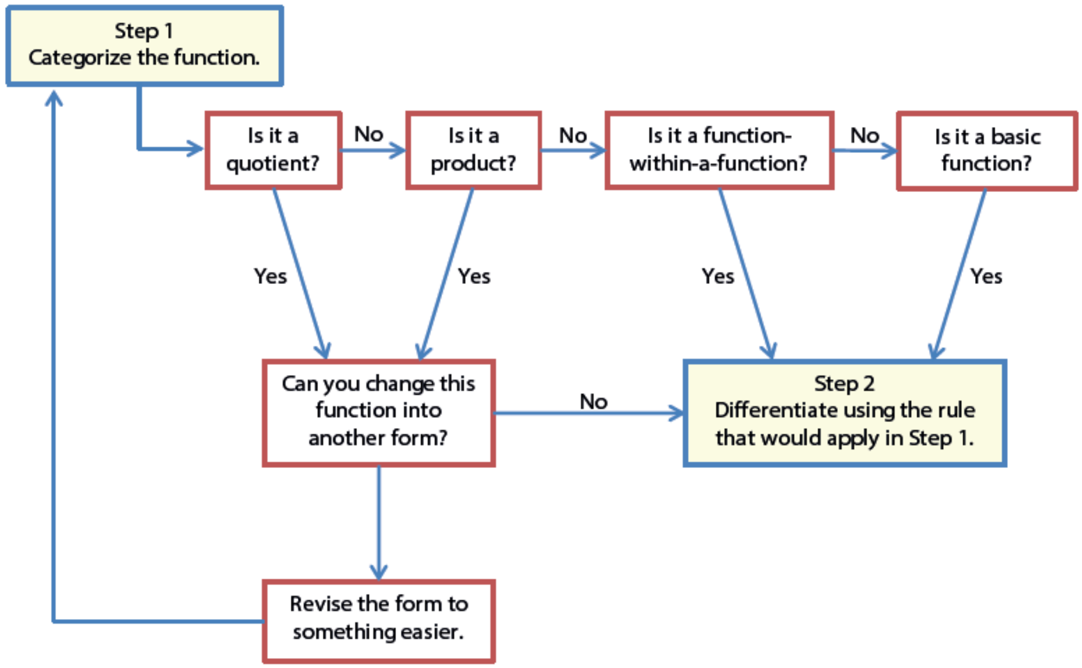
O) $f(x)=\dfrac{(x+3)(x-4)}{(x+1)(x-3)}$

P) $f(x)=\dfrac{\sqrt[3]{x}+1}{\sqrt[3]{x}-1}$

	Find the equation for the tangent line at the given point Q) $y = \frac{x^5 + 2x}{x^2}$ at x = 1 R) $y = 5x^2 + 3$ at x = 3 S) Find an equation of the line perpendicular to the tangent to the curve $y = 4x^3 - 6x + 2$ at the point (2, 22). T) Find the points on the curve $y = x^3 - 3x^2 - 9$ where the tangent is parallel to the x-axis

	U) Suppose u and v are differentiable functions at x = 2 and u(2) = 3, $u'(2) = 3$, v(2)=1, $v'(2) = 2$ i) Find $\frac{d}{dx}(uv)$ ii) Find $\frac{d}{dx}\left(\frac{u}{v}\right)$ iii) Find $\frac{d}{dx}(3u - 2v + 2uv)$ V) Find the derivative of y = x with respect to x W) Find the derivative of y = x with respect to t X) Find the derivative of y = x with respect to P

Flowchart: Selecting a Procedure for Derivatives



What you'll Learn About

- How to find the derivative of a trig function

A) $y = 5 + x^2 - \tan x$

B) $y = x\sin x$

C) $y = \frac{4}{\cot\theta}$

C) $y = \frac{4}{\cot\theta}$

D) $y = \frac{\sin\theta - \cos\theta}{\sec\theta + \csc\theta}$

	Find equations for the lines that are tangent and normal to the graph of y = 2cosx at $x = \frac{\pi}{4}$ Find the points on the curve y = cot x, $0 \le x \le \frac{\pi}{2}$, where the tangent line is parallel to the line y = -2x.

What you'll Learn About

- How to find the derivative of a composite function

$A)\quad y = \sin(x)$

$B)\quad y = \sin(x^2 - 4)$

$C)\quad y = cos^2(3x)$

$D)\quad y = (\csc x)^2 \cot x$

	$E)\quad y = 5\sqrt{\sin(2x) + \cos(2x)}$ $E)\quad y = (\sin x + \cos x)^{-2}$ $F)\quad y = \dfrac{1}{\left(\sin\left(x^3\right) + \cos\left(x^3\right)\right)^4}$

	$G) \quad y = \frac{x^2}{\sqrt{1+x^3}}$ $G) \quad y = \frac{x^2}{\sqrt{1+x^3}}$ $H) \quad y = \left(5x + \sqrt[3]{x}\right)^{-4}$

	$I)\quad y = x^4(3\text{x} - 6)^5$ $J)\quad y = \dfrac{1}{(1-2x)^3}$

	$L) \quad y=\sqrt{3x\csc x}$ $M) \quad y=3x\sqrt{\csc x}$ N) Find y″ if $y=9\cot\left(\frac{x}{3}\right)$

Suppose that functions f and g and their derivatives have the following values at x = 2 and x = 3.

x	f(x)	g(x)		
2	8	2	1/3	-3
3	3	-4	2π	5

Evaluate the derivatives with respect to x

A) $2f(x)$ at $x = 2$

B) $f(x) + g(x)$ at $x = 3$

C) $f(x)g(x)$ at $x = 3$

D) $\dfrac{f(x)}{g(x)}$ at $x = 2$

	$E)\quad f\left(g(x)\right)$ at $x=2$ $\qquad F)\quad \sqrt{f(x)}$ at $x=2$ $G)\quad \dfrac{1}{g^2(x)}$ at $x=3$ $F)\quad \sqrt{f^2(x)+g^2(x)}$ at $x=2$

What you'll Learn About

- How to find the derivative of inverse functions

Find the derivative of the inverse sine function using implicit differentiation

	$A)\quad y = \arcsin\left(x^2\right)$ $\qquad B)\quad y = \arccos\left(\frac{1}{x}\right)$ $C)\quad y = x^2\arccos(\sin x)$ $D)\quad y = x\sqrt{1-x^2} + \arctan\sqrt[3]{x}$ $\qquad E)\quad f(x) = arccsc\left(5x^3 - \sin x\right)$ Find the equation of the tangent line $F)\quad y = \csc^{-1}x \text{ at } x = 2$

	G) Find the derivative of f(x) = sinx at $x = \frac{\pi}{6}$ H) Find the derivative of f(x) = arcsinx at $x = \frac{1}{2}$ 1. Let f be a differentiable function such that f(3) = 15, f(6) = 3, $f'(3) = -8$ and $f'(6) = -2$. The function g is differentiable and $g(x) = f^{-1}(x)$ for all x. What is the value of $g'(15)$? a) -1/2 b) -1/8 c) 1/6 d) 1/3 e) The value of $g'(15)$ cannot be determined

	2. Let f be a differentiable function such that f(3) = 5, f(8) = 4, $f'(3) = 6$ and $f'(8) = 3$. The function g is differentiable and $g(x) = f^{-1}(x)$ for all x. What is the value of $g'(4)$? a) -1/2 b) -1/8 c) 1/6 d) 1/3 e) The value of $g'(4)$ cannot be determined 3. Let f be a differentiable function such that f(3) = 5, f(8) = 4, $f'(3) = 6$ and $f'(8) = 3$. The function g is differentiable and $g(x) = f^{-1}(x)$ for all x. What is the value of $g'(5)$? a) -1/2 b) -1/8 c) 1/6 d) 1/3 e) The value of $g'(5)$ cannot be determined 4. If $f(2) = -3$, $f'(2) = \frac{4}{3}$, and $g(x) = f^{-1}(x)$, what is the equation of the tangent line to g(x) at x = -3? A) $y-2 = \frac{-3}{4}(x+3)$ B) $y+2 = \frac{-3}{4}(x-3)$ C) $y-2 = \frac{3}{4}(x+3)$ D) $y+3 = \frac{3}{4}(x-2)$ E) $y-2 = \frac{4}{3}(x+3)$

5. If $f(2) = -3$, $f'(2) = \frac{-4}{3}$, and $g(x) = f^{-1}(x)$,

what is the equation of the tangent line to g(x)

at x = -3?

A) $y-2 = \frac{-3}{4}(x+3)$

B) $y+2 = \frac{-3}{4}(x-3)$

C) $y-2 = \frac{3}{4}(x+3)$

D) $y+2 = \frac{4}{3}(x-3)$

E) $y-2 = \frac{4}{3}(x+3)$

6. If $f(2) = -3$, $f'(2) = \frac{-3}{4}$, and $g(x) = f^{-1}(x)$,

what is the equation of the tangent line to g(x)

at x = -3?

A) $y-2 = \frac{-3}{4}(x+3)$

B) $y+3 = \frac{-4}{3}(x+2)$

C) $y-2 = \frac{3}{4}(x+3)$

D) $y+2 = \frac{4}{3}(x-3)$

E) $y-2 = \frac{-4}{3}(x+3)$

What you'll Learn About
How to take the derivative of exponential and logarithmic functions

$A)\quad y = 5^x$

$B)\quad y = 7^{x^2}$

$C)\quad y = 5^{\sin x}$

$D)\quad y = 6^{\arctan x^3}$

$E)\quad y = e^x$

$F)\quad y = 5e^{5x}$

$G)\quad y = (5e)^{5x}$

$H)\quad y = e^{\frac{-3}{4}x}$

$I)\quad y = x^3 e^{4x} - x^4 e^{2x}$

$B)\quad y = 7^{x^2}$

	$A) \quad y=\log_5\left(x^3\right)$ $B) \quad y=\log_6 \sqrt[3]{x}$ $C) \quad y=\log_5\left(\frac{4}{x}\right)$ $D) \quad y=\frac{5}{\log_7\left(x^2\right)}$ $E) \quad y=\ln x$ $F) \quad y=\ln\left(x^4\right)$ $G) \quad y=(\ln x)^4$ $H) \quad y=\ln\left(\frac{5}{x}\right)$ $I) \quad y=x^3 \ln\left(x^2\right)-\ln(\ln(\arcsin x))$

What you'll Learn About
How to take the derivative of functions in Parametric Form

Graph the parametric function given

$A)\quad x = t^2 - 3 \quad y = t \quad t \geq 0$

B) Find the derivative of the function at t=5

C) Find the equation of the tangent line at t=1

$x = 3t \quad y = 9t^2$

D) Find the equation of the tangent line at $\theta = \frac{\pi}{4}$

$x = \cos\theta \quad y = \sin\theta$

E) Find the equation of the tangent line at $t = \pi$

$x = \sec^2(2t) - 1 \quad y = \tan(2t)$

	A curve C is defined by the parametric equations $x = t^2 - 4t + 1$ and $y = t^3$. Determine the equation of the line tangent to the graph of C at the point (1, 64)? Determine the horizontal and vertical tangents for the parametric curve $A)\quad x = 1 - t \quad y = t^2 - 4t$ $B)\quad x = \cos\theta \quad y = 2\sin(2\theta)$

$$\frac{d}{dx}e^u = e^u \frac{du}{dx}$$	The derivative of e^x is: (Itself)(Derivative of the power)
$$\frac{d}{dx}\left(a^u\right) = a^u \ln a \frac{du}{dx}$$	The derivative of a^x is: (Itself)(*ln* of the base)(Derivative of the power)
$$\frac{d}{dx}\ln u = \frac{1}{u}\frac{du}{dx}$$	The derivative of a^x is: (Itself)(*ln* of the base)(Derivative of the power)
$$\frac{d}{dx}\log_a u = \frac{1}{u \ln a}\frac{du}{dx}$$	The derivative of *ln u* is: (one over what you are taking the ln of) times now you should be in the numerator (Derivative of what you are taking the *ln* of)
	$$\frac{d}{dx}\sin^{-1} u = \frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$$ • One over the square root of 1 – the ratio squared all times the derivative of the ratio. $$\frac{d}{dx}\cos^{-1} u = -\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$$ • Negative One over the square root of 1 – the ratio squared all times the derivative of the ratio.

	$$\frac{d}{dx}\tan^{-1}u=\frac{1}{1+u^2}\frac{du}{dx}$$ • One over 1 + the ratio squared all times the derivative of the ratio. $$\frac{d}{dx}\cot^{-1}u=-\frac{1}{1+u^2}\frac{du}{dx}$$ • Negative One over 1 + the ratio squared all times the derivative of the ratio. $$\frac{d}{dx}\sec^{-1}u=\frac{1}{\lvert u\rvert\sqrt{u^2-1}}\frac{du}{dx}$$ • One over the absolute value of the ratio times the square root of the ratio squared minus 1 all times the derivative of the ratio. $$\frac{d}{dx}\csc^{-1}u=-\frac{1}{\lvert u\rvert\sqrt{u^2-1}}\frac{du}{dx}$$ Negative One over the absolute value of the ratio times the square root of the ratio squared minus 1 all times the derivative of the ratio.

When you do the power rule the base does not change only the power

- Once you have done the power rule, you are done with the powers

When you do the derivative of a trig function the angle does not change

Chain Rule

- Polynomial
  - (Power Rule)(Derivative Base)

$$y = (1 + x^2)^5$$

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

- Trig Function
  - (Power rule)(Derivative of base)(Derivative of angle)

$$y = \sin^5(3x)$$

$$y' = 5\sin^4(3x) \cdot (\cos(3x)) \cdot 3$$

Chain Rule

- Product and quotient rule over rule everything when you have 2 functions

$$y = x(\sin 3x)^{1/2}$$

$$y' = x[\frac{1}{2}(\sin 3x)^{-1/2} \cdot (\cos(3x)) \cdot 3] + (\sin 3x)^{1/2}$$

  - If the base is a product or quotient rule then you must start with the power rule

$$y = (x \sin 3x)^{1/2}$$

$$y' = \frac{1}{2}(x \sin 3x)^{-1/2} \cdot [x(\cos(3x)) \cdot 3] + (\sin 3x)$$