

The Derivative and Its Definition: math practice, College – download the PDF

21 problems graded by difficulty (★ easy, ★★ medium, ★★★ hard). Try first, without looking at the solutions!

1 Average rate of change

★ ★ ★

Let $f(x) = x^2 + 1$. Compute the average rate of change of f from $x = 1$ to $x = 4$.

2 A linear difference quotient

★ ★ ★

Let $f(x) = 5x - 2$. Simplify $\frac{f(x+h) - f(x)}{h}$ and find $f'(x)$.

3 Power rule practice

★ ★ ★

Differentiate: (a) x^7 ; (b) x^{10} ; (c) $6x^4$.

4 A quadratic polynomial

★ ★ ★

Find the derivative of $f(x) = 3x^2 - 8x + 11$.

5 Skateboard distance



A skateboarder's distance from a ramp is $s(t) = 4t^2$ feet after t seconds. Find the average velocity between $t = 1$ and $t = 3$, in feet per second and in meters per second (1 ft = 0.3048 m).

6 True or false?



Decide whether each statement is true or false and justify. (a) $\frac{d}{dx}(12) = 12$. (b) $\frac{d}{dx}(5x) = 5$. (c) $\frac{d}{dx}(x^4) = 4x^4$. (d) If f is continuous at a , then f is differentiable at a .

7 Slope of a tangent



Find the slope of the tangent to $f(x) = x^2$ at $x = 3$, then write the tangent line.

8 Derivative at a point from the definition



Let $f(x) = x^2 - 4x$. Use the limit definition to find $f'(2)$.

9 Tangent line to a cubic



Find the equation of the tangent line to $f(x) = 2x^3 - x$ at $x = 1$.

10 Temperature during the day

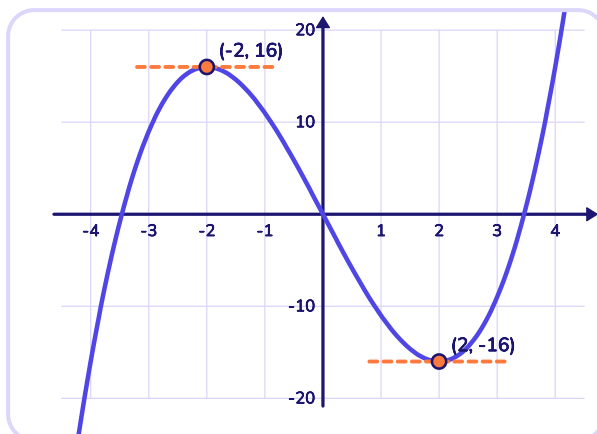


The temperature in a greenhouse is $T(t) = -0.5t^2 + 6t + 50$ degrees Fahrenheit, t hours after sunrise. (a) Find $T'(t)$. (b) Interpret $T'(2)$ and $T'(8)$. (c) When is the temperature at its peak, and what is it in $^{\circ}\text{F}$ and in $^{\circ}\text{C}$?

11 Horizontal tangents



Find the points where the graph of $f(x) = x^3 - 12x$ has a horizontal tangent.



12 Powers and roots



Let $f(x) = \frac{1}{x^2} + 3\sqrt{x}$. Find $f'(x)$ and then $f'(4)$.

13 A corner



Let $f(x) = |x - 2|$. Show that f is not differentiable at $x = 2$.

14 Where is the slope 4?



At which point of the parabola $y = x^2 - 6x + 1$ is the tangent line of slope 4?

15 Definition applied to a reciprocal



Use the limit definition to find the derivative of $f(x) = \frac{1}{x}$ for $x \neq 0$. Then compute $f'(2)$ and write the tangent line at $x = 2$.

16 Making a piecewise function differentiable

★★★

Let $f(x) = x^2$ for $x \leq 1$ and $f(x) = ax + b$ for $x > 1$. Find a and b so that f is differentiable at $x = 1$.

17 Marginal cost

★★★

A workshop's cost to produce q units is $C(q) = 0.02q^2 + 3q + 500$ dollars. (a) Find $C'(q)$. (b) Compute $C'(100)$ and compare it with the actual extra cost $C(101) - C(100)$.

18 Tangent lines through an outside point

★★★

Find every tangent line to the parabola $y = x^2$ that passes through the point $(0, -4)$.

19 Parallel tangents

★★★

Find the tangent lines to $y = x^3$ that are parallel to the line $y = 12x + 5$.

20 A ball thrown upward

★★★

A ball's height in feet is $h(t) = -16t^2 + 96t + 10$, t in seconds. (a) Find the velocity $v(t) = h'(t)$. (b) Find $v(1)$ in ft/s and m/s. (c) When does the ball reach its maximum height, and how high is it (in feet and meters)? (d) Find $v(5)$ and explain its sign.

21 A vertical tangent

★★★

Let $f(x) = x^{1/3}$ (the cube root). Show that f is continuous but not differentiable at 0 , and say what the graph looks like there.



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