\[ \frac{\partial}{\partial s} \mathbf{r} = \frac{\mathbf{r}(s + \Delta s, t) - \mathbf{r}(s, t)}{\Delta s} \]

\[ \frac{\partial^2}{\partial t} \mathbf{r} = \frac{\mathbf{r}(s, t + \Delta t) - \mathbf{r}(s, t)}{\Delta t} \]

\[ |\mathbf{a} \times \mathbf{b}| = \text{area of parallelogram defined by } \mathbf{a} \text{ and } \mathbf{b} \]

\[ \mathbf{r}(s, t) = \chi(s, t) \hat{\mathbf{r}} \]

Sal Khan (Multivariable Calculus)
Scale

75 million users to date

>6 million Unique users / month

>220 million lessons delivered

1 billion problems answered

216 countries

20,000 classrooms around the world
Derivative intuition

Related videos: Calculus: Derivatives 1 (new HD version), Calculus: Derivatives 1

\[ f(x) = 7x^3 \]

Drag each one of the 7 orange points up and down to adjust the slope of the corresponding tangent line.

The derivative of a function is defined as the slope of a line tangent to the curve at each point. Adjust the slopes of the lines to visually find the derivative \( \frac{df}{dx} \) at each point.

Answer

\[
\frac{df}{dx} f(-2) = -28 \\
\frac{df}{dx} f(-1.5) = -21 \\
\frac{df}{dx} f(-1) = -14 \\
\frac{df}{dx} f(0) = 0 \\
\frac{df}{dx} f(1) = 12.17 \\
\frac{df}{dx} f(1.5) = 0 \\
\frac{df}{dx} f(2) = 0
\]

Check Answer

Need help? Get a hint.
This will reset your streak!
I'd like a hint

Stuck? Watch a video.
This does not reset your streak.
Changing lives

“We recognized that we had found a powerful tool that reached students and changed their habits in ways we had never even considered possible.”
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In the last year, 24 employees reached 43 million unique students in 216 countries.