Rectilinear Motion

Special case: Distance + Time

Two quantities:

Describes relationship between:

\[ f(x) = f'(x) \]

\[ \text{Regr. Eqn. of } y \]

\[ \text{Connected to GEAP} \]
We have discussed many examples of (2) x.

Example of free chemistry.

3) From chemistry.

Output

Input

Molecule

Interpreted: Spectroscopy Chart

[Graph with peaks labeled 1-octanol, 3350, 3350, 3400, 1400, 1065]
ABSORPTION DEPENDS ON FREQUENCY OF A LOT.

ABSORBED A LITTLE IMPUR, LIGHT IS REFLECTED OR DEPENDING ON
Density depends on temperature. As temperature increases, density decreases. At freezing (0°C) water density is highest. Above freezing, density decreases with temperature. Example:
Physics

At time \( t \):

\[ x(t) = \text{position of car} \]

\[ x = \text{position of car} \]

1. Rectilinear motion (motion in a straight line)

Relation for basic time most important.

Position decreasing as.
\[ \frac{\Delta y}{\Delta x} \]

\( \text{(} \Delta \text{ means change) } \)

\[ \frac{x^2 - x}{y_2 - y_1} = \frac{x_2 - x_1}{y_2 - y_1} \]

\( \frac{\text{change in } y}{\text{change in } x} \)

\( \text{Change in } x \)

\( \text{Change in } y \)

\( y \)

\( (x_1, y_1) \)

\( (x_2, y_2) \)

\( \text{on } x \)

\( y \)

\( \text{depends on } \)

\( x \)

\( \text{The relationship between } \)

\( \text{two quantities:} \)

\( \text{Average rate of change:} \)
Deceptive change in temperature:

\[ \frac{21 - 18}{99.85 - 99.787} = \frac{0.0021}{0.0657} = 0.0316 \]

Change in density:

\[ \frac{0.997996 - 0.996237}{9.996237} = \frac{0.001759}{9.996237} = 0.0001759 \]

Change in rate of change of density:

\[ \frac{0.001759}{9.996237} = 0.0001759 \]

What is the average rate of change of water density with respect to temperature? 

Q: Over range 18°-21°, what is the average rate of change of density?
\[
\frac{28 - 24}{10} = \frac{4}{10} = 0.4
\]

Choose the right answer:

1. C

24° → 28°.

O: Same question, but not interval.
Interval: \([61, 62]\)

\[
\text{Velocity over the interval is the average}
\]

\[
\frac{62 - 61}{x(62) - x(61)}
\]

Then, let \(t\) denotes time, \(x\) denotes position.

If \(x\) denotes position,
\[
\int_{1.105}^{1.105} \frac{1}{1.105 - x/1.2} \, dx = 1.2949
\]

In the intervals

velocity over the

what is the average

\[
\int_{0}^{1} e^{-t} = 1 - e^{-t}
\]
Secant Line

\( \frac{x_2 - x_1}{f(x_2) - f(x_1)} \)

Line connecting \( P \) to \( P_1 \)

Slope of Line connecting \( P \) to \( P_1 \)

\( \frac{y - y_0}{x - x_0} \)

Geometric Interpretation of \( \frac{dy}{dx} \)
\[
\frac{f(x_2) - f(x_1)}{x_2 - x_1}
\]

Geometrical: Slope of secant line

Mathematical: A ratio related to \( f(x) \)
Average Velocity

\[
\text{Average Velocity} = \frac{t_2 - t_1}{(t_2 - t_1) - (t_1 - t_1)}
\]
The slope of \( f(x) \) at a point is defined as \( \frac{f(x) - f(x_0)}{x - x_0} \), and when \( x = x_0 \), it becomes \( \frac{f(x) - f(x_0)}{x - x_0} = f'(x_0) \), which is the derivative of the function at that point.

The line tangent to a curve at a point is a line that just touches the curve at that point and has the same slope as the curve at that point. Geometrically, the slope of the tangent line is \( f'(x) \).
\[
\text{Velocity}
\]
\[
\text{Call the instantaneous average of } \text{a number}
\]
\[
\frac{t_2 - t_1}{x(t_2) - x(t_1)}
\]

As \( t_2 \to t_1 \), \([t_1, t_2]\) becomes small:

\[
\text{Velocity}
\]
\[
\frac{t_2 - t_1}{x(t_2) - x(t_1)}
\]

represents an average.
The limit \( \lim_{x \to x_1} f(x) \) is useful because of its connection to geometric physics.

As \( x \to x_1 \), we can compute (maybe):

\[
\frac{x - x_1}{f(x) - f(x_1)} = l
\]
Distance Between Two Points

$$f(\text{one place}) - f(\text{another place})$$

At

$$\lim_{x \to x_1} \frac{x_2 - x_1}{f(x_2) - f(x_1)} = \text{DERIVATIVE}$$

English Version

Small Distance

Make
\[
y = 4 + y = \frac{y}{4y + y^2} = \frac{y}{y + y - y^2} = \frac{y}{(y + y + y^2) - y} = \frac{y}{(y + 2y) + (y^2 + 2y)} + 1 \]

\[
i = \{2, f \} \quad x = \int f(x) \quad \exists x \]

\[
\left( x, f \right) = \frac{y}{y + y + y^2 - y^2 - y} = \frac{y}{\lim_{x \to y} f(x)} = \lim_{x \to y} \frac{x - (y + y)}{(x - y) + y} \quad y \in \mathbb{R}
\]
\[
\frac{h}{h} \frac{h(4 + h + 2)}{4} = \frac{n}{2^n + 2} = \frac{n}{4^n} - 2
\]

\[f(x) = \frac{1}{x} + x^2\]

\[\lim_{x \to 0} \frac{1}{x} = \lim_{x \to 0} \frac{1}{x^2} = 0\]
\[
\lim_{h \to 0} \frac{f(4+h) - f(4)}{h} = \lim_{h \to 0} \frac{1}{h} \left( \sqrt{4+h+2} - \sqrt{1+2} \right)
\]
so \( \lim_{h \to 0} \frac{f(3+h) - f(3)}{h} = \lim_{a \to 1} \frac{(a+h) - 1}{h} = \lim_{h \to 0} \frac{(3+h) - 3}{h} = \lim_{h \to 0} \frac{h}{h} = 1 \) 

Ex: \( f(x) = \frac{1}{x} \)  
\( f'(3) = \lim_{h \to 0} \frac{f(3+h) - f(3)}{h} = \lim_{h \to 0} \frac{1}{3+h} - \frac{1}{3} = \lim_{h \to 0} \frac{3 - (3+h)}{3(3+h)} = \frac{-1}{9} \)
\[
\lim_{x \to a} f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = \lim_{x \to a} \frac{f(x+\Delta x) - f(x)}{\Delta x}
\]
Related quantities (distance, time, etc.)

Instantaneous rate of change of material scientists use it to find

Physical scientists use it to find

Image purposes (improve fault targeting)

Geophysicists people use it to find

Preliminary

"Algebraic"
"Mathematical"