K3

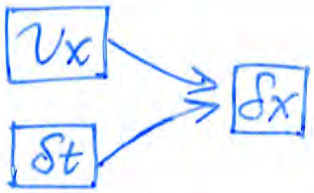
Title (Instantaneous) x-velocity

Ingredients

Sketch	
At/Through	$[t_i, t_f]$
Owner	System; Frame
Quantity	"Tiny" x-displacement; Instantaneous x-velocity; "Tiny" elapsed duration
Variable	δx; v_x; δt
Giver	

Recipe

Diagram the relationship

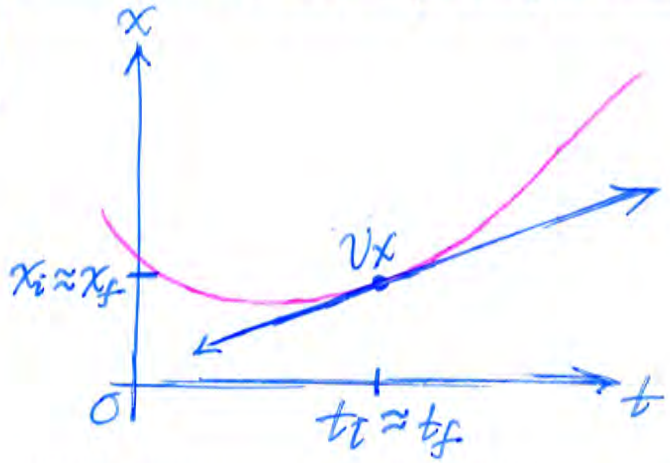


Graphically present quantities

Velocity vector in breadcrumb motion diagram

$t_i \approx t_f$ → v_x

On x-t plot: Slope of tangent line



Mathematical relationship

$$v_x \delta t = \delta x$$

$$v_x = \frac{\delta x}{\delta t}$$

Recipe number **K3**: The **title** of this recipe sheet is **"(Instantaneous) x-velocity**", with the word "Instantaneous" surrounded by parentheses to indicate this word is often omitted.

The top half of this sheet consists of an "**Ingredients**" section with a row labeled "Sketch", a row labeled "At/Through", a row labeled "Owner", a row labeled "Quantity", a row labeled "Variable", and a row labeled "Giver." In this sheet, the row labeled "Giver" isn't used.

For the "Sketch", draw two mostly overlapping snapshots showing a cart moving toward the right across a firm surface. Indicate that the snapshots correspond to almost identical moments in time by drawing the second snapshot of the cart in almost the same position as in the first, with the first snapshot almost completely covering the second snapshot. Draw trailing motion-blur streaks or so-called "whooshies" to emphasize instantaneous motion. Draw a dashed bubble around the earlier snapshot of the cart, at the left, to indicate that the cart is the so-called "System". Draw an arrow labeled +x to indicate that the positive-x direction points to the right.

In the rows of the "Ingredients" section other than the row for the sketch, document the following relationships, using flowchart paths, if helpful: There are two "Owners": one is the "System", and the other is the "Frame". For the interval from initial time t_i (t-sub-i) to final time t_f (t-sub-f), the system has both the "Quantity" called "Tiny x-displacement" denoted by the "Variable" (lowercase-delta x) and the "Quantity" called "Instantaneous x-velocity" denoted by the "Variable" v_x (v-sub-x). Also for the same interval from initial time t_i (t-sub-i) to final time t_f (t-sub-f), the "Frame", meaning the collection of rulers and clocks used to make measurements and referred together as the "frame of reference", has the "Quantity" called "Tiny elapsed duration" denoted by the "Variable" (lowercase-delta t).

The bottom half of this sheet consists of a "**Recipe**" section with a row labeled "Diagram the relationship", a row labeled "Graphically present quantities", and a row labeled "Mathematical relationship".

In the row labeled, "Diagram the relationship", draw a flowchart arrow showing that instantaneous x-velocity v_x (v-sub-x) contributes to the tiny x-displacement (lowercase-delta x). Draw another arrow showing that tiny elapsed duration (lowercase-delta t) also contributes to the tiny x-displacement (lowercase-delta x). Recite a story: "Traveling with greater instantaneous x-velocity through a given brief elapsed duration results in a greater tiny x-displacement, but even if the instantaneous x-velocity remained unchanged, simply traveling for a longer tiny elapsed duration would also result in a greater tiny x-displacement."

The row labeled "Graphically present quantities" will be used for two sections. For the first section, write the title "Velocity vector in breadcrumb motion diagram". Draw a dot representing a snapshot of the cart. Just to the left of the dot, write the label, "(t-sub-i approximately equals t-sub-f)". Draw a horizontal arrow with its tail on the dot and with its head pointing to the right. Label this velocity vector v_x (v-sub-x). For the second section, write the title "On x-t plot: Slope of tangent line". Create an axis system with x-position x on the vertical axis and time t on the horizontal axis. Draw a smooth plot with some variety of x values (the exact shape isn't very important). Draw a single dot on the plot. Draw the corresponding tickmark on the t axis and label this tickmark (t-sub-i approximately equal to t-sub-f). Draw the dot's corresponding tickmark on the x axis and label this tickmark (x-sub-i approximately equals x-sub-f). Draw a tangent line to the plot through the dot. Using slanted writing, label the tangent line v_x (v-sub-x).

In the row labeled, "Mathematical relationship", write (v-sub-x times lowercase-delta t = lowercase-delta x) and (v-sub-x equals lowercase-delta x divided by lowercase-delta t).