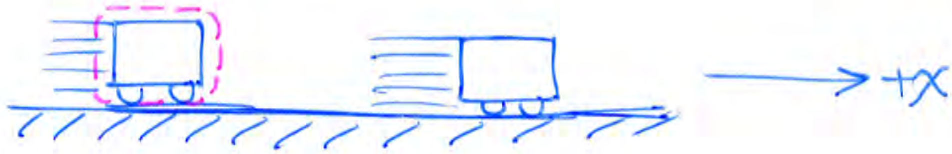
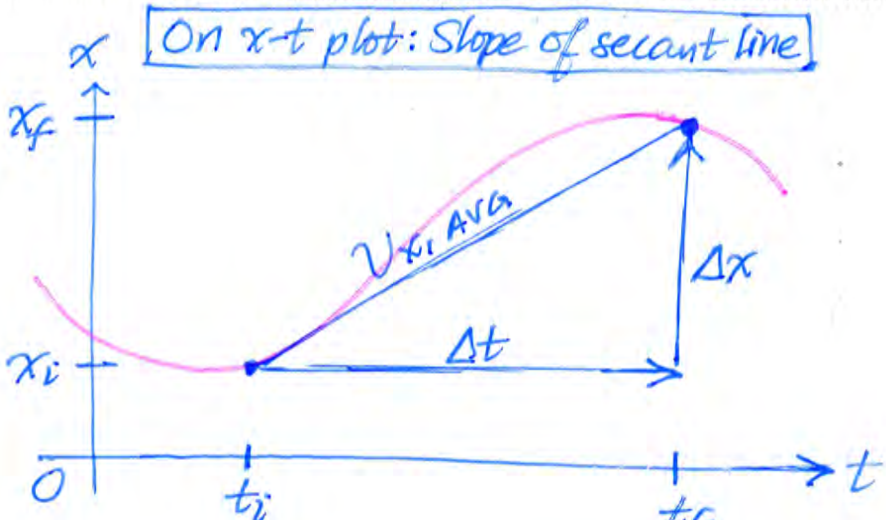
Title		Average x-velocity
Ingredients	Sketch	
	At/Through	$[t_i, t_f]$
	Owner	System; Frame
	Quantity	x-displacement; Average x-velocity; Elapsed duration
	Variable	Δx; $v_{x,AVG}$; Δt
	Giver	
Recipe	Diagram the relationship	$v_{x,AVG}$ → Δx; Δt → Δx
	Graphically present quantities	On x-t plot: Slope of secant line 
	Mathematical relationship	$v_{x,AVG}\,\Delta t = \Delta x$; $v_{x,AVG} = \frac{\Delta x}{\Delta t}$

Recipe number **K2**: The **title** of this recipe sheet is “**average x-velocity**”.

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 snapshots showing a cart moving toward the right across a firm surface. Draw trailing motion-blur streaks or so-called “whooshies” to emphasize instantaneous motion in each snapshot. 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” “x-displacement” denoted by the “Variable” (Delta x) and the “Quantity” “Average x-velocity” denoted by the “Variable” $v_{x,\mathrm{AVG}}$ (v-sub-x-average). 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” “Elapsed duration” denoted by the “Variable” (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 average x-velocity $v_{x,\mathrm{AVG}}$ (v-sub-x-average) contributes to the x-displacement (Delta x). Draw another arrow showing that elapsed duration (Delta t) also contributes to the x-displacement (Delta x). Recite a story: “Traveling with greater average x-velocity through a given elapsed duration results in a greater x-displacement, but even if the average x-velocity remained unchanged, simply traveling for a longer elapsed duration would also result in a greater x-displacement.”

In the row labeled “Graphically present quantities”, write the title “On x-t plot: Slope of secant 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 two dots on the plot, with one more toward the left and lower on the page and the second more toward the right and higher on the page. For the dot on the left, draw corresponding tickmarks labeling initial time t_i (t-sub-i) on the t axis and initial x-position x_i (x-sub-i) on the x axis. For the dot on the right, draw corresponding tickmarks labeling final time t_f (t-sub-f) on the t axis and final x-position x_f (x-sub-f) on the x axis. Draw a slanted segment with the dots as endpoints. Use this slanted segment as the hypotenuse of a right triangle, with a horizontal leg represented by an arrow pointing to the right labeled with the elapsed duration (Delta t) and a vertical leg represented by an arrow pointing up labeled with the x-displacement (Delta x). In slanted writing, label the hypotenuse of the right triangle $v_{x,\mathrm{AVG}}$ (v-sub-x-average).

In the row labeled, “Mathematical relationship”, write (v-sub-x-average times Delta t = Delta x) and (v-sub-x-average equals Delta x divided by Delta t).