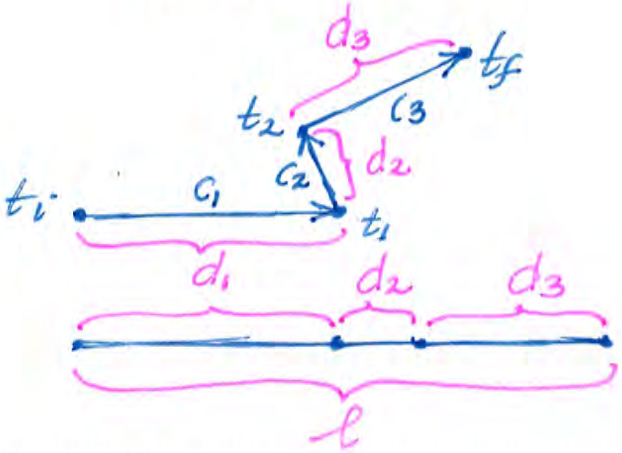
K10

**Title** Total distance traveled

## Ingredients

| | |
|---|---|
| Sketch |   |
| At/Through | $[t_i, t_1]$ $[t_1, t_2]$ ... $[t_i, t_f]$ |
| Owner | System |
| Quantity | Path segment; Distance; Path segment; Distance; Total distance traveled |
| Variable | $c_1$ $d_1$ $c_2$ $d_2$ $\ell$ |
| Giver | |

## Recipe

| | |
|---|---|
| Diagram the relationship |   |
| Graphically present quantities | Unfurled path   |
| Mathematical relationship | $\ell = d_1 + d_2 + \ldots$ |

Recipe number **K10**: The **title** of this recipe sheet is "**Total distance traveled**".

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 an overhead view showing two snapshots of a cart, with the initial snapshot showing the cart at the lower-left moving toward the right and the final snapshot showing the cart at the upper-right moving diagonally upward and rightward. Draw trailing motion-blur streaks or so-called "whooshies" to emphasize instantaneous motion in each snapshot. Draw a dashed zig-zag path connecting the initial and final snapshots so that the path consists of three segments and two corners. 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. From the tail of the arrow you just drew, draw another arrow labeled +y to indicate that the positive-y direction points up the page.

In the rows of the "Ingredients" section other than the row for the sketch, document the following relationships, using flowchart paths, if helpful: The "Owner" is the "System". Through the interval from initial time $t_i$ (t-sub-i) to a time $t_1$ (t-sub-1), the "System" owns the "Quantity" "Path segment" denoted $C_1$ (C-sub-1) and the "System" also owns the "Quantity" "Distance" denoted $d_1$ (d-sub-1). Through a subsequent interval from time $t_1$ (t-sub-1) to time $t_2$ (t-sub-2), the "System" owns the "Quantity" "Path segment" denoted $C_2$ (C-sub-2) and the "System" also owns the "Quantity" "Distance" denoted $d_2$ (d-sub-2). In the "At/Through" row, write an ellipsis to allude to other time intervals with their own path segments and distances. Through the interval from initial time $t_i$ (t-sub-i) to final time $t_f$ (t-sub-f), the "System" owns the "Quantity" "Total distance traveled" denoted $\ell$ (cursive l).

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 distance $d_1$ (d-sub-1) contributes to the total distance traveled $\ell$ (cursive l). Draw another arrow showing that distance $d_2$ (d-sub-2) also contributes to the total distance traveled $\ell$ (cursive l). Draw an ellipses alluding to other path-segment distances, and draw a dashed arrow from the ellipsis to indicate that these other path-segment distances also contributes to total distance traveled $\ell$ (cursive l).

In the row labeled "Graphically present quantities", write the title "Unfurled path". Copy the three-segment zig-zag path originally represented using dashed segments in the "Sketch" row of the "Ingredients" section, but now with solid segments. Replace the initial and final snapshots of the cart with dots. Draw a dot at each corner of the path. Label the initial dot with initial time $t_i$ (t-sub-i) and label the final dot with final time $t_f$ (t-sub-f). Following the path from initial dot to final dot, label the intervening dots, in order of encounter, $t_1$ (t-sub-1) and $t_2$ (t-sub-2). For the path segment connecting the dot at initial time $t_i$ (t-sub-i) to the dot at time $t_1$ (t-sub-1), write the label $C_1$ (C-sub-1), draw an arrowhead pointing to the dot at time $t_1$ (t-sub-1), and use a brace to label the length of the path segment $d_1$ (d-sub-1). For the path segment connecting the dot at time $t_1$ (t-sub-1) to the dot at time $t_2$ (t-sub-2), write the label $C_2$ (C-sub-2), draw an arrowhead pointing to the dot at time $t_2$ (t-sub-2), and use a brace to label the length of the path segment $d_2$ (d-sub-2). For the path segment connecting the dot at time $t_2$ (t-sub-2) to the dot at final time $t_f$ (t-sub-f), write the label $C_3$ (C-sub-3), draw an arrowhead pointing to the dot at final time $t_f$ (t-sub-f), and use a brace to label the length of the path segment $d_3$ (d-sub-3). Underneath the diagram of the zig-zag path, draw three horizontal segments joined gaplessly two-at-a-time. Use a brace to label the first segment, at the left, with length $d_1$ (d-sub-1). Use a brace to label the next segment, in the middle, with length $d_2$ (d-sub-2). Use a brace to label the last segment, at the right, with length $d_3$ (d-sub-3). Draw dots at the endpoints of each of these three segments. Indicate the combined total length of these three segments using a brace labeled $\ell$ (cursive l).

In the row labeled, "Mathematical relationship", write (cursive l = d-sub-1 + d-sub-2 + dot-dot-dot).