About the Mathematics

These documents are based on the context of the rectilinear (straight line) vertical motion of an elevator. The motion of an elevator is a particularly nice context for introducing ideas related to rectilinear motion (position, velocity, speed, acceleration, etc.) because the connection to the vertical coordinate of related graphs is more natural and does not require the additional mental work of representing functions depicting horizontal motion (for example, of a car).

The Elevator Height as Integral of Velocity documents allow the user to provide a velocity function *v* to "drive" the motion of an elevator. Assuming an initial starting point of height $h = 0$ at time $t = 0$, the document produces a height function by antidifferentiating the given velocity function. This height function, in turn, drives the motion of the elevator as the user advances the value of time *t* via a slider.

Math Objectives

- Students will have an opportunity to work with linked graphical and physical (in the virtual environment of the .tns document) representations of the vertical motion of an elevator.

Using the Documents

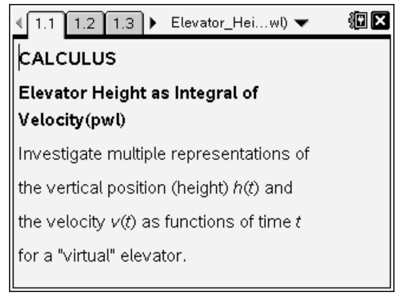
The two documents differ in how the user sets the velocity function *v*.

In *Elevator_Height_as_Integral_of_Velocity_f1.tns,* the function **f**1(*x*) represents the velocity **v**(*t*) (with *x* interpreted as *t*). The user can get access to **f**1 by pressing ctrl G to reveal the function entry line.

In *Elevator_Height_as_Integral_of_Velocity_pwl.tns,* the velocity function **v**(*t*) is presented as a continuous piecewise linear graph that can be directly manipulated by moving the vertices that connect the linear pieces of the graph up or down by grabbing and dragging.

In both documents, page 1.1 provides the title and setting and page 1.2 gives the instructions. On page 1.3, the velocity function is displayed in the graphing window on the right. On page 1.4, the corresponding height function (determined by integrating the user-defined velocity function with an initial position of $h(0) = 0$) is displayed.

On page 1.5, both graphs (with time axes aligned) are displayed.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point
- Click on a minimized slider
- Enter text on the function entry line

Tech Tips:

- Make sure the font size on your TI-Nspire handheld is set to Medium.
- You can hide the function entry line by pressing ctrl G.

Lesson Materials:

Elevator_Height_as_Integral_of_Velocity_f1.tns

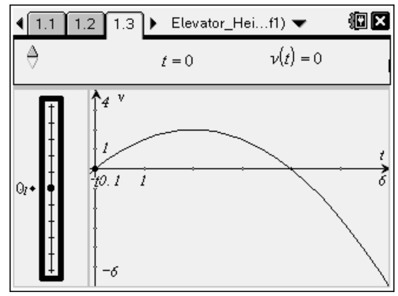
Elevator_Height_as_Integral_of_Velocity_pwl.tns

Visit www.mathnspired.com for lesson updates.

In all three cases, a slider has been set up to allow the user to change the value of time *t* (alternatively, the time point can be grabbed and dragged along the horizontal axis) and a virtual depiction of the elevator's motion is enacted dynamically. When the height graph is present, the vertical coordinate aligns with the position of the elevator.

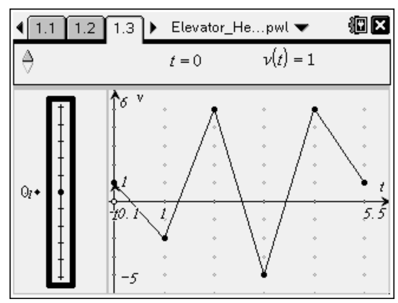
Possible Applications

Natural questions to ask with these documents concern physical interpretations of the graphical characteristics of the height and velocity functions, especially in terms of direction of movement. A common mistake is to think of the direction of the velocity graph as corresponding to the direction of the elevator's movement (as opposed to the sign of the velocity graph being the relevant characteristic).



Elevator_Height_as_Integral_of_Velocity_f1.tns

With the piecewise linear (but continuous) velocity function, it is important to discuss why the height function is smooth even when the slope of the velocity function changes abruptly at a vertex. Relating the value of the velocity to the slope of the height function graph is key. Being able to manipulate the graph allows for questions about graphs that "tell a story" about the elevator's movement.



Elevator_Height_as_Integral_of_Velocity_pwl.tns