eMATH Activity

Alternative Method of Producing a Velocity-Time Graph

Purpose:

To create a velocity-time data table and plot a velocity-time graph from a set of position-time data values.

Background:

An object's motion can be recorded as a set of position-time values in a position-time chart. This chart can be used to plot a position-time graph and a corresponding velocity-time graph.

The average velocity of an object is given by the equation $\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$. The average velocity can be computed for each time interval on a position-time graph by taking the change in displacement between two successive time intervals and dividing it by the change in time. For example, the average velocity for the following position-time data table can be determined as follows:

Position (m)	Time (s)
0.0	0.0
5.0	1.0
10.0	2.0

Average velocity for the time interval from 0.0 s to 1.0 s:

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$
$$= \frac{(5.0 - 0.0)\ \text{m}}{(1.0 - 0.0)\ \text{s}}$$
$$= 5.0\ \text{m/s}$$

The average velocity for the time interval from 0.0 s to 1.0 s is 5.0 m/s.

Average velocity for the time interval from 1.0 s to 2.0 s:

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$
$$= \frac{(10.0 - 5.0)\ \text{m}}{(2.0 - 1.0)\ \text{s}}$$
$$= 5.0\ \text{m/s}$$

The average velocity for the time interval from 1.0 s to 2.0 s is 5.0 m/s.

This method can be used for each successive time interval on a position-time table. But the average velocity is for the entire time interval. So how do we plot a velocity-time graph for a specific time? The answer lies in an interesting fact:

For an object undergoing a constant acceleration, the average velocity for a time interval is the same as the instantaneous velocity at the midpoint of the time interval.

This means that the average velocity from 0.0 s to 1.0 s is the same as the instantaneous velocity at the midpoint of the interval, or 0.5 s. We can use this knowledge to create a velocity-time table, and from there, plot a velocity-time graph.

Displacement (m)	**Time (s)**	**Velocity (m/s)**	**Time (s)**
0.0	0.0	5.0	0.5
5.0	1.0	5.0	1.5
10.0	2.0		

Instructions:

1. Download and open the accompanying Excel spreadsheet and use the position-time table given to create a velocity-time table. Remember to create the table with the midpoint times for each interval as shown above. Print this spreadsheet page with the completed velocity-time table.

2. From the velocity-time table plot the velocity-time graph using a graphing calculator or graphing program. Print this graph.

3. Determine the slope of the resulting velocity-time graph to find the acceleration of the object. Record the value that you found for the acceleration on the velocity-time graph.

Analysis:

1. What is the velocity of the object when the displacement is 0?
2. Why is there one less point to be plotted on the velocity-time graph than on the displacement-time graph?
3. What advantages can you see with regard to this method compared to taking the slopes of the tangents to the line?