

**ALL ABOARD!**

You are given a timetable for a train route connecting New York City and Cape Cod, Massachusetts. The times going down the left side describe the trip of Train 235 from Hyannis to New York, while the times running up the right side are for Train 234, traveling on a different day from New York to Hyannis. **315P** means the time 3:15 p.m.

The distance to each station from Hyannis is given in the mileage column. Note that the total length of the trip is 264 miles.

1. Graph the position of Train 235 along its track as a function of time, for the entire duration of its trip. Use the timetable information, and your best guess of what happens in between the scheduled times.

235	Train Number			234
Su	Days of Operation			Fr
Read Down	$\tau$		Mile	Read Up
3 15P	Dp	Hyannis, MA	0	10 45P
3 28P		West Barstable, MA	9	10 17P
3 43P		Sandwich, MA	16	10 05P
4 00P		Buzzards Bay, MA	24	9 51P
4 10P		Wareham, MA	29	9 37P
4 55P		Taunton, MA	56	8 65P
5 55P		Providence, RI	76	8 03P
7 42P		New Haven, CT	189	6 01P
8 35P	↓	Stamford, CT	228	5 03P
9 27P	Ar	New York, NY-Penn Station	264	4 17P

2. Use your graph to answer the following questions.
  - a. Between which two stations does the train travel at the fastest speed? How fast?
  - b. Between which two stations does it travel at the slowest speed? How slow?
3. In what way should a graph of the position of Train 234 resemble the Train 235 graph? Write a mathematical description of what the graphs ought to have in common, and give a realistic explanation of why this might be expected.
4. Now make a separate graph of the position of Train 234 as a function of time.
5. Comparing the two graphs, point out the biggest discrepancies between quantities or features that you expected to be identical.

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## A Sample Solution

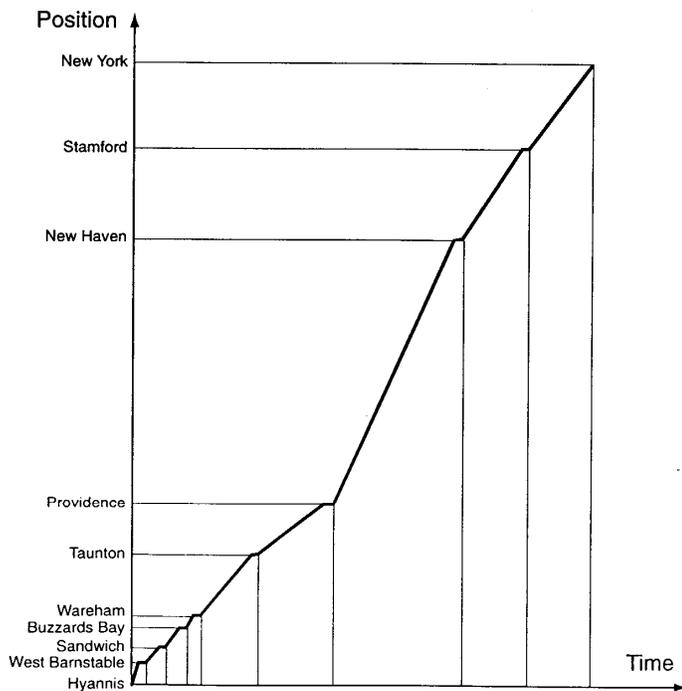
Task

8

One can expect students to plot distance along the vertical axis and time along the horizontal axis. (It is possible, but uncommon, to do it the other way around.) In plotting distance versus time students will have to make some assumption about how the speed of the trains varies between stations. The most reasonable assumption, given the data, is that the trains travel at a uniform speed between stations. Further, the students will have to make some assumption about the length of time that the trains are stopped at each station. Thus students may be expected to plot a graph that consists of linear segments connected by horizontal segments.

The steepness of each linear segment is a measure of the average speed during the corresponding time interval. Train 235 is seen to travel most rapidly between Providence and New Haven (about 63 miles per hour) and most slowly between Taunton and Providence (20 miles per hour).

Here is a possible graph of distance versus time for Train 235.



All Aboard!

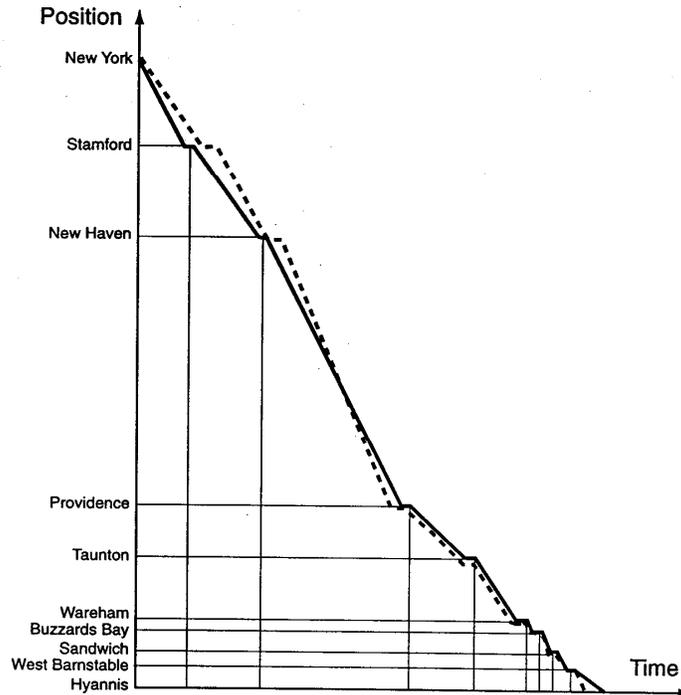
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Task



Inspecting the timetable for Train 234 leads us to expect a similar but not identical graph. First of all, if one plots the stations along the distance axis in the same way as they were plotted for Train 235, then the graph will always have either zero or negative slope, as opposed to Train 235's graph which always has zero or positive slope. Here is a graph of Train 234's distance as a function of time (overlaid on that of Train 235 reflected).



There are some interesting discrepancies between travel times in the two directions. For example, the time from Hyannis to West Barnstable is 13 minutes while the time from West Barnstable to Hyannis is 28 minutes.

Advanced High School Package 2

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