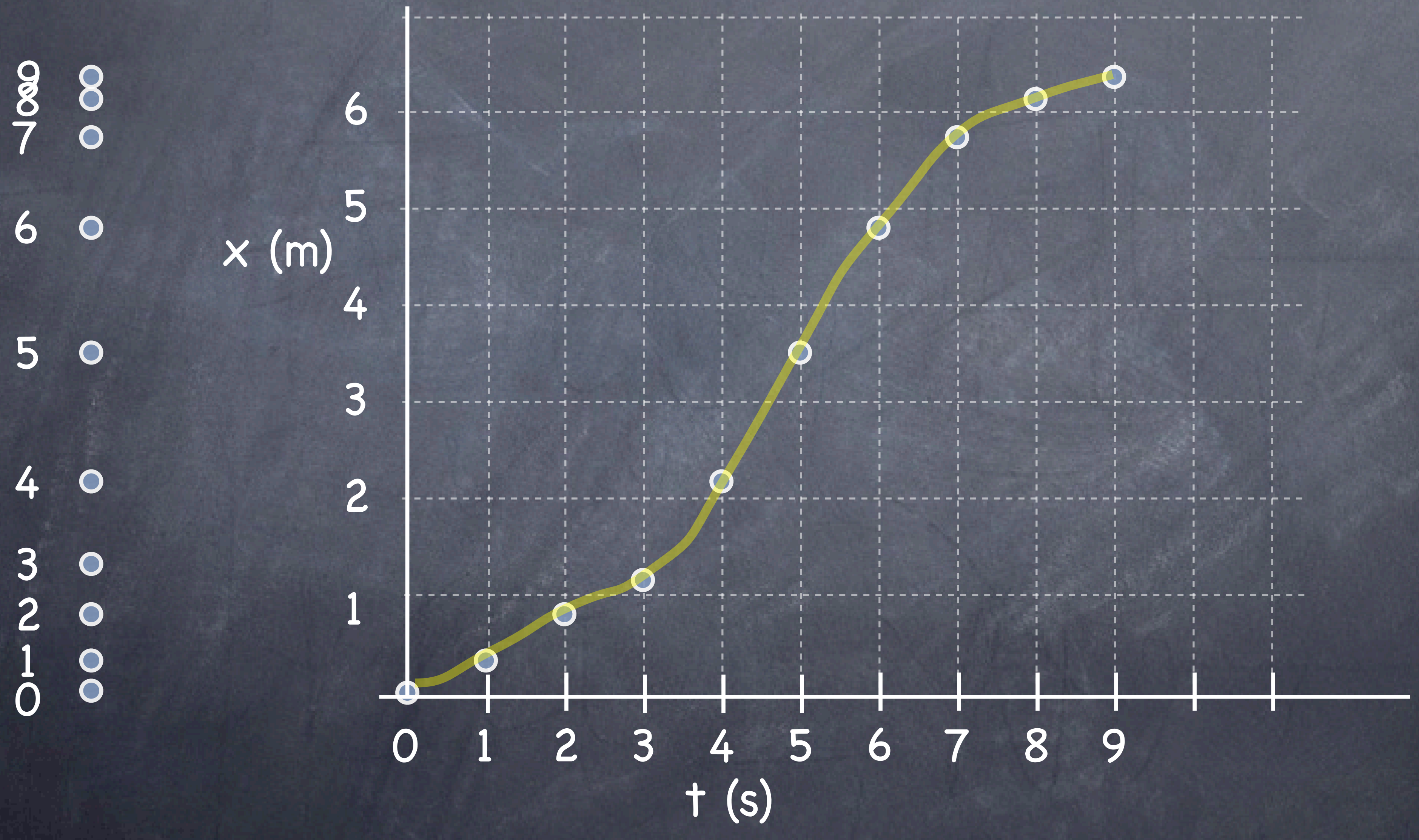
Kinematics
The Mathematics of Motion in a Straight Line

Goal:

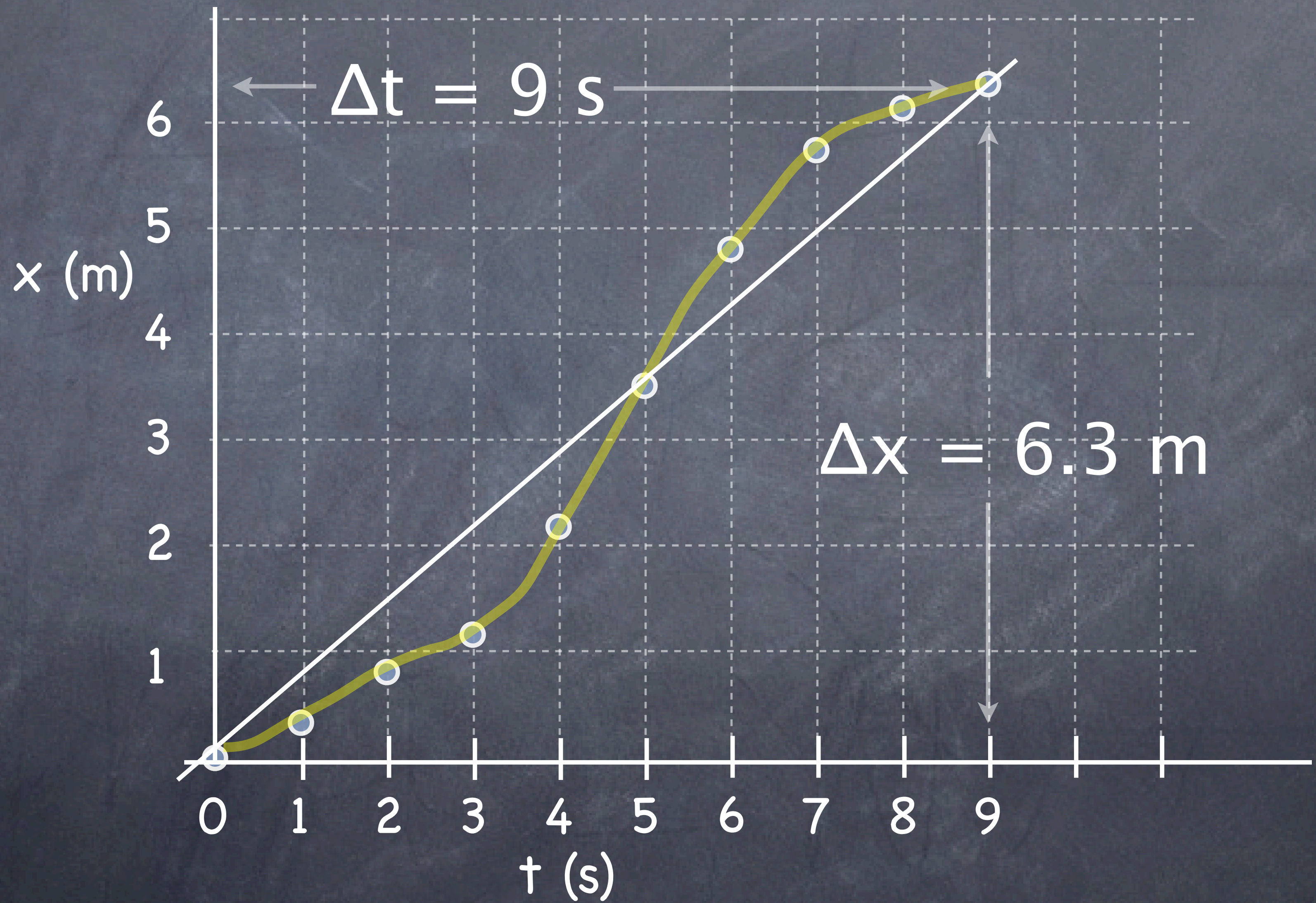
Learn how to solve problems about motion in a straight line.

Motion Diagram—Graph



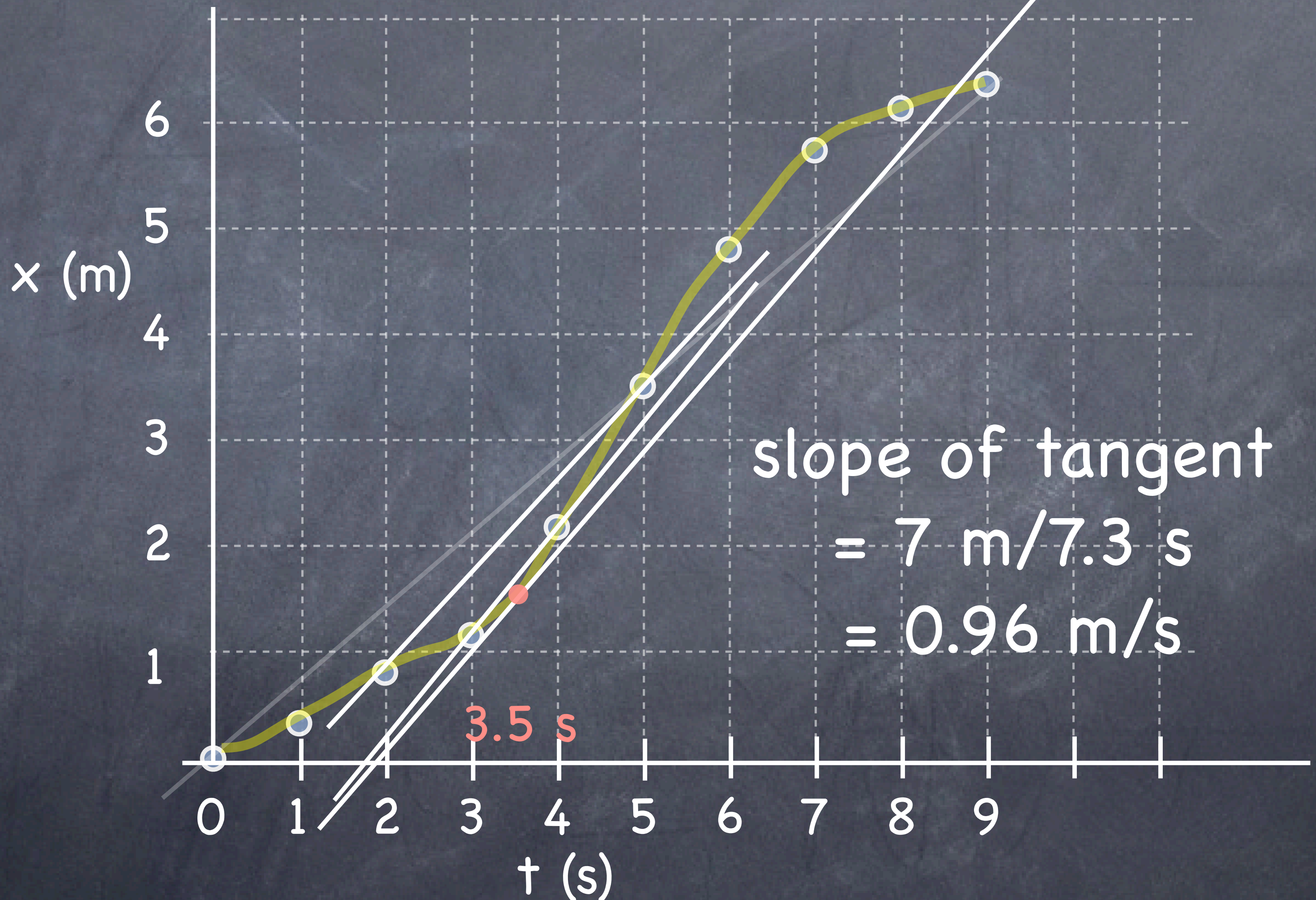
Average Velocity

$v_{avg} = 6.3m/9s = 0.7\ m/s$



Instantaneous Velocity

dx/dt at 3.5s = v(3.5 s) = 0.96 m/s

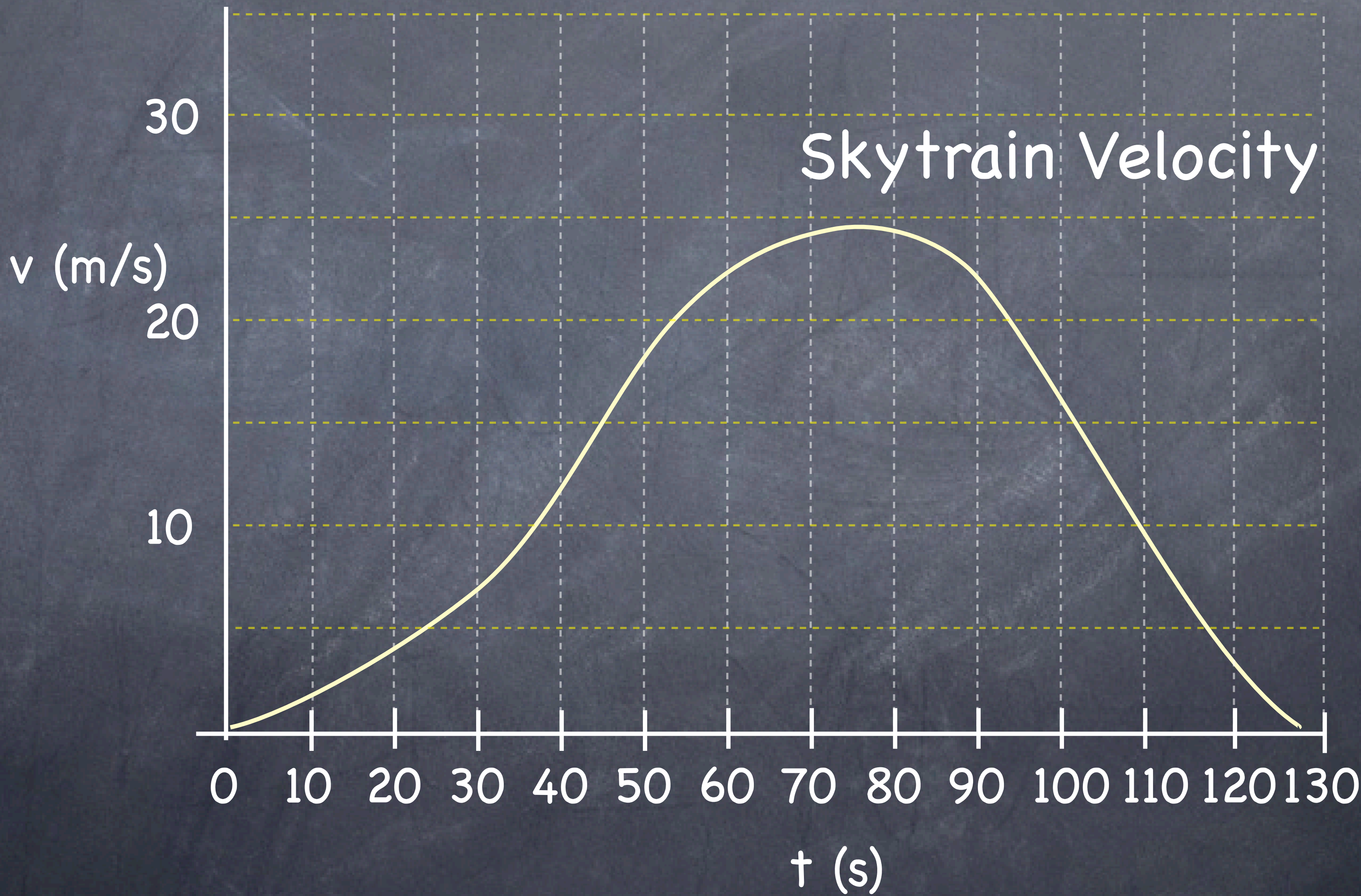


slope of tangent

= 7 m/7.3 s

= 0.96 m/s

How far does it go between stations?



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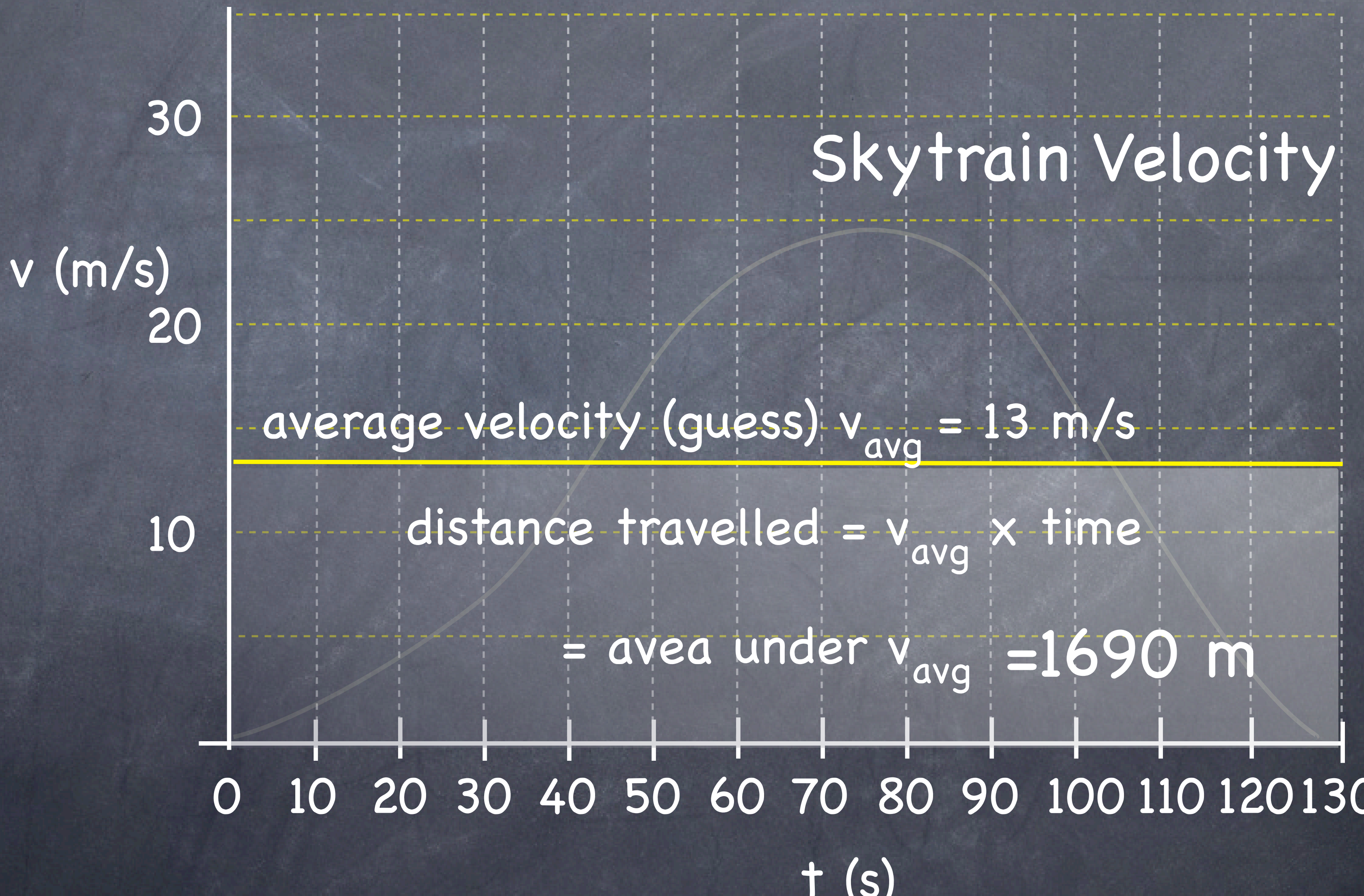
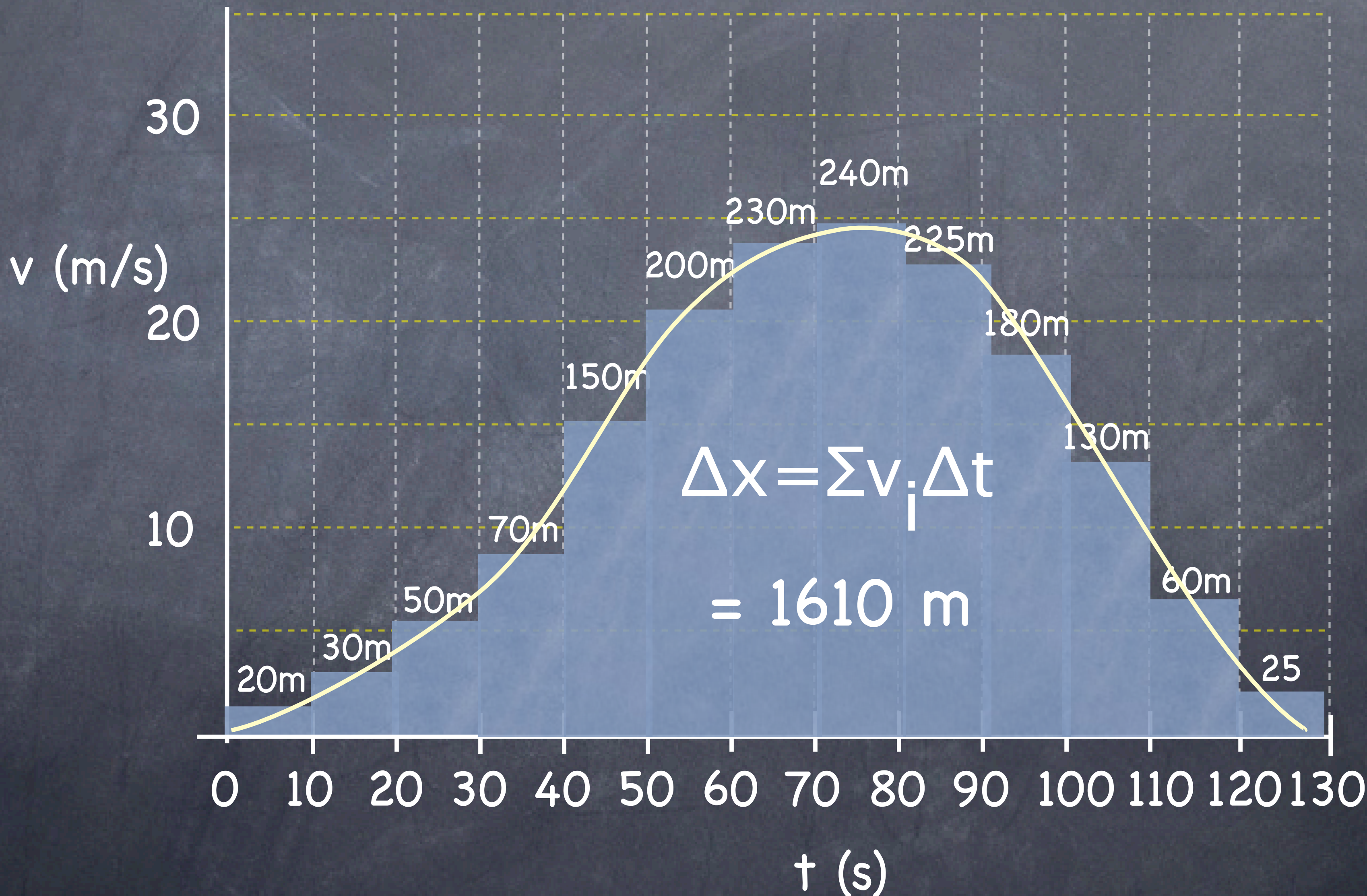


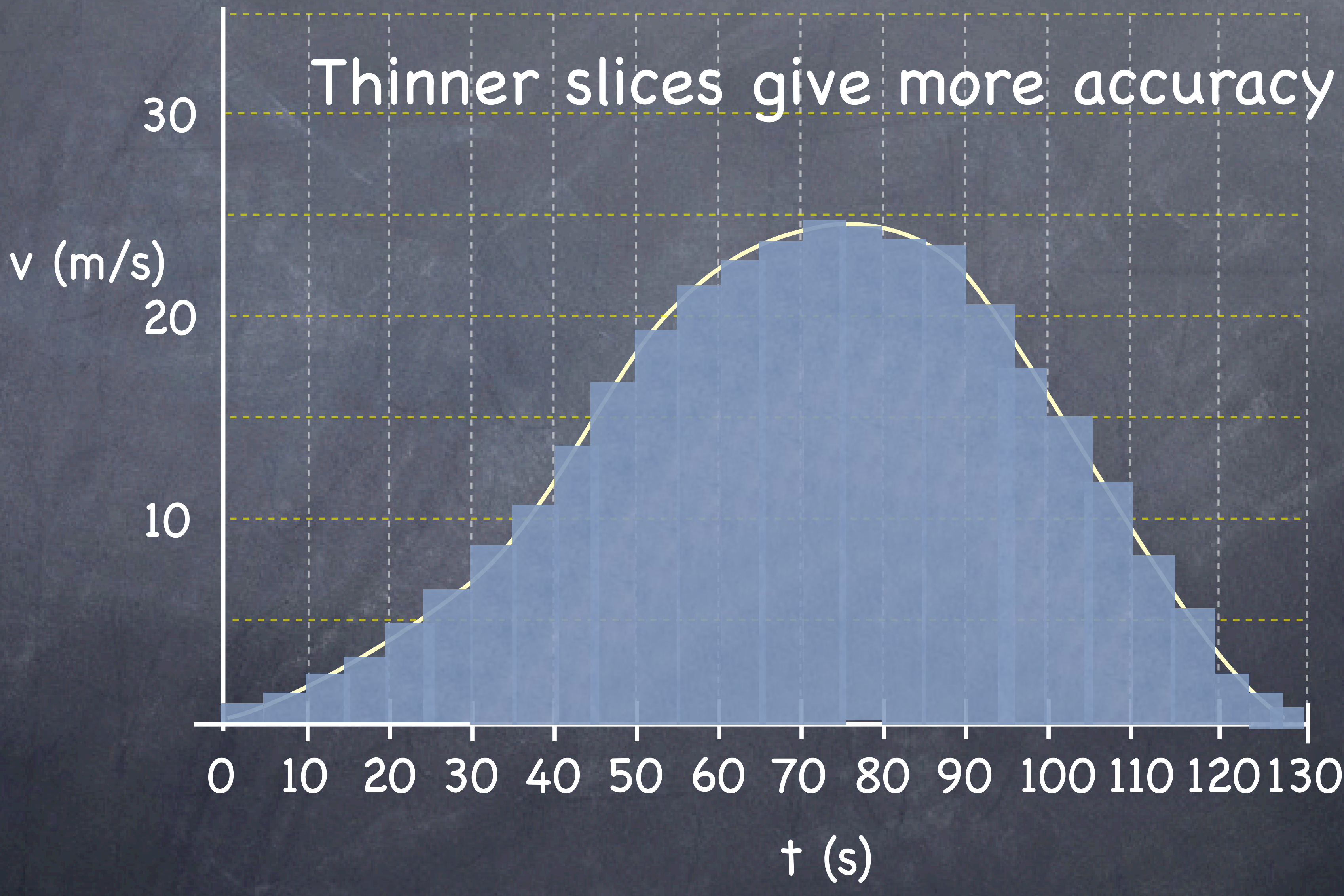
How far does it go between stations?



$$\Delta x = \Sigma v_i \Delta t$$

$$= 1610 \text{ m}$$

How far does it go between stations?



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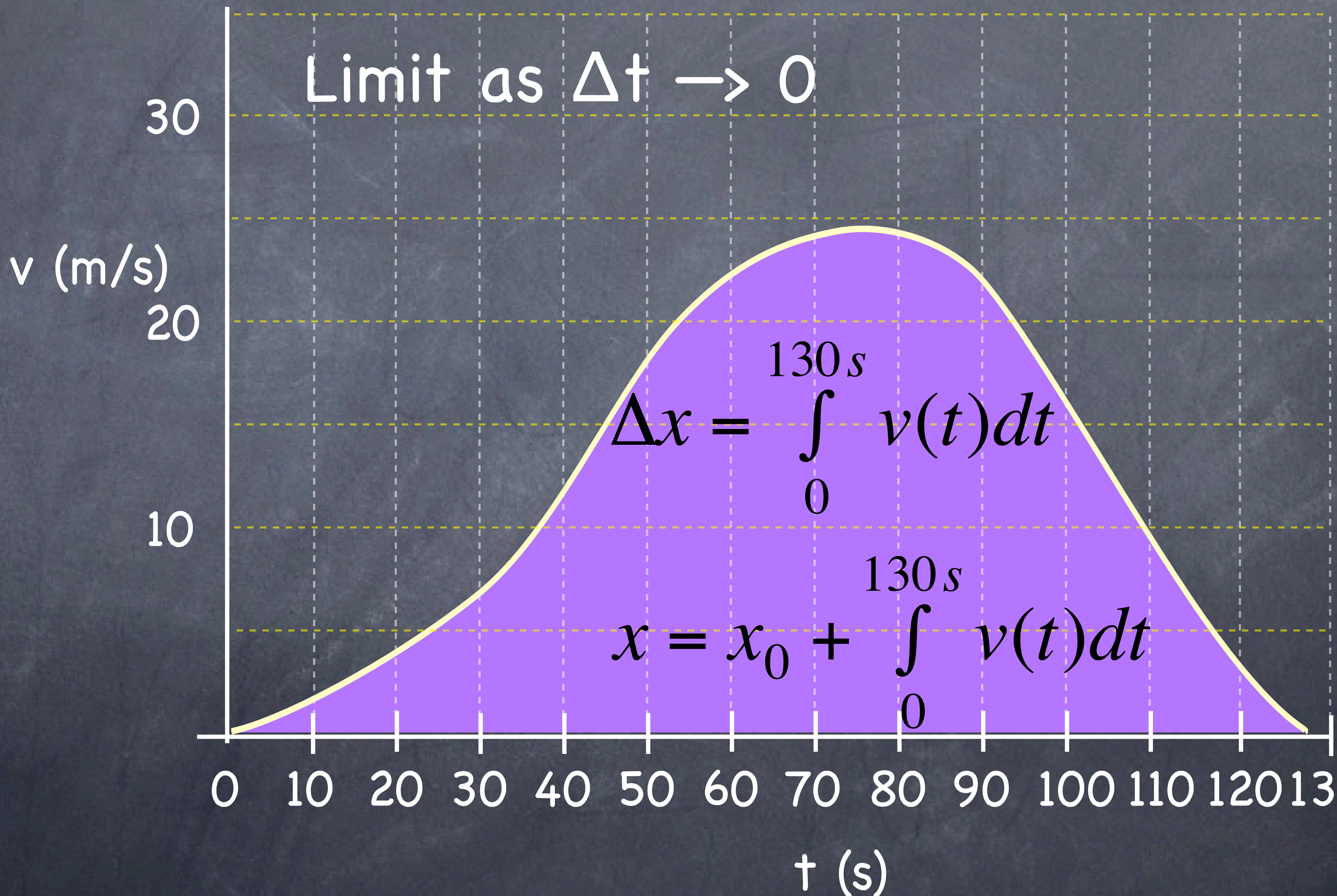
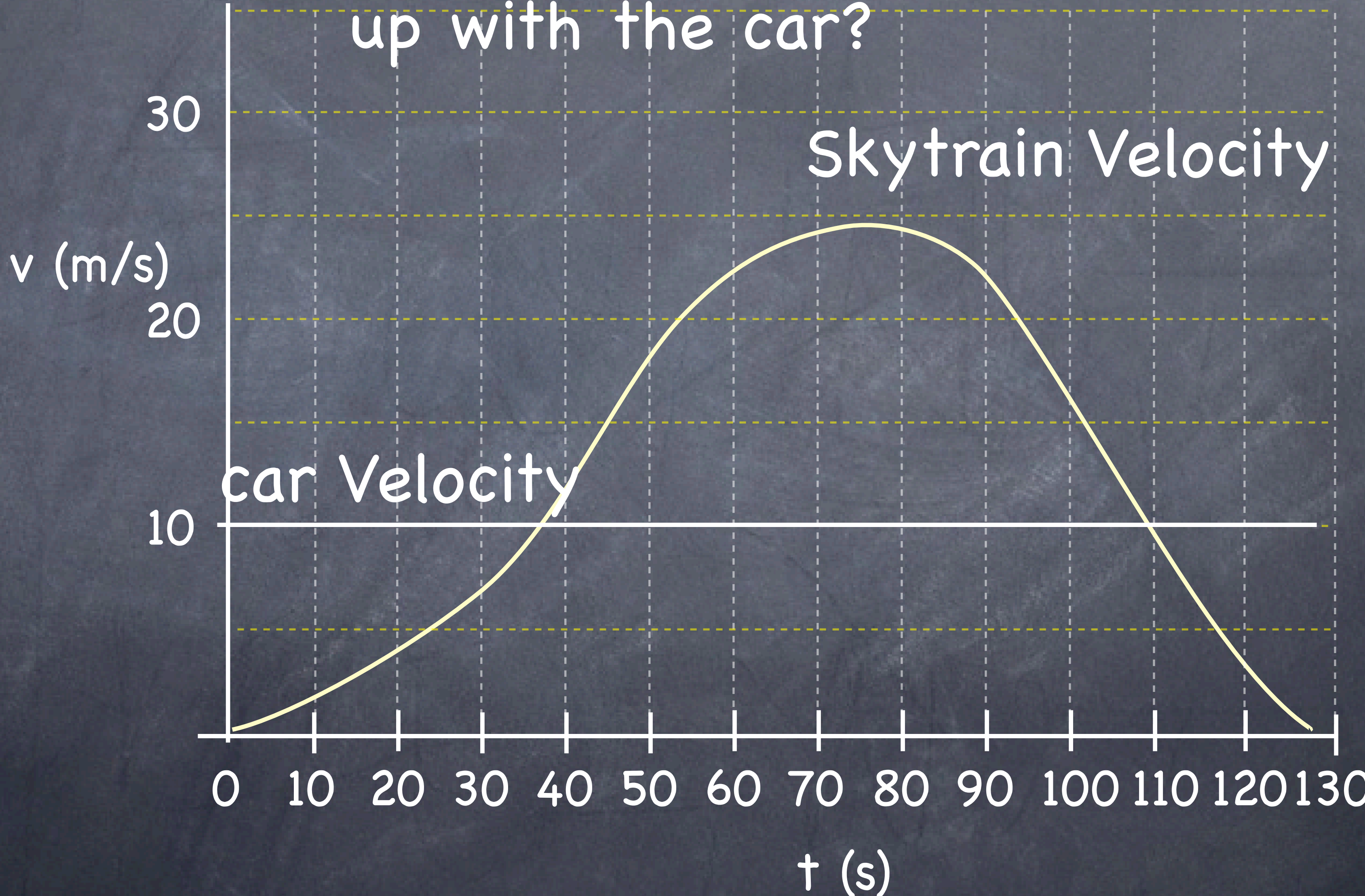


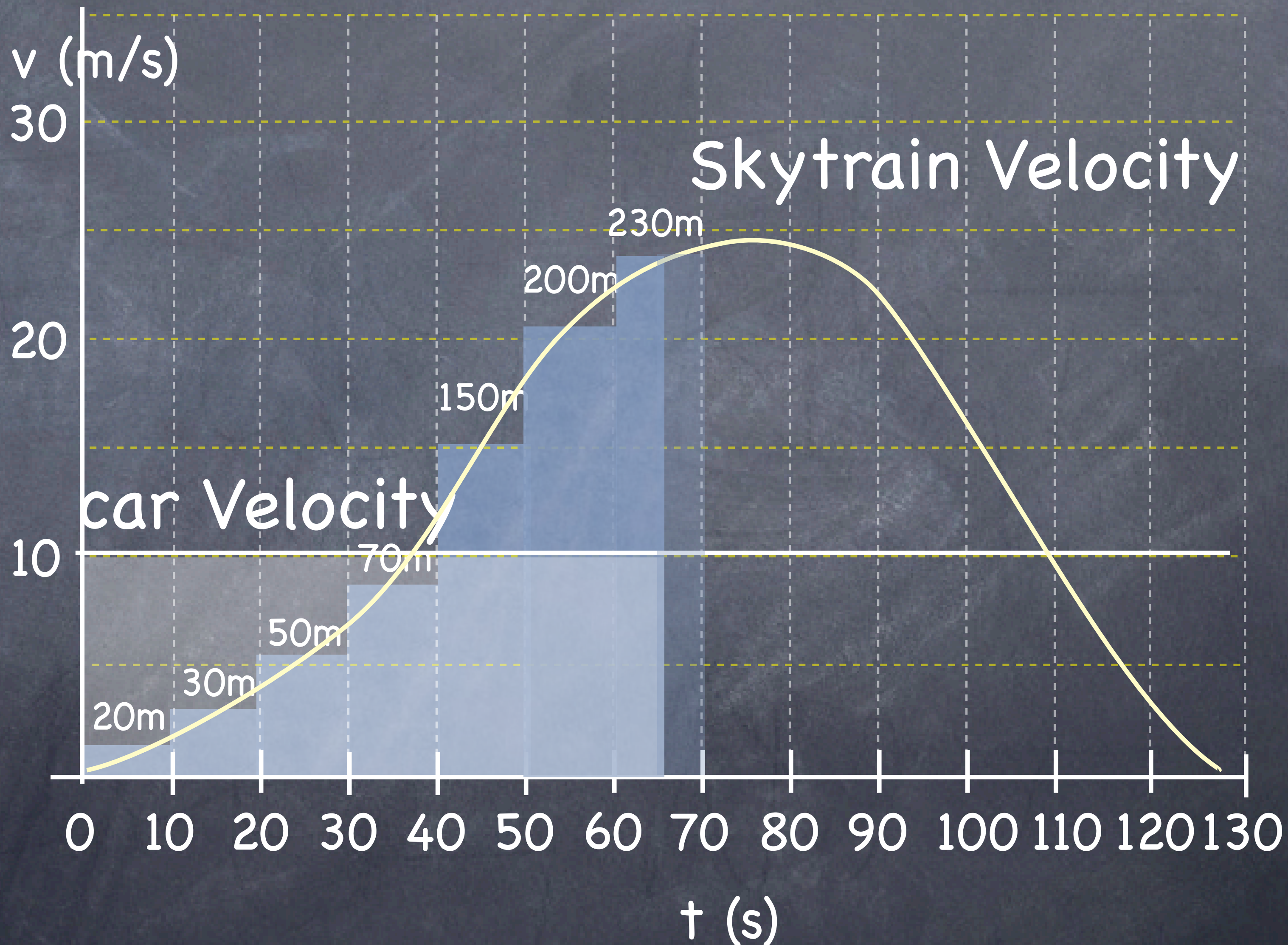
Problem: Car going 10 m/s passes the skytrain as it starts from the station

Where does the skytrain catch up with the car?



t(s)	train (m)	car (m)
10	20	100
20	50	200
30	100	300
40	170	400
50	320	500
60	520	600
70	750	700

Make a table showing car and skytrain positions.

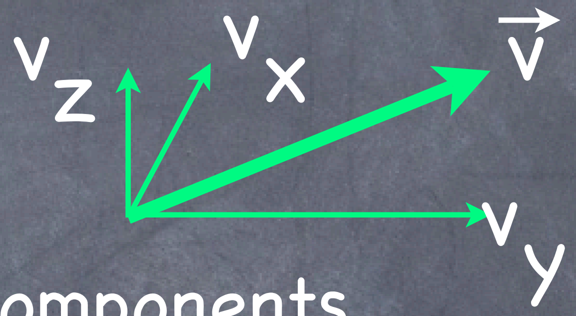


Skytrain catches up at about 65 s and 650 m from station

- Take thinner slices to get a more accurate answer.
- Print the graph on paper.
   1. Cut out the area under the curve and weight it.
   2. Compare to weight of a 100-m square.
- If you know the mathematical function of the v(t) curve, use integral calculus.

- These graphical methods are general and apply to all kinds of motion.
- If you know the mathematical functions you can use calculus:
  - $v(t) = dx/dt$
  - $x(t) = x_0 + \int v(t)dt$
- If you only have a data record of x or a data record of v you can use approximate numerical techniques to find the velocities at specific times, or to find the distance travelled in a given time.

For 2 and 3 Dimensions



- Express the vectors as components
- Use the 1-dimensional graphical methods for each component.