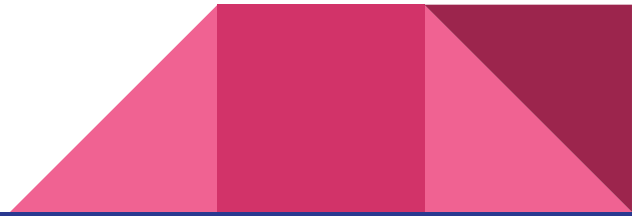
How do we measure velocity?

MTH 201 -- Module 1A

Today

- Review of Daily Prep 1A
- A trip to Meijer without a speedometer
- Practice finding instantaneous velocity from position
- Feedback



An object is moving so that its position (in feet) from the start at time t seconds is $s(t) = 10 - \sqrt{t}$. What is its average velocity from $t = 1$ to $t = 4$?

-3

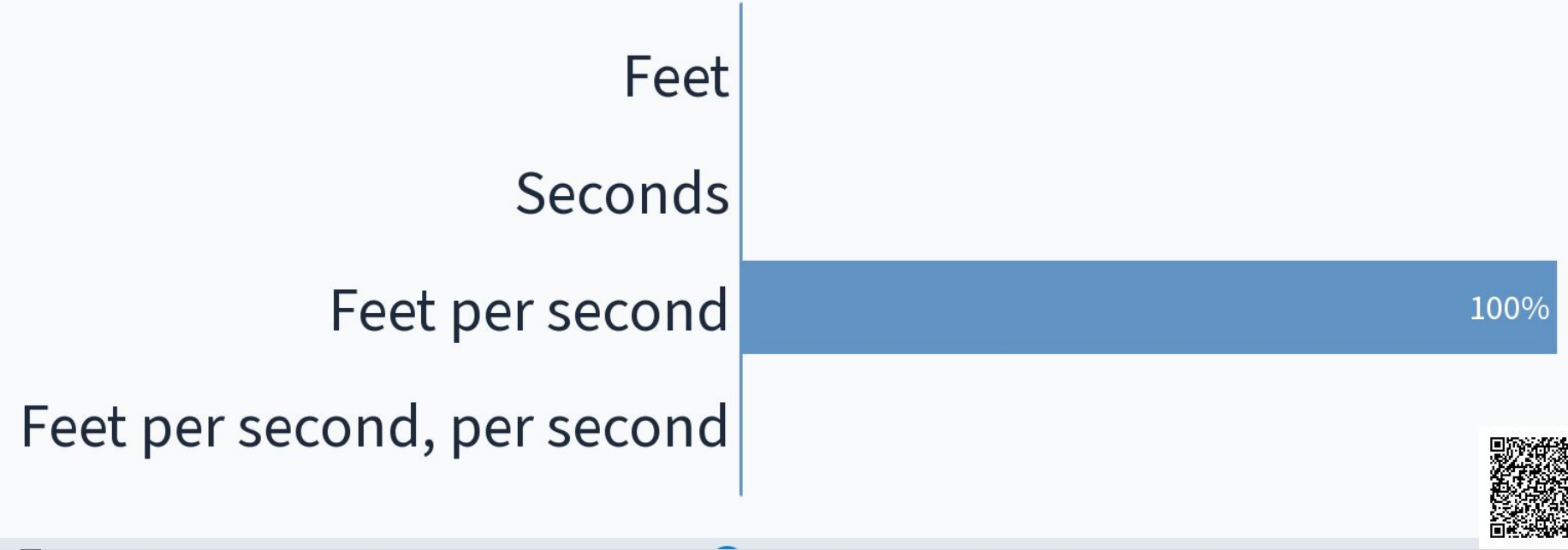
-1/3

1/3

3

None of the above

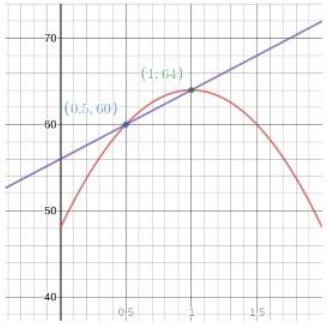
Remember $s(t)$ is measured in feet and t in seconds. What are the units of measurement of the quantity you computed in the previous question?



The position function of a ball is shown in this graph. Select ALL of statements below that are true.

- The ball was released at t = 1 second.
- The ball reaches its highest point at t = 1 second.
- The ball is momentarily motionless at t = 1 second.
- The ball is on the ground at t = 0 seconds.
- The ball is on the ground at t = 3 seconds.
- The ball is moving upwards from t = 0 to t = 1 seconds.
- The ball is moving downwards from t = 1 to t = 3 seconds.
- The ball is moving upwards on the entire interval from t = 0 to t = 3 seconds.

Here's the graph of the position s of the ball again, with the points $(0.5, s(0.5))$ and $(1, s(1))$ plotted and the line that connects them. The line has slope equal to 8. This is also



- The average velocity of the ball on the interval $[0, 1]$
- The average velocity of the ball on the interval $[0.5, 1]$
- The instantaneous velocity of the ball at $t = 0.5$
- The instantaneous velocity of the ball at $t = 1$
- None of these

To

0

Takeaways from Daily Prep 1A

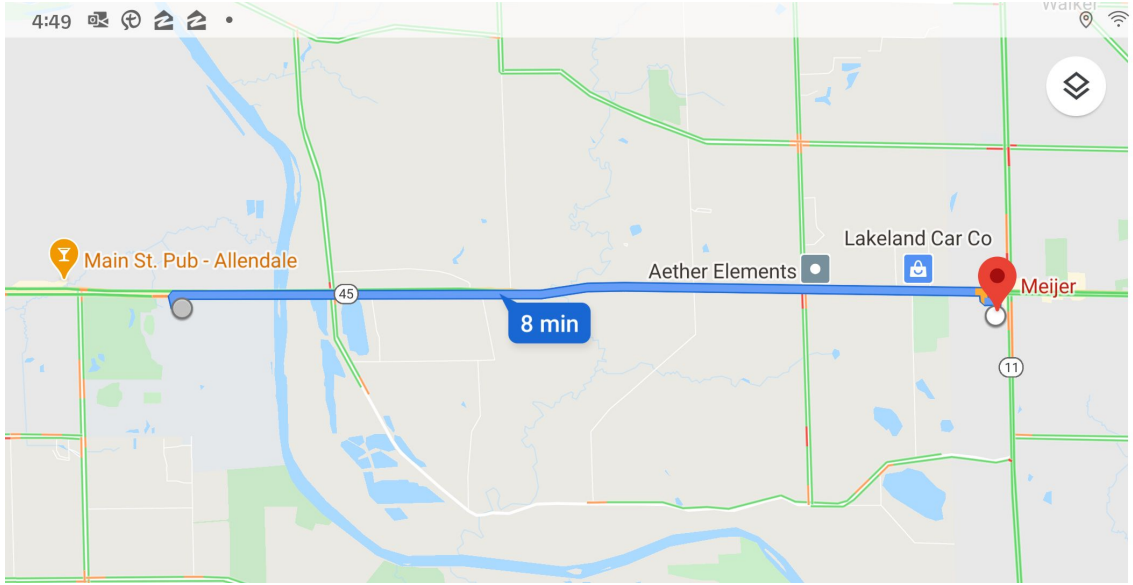
- Average velocity of a moving object on the time interval [a,b] is (Distance traveled)/(Time elapsed) or (s(b)-s(a))/(b-a).
- The units of measurement are (Units of position)/(Units of time)
- It's the same as the slope of the line connecting (a,s(a)) and (b,s(b)).
- Can also be computed using this formula where h = b-a:

$$AV_{[a,a+h]} = \frac{s(a+h)-s(a)}{h}$$

What is instantaneous velocity and how do we find it?

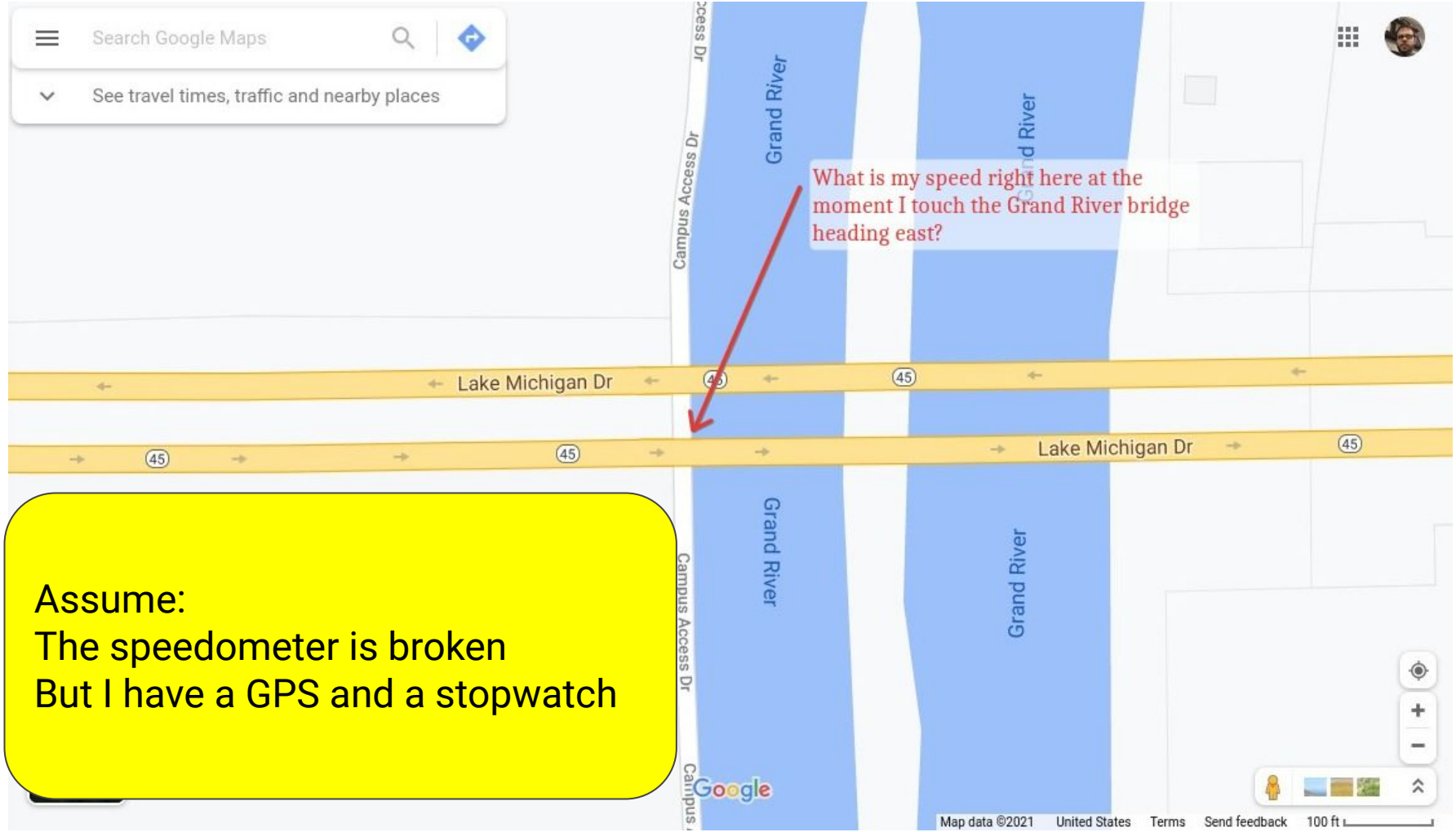
Average velocity = An *estimate* of velocity over an interval of time, found using the distance traveled divided by the time elapsed

Instantaneous velocity = The *exact* velocity at a single moment of time.

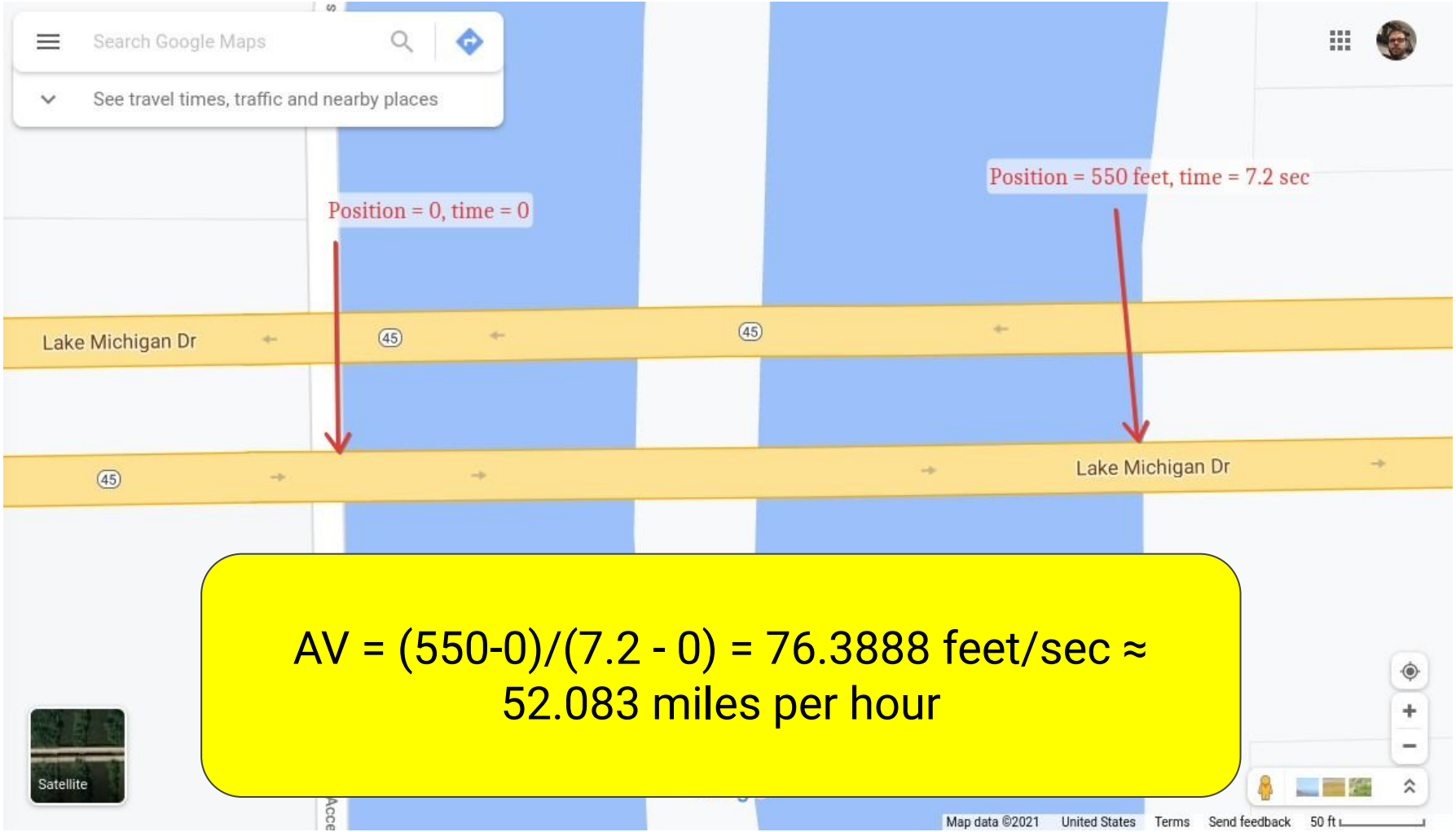


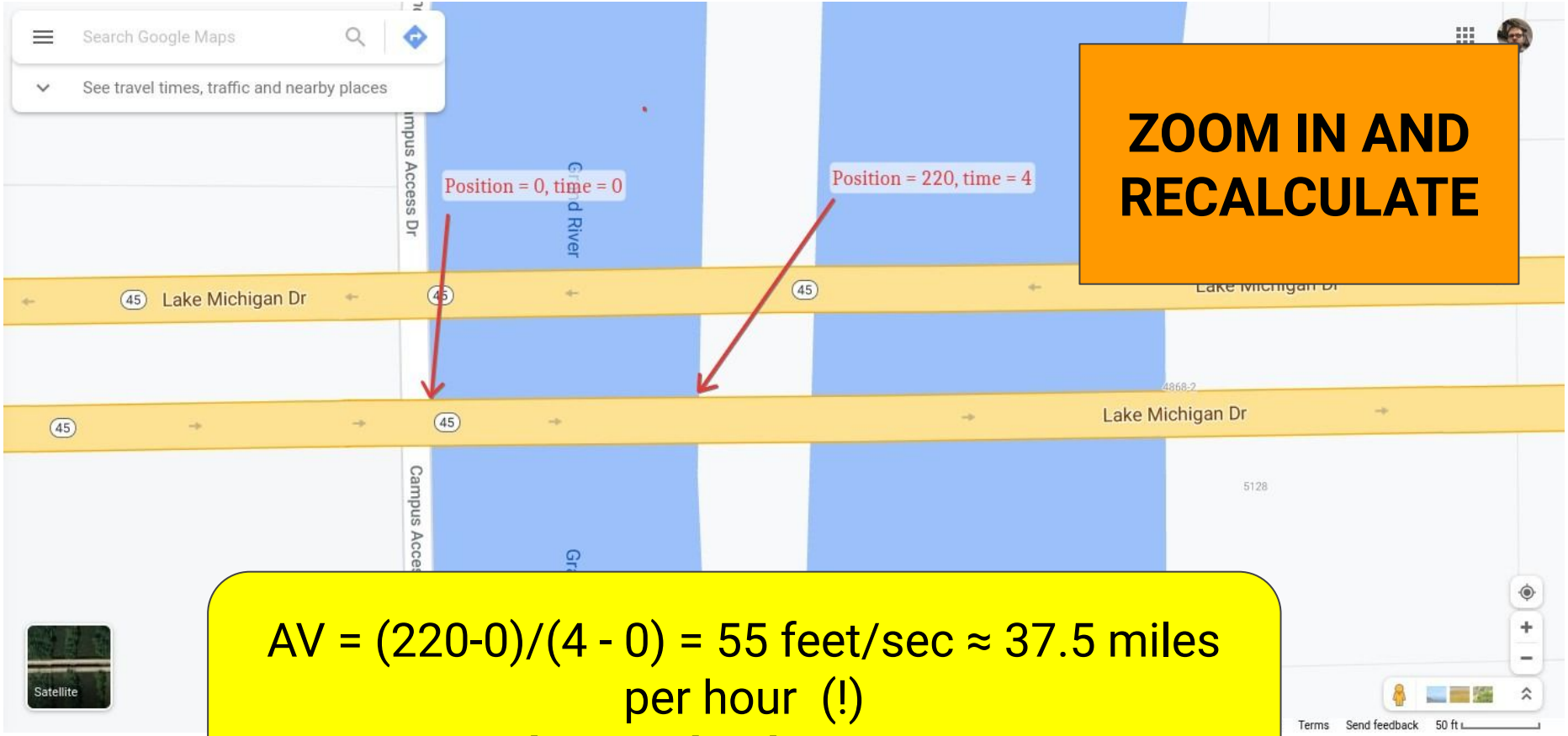
It's 6.1 miles from GVSU Allendale to the Meijer on Wilson Street. Google Maps says I can make it in 8 minutes. What's my average velocity if I do get there in 8 minutes? Was I probably going that speed the **entire time?**

Answer 1: (6.1 miles - 0 miles)/(8 minutes - 0 minutes) = 0.7625 miles/min ≈ 45.75 miles per hour
Answer 2: Probably not! **Different speeds at different times.**



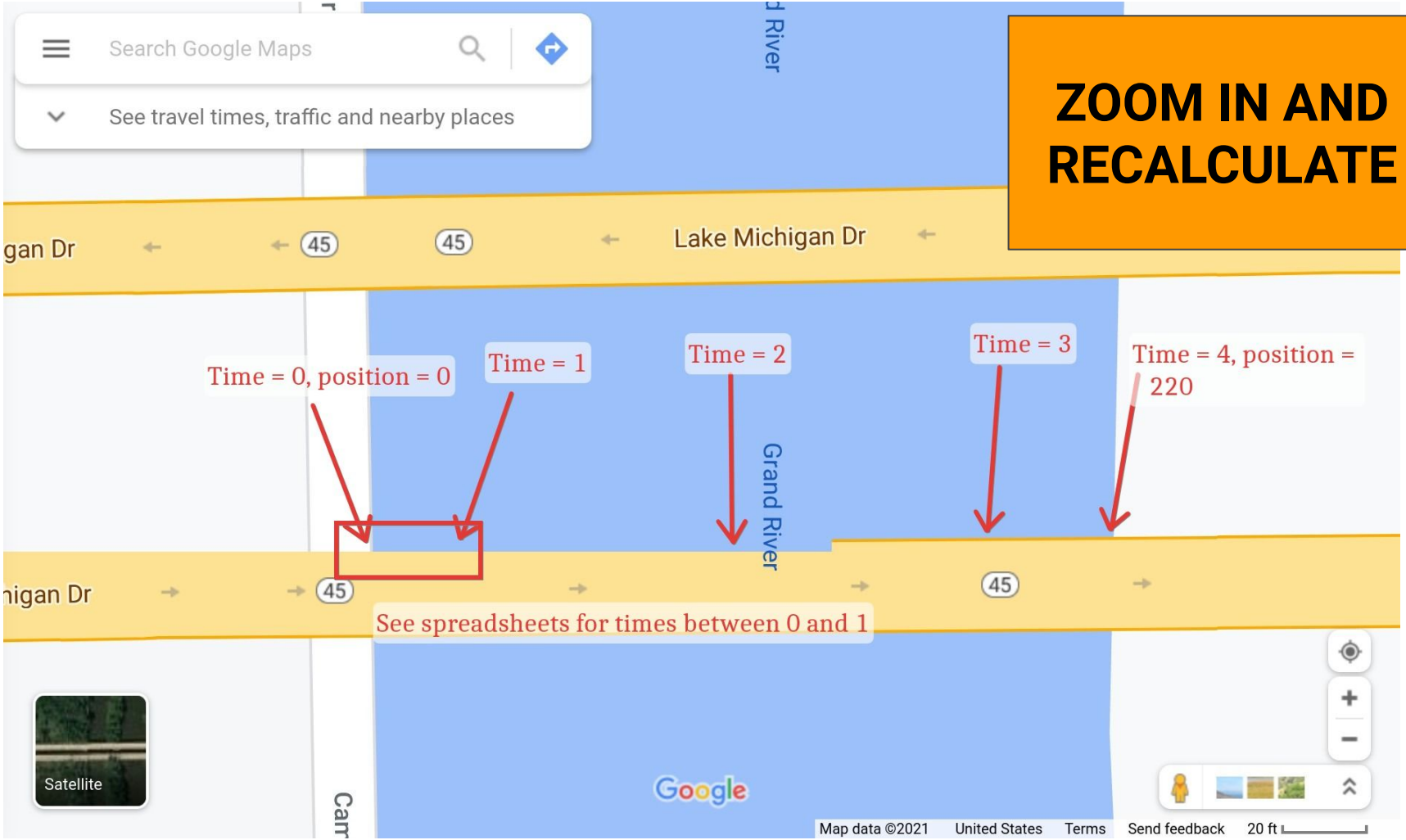
Assume:
The speedometer is broken
But I have a GPS and a stopwatch


Search Google Maps
See travel times, traffic and nearby places
Position = 0, time = 0
Position = 550 feet, time = 7.2 sec
Lake Michigan Dr
45
45
45
Lake Michigan Dr
AV = (550-0)/(7.2 - 0) = 76.3888 feet/sec ≈
52.083 miles per hour
Satellite
Map data ©2021
United States
Terms
Send feedback
50 ft



AV = (220-0)/(4 - 0) = 55 feet/sec ≈ 37.5 miles per hour (!)

How could we make this more accurate?


Search Google Maps
See travel times, traffic and nearby places
ZOOM IN AND RECALCULATE
Lake Michigan Dr
45
Time = 0, position = 0
Time = 1
Time = 2
Time = 3
Time = 4, position = 220
Grand River
See spreadsheets for times between 0 and 1
Satellite
Google
Map data ©2021
United States
Terms
Send feedback
20 ft

Time	Position
4	220
3	191
2	124
1	61
0.5	30.1
0.1	6.1

Find the average velocities over the last five time intervals shown. The starting position is time = 0, position = 0.

To convert from ft/sec to miles/hr, multiply by 0.6818.

Based on the trend, what's a reasonable guess for my speed right at time = 0?

Time	Position	AV ft/sec	AV mi/hr
4	220	55	37.499
3	191	63.66666667	43.40793333
2	124	62	42.2716
1	61	61	41.5898
0.5	30.1	60.2	41.04436
0.1	6.1	61	41.5898

As the time interval shrinks to zero length, the average velocities converge on a single value.

This value is the instantaneous velocity at t = 0.

Practice: Go to student.desmos.com and look for “Practice with instantaneous velocity”

http://gvsu.edu/s/1zJ