# HOMEWORK 1 SOLUTIONS.

① Avg. velocity for the race

$$= \frac{\Delta x}{\Delta t} = \frac{100\text{m}}{9.58\text{s}} \approx 10.43\text{ m/s}$$

② To find the instantaneous velocity for $t = 5s$, we need to take

$$V = \lim_{dt \to 0} \frac{x(5s + dt) - x(5s)}{dt}$$

In practice, if we choose dt smaller and smaller, we'll get closer and closer to the instantaneous velocity, until dt gets smaller than the accuracy of the data (at which point we'll get nonsense). To get 3 decimal places of accuracy, we just need to take dt small enough that the 3rd decimal place doesn't change any more if we make dt smaller. For the Bolt data, we find

$$V(5s) = 11.999 \text{ m/s}.$$

[illegible]

$V_{max} = 12.2 \text{ m/s}$

③ Here,

$$a_{9s} = \lim_{dt \to 0} \frac{v(9s + dt) - v(9s)}{dt}$$

We need to choose a small dt, calculate v at 1s+dt and at 1s as in #2 (perhaps using an even smaller dt to make sure our instantaneous velocities are accurate enough to take a difference) and then get $a_{1s}$ using the formula. We should check that using a smaller dt does not change the 2nd decimal place.

We find: $a(9s) \approx -0.080 m/s^2$

[illegible]

[illegible]

④ Average acceleration for the race:

$$a_{avg} = \frac{\Delta v}{\Delta t}$$

$$= \frac{V_{100m} - V_{0m}}{\Delta t} \leftarrow \text{instantaneous velocities}$$

$$\approx \frac{12.0 \text{ m/s}}{9.58 \text{ s}}$$

$$\approx 1.2 \text{ or } 1.3 \text{ m/s}^2$$

⑤ See attached graph

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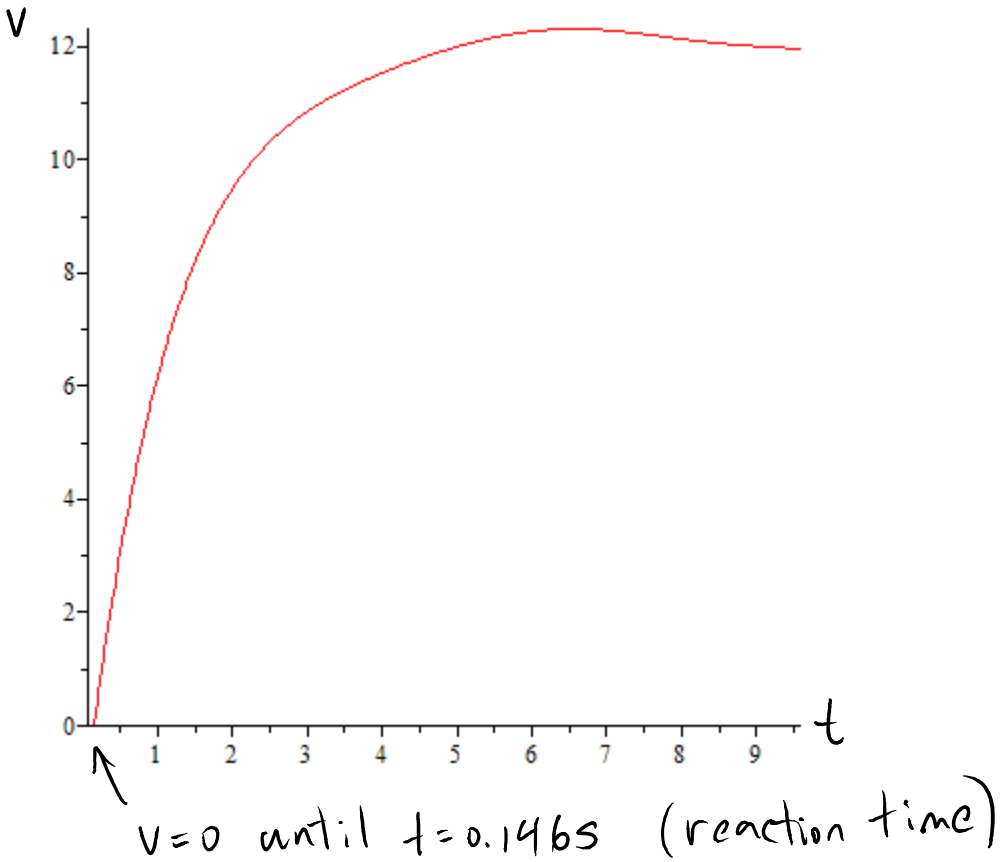


v = 0 until t = 0.1465 (reaction time)