Instantaneous Rates of Change

A. Watch the video of Usain Bolt's world-record run in the 100m and answer the following questions:

1. This was the fastest-ever 100m run. But how fast was it? What was Usain Bolt's speed over the entire race?
2. Do you think he ran at the same speed over the course of the entire race? Why / Why not? Explain your reasoning.
3. Sketch what you think the graph of Usain Bolt's distance (y axis) versus time (x-axis) looks like. Briefly comment on why you sketched the graph you did.

B. Open the file called [*Usain Bolt Data*](https://www.projectmaths.ie/wp-content/uploads/2020/04/Usain-Bolt-Data.docx)which has a graph showing the distance-time information recorded during this race. Answer the following questions:

1. By referring to your graph - calculate Usain Bolt's average speed over the duration of the entire race.
2. By referring to your graph, make a supporting argument for your answer to Q2. from Activity A above. Outline as much supporting evidence as you can.
3. Compare this graph to your predicted graph in Q3. from Activity A above. Comment on any differences between your prediction and the actual graph.
4. At what point in the race do you think Usain Bolt's speed was highest? Explain your reasoning.

You may find the video from Khan Academy useful if you’re experiencing difficulties with the above work. If you’re watching the video – only watch up to 4:40.

[Link to Khan Academy Video](https://www.khanacademy.org/math/in-in-grade-11-ncert/in-in-class11-derivatives/copy-of-derivative-as-instantaneous-rate-of-change-ab/v/slopes-of-secant-lines)

C. Download and [open the attached GeoGebra file called *Usain Bolt WR Run*](https://www.projectmaths.ie/geogebra/usain-bolt-2020/). Use it to help answer the following questions.

1. Confirm Usain Bolt's average speed over the course of the race by dragging points A and B to the appropriate points on the graph.
2. By moving points A and B, confirm that Usain Bolt's speed was not constant over the course of the entire race. Explain your thinking.
3. By moving points A and B, investigate the time at which Usain Bolt was travelling fastest during the race. Make a prediction of when Usain Bolt was moving at top speed and what this speed was. Explain your approach to doing this.
4. By moving points A and B, get the best estimate of Usain Bolt's speed as he crosses the 10 m mark on the track. Explain your approach.

If you are having difficulty accessing or using the GeoGebra file – [here’s a quick video showing how to do so](https://youtu.be/GvL9bN-OQO0).

D. Review the learning intentions and success criteria below, then complete the following statements:

1. The key learning for today was….
2. What I found difficult today was…
3. I need more help with….

**Learning Intentions**

Students will be able to:

* Recognise situations involving non-constant rates of change
* Understand that average rate of change and instantaneous rate of change are not equal when rate of change is not constant
* Understand how to estimate instantaneous rate of change using average rate of change
* Understand the difficulty of calculating instantaneous rate of change when rate of change is not constant

**Success Criteria**

* I know what type of situations involve non-constant rates of change
* I can explain the difference between average rate of change and instantaneous rate of change
* For a situation involving non-constant rates of change I can explain
  + why average rate of change and instantaneous rate of change may not be equal
  + how to use the average rate of change to estimate the instantaneous rate of change
  + the limitations of the slope formula for finding the instantaneous rate of change