**Formulas**

**Questions**

1. In the 1988 Olympics in Seoul, South Korea, Canada’s Ben Johnson set the men’s 100m world record by sprinting 100.00 m in 9.79 seconds. What was his average velocity for the race?  
   Note: Johnson tested positive for steroids, and had his gold medal stripped from him.
2. In the 2008 Olympics in Beijing, China, Jamaica’s Usain Bolt set the men’s 100m world record by sprinting 100.00 m in 9.69 seconds. What was his average velocity for the race?
3. Do you think Bolt was running at the average velocity throughout the whole race?
4. Here are the split times for Johnson and Bolt’s runs, in seconds. For each section of the race, determine the average velocity of both athletes in m/s.

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| **Interval** | **Johnson** | **Average Velocity (m/s)** | **Bolt** | **Average Velocity (m/s)** |
| Reaction time | 0.13 s |  | 0.17 s |  |
| 0.00-10.00 m | 1.50 s |  | 1.68 s |  |
| 10.00-20.00 m | 1.04 s |  | 1.02 s |  |
| 20.00-30.00 m | 0.930 s |  | 0.910 s |  |
| 30.00-40.00 m | 0.860 s |  | 0.870 s |  |
| 40.00-50.00 m | 0.840 s |  | 0.850 s |  |
| 50.00-60.00 m | 0.830 s |  | 0.820 s |  |
| 60.00-70.00 m | 0.840 s |  | 0.820 s |  |
| 70.00-80.00 m | 0.850 s |  | 0.820 s |  |
| 80.00-90.00 m | 0.870 s |  | 0.820 s |  |
| 90.00-100.00 m | 0.900 s |  | 0.900 s |  |

1. Compare the velocities of Bolt and Johnson. Who achieves the highest velocity? What do you think each sprinter would need to do to improve their overall time?
2. Convert Bolt’s maximum velocity to km/h. Using the Internet, find an animal with a top speed that is approximately the same as Bolt’s.
3. In Berlin in 2009, Jamaica’s Usain Bolt also set the men’s 200m world record by sprinting 200.00 m in 19.19 seconds.  
   1. What was his average velocity during the race?
   2. How does this compare to his average velocity during the 100m race?
4. Listed below are the times it took for Bolt to reach various stages of the 200m race, in seconds.  
   1. For each section of the race (0-50m, 50-100m, 100-150m, 150-200m), determine Bolt’s average velocity.  
      Note: The listed times are not for each interval! They represent the total elapsed time.

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| **Distance** | **Time (s)** | **Average Velocity (m/s)** |
| Reaction time | 0.133 |  |
| 50.00 m | 5.60 |  |
| 100.00 m | 9.92 |  |
| 150.00 m | 14.44 |  |
| 200.00 m | 19.19 |  |

* 1. How long did it take Bolt to run the 2nd 100m of the 200m race?
  2. Is this faster or slower than his 100m world record? How? Why?