Investigating the Mechanics of the 100 Metre Sprint

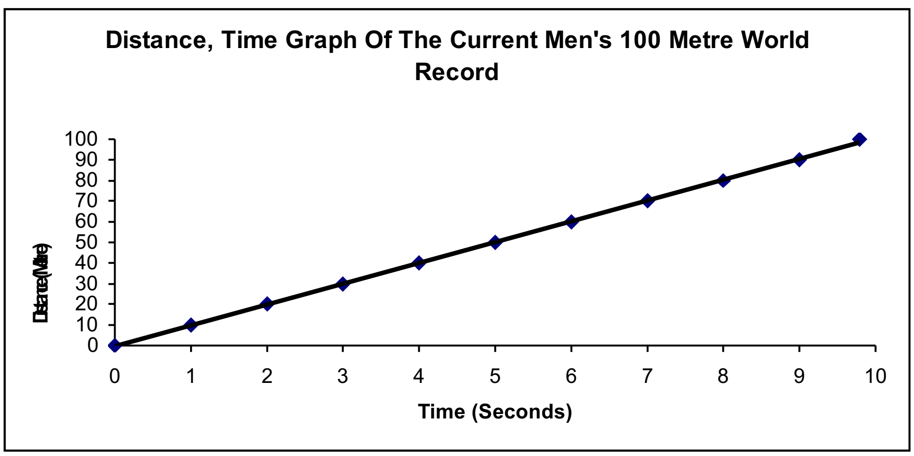
In this assignment, I will be investigating the way in which an athlete run a race of 100 metre and also I will look at other different possibilities such as when an athlete accelerate or decelerate during the race.

The course is a track of 100 metres in length and I decided that I would not take into account the wind variation in this model because of lack of information. So therefore I assume that there is light wind that will not affect the time.

Before my research I always thought that sprinters run as fast as they can for the whole distance of the race. But in my researches using the Internet and books, I found out that sprinting is a skilful activity just like football kicking and ten nis. Such activity must be practised constantly to retain or improve an athlete's level of ability.

Currently the world record time of the 100-meter race is 9.79 seconds produced by Maurice Greene. I was able to work out his average speed in the following way:

$$\text{Average speed} = \frac{\mathbf{100}}{\mathbf{9.79}} = \mathbf{10.21\ m/s^{-1}}$$



The 100m are a very intense and technical race. Initially the athlete should concentrate totally on his starting technique, which he has fine-tuned in training. Irrespective of the lane or adversaries, he now focuses on a smooth acceleration towards attaining his maximum speed. Once he has attained his top speed, he now relaxes totally in order to maintain his speed with the least amount of unnecessary interaction from muscles or parts of the body not being used for sprinting. The finish also requires some though because a centimetre gained by a correct finishing technique can win a race, a positive and active forward lean can help to achieve that.

NB: Any diagrams within my assignment are not drawn into scale.

Model 1: (sources = www.hypertextbook.com, encyclopaedia of athletics and Brian Mackenzie- UK athletics senior coach)

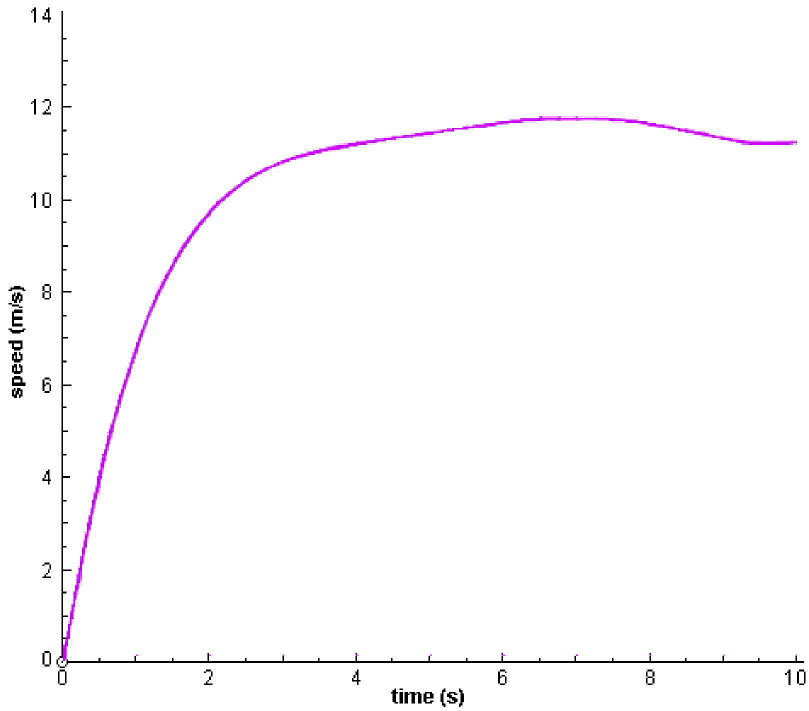
- Total time 9.79 seconds
- Total distance of 100 metres
- No air resistance
- Straight track field
- Athlete starts at rest

For this model, I will examine Maurice Greene's 100-metre race.
This table shows Maurice Greene's split time and speed in 10 metres interval.

Distance (m)	**Time (s)**	**Speed (m/s)**
0	0.00	0.00
10	1.71	8.71
20	2.75	10.47
30	3.67	11.14
40	4.55	11.50
50	5.42	11.67
60	6.27	**11.80**
70	7.12	11.68
80	7.98	11.57
90	8.85	11.51
100	9.73	11.30

As this table demands an accurate graph, I got the following polynomial graph from the same web because I do not have that special software that can draw different shapes of graphs.

It is a velocity-time graph, which shows the variations of speed of Maurice Greene during the race.



As it shows in the table, Greene's acceleration phase is approximately the first 30 – 40 metres; his acceleration is reduced in that his maximum speed reaches 11.5 – 11.8 m/s-1 (41.76 and 42.48 km/h). This represents an increase of about 3 m/s-1. Then the last 30 metres there is almost a steady retardation due to muscle fatigue.

Model 2:

(sources= my knowledge)

Assumption being made:

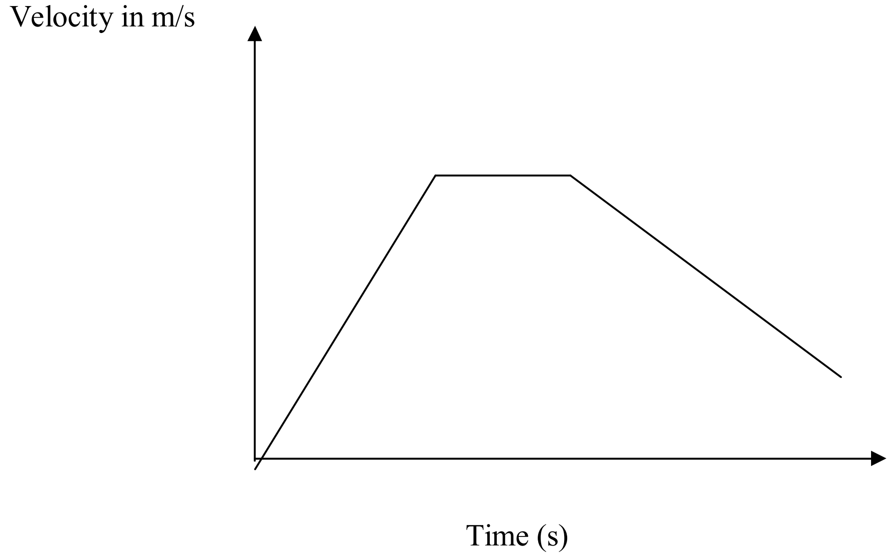
- Total time 17.5 seconds
- A distance of 100 metres
- No air resistance
- Straight track field
- Start at rest
- / = Divide
- ms-1 = meter per second

Since I am doing this investigation, I run a 100-metre race to experience by myself. By the fact I am a less experienced person, I produced an incredible time of 17.5s, which is obviously a very slow time from the view of world-class sprinters. However if I have used a start block maybe it will reduce the time.

I carry out this race in a track field inside Hampstead Heath Park. There was a clear sky and a very light breeze therefore I will not take into account the air variations.

Average speed = 100/17.5= 5.71 ms-1

The next graph is a velocity-time graph to show my variation speed during the race.



At the start, I accelerate for the first 10-20 metres in order to reach my maximum speed. Once I attained, I tried to keep that speed for the next 40-50 metres, but I was getting tired. This is because maybe my muscles had a limited quantity of 'fuel' so called ATP (adenosine triphosphate), which ran out quickly, no wonder why retardation occurred early.
However sprinters have developed a mechanism called 'alactacid anaerobic', which provides a great amount of energy for use of ATP.

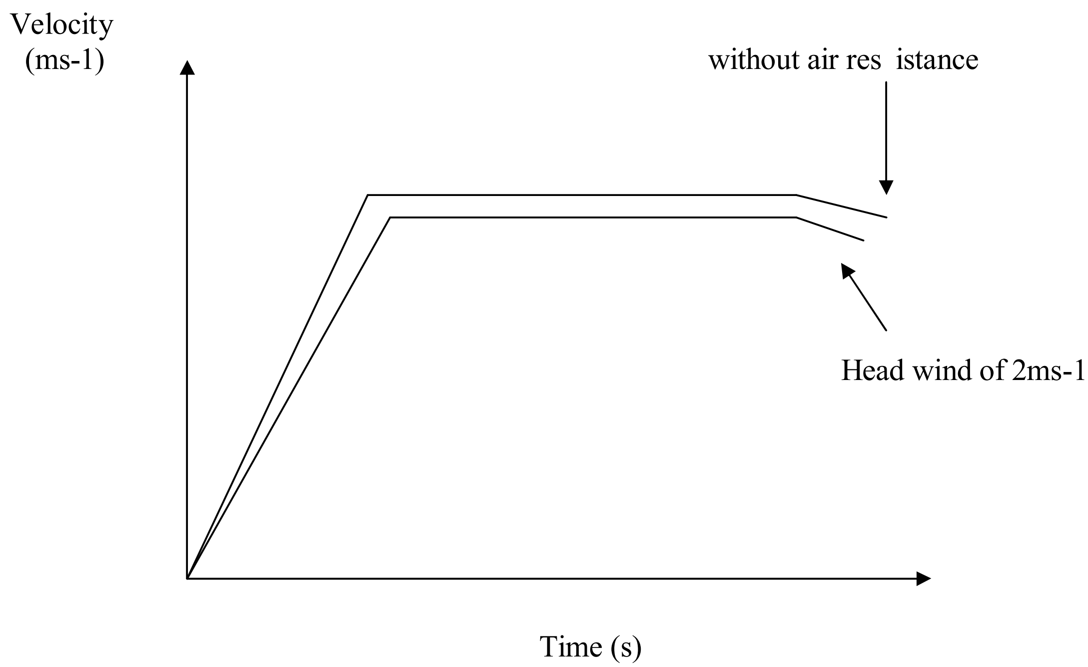
For the next models, since I am assuming the different possibilities of how sprinters run. I decided that the time should be a bit slower since that the athlete is not stated as a world-class sprinter who breaks the barrier of 10 seconds but maybe an average, athlete so therefore I chose his time to be 10 seconds and besides this is less complicated. However I will use the technique of sprinting of Maurice Greene.

The following 2 models show how the wind variations can affect the time. They help sprinters to break the world records or sometimes they prevented them to break it.

MODEL 3:

Assumption being made:

- Athlete should be on the block start.
- Head wind (blow against) 2 ms-1.
- The athlete should start at rest on the block start.

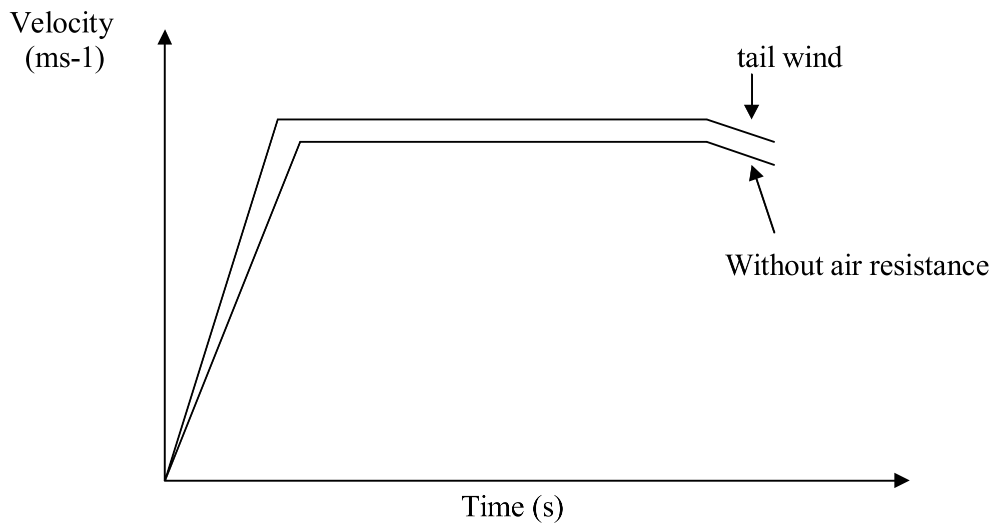


Head wind is when the wind blows against the athlete and this can increases the time. For example the graph above shows how the wind could slow down.

Model 4:

Assumption: (same as model 3 but this time)

- Tail wind (blow forward) of 2 ms-1



This is type of wind has an affect on time as well. But it gives the athlete an extra speed. As you can see from the graph it has slightly increased the athlete's velocity.

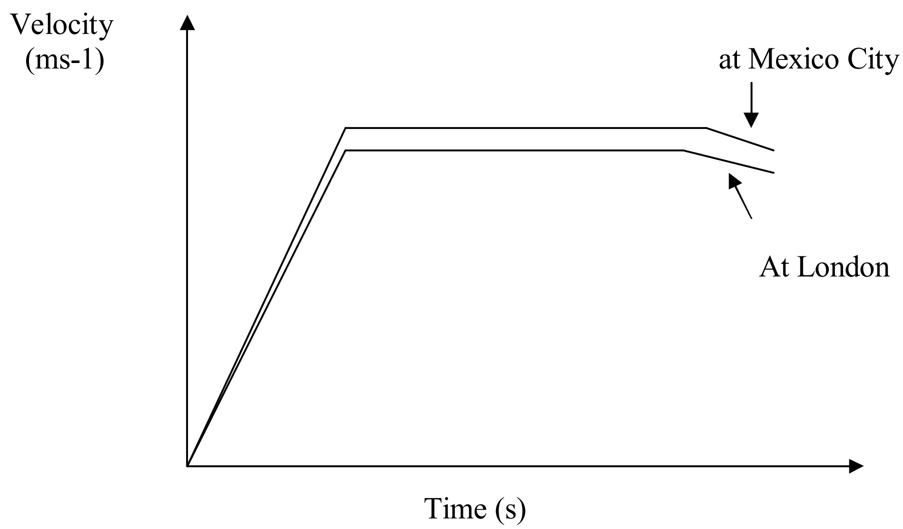
Wind variations are not the only factors that affect the time but also altitude. In my research I found out at higher altitude you become faster meaning that the higher you go up, the faster you become.

The next model is about altitude.

Model 5: (sources = e ncyclopaedia of athlete by eric)

Assumption:

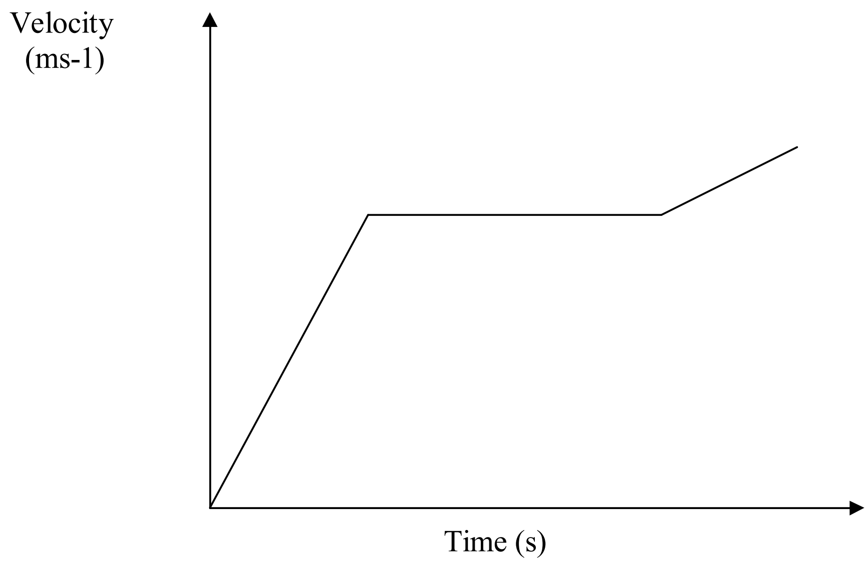
- Different locations (Mexico City and London)
- No air resistance



For examples, if an event is held at Mexico City (2250m above sea level), athlete could gain about 11/100 second (e.g. a time of 10.11seconds in London is equivalent of 10.00seconds, in Mexico City).

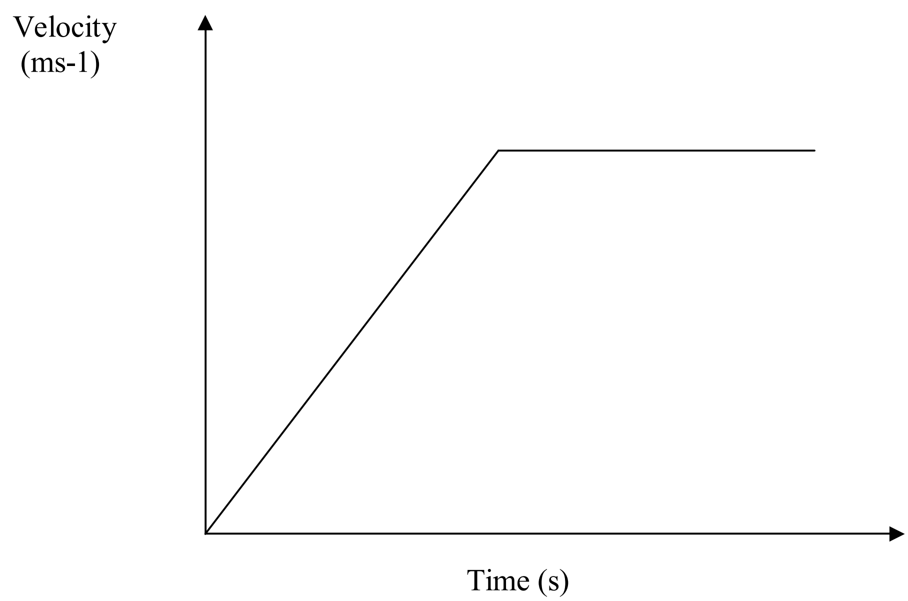
The following models show the way athlete runs the race. I assume that the athlete time is 10 seconds; I will not take into account the air resistance.

Model 6:



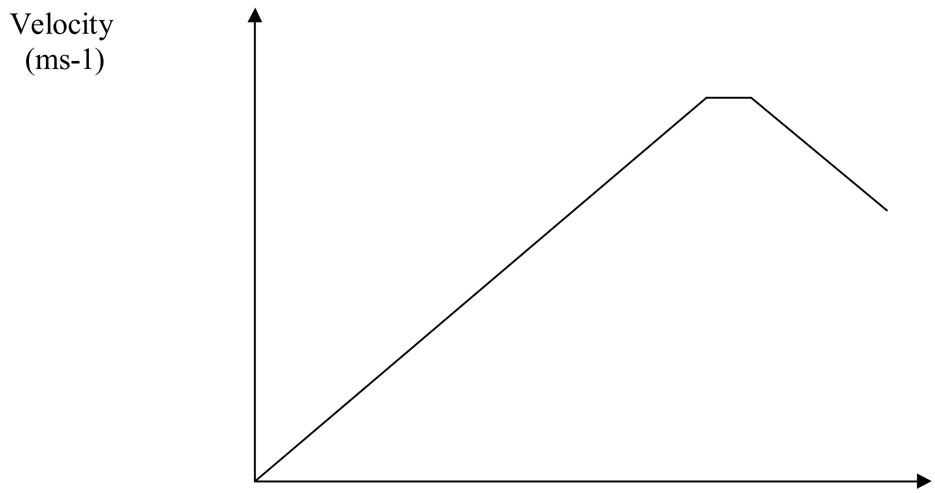
This athlete accelerates for the first 20-30 meters, when he reaches his maximum speed he sprints at a constant speed. For the last 15-10 meters, he begins to accelerate.

Model 7:



This one demonstrates the athlete has accelerated for about the first 40 meters and then he stays at constant speed for the last remaining meters.

Model 8:



This athlete accelerates at a steady speed for about 50-60 meters then he remains constant for 10 –15 meters. He retards fairly fast because he used most of the energy in the first phase.

<u>Extension:</u> (source = Athletic sports by Hamlin)

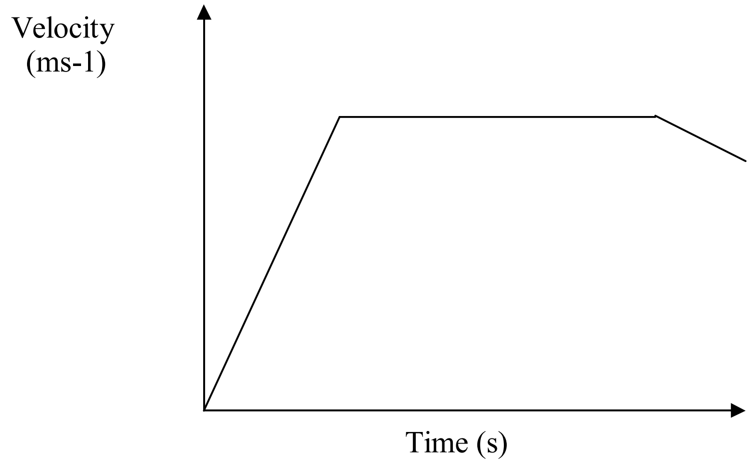
For further investigation, I will look at the 4 × 100 meters relay, this race uses four sprinters together running a complete lap of the track, passing on a baton which has to arrive at the finishing line. The athletes on each leg run 106 m; 126 m, 126 m and 120 m. the three baton changeovers take place 26 meters from the start of that zone.

The current world record of 4 × 100 meters relay is 37.40 seconds produced by the United States team.

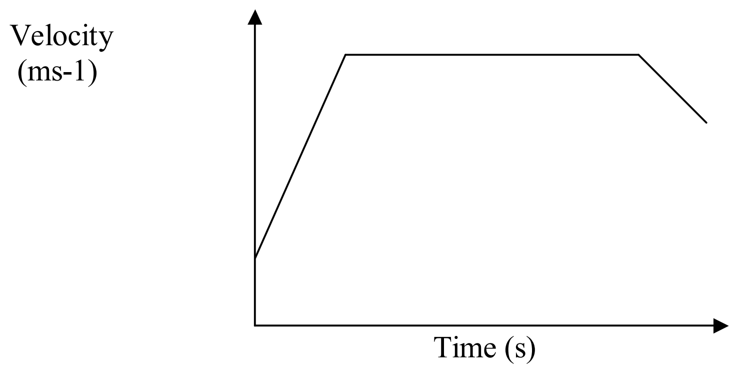
It said that even though that they sprint longer distance (478 m) but they produce a total time which is four time less than the world record time of 100 meters race. However, lets not forget that three of 4 × 100 relay sprinters are in motion before they starts sprinting.

These following models demonstrate the race of each four sprinters. As each individual sprinter runs in a different way then to make less complicated I will use one technique for all of them.

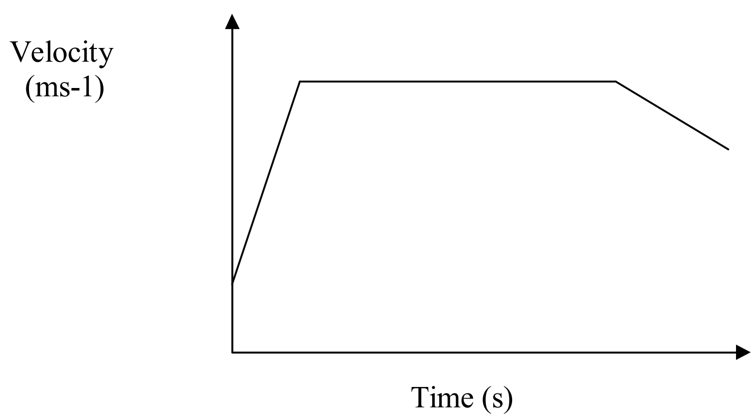
First sprinter: who covers 106 meters



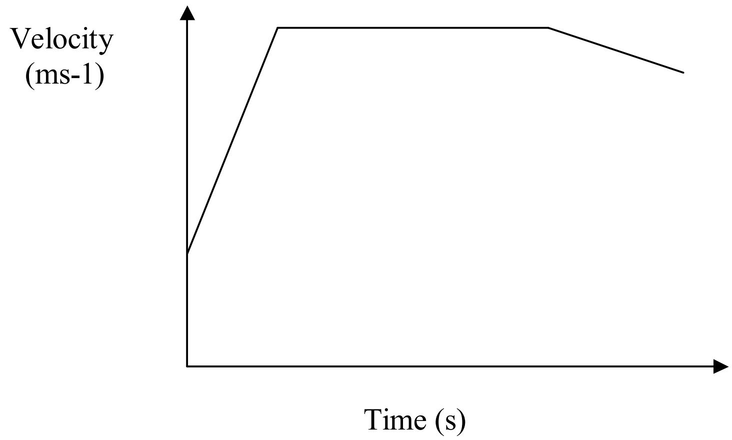
Second sprinter: 126 meters



Third sprinter: 126 meters



Fourth sprinter: 120



As you can see from the graph, the last three sprinters have already built up speed before they reached the starting line and this suggest that they can accelerate quicker than the 100-meters sprinter.

Analysis and interpretation:

After carefully studying the models, I noticed that most athletes use almost the same technique, which first accelerate then stay at constant speed and they eventually decelerate slightly. But in my models I have shown different ways of running where some of them were a bit unrealistic. For examples model 6, the athlete accelerates at the beginning, remains at constant speed, and accelerates again toward the finish line. Model 7 also shows that the athlete once he attained his full speed, he remains steady speed all the way to the finishing line. Even though they are some assumptions but I do not think athletes could run in such way because they have some limited energy, which run out quickly.

However, these two models can produce the fastest time for the reason that there is no retardation but positive speed.

Overall, I think that Maurice Greene's technique is the effective one that human can run. But winning the 100-meters race depends on how they conserve their energy and muscular they are.