Anousha Manji

Maths Portfolio Type II- Stopping Distances

The table below shows the average stopping and thinking distances when a person is driving a car and needs to apply the brakes at various speeds.

Speed (kmh^{-1})	Thinking Distance (m)	Braking Distance (m)
32	6	6
48	9	14
64	12	24
80	15	39
96	18	55
112	21	75

From this data we can graph two data plots: one showing the relationship between speed versus and the other between speed versus braking distance.

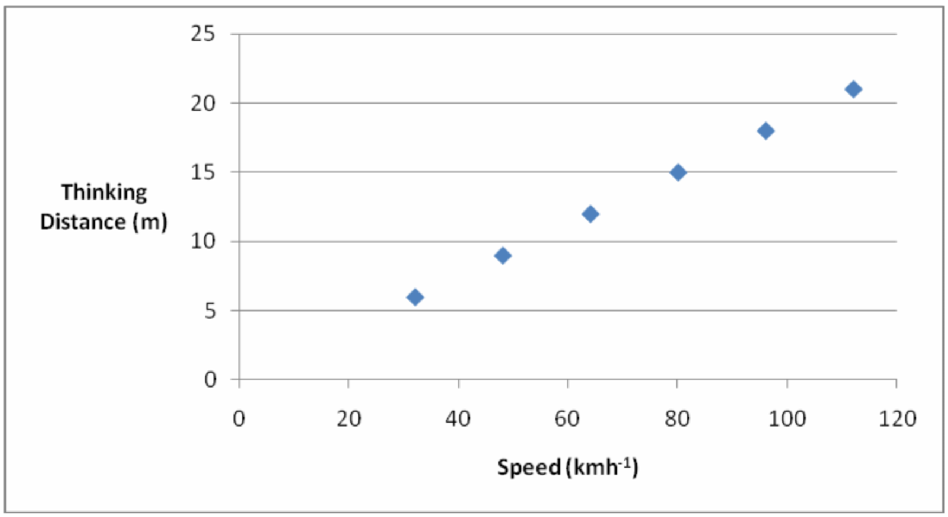


Figure 1

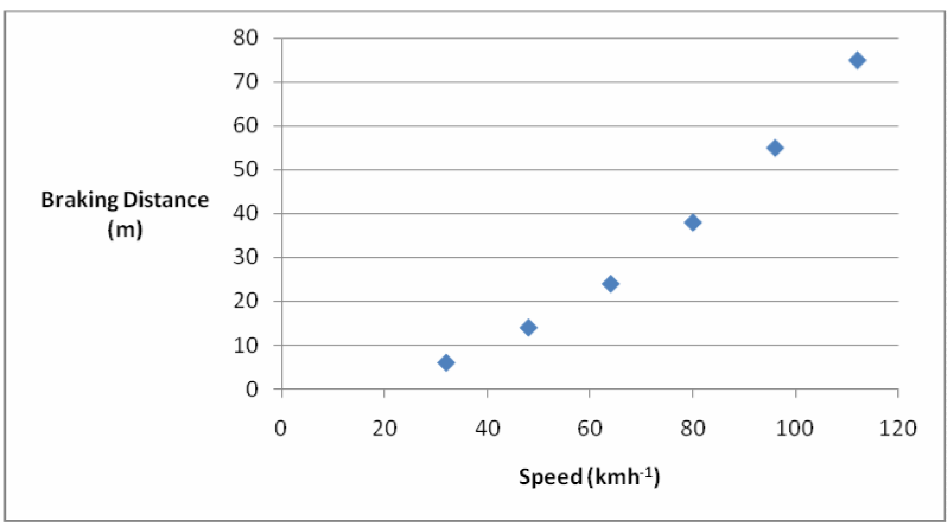


Figure 2

Figure 1 shows a straight line, and therefore it can be said that it is a linear graph. It shows that the correlation between speed and thinking distance is directly proportional and shows the trend that as the speed increases the thinking distance also increases.
The equation of this graph is in the form $y = mx + c$, where *m is* the gradient, and *c* is the y intercept. The equation can be worked by following these steps:

- Find *m* (the gradient) using the following equation: $m = \frac{y_2 - y_1}{x_2 - x_1}$

$$m = \frac{21 - 9}{112 - 48} = 0.1875$$

- *b* is the y intercept but as the graph passes through the origin this value is 0 because while the car is moving at 0 kmh^{-1} the braking distance is 0 m.
- The final linear equation is $y = 0.1875x$ for the domain 32<x<112 because we do not know how long the thinking distance will be for any higher speeds. We could guess from the graph but in a real life situation this would be putting the drivers' life at risk.

Although finding the equation of straight line is relatively easy, one should further prove that the line fits. Below is a table showing the original values for thinking distance and the output values from the equation, $y = 0.1875x$.

Speed (kmh^{-1})/x	**Thinking Distance already given (m)**	**Thinking Distance from function (m)/y**
32	6	6
48	9	9
64	12	12
80	15	15
96	18	18
112	21	21

This shows that the line, $y = 0.1875x$, fits exactly with the values given.

Figure 2 has a graph with an increasing gradient and looks like a part of a quadratic curve suggesting that the braking distance increases with speed. The equation of the curve above almost follows the curve, $y = 0.006x^2$. This can be found using a graphic calculator.

To see how well the curve fits mathematically, below is a table showing the output values from the equation $y = 0.006x^2$ and comparing them to the values already given.

Speed (kmh^{-1})/x	**Braking Distance already given (m)**	**Braking Distance from function (m)/y**
32	6	6.144
48	14	13.824
64	24	24.576

80	39	38.400
96	55	55.296
112	75	75.264

We can see from looking at the table that the output values lie very close to the original values so it can be concluded that the equation is $y = 0.006x^2$ for the domain 32<x<112.
However, from a critical point of view, the values for when $x = 64$ and $x = 80$ are slightly further from the original values.

Speed (kmh^{-1})	Overall Distance (m)
32	12
48	23
64	36
80	53
96	73
112	96

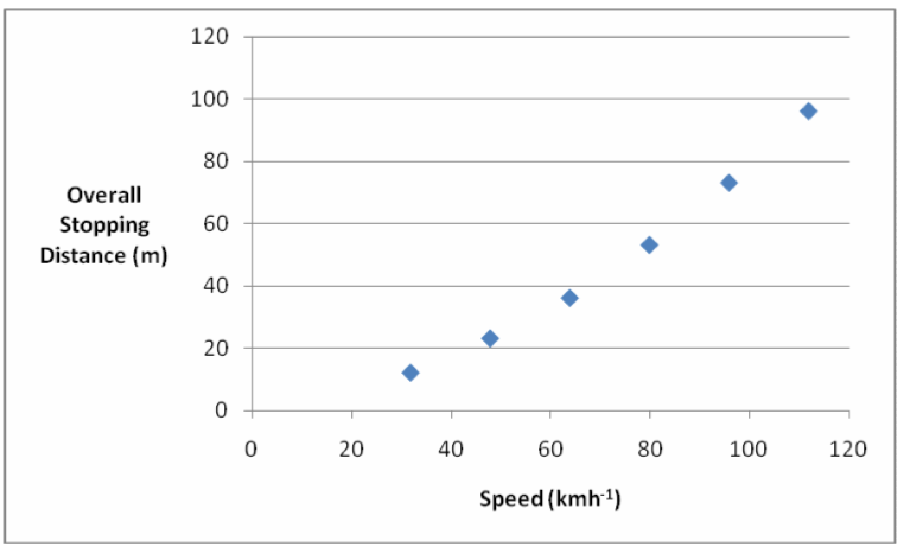


Figure 3

Figure 3 is a graph representing the relationship between speed and the overall stopping distance. This again is a quadratic curve and the best fitting equation (found using a GDC) is: $y = 0.0089x^2$. This function is similar to that of figure two as both graphs show an increase and both could be parts of a quadratic curve. The main similarity between figure 1 and figure 3 is that both graphs have a positive increase.

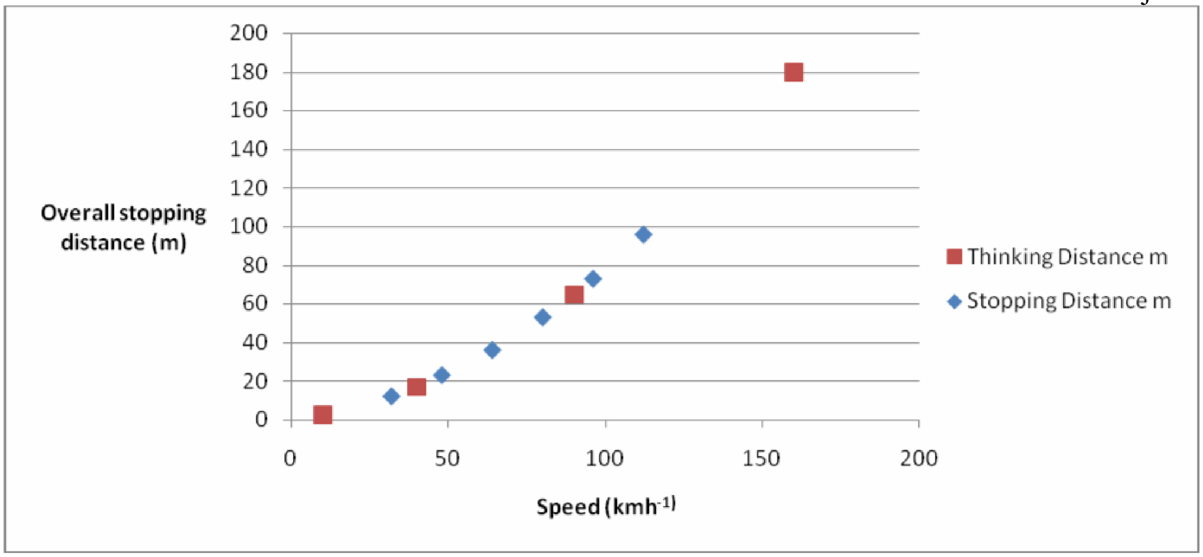
Below is a table comparing the overall stopping distance values (obtained from adding thinking distance and braking distance values together) and the output values from the equation, $y = 0.0089x^2$.

Speed (kmh^{-1})/x	**Overall Distance already given (m)**	**Overall Distance from function (m)/y**
32	12	9.1136
48	23	20.5056
64	36	36.4544
80	53	56.9600
96	73	82.0224
112	96	111.6416

This function obviously does not fit as well as the last two functions although the values do link, just not very closely. If the function is changed, it may fit the top end of the x values but not the bottom, or vice versa.

The overall stopping distances for other speeds are shown below:

Speed (kmh^{-1})	**Overall Distance (m)**
10	2.5
40	17
90	65
160	180



The graph above shows the values for the different overall stopping distances. The points in the red show the values from the last table and the points in blue show the values that were obtained from adding the initial thinking and braking distance values.

The table below shows how the new values for the stopping distance fits into the equation $y = 0.0089x^2$

Speed (kmh^{-1})/x	Overall Distance already given (m)	Overall Distance from function (m)
10	2.5	0.89
40	17	14.24
90	65	72.09
160	180	227.84

The first and last values to do not fit the curve well but the middle 2 values do. From looking at the graph above we can see that all the overall stopping values sit on a curve so it is evident that the problem is in the curve function itself.