In this activity you will draw graphs of data generated in a test drive.

You will also find linear and quadratic functions to model the data.

Information sheet

In a test drive a sports car was accelerated from rest.

The time taken by the car to reach the true speed of 30 mph was recorded, as well as the speed indicated by the speedometer at that time. This was repeated at intervals of 10 mph up to a maximum speed of 90 mph.

The results of this test are given in the table below.

Table 1 Acceleration from rest

Time t (seconds)	True speed v (miles per hour)	Indicated speed u (miles per hour)
2.3	30	34
3.5	40	45
5.0	50	55
6.8	60	66
9.4	70	78
13.1	80	89
20.5	90	99

The brakes were tested by measuring the distance travelled by the car in coming to rest from different speeds. The track surface was dry and maximum braking was used.

The results of this test are given below.

Table 2 Brakes

True speed v (miles per hour)	Distance d (metres)
30	9.5
50	27.5
70	52.4
85	98.7

You can find data like this in magazines such as *Autocar*.

Think about…

- In table 1, which is greater: the speedometer speed or the true speed? Is the difference always the same?
- Is there a rough rule to connect the two sets of speeds?
- How could you get a more accurate rule to link the two sets of data?
- Why is it more difficult to know what sort of function will fit the data in table 2?

1 Indicated speed against true speed

Use the 'Acceleration from rest' data on the information sheet.

a Plot a graph of indicated speed against true speed.

b The data is approximately linear.
Draw a line of best fit passing through the origin.

c Explain the assumption that has been made in drawing the line through the origin.

d Find the gradient of the line, and explain the information it gives.

e Write down the function that gives the indicated speed u in terms of the true speed v.

f Use your function to predict the indicated speed when the true speed is 100 mph.

g The function suggests that there is a constant percentage error in the indicated speed. What is this percentage error?

h What advice would you give the owner of this car when using it on roads?

Extension

Use a spreadsheet to draw a graph of indicated speed against true speed.
Draw the linear trendline and find its equation.
Compare the result with the function you found in part **e**.
Comment on the differences.

2 Braking

Use the 'Brakes' data on the information sheet.
Graphs can be drawn by hand or by using a computer or graphic calculator.

a Plot a graph of distance against true speed.

b Draw a curve through the origin and the data points.

c Explain why it is appropriate to draw the curve passing through the origin.

d The shape of the graph suggests that a quadratic function of the form $d = kv^2$ may be an appropriate model. By substituting the values of the last data pair (85, 98.7), into this equation, find a value for the constant k.

e Using this value of k draw the curve $d = kv^2$ on your graph.

f Comment on the suitability of the function you have found as a model of the data.

g Repeat parts **d**, **e** and **f** using a different data pair to find a value for k.

Extension

Use a spreadsheet to draw a graph of distance against true speed.
Draw a quadratic trendline and find its equation.
Comment on the suitability of this function as a model of the data.

3 Acceleration from rest

Use the 'Acceleration from rest' data on the information sheet.
Graphs can be drawn by hand or by using a computer or graphic calculator.

a Plot a graph of true speed against time.

b Explain why it is appropriate in this case to use the origin as a data point.

c Draw a curve through the origin and the data points.

d The shape of the graph suggests that a quadratic function may give an appropriate model. The general quadratic function is of the form $v = at^2 + bt + c$. Explain why in this case the value of c is zero.

e By substituting the values of the last data pair (20.5, 90) into the equation $v = at^2 + bt$, show that $90 = 420.25a + 20.5b$.

f By substituting the values of the data pair (13.1, 80) into the equation $v = at^2 + bt$, find another equation relating a and b.

g Solve the simultaneous equations in **e** and **f** to give values for a and b.

h Using these values for a and b, draw the curve $v = at^2 + bt$ on your graph.

i Comment on the suitability of the function you have found as a model of the data.

j Find an alternative quadratic model by finding values of a and b from simultaneous equations, based on the first and last data pairs.

k Compare the two quadratic models. Say which you think is the better model and why.

Extension

Use a spreadsheet to draw a graph of true speed against time.

Draw a quadratic trend line and find its equation.
Comment on the suitability of this function as a model of the data.

Also draw a cubic trend line and find its equation.
Comment on the suitability of this function as a model of the data.

4 Summarising findings

Write a short report stating your main findings from this work.

Include any diagrams you think would help illustrate the main points.

At the end of the activity

- Which method of finding a model do you like best?
- Which method do you think is the most accurate?
- Would using a cubic or higher order function be better?
- What difference would it make if you were able to take into account the inaccuracies in the data you have been given?