Hit the brakes, Charles!

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Student Activity

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TI-Nspire Investigation Student 60 min

Introduction

Hit the brakes, Charles! – bivariate data including x^2 data transformation

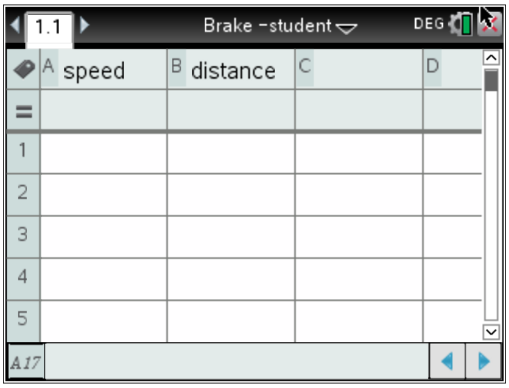
As soon as Charles got his P's he did some real data collection for his mathematics project. He decided to check whether the Auto Club figures for stopping distances and speed were true.

The table below shows the speed in *km/h* when Charles hit the brakes with the distance in *m* it took him to come to a complete stop.

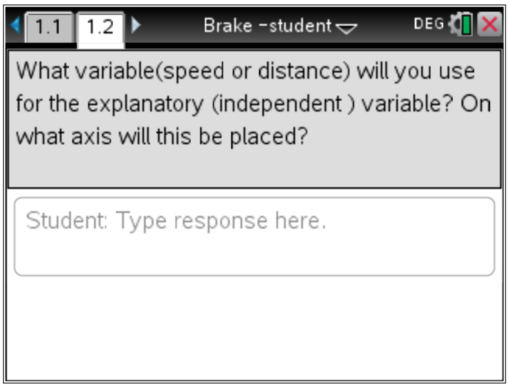
Speed km/h	40	60	70	80	90	110	120
Stopping distance m	29	55	67	96	112	168	223

Problem 1A

Construct a data table in the **Lists & Spreadsheet** page using the variables ***speed*** and ***distance***.



What variable (***speed*** or ***distance***) will you use for the explanatory (independent) variable? On what axis will this be placed?



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Problem 1B

Construct a scatter plot showing the relationship between the speed and braking distance.

Insert a **Data & Statistics** page.

Add the variables to the axes by clicking on the **Click to add variable** boxes or press [tab] to go to the variables list.

Describe the relationship between the two variables.

Perform a Quadratic regression on the data using [menu] **>Analyze>Regression>Show Quadratic**

Use the regression equation in a **Calculator** page to predict the stopping distance (to the nearest metre) of a car travelling at 50 km/h.

Hint: the regression equation can be recalled by pressing [var] and scrolling to **stat.regeqn** and adding (x).

Answer: ***m.***

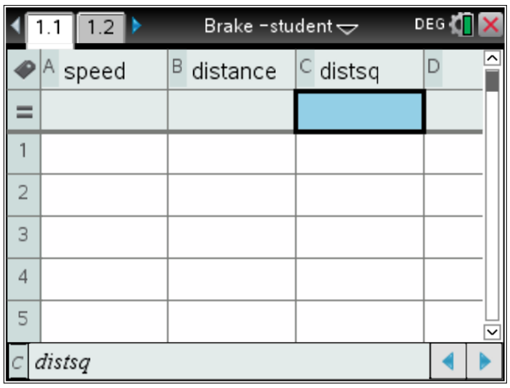
Note: If you are asked to do a data transformation to linearise (e.g. VCE Further Mathematics) then this answer is not acceptable. Instructions on this procedure follows; for courses not requiring linearization, you may be given the transformed data to continue as a linear relationship.

Problem 2A

Apply an x^2 transformation.

Use [ctrl] + ◀ to return to the **Lists & Spreadsheet**. Label the new list as ***spdsq***. Enter the formula in the formula cell shown opposite i.e. ***=speed²***

Hint: use the [var] key to paste in list variables to avoid any typing errors.



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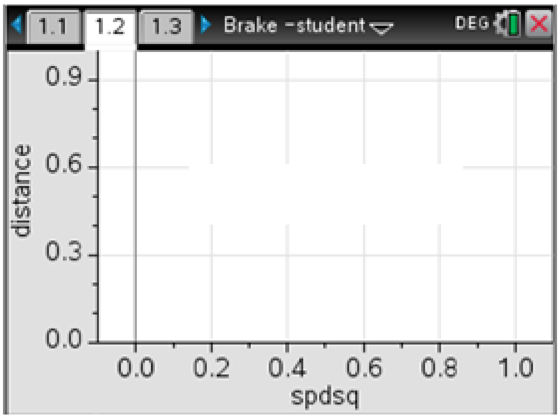
Construct a scatter plot on a new **Data & Statistics** page showing the relationship between y (distance) and x^2 (speed squared). You will need to mouse click on the axes label to use the [tab] key to insert the variables.



To go to other existing pages in your document at any time press [ctrl]+▲ to see thumbnail pages. Use your cursor to highlight the page you want and press [enter]. If you want the previous page you can also use [ctrl]+◀, similarly [ctrl]+▶ will give the next page.

Problem 2B

Determine the least squares regression for this transformation.

On the linearised scatter plot page press

[menu]**>Analyze>Regression>Show Linear (a+bx)**.

Note: your teacher will let you know if they prefer you to use **Show Linear(mx+b)**

Hint: to show the r^2 value when doing linear regressions press [menu]**>Settings** and tick the **Diagnostic** field, then select **Make Default**.

The regression equation, correct to 3 decimal places, is:

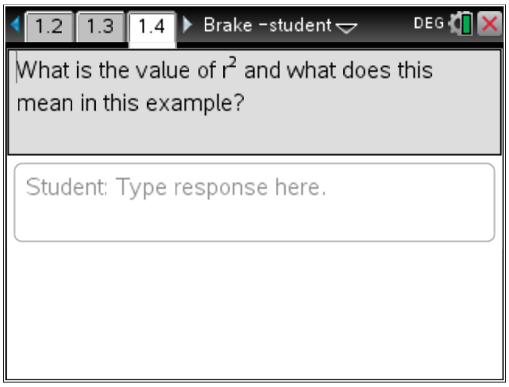
y(distance)= …………… + …………………x (speed squared)

A full statistical display can be shown in a **Calculator** page using [menu]**>Statistics>Stat Calculations>Linear Regression (a+bx)**. Complete the table depending on the Linear model you have used.

Using **Linear a+bx**	Using **Linear mx+b**
a =	m =
b =	b =
r =	r =
r^2 =	r^2 =

Note: if you have performed a linear regression in the **Data & Statistics** page you can access the statistics in the **Calculator** page by pressing [var]**>Stat Results**.

What is the meaning of the r^2 value in this practical example?



By pressing menu **>Analyze>Residuals>Show Residual Squares** you can display the residual squares on the plot. These appear as boxes based on the vertical distances the points are from the regression line and also the numerical value is shown. This figure is the smallest sum of squares possible and the regression line is often referred to as the ***Least Squares Regression Line***.

Use menu **>Analyze>Residuals>Hide Residual Squares** to remove this line before doing the next section.

Problem 2C

Show a residual plot (residual vs speed squared) linearised data.

On **Data &Statistics** page showing the transformed data plot with regression line press menu **>Analyze>Residuals>Show Residual Plot**. You will see the original plot and the residual plot on the same screen.

Does the residual plot show any obvious pattern?

For a data transformation to be considered appropriate it must satisfy two things.

1.

2.

Was the x^2 transformation appropriate in this example?

Use the regression equation to predict the stopping distance (to the nearest metre) of a car travelling at 50 km/h

In the **Calculator** page recall the regression equation by pressing var and select **stat.regeqn** to paste to work area. You need to add (x) after pasting as shown. When substituting in the speed value remember that the x now represents *speed squared* so enter as 50^2.

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The stopping distance when travelling at 50 km/h is …………………………….. m

How does this value compare to the one obtained earlier calculated from the quadratic regression?

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