Using the EA-100 Data Logger and the Graphic Calculator.

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Select RUN mode from the main menu by using the arrow keys to highlight the RUN icon or pressing 1 and in STAT mode, icon number 2 and in PRGM mode, icon letter B.

This worksheet looks at:
- use the data analyser to collect data on time and temperature.
- transfers data from the data analyser to the calculator.
- use the calculator to graph the relationship between time and temperature.
- use a mathematical model to model the collected data.
- Application of Newton's Law of Cooling.

An overview of the Data Logger.

The EA-100 Data Logger features:
6 Channels: 3 analog inputs, 1 ultra-sonic motion detector input, 1 digital input, 1 digital output.
The unit automatically recognises the type of probe being connected to each channel. One temperature probe, one light probe and one voltage probe are included in the pack. Other types of probes are available You can measure motion, temperature, light, force, sound, pH and more with the use of appropriate probes. The Data Logger allows for the display of data from the specified channel during the sampling to confirm when sampling is taking place and when the sampling has finished. You can collect data from up to five channels simultaneously (The 6th is reserved for time). The unit can collect data at rates of up to 10,000 data points per second for up to 250 data points (maximum entry for each column in **STAT** or **LIST** icon is 255 data values) per channel.

Time Interval Settings:
1. To access, Press [**SHIFT**] [**MODE**]
2. Press [**DataLog**] to scroll through available settings.
Settings are: mSec: 10, 20, 50, 100, 200, 500: Sec: 1, 2, 5, 10, 20, 30, 60.
3. Press [**Trigger**] to set the Time Interval and to advance to the next setting.

Number of Samples Setting:
1. Press [**DataLog**] to scroll through available settings: 10, 20, 30, 50, 100, 200.
2. Press [**Trigger**] to set the Number of Samples and to advance to next setting.

Time Type:
1. Press [**DataLog**] to scroll through available settings:
    0 - time recording off;
    1 - absolute time recording
    2 - relative time recording
2. Press [**Trigger**] to set the Time Setting.
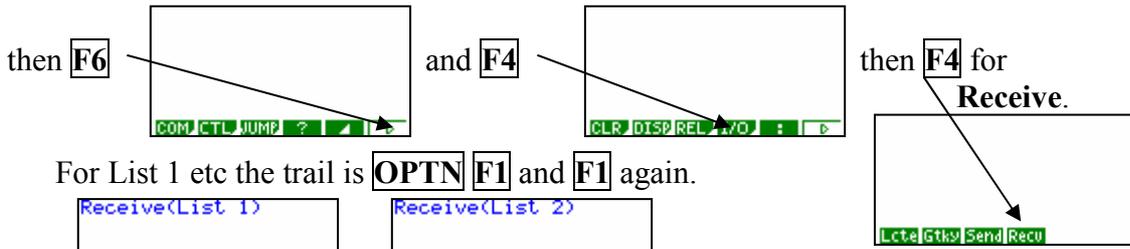
Data Collection and Transfer.
"Ready" appears on the display.
1. Press [**Trigger**] for the Data Analyser to begin collecting data.
2. "Done" appears when data collection is completed.

Data Transfer to a Graphics Calculator.
1. Connect the calculator to the Data Analyser (Make sure that the plugs are in firmly).

2. In **RUN** mode and using **PRGM** SHIFT VARS

then **F6** ⟶ and **F4** ⟶ then **F4** for
Receive.

COM CTL JUMP ? ▮ ◢ ▶   CLR DISP REL A/O : ▶

For List 1 etc the trail is **OPTN** **F1** and **F1** again.

Lcte Gtky Send Recv

Receive(List 1)   Receive(List 2)

List L→M Dim Fill Seq ▶   List L→M Dim Fill Seq ▶

List 1 is **TIME** and **List 2** is the
TEMPERATURE reading

Alternatively a 'short programme in the **PRGM** icon from the **MAIN MENU** will do this data transfer from the Data Logger to the calculator very quickly.

The example shown in this worksheet is to show how heat is lost from a hot cup of water when it is placed in a room, free standing, to cool.

Two experiments are conducted, one with a simple cup of water and the second with a cup of water with a metal spoon placed in the water to act as a "radiator" to compare and to see if there is any difference in the cooling rates.

PROCEDURE.
1. Heat approximately 250 ml of water. Bring it to the boil (approx 100° C).
2. Place the thermometer probe into the cup of water after it has been heated.
3. Set the rate of sampling of the EA-100 at 10 seconds and the number of samples to be taken at 200. Start the data gathering with the EA-100 and relax for the next 33 minutes and 10 seconds.
4. Transfer the data from the EA-100 to the graphic calculator.
5. Analyse the data collected as a time series. Fit an appropriate mathematical model to the data collected.
6. Repeat the experiment with the spoon in the cup of water.
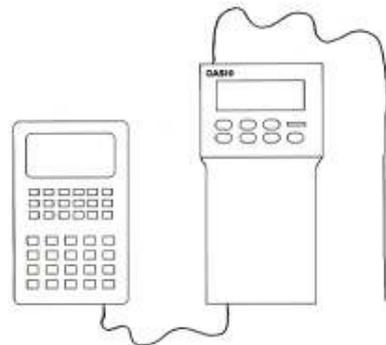
ANALYSIS OF THE RESULTS.
The trend of the two curves displays the rate of cooling for the water. You may expect some results to differ as this is dependent on different surface areas, different composition containers, addition of insulating materials, etc.

The analysis is done in the **STAT** icon, setting the statistical graph to be either a time series or scattergraph
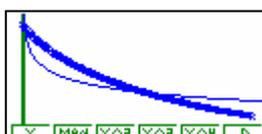
Time (sec)
Temp(° C)
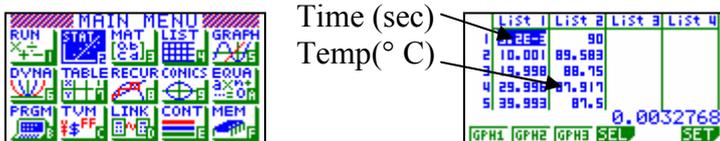
Result #1:Without the spoon:
An exponential model:
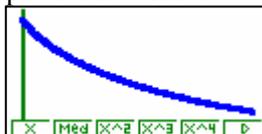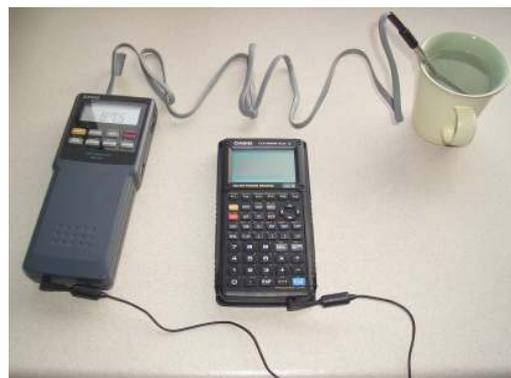
ExpReg
a =81.9846781
b =-3.554ᴇ-04
r =-0.9896281
r²=0.97936385
y=a·e^bx

A power model:

PowerReg
a =131.876219
b =-0.1265144
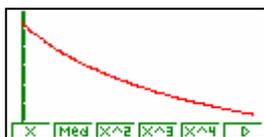r =-0.7859067
r²=0.6176494
y=a·x^b

From the value of r^2 and comparing the two mathematical models, the exponential model is the 'best fitting'.

Result #2: With the spoon:
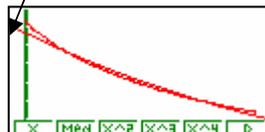Transfer the data from the Data Logger into List 3 and List 4 of the calculator.

An exponential model:

The theoretical model displayed.
$y = 77.958e^{-0.000325}$

Making comparisons between the cooling (i) without and (ii) with the spoon (radiator). The spoon 'absorbs' the heat – heats up – (logarithmically). So the initial temperature is lower, but the cup of water cools at similar rates.
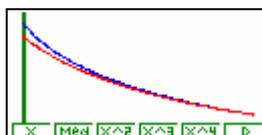
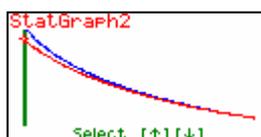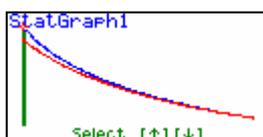Without spoon: $y = 81.985^{-0.000355}$

With spoon: $y = 77.958e^{-0.000325}$

Graphically, viewing both time series or scattergraphs simultaneously.

Select **F1** then **F4**

Then turn **StatGraph1** and **StatGraph2** on by pressing **F1**
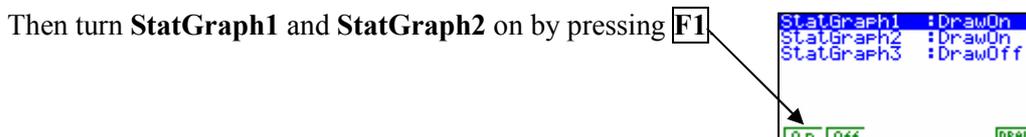
F6 will draw the two graphs.

Choosing the mathematical model the calculator will sensibly ask which graph do you want to analyse. Select and press **EXE** to analyse.

N.B**. Newton's Law of Cooling** states: That the time a substance takes to cool off depends on the temperature difference between the substance and the surroundings. This law may be written as:

$$\text{time to cool } \alpha \; \Delta T$$