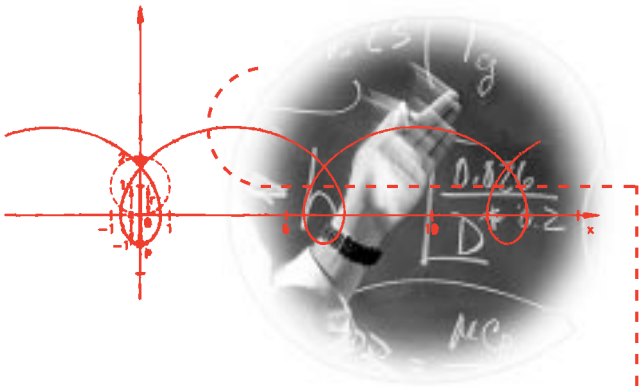
TEXAS INSTRUMENTS



TI-TIME

Issue 2/99

Harry Gretton, Neil Challis

Bungee Jumping – a Mathematical Perspective using a CBL™/CBR™

Introduction

Some people feel moved to throw themselves from high places and to bounce on the end of an elasticated rope. Those who cannot face the adrenalin rush that bungee jumping must bring, can still experience something of the thrill with the help of the Calculator-Based Laboratory™ (CBL™) system. This example is one of those we use in teaching mathematics at Sheffield Hallam University, to help motivate our sport, engineering and mathematics students and to enrich their experience.

In conjunction with the TI-82, TI-83 or TI-92, we (and our students) use the CBL™ to investigate for instance movement, the temperature of cooling liquids, sound or light.

In this article we describe how we have brought bungee jumping into the classroom, to help students to get a "feel" for common mathematical functions.

The problem

A person, attached to a bungee cord, steps off an elevated platform. What mathematical function(s) describe their position over a period of time?

At this stage we must admit that instead of a person with a bungee cord, we use a partially filled can of liquid and some knicker elastic, partly because of the weakness of the ceiling, but also because of a lack of volunteers!

continues on page 3

Inside this issue

Dear Teacher

Welcome to the 13th issue of TI-Time!
I'd like to take this opportunity to introduce myself. My name is Guy Harris, and I am the new Educational Marketing Manager for Texas Instruments in the UK. Prior to this assignment I was working for TI in Product Development, helping design calculators and software for education. I spent a lot of time working closely with teachers like you, in classrooms and at conferences. My job involved learning about maths and science education, listening to teachers, and discussing ideas for educational tools. After finding out what was needed in schools, I was able to explain the needs to our engineers working on new products.

For those of you who know Monika Blair, my predecessor, I am pleased to be able to tell you she has arrived safely home in Texas. She is now working as a Product Line Manager at our headquarters in Dallas.

I would like to thank those of you who have contributed to this issue with ideas and articles. Sharing articles in this way helps bring new and creative ideas into other classrooms across the United Kingdom and Ireland. If you have an activity that you or your students have enjoyed, please share it with us! You can send them to me at the address below.

We are in the process of updating the TI-TIME database. If you would like to continue to receive this newsletter, please e-mail us or send in the card in the centre of this newsletter.

Guy Harris
Educational Marketing Manager
Texas Instruments Limited
800 Pavilion Drive
Northampton NN4 7YL

Bungee Jumping – a Mathematical Perspective using a CBL™/CBR™

continued from front page

The conjecture

Restrict the experiment for now to the part where the jumper begins to oscillate like a mass on a spring, so that the elastic property of the cord is important (but see suggested extensions below). It would seem that the jumper's position then will be described by a damped sinusoid, where

$$s(t) = Ae^{-kt}.\sin(bt + c) + d \text{ , where } Ae^{-kt}$$

is the damping function.

Materials required for the experiment

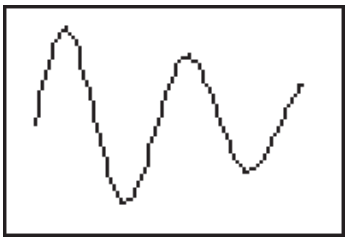
A ring-pull soft drink can, 1 metre of elastic, a CBR™ or CBL™ with a motion detector, and a TI-82.

A first experiment

1. Drink some of the liquid in the can. (If it is too heavy, it will bounce back up too far.)
2. Tie the elastic to the ring pull on the can.
3. Set up the calculator, CBL™ and motion detector, with the detector on its back on the floor. Run the program called HOOK, available from the web site **http://www.ti.com (also listed below).**
4. Suspend the can by the loose end of the elastic, directly above the motion detector, and high enough so that when the elastic is completely stretched out the can is not closer than 0.5m to the motion detector.
5. Set the can bouncing by displacing it from equilibrium. For now restrict the size of the bounce so that the elastic is always stretched. Once movement is established, hold the suspending hand steady, and press the button to record the height variation.

Some of our results

Here is a screen dump of the height vs.time graph, produced using STAT PLOT



Fitting a mathematical model

Although the standard method for model fitting is the method of least squares, we do not use that directly here, for two reasons. First the TI-82 cannot fit a model of the required form

$$s(t) = Ae^{-kt}.\sin(bt + c) + d \text{ ,}$$

(although the TI-83 has a sinusoidal regression function!).

Second and more important, we think it is instructive for students to "play" with the parameters in the function, to help them to get a feel for their significance. Here is one approach – you may think of others:

- The base line, or the "average" value of the function – parameter d.
  You can find the average using STAT, 1-Var Stats on L2, giving a value for d of 2.7818.

```
1-Var Stats
 x̄=2.781795859
 Σx=275.39779
 Σx²=777.017641
 Sx=.3337665208
 σx=.3320765529
↓n=99
```

- The amplitude and decay rate – parameters A and k. We can estimate these as follows. Take the 4 successive maxima and minima in the list L2 (0.23999, 3.3742), (0.68001, 2.2038), (1.14, 3.1869), (1.58, 2.4019). Store the X values in L3 and Y values in L4. Into L5 put the L4 values minus the average value d already found, then put the modulus of the L5 values into L6.

```
L4-2.781795859→L
5
{.592404141  -.5…
abs L5→L6
{.592404141  .57…
```

Finally take the exponential regression of L6 on L1.

```
ExpReg
 y=a*b^x
 a=.6758577796
 b=.6851902981
 r=-.9402544064
```

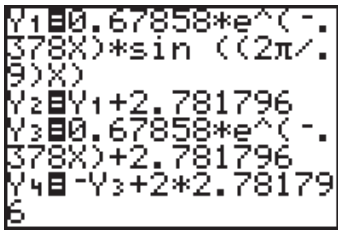
This can be stored in one of the Y variables for plotting. It is useful to convert it to the more usual form, and add the 2.78 … to raise it to the right level for plotting, where if all is well it should show the envelope of the decay:

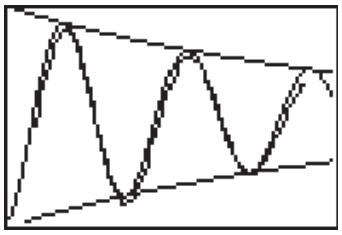
```
Y3■0.67858*e^(-.
378X)+2.781796
```

- **The frequency – parameter b**
  If it were a pure sine wave, and if we had a TI-83, we could do a sine regression, but neither of these is the case, so we use the values on list L2 to find the time between "zeroes" of the sinusoid. We estimate this period for the sine wave to be 0.9, with frequency therefore.

$$b = \frac{2\pi}{0.9}.$$

We can now try graphing the function so far, in Y1, with X as Time (the decay envelopes are also plotted, in Y2 and Y3)
Distance= Y1 = 0.67858 e^(-0.378*Time) sin((2_/.9)*Time)





Graphing these equations, the fit seems convincing to us. Thank goodness for the pleasure of having instant graphical feedback on your model!

Luckily it seems we can take the phase angle c as 0 in this case – that might not be so on another day!

Programme HOOK for TI-82

```
:PlotsOff
:FnOff
:AxesOn
:{1,0}→L1
:Send(L1)
:{1,11,3}→L1
:Send(L1)
:{3,.02,99,1,0,0,0,0,1}→L1
:Send(L1)
:ClrList L1,L2,
:Get(L,)
:Get(L1)
:Plot1(Scatter,L1,L2, ' )
:ZoomStat
:Stop
```

Author:
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Sheffield Hallam University
Sheffield S1 1WB

World Wide Web Sites

Here are a few web sites that you might find useful. If you visit one and find it particularly helpful, let us know so we can let other TI-Time readers know. If you would like to see a site listed in a future issue, send us the web address.

- **Maths Net**
  http://www.anglia.co.uk/education/mathsnet/
  Mathematics, Education, Information Technology and the Internet - and some straightforward sums too...

- **The Math Forum**
  http://www.forum.swarthmore.edu/
  An Online Maths Education Community Centre. Their goal is to build an online community of teachers, students and parents who have an interest in maths and maths education.

- **United Kingdom Mathematics Trust Website!**
  http://www.mathcomp.leeds.ac.uk/index.htm
  The UK Mathematics Trust organises and co-ordinates national mathematics competitions in the UK for 12-18 year old school pupils.

- **The Northern Ireland Supercalculators Through The Curriculum Project**
  http://www.infj.ulst.ac.uk/NI-Maths/CalcMenu.html
  This project developed ways of using Graphics Calculators throughout the Northern Ireland Mathematics Curriculum at Key Stages 3 and 4, and in the 6th form.

- **Texas Instruments**
  http://www.ti.com/calc/uk/uk.htm
  Texas Instruments UK and Ireland web pages, including UK developed classroom activities.

- **Texas Instruments**
  http://www.ti.com/calc/docs/other.htm
  Gives links to other maths and science related links.

Eric Brown, Ian Forbes and Tom Macintyre

CAS Research in Scotland

What is the appropriate role, of hand-held Computer Algebra Systems (CAS) in the teaching and learning of secondary school mathematics in Scotland?

In issue 7 of TI-TIME in the Autumn of 1996, Bert Waits and Frank Demana commented that "the portability and affordability of this tool (the TI-92) will mean the teaching and learning of mathematics will change significantly in the next few years." Since then the price of a TI-92 has dropped from £200 as it was then, to nearer £100 and the TI-89 (with CAS but not Cabri) is now with us. Frank and Bert also said at that time that "some traditional paper and pencil skills will continue to be necessary... However, we must stop spending large portions of our time teaching obsolete paper and pencil algebra and calculus manipulations. This is our challenge for the future."

In 1998 the Scottish Consultative Council on the Curriculum (SCCC) published a paper for discussion and consultation on 'Advanced Calculators and Mathematics Education.' One of the recommendations was for the Council of the SCCC to "encourage detailed research into the potential benefits and problems associated with using graphics calculators and, in particular, CAS calculators, to ensure that future curriculum development in this area is well informed."

Texas Instruments agreed to support the project by providing the TI-92's.

The Faculty of Education of the University of Edinburgh decided to take up the challenge set by Frank and Bert and recommended by the SCCC, and in August of last year put forward a research proposal and application for central support. The application was successful and Texas Instruments agreed to support the project by providing the TI-92's. The University agreed to fund the time for the research and the Scottish Office Education and Industry Department (SOEID) also agreed to provide funding to be used as an incentive to participating schools. Finally, the University of Edinburgh Development Trust provided a Small Project Grant.

CAS systems have been available on PC or Macintosh for many years. As a result their impact on mathematics has been largely limited to university level. Advances in technology have resulted in 'advanced calculators' like the TI-92 which have computer algebra software built in, are powerful, highly portable and user friendly. The aim of this project is "to gather information on the use of Computer Algebra Systems in the teaching and learning of mathematics in a situation where whole classes of students have regular access to them in hand-held form."

"the TI-92 ..... are powerful, highly portable and user friendly".

The study aims to identify areas of the current curriculum where the use of CAS is appropriate; to identify ways of developing 'symbol sense' and thus enable students to tackle algebraic work with greater confidence; and to develop student confidence with the use of CAS technology and make staff less 'computer shy'. The study will focus on the Mathematics Units leading towards the Higher Course from the Higher Still programme currently being implemented in Scottish schools and colleges. Achieving data on the use of technology balanced by pencil and paper methods is an expected outcome of the study. The findings of the research will be complementary to similar studies being carried out in Norway, Austria and the USA and will focus on the Scottish curriculum.

Texas TI-92 models of CAS calculators, will be provided and loaned to each student for their dedicated use throughout the duration of their Higher course – i.e. until June 2000.

The research is taking place in six large comprehensive secondary schools in the City of Edinburgh, Midlothian, Fife and West Lothian Councils. Three of the schools will be given equipment and worked with directly and three will be non-intervention 'control' schools. Two teachers delivering the Higher Course of study in Mathematics have also been selected from each school. An expected sample population of between 150 and 180 students will ultimately be involved in the project. Texas TI-92 models of CAS calculators, will be provided and loaned to each student for their dedicated use throughout the duration of their Higher course – i.e. until June 2000.

The project has four phases over the period from Autumn 1998 until the Summer of 2000. Phase one was the identification of schools, teachers/groups of students to take part in the study and agree access through the local authority and senior management. Having done this, staff had to be familiarised with the technology and trained in appropriate use of TI-92. Finally in this phase, time had to be spent identifying and agreeing with the staff involved, both areas of the curriculum to target with CAS input and approaches to be taken.

The second phase is to 'pre-test' the target groups to ascertain their algebraic skills and confidence level at the start of the project, prior to being introduced to CAS. Students will be expected to work until they have completed all they can do or until the end of the allocated time. The 'test' will give a starting point and benchmark, covering algebraic skills expected of students at this level (and beyond). Alongside each question is a space for students to comment and to indicate how confident they feel with the work, allowing a measure of the student's attitude towards mathematics generally and algebra in particular, to be gauged. Once this has been done, arrangements will be made for the hardware to be put in place and to familiarise students with the operating system.

During the third phase, staff from the Faculty involved in the research will provide tutor support for the schools, team teach, observe and evaluate lessons on agreed areas of the curriculum.

The fourth and final phase of the research will be to conduct a series of face-to-face interviews with staff and a sample of students. Towards the end of the project and before the Higher 'Course Assessment' (Higher Still provision) all students will sit an algebraic skills 'test' of a similar nature to the one sat at the beginning. Some of the same questions will be utilised, but in addition, algebraic work covered during the course of study will also be explored. This will also give an opportunity to measure student abilities and attitudes at the end of the period of using CAS and an opportunity to consider progress made in skills level and algebraic confidence by the pupils in the control schools compared with those directly supported through the use of CAS. All students will also be asked at this final stage to complete a questionnaire on the different aspects of the study. Once this has been completed there will be an analysis of the interviews and a final evaluation of the study. On completion of this final analysis, the findings will be reported, leading to final publication of the study in Autumn of 2000.

There are a few potential difficulties with the research. Since CAS calculators are currently disallowed in examinations, and are likely to remain so for the duration of the project, they will be used in the teaching and learning only. On ethical grounds, it may be necessary for the researchers to provide TI-82 or TI-83 calculators for examination purposes. These alternative calculators are permitted in examinations and have similar operating systems but no CAS. Local authority and school permission was sought and granted, for students to be involved in the study. The context of the study and the perceived benefits which participants will gain, through greater access to the technology, will hopefully make access issues fairly straightforward.

There may also be difficulties in terms of release of staff and use of staff time. It is hoped that the project can be linked to school development plans, target setting and a general commitment to improving standards. The link with improving numeracy and algebraic standards, currently a priority in mathematics education, will help ensure that there is a school commitment to the project.

Eric Brown, Ian Forbes and Tom Macintyre are Lecturers in Mathematics at The Faculty of Education of The University of Edinburgh (formerly Moray House Institute of Education)

Free Workshops and Demonstrations

We can send an instructor to your school to help support the use of graphics calculators in education ! Just put together a group of teachers who would like to attend a workshop or get some specialised training, and call one of the instructors below. Best of all, these workshops are completely free !

In England and Wales, contact Barrie Galpin
Phone: 01780 444360.
e-mail: barrie@fineshade.u-net.com

Barrie taught Maths for 13 years in comprehensive schools in Cambridgeshire before moving to Leicester University where he was involved in research and teacher training. From 1990 to 1998 he worked in the Centre for Maths Education at the Open University where he worked on a range of projects linked to graphics calculators.

In Scotland, contact David McLaren
Phone: 0141 956 4090.
e-mail: dmclaren@email.menet.net

David taught mathematics and was a Principal Teacher of Mathematics in the east end of Glasgow before joining the advisory service, from which he retired prematurely some two years ago.

Derek Simpson, T³ Scotland

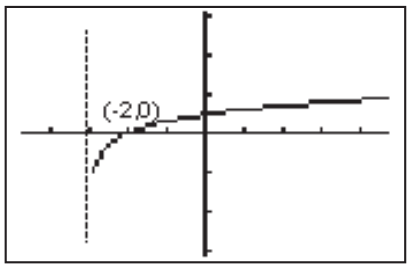
Assessment and Graphics Calculators

Recently my school, along with all schools in Scotland, received the Higher Still material Additional Question Bank for Higher. This included a list of past paper questions, categorised as non-calculator, calculator and calculator neutral, for use in internal assessment. I was immediately intrigued; this requires detailed knowledge of the machines on the market as well as understanding of how they may be used to answer questions. Disappointment followed, it was the same old stuff, a reiteration of the allpervading view that GCs are useful only in a limited area.

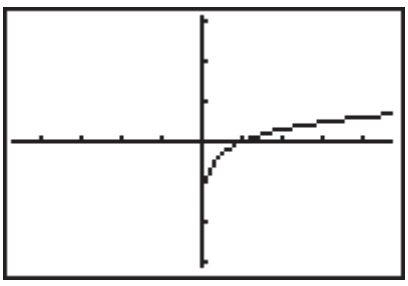
I offer the following example to illustrate where the calculator, used to its full extent, having been embedded in the curriculum from S1 and ably demonstrated as an exploration tool, can make a difference.

Example: 1992 Paper 1, Question 12
Category: Calculator neutral

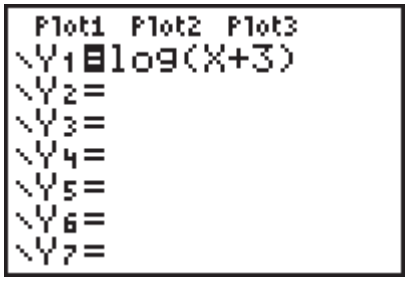
An incomplete sketch (not drawn to scale) of the graph of $y = \log_{10}(x+a)$ is shown. Find the value of a

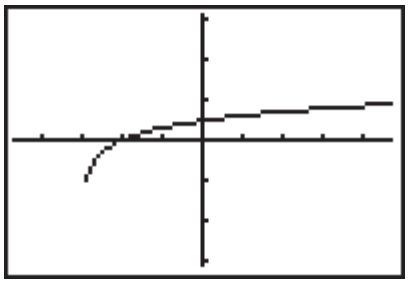


Calculator neutral?
Not so, the following would be of some advantage:
Plot: $y = \log_{10}(x)$

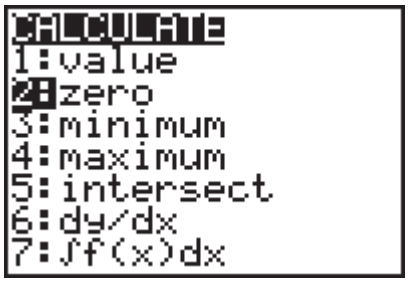


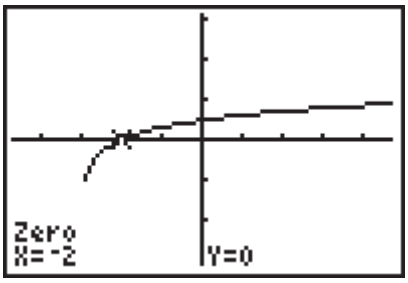
Then try various values of "a" until you get the graph





Check the root using calc function





This is perhaps not the most efficient method to get to the solution but one which illustrates the fact that the advantage of the calculator does not necessarily come from the machine but form the skill of the user. Here then, lies the greatest source of inequality, the training our students receive in the use of this technology. This in turn raises the issue of the training we as teachers must receive if equity is to be maintained. Clearly none of this is relevant unless examining bodies address the issue of assessment head on.

Author:
Derek Simpson, Beeslack High School, Peniciuk, Scotland

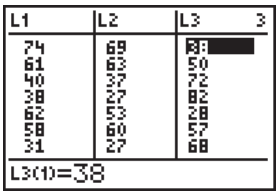
Linear Regression

The graphics calculator can be used to plot scatter graphs and to determine the equation of the line of best fit for linear data.

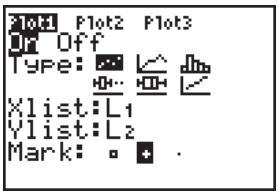
Example: 13 pupils sat tests in Mathematics, Physics and English: The results are shown in the table below:

Maths:	74	61	40	38	62	58	31	48	50	35	20	80	24
Physics:	69	63	37	27	53	60	27	30	62	43	20	72	14
English:	38	50	72	82	28	57	68	51	21	70	92	16	96

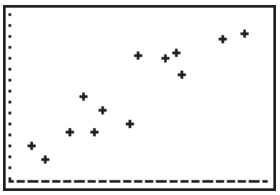
Enter the data into lists L1 , L2 and L3



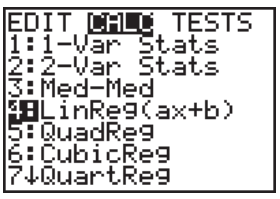
Consider first the relationship between the Mathematics mark and the Physics mark. Set up Plot 1 as shown, ensuring that all other plots are turned off.



From the [ZOOM] menu, choose 9: ZoomStat. The graph shown will appear.

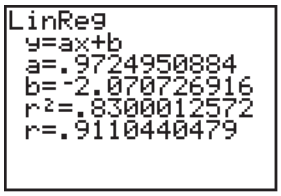


As the data looks linear we could perform linear regression on it. Press [STAT] , choose CALC and then 4: LinReg(ax+b).



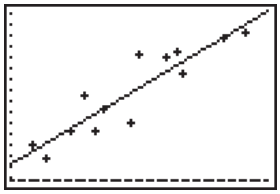
We want to perform linear regression on L1 and L2 and put the resulting equation into Y1, so that we can plot it on the graph.
Enter L1, L2 and Y1 as the argument and press [ENTER]

Y1 can be found under [VARS], Y-VARS, 1: Function. The display gives the values of a and b.



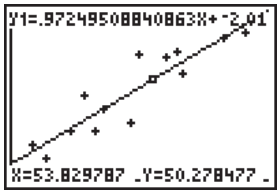
What has the calculator worked out ?

The graphics calculator has worked out the theoretical line of best fit using a process called Linear Regression. The equation relating the Mathematics mark to the Physics mark is stored in Y1. The fitted line can be seen on the graph below:



Predicting with the Line of Best Fit:

Pressing the [TRACE] function allows you to work out a good estimate for any pupil who may have missed any exams. Using the cursor keys you can display the x and y coordinates at any point along the line.



One pupil was absent for her Physics test. If she scored 54 in her Mathematics test, what mark would you give her for Physics?

Repeat the previous steps to find equations to represent the relationships between:
(i) the Mathematics and English marks.
(ii) the Physics and English marks.

What mark should the absent pupil be awarded if she missed her exam in English ?

Remember: always plot a scatter diagram of your data first. Only perform linear regression if your data is linear!

David Elgin
High School of Dundee

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Level: Tick all that apply
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Focus: Tick all that apply
❒ Maths ❒ Science ❒ ICT

TEXAS INSTRUMENTS

Calculator Maths from A+B Books

(excerpt follows on next page)

There are five books in the series which link the use of graphics calculators into four specific areas of the curriculum. These are Number, Algebra, Shape and Handling Data. The fifth book, called Foundations, deals with the basic operation of the machine and some specific calculator skills required for work in the other books. The books are designed to be used with TI-80 machines and make use of one or two of the specific functions available on this machine. We must confess that we are not big fans of the TI-80 and we were originally put off these books by the choice of machine. This was a mistake; there are some real gems here that which both of us have used in the classroom and most (if not all) the ideas can be used with other models of TI machines, and could easily be adapted for use with other manufacturers' machines.

Many of the ideas were a new departure for most graphic calculator books in that there is a genuine attempt to tackle many of the fundamental ideas we teach. We were particularly impressed with the way Number is tackled. The current push towards numeracy would caution against using a calculator but this book suggests otherwise. Topics such as equivalent fractions, calculating with fractions, decimals and integers are all tackled with an imaginative approach, the calculator being used as a tool for discovery rather than as a calculating machine. This has led to fun in an often dry numeracy lesson. The book also looks at standard form, and hence can be used as a resource across the school, not just in specific year groups. To our mind this makes them a valuable resource. It is not often you buy textbooks which can span the year groups.

We were intrigued to find Algebra as a topic for one of the books, wondering how it would be tackled on a non-Computer Algebra System (CAS) machine. Here was one of the first gems (and something we have been kicking ourselves for not thinking of ever since!). The basic idea is that you store a number to a variable name then enter an equation using this variable, successively "stripping" away the additive constants and coefficients while evaluating at each step. This essentially takes you through the process of solving the equation; a new approach which we have both tried in our classroom with great success.

Shape is perhaps our least favourite since we do not do much of what is in the book. One of us wanted to do the tessellations "Brain stretcher" when S1 were tackling their Tiling module, but found that it required programming. There were no listings in the book which would have helped. The similar shapes section worked well as a class-room lesson driven by the teacher on the overhead version of the calculator, as a pupil "work through" it is uncertain how it would have gone as it requires some quite advanced use of the machine.

By far the most useful book in the series is Handling Data and if you have to buy only one, buy this one. This book covers a great deal of the statistics introduced at standard grade and into the 5-14 documents as well as some material for intermediate two. Its greatest strength is perhaps that it introduces the user to statistics on the machine and allows you to explore and interpret many data sets without the tedium of long calculation. With the focus on interpretation of statistics in Higher Still, this is a must.

The authors (Alan Graham and Barrie Galpin) many people will recognise from the "Tapping into" series of books for the Open University. Over a number of years they have obviously invested a great deal of time in getting to know the strengths of the technology and where to best apply it, this series is the obvious fruits of their labours. I have often heard "I would use the Graphics calculator in my class but there are no resources" – well these books solve that, there is something in each book which is useful right away with little preparation. With so few useful resources out there these are a must for anyone looking to start using graphics calculator technology in the classroom.

The following is an excerpt from Calculator Maths:
Number by Alan Graham and Barrie Galpin.
It is part of a unit on Standard Form. The book contains twelve units, each of which presents a topic from the KS3/4 curriculum in a fresh way that uses the calculator as a tool in the learning process.

For more details about the series contact:
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Changing from standard form

Numbers can be entered into the calculator directly in standard form using ^ which is the second function of b

Press 5 2 ^ 3 , The result is 5000.

Now press 5 2 ^ • 2 , The result is .05.

Guess each answer and then press an appropriate key sequence to change the following numbers from standard form to normal notation.

(a) 7.123E2 (b) 7.123E3 (c) 7.123E5

(d) 5E-2 (e) 3.21E-3 (f) 6.38E0

The meaning of E

Change the mode setting of your calculator to SCI.

Another way of writing the number 5.28E3 is as 5.28×10^3.

Confirm this by pressing: 5.28 p 2 h 3 ,

The result is 5.28E3.

Now press 637 p 2 h 2 ,

The 637 has changed to 6.37 and the 2 has increased to 4. This is because, when numbers are expressed in standard form, the number before the E must always lie between 1 and 10.

Guess and press the following when converted to standard form.

(a) 6×10^2 (b) 375×10^5

(e) $.000786 \times 10^{-5}$ (f) $-.004 \times 10^{-3}$

Calculating with Es

Enter the following calculation on your calculator: 2E3 x 4E2 and press , .

The result, 8E5, suggests the following rule for multiplying two numbers in standard form:

Multiply the numbers before the E
and add the powers of 10 (the numbers after the E).

Enter the following calculation on your calculator: 8E5 ÷ 2E3 and press , .

The result should suggest a rule for dividing two numbers in standard form.

Write down your rule.

Now try the following calculations.

(a)5E3 x 4E2 (b) 3E7 ÷ 6E3

Explain briefly why the multiplication and division rules seem to have broken down.

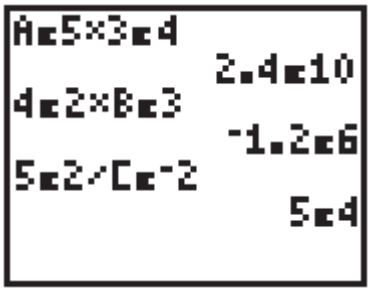
Guess and press the following calculations, giving your answer in standard form.

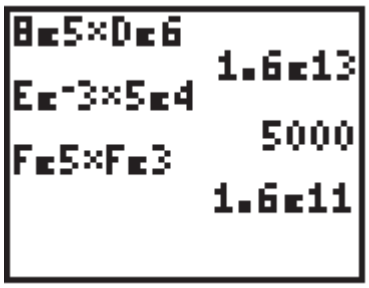
(c) 3E2 x 2E3 (d) 3E2 x 4E4 (e) 5E1 x 6E4 (f) 3E-2 x 2E5

(g) 3E-2 x 2E-3 (h) -3E2 x 2E-3 (i) 8E3 x 2E-3 (j) -5E-4 x -4E-3

Screensnaps

(a) What values have been stored in A, B, C, D, E and F in these screen displays?





(b) Use your answers from part (a) to create these screens on your calculator.

Now return to NORMAL mode.

Brain stretcher **Max score**

What is the largest number you can display on your calculator by pressing:

(a) 4 keys? (b) 5 keys?

Light year

One light year is the distance travelled by light in one year. If the speed of light is approximately 186000 miles per second, how far is a light year:

(a) in miles?

(b) in km? (One km is approximately 5/8 of a mile.)

Give your answers in standard form.

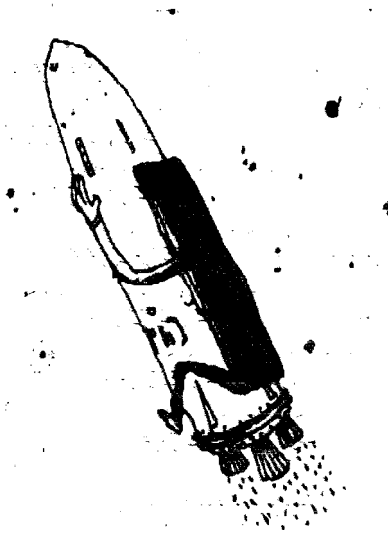
Klingon for dear life

Fans of Star Trek will know that Warp is a measure of speed. It is stated in terms of a single number, called the 'warp factor'.

To convert the Warp factor into miles per hour, it must first be cubed and then multiplied by the speed of light.

The highest speed ever reached by the Star Ship Enterprise in the original TV series was Warp Factor 14.1. What is this in miles per hour?

"CLINGING ON FOR DEAR LIFE"



By Alan Graham

The TI-83 Problem Page

The Centre for Mathematics Education, The Open University.

Here are some questions I am often asked by TI-83 users. I hope you find my answers helpful!

Q I haven't had my TI-83 too long and sometimes I can't remember where to find a particular command that I need. Any suggestions?

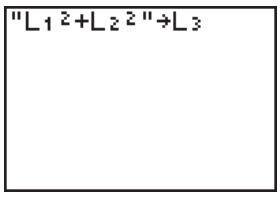
A The key labelled CATALOG will solve this problem – it provides all the commands of the calculator in a single menu. Suppose, for example, that you want the command Seq(. Press [2nd] [CATALOG] and you will see the commands listed alphabetically. Now press S (no need to press [ALPHA]). This will scroll to the beginning of the commands starting with the letter S. Use [▼] to select seq(and press [ENTER] to paste it onto the screen. (Handbook 15-2.)

Q I've just carried out a linear regression using linReg and now want the value of the correlation coefficient to be displayed. It doesn't seem to want to! Am I missing something?

A Your calculator will have calculated the value of r and r^2 but will not display them until you select the DiagnosticOn command. DiagnosticOn and DiagnosticOff can be found in CATALOG. (Handbook, 12-25.)

Q I enjoy doing list arithmetic – like squaring and adding L1 and L2 and storing the result in L3. The only problem is that, if I subsequently change a value in L1 or L2, the corresponding value in L3 doesn't change with it. This is a real drawback. Why can't lists be linked dynamically in the way that spread-sheets are?

A You can link lists dynamically and it is very simple to do.



Instead of entering formula as $L1^2+L2^2$->L3, put the formula inside quotes as shown here. This will achieve the dynamic link you want! (Handbook 11.9.)

Q I have just written a longish program and now I want to save a slightly different version of it using another name. Is there a 'Save as …' command that saves a named program to a different name or, alternatively, is there a way of copying and pasting command lines from one program to another?

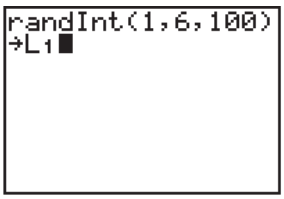
A There isn't a 'Save as …' command but you can copy and paste command lines from one program to another with the aid of the RCL command. Quit from the program you wish to copy and create and name the new one. Then follow these steps.

1. Press [2nd] [RCL]. RCL is then displayed on the bottom line of the program editor in the new program.
2. Press [PRGM] [▶][▶] to display the PRGM EXEC menu.
3. Select from the menu the name of the program that you want to copy. **prgm***name* is pasted to the bottom line of the program editor.
4. Press [ENTER]. All the command lines from the selected program are copied into the new program.

(Handbook 16-7.)

Q I've been wondering if there was a slick way of storing, say, 100 dice scores (using randInt) into a list. I've only recently upgraded from a TI-80 to a TI-83 and am currently doing this with the aid of the seq command. Can I do it without going though this palaver?

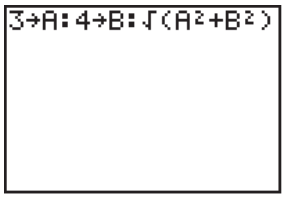
A In a word, yes!



The TI-83 provides an optional third argument to randInt which specifies the number of trials. The command shown here will store 100 dice scores in L1. (Handbook 2-23.)

Q I've recently discovered the Last Entry facility (using [2nd] [ENTER] on the Home Screen to recall a recent entry) and I find it very useful. But sometimes I want to repeat two or three commands at a time. Is there any way of putting several commands together on the Home Screen so they can be treated basically as a single command?

A The colon command, : will do this. You can string together a sequence of commands together, separated by colons. Then press [ENTER] and the entire sequence will be executed as a single command. For example, the sequence shown below consists of the following three separate commands:
3 is stored in A,
4 is stored in B,
the square root of A2+B2 is displayed.



Execute this command, then press [2nd] [ENTER] and edit the numbers 3 and 4 to something else. Press [ENTER] again to get the result. This procedure can be repeated indefinitely.

Incidentally, if you look at the way commands are listed inside a program, they are separated by colons in a very similar way, so the notation is consistent.
(Handbook Getting Started 7.)

Walk this Way

Karen Ward
Student Teacher
Preston Lodge High School

This activity is ideal for Standard Grade Credit pupils who are studying simultaneous equations. It reinforces algebraic skills and effectively combines these skills with technology. It is a perfect companion to Maths In Action 3B Page 130-131.

Simultaneous equations is a topic that can be considerably enhanced through careful use of TI-83 and an obvious introductory lesson is the intersection of two lines and using the [TRACE] and [CALC: 5 Intersect] functions.Once pupils have been introduced to the concept of simultaneous equations and they have been taught the algebraic method of solution, this activity allows these new skills to be tried with real life equations. It also provides great revision opportunity of y = mx + c and provides a genuine interactive introduction to the concept of mathematical modelling.

Equipment required:

- **TI-83 graphics calculator and viewscreen**
- **CBR™**
- **Link cable**
- **OHP and screen**
- **Sticky labels**
- **Class set of TI-83's (if possible)**

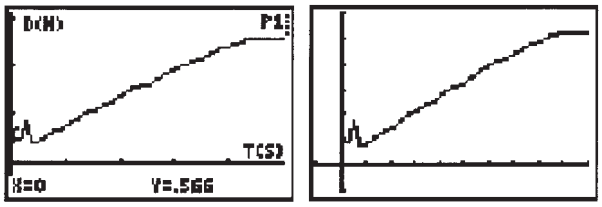
1. Clear a space in the classroom to allow a pupil to walk back and forward in front of the CBR™ (3 - 4m is fine). Mark the floor at 0.5m intervals using the sticky labels. Position the CBR™ and ensure that it is connected to the TI-83 by a link cable.

2. Switch on the TI-83, and then press [PRGM] then select the program titled RANGER. This program comes with the CBR™ and the instructions for installing it are in the CBR™ manual.
   Choose option [1]:SETUP/SAMPLE.
   Select a sampling rate of about 5 seconds total time, and choose metres as the units of length.

3. A volunteer pupil should now be asked to stand in front of the CBR™ and on instruction move away from the CBR™ at a constant rate.

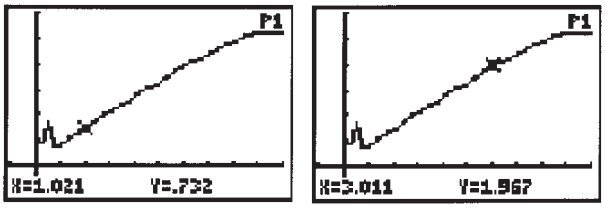
4. Press [ENTER] and start the pupil moving. The CBR™ will record the distance at the sampling rate set. This should last about 5 seconds (classrooms are only so long).

5. A set of results for this is shown below. The 1st screen shows the graph produced by the CBR™, the 2nd screen shows the same result with the [WINDOW] adjusted to make axes more visible, this is optional.



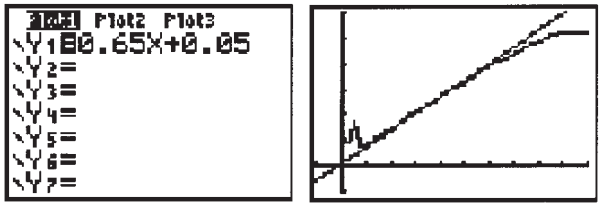
6. We are now going to find the equation of the "straight" section of this graph. Teachers can also take this opportunity to discuss with the class the detail of the graph and talk about any "bumps or squiggles". This provides an opportunity to discuss distance-time graphs. Pupils should be encouraged to see that the model they will build will be for the straight sloping section that can be represented by y = mx + c. It is recommended that the initial approach to this model is based on the pupils knowledge of y = mx + c and discussion with them about gradient and y-intercept, perhaps a few attempts at modelling based on the knowledge can be graphed.

7. Once this discussion has concluded pupils should be shown how to obtain two points on the line using the [TRACE] button. Shown below.

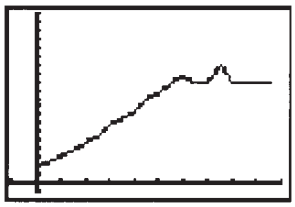


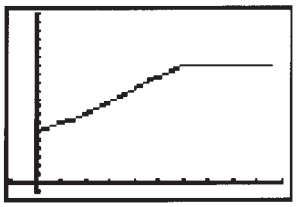
   These values for x and y can now be substituted into y = mx + c in order to create a pair of simultaneous equations in m and c. Pupils can now solve these by an algebraic method, perhaps elimination, but more easily substitution to obtain values for m and c.

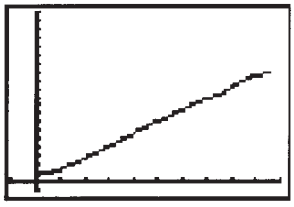
8. The equation of the line can now be entered on the [Y =] screen and when the [GRAPH] button is pressed the modelled line should be a good fit with the original.



9. It is possible to repeat this process in live class, or give each pupil a TI-83 with 3 previously prepared "walked lines" stored as Plot1, Plot2 and Plot3 using Lists 1 to 6. Pupils can now attempted to model these lines using their newly found algebraic skills.







10. To conclude the exercise the teacher can check the pupils' equations of the lines as a whole class. This will provide a class discussion and verbal explanations of the graphs. What does the value of c tell us? Is there a relationship between the gradient and speed?

EXTENSION

Given values of m and c can they "walk" this equation?

By Harry Gretton and Neil Challis, Sheffield Hallam University

The TI-83 Plus
The Best of the Old and the New

Our first reaction to news of the TI-83 Plus? "Oh no, not another calculator! I have only just got comfortable with my TI-83!" This mixture of irritation and dread always accompanies the excitement about a new product. We were ready to feel annoyed with Texas Instruments for changing the familiar after the innovations of the TI-89, but we resisted that feeling, and started asking questions. How different is this TI-83 Plus machine from the TI-83? What new things have we to learn to be able to enjoy its advanced technology?

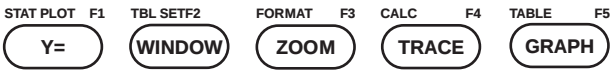
The brief answer is that anything you can do on a TI-83, you can do with no problem on the TI-83 Plus. However you gain some very useful extras with the new machine, not least of which is that it has the Flash technology, which means you can keep your machine up to date by downloading software upgrades and applications! So exactly what does this new machine bring?

The seemingly superficial

Let's get started by being superficial. The first things we notice are that the number keys are made more obvious by being all white, and that the screen is easier to look at – it appears to be nearer the top surface of the display screen.

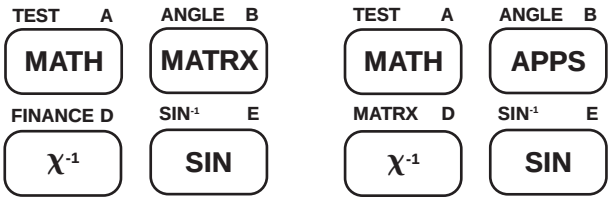
Moving down from the screen, the first line of keys on the TI-83:

has become on the TI-83 Plus:



A hunt in the **GUIDEBOOK** reveals nothing about these F1…F5 keys. Apparently they will be used when applications are flashed into the machine. More of this later.

The only other discernable cosmetic difference is this one below, where the set of keys on the left from the TI-83 has evolved to the set on the right, with the new **APPS** key coloured blue.



Well, it seems **MATRX** is still there, but where has **FINANCE** gone? Surely we haven't lost this really nice feature? A simple press of **APPS** relieves the anxiety, revealing:

Improve your memory!

Something else pops up from the APPS menu: CBL™/CBR™. As we reflect on our experience with using the CBR™, we are led to discover something else radical which distinguishes the TI-83 Plus from the old TI-83. Running out of memory has been a perennial and general problem, which has particularly surfaced when using the CBR™ and storing other programs at the same time. We are not the first to encounter this.

"All progress is based upon a universal innate desire on the part of every organism to live beyond its income". Butler, Samuel (1835-1902)

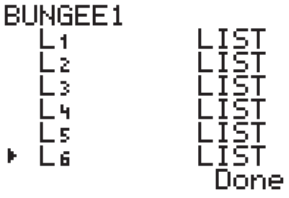
What has the TI-83 Plus to say about this? Let's compare the **MEM** information between the two machines:

TI-83

TI-83 Plus

It seems the TI-83 Plus is helping to reduce the problem of running out of memory. This calculator has almost 7 times the memory of the TI-83. There is still roughly 25K of user available RAM, but there is also over 150K of data archived memory. The extra, archived memory can be used to store data, programs, and applications. These archived values cannot be edited or deleted by mistake. You can move things from the user memory to the archive memory as needed. By archiving data, variables, or programs you can "free-up" the amount of user available memory.

What is a good way to use this extra memory? Well, you can create a "group", name it, and store anything from the calculator in it, for instance a suite of games, or all the data a class has gathered in any one session. You can then store the group in the archived memory, and use the calculator for other tasks, recalling the information in the group by ungrouping it at any time later.

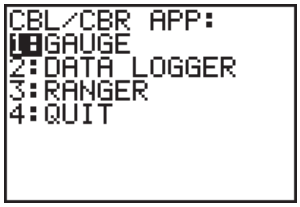


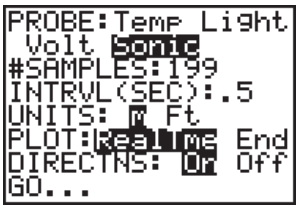
Imagine the extra possibilities and flexibility this gives in using the machine to the full.

"Applications" and the Flash Technology

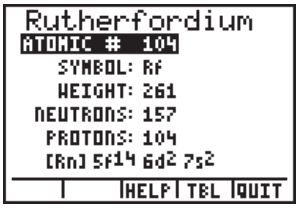
Let's move on to investigate how applications work, via the APPS button and the way this interacts with the Flash technology.

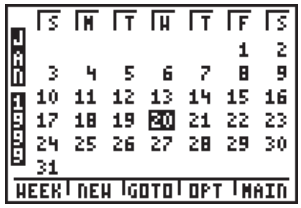
As shown earlier, the blue APPS button gives the Finance package from the "old" TI-83, and a new general purpose CBL™/CBR™ program that will let you work with the Light, Temperature, Voltage, and Distance probes





Both of these are examples of "applications". The flexibility and power of the Flash technology means that other applications can be downloaded into the TI-83 Plus as they are created, either from the internet or from another calculator. Many features are now being turned into TI-83 plus applications, and the possibilities are many. Those on stream already include different language versions of the machine software (French, German, Spanish, Finnish, Italian, and others), the periodic table of the elements, and an organiser.





It is worth noting that applications will run without being unarchived, and they are not loaded completely into the active user RAM. Thus memory use is optimised which means that you can use larger programs.

These examples give some hint of the potential of the Flash Technology, but don't forget that the Apps are only part of the story. You can also download upgrades to the standard machine software as they are created. As your needs from the calculator change then so can your calculator.

In summary the TI-83 Plus is

- A calculator that can do at least what the TI-83 can do.
- A calculator that can respond to change by being upgraded through flash technology.
- A calculator that can download and run specialist applications.
- A calculator that allows you to group and archive anything in the calculator for later recall..
- A calculator that can store 7 times as much as your TI-83.
- A calculator that is still compatible with the CBL™, CBR™, and the same ViewScreen™ panel as the TI-82 and TI-83.
- Possibly the last calculator you will ever have to buy (for a while)!

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