

Teachers in Action with HP Calculators

With the integration of technology into education, the past two decades have brought about enormous change in classrooms nationwide. One technological advancement in particular has made an enormous impact on math academia: the advent of calculators.

HP 38G Developed from Teacher's Know-How

For Mark Howell, a teacher at Gonzaga High School in Washington D.C., this impact has come full circle. As a long-time user and advocate of calculators in the classroom, Mr. Howell eventually had a hand in creating one, too, when he was asked by Hewlett-Packard Company to join their educational advisory committee to assist in creating the HP 38G.

Now Hewlett-Packard calculators are his classroom tools of choice—especially, the HP 38G, of course, which he uses in his AP Calculus class. “Classrooms are better places since graphing calculators were introduced,” notes Mr. Howell. “Students are more active participants and are better able to manipulate math equations. By witnessing the effect of their actions on screen, they directly see how their calculations are brought to life by graphics.”

While he uses the HP 38G in over a dozen different lessons in his AP Calculus class, the differential equation lesson is the most widely successful with students. In this lesson the HP 38G lets students view solutions graphically, analytically and numerically. “These three approaches to solving problems are coherent and fit one another by yielding compatible results,” says Mr. Howell. He also notes that the HP 38G is more cost effective for teachers to integrate into lesson plans, retailing for \$30 less than other brands—and with more symbolic capabilities.

HP 48 Inspires Lesson Clarity

The curricula themselves can borrow a few hints from calculators, too—for better organization, clarity and simplicity through visual cues, such as layout design, typefaces and sizes. At least that’s the observation of Antony Dekkers, author of *Module 5 Matrix Applications* (Mathematics Learning Centre, Centre Queensland University, 1998).

Mr. Dekkers notes that, while many math textbooks are written assuming that students understand the basic uses of graphic calculators, such curricula still need to do a better job in supporting students’ abilities to use calculators to

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develop mathematical thinking and process skills. “When developing study material, it is important to consider the audience, content and learning context in which it will serve.”

In demonstrating this often overlooked point, Mr. Dekkers offers examples of a developed course module on matrix calculations and solutions:

“The integrating device for this module is the HP 48G graphics calculator. All content is structured around the use of this tool. Consideration is given to the skills, processes and problem solving strategies central to the effective and efficient use of the calculator as a learning tool in mathematics.”

Moreover, Mr. Dekkers maintains, to design effective written materials, one must meet on paper the same sorts of expectations for visual cues that users are now accustomed to encountering on the calculators. To accomplish this, he advocates careful attention not only to proper organization of the content but also to micro-typographical details, which maximize legibility, accessibility and utility.

Here are two checklists that summarize Mr. Dekker’s uses of organization and micro-typography to integrate the HP 48G Series calculator into the matrix solutions module:

Organization

The module follows a linear approach to methods for solving equations, engaging the student in an active learning process.

- Introduction.
- Objectives.
- Overview or outline of the unit’s progression.
- Learning activities:
 - Worked examples.
 - Exercises with solutions. (Students can follow the steps to solutions via presentation of actual HP 48G displays.)
 - Side comments and summaries.
- Selected readings.

Micro-Typography

- Over-size type (12 points) for the main text.
- Clear visual cues to highlight various elements:
 - Headings provide visual cues about the forthcoming content.
 - Sub-headings for each section denote new methods and content.
 - Bold face introduces new terminology and formulae.
 - Examples are shaded to differentiate them from the theory.
- Substantial white space on the page separates ideas and allows notetaking.

HP Calculators and Teachers: Truly Win-Win

Occasionally HP calculators can even enhance your lifestyle. As an Inter-Disciplinary Curriculum Specialist in Nashua, New Hampshire, Cecile Carlton already took an active interest in helpful classroom products, including calculators. “Calculators open windows for opportunities to investigate with applications,” she observes. “They enhance conceptual understanding.”

So when Mrs. Carlton attended the 1998 annual NCTM conference in Washington D.C. last March, of course she visited the Hewlett-Packard booth to check out their latest calculators. There she dropped her business card into a drawing for a free trip to Europe.

Never before having won any sort of prize, she was a bit shocked to hear her name called—but she quickly recovered. And this past September, Mrs. Carlton and her husband enjoyed her prize together, travelling to London and Zurich, a thrilling and memorable trip—courtesy of HP Calculators.

Will she be attending the 1999 NCTM conference in San Francisco? She says she’ll try. And if she makes it, don’t be surprised if one of her first stops is the HP Calculators booth.

If you have an idea for a feature article or story to tell the readers of **hp^c**, please send a brief description to:

HP Calculators
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If you have an idea for a technical article to submit, or any comments or questions about **hp^c**, please see page 40.

Defining Your Own Functions on the HP 48G/GX

by Michael Grasse

On the HP 48, you usually evaluate expressions like this: (i) store the expression, (ii) store values into each of its variables, then (iii) evaluate the expression. That's fine, but it's a lot of steps and storing. Did you know that you can define an algebraic expression to take values right off the stack?

On the HP 48, any command that you can use in an algebraic object (i.e. between ' ' marks) is a function. For example, you're familiar with common built-in functions like SIN and ∫, but notice that they can either take a named variable as an argument, *or*—if you don't name anything—they can grab a value from the stack. The point is, you can define your own functions to do that too—it's *easy*.

For instance, to define $f(x) = x^2 + 1$:

1. Put the function onto the stack: 'F(X)=X^2+1'
2. Press $\leftarrow$ DEF.... Done!

Press VAR and notice a new menu item, F. Clear the stack and press F. You'll get Too Few Arguments, because the function expects to find its input—its x -value—on the stack, just as does SIN or any other built-in function you execute from the keyboard. (Now put a value, 2, onto the stack and press F. Presto.) And you can also use your F(X) within algebraic expressions—or graph it, differentiate it, integrate it, etc.—again, like SIN or any other built-in function.

Now define $g(x) = x + 7$ and then evaluate the following.

- | | | |
|----------------------|---------------|------------------|
| 1. $f(3)$ | 2. $g(3)$ | 3. $f(7) + g(7)$ |
| 4. $f(7) \cdot g(7)$ | 5. $g(x + h)$ | 6. $f(\pi)$ |

In the last problem, you may have gotten symbolic results. You can force the machine to return numerical values—if there are any—by using the $\leftarrow$ +NUM key. However, as in problem 5, if a function's variables aren't defined, then of course it won't return anything but symbolic results—which may not be too pretty. When this happens, you can sometimes use EVAL and/or the SYMBOLIC menu to clean things up a bit.

For example, find $f(x^2)$ The result is correct: 'X^2^2+1'

But that isn't how you'd normally write it. When you see something like this, the first thing to do is use the **EVAL** key—repeatedly until the expression doesn't change any more. (Note: If x has a numeric value, you'll get a numeric result.)

In this case **EVAL** doesn't do much, so try using the **SYMBOLIC** menu. (Press **⬅****SYMBOLIC** now.) The two main keys to use here are **COLL**, which collects and combines like terms; and **EXP**, which expands expressions and multiplies out exponents. These algorithms will not work on every expression and will sometimes work differently than you might expect, so proceed carefully.

Try **COLL** on your unconventional expression.... Unfortunately, it doesn't do much here besides change the order of the terms. So try **EXP**—repeatedly, until it doesn't alter the expression any more. Now try another **COLL**.... Better! (Keep in mind that at any point in your simplifying process, you can press **ENTER** to make a copy of level 1—useful in showing the progress of your work.)

Remember, too, that whenever you wish, you can press **VAR** to return to the menu of objects stored in the current directory (and **➡****MENU** toggles you back and forth between the two most recent menus).

Experiment with **EVAL**, **COLL** and **EXP** in simplifying the following.

7. $f(x^3)$

8. $g(2x+1)$

9. $f(x+0.1)$

10. $\frac{f(x)-f(x-0.1)}{0.1}$

11. $f(x+7)$

12. $g(x^2+1)$

Answers

1. 10
2. 10
3. 64
4. 700
5. 'X+H+7'
6. ' π^2+1 '
7. ' X^3^2+1 ' becomes ' $1+X^6$ '
8. ' $2*X+1+7$ ' becomes ' $8+2*X$ '
9. ' $(X+.1)^2+1$ ' becomes ' $1.01+X^2+.42*X$ '
10. The original expression becomes ' $-.1+2*X$ '
11. ' $(X+7)^2+1$ ' becomes ' $50+X^2+14*X$ '
12. ' X^2+1+7 ' becomes ' $8+X^2$ '

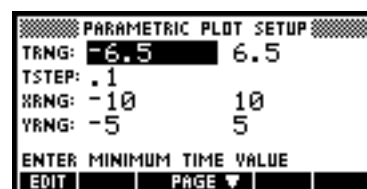
Michael Grasse teaches AP Calculus and is the Computer Co-coordinator at Elk Grove High School in Elk Grove Village, IL. A 1993 grant awardee in the Calculus Connections Project, he has taught HP graphing calculator workshops across the U.S. and in Singapore. Michael enjoys camping, photography and beer making. He lives with his wife, Nicolle, and dog, Scout, in Des Plaines, IL.

Inverse Trigonometric Functions on the HP 38G

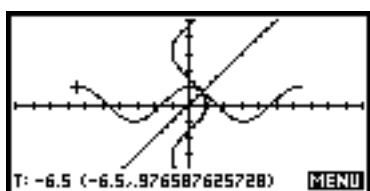
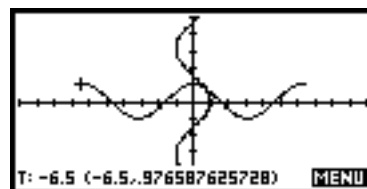
by Jim McManus

Two functions, $f(x)$ and $g(x)$, are inverses of each other if one function “undoes” the other over their domains. For example, if $f(3)=7$, then $g(7)=3$. Graphically this means that if (x,y) is on the graph of f , then (y,x) is on the graph of g . The two graphs are *mirror images* of each other about the line $y=x$.

Look at the trig functions and their inverses via the Parametric Aplet. (At **LIB**, highlight Parametric and press **RESET** **YES** and **ENTER**). To enter a cosine curve, let $X1(T)=T$ and $Y1(T)=\cos(T)$. Adjust the plot setup (via **SETUP** **PLOT**) as shown. Then **PLOT** to get the graph of $y = \cos x$.



A function's inverse will interchange its domain and range, so press **SYMB** and let $X2(T)=Y1(T)$ and $Y2(T)=X1(T)$. Now press **PLOT** to see both $y = \cos x$ and its inverse relation. Trace along $y = \cos x$ until the indicated value is $T:-2.3$. The coordinates here are $(-2.3, \cos(-2.3))$. Now **▼** to shift the trace to the other curve. The cursor will be on the corresponding point, $(\cos(-2.3), -2.3)$.



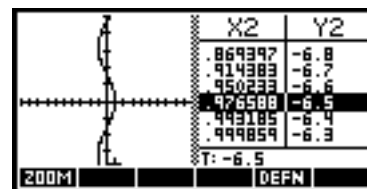
In effect, the x and y values are switched at every corresponding point on the two curves. Thus the two graphs are symmetric—“reflected”—about the line $y=x$. To see the symmetry, graph the reflection line, too: Press **SYMB**, then let $X3(T)=T$ and $Y3(T)=T$ and **PLOT** again.... See? If $y = \cos x$ were folded across $y=x$, it would match its inverse relation.

Press **SYMB** and uncheck (via **✓** **OFF**) $X1(T)$, $Y1(T)$, $X3(T)$ and $Y3(T)$. Then **PLOT** to observe just the inverse relation. What are its domain and range? Trace to help you decide: Observe the x values to judge the domain and the y values to judge the range.

Even better, press **NUM** to see the coordinates in a tabled form. Use **▼** repeatedly and notice the values in the $X2$ column, which imply the domain, and the $Y2$ column values, which imply the range.

T	X2	Y2	
0	1	0	
1	.9950042	.1	
2	.9800666	.2	
3	.9553365	.3	
4	.921061	.4	
5	.8775826	.5	

Use a different view to see both a graph and a table at once. Press **VIEWS**, highlight **Plot-Table** and press **OK**. Use **◀** and **▶** to trace the curve and show the coordinates. What is the domain of the inverse relation of cosine? What is its range?



How about the inverse relation of sine? To graph it, press **SYMB** **CLEAR** **YES**. Let $X1(T)=T$ and $Y1(T)=\sin(T)$. You could now plot $y=\sin x$, but you also want to plot the inverse by reversing x and y : Let $X2(T)=Y1(T)$ and $Y2(T)=X1(T)$. To check, highlight $X2(T)$ and **EQN**; highlight $Y2(T)$ and **EQN**. Now **PLOT** to see the graphs of $y=\sin x$ and its inverse relation.

Investigate the graphs, noting the relationship in the coordinates as you trace corresponding points on the two curves. Find the domain and range of the inverse relation of sine. First, press **SYMB** and uncheck $X1(T)$ and $Y1(T)$. Then **PLOT** or look at the table view (via **NUM**)—or look at both at once (**VIEWS** and choose **Plot-Table**) to surmise the domain and the range.

What is the domain of the inverse relation of sine? What is the range?

Investigate the domains and ranges of the inverse relations of the four other trig functions. Press **SYMB**. $X1(T)$ will stay the same from now on, though sometimes you will uncheck it. Let $Y1(T)=\tan(T)$. Then let $X2(T)=Y1(T)$ and $Y2(T)=X1(T)$. For awhile, don't alter $X2(T)$ and $Y2(T)$. (As you change $Y1(T)$ later, $X2(T)$ and $Y2(T)$ will be updated by the calculator.)

Press **PLOT** to look at the curves. Again, notice the symmetry. Uncheck $X1(T)$ and $Y1(T)$ and **PLOT** only the inverse relation of $y=\tan x$. Trace the curve, or look at the table or both, to find its domain and range. What are they?

The inverse relation of $y=\sec x$ is next. Press **SYMB** and highlight $Y1(T)$. Since this function doesn't have its own key on the calculator, hold down **A...Z** and type **SEC**. Then release **A...Z** and type **(T)** **OK**. **PLOT** will graph this trig function and its inverse relation. Press **SYMB** and uncheck $X1(T)$ and $Y1(T)$ to observe only the inverse. What are its domain and range?

Do the same for the inverse relations of $y=\csc x$ and $y=\cot x$, changing $Y1(T)$ to **CSC(T)** and **COT(T)**, respectively, spelling them out as with **SEC**. Find the domain and range of each as before, using the graphs and/or tables. What are the domain and range of the inverse relation of cosecant? How about the inverse relation of cotangent?

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Did you notice that none of these inverses were functions? To force them to be functions, you must restrict their domains. The calculator is programmed to know these restrictions, so why not allow it to help you find out what they are?

Press **LIB**, highlight **Function** and press **RESET** **YES** and **QUIT**. Highlight **F1(X)**, enter **ACOS(X)** and press **PLOT**. **ACOS** is the restricted portion of the inverse cosine relation—restricted to the largest domain that still allows it to be a function. Trace on it and look at the table (via **NUM**) to find its domain and range. Fill in the chart below with your results. Find the domains and ranges of the rest of the inverse trig functions similarly. There are keys for **ASIN** and **ATAN** but not for the others, which you must either type (**ASEC(X)**, **ACSC(X)** or **ACOT(X)**) or find under **MATH Trig**.

<u>Function</u>	<u>Domain</u>	<u>Range</u>
ACOS(X)	_____	_____
ASIN(X)	_____	_____
ATAN(X)	_____	_____
ASEC(X)	_____	_____
ACSC(X)	_____	_____
ACOT(X)	_____	_____

Extensions: Investigate other inverses. Find the inverse of $y = 3\sin(2x)$

Can you find a function that is its own inverse?

Solutions

<u>Inverse Relation of</u>	<u>Domain</u>	<u>Range</u>	<u>Function</u>	<u>Domain</u>	<u>Range</u>
$y = \cos x$	$-1 \leq x \leq 1$	$-\infty < y < \infty$	Acsc(x)	$-1 \leq x \leq 1$	$0 \leq y \leq \pi$
$y = \sin x$	$-1 \leq x \leq 1$	$-\infty < y < \infty$	Asin(x)	$-1 \leq x \leq 1$	$-\frac{\pi}{2} \leq y \leq \frac{\pi}{2}$
$y = \tan x$	$-\infty < x < \infty$	$R, y \neq \frac{\pi}{2} + k\pi, k \in J$	Atan(x)	$-\infty < x < \infty$	$-\frac{\pi}{2} < y < \frac{\pi}{2}$
$y = \sec x$	$ x \geq 1$	$R, y \neq \frac{\pi}{2} + k\pi, k \in J$	Asec(x)	$ x \geq 1$	$0 \leq y \leq \pi, y \neq \frac{\pi}{2}$
$y = \csc x$	$ x \geq 1$	$R, y \neq k\pi, k \in J$	Acsc(x)	$ x \geq 1$	$-\frac{\pi}{2} \leq y \leq \frac{\pi}{2}, y \neq 0$
$y = \cot x$	$-\infty < x < \infty$	$R, y \neq k\pi, k \in J$	Acot(x)	$-\infty < x < \infty$	$0 < y < \pi$

Jim McManus teaches math at West Albany High School in Albany, Oregon. He is an HP calculator veteran, having used various HP calculators in his classroom for the past ten years. He has also conducted workshops on the classroom uses of the HP 38G and HP 48 throughout the U.S. and in England, Singapore and Canada. Jim and his wife, Marti, and their two kids, Kinsey and Corey, live in the rural heart of the Willamette Valley in western Oregon.

Taylor Polynomial Approximations of Functions on the HP 48G/GX

by Michael Grasse

Polynomials have properties that endear them to mathematicians. They are continuous and differentiable everywhere, with relatively easy-to-find roots, and you can evaluate them using only basic arithmetic operations (addition, subtraction, multiplication and division). In fact, polynomials are so easy to work with that we often use them to approximate the local behavior of a more complex function.

In this lab you'll see graphically how a Taylor polynomial approximates a function more closely as more terms are added. You will also see a graphical method for finding the interval around a given point in which the polynomial approximates the function to within a given error tolerance.

To begin, suppose you want to approximate $f(x) = \sin(x)$ near $x = 0$, using a first-degree (linear) polynomial. The best linear approximation, $p_1(x)$, for $f(x)$ near any point, $x = a$, will satisfy $p_1(a) = f(a)$ and $p_1'(a) = f'(a)$. That is, the first-order Taylor polynomial is a line through the point $(a, f(a))$ with the same slope as the function at $x = a$. It is the *line tangent to the graph of $f(x)$* at the point $(a, f(a))$.

Clear the stack ( CLEAR) and put 'SIN(X)' onto stack level 1. Make a copy of it (press ) and store the copy into the variable `EXPR` (type 'EXPR'  ). Now use the calculator to find $p_1(x)$: Press  and select **Taylor poly....** Put `X` in the `VAR` field, 1 in the `ORDER` field. Leave the `RESULT` field **Symbolic**, and press .... The Taylor polynomial, '`X`', appears on stack level 1; the function being approximated, '`SIN(X)`', moves to level 2. This *first-degree* approximation isn't very exciting, but it does satisfy the two requirements:

$$p_1(0) = 0 = f(0) = \sin(0) \quad \text{and} \quad p_1'(0) = 1 = f'(0) = \cos(0)$$

The *second-degree* Taylor polynomial is the best quadratic approximation, $p_2(x)$, for $f(x)$ near any point, $x = a$, as it satisfies these three properties:

$$p_2(a) = f(a) \qquad p_2'(a) = f'(a) \qquad p_2''(a) = f''(a)$$

1. Now use the HP 48 to find the 2nd-degree Taylor polynomial approximation of $f(x) = \sin(x)$ near $x = 0$.
2. Verify that this result has the above three properties by comparing its value and its first and second derivative values to those of $\sin(x)$, at $x = 0$.

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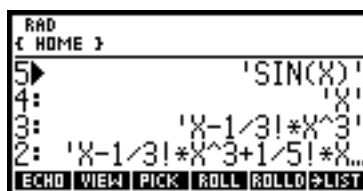
Now **[DROP]** this 2nd-degree Taylor polynomial and, in a similar manner, find the 3rd-degree Taylor polynomial approximation of $f(x) = \sin(x)$ near $x = 0$.

3. Verify that this polynomial, $p_3(x)$, satisfies these four properties at $a = 0$:

$$p_3(a) = f(a) \quad p_3'(a) = f'(a) \quad p_3''(a) = f''(a) \quad p_3'''(a) = f'''(a)$$

Now put the 5th- and 7th-degree Taylor polynomial approximations of $f(x) = \sin(x)$ near $x = 0$ onto the stack. (Also, make a copy of the 7th-degree polynomial and store this into a variable named $P7$, since you'll need it later.)

You should now have ' $\sin(x)$ ' on stack level 5, ' x ' on level 4, and the other polynomials—3rd-, 5th- and 7th-degree—on levels 3, 2 and 1, respectively:



Use **[▲]** to climb up the stack to ' $\sin(x)$ ' (level 5), then press **[F1]** **[ENTER]** to form a list. Store this list into the variable EQ (i.e. type ' EQ ' **[ENTER]** **[STO]**), then plot it in the default window—with simultaneous mode turned off. (Press **[F2]** **[PLOT]** **[OFF]** and uncheck **SIMULT**. Then press **[ON]** and **[GRAPH]**.)

4. What can you observe about how the polynomial approximations conform with the function as the degree increases?

The error involved in using a Taylor polynomial to approximate $f(x) = \sin(x)$ apparently depends on degree of the Taylor polynomial and the x -value of interest. That error at any given x -value is expressed simply as $E(x) = p_n(x) - f(x)$.

Clearly the error at $x = a$ is zero, regardless of the degree of the polynomial. To see the error involved in your experiments, subtract the original function from each polynomial in your list. This is easier to do than it sounds: Just go back to the stack (**[ON]**) and press **[VAR]** **[EQ]** to put the list onto the stack. Then type ' $\sin(x)$ ' **[ENTER]**, then **[−]**. This subtracts ' $\sin(x)$ ' from each element of the list, forming a new list with the results. Store the new results list into ' EQ ' and plot it.

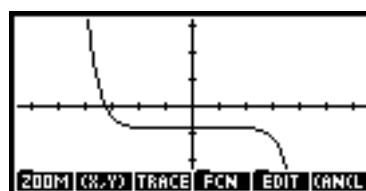
5. Summarize the relationship between the error function and degree of the Taylor polynomial.

Now focus your attention on the 7th-degree Taylor polynomial approximation of $f(x) = \sin(x)$ near $x = 0$. (Recall that you stored this in the variable P7.) For what values of x will this polynomial approximate $\sin(x)$ to within 0.1? We will develop a graphical method of answering questions such as this.

Return to the stack and press $\boxed{\text{P7}}$ to put this polynomial onto the stack. Now type 'SIN(X)' and press $\boxed{=}$. The resulting expression is the 7th-degree Taylor polynomial error function. Store this into 'EQ' and plot it.

Tracing the graph and looking at x and y values will give a good approximate answer to the question, but a better strategy is to translate the graph downward by 0.1 and find the root. This will give the left endpoint of the interval.

Get back to the stack, press $\boxed{\text{EQ}}$ and subtract 0.1 from the expression. Store the new resulting expression into 'EQ' and plot it. If you zoom in vertically by a factor of 8 you should see the following:



Now use the root finder to find the left endpoint of the interval.

6. Find the entire interval of x for which values of the 7th-degree Taylor polynomial will approximate $\sin(x)$ near $x = 0$ to within 0.1.
7. Write down the 1st- through 8th-degree Taylor polynomial approximations for $\cos(x)$ near $x = 0$.
8. Do you notice anything about these polynomials that is similar to the polynomial approximations for $\sin(x)$?
9. For what interval of x around $x = 0$ will the 8th-order Taylor polynomial approximate $\cos(x)$ to within 0.1?

Michael Grasse teaches AP Calculus and is the Computer Co-coordinator at Elk Grove High School in Elk Grove Village, IL. A 1993 grant awardee in the Calculus Connections Project, he has taught HP graphing calculator workshops across the U.S. and in Singapore. Michael enjoys camping, photography and beer making. He lives with his wife, Nicolle, and dog, Scout, in Des Plaines, IL.

An Exponential Decay Study Using the HP 38G

by Mark Howell

This activity simulates real radioactive decay, which is typically exponential. The rate at which a substance decays is proportional to the amount of the substance present; the more “stuff” you have, the faster it decays. But the decay of any one molecule is largely random—a matter of chance. For this activity, therefore, you will randomly select among 625 molecules for decay, using the HP 38G’s random number generator. You’ll track the fates of the molecules on a 25x25 paper grid of squares, blackening squares to indicate which molecules have decayed.

Since your grid is 25x25, it's easiest to choose a column value from 1 to 25, rather than one value between 1 to 625. To randomly select among 25 molecules, you can use `FLOOR(25*RANDOM+1)`, because $0 \leq \text{RANDOM} < 1$, so $0 \leq 25 * \text{RANDOM} < 25$, and $1 \leq 25 * \text{RANDOM} + 1 < 26$. And `FLOOR` finds the greatest integer less than or equal to its argument, so then $1 \leq \text{FLOOR}(25 * \text{RANDOM} + 1) \leq 25$. So: At the `HOME` screen, type `FLOOR(25*RANDOM+1)`—but don't press `ENTER`. Now you're ready to begin...

1. Press **ENTER** to select a molecule for decay. On the grid, darken the square in Row 1 in the column given by the HP 38G; that molecule has now decayed.
2. Press **ENTER** again to select another molecule for decay. Darken the indicated square in Row 2.

[illegible]

3. Press **ENTER** again to select another molecule for decay. Darken the indicated square in Row 3.
- Continue likewise for steps **4** through **25**, until you have selected and “decayed” one molecule in each row on the grid. This completes Trial 1.
- 26.** In the Decay History Table, record 600 molecules left for Trial 1. (You had 25 new decays, so that left 600 still undecayed.)

Now repeat the above 26 steps for Trials 2 through 20, recording your results. If a random number indicates a molecule already decayed, do nothing for that row; go on to the next row (using a fresh random number).

Decay History Table	
<u>Trial</u> <u>Number</u>	<u>Undecayed</u> <u>Molecules</u> <u>Remaining</u>
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____
8	_____
9	_____
10	_____
11	_____
12	_____
13	_____
14	_____
15	_____
16	_____
17	_____
18	_____
19	_____
20	_____

n	C1	C2	C3	C4
1		500		
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
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STATS

- (continued on page 14)

13. How could you modify this experiment to cause the number of remaining molecules to approach zero more rapidly?

14. In the Function Aplet, press  **SETUP** **PLOT**. Set **XRNG:** 0 3.25 and **YRNG:** 0 25. Then press **SYMB** and enter these functions:

$$F1(X)=25*e^{(-.5*X)}$$

$$F3(X)=25*e^{(-2*X)}$$

$$F2(X)=25*e^{(-X)}$$

$$F4(X)=25*e^{(-4*X)}$$

Now draw the graphs. What is the effect of the coefficient of X (i.e, the $-.5$, -1 , -2 , -4)?

15. Why does the exponential fit curve flatten out as the trial number increases?

This activity was inspired by Jerald Murdoch of Interlochen Arts Academy. As question 14 suggests, a good follow-up activity would be to investigate the effects of parameters A , B and C on the graph of $f(x) = Ae^{Bx+C}$.

To reduce the tedium of 20 decay trials, divide students into 10 groups, giving each group two transparencies of the grid; each group does two trials. As each trial completes, that transparency is laid atop the other finished sheets. The “undecayed” squares are then easy to count via an overhead projector.

Or, other possible explorations of the exponential model include:

- Throw a handful of thumbtacks on a desk. Remove any landing “point up.” Repeat for many trials, recording the number remaining after each trial.
- Give each group of 2-3 students a paper plate. On the plate, each group draws crossed lines, dividing the plate into four quadrants. Select and mark one of the four quadrants to serve as the “remove” section. Then toss M&Ms (or some other uniformly shaped pieces) onto the plate, removing those that fall onto the chosen quadrant. Record the number of remaining M&Ms after each trial.
- Heat up a thermometer by using your own body heat to warm up the part that measures the temperature. Then allow it to cool and measure the temperature of the thermometer at 10 second intervals. Record the differences between the thermometer and room temperature at each ten second interval.

Mark Howell has been teaching mathematics and computer science at Gonzaga High School in Washington, DC, since 1977. Currently a member of the AP Calculus Test Development Committee, he is a longtime Reader, Table Leader, and Question Leader at the AP Calculus exam reading. Mark worked with the Hewlett-Packard software team during the development of the HP 38G. Mark and his lovely wife, Maureen, have a son Ryan, who is a budding computer science guru, age 3.

Visualizing Recurrence Relations with Cobweb Plots on the HP 38G

by Carla Randall

Cobweb plots can help you visualize what's happening in a recurrence relation. For example, consider a recurrence relation such as $t_n = 2t_{n-1} - 1$.

$$\begin{aligned}\text{If you let } t_1 = 3, \text{ then:} \quad & t_2 = 2(t_1) - 1 = 2(3) - 1 = 5 \\ & t_3 = 2(t_2) - 1 = 2(5) - 1 = 9 \\ & t_4 = 2(t_3) - 1 = 2(9) - 1 = 17, \dots \text{ etc.}\end{aligned}$$

Notice how each term takes on the role of t_n first, then the role of t_{n-1} . (In the above case, for example, 3 is t_n when $n = 1$, but then it becomes t_{n-1} when $n = 2$.)

A cobweb plot is based on exactly this idea. To do a cobweb plot of the above, think of the recurrence relation $t_n = 2t_{n-1} - 1$ as two separate functions operating alternately: the given function, $y = 2x - 1$; and the “substitution” or “feedback” function, $y = x$. To plot successive points, you *alternate* which function you use.

Try it on paper first. Begin simply by graphing the line $y = x$. Then start plotting successive points, alternating functions as you go, starting with $y = x$:

1. For your first point, use the given value of y to find x . Your given y value was $t_1 = 3$, and according to the function you're using, $y = x$, so $x = 3$, also. Your first plotted point is therefore $(3,3)$.
2. For the next point, switch to the other function, $y = 2x - 1$, using the previous value of x to find y . In effect this substitutes the previous term, t_n (which was $t_1 = 3$) for t_{n-1} in the relation $2t_{n-1} - 1$, to generate a new t_n : $t_2 = 5$. When $x = 3$, $y = 5$, so your new point is $(3,5)$. Draw a segment from $(3,3)$ to $(3,5)$.
3. For your next point, switch to the other function, $y = x$, and use the previous value of y to find x . Why? Well, previously, y was 5—the former t_n —but you are now changing its role to that of t_{n-1} , i.e. changing its role from y to x . This is like using y to determine x in the function $y = x$. Since $y = 5$, $x = 5$. Draw a segment from $(3,5)$ to $(5,5)$, which, of course, puts you back on the line $y = x$.
4. For your next point, switch to other function, $y = 2x - 1$, and use the previous value of x to find y : When $x = 5$, $y = 9$. Draw a segment from $(5,5)$ to $(5,9)$.
5. For your next point, switch to the other function, $y = x$, and use the previous value of y to find x : $y = x = 9$. Draw a segment to the point $(9,9)$.

(continued on page 16)

And so on—continue this process to visualize as many terms as you like.

To draw a cobweb plot on the HP 38G, first look at the sequence numerically.

1. Press **[LIB]**, highlight Sequence, and press **[RESET] [YES] [ENTER]**.
2. Enter 3 for $U1(1)$, 5 for $U1(2)$, and $2*U1(N-1)-1$ for $U1(N)$.
3. Next, press **[NUM]**. This numeric view shows that if you want to visualize the first five terms of this recurrence relation, you'll need to see from (0,0) to (33,33).

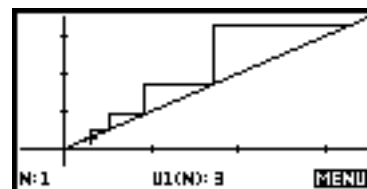
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2	5		
3	9		
4	17		
5	33		
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4. Press **[SETUP] [PLOT]** and adjust the settings as follows:

SEQUENCE PLOT SETUP	
SEQPLOT:	Cobweb
NRNG:	1 5
XRNG:	-5 35
YRNG:	-10 35
CHOOSE SEQUENCE PLOT TYPE	
[CHOOS]	[PAGE]

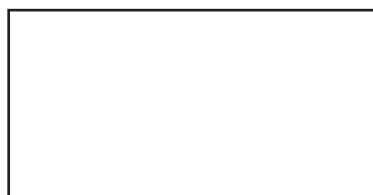
SEQUENCE PLOT SETUP	
XTICK:	10
YTick:	10
[SIMULT]	[INV. CROSS]
[AXES]	[LABELS]
[GRID]	
ENTER HORIZONTAL TICK SPACING	
[EDIT]	[PAGE]

Now **[PLOT]**. Using **[▶]**, move through the terms of the sequence along the line $y = x$. You can see how a cobweb plot helps to see what happens in successive terms of a recurrence relation.

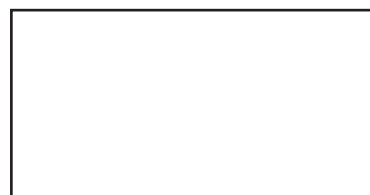


Problems:

1. a. Enter the recurrence relation $t_n = 3t_{n-1} - 8$, with $t_1 = 5$ into the HP 38G's Sequence Applet. Then use the **[NUM]**eric view to find the first ten terms.
- b. Set up your plot so that you can see the first four terms, then **[PLOT]**. Sketch your **SEQUENCE PLOT SETUP** and a picture of your plot.



SEQUENCE PLOT SETUP



SEQUENCE PLOT (Cobweb)

- c. A **fixed point** occurs in a recurrence relation whenever $t_n = t_{n-1}$, or in this case, when $x = 3x - 8$. What is that the fixed point for this relation?
- d. To visualize the fixed point on your cobweb plot, press **[LIB]**, highlight Function, and press **[ENTER]**. Enter $3*X-8$ for $F1(X)$ and set your **FUNCTION PLOT SETUP** values to match those of your **SEQUENCE PLOT SETUP**. Then press **[VIEWS]**, highlight Overlay Plot and press **[OK]**. Trace along this line until the x-coordinate matches the fixed point you determined above. What do you notice about the graphs of $y = x$, $y = 3x - 8$, and the value of this fixed point?

Now repeat steps **a - d** for problems **2 - 4**, too:

2. $t_n = 5 - t_{n-1}$, with $t_1 = 3$
3. $t_n = 9 - 0.5t_{n-1}$, with $t_1 = 2$
4. $t_n = 0.5t_{n-1} + 6$, with $t_1 = 2$
5. Fixed points are often categorized as “repelling” or “attracting.” Which fixed point(s) in problems 1 - 4 do you think are attracting? Which seem to be repelling? Are there any that seem to be neither? Explain your reasoning.

Bibliography

Crisler, Nancy. Fisher, Patience. Froelich, Gary. *Discrete Mathematics Through Applications*. New York: W.H. Freeman & Co., 1994. pp 440-445.

Extensions

1. Experiment with recurrence relation $t_n = at_{n-1} + b$, trying various values of a and b . When is the fixed point attracting? Repelling? Neither?
2. Consider a second-degree recurrence relation $t_n = 4 - 0.5(t_{n-1})^2$, with $t_1 = 0$.
 - a. Make a table showing the first 6 terms.
 - b. Draw a cobweb diagram displaying the first 6 terms.
 - c. Change the first term, t_1 , to 1. Use the HP 38G's table feature to observe the first 20 terms. Explore the related cobweb diagram.
 - d. Change the first term to 2. What happens?
 - e. Change the first term to 5. What happens?
 - f. Use algebra to find the fixed points. (Because this recurrence relation is second degree, it has two fixed points.)
 - g. In which cases (first term = 0, 1, 2, or 5) were the relations apparently attracted to a fixed point? In which were they repelled? Were there any cases where neither seemed to happen or where you couldn't tell?

Carla Randall is now Curriculum Vice Principal at Cleveland High School in Portland, Oregon, after having taught calculus for many years at Lake Oswego High School. Carla first used HP graphing calculators as part of a grant program in 1990. Since then she has shared her classroom calculator skills and experience by designing curricula and conducting teacher workshops and by serving on Hewlett-Packard's Advisory Committee for the development of the HP 38G.

Educator Resources

The easy way to integrate Hewlett-Packard calculators into the learning process? Try them for yourself! That's what the HP Educator Program is all about.

Through HP's partnership with **The Math Learning Center (MLC)**, you have a wide variety of ways to learn about and get HP products into your classroom.



Evaluating HP Calculators

To evaluate an HP calculator for use in your classroom, just contact **MLC** and they will send you an evaluation request form.

Training Workshops

HP is committed to helping you get the most out of HP graphic calculators through its ongoing training program. For an up-to-date list of scheduled workshops on HP graphic calculators, contact **MLC** by phone, mail, e-mail or fax. Or, if the already-scheduled workshops don't fit into your calendar, schedule your own! **MLC** has a list of instructors who are available to conduct workshops on HP graphic calculators—and they also will help you publicize it. (Just send information on your workshop to **MLC** after you have finalized the schedule.)

Free Classroom Materials

Then, to help you successfully integrate HP calculators into your classroom, Hewlett-Packard offers a wide assortment of materials and aids:

- Classroom posters for HP 38G or HP 48G series
- Overhead transparencies of all HP calculator keyboards
- Training guides/examples for the HP 38G and HP 48G series
- Additional copies of any issue of this newsletter—or a free subscription

To request any of these materials, contact **MLC**.

The Math Learning Center (MLC)
Hewlett-Packard Educator Program
P.O. Box 3226
Salem, OR 97302-0226
Phone: **800-750-8130** (8-5 PT M-F)
Fax: 503-370-7961
E-mail: hp@bbs.mlc.pdx.edu

Other Resources:

Books and Software

The following books address the use of HP Graphic calculators. (HP does not represent or endorse these books.)

Algebra & Pre-Calculus on the HP 48G/GX; Dan Coffin; Grapevine Publications; ISBN 0-931011-43-4

Calculator Enhancement for Differential Equations; T.G. Proctor;
Harcourt Brace Jovanovich; ISBN 0-155056-73-5

Calculator Enhancement for Linear Algebra; D.R. LaTorre;
Harcourt Brace Jovanovich; ISBN 0-155056-74-3

Calculator Enhancement for Multivariable Calculus; J.A. Reneke;
Harcourt Brace Jovanovich; ISBN 0-155056-78-1

Calculator Enhancement for Single-Variable Calculus; James Nicholson;
Harcourt Brace Jovanovich; ISBN 0-155056-76-X

Calculus Activities for Graphic Calculators; Dennis Pence; PWS Publishing Co.; ISBN 0-534924-31-X

Calculus Concepts: Graphing Calculator Instruction Guide; Iris B. Fetta;
DC Heath and Co.; ISBN 0-669398-69-1

Calculus Concepts: An Informal Approach to the Mathematics of Change; D.R. LaTorre, John W. Kenelly, Iris B. Fetta, Cynthia R. Harris, Laurel L. Carpenter; DC Heath and Co.; ISBN 0-669398-65-9

Calculus Investigations with the HP 48G/GX; D.R. LaTorre;
Charles River Media, Inc.; ISBN 1-886801-18-5

Calculus of a Single Variable; Thomas P. Dick, Charles M. Patton; PWS Publ. Co.; ISBN 0-534939-36-8

Calculus on the HP 48G/GX; Dan Coffin; Grapevine Publications, Inc.; ISBN 0-931011-44-2

Differential Equations using the HP 48G/GX; T.G. Proctor; Charles River Media.; ISBN 1-886801-19-3

An Easy Course in Using and Programming the HP 48G/GX; Chris Coffin;
Grapevine Publications, Inc.; ISBN 0-931011-41-8

Experiments in Computational Matrix Algebra; David Hill;
Random House/Birkhauser; ISBN 0-394356-78-0

Exploring Calculus with a Graphing Calculator; Charlene E. Beckman, Ted Sundstrom;
Addison-Wesley Publishing Company; ISBN 0-201555-74-3

Graphing Calculator Laboratory Manual for Calculus; Charlene E. Beckman, Ted Sundstrom;
Addison-Wesley Publishing Company; ISBN 0-201549-71-8

HP 48G/GX Investigations in Mathematics; D.R. LaTorre, Donald Krieder, T.G. Proctor;
Charles River Media, Inc.; ISBN 1-886801-23-1

Linear Algebra Investigations with the HP 48G/GX; D.R. LaTorre;
Charles River Media, Inc.; ISBN 1-886801-20-7

Mastering the HP 38G Graphics Calculator – A Guide for Students and Teachers; Colin Croft;
Applications in Mathematics; ISBN 0-958691-72-X

Technology in Calculus; Thomas P. Dick, Charles M. Patton; PWS Publishing Co.; ISBN 0-534930-81-6

For these and other books, see your local bookseller or visit amazon.com online. (Suggestion: search with keyword “HP 48G” or “HP 38G.”) Public-domain software is also available via links from HP’s web site at www.hp.com/calculators.

Earn Free Calculator Equipment: The New HP Calculator Redemption Program

When you and your students buy Hewlett-Packard calculators, you are on your way to earning free calculators and accessories through HP's new Calculator Redemption Program, now open to all educators throughout the U.S and Canada.

What Can You Get?

The program is based on a point system. When you buy 30, 60 or 90 HP graphic calculators, you earn points that you can redeem toward free calculator products and accessories.

For 25 Points	For 50 Points	For 100 Points
Connectivity Kit (for PC or Mac) or HP 38G or HP 48G	HP 48G+ or HP Infrared Printer (usable with the HP 38G, HP 48G Series, HP 17BII, and HP 19BII)	HP 48GX or HP Overhead Display Unit (usable with the HP 38G, HP 48SX and HP 48GX)

Notice that you can apply your redemption points flexibly—in whatever way works best for your program. For example, if you earn 100 points, you could apply it all to a single redemption from the 100-point column or, if you prefer, choose multiple redemptions from the 25- or 50-point columns.

How Do You Earn Points?

You can earn points whenever you or your students purchase HP graphic calculators, as follows:

Calculators Purchased	Calculator Type	
	HP 38 or HP 48G	HP 48G+ or HP 48GX
30	Earn 25 points	Earn 50 Points
60	Earn 50 points	Earn 100 Points
90	Earn 75 points	Earn 150 Points

What Documentation Do You Need?

If you are a **primary** or **secondary** educator, just send the proof-of-purchase (UPC) codes from the ends of the boxes, along with a letter on your school stationery detailing the product(s) you want to receive. (Your position as an educator will be verified prior to fulfillment.)

If you are a **college** or **university** educator, just send a letter on your school's stationery that includes these three items:

1. A statement that HP graphic calculators are required or strongly recommended for your class (please indicate models);
2. A description of the classes for which the HP calculator is required or recommended;
3. An estimate of the number of students purchasing HP graphic calculators per term or semester.

(Only one request per department is eligible for each term or semester. Your position as an educator will be verified prior to fulfillment.)

Where Do You Apply?

Send your request and documentation to:

The Math Learning Center
Hewlett-Packard Educator Program
P.O. Box 3226
Salem, OR 97302-0226

Note that Hewlett-Packard Company reserves the right to change this program or discontinue it at any time and without notice. If you have any questions about the program, feel free to contact The Math Learning Center:

Call: **1-800-750-8130**
E-mail: **hp@bbs.mlc.pdx.edu**

The HP 38G

Graphic Calculator

In Detail

Easy, Powerful, and Built for Math Class

The HP 38G has all the functionality and features of other graphic calculators, plus a lot more. Designed with the secondary school math classroom in mind, no other calculator makes learning and teaching math so exciting.

The HP 38G is the first calculator with interactive, electronic lessons, called ApLets, that help students learn faster and get more from classroom and homework sessions. It's the future of calculator-based instruction: powerful, flexible, easy. And the HP 38G can connect to an overhead display unit, so students can see your keystrokes or share their own work!



Understanding comes more naturally to students, too, as the HP 38G lets them view expressions numerically, graphically and symbolically. The new split-screen view lets them compare two views at once, helping them to build a stronger conceptual base; the HP 38G makes math make sense.

Easy Menus and Commands

The HP 38G is the first graphic calculator from HP to use standard algebraic notation for its operations—no need to learn new methods to do the same old calculations. And the HP 38G remembers your calculations for future use. Simply move up the list and copy the information you want—point and shoot!

With easy-to-use menus, you get results fast. Pop-up menus offer commands with just a few keystrokes, and input forms offer easy screens to set up problems. Students just fill in the blanks, and the SHOW equation feature lets them be sure they've entered expressions correctly. There's even a fraction display mode!

Built-in Tools, Lots of Power

The HP 38G offers over 200 easy-to-find commands in clear, organized menus. Evaluate expressions symbolically, isolate variables, solve quadratic equations, and use HP Solve to conduct “What if...” investigations. Other features include:

- Taylor series approximations
- List-based, 1- and 2-variable statistics; regression models and plot types
- Complex numbers
- Real and complex matrices
- Programming to create your own Views, ApLets, and automatic calculations

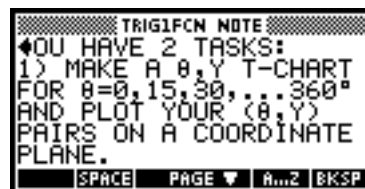
ApLets Make Teaching Easier for You

ApLets combine variables, pictures, graphs and custom-designed views into one complete package. With ApLets, students can explore the problems without your guidance—and without fear of losing their work or the original lesson. They can save their work or start over if necessary. ApLets are easy and natural to use: students will even begin to create their own to share with you and others.

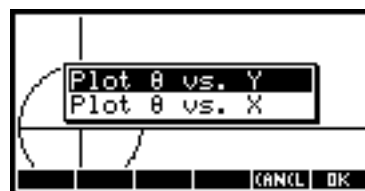


It's easy to create ApLets! Once you set up a problem for use in the classroom, just save it. All of the configuration information is saved, along with any notes and sketches you've created—together in a package easily transferred to your students via simple, wireless infrared. (Just point two calculators at each other and beam it across—and the same infrared beam also operates the I/R printer!) In very little time, everyone in class is working with the same information and problems—a complete lesson that you prepared.

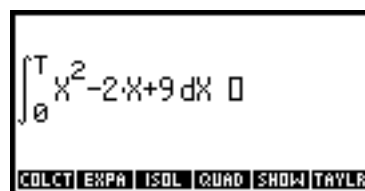
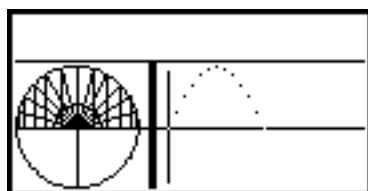
An ApLet (such as this one, written by G.T. Springer, of San Antonio, TX) is stored in the ApLet Library. It can begin with a note....



Students can then see a sketch of the problem and even customized views....



They can compare graphical and numeric views as they are generated. And if they goof, they just start over—the original ApLet isn't changed until it is saved.



ApLets are being created by teachers, publishers, and HP. They are available on bulletin boards and on the Internet. (Please see pages 20-21 and page 38 for more information.)

(Please see page 27 for Bid Specifications for the HP 38G Graphic Calculator.)

THE HP 48G Series Graphic Calculators in Detail

The State of the Art

The HP 48G Series of graphic calculators represent the best of the best—a new level of capability and convenience. They offer more memory, more functionality, and more graphics, including input forms, dialog boxes, enhancements to plotting, 3-D graphics, and built-in equations.

The HP 48G Series of calculators is truly at the head of its class, offering you and your students a wide range of choices in power, ease of use and expandability for the future.



The HP 48G Graphic Calculator has 32 KB RAM built-in and includes all HP 48GX features except the plug-in option—an excellent choice when plug-in expandability is not a requirement.

The new HP 48G+ Advanced Graphic Calculator opens up new horizons. With a full 128 KB of RAM built-in—four times the memory of the HP 48G—think how many more equations, programs, notes and formulas your students could have at their fingertips!

The HP 48GX Graphic Expandable is the finest calculator for your education and your career—period. With 128 KB of RAM built-in, plus the expandability of two plug-in ports for application cards or up to 1.25 MB of RAM, it's the most power you'll find in a calculator anywhere.

Power with No Equal

The power packed by the HP 48G Series is staggering. Graphics and calculus combine as in no other calculator. While you view the graph, the HP 48 finds roots, intersections, local extrema, derivatives, slopes, and areas under curves. You also get hundreds of built-in equations for geometry, stress analysis, electrical engineering, fluid flow, heat transfer, and more—all with HP Solve that lets you play “What if...” by varying your known values and solving for the unknown values—even with multiple equations!

And if all this isn't already precisely what you need, the HP 48G Series also offers powerful, structured, object-based programming. Write quick, simple utility programs, and then combine them into sophisticated applications—with totally custom menus and key assignments to make their use even faster.

Built to Make Sense

But is all this power only for the technically gifted? Not at all! The HP 48G Series is easy to use, even for beginners.

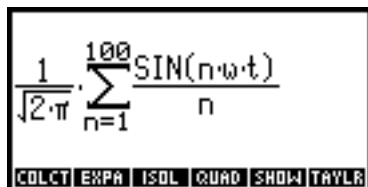


Look at the easy-to-use forms that speed up learning: each built-in application tool has an input form you just fill in.

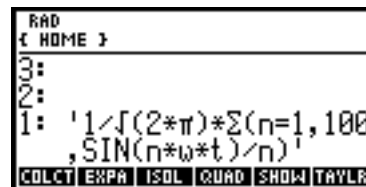
With clear prompts and menus organized for easy access, you and your students get satisfying results quickly. From unit management to matrices, the HP 48G Series is first-class in friendliness, too.



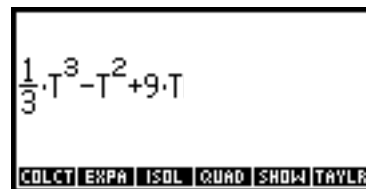
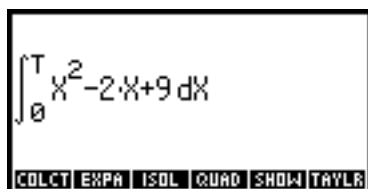
With the EquationWriter, you see this...



...instead of this.



And its symbolic math capabilities open new possibilities for your students. They can create expressions on the calculator, then evaluate them symbolically....



Calculators to Expand with Your Horizons

You can add up to 1.125 MB of RAM to the HP 48GX—or customize it with plug-in application cards. It can grow with you—you'll never need another calculator! And even the HP 48G and HP 48G+ offer expandability via data transfer—and you don't even need cables with the built-in infrared I/O! Just send and receive files via the HP 48 infrared port—to another HP 48 or to the optional HP infrared printer. And for longer-term storage and exchange, the built-in serial port makes sharing just as easy: with the Connectivity Kit accessories, you can link your HP 48 to your Macintosh or DOS computer via RS-232 for file exchange, program storage, and program development.



(Please see page 27 for Bid Specifications for HP 48G Series Graphic Calculators.)

HP Graphic Calculators

Features Summary

Product Name	HP 38G	HP 48G Series
Display	8 line × 22 char. LCD	8 line × 22 char. LCD
Entry system logic	Algebraic	RPN
Menus and softkeys	Yes	Yes
Prompts and alpha messages	Yes	Yes
Built-in RAM	32 KB	32 or 128 KB
Variables or registers	Unlimited within available memory	Unlimited within available memory
Built-in functions	Over 600	Over 2300
Re-definable keyboard and menu keys	Yes	Yes
+, -, ×, ÷, +/-, ln(x), e ^x , y ^x , log(x), 10 ^x	Yes	Yes
Square root, 1/x, n!, x ² , %, pi	Yes	Yes
Fractions format	Yes	No
Trig., Hyperbolics, HP Solve (root finder)	Yes	Yes
Numeric integration	Yes	Yes
Complex numbers and functions	Yes	Yes
Statistical analysis	Multivariate/stat.	Multivariate/stat.
Σx , Σx^2 , Σy , Σy^2 , Σxy	Yes	Yes
Sample stand. dev./mean/weighted mean	Yes + population stand. dev.	Yes
Linear regression, comb./permutations	Yes	Yes
Curve fit (LIN, LOG, EXP, POW)	Yes	Yes
Normal, X, t, F distribution	No	Yes
Decimal hrs./hrs.min.sec. conversions	No	Yes
Polar/rectangular and angle conversions	Yes	Yes
Base conversions and arithmetic	No	Yes
Unit conversions	No	Yes
Bit/Boolean operations	No	Yes
Matrix operations, rectangular and polar	Yes	Yes
Matrix operations, cylindrical/spherical	No	Yes
HP MatrixWriter, row/column operations	Yes	Yes
ApLets	Yes	No
Notepad	Yes (built-in)	Yes (via variables)
Graphic functions/interactive graphics	2D	2D, 3D
Programming	Yes	Yes (RPL)
Number of formulas/programs	Unlimited within available memory	Unlimited within available memory
Optional infrared printer (HP 82240B)	Yes	Yes
Computer link	Yes	Yes
Two-way infrared I/O	Yes	Yes
Batteries	3 x AAA	3 x AAA
Warranty	One-year warranty	One-year warranty

In addition, all HP 48G Series calculators offer symbolic algebra (quadratic and polynomial); symbolic calculus (integration and differentiation); symbolic constants; business features; and a built-in Solve Equation Library. The HP 48GX also has expansion capabilities of two slots for multiple applications or up to 1.25 MB of memory.

HP Graphic Calculators

Bid Specifications

HP 38G



- 8-line x 22-character display
- Advanced functions access via pop-up display windows
- 15-digit calculation accuracy, displayed with up to 12 digits plus a 3-digit exponent
- Graph rectangular functions, parametric and polar expressions, recursively-defined sequences
- Up to 10 graphing functions defined, saved, graphed and analyzed simultaneously
- Up to 10 functions traceable on a single graph
- ApLets (small electronic lesson packets); ApLets limited only by available memory
- 15 interactive zoom features accessible from the display
- Sequence graphing mode shows both time series and cobweb/stairstep plot
- Numeric evaluation of functions in table format
- Interactive function analysis: values, roots, maxima and minima, integrals, derivatives
- Presents mathematical solutions in multiple views
- Split-screen capability displays 2 screens side-by-side for dynamic comparison
- HP Equation Solver
- Notes and pictures feature
- Matrix operations: inverse, determinant, transpose, augment, eigenvectors, and elementary row operations
- 10 matrices; sizes limited only to available memory
- List-based 1- and 2- variable statistics; regression models: linear, log, power, exponential, quadratic, cubic, logistic
- Box and whisker plots
- Histograms, scatter plots, regression equation graphs
- Programs; quantities limited only by available memory
- Dynamic results history stack at HOME screen
- Symbolic tools: variable isolation, substitution, quadratic solving, Taylor series
- Polynomial root finding
- Complex numbers
- 32 KB memory
- Data transfer with built-in IR (infrared) and serial port
- Connects to overhead projector accessory
- IR printer accessory
- Connectivity accessory kits for IBM-PC or Macintosh
- Powered by 3 AAA batteries
- Sturdy sliding hard case
- 1-year warranty



HP 48G Series



- Built-in RAM: 32KB on 48G; 128KB on 48G+ and 48GX
- 131 x 64 dot display
- 12-digit values, with 3-digit exponents
- HP EquationWriter for formatted equation entry
- Multiple plots on single graph; limited only by available memory
- Quadratic and polynomial root finder
- Symbolic and numeric integration and differentiation
- Differential equation solver
- Real and complex matrices; sizes and numbers limited only by available memory
- Object-based programming language; structures include CASE, DO, FOR, IF, UNTIL, and WHILE; program sizes and numbers limited only by available memory
- Infrared I/O; wireless transfer of instructor data to students
- Dialog-box function access
- Graphing: function, conic, polar, parametric, truth, differential equation, bar, histogram, scatter plots
- Graphic controls: zoom, box Z, tracing, shading, spacing, axis tick marks, scrolling
- Matrix operations: inverse, transpose, determinant, row operations, row-to-column conversions
- Statistical capabilities: standard deviation, mean, linear regression, combinations, permutations, weighted means
- Keys can be assigned new functions or programs
- Serial-wired Mac/PC interface
- Size: 8.1 x 18.0 x 2.9 cm (3.2 x 7.1 x 1.2 inches)
- Weight: 264 g (0.58 lb)
- 1-year warranty
- HP 48GX has two expansion ports, allowing plug-in applications or RAM memory accessory cards



Accessories for HP Graphic Calculators

Connectivity

Share your computer's peripherals with your HP 38G and HP 48G Series—and protect your calculator data and programs by storing them to your computer's disk drive! The HP Connectivity Kit provides desktop computer cables and utilities (including Windows-compatible programs) to capture HP 38G or HP 48G Series screen images, and to remotely control the HP 38G or HP 48G Series.

F1207C Serial Interface Kit, HP 38G/48G Series to DOS/Windows-compatible PC's.

Program transfers files between calculator and PC: libraries, programs, grobs, data sets, or ApLets. Includes utility to capture/save calculator screen images.

On the HP 48G Series, controls calculator memory remotely from a PC. (Has a simple file editor and an archive command to back up memory in a compressed file.) On the HP 38G, controls file storage remotely, from the calculator.

Includes 1.5-meter serial cable, 4-pin to 10-pin connector, two 3.5" HD disks with PC software (Windows 3.1 and DOS 5.0 versions), User's Guide. Requires open PC serial port (9-pin to 25-pin).

F1015A Serial Interface Cable, for IBM-compatible PC's.

Includes 1.5-meter serial cable, 4-pin to 10-pin connector.

F1023A Serial Cable Adapter Kit, for IBM-compatible PC's.

Includes 9-pin to 25-pin serial modem adapter, 9-pin to 25-pin serial PC adapter, 9-pin to 25-pin serial printer adapter, 9-pin to 9-pin null modem adapter.

F1208B Serial Interface Kit, for HP 38G/HP 48G Series to Macintosh. Transfers files

between calculator and Mac: libraries, programs, grobs, data sets or ApLets. Screen grabber utility saves calculator screen images.

On the HP 48G Series, controls calculator memory remotely from a Mac. (Has a file editor and archive command to back up compressed memory.) On the HP 38G, controls file storage remotely, from the calculator.

Includes 1.5-meter serial cable, 4-pin to 10-pin connector, 3.5-inch disk with Macintosh software, User's Guide. Requires open PC serial port (9-pin to 25-pin).

F1016A Serial Interface Cable, for Macintosh computers.

Includes: 1.5-meter serial cable, 4-pin to 10-pin connector.

Classroom Overhead Display

The Overhead Display Unit (ODU) is the perfect way to teach or present lessons. It's easy to demonstrate HP 38G or HP 48SX/GX calculations to the whole class—step by step!

Just set this unit on an overhead display projector, connect it to your calculator with the proper cable, and you're ready to conduct class.



You can adjust contrast and screen positioning, and the ODU has cables for the HP 38G and HP 48SX/GX—and a built-in compartment for easy cable storage.

HP F1212A Overhead Display Unit

Includes: Display unit, one 9V battery, 2 cables, User's Guide.

Printing

The battery-powered infrared printer is a revolutionary companion for your HP graphic calculator. Operating via an invisible infrared beam, it needs no cord to connect to the calculator; producing hard copies in the field or office couldn't be easier! And you get easier-to-read output and automatic shutoff for extended battery life.

Operating this printer is easy. Just aim your calculator at the printer (up to 18 inches away), send print instructions, and you get a neat, clean copy of your calculations. Print a complete record of your work, or select only what you need. Just 4 AA alkaline batteries give the printer go-anywhere portability. Or, to extend battery life, plug in the optional AC adapter.



HP 82240B HP Infrared Printer

Includes: Printer, 4 AA alkaline batteries, 1 roll of paper, User's Guide.

HP 82175A Thermal Paper, for HP 82240B or HP 82240A Infrared Printers.

Includes: 6 rolls, 2 1/4" x 80" (5.7 cm x 25 cm), black.

HP F1011A AC Adapter for HP 82240B or HP 82240A Infrared Printers.

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Memory Cards

Take advantage of additional RAM! Develop large programs and store more data in your HP 48GX. Choose the memory configuration you need. Add to the main memory or use the plug-in card as an electronic disk. You save your information even when you unplug the RAM card from the HP 48GX! Each card is powered by its own long-lasting battery.



HP 82215A 128 KB Battery-backed RAM Card, for the HP 48GX.

Includes: 128 KB battery-backed RAM card, CR2016 battery, installation card.

HP 82216A 1 MB Battery-backed RAM Card, for HP 48GX (indep. memory only).

Includes: 1 MB battery backed RAM Card, CR2016 battery, installation card.

Other Accessories

There's also plenty of concise information in book form available for the HP 48G Series calculators—either replacement Owner's Manuals or extended help with programming and other advanced topics.

00048-90136 HP 48G Series Advanced User's Reference Manual

Includes: Programming Techniques; Programming Examples; Comprehensive Command Reference; Equation Reference; Table of System Messages; Table of Units; Table of System Flags and Table of Reserved Variables.

00048-90126 HP 48G Series Replacement Owner's Manual and Quick Start Guide

82221-60001 Soft Case, replacement case for HP 48 Series.

Where to Buy HP Graphic Calculators and Accessories

Distributors

Axidata (Canada)...514-738-6996
Azerty...check local area listings
Beamscope (Canada)...905-763-3000
Carolina Wholesale...check local area listings
Commonwealth...check local area listings
D&H Distributors...800-877-1200
Daisytek (Canada)...905-940-9800
Douglas Stewart Co....800-279-2795
El Dorado Trading Co....800-227-8292
Hartco Enterprises/MultiMicro (Canada)...514-354-0580
NEAMCO...check local area listings
PRO Distributors...check local area listings
Taylor...check local area listings
United Stationers...check local area listings

National Retailers

Best Buy (HP 38G only)...check local area listings
Boise Cascade...check local area listings
Business Depot (Canada)...905-513-6116
CDW Computer...check local area listings
Circuit City...check local area listings
Corporate Express...check local area listings
CostCo...check local area listings
Fry's Electronics...408-487-1000
J&R Computer World...800-221-8180
Nobody Beats the Wiz...800-846-NBTW
Office Depot...800-685-8800
Office Depot/Office Place (Canada)...905-615-0980
OfficeMax (HP 48G only)...800-788-8080
S.P. Richards...check local area listings
Service Merchandise...800-251-1212
Staples...800-333-3330
Walmart...check local area listings

Local and Independent Retailers

Alabama	Auburn University Bookstore ...1360 Haley Center...Auburn, AL 36849...334-844-1354 Off Campus College Bookstore ...1020 Henderson Rd....Huntsville, AL 35816...205-837-9529
Alaska	University Supply ...P.O. Box 870291...Tuscaloosa, AL 35487...205-348-6168 Lewis & Lewis Computer Store ...611 Fairbank St....Anchorage, AK 99501...907-277-9432 Alaska Pacific Univ. Bookstore ...4101 Univ. Dr....Anchorage, AK 99608-4625...907-564-8218 University of Alaska ...2905 Providence Dr....Anchorage, AK 99508-4630...907-786-4759 University of Alaska ...PO Box 750127...Fairbanks, AK 99775-0001...907-474-7348

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Arizona	Computer Physicians Unlimited ...10211 N. 60th Dr....Glendale, AZ 85302-1255
	Arizona State University Bookstore ...Tempe, AZ 86287-0310...602-965-7928
	Arizona Bookstore ...815 N. Park Ave....Tucson, AZ 85719...520-622-4717
California	University of Arizona Bookstore ...850 E. 18th St....Tucson, AZ 85719...520-621-8870
	ASUC Store ...Bancroft at Telegraph...Berkeley, CA 94720...510-642-7010
	Associated Students Bookstore ...Chico, CA 95929-0001
	Off Campus Bookstore ...236 A St....Davis, CA 95616...916-758-2665
	UC Davis Bookstore ...Davis, CA 95616...916-752-5907
	Kennel Bookstore ...Fresno, CA 93740-0022...209-278-4062
	UCI Bookstore ...Irvine, CA 92717-1550...714-824-7877
	UCSD Bookstore ...Mail Code 0008...La Jolla, CA 92093-0008...619-534-7095
	Forty Niner Shops, Inc. ...6049 E. 7th St....Long Beach, CA 90840-0001...562-985-7704
	UCLA Student's Store ...308 Westwood Blvd....Los Angeles, CA 90024-8311...310-206-0825
	University Bookstore ...840 Childs Way...Los Angeles, CA 90089-0009...213-740-8993
	Matador Bookstore ...18111 Nordhoff St....Northridge, CA 91330-0001
	Titan Shops ...2875 Orange-Olive Rd....Orange, CA 92665
	Bronco Bookstore ...CA St Ply U Building 66...Pomona, CA 91768-2557...909-869-3274
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	Hornet Bookstore ...6000 J St....Sacramento, CA 95819-2605...916-278-7297
	Adams Office Supply ...3038 University Ave....San Diego, CA 92104-3072...619-295-4131
	Aztec Shops Ltd. ...San Diego, CA 92182-1701...619-594-7508
	USD Bookstore ...5998 Alcala Park...San Diego, CA 92110...619-260-4551
	Franciscan Bookstore ...1650 Holloway Ave....San Francisco, CA 94132-1781...415-338-7369
	Spartan Bookstore ...San Jose, CA 95112...408-924-1817
	El Corral Bookstore ...San Luis Obispo, CA 93407...805-756-1101
Colorado	UCSB Bookstore ...University Center...Santa Barbara, CA 93107-3400...805-893-8579
	Stanford Bookstore ...Stanford, CA 94305-3079...800-533-2670
	Mawson Computer ...3343 Industrial Dr., Ste. 1...Santa Rosa, CA 95403...707-528-2841
	University Book Center ...Campus Box 36...Boulder, CO 80309...303-492-6411
	Cadet Bookstore ...Bldg. 2360, Vandenburg Hall...USAF Academy, CO 80841...719-472-6268
District of Columbia	Follett's CSM Bookstore ...Ben Parker Student Ctr....Golden, CO 80401-1887...303-273-3113
	Follett's GWU Bookstore ...2110 "I" St., N.W....Washington D.C 20052-0001...202-994-6870
Florida	University of Miami Bookstore ...University Center...Coral Gables, FL 33124...305-284-3592
	ERAU Bookstore ...Embry-Riddle Aeronautical Univ....Daytona Beach, FL 32114...904-226-6062
	Florida Bookstore & Computer Ctr. ...1614 W. Univ. Ave....Gainesville, FL 32604...904-376-5606
	Mr. Data ...3206 S.W. 35th Blvd....Gainesville, FL 32608...904-335-9616
	University Book & Supply ...1227 W. University Ave....Gainesville, FL 32601...904-377-1788
	University of Florida Bookstore ...Stadium Rd.-Hub...Gainesville, FL 32611-2011...904-392-0194
	International Calculator ...2916 Corrine Dr....Orlando, FL 32803...800-535-5692
	Univ. of Cent. Florida Comp. Store ...4000 C. Florida Blvd....Orlando, FL 32816...407-823-0145
	University Bookstore ...P.O. Box 25001...Orlando, FL 32816-0444...407-823-3028
	Mayes Printing & Office Supply ...6120 Pensacola Blvd....Pensacola, FL 32589...904-477-1111
	Florida State Univ. Store ...New Union Bldg. #0127...Tallahassee, FL 32306...904-644-2072
	Univ. of South Florida Bookstore ...4202 Fowler Ave....Tampa, FL 33620-6550...813-974-0523
Georgia	Allen Precision Equipment ...3427 Oakcliff Rd....Atlanta, GA 30340...800-241-6223
	Engineers Bookstore ...748 Marietta St., N.W....Atlanta, GA 30318...404-221-1669
	Georgia Tech Bookstore ...Atlanta, GA 30332-0001...404-894-2513
	Allen Precision Equipment, Inc. ...1550 Boggs Rd....Duluth, GA 30136...770-458-8885
	Southern Tech Bookstore ...Marietta, GA 30060-2896...770-528-7355
Hawaii Idaho	A. Baldwin Ag. College Bookstore ...2802 Moore Hwy....Tifton, GA 31793-0016...912-386-3226
	Univ. of Hawaii Bookstore ...2465 Campus Rd....Honolulu, HI 96822-2216...808-956-6612
	Oregon Digital ...5511 Kendall St....Boise, ID 83706...208-377-1521
	University of Idaho Bookstore ...Moscow, ID 83843...208-885-6469
	Ricks College Bookstore ...Manwaring Center 116...Rexburg, ID 83460-2211...208-356-2211

Illinois	Illini Union Bookstore ...715 S. Wright St....Champaign, IL 61820...217-333-2050
	Follett College Store ...627 S. Wright St....Champaign, IL 61820-5709...217-356-1368
	TIS Bookstore ...707 South 6th St....Champaign, IL 61820-5716...217-337-4900
	Follett's Commons ...3200 S. Wabash Ave....Chicago 60616-3821...312-791-0770
	Student Book Exchange, Inc. ...1737 Sherman Ave....Evanston, IL 60201-3712...847-328-2717
	The Alamo II ...319 North St....Normal, IL 61761-8100...309-452-7400
	Book Center in the Illini Union ...Urbana, IL 61801-2917...217-244-3743
Indiana	The Write Stuff, Inc. ...1 S. 781 Country Club...Wheaton, IL 60564-5646...708-871-8545
	Purdue Bookstore ...Library Building...Hammond, IN 46323-2051...219-844-1081
	Follett's Purdue West ...1400 W. State St....West Lafayette, IN 47906-3405...765-743-9642
Iowa	University Book Store ...360 State St....West Lafayette, IN 47906...765-743-9618
	Campus Bookstore ...2300 Lincoln Way...Ames, IA 50010...515-292-1616
	Iowa Book & Supply Co. ...Box 2030...Iowa City, IA 52240-3912...319-337-4188
Kansas	University Bookstore ...Iowa Memorial Union...Iowa City, IA 52242...319-335-3179
	Kansas Union Bookstore ...Jayhawk Blvd....Lawrence, KS 66045-0501...913-864-4640
	University Book Shop ...1116 W. 23rd St....Lawrence, KS 66045...913-749-5209
Kentucky	K-State Union Bookstore ...Manhattan, KS 66506-2809...913-532-6583
	University Book Store ...623 N. Manhattan...Manhattan, KS 66502-5333...913-539-0511
	University Book Store ...106 Student Center...Lexington, KY 40506-0001...606-257-6304
Louisiana	Louisiana State Univ. Bookstore ...110 Union Bldg....Baton Rouge, LA 70893...504-388-5137
	University Bookstore ...P.O. Box 41209 USL...Lafayette, LA 70504-1209...318-482-6922
	Computer Store of Louisiana ...1440 Canal Street...New Orleans, LA 70112...504-486-9055
Maine	Maine Surveyors Supply ...28 U.S. Route 1...Yarmouth, ME 04096...207-846-5143
	U.S. Naval Academy Store ...101 Wilson Rd....Annapolis, MD 21402-5081
	Maryland Book Exchange ...4500 College Ave....College Park, MD 27040-3326...301-927-2510
Maryland	The University Shop ...Campus Center...Amherst, MA 01003-0146...413-545-2619
	Boston University Bookstore ...660 Beacon St....Boston, MA 02215...617-267-8484
	Campus Camera & Video ...660 Beacon St....Boston, MA 02215...617-236-7476
Massachusetts	Harvard Coop ...1400 Mass. Ave....Cambridge, MA 02238...617-499-2000
	MIT Comp. Connection ...84 Mass. Ave., Rm. W20-021...Cambridge, MA 02139...617-253-7241
	Central Street Assoc., Inc. ...18 Kenneth Terr....Stoneham, MA 02180...781-438-8622
Michigan	Worcester Polytechnic Institute ...Daniel Hall...Worcester, MA 01609...508-831-5247
	Ulrich's ...549 E. University Ave....Ann Arbor, MI 48104...313-662-3201
	Lundberg Bookstore ...Rankin Ctr....805 Campus Dr....Big Rapids, MI 49307...616-592-2607
	Instrument Sales & Service ...24037 Acacia...Bretford, MI 48239...313-535-5252
	Gibson's Tech. Bookstore ...128 W. Grand River Ave....East Lansing, MI 48823...517-332-8681
	MSU Bookstore ...East Lansing, MI 48824-1035...517-355-3450
	Mott College Store ...1401 E. Court St....Flint, MI 48502...810-762-0232
	Michigan Surveyors Supply ...4655 Willoughby...Holt, MI 48842-2162...517-694-4600
	Michigan Tech Bookstore ...1503 College Ave....Houghton, MI 49931-1295...906-487-2410
	Western Michigan University ...Bernhard Center...Kalamazoo, MI 49008...616-387-3930
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North Dakota	Varsity Mart ...PO Box 5476...Fargo, ND 58105-7761 Univ. of N. Dakota ...Univ. Station, Campus Dr....Grand Forks, ND 58202...701-777-2681
Ohio	Safe Technologies Corp. ...4131 State Park Dr....Akron, OH 44319...800-638-9121 College Book Store ...50 S. Court St....Athens, OH 45701...614-594-3505 Univ. of Cincinnati Bkstr. ...123 W. Univ. Ave., ML 217...Cincinnati, OH 45221-0001...513-556-1900 Long's College Book Co. ...1836 N. High St....Columbus, OH 43201-1146...614-294-4674 Ohio State Univ. Bookstore ...2009 Millikin Rd....Columbus, OH 43210...614-292-2991 Case Western Reserve University ...11111 Euclid Ave...Cleveland, OH 44106...216-368-2650 University Bookstore ...Thwing Center...Cleveland, OH 44106-1715...216-368-2650
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Oregon	Calculating Edge ...899 N.W. Grant Ave....Corvallis, OR 97330...800-677-7001 Corvallis System Sales Corp. ...800 N.W. Starker, Ste. 35...Corvallis, OR 97330...541-752-4419 OSU Bookstore ...2301 S.W. Jefferson...Corvallis, OR 97331...541-737-4323 University of Oregon Bookstore ...895 E. 19th Ave...Eugene, OR 97401...541-346-4331 Paper Owl Bookstore ...3201 Campus Dr....Klamath Falls, OR 97601...541-885-1050 Portland Comm. Coll. Bookstore ...1200 S.W. 49th Ave...Portland, OR 97219...503-977-4910 Power Source – PSU Bookstore ...626 S.W. College...Portland, OR 97201...503-295-1130 Chemeketa Comm. College Bookstore ...P.O. Box 14007...Salem, OR 97309-7070...503-399-5131
Pennsylvania	Lehigh Univ. Bookstore ...Maginnes Hall, Bldg. 9...Bethlehem, PA 18015-3073...610-758-3376 Drexel University Store ...33rd & Chestnut St....Philadelphia, PA 19104...215-895-2855 Temple Univ. Bookstore ...13th & Montgomery Ave....Philadelphia, PA 19122...215-204-7385 Univ. of Penn. Bookstore ...3729 Locust Walk...Philadelphia, PA 19104-3610...215-898-7595 Carnegie Mellon Univ. Bookstr. ...Baker Hall, Schenley Pk....Pittsburgh, PA 15213...412-268-2966 Penn State Bookstore ...Bookstore Bldg...University City, PA 16802...814-863-3250

Puerto Rico	Relojes y Calculadoras...Mayaguez Mall...Manaqueer, PR 00680...787-834-5559
Rhode Island	HP Only...Binero Avenue #1031...Puerto Nuevo, PR 00920...787-793-8033
South Carolina	Brown University Bookstore...71244 Thayer St....Providence, RI 02912-0001...401-863-3216
	J & J Electric...384-7 College Ave....Clemson, SC 29631...864-654-3663
	Clemson Bookstore...P.O. Box 2096...Clemson, SC 29632-2096...864-656-2050
	Student Off-Campus Bookstore...359 College Ave....Clemson, SC 29633...864-654-3000
	Carolina's...629B Main...Columbia, SC 29201...803-799-7406
	Follett's Addam's Univ. Bkstr....601 Main St....Columbia, SC 29201-4058...803-256-6666
	Follett's Univ. Bookstore...The Russel House...Columbia, SC 29208-0001...803-777-4160
South Dakota	Tech Bookstore...501 E St....Rapid City, SD 57701...605-871-1984
Tennessee	University Center Bookstore...Box 5075...Cookville, TN 38505...931-372-3226
	Surveyors Module, Inc....412 Payne Ridge Rd....Church Hill, TN 37642...423-357-8931
Texas	Univ. Book & Supply...U.T. Center, Rm. 147...Knoxville, TN 37916-4800...423-974-1040
	University Cooperative Society...2246 Guadalupe...Austin, TX 78705...512-476-7211
	Professional Computing...505 Church St....College Station, TX 77640...409-846-5332
	U Bookstores & Aggie...700 University Dr., E....College Station, TX 77840...409-846-4818
	CompuCom Systems, Inc....9333 Forest Ln....Dallas, TX 75243...972-783-1252
	Holman's...5776 N. Mesa...El Paso, TX 79936
	Century Business Equipment...6810 Larkwood...Houston, TX 77074...713-777-2673
	Rice Campus Store...6100 S. Main St....Houston, TX 77005...713-527-4052
	Executive World...3312 Santa Ursula Ave....Laredo, TX 78040...956-722-6385
	Palmtop Connection...6814 Leyland...San Antonio, TX 78239...210-590-7444
Utah	Utah State University Bookstore...Logan, UT 84322...801-797-1667
	Weber State University Bookstore...Ogden, UT 84408-2103...801-626-6352
	BYU Bookstore...Provo, UT 84602...801-378-6808
	University Bookstore...Salt Lake City, UT 84112...801-581-3582
Virginia	R H Enterprises, Inc....3601 S. 2700 W....West Valley City, UT 84119...801-576-8301
	Tech Bookstore...118 S. Maine St....Blacksburg, VA 24060...703-552-6444
Washington	Southern Photo & Supply...3813 Old Forest Rd....Lynchburg, VA 24502...804-385-6060
	Student Book Corp....N.E. 700 Thatuna...Pullman, WA 99163...509-332-2537
	Univ. of Washington Bookstore...4326 University Way, N.E....Seattle, WA 98105...206-634-3400
Wisconsin	Pacific Lutheran Bookstore...Tacoma, WA 98447...253-535-7665
	Weiherts Business Machines...18050 Continental Dr....Brookfield, WI 53045-1203...414-782-0909
	Your One-Stop Palmtop Shop...170 S. Jackson St....Janesville, WI 53545...800-709-9494
	University Bookstore...711 State St....Madison, WI 53703...608-257-3784
	Ace Electronics...1540 N. 68th St....Milwaukee, WI 53213-2806...414-771-8484
	B J TV Service...3429 S. 13th St....Milwaukee, WI 53215-5011...414-643-8555
	Blue & Koepsell, Inc....739 N. Mayfair Rd....Milwaukee, WI 53226-4281...414-476-5041
	The H. H. West Co....P.O. Box 1570...Milwaukee, WI 53233-1570...414-344-1000
	Tele-Port, Inc....7120 W. Good Hope Rd....Milwaukee, WI 53223-4611...414-358-1923
	University of Wisconsin Bookstore...Milwaukee, WI
	University Bookstore...Student Center...Platteville, WI 53818...608-342-1486
Alberta	Univ. of Calgary Bookstore...2500 University Dr., N.W....Calgary T2N 1N4...403-220-4765
British Columbia	Trentech Office Products...2828 18th St., N.E., #3...Calgary T2E 7B1...403-250-9267
	UBC Bookstore...6200 University Blvd....Vancouver V6T 1Z4...604-822-2665
Nova Scotia	Cariboo College Bookstore...900 College Dr....Kamloops V2C 5N3...250-828-5141
	St. Francis Xavier University Bookstore...Antigonich B2G 1C0...902-867-2450
Ontario	Bookstore – Tech. Univ. of Nova Scotia...P.O. Box 1000...Halifax B3J 2X4...902-420-7707
	McMaster University Bookstore...1280 Main St., W....Hamilton L8S 4L8...905-525-9140
	Queens Univ. Campus Bookstore...Queens Univ. Grounds...Kingston K7L 3N6...613-545-2955
	Downtown Electronics...356 Yonge Street...Toronto M5B 1S5
Quebec	University of Waterloo Bookstore...200 University Ave., W....Waterloo N2L 3G1
Saskatchewan	COOP Concordia...1455 de Maisonneuve, O....Montreal H3G 1M8...514-848-3615
	University of Saskatchewan Bookstore...Marquis Hall...Saskatoon S7N 0W0...306-966-4468

Frequently Asked Questions

About the HP 48G Series

Why does my HP 48 flash when I turn it on, or pause momentarily during a calculation?

This is normal. The pauses are to “tidy up” memory (needed more often as more memory is used).

What does the  annunciator indicate?

It signals either a low battery or past-due alarm. To find out, turn the machine off, then on.

How can I find out if the calculator is malfunctioning or if I’m doing something incorrectly?

See page A-9 of your User’s Guide, “Testing Calculator Operation.”

How do I determine how much free memory my calculator currently has?

To find out, press  **MEMORY** .

How do I change the format or number of decimal places displayed by the calculator?

Use  **MODES** or  **MODES** . See page 4-2 of your User’s Guide.

What does an E in a number mean?

It’s scientific notation (e.g. $6.02E23 = 6.02 \times 10^{23}$).

I lost/broke my calculator’s battery door, port cover, or rubber foot. How do I get a new one?

Call Calculating Edge at 888-338-2252.

What replacement batteries should I get for my calculator?

Use three size AAA, all of the same brand. Note that NiCad batteries are not recommended, due to their low capacity and short warning time. See also page A-5 of your User’s Guide.

How do I adjust the display to be easier to read?

While holding the  key down, press  or  repeatedly.

My calculator is “locking” up or behaving strangely. How can I check and/or correct this?

See “Special Memory Operations” on page 5-16 of the User’s Guide.

Why can't I find the variable(s) I stored?

You're now in a different directory than where you stored the variable(s).

Why am I getting wrong results with trig functions?

Check the angle mode. If you see the annunciator **RAD** or **GRAD**, the machine isn't using degrees. Use $\leftarrow$ **RAD** or the $\rightarrow$ **MODES** menu to adjust accordingly.

Why don't I get 0 when I take the sine of pi?

If you get 'SIN(π)', the calculator is in Symbolic Results mode (i.e. Flag -3 is clear) but not in **RAD**ians mode. Set **RAD**ians mode (via $\leftarrow$ **RAD**), then use either $\leftarrow$ **+NUM** or **EVAL**. **EVAL** will return the trig identity, 0, if Flag -2 (Symbolic Constants) is also clear. Otherwise, **EVAL** behaves like $\leftarrow$ **+NUM**, which never returns 0, because it does its calculation on a 12-digit approximation of π , 3.14159265359. (No machine uses a numerically exact value of π ; it has an infinite number of digits.) And the sine of 3.14159265359 radians is simply not zero. For similar reasons, pressing $2 \sqrt{x} \leftarrow x^2$ on the HP 48 doesn't return 2.

Why am I getting an Undefined Name error when integrating or differentiating?

The machine is in Numeric Results mode (Flag -3 is set) but is encountering symbolic arguments. Either change the flag or numerically define the arguments.

Why do I get a complex number when I evaluate '(-1)^(2/3)'?

The machine returns a complex principal solution for expressions with fractional exponents. To get a real-valued result to the above, use 'XROOT(3, (-1)^2)' (or its keyboard equivalent: $1 \div \leftarrow x^2 3 \rightarrow x^y$).

Why do I get error messages such as Too Few Arguments or Bad Argument Type?

The command you attempted needs more or different-type arguments than what it currently finds on the stack. (See also Appendix B in your User's Guide.)

How do I turn off the HALT annunciator?

Use KILL: **PRG** **NXT** **QUIT** **QUIT**.

My machine seems to gradually slow down. Why?

It may need to clean up fragmented sections of memory. To do a cleanup, while holding down **ON**, press and release **C**. (This clears both the stack and PICT.)

Why am I getting mixed units in the Equation Library Solver even after I have specified ENG or SI?

The Solver creates only variables not already present in the current directory; the already-present variables may have unintended units. For unit consistency, first select your desired equation category in the Equation Library, press **UNIT** **NXT** **PURE**, then select your units.

Frequently Asked Questions About the HP 38G

What calculus can I do with the HP 38G?

Some instructors have already written calculus ApLets, but even without ApLets, the HP 38G can help you study derivatives and integrals numerically and Taylor polynomials either numerically or symbolically.

Where can I find examples and information about writing my own ApLets?

Go to http://www.hp.com/calculators/products/hp38g_aplets.html.

Does the HP 38G handle any symbolic algebra?

The HP 38G is more limited in this area than the HP 48G/GX, but it offers symbolic features such as POLYFORM, which expands and simplifies polynomial expressions.

How can I trace along the FIT that I determine when working with a scatter plot?

First, set up the Statistics and Function ApLets identically. Next, draw the scatter plot and store PREDY(X) into F1(X). Check only F1(X) in FUNCTION SYMBOLIC VIEW (F1(X) with F1(X) highlighted to see the fit), and then choose Overlay Plot via  VIEWS.

How do I print the current display of the HP 38G on my infrared printer?

When viewing the display, hold down  and press . Align the printer's input port with the triangle atop the HP 38G—within 18". Press  and type PRVAR GO .

How do I get ApLets from the HP ApLets Library?

Go to http://www.hp.com/calculators/products/hp38g_aplets_lib.html on the Internet, then select HP 38G ApLets Library and then your desired topics/ApLets.

ApLets in the HP Library are compressed with pkzip, so after downloading, “unzip” the package. The files inside include a Word 6.0 file, a text file, and files tagged with .000 (e.g. HP38DIR.000 and HP38DIR.CUR). (Note that all ApLet packages contain the HP38DIR.000 file, so be careful not to overwrite this file by unzipping or copying other packages of ApLets into the same directory or folder.)

How to Contact HP

Why

- If your calculator needs repair.
- If you don't understand something in the manuals.
- If you want to locate an HP retailer near you.
- If you want to learn more about HP products.

Where

- **Phone:** North American technical support: **970-392-1001**
Pre-sales product/dealer information: **800-752-0900**
- **Internet:** **www.hp.com/calculators**

When

- **Phone:** 8 am - 5 pm Pacific Time
- **Internet:** Anytime!

Educators! Keep in mind the
HP Educators Program at:
The Math Learning Center (MLC)
P.O. Box 3226
Salem, OR 97302-0226
Phone: **800-750-8130** (8-5 PT M-F)
Fax: 503-370-7961
E-mail: hp@bbs.mlc.pdx.edu

Your Turn: Surf HP!

A Brand-New Web Site— HP Listens!

Welcome back from the Holidays!

What's on your New Year's agenda? Looking for some student motivation tools? New curriculum ideas or examples? How about information on grant resources? You'll find all these and a lot more at HP's new calculator web site. HP has been listening to your feedback and making changes to make the site easier to use and more informative than ever. It's a resource you'll come back to.

To get started, just point your browser to <http://www.hp.com/calculators/>. Then move your mouse to the Education heading. You'll see subcategories for K-12, College and University, and Professional Education—click on any of these to see more information.

Wondering when the next HP Graphing Calculator workshops will be? Just look under the HP Educator Program to find how to get the latest schedule and sign up. Or maybe you've misplaced a previous copy of **hp^c**. No worries—you'll find an archive of electronic copies here, too!

Maybe you're looking to buy an HP calculator? They've made that easy too—with on-line shopping. Just move your mouse to the Where to Buy heading and click on the on-line purchase category. It's as easy and safe as purchasing at your favorite store—and with all the features and accessories you're looking for.

All this is waiting for you now at the new HP web site—and it's just the tip of the iceberg compared to what you'll be seeing there in the months to come. "Watch That Site!"

Please send all opinions or comments regarding **hp^c** to: **Grapevine Publications, Inc.**
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If you have an idea for a technical article or sample lesson, please contact **Dianne Hart** at 541-917-4627 or hartd@gw.lbcc.cc.or.us.

If you have a feature article or story, please contact: **HP Calculators**
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