Lost and Found

Following Directions to the 21st Century

By Garry Heinze

A classic situation in my family: Sunday drives ending up in a furor. Dad would never ask for directions when lost. "Too proud," Mum would say. "Too mule-stubborn," my elderly aunt would grumble from the back seat, as we drove round and round, looking for *wherever it was*.

London, September 1997. I was late for the HP Handheld Users' Conference at Imperial College. Just in from Downunder, I was driving a rental car from Heathrow on the M4. Into Cromwell Road, past the Museum. I knew I was close. Too far, maybe. It's on the left side somewhere. Turn here—might be a sign or something. No sign, no Imperial College. No one except a postman on his little red motor-bike. Quick decision needed—no time for Sunday-driving pride or stubbornness. I rolled down the car window. "Can you tell me where Imperial College is, mate?" Maybe he recognized the Aussie accent. Or maybe all London Posties are just nice people. He beckoned me to follow him. What a sight that must have been: a postman with his yellow jacket and little red motor-bike, weaving through the streets of Knightsbridge with me in tow. Up one lane, down the next, around Albert Hall, down Exhibition Road to Imperial College. Then he just peeled off with a wink and a nod. My trust in this obliging man had been rewarded.

In fact, that day held many more rewards for trusting expertise: The new HP 49G had its genesis at that Handheld Users' Conference. There I saw the enthusiasm and skills of HP calculator buffs from all over the world. I saw how many knew more about the HP 48 Series machines than I ever would (a humbling realization). I saw brash, young engineers present brilliant entries to the Conference programming contest—not one, but three elegant solutions—the best by far. (We soon hired three of those engineers.) In short, I saw the key to HP's approach to the development of new calculators, and I said it in my presentation: HP resolved to listen to and involve the user community.

The rest is history. Now being released, the HP 49G is a sophisticated machine that will help re-establish HP as a leader in the field—thanks largely to the community of enthusiastic users. Its new Kernel has its roots in that user community, as does the new CAS. And the product was beta-tested in the user community, too. In fact, dozens of people from outside HP, and from within, made unique contributions—which were all the more amazing and valuable given the short time frame of the development.

So on behalf of HP, I want to thank all who played roles in creating this product. I look forward to continued involvement from the HP user community with a new generation of HP Calculators. Like the London postman, the users really helped HP deliver the HP 49G. For other destinations yet ahead, I am still asking for directions.

Garry Heinze (garry_heinze@hp.com) is the Future Products Development Manager at HP's Australia Calculator Operation.

HP resolved to listen to and involve the user community.

The rest is history....

...the users really helped deliver the HP 49G.

A Long Time Coming: Following the Sizzle to the Steak

What We Always Knew Technology Could Do

By Kevin Fitzpatrick

We all have our favorite technology "someday" dreams. Whether they are cars, computers, "smart" houses, personal communicators or personnel hovercrafts, once we hear of technology that promises to make such gadgets possible "someday," that's where our minds immediately leap--ahead to that "someday." You hear the sizzle long before you taste the actual steak.

Well, one "someday" has finally arrived. The promising technology is the graphing calculator; and now delivering on the promise is the HP 49G.

The road was not a short one, though. I remember the day, about 10 years ago, I was working with a student, and he pulled out a rather strange-looking device. I asked him what it was and he said it was a calculator that would also draw graphs right there on its oversized display. He had just bought it (a friend had told him about it), so he didn't know much about it yet. So we played around with it for awhile and watched it graph some trig functions, and it was all very cool. But at the time its novelty made it seem more like a nice toy than the future of math teaching.

I had already been teaching for 15 years and was pretty close to burning out....

Watching what graphic calculators could do made me wonder how they might change what I did. Would that change be for the better?

It wasn't long, though, before the technology—large displays in small boxes—began to promise big things to the math classroom. Just a year later, I found myself at a workshop, discussing real classroom uses of graphing calculators, and that's when it really hit me.

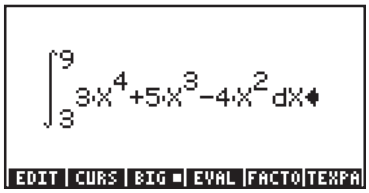
At that point, I had already been teaching for 15 years, and I was pretty close to burning out. Memorizing the quadratic formula and working with computational logarithms can sustain mind and body for only so long. But watching what these new machines could do really engaged me again, made me think—and wonder how they might change what I did as a teacher. Would that change be for the better?

Of course, I didn't have much choice but to find out. In the next few years, graphing calculators took up permanent residence in the secondary math classroom. And they grew up a lot in the process. Features and memory expanded to the point where they saved much of the "grunt work" associated with the "boring" parts of visual math. I could truly expect more plotting and data analysis from my students.

But still it was more a calculating tool than a teaching tool. The time and attention it saved my students in crunching numbers and drawing graphs was taken up in navigating through complex features and a not-very-intuitive interface; one labor replaced the other. The technology's mesmerizing promise—of real pedagogical fire-power—was still out there in the future.

The future begins today. The HP 49G is a new generation of machine—not just an update with a few added bells and whistles—a real move ahead, taking full advantage of the technology tsunami still enveloping us. This "sea change" is clear even at first glance at the HP 49G. Gone is the dull industrial look; it's now a colorful, eye-catching machine.

Turn it on, and it's even more impressive. The HP 49G offers—for the first time anywhere—a "two-for-one" deal on calculators: a friendly, true ALGEBRAIC entry system in the same box with a powerful, full-featured RPN engine. And any HP 49G can connect to an overhead display panel, so students as well as teachers can demonstrate their own view of a concept right from their own machines.

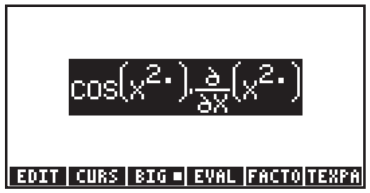


Then there's a long list of features that make the HP 49G an ideal classroom tool. Power? It finds 1000! with the same ease it does 2+3 (though taking a bit longer). Smarts? Ask it cos (π/4) and it promptly returns the meaningful symbolic answer: $\sqrt{2}/2$. Need to compute exponential growth or compound interest? Hey, it even does amortizations!

The list goes on, but there are three specific features that really make the HP 49G unique in its class.

The first is its completely interactive Equation Writer environment, where you enter functions and expressions in textbook form—no need to worry about remembering peculiar calculator syntax. But it's more than just a fancy chalkboard. Use the EW also to select and operate on all or part of an expression, operations that include expansions, factors, limits, derivatives and integrals.

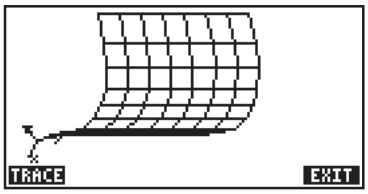
The HP 49G's powerful computer algebra system (CAS) allows for step-by-step solutions of derivatives and integrals, showing not only answers but processes as they were applied—a true learning environment—and with the EW's cut/paste tools and easy stack/storage access, it adds up to a virtually limitless "symbolic sand-box" to play in.

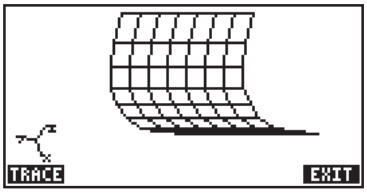


The second big eye-opening feature on the HP 49G is a greatly expanded and improved statistics package. Having taught AP Statistics for the first time last year, I would have loved to have used this machine. It not only does the calculations, but it prompts as you go through the edit lines in the confidence intervals and hypothesis tests. You even get "help" screens that remind you, if you ask, what the particular test you are applying is used for. Again: more than just *answers*, the HP 49G supplies and demonstrates complete *solutions*—a dream for the classroom.

The HP 49G's third notable feature is one that I'm still getting used to: real-time rotation of 3-D graphs. Imagine what it could do for multivariable calculus and analysis....

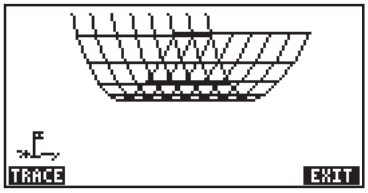
First you would graph your 3-dimensional surface,...

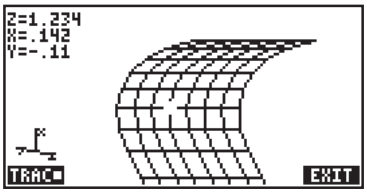




...then rotate your view,

seeing even the axes rotate too (lower left corner),...





...then trace along the surface and watch the values change.

Imagine no more; the HP 49G does all the above. Such stuff is still the province of less common multivariable calculus classes, but recall that the mere existence of graphing calculators brought sophisticated concepts such as optimization "down" from the Mount of Calculus and made them available to anyone who could find the expression to fit the problem. Might this new feature do the same for introductory three-dimensional analysis?

The HP 49G is one "book" you really can judge by its cover. It has eye-catching looks outside and "mind's-eye"-catching features inside. With its debut, the horizons and promises of calculator technology have again leaped ahead. I can only wonder what comes next.

Kevin Fitzpatrick has been teaching Mathematics since 1976. Currently in his 16th year at Greenwich High School in Greenwich CT, he has been involved with graphing calculators since 1989, conducting numerous regional and national presentations, and he's still excited about advances in technology for the classroom.

How it Happened
the HP 49G Inside Story

By Tanya Brooks

How does a technology product happen? What's involved in its progress from a sketch on a napkin to finished goods on a store shelf, particularly in this age of rapid technological changes and fluid but demanding markets? Here's the brief version of the conception and birth of the HP 49G.

In August of 1998, we (Hewlett-Packard) hosted the annual Handheld Users Conference at our site in Vancouver. By then it was apparent that we needed to offer our best calculator features and design in a package far better geared to our typical users. We'd found, in fact, that many college students preferred to make do with their old high school calculators rather than learn the not-so-intuitive RPN format of the HP 48G Series.

We needed to build a "must-have" machine for die-hard HP fans and brand-new users alike—an "HP 48G on steroids"—and on a silver platter.

Needless to say, our mission (and its urgency in a tightly competitive marketplace) became clear: To continue to offer the most powerful graphing calculator around, *it had to be easier.* And it needed algebraic input, faster and better symbolic manipulation, more memory and an appealing (not just 'functional') design. In other words, we had to build a "must-have" machine both for die-hard HP fans and for brand-new users—an "HP 48G on steroids" —and on a silver platter. But it all had to be at an affordable price and ready for the Fall '99 school year in the U.S. and Europe, less than a year away.

Yow! Building a completely new calculator from scratch (hardware, software, industrial design) is a HUGE task and generally takes years. (By way of comparison, the HP 38G, a high-school calculator with far fewer features than the HP 49G, took 18 months.) That was not an option here—the time constraints were merciless. We were stymied... unless somehow we could combine the best parts of the HP 48G with the best work coming out of the very talented HP 48G user groups. (See Garry Heinze's page-1 account of that.)

A long shot still, that became our plan less than a year ago. Now the near-impossible mission has come to successful fruition, and some well-earned thanks are due.

I must start with our three key software engineers, Jean-Yves Avenard, Gerald Squelart and Cyrille De-Brebisson, whose passion has been an inspiration. They, along with Christian Bourgeois and Etienne de Foras (outside of HP), had been the originators of the Metakernel operating system. Once on the HP staff, they brought the same focus and passion—the most I've ever seen—to the entire project. Most of us work to pay the bills, but these three young men worked more for the love of the profession—nearly "24/7"—often sleeping just a few hours at night, our building having become their virtual home. (The round table between their desks was their dining room.)

Such dedication soon spilled over into the rest of the project team: hardware engineers, industrial designers, mathematicians and marketers. On many occasions I saw one or more of them working into the wee hours on problems that would have severely affected the success of the project.

Then there were the many outstanding contributions from the professional community outside of HP. In particular, we thank mathematician Dr. Bernard Parisse, who developed the Computer Algebra System, and Mika Heiskanen and Claude-Nicolas Fiechter, who developed the HP symbolic math package. And for help with calculator features, concepts and design, our thanks go to the European and U.S. User Groups, to the calculator engineers in Corvallis, and to the calculus, statistics and engineering educators who gave so generously of their time and expertise. It was a tremendous team effort, and the HP 49G shows it.

Tanya Brooks (tanya_brooks@hp.com) is HP's Product Manager for the HP 49G.

The "rubber meets the road" as students react to the HP 49G

The All-In-One Package:

Power Meets Simplicity

By Katie Fitzpatrick

The HP 49G is a difficult calculator to get used to. Not that it's hard to use—just the opposite. It requires very little thought and effort to use and has become the all-purpose calculator that the HP 38G once was.

The HP 49G's simplicity starts with its layout; everything I want to use is obviously placed and simple to find, and there's a catalog of commands for anything else. This logic applies to its nested menus, too. If you enter one menu from another (i.e. if you choose any menu selection followed by an ellipsis, ...), you can return to the first menu via a similar selection at the end of the second menu. Nice.

The calculator's aim for simplicity is also obvious in its inclusion of the algebraic notation option. I struggled so much with the HP 48G due to its postfix notation (a.k.a. RPN). 'Why does it have to be so backwards?' I'd grumble. The algebraic mode on the HP 49G resolves this problem. If I want to use RPN, I can—just change modes and go — so I won't need to carry around both a 48G and a 38G anymore. On the 38G I did all the easy algebraic things; on the 48G I did powerful things such as integration and differentiation—and rarely needed anything it couldn't handle. But the RPN kept me from relying on the 48G entirely, because even to balance my checkbook, I had to use what seemed like a completely different language.

In short, the HP 49G offers all the power of the HP 48G (and more) in a package far more accessible to the average college or high school student. With its dual modes, the 49G pleases not only techie geeks who really like RPN, but also us "commoners" who want nothing more than a good calculator for physics and calculus. I'm sure it was the RPN factor that kept many high school students away from the HP 48G, and I know a dual-mode machine like the HP 49G would have helped me on the AP Calculus exam. It's an improvement on its predecessors in every sense: looks, flexibility, power and ease of use. If one of those factors doesn't grab you, another will.

Katie Fitzpatrick is now a sophomore at Smith College. She has used technology in her math and science classes throughout high school.

Pretty and Pretty Good:

Quibbles but Kudos

By R. Carter Dunn

If first impressions are based on appearances, HP is ahead of the game with the HP 49G. With its silver-blue face and translucent green cover, it really stands out on the shelf.

Turning the calculator on, I got another pleasant surprise: the machine can switch between Algebraic and RPN modes. For those used to TI machines, or who are just now learning graphing calculators, the Algebraic option is a big plus.

Then there's the interactive Equation Writer to enter equations and expressions in "textbook" form. It takes some getting used to, but it's a fine example of the HP 49G's user-friendliness. And the machine can return answers in "pretty print" mode, too, rather than in the 48G's decimal approximations, which were often difficult to read.

I was slightly disappointed to find that the HP 49G's screen resolution had not improved from the HP 48G Series, however. Though it is clearer and more readable, a higher resolution would make a big difference. There would be more room for menu items, for "pretty print" answers, and for sharper, clearer graphs, especially when zooming.

For test-taking purposes, speed is still an issue, too. As it stands now, the HP 49G rotates 3D graphs quickly, but displaying edits, menus and screen switches take awhile, as do some integrals. Better keyboard ergonomics could help here, too: If a comma is needed in integrals, derivatives and algebraic functions, why require a shift key to access it?

Some of the HP 49G's best features, however, are for those like me who write programs. It will support a variety of programming languages, and the sound program, stack edit features, and other I/O functions also caught my eye.

Overall, the HP 49G is a good machine. You can use it from algebra all the way through calculus (and in accounting courses, too, with its financial functionality). While I wish for more, it's a vast improvement over the HP 48G Series.

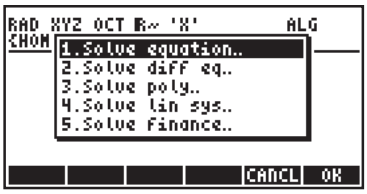
R. Carter Dunn is a senior at Greenwich High School in Connecticut. A technology enthusiast, he enjoys programming, web design and robotics. He also likes SCUBA diving, climbing and basketball. He plans to major in engineering in college.

Touring the New Machine

Numerical Solving on the HP 49G

By Kevin Fitzpatrick

To start getting acquainted with the HP 49G, look at some examples of the numerical solver tool. Press → NUM.SLV to see your choice of five types of solvers. Use the ▼ key to highlight a selection, press ENTER and you're ready to begin.

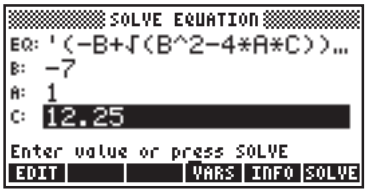


Solve equation..

Start with SOLVE EQUATION.. To enter any expression or equation, it's usually easiest to use the Equation Writer.* Just press EQW and type your equation (say, the one shown here). Notice how the ▶ key allows you to move between levels in the expression.

When you finish, be sure the whole thing is highlighted (use ▶ as necessary) and press ENTER. It will appear in proper form in the solver's EQ field.

Now the HP 49G will display a field for each of the variables in the equation. (If it's only an expression, it will be equated to zero automatically.) You'll need to provide all but one of the values, then highlight the unknown variable and press SOLVE. That's all there is to it. Note that the newly calculated value will also go onto the stack.

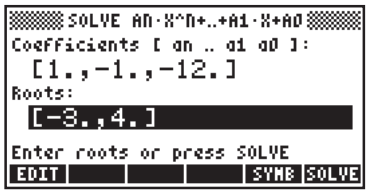


Solve poly..

To solve a polynomial, just select the SOLVE POLY.. tool (via → NUM.SLV). To enter a polynomial, you simply enter the coefficients, in descending order, as a vector, with each coefficient separated by a comma.

**Of course, you could instead type any equation directly into the EQ: field on the SOLVE EQUATION screen. If you do so, note that if the HP 49G is set to Algebraic mode, it understands implied multiplication between numbers and variable names; in RPN mode, you must insert the operation symbols.*

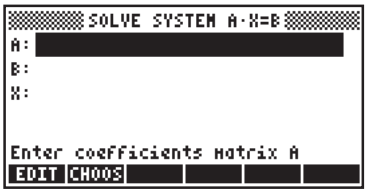
For example, to solve $x^2 - x - 12 = 0$, you would type [↶][()] 1 [→][,] [1][+/−] [→][,] [1][2][+/−] [ENTER]. The cursor will move to the ROOTS field. If you now press [SOLVE], the computed roots appear there. (If any roots are complex, they appear as ordered pairs.) Note that you can solve going the other way, too: key in the roots (in a vector, using commas to separate the values) and solve for the polynomial.



Note that if you press [SYMB], the results will return to the stack in factored form (roots) or traditional decreasing-order polynomial form (coefficients).

Solve lin sys..

It's also easy to solve an entire system of linear equations. Select the SOLVE LIN SYS.. tool via [→][NUM.SLV]. The screen will then show these three fields:



- A: A matrix with each row containing the coefficients of an equation in the system.
- B: A column matrix containing the constants of each equation in the system.
- X: A column matrix that will contain the calculated solutions to the system.

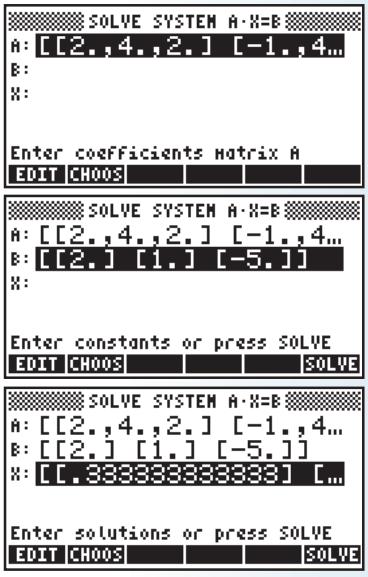
Suppose, for example, that you want to solve the system

$$\begin{aligned} 2a + 4b + 2c &= 2 \\ -a + 4b + 2c &= 1 \\ 3a - 2b + 2c &= -5 \end{aligned}$$

Select the A field and use [EDIT] to go to the Matrix Writer. Be sure the menu item [CHOOS] is showing (press [CHOOS] to toggle it, if necessary), then enter the values: [2][ENTER] [4][ENTER] [2][ENTER] [▼][◀][◀][◀] [1][+/−][ENTER] [4][ENTER] [2][ENTER] [3][ENTER] [2][+/−][ENTER] [2][ENTER] [ENTER].
The matrix appears in A.

Next, with the B field highlighted, press [EDIT]. Be sure the menu item [CHOOS] is showing (press [CHOOS] to toggle it, if necessary), then enter the values: [2][ENTER] [1][ENTER] [5][+/−][ENTER] [ENTER]. The matrix will appear in B.

Now simply press [SOLVE].... The solutions will appear in decimal form. (To view the full values, press [EDIT] and browse through the results matrix.)



Solve finance..

The SOLVE FINANCE.. selection on the [→][NUM.SLV] menu is just another way to get to the [↶][FINANCE] tool. This tool makes a good in-depth case study of the power of "What-if" offered by HP's solver—see the next two pages.

Not only has Kevin Fitzpatrick contributed his HP 49G product review this issue (see pages 2-3), he has also kindly supplied us with these previews (pages 6-11) of HP 49G workshop activities now being developed. HP will be sponsoring the HP 49G workshops throughout the '99-'00 school year. Kevin is a member of the workshop development team, along with Tom Dick, Mark Howell and Michael Grasse, who are all regular contributors to ***hp***^{c}.

It Even Makes Cents

Financial Calculations on the HP 49G

By Kevin Fitzpatrick

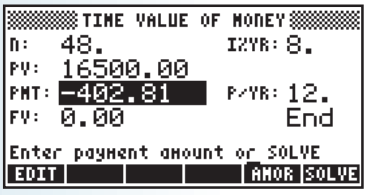
This activity introduces compound interest and the time value of money. It also gets students to make the leap from classroom math drills to real-life decision making. If any of them have ever complained to you about the relevance of numerical solving to the real world, here's a good answer.

Skills Used:

- *Compound growth formula*
- *Playing "What-If" with a numerical solver tool*

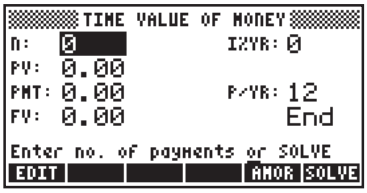
Skills Introduced:

- *The HP 49G's Finance application*
- *Familiarity with amortization*
- *The concept of the Time Value of Money*



You have your eye on a brand-new $18,000 car that a local car dealer has on the lot. Their ad makes this offer: With any new car purchased, they will either extend 100% financing (i.e. no down payment) at 2.9% for 4 years OR give you a $1500 cash rebate (that you can apply immediately to the purchase price), in which case you'd finance the rest, $16,500, at 8% with your parents. ***Which is a better deal?***

Luckily, your HP 49G has just the tool to help you find out: Press ↰FINANCE. to see the TIME VALUE OF MONEY screen. This is really just another numerical solve screen, with some special features.



- N: Number of payments to be made.
- I%YR: Interest rate (in mixed decimal form).
- PV: Present value (amount financed).
- PMT: Periodic payment amount.
- FV: Future value (amount left to be paid at the end of the loan's term).
- P/YR: The number of payments made per year.
- End or Begin The point in each payment period where the payment occurs.

As with the other numerical solvers, you move between fields via the arrow keys, typing values in fields and pressing ENTER. After you enter all known data (in any order), highlight the unknown field and press SOLVE. If you exit the screen accidentally, ↰FINANCE returns you; the values you've entered will be there.*

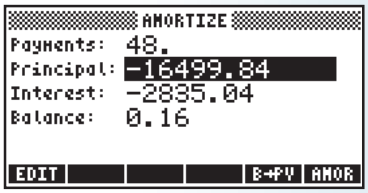
First, calculate the monthly payment and total cost of a loan from your parents: At the N field, press 48ENTER; at I%YR, 8ENTER; at PV, 16500ENTER. Skip PMT for now (it's the unknown)—press ▶. At P/YR press 12ENTER; at FV, 0ENTER (since you want nothing left to pay off at the end.) Most purchase loans put the payment at the end of the period (and most lease contracts specify the beginning), so be sure End appears on the screen. Now just go back to PMT and press SOLVE.... You'll get −402.81,** your per-month cost for the car.

To calculate the total cost of this scenario, press AMOR. The amortization feature calculates the amounts paid to principal and interest over any given number of payments. So at the PAYMENTS field, press 48ENTER. The cursor will move on

**For best results when using the Finance application, you'll want to set your display to 2 decimal places to reflect dollars and cents: Press MODE, then ▼ to NUMBER FORMAT and CHOOS and select FIXED OK. Then ▶ to the decimal places field, CHOOS and select 2 OK. Then OK once again to exit.*

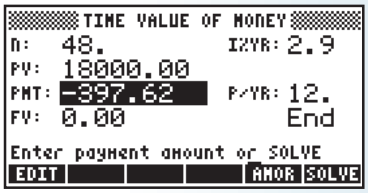
***Why the minus sign? It's to indicate which way cash is flowing. The monthly payment is going out of your pocket, so it's negative. (By entering a positive 16,500 into PV, you indicated you were **receiving** the loan, so the payment amount must be going the other way.) If your parents were to do this same calculation, they'd enter -16,500 into PV, since the loan is coming **from** them; their PMT result would then be a positive 402.81, since it's coming **to** them.*

to the PRINCIPAL field. Now just press AMOR to see that over the 48-month life of this loan, you will have paid $16,499.84 in principal and $2,835.04 in interest.*

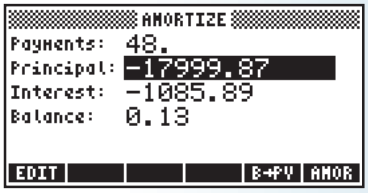


To quickly calculate that total, press CANCEL CANCEL to go to the stack screen. Notice how your results have been echoed here, for your convenience. Now you can just add the principal and interest (and the odd-cents $0.16 balance remaining from rounding error) to get the total loan cost: $19,335.04.**

OK, that's one option. What about the other? What if you skip the $1,500 rebate but get the loan at 2.9%? Press ↰ FINANCE to go to the TVM screen again, and change I%YR and PV; leave the others as they are: At I%YR, press 2 • 9 ENTER; at PV press 1 8 0 0 0 ENTER. Now go to PMT and SOLVE.... This way, your monthly payment will be $397.62—about $5.19 less than the first scenario.



Now use press AMOR and amortize all 48 months of this scenario to calculate the interest you'd pay (i.e. at PAYMENTS press 4 8 ENTER, then press AMOR).... Over the 48-month life of this loan, you will have paid $17,999.87 in principal and $1,085.89 in interest. And this totals $19,085.89, which you can verify by exiting and doing the arithmetic at the stack screen (and don't forget the odd-cents $0.13 remaining balance). It seems, then, that it's slightly cheaper to skip the rebate and go for the 2.9% dealer loan. You wouldn't see this unless you do the math!



Follow Ups

1. You'll have $249.15 more after 48 months with the dealer's 2.9% loan, assuming you simply pocket the $5.19 monthly savings as you receive it. But what if you invest it instead, in an account paying 5% annually (compounding monthly)? Then how much extra would you have after 48 months?

2. How much less are you borrowing with the dealer's loan than with your folks? That is, what loan amount at 8% would require the same payments as the 2.9% loan scenario? (This is not the same savings as the answer to **1**, because that's money at the end of the 48 months; this is money at the beginning. The value of money depends on *when* it flows—the Time Value of Money. $1.00 today is not the same as $1.00 tomorrow; interest accrues meanwhile.)

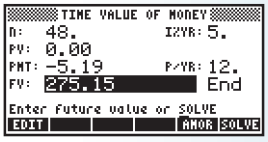
3. If you have $1,500 of your own to put down on the car anyway, but an investment CD would pay 6.5% annually (compounded monthly) on that amount, is the cheaper loan still a better choice than the rebate?

   What annual rate (compounded monthly) must your investment account earn in order for the 2.9% loan to remain the better deal? How would you find out?

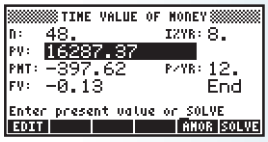
**Why isn't the principal paid exactly 16,500? Rounding: The payment amount necessary to pay off exactly $16,500 in 48 equal installments is $402.8132186.... But nobody writes a check for that amount. Since your real monthly payments are each a fraction of a penny smaller than mathematically required, you'll owe a few pennies at the end.*

***You could total the P & I simply by multiplying N x PMT (402.81 x 48), but this wouldn't tell you the rounding error.*

1.



2.



You're borrowing $212.63 less.

3. No. If you apply your $1,500 to your parents' loan, you save 8% interest, or $563.50 by the end of 48 months. A 6.5% CD earns $444.03. (Either beats $249.15.)

At the front end, you know the 2.9% loan equates to an 8% loan of $16,287.37. Now you're comparing to a $15,000 loan. The investment earnings must exceed 8%,—by enough to make up this starting difference of $1,287.37. (Ans.: 23.70%)

Proof Inputting

Coordinate Geometry on the HP 49G

By Kevin Fitzpatrick

With its ability to work with variables and its powerful Equation Writer, the HP 49G offers great ways to connect properties studied in Geometry with coordinate algebra. This activity demonstrates a coordinate proof, then suggests an extension.

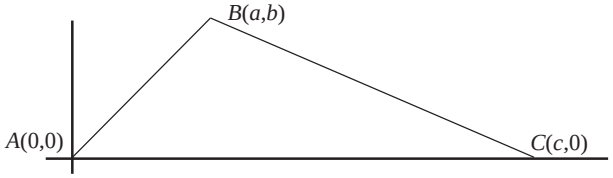
Skills Used:

- *Properties of segments connecting the midpoints of a triangle*
- *Slope of a line segment*
- *Distance formula*
- *Midpoint formula*

Skills Introduced:

- *Storing & manipulating variables on the HP49G*
- *Relating lengths and slopes of segments*

Problem: Show that in any triangle, the segment connecting the midpoints of any two sides is parallel to the third side and has a length 1/2 that of the third side.



Strategy: Using the triangle sketched here, show that the segment connecting the midpoints of AB and BC is parallel to AC and has a length equal to $(AC)/2$.

1. Store the coordinates of the labeled diagram into variables. For example, to store the two coordinates of $A(0,0)$ into variables XA and YA, respectively, type [0] [STO] [X] [ALPHA] [A] [ENTER] [0] [STO] [ALPHA] [ALPHA] [Y] [A] [ENTER].

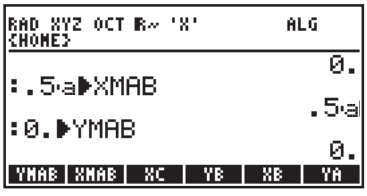
Similarly, to store the two coordinates of $B(a,b)$ into XB and YB, and those of $C(c,0)$ into XC and YC, respectively, type:
[↱] ['] [ALPHA] [←] [A] [▶] [STO] [X] [ALPHA] [B] [ENTER]
[↱] ['] [ALPHA] [←] [B] [▶] [STO] [ALPHA] [ALPHA] [Y] [B] [ENTER]
[↱] ['] [ALPHA] [←] [C] [▶] [STO] [X] [ALPHA] [C] [ENTER]
[0] [STO] [ALPHA] [ALPHA] [Y] [B] [ENTER]

2. Calculate the midpoint of side AB of the triangle. Press [EQW] to go into the Equation Writer, then [X] [ALPHA] [A] [+] [X] [ALPHA] [B].

Use [▶] to select (highlight) the entire expression. Next, press [÷] [2], re-highlight it all, and [↱] [EVAL] to simplify.

Then [ENTER] [STO] [ALPHA] [ALPHA] [X] [M] [A] [B] [ENTER] stores that result into the variable XMAB.

Now do likewise for YMAB:
[EQW] [ALPHA] [ALPHA] [Y] [A] [+] [Y] [B] [ALPHA] [▶] [÷] [2] [▶] [↱] [EVAL] [ENTER] [STO] [ALPHA] [ALPHA] [Y] [M] [A] [B] [ENTER]. The variables menu ([VAR]) should look something like this.



Frequently in proofs like this, poor labeling choices cause more errors than bad computation. Hence the careful naming of the variables here.

3. Similarly, calculate the midpoint of segment BC, storing the midpoint's x-coordinate in XMBC and its y-coordinate in YMBC.

4. With the necessary values all stored, you can now use them to complete the proof. To demonstrate that the segment connecting the midpoints is parallel to the base, calculate the slopes of those two segments, storing each in an appropriately named variable (SLMS and SLB).

For example, to do the base slope calculation, press EQW ALPHA ALPHA Y C − Y A ALPHA, then ▶ ▶ (to highlight the entire statement) and then ÷ ALPHA ALPHA X C − X A ALPHA ENTER ↱ EVAL ENTER STO ALPHA ALPHA S L B ENTER.

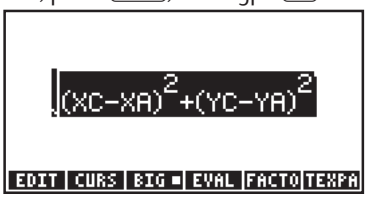
Calculate and store the slope SLMS similarly....
How do these two slopes compare?

With horizontal lines in this activity, slope values of zero should come as no surprise. Hopefully, students will jump on that point.

5. Now demonstrate the other part of the proof—the ratio of the length of the midpoints segment (call it LMSG) to the base length (call it LBASE).

For example, to calculate and store LBASE, press EQW, then type √x X ALPHA C − X ALPHA A ▶ ▶ y^x 2 ▶ + ALPHA Y ALPHA C − ALPHA Y ALPHA A ▶ ▶ y^x 2 ▶ ▶ ▶

Your screen should look like this.



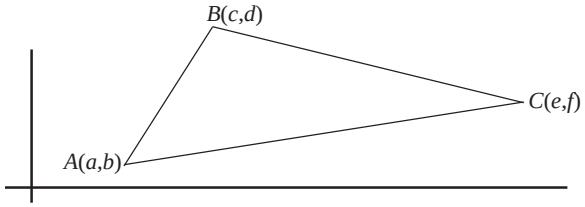
Then press ↱ EVAL ENTER STO ALPHA ALPHA L B A S E ENTER. Do likewise to calculate and store LMSG.

To find the ratio of the lengths, enter this expression in the Equation Writer and press ↱ EVAL. What do you get?

The distance formula is not strictly necessary to find the lengths here, since they're horizontal lines; simply subtracting the x-coordinates would suffice—worth pointing out if students don't see it. The calculation is more to set up the follow-up, where the distance formula is necessary.

Follow-Up

The above proof is made simpler by a convenient choice of a triangle whose base sits on the x-axis. But the proof should still hold for a triangle of any orientation:



How would you demonstrate the same proof using a triangle not based on any axis, such as the one shown here? What changes might you expect in your calculations? How might you have to adjust them to compare results?

In the follow-up, with some thought or prodding, a few students may see that the slopes are identical. And of course, setting up their ratio should produce a value of 1 (or −1, which can lead to a discussion of difference quotients and the importance of variable order).

No amount of inspection, however, will reveal the ratios of the distances (1/2 or 2/1); for that, the students will need an actual computation.

Shooting Globs Precisely

Linear Systems on the HP 48G Series

By R. Staff

Whether it's an arrow, an orbit or an interactive computer game, one common mathematical need these days is to find functions—parabolic, cubic or otherwise—that pass through specific points. In the real world (and many games), those points reside in 3-space, but for the purpose of graphic illustration on the HP 48G, here's how to fit curves to co-planar points. (This logic would apply to 3-D applications.)

Find the cubic polynomial that passes through the points (-3,12), (-1,4), (1,12), and (2,-8). That is, solve $ax^3 + bx^2 + cx + d = y$ for the coefficient values.*

To do so, you will need to solve this linear system:

$$\begin{aligned} -27a + 9b - 3c + d &= 12 \\ -a + b - c + d &= 4 \\ a + b + c + d &= 12 \\ 8a + 4b + 2c + d &= -8 \end{aligned}$$

Press [→] [SOLVE] and select `Solve lin sys...` ([▼][▼][▼] [OK]). Then go into the Matrix Writer ([→] [MATRIX]) and enter the coefficient matrix above as A, and the column of constants as B. For example, to enter the first row of A, you would press [2] [7] [+/–] [ENTER] [9] [ENTER] [3] [+/–] [ENTER] [1] [ENTER] [▼]. (Be sure the Matrix Writer is set to [EDIT].)

**Note that if for any reason you wish to construct such expressions easily on the HP 48G stack (not necessary in this activity), you can do so as follows. First, purge the variables A, B, C and D. Then store this modified version of the general form:*

'X^3*A+X^2*B+X*C+D=Y' [ENTER] 'P' [STO]

(This seemingly "backward" format allows the [EVAL] key to produce coefficients and variables in the correct order on the stack without needing to expand and collect terms.)

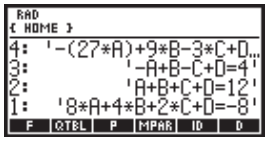
Now store the first set of values: [3] [+/–] 'X' [STO] and [1] [2] 'Y' [STO]. Then just press [VAR] [P] [EVAL].

For subsequent points, just store new coordinates and re-evaluate P:

[1] [+/–] [←] [X], [4] [←] [Y] *and* [P] [EVAL]

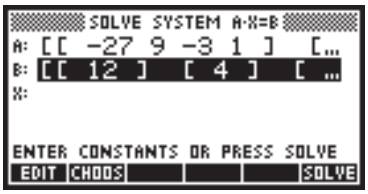
And so on.

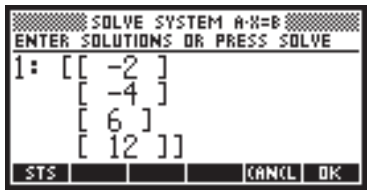
After four points, your stack would look like this:



Enter the next three rows of coefficients similarly, then press ENTER one last time to return to the SOLVE SYSTEM A·X=B screen. Now highlight the B field and enter the column of constants in the same manner you entered A.

When you finish, the SOLVE SYSTEM A·X=B screen should look like this:





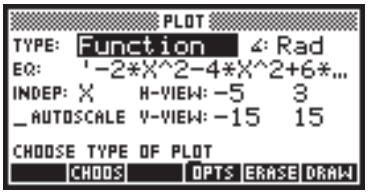
Highlight the X field and SOLVE the system. Then exit to the stack (press NXT CANCEL) to look at the solution.

Therefore, the solution cubic polynomial is $f(x) = -2x^3 - 4x^2 + 6x + 12$.

You can demonstrate this graphically (like a "Green Globs" game). Do this:

Press ↱PLOT. Then set TYPE to Function, highlight the EQ field and type '-2*X^3-4*X^2+6*X+12' OK.

Next, press ERASE and set the PLOT screen parameters as shown here. Then, to save all these in the PLOT screen settings before returning to the stack, press OPTS OK. Do not draw the plot yet!

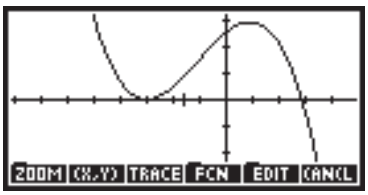


Instead, press CANCEL to return to the stack and enter the four known points onto the stack: ↰( ) 3 +/– SPC 1 2 ENTER ↰( ) 1 +/– SPC 4 ENTER, etc....

Now, to turn on the 4 display pixels (the target points) represented by these 4 coordinate pairs, press PRG PICT NXT PIXON PIXON PIXON PIXON ↰PICTURE.

Then press CANCEL and return to the Plot environment (↱PLOT). Make sure the PLOT screen is still as before, and press ORAW. (Do not press ERASE!)

You can watch as the resulting graph hits each lighted pixel (i.e. each "Green Glob")!



We don't know who created this lesson originally, but it has been presented in the HP summer workshop materials and seemed appropriate to include in this issue. We'd like to extend credit where credit is due, if someone would oblige us by identifying those responsible.

Roots and Algorithms

The Decimal and Newton Methods on the HP 48G Series

By Michael Grasse

How does a computer numerically find the roots of functions? Here's an inside look at how the machine does it—and how it's sometimes wrong.

Both of these methods are *algorithms*. An algorithm is a series of steps to perform a particular task—like following a recipe. Since computers do only what they are told to do, they need a well defined algorithm to accomplish anything.

These methods also use the limiting process. With well-behaved functions, each gives root approximations arbitrarily close to (within any of) the real roots , if you repeatedly apply the algorithm.

The Decimal Method

1. Let $f(x) = x^2 - 3$. Use the decimal method to approximate its positive root. First, evaluate the function for 5 different values of x, starting at $x = 0$ and incrementing by $\Delta x = 1$. (See the sidebar here for a quick way to do this.)

a. Between what two numbers must the root appear?

Now compute more function values, starting at the smaller of the two numbers in your answer to part **a**. This time, use $\Delta x = 0.1$ and find 10 values.

b. Between what two numbers must the root appear?

This is the essence of the decimal method. Each successive application of the algorithm provides one more decimal place of accuracy.

c. What is the root of $x^2 - 3$, approximated to four decimal places?

2. Let $f(x) = 3\cos(\cos(x)) - 2$. Use the decimal method to approximate (to four places) the root of $f(x)$ that lies between $x = 0$ and $x = 1$.

3. Can you find a positive root of $f(x) = \frac{1}{x-1}$, using the decimal method?

4. What sorts of functions will confuse the decimal method?

A Quick Table Program

```
« STO
  → n b d
  « b b n d * d - +
    FOR x
    x F
    "f(" x + ")" +
    →TAG
    d
    STEP
  »
»
```

Enter the above program onto the stack. Then enter the desired name (say, 'QTBL') and press STO.

Next, define your function, naming it F(X). For example:

'F(X)=X^2-3' ← DEF

To use the program, enter onto the stack three values (in this order):

the total number of x-values
x_0
Δx

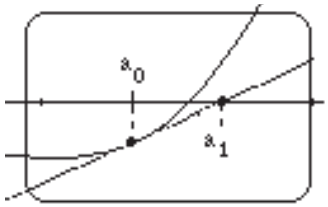
Then just execute QTBL.

For example, to compute 5 values, beginning at $x = 0$ and incrementing x by 1, you would just enter the values 5 0 1 and press QTBL.

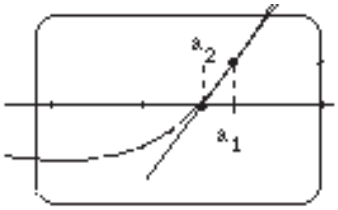
Newton's Method

Newton's method is a bit more sophisticated. When it converges to a value, it does so very quickly, but it can also fail miserably in a variety of ways. The method is an *iterative* process; the output of one step is used as the input of the next step. (Each step of the process is called an iteration.)

In Newton's method, you pick an initial x-value—also called the seed—and find the equation of the line tangent to the curve at that value. Then you calculate the x-intercept of that line. This x-value is the new seed, and you repeat the process.



This shows the function f with a line drawn tangent to it at the point $(a_0,f(a_0))$, where a_0 is the initial seed. The x-intercept of that line is at a_1.



This shows the function f with a line drawn tangent to it at the point $(a_1,f(a_1))$. The x-intercept is a_2.

To formulate an algorithm for Newton's method, you need a generalized description of the requisite tangent line—expressed in terms of your chosen x-value, a. Recall that the Taylor form of a line is given by $y = y_0 + m(x - x_0)$. You can use this to describe the line tangent to the graph of $f(x)$ at the point $(a,f(a))$—a function of a that contains an implicit x in its definition: $L(a) = f(a) + f'(a)(x - a)$. L is a function that takes an input a and outputs a function of x (the tangent line).

You also need an expression for the x-intercept of $L(a)$. Call this function $R(a)$:

$$L(a) = f(a) + f'(a)(x - a)$$

$$0 = f(a) + f'(a)(x - a)$$

$$x = a - \frac{f(a)}{f'(a)}$$

$$R(a) = a - \frac{f(a)}{f'(a)}$$

To ease the iteration process, define these functions in the HP 48G. Press [→][HOME], then [→][MEMORY], NEXT, [▼]. Now name the variable NEWT, press [ON], [CHS] the DIRECTORY box, and press [ON] [CANCEL] [VAR]. In the {HOME} directory you'll see a new "folder," NEWT. Press it to move to that new directory.

Now create three user-defined functions—for f, L and R. For example, to define $f(x) = x^3 - x - 1$, type 'F(X)=X^3-X-1' [←][DEF]. Define L and R likewise, as they appear above. Note that to denote the derivative, you type ∂A(F(A)).

(continued on page 16)

(continued from page 15)

All that may have seemed like a lot of work, but you now have a versatile tool for doing Newton's method iterations for any function you choose, simply by redefining $f(x)$. To see how it works (and verify that you entered everything correctly), try this example problem.

5. First be sure to purge the variable ▓▓ (press ' α X ⬅ PURG)—both in the NEWT directory and in the HOME directory.

Find the first two iterations of Newton's method applied to $f(x) = x^3 - x - 1$, with an initial guess of $a_0 = 1$. Put a 1 onto the stack and press ▓▓ to find $R(1)$. You may need to press EVAL to evaluate the function and derivative. You should eventually get 1.5. Thus, $a_1 = 1.5$. Now just press ▓▓ again to get $R(1.5)$. After an EVAL, this should be $a_2 = 1.34782608696$.

You can get a picture of what is happening at each iteration by computing the function $L(a)$ and combining that into a list with $f(x)$. For instance, put a 1 onto the stack and press ▓▓. Press EVAL and you should see something like '-1+2*(X-1)', which is just $L(1)$. Now put 'F(X)' on the stack, press ▲▲, then ▓▓ and ENTER. This will create the desired list at stack level 1. Store this list into EQ and plot.

6. Do three iterations of Newton's method to find a root of $\tan x = 0$. Use $a_0 = 3$. Draw a sketch of the first iteration.

7. Newton's method may fail with particular functions and choices of a_0. For example, use Newton's method to investigate a root of $f(x) = x^4 - 10x^2 - 8$.

a. Use $a_0 = 2$ and do four iterations. Look at the picture generated at each iteration and try to explain the behavior of this process.

b. Repeat the problem with $a_0 = 3$. Does this converge to a root?

8. Investigate the root of $f(x) = x^{1/3}$, with $a_0 = 1$. Can you explain the behavior of this process?

9. Find a function for which Newton's method could approximate $\sqrt[3]{2}$.

10. Find a function for which Newton's method could approximate e.

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.

Answers

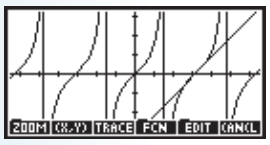
1. **a.** Between $x = 1$ and $x = 2$.
b. Between $x = 1.7$ and $x = 1.8$.
c. 1.7320

2. 0.5715

3. No.

4. Functions with no roots and discontinuous functions.

6.



7. **a.** At $a_0 = 2$, the x-intercept of the tangent line is $a_1 = -2$. At $a_1 = -2$, the x-intercept of the tangent line is $a_2 = 2$. So you oscillate back and forth, getting nowhere.
b. Yes.

8. The iterating function is $R(a) = -2a$ when simplified. So for any seed except $x = 0$, Newton's method takes you ever farther from the true root.

9. $f(x) = x^3 - 2$

10. $f(x) = \ln x - 1$

Partial Sums in Full View

Plotting Sequences on the HP 48G Series

By R. Staff

Did you know that it's easy to plot a sequence with the HP 48G's function plotter?

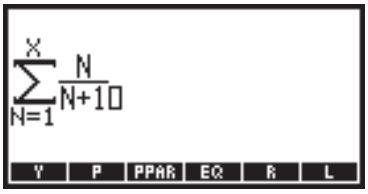
Take a simple example: $\frac{n}{n+1}$, where $n = 1, 2, 3, \ldots, 50$

1. Set the PLOT and PLOT OPTIONS screens as shown here:

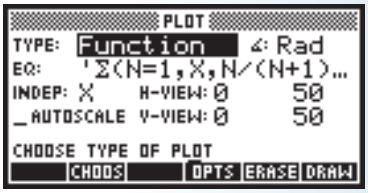
2. Press OK, then ERASE DRAW to see the 50 points plotted.

To create the partial sum of a series, it's convenient to use the Equation Writer.

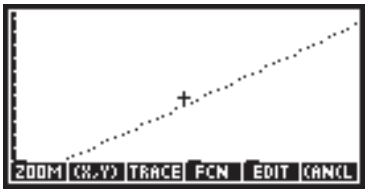
1. Press CANCEL CANCEL to go to the stack. Press ↩ EQUATION and type ↱ Σ α N ▶ 1 ▶ α X ▶ α N ÷ α N + 1. ENTER sends this to the stack. Then save it: 'S' STO.



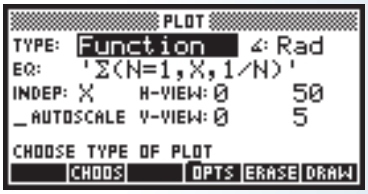
2. At the PLOT screen (↱ PLOT), CHOOS S for the EQ field; set V-VIEW as shown:



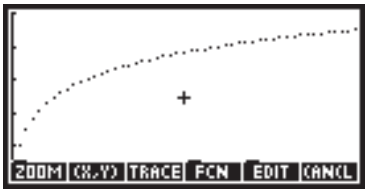
3. Press ERASE DRAW.



4. Press CANCEL and EDIT the EQ field and the V-VIEW as shown:



5. Press ERASE and DRAW. This harmonic series does diverge—but very slowly. Do the plotted points remind you of any special curve?



We don't know who created this lesson originally, but it has been presented in the HP summer workshop materials and seemed appropriate to include in this issue. We'd like to extend credit where credit is due, if someone would oblige us by identifying those responsible.

About the HP 48G

Frequently Asked Questions

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 is the meaning of the annunciator?

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

Is the calculator malfunctioning or am I doing something wrong?

See page A-9 of your User's Guide, "Testing Calculator Operation."

How much free memory does my calculator currently have?

To find out, press ← MEMORY MEM.

How do I change the display format or decimal places?

Use → MODES or ← MODES FMT. See page 4-2 of your User's Guide.

What's an E doing in my number?

This is scientific notation. For example, 6.02E23 = 6.02×10^{23}.

How do I get a new battery door, port cover, or rubber foot?

Call Calculating Edge at 888-338-2252.

What kind of replacement batteries should I get for my machine?

Use three size AAA, all of the same brand. 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 make it easier to read?

While holding the ON key down, press + or − repeatedly.

Why is my calculator "locking" up or behaving strangely?

See "Special Memory Operations" on page 5-16 of the User's Guide.

Why can't I find my variable(s)?

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 ←RAD or the →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 RADians mode. Set RADians mode (via ←RAD), then use either ←→NUM or EVAL. EVAL will return the trig identity, 0, if Flag -2 (Symbolic Constants) is also clear. Otherwise, EVAL behaves like ←→NUM, which never returns 0, because it does its calculation on the 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 √x ←x² on the HP 48 doesn't return 2.

Why do I get 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 does the calculator give me complex numbers when I evaluate expressions such as '(-1)^(2/3)'?

The machine gives a complex principal solution for expressions with fractional exponents. To get a real-valued result to the expression, you need to use 'XROOT(3,(-1)^2)' (or the keyboard equivalent to it: 1 +/− ←x² 3 →$\sqrt[x]{y}$).

Why am I getting error messages such as Too Few Arguments or Bad Argument Type?

The command you are attempting 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 ▮▮▮▮ (PRG NXT ▮▮▮▮ ▮▮▮▮).

Why does my machine seem to gradually slow down?

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 ▮▮▮▮ NXT ▮▮▮▮, then select your units.

A Mathitis Epidemic in Class

Modeling a Communicable Disease on the HP 38G

By Claudia R. Carter and Suzanne Westegaard

How fast and far does a communicable disease spread? You can use the HP 38G to study this. Suppose someone in class comes down with the dreaded Mathitis virus. The HP 38G can simulate how this spreads to other class members.

Before you look at two different simulations, describe in words what you think will happen. What sort of infection rate and pattern might the disease show? Can you describe it graphically? Sketch a graph here of what you believe the function of number of people vs. time (number of turn) might look like.

A. Random Infection (Case By Case)

This simulation involves everyone in class. Each of you will be assigned a unique number. Remember your assigned number and pay close attention! (When the HP 38G program* chooses your number, it means you've been "infected.")

Turn	Total Infected
0	1
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

1. How many turns will it take before everyone in class has come down with Mathitis? Try to predict this.

2. Now fill in a chart like the one shown here, to track the "epidemic" as the program simulates the spreading of the Mathitis.

_____

**This case-by-case simulation uses a simple program to generate random numbers to indicate the persons "infected." First the program will prompt you for the class size and number of persons to be "infected" per unit time. Then you just repeatedly press ENTER to see the identities of the students who come down with mathitis.*

Press ▶ PROGRAM NEW, type SIM1 and press OK. Then type the following program. (You can run all the commands together; the line breaks shown here are simply to clarify how the program works.)

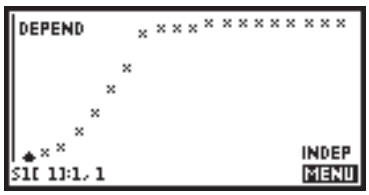
```
ERASE:
INPUT C;"CLASS";"SIZE";;C:
INPUT D;"INFECTED";"NUMBER";;D:
ERASE:
FOR A=1 TO D STEP 1;DISP 2;INT(RANDOM(C)+1):
FREEZE:
END:
WAIT 2:
```

Now just press ▶ PROGRAM and RUN. Run it repeatedly until everyone is "infected."

B. A Graphical Summary of the "Epidemic"

The second program* produces a summary of what the class experienced over the whole simulated "epidemic"—for a given number in the population and a choice in number of trials.

After the program runs, it will plot a summary similar to this:



3. What advantage(s) do(es) the second program have over the first?

4. How did your prediction compare with the actual results for the number of turns it would take for Mathitis to spread to the entire class?

5. List at least three other "real-world" situations that you would expect to have the behavioral pattern similar to the function of a spreading disease. Why do you expect those behaviors to be similar?

**The second program (call it SIM2) is as follows:*

```
INPUT A;"POPULATION";"SIZE";;A:
INPUT B;"NUMBER OF";"TRIALS";;B:
ERASE:
MAKELIST(X,X,1,20,1)▶C2:
MAKELIST(0,X,1,20,1)▶C3:
B▶C3(1):
FOR I=1 TO B STEP 1;DISP 3;I:
WAIT 1:
MAKELIST(0,X,1,A,1)▶C1:
1▶C1(1):
1▶H:
FOR T=2 TO 20 STEP 1;FOR C=1 TO H STEP 1;1▶C1(INT(A*RANDOM+1)):
END:
ΣLIST(C1)▶H:
C3(T)+H▶C3(T):
END:
END:
C3/B▶C3:
PLOT:
```

Just key this in and run it. After awhile, the program screen will reappear. At that point, start the Statistics *ApLet, then press* SYMB *and put a check* (CHK) *at* S1: C2 C3. *(You can disregard* Fit1.*)*

Then, from the VIEWS *menu, select* Auto Scale *and press* OK.

Claudia Carter has been teaching for 27 years and is a Presidential Awardee, Tandy Scholar, Christa McAuliffe Fellow, National Board Certified Teacher, President of National Mu Alpha Theta, and Chair of the Mathematics Education Trust Committee. Now teaching at Mississippi School for Mathematics and Science in Columbus, MS, she has been using graphing calculators since 1989, when she attended the Woodrow Wilson fellowship Institute in Algebra (which is where she first met Suzanne Westegaard). She enjoys tennis, walking and listening to 50's music.

Suzanne Westegaard also contributed to this article. We have no current biographical information on her—but we thank her all the same!

About the HP 38G

Frequently Asked Questions

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/graphic/aplets/aplet_guide.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 (using EXIT with F1(X) highlighted to see the fit), 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 ON and press PLOT. Align the printer's input port with the triangle atop the HP 38G—within 18". Press HOME and then type PRVAR G0 ENTER.

How do I get ApLets from the HP ApLets Library?

Go to **http://www.hp.com/calculators/software/38g/hp38g_aplets_lib.html** on the Internet, then select the link called HP 38G ApLets Library, 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:

Argentina	54 (11) 4787.7100	00.800.888.1030 *(sin costo)*
Brasil	55 (11) 822.5565	0800.157751 *(sin costo)*
Canada	1.970.392.1001	
Chile	(56) 2.800.360.999	
Colombia	(57) 1.629.5030	
Mexico	(52) 5258.4044	01.800.90.072.00 *(sin costo)*
Peru	(51) 1.222.6600	
Puerto Rico	(78) 7.289.8900	
U.S.	1.970.392.1001	
Venezuela	(58) 2.800.47888	
Latin America	1.305.267.4200	
(for countries not listed above)		

Internet:

www.hp.com/calculators *(North America)*
www.hp.com/latinamerica *(Latin America)*

When?

Phone:

U.S./Canada: 8 am - 5 pm Pacific Time
Latin America: *(hours vary by country)*

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, U.S./Canada)
Fax: 503.370.7961
E-mail: hp@bbs.mlc.pdx.edu

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**—see the contact information on the next page), you have a wide variety of ways to learn about and get HP products into your classroom.*

Evaluating an HP Calculator

To evaluate any particular HP calculator model for use in your classroom, just contact **MLC** and they'll send you a simple request form. The form asks which classes (subjects and levels) you now teach, and which calculator(s), if any, you now use. Then you just indicate which model HP calculator you'd like to try, and for which classes. (Limit: One model at a time per educator.)

HP wants your comments and feedback, too. There's space on that same form to tell them what they could do better to support your teaching and what would encourage you to consider using an HP model in your classroom.

A simple call to **MLC** will get you started.

HP Calculator Loaner Sets For Your Whole Class

Suppose you've already made your evaluation—and you liked what you saw—but now you want to see how all your students will fare with that model. HP offers complete classroom sets of calculators for two of its most popular models.

HP 38G Classroom Set	HP 48G+ Classroom Set
30 HP 38G Calculators	29 HP 48G+ Calculators 1 HP 48GX Calculator
1 Overhead Display Panel (with connector cable)	1 Overhead Display Panel (with connector cable)
1 HP 38G manual set	1 HP 48G Series manual set
1 shipping case	1 shipping case

The sets are available for loan for two to four weeks. (Longer periods may be granted on a case-by-case basis, depending on availability.) Again, contact **MLC** for full details.

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 and examples for the HP 6S and HP 6S Solar, 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**.

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.)

The Math Learning Center (MLC)
Hewlett-Packard Educator Program, P.O. Box 3226, Salem, OR 97302-0226
Tel: 800.750.8130 (8-5 PT, M-F, U.S./Canada)
Fax: 503.370.7961, E-mail: hp@bbs.mlc.pdx.edu

More Resources:
A New Data Collector

Heating, cooling, time, motion, friction, magnetic fields, light, sound, pH, humidity...

The everyday physical world is filled with learning opportunities in applied math, science and engineering. The Portable DataLab (Firmware Systems, Inc.) is a new device that seizes these opportunities, taking full advantage of the computational power of the HP 49G, HP 48G Series, and HP 38G calculators and most common personal computers.

Now students can collect and analyze data in the classroom, the field, and many other research environments, with calculator transfer rates of up to 9.6K baud. For computer-based data logging applications, the DataLab's hardware design and software also work with the PC and Macintosh platforms, at communication speeds up to 56K baud.

The DataLab Companion software makes everything simple. It optimizes each calculator's commonly used keys, analysis functions and memory, and shows real-time displays and graphs. It lets you store and retrieve experimental setups and easily specify ports and calibrate probes.

With a capacity of 32,000 data points, high-resolution triggering, and CMOS-compatible digital ports, the DataLab opens up your options for accurate, flexible, multi-channel control and testing—all in a simple and low-cost handheld package.

Portable DataLab Specifications

- External ports: 3 analog, 1 digital input, 1 digital output (digital I/O has 4 lines + clock), 1 ultrasonic motion detector
- COM port with standard 9-pin serial connector and transfer speeds up to 56K baud
- CMOS-compatible digital I/O ports • 12-bit A/D converter • Analog channels can be triggered at any level
- Collection rates up to 20,000 data points per second • Simultaneous sampling on all channels
- Compatible with many commonly available probes • Probe auto-identification capability
- External temperature probe included • Built-in microphone and light sensor
- Powered internally by 4 AA batteries • External power via AC adapter or 12-volt DC
- Operating environment: 0° – 45° C; maximum humidity 90% at 40° C
- Durable plastic case: 21.0 x 9.0 x 3.5 cm • Weight (w/batteries): 326 g
- Software included for HP 38G, HP 48G Series, HP 49G, PC and Macintosh
- Classroom activity source book included for math, physics and chemistry
- One-year limited warranty

More Resources: Books and Software

The books listed here address the use of HP Graphic calculators. (HP does not represent or endorse them.)

For these and other books, see your local bookseller or visit amazon.com online (and search with the keywords "HP 48G" or "HP 38G").

Public-domain software is also available via links from HP's web site at www.hp.com/calculators.

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

Differential Equations using the HP 48G/GX
T.G. Proctor; Charles River Media, Inc.; 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

More Resources: Purchase Incentives

What Can You Get?

When you and your students buy Hewlett-Packard calculators, you're on your way to earning free calculators and accessories through HP's Calculator Redemption Program, open to all educators throughout the U.S and Canada. This updated* program is based on a simple point system. When your school or students buy any HP calculator or calculator accessory, you'll earn points that you can redeem toward free calculator products and accessories.

For 25 Points	For 50 Points	For 75 Points	For 100 Points	For 125 Points
HP 6S *or* **HP 6S Solar**	**HP 10B** *or* **HP 20S** *or* **HP F1897A**** **(PC Connect. Pack)** *or* **HP F1898A**** **(Mac Connect. Pack)**	**HP 12C** *or* **HP 32SII** *or* **HP 38G**	**HP 17BII** *or* **HP 48G** *or* **HP 48G+** *or* **HP 82240B**** **(Infrared Printer)**	**HP 19BII** *or* **HP 48GX** *or* **HP 49G** *or* **HP F1212A**** **(Overhead Display)** *or* **Portable DataLab**** **(by Firmware Systems)**

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 choose multiple or combination redemptions from the lesser columns. (Note, however, that odd point overages are not retained: If you redeem 104 points, the extra 4 points are forfeited.)

How Do You Earn Points?

You earn points through purchases of HP calculators or accessories,** as follows:

Calculator or Accessory Purchased	Points Earned/Unit
HP 6S *or* **HP 6S Solar**	**1**
HP 10B, **HP 20S**, **PC Connect. Pack** *or* **Mac Connect. Pack**	**2**
HP 12C, **HP 32SII** *or* **HP 38G**	**3**
HP 17BII, **HP 48G**, **HP 48G+** *or* **HP 82240B Infrared Printer**	**4**
HP 19BII, **HP 48GX**, **HP 49G** *or* **HP F1212A Overhead Displ.**	**5**

**The program now rewards your purchases of HP non-graphing and financial calculators and accessories. You can redeem under the earlier program until 12/31/99, but consider this new system first—it may be better for you.*

***The HP F1897A PC Connectivity Pack and HP F1898A Macintosh Connectivity Pack can be used with the HP 38G, HP 48G Series and HP 49G. HP F1897A works with Windows versions 95, 98, 2000 and NT. HP F1898A is System 8-compatible and requires a serial port. The HP Infrared Printer works with the HP 17BII, HP 19BII, HP 38G and HP 48G Series. The HP Overhead Display Unit can be used with the HP 38G, HP 48GX , HP 48SX (now discontinued) and the HP 49G. The Firmware Portable DataLab can be used with the HP 38G, HP 48G Series and the HP 49G.*

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 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 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 (8-5 PT, M-F, U.S./Canada)
E-mail: hp@bbs.mlc.pdx.edu

In Detail: The HP 49G Graphic Calculator

The State of the Art

Count on HP to keep leading the way to new levels of easy-to-use-power in graphing calculators. From step-by-step solutions to textbook style equations, this is a learning and computing tool like no other. From its speed to its memory, and flexibility (even good looks!), it's a lot of calculator—a lot to like. It is truly the best of the best, with a level of capability and convenience that puts it in a class by itself—your class!

Technology For the New Millennium

The HP 49G offers something for everyone. It has the teaching tools for college-level math, science and engineering—even advanced high school math and physics—but it comes packed with plenty of advanced functions and sophistication for professionals, as well.

A large 1.5 MB of Memory (512KB RAM and 1 MB Flash ROM for data storage) takes full advantage of the largest, most comprehensive library of third party calculator software: programs, games and software applications. And 2MB of Flash ROM allows for future electronic software upgrades—no need to buy a new calculator to get a software upgrade or enhancement!

Futuristic Design, Too

If you get an HP 49G, you'll be using it—a lot. So why should you have to look at something dull and dreary? (Who says calculators have to look dull and dreary, anyway? Mathematics is serious, but it needn't be boring.) Smooth edges, soft curves and a sleek, sturdy design make the HP 49G ideal for either hand-held or desk-top use. It's cast in an appealing light metallic blue, with a matching translucent blue slide-on cover to protect the screen and keyboard.

But the glamour doesn't substitute for simple usability. The heart of a great design is still great functionality. So if you're weary of intimidating, confusing keyboard clutter, look at the HP 49G. Its user-friendly layout has large keys with soft edges and generous spacing to help minimize "fumble-finger" accidents. And the alpha letters appear on the key faces themselves, rather than above the keys, further helping to reduce keyboard clutter.

Let the HP 49G Help the Learning Process!

In homework or exams, the answer is only part of the solution, and now there's a calculator that can show you how it got there, too! (And the HP 49G's history display retains every result, so you can see and correct where you erred—or combine previous results to get fast new related solutions.) Use the CAS step-by-step mode for dynamic differentiation, integration and linear systems solving—true tutorial smarts. The HP 49G even prompts you for complex mode if it encounters complex equations or expressions.

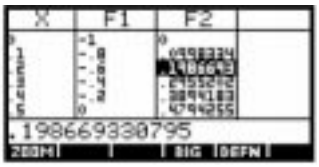
You see everything better and bigger too. Not only can you input and view expressions on the big 131 x 64-pixel display in "textbook" mode (i.e. as in a book or on the chalkboard), but you get all output steps and results that way, too, for easy viewing and understanding—in your choice of four font sizes and styles.

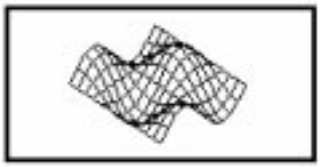
Got an example or solution you want to share with others? No problem: You can easily exchange programs, data and games with other HP 49G's and HP 48G Series models, via a unit-to-unit link serial cable. (But there's no infrared—which prevents "untimely communication" between students during exams!)

Power to the Pupil

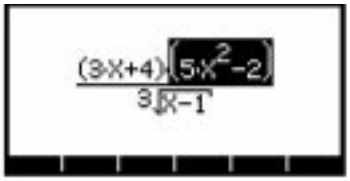
Behind the clear, clean displays and user-friendly features of the HP 49G lies a stunningly powerful math engine that can instantly cut your work. The HP 49G offers over 1000 functions and commands, all grouped in various menus, but the built-in catalogue serves them up to you, all under one convenient key.

Then there are the "power tools"—for graphing and solving and statistics.





After analyzing sample data, you can make and measure inferences about the population, with hypothesis tests and confidence intervals. You can input, view and edit sample data in a table format—like a computer spreadsheet or table—then plot the results. With some fifteen built-in plot types to choose from (and with zoom and trace options), visualization plays a leading role in the HP 49G's power to enhance your understanding of mathematical concepts.



Used to cut-and-paste on a computer? Enjoy it on the HP 49G, too, editing expressions, text, graphs and programs quickly and easily! And it's more than just a passive editor. You can isolate and evaluate sub-expressions too. The intelligent editor even inserts missing parentheses and prompts your inputs as you go!

(Please see page 38 for Bid Specifications for HP 49G Graphic Calculator.)

In Detail: The HP 48G Series Graphic Calculator

The Platform of Choice

The HP 48G Series of graphic calculators represent the widest assortment of top-level machines—an impressive array of power, convenience, memory and functionality. Whether you want sophisticated graphics, input forms, dialog boxes, enhancements to plotting, 3-D graphics, or built-in equations—it's all here.

Take a good look. The HP 48G Series of calculators offers you and your students a full spectrum of choices in power, ease of use and expandability.

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 can have at their fingertips!

The HP 48GX Graphic Expandable is, quite simply, the finest calculator for your education and 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.

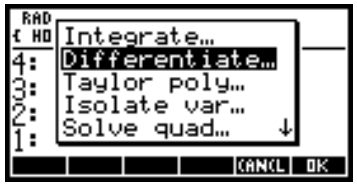
Power and Smarts

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 customized menus and key assignments to make their use even faster.

Built to Make Sense

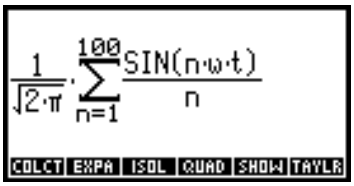


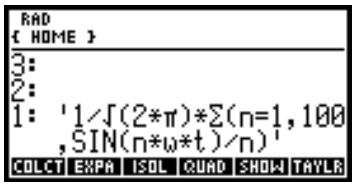
But is all this power only for the technically gifted? Not at all! The HP 48G Series is easy to use, even for beginners.

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.

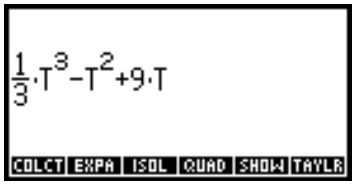
From unit management to matrices, the HP 48G Series is first-class in friendliness, too. For example, with the Equation Writer tool, you can key in an expression like this... ...instead of this....





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

then evaluate them symbolically....



Calculators that 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 Pack 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 39 for Bid Specifications for HP 48G Series Graphic Calculators.)

In Detail: The HP 38G Graphic Calculator

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 ever 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 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. Just move up the list and copy the information you want—it's 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 so natural to use that students will even begin to create their own to share with you and others.

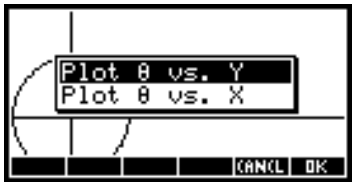
It's easy to create ApLets! Once you set up a problem for use in the classroom, just save it. All of the configuration information is saved—along with any notes and sketches you've created—together in a package easily transferred to your students via wireless infrared. (You just point two calculators 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) is stored in the ApLet Library.

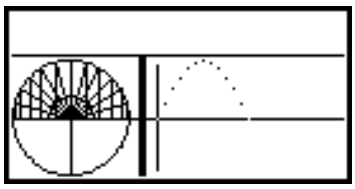
It can begin with a note....

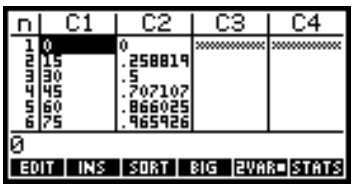
Students can then see a sketch of the problem...

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 altered until saved.

ApLets are created by teachers, publishers, and HP and are available on bulletin boards and on the Internet. (See page 22 for more information.)

Please turn to page 39 for Bid Specifications for the HP 38G Graphic Calculator.

HP Graphic Calculators Side by Side

	Features	HP 49G
Configuration	Scientific programmable graphing calculator	Yes
	User Memory	1.5 MB
	Flash ROM for future electronic software upgrades	Yes
Physical Features	Color	Light metallic blue
	Carry case	Slide-on translucent blue
	High contrast display	Yes, with enhancements
	Dimensions (L × W × D)	7.4 × 3.5 × 1.1 in (18.7 × 8.9 × 2.8cm)
	Weight (with batteries)	9 oz (264 g)
	Display size (W × H)	131 × 64 pixels LCD
	Number of keys	51
	Infrared port for printing/unit-to-unit communication	No
	Expansion ports for memory and software cards	No
	Serial (RS232) port	Yes, 10-pin
Operating Features	User interface speed	Yes, with enhancements
	Operating modes	RPN/Algebraic (+ Textbook formatting)
	Default screen display modes	Textbook/Algegraic
	Default screen stack/history display	Results/objects
	Built-in fonts	4
	Downloadable fonts	Yes
	Font sizes	4
	Cut/paste/copy operations	Yes
	Manipulating and solving sub-expressions	Yes, with enhancements
	Catalogue of functions	Yes
	Object storage (variables and directories)	Yes
	Date and time (including alarm set)	Yes
Math Features	Built-in, dynamic computer algebra system	Yes
	Mathematical constants library	Yes
	Factorization and expansion	Yes
	Substitution	Yes, with enhancements
	Symbolic and numeric differentiation and integration	Yes, with enhancements
	Differential equations	Yes, with enhancements
	Solving systems of linear equations	Yes, with enhancements
	Linear algebra and matrices	Yes, with enhancements
	Symbolic and numeric solve	Yes, with enhancements
	Step-by-step numeric and symbolic solve	Yes, with enhancements
	Complex arithmetic	Yes, with enhancements
	Exponential and logarithmic functions	Yes
	Taylor polynomials	Yes
	Lists and sequences	Yes
	Trigonometry	Yes
	Vector operations	Yes
Scientific Features	Built-in equation library	No
	Physical constants library	Yes
	Units-of-measure library	Yes
	Unit conversions	Yes
Statistical Features	Inferential	Yes
	Descriptive	Yes
Financial Features	Time-value-of-money	Yes
	Amortization	Yes
Customizing Features	Additional memory card options	No
	Supports third party RPL programs, games	Yes
	Programming languages	RPL/Assembly/HP Basic
Graphing Features	Tables	Yes
	15 plot types	Yes
	2D/3D plotting	Yes
	Function analysis	Yes
	Tracing and zooming	Yes
Accessories	Overhead Display Unit (F1212A)	Yes
	Portable DataLab (Firmware Systems, Inc.)	Yes
	PC/Mac Connectivity Packs (F1897A/F1898A)	Yes

HP 48GX	HP 48G+	HP 38G
Yes	Yes	Yes
128 KB	128 KB	32 KB
No	No	No
Gray	Gray	Green-gray
Soft, dark grey pouch	Soft, dark grey pouch	Slide-over (attached) green-gray
Enhancements	Enhancements	Enhancements
7.1 × 3.2 × 1.15in (18.0 × 8.1 × 2.9cm)	7.1 × 3.2 × 1.15 in (18.0 × 8.1 × 2.9cm)	7.1 × 3.4 × 1.0 in (18.0 × 8.6 × 2.5cm)
9 oz (264 g)	9 oz (264 g)	10 oz (283 g)
131 × 64 pixels LCD	131 × 64 pixels LCD	131 x 64 pixels LCD
49	49	47
Yes	Yes	Yes
Yes	No	No
Yes, 4-pin	Yes, 4-pin	Yes, 10-pin
No	No	No
RPN/Textbook	RPN/Textbook	Algebraic
Algegraic only	Algebraic only	Algebraic
Results only	Results only	Results/objects
3	3	3
No	No	No
3	3	32 KB
No	No	No
Yes	Yes	No
No	No	Yes
Yes	Yes	Variables and ApLets
Yes	Yes	No
No	No	No
Yes	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes
Yes	Yes	Numeric only
Yes	Yes	No
Yes	Yes	Yes, via matrix operations
Yes	Yes	Yes
Yes	Yes	Numeric solve
Yes	Yes	No
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	No
Yes	Yes	No
Yes	Yes	No
Yes	Yes	Yes
No	No	No
Yes	Yes	Yes
Yes	Yes	No
Yes	Yes	No
128KB, 1MB	No	No
Yes	Yes	No
RPL	RPL	HP Basic
No	No	Yes
Yes	Yes	6 ApLets, each with 3-7 viewing options
Yes	Yes	2D only
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes
Yes	Yes	Yes

Bid Specifications: HP Graphic Calculators

HP 49G

- 1.5 MB RAM built in, with Flash ROM for electronic upgrades
- 131 x 64-dot display
- 12-digit numeric values with 3-digit exponents
- Dual operating modes: RPN or Algebraic, with results and history stacks
- Computer Algebra System allows enhanced and dynamic manipulation and solving
- 4 font sizes built in, with capability to download other fonts
- Hierarchical storage structure for variables and subdirectories
- Customized menus
- Multiple plots on single graph; number of plots limited only by available memory
- Quadratic and polynomial root finders

- Factorization, expansions and substitutions of expressions
- Select, Cut, Paste and Copy operations
- Step-by-step numeric and symbolic solutions
- "Textbook" format for equations and expressions in the Equation Writer and stack
- Symbolic and numeric integration and differentiation
- Differential equation solver
- Real, complex and symbolic matrices, with solutions of linear systems and matrix manipulation operations; sizes and numbers of matrices limited only by available memory
- Object-based user programming language; program sizes and numbers limited only by available memory
- Program structures include FOR, DO, IF, CASE, UNTIL, and WHILE
- 2D and 3D plotting—15 types, including function, conic, polar, parametric, truth, differential equation, bar, histogram and scatter plot
- Graphic controls include zoom, box Z, tracing, shading, spacing, axis tick marks, and scrolling
- Matrix operations include inverse, transpose, determinant, row operations, and row-to-column conversions
- Statistical capabilities include inferential testing, plus standard deviations, mean, linear regression, combinations, permutations and weighted means
- Lists and sequences
- Financial functions
- Date, time and alarm functions
- Physical constants and units libraries
- Keys can be assigned new functions or programs
- Serial-wired Mac/PC interface
- Overhead display and data collector accessories available
- Size: 8.9 × 18.7 × 2.8 cm (3.5 × 7.4 × 1.1 inches)
- Detachable sliding hard cover included
- Weight: 264 g (0.58 lb)
- 1-year warranty

HP 48G Series

- 32KB RAM built into HP 48G; 128KB in HP 48G+ and HP 48GX
- 131 x 64-dot display
- 12-digit numeric values with 3-digit exponents
- HP EquationWriter allows "text-book"-formatted equation entry
- Multiple plots on single graph; number of plots limited only by available memory
- Quadratic and polynomial root finders
- Symbolic and numeric integration and differentiation
- Differential equation solver
- Real and complex matrices; sizes and numbers of matrices limited only by available memory
- Object-based user programming language; program sizes and numbers limited only by available memory
- Program structures include FOR, DO, IF, CASE, UNTIL, and WHILE
- Infrared I/O; wireless transfer of instructor data to students
- Plot types include function, conic, polar, parametric, truth, differential equation, bar, histogram, scatter plot

- Graphic controls include zoom, box Z, tracing, shading, spacing, axis tick marks, and scrolling
- Matrix operations include inverse, transpose, determinant, row operations, and row-to-column conversions

- Statistical capabilities include standard deviation, mean, linear regression, combinations, permutations and 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
- The HP 48GX has two expansion ports, allowing plug-in applications or RAM memory cards

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
- HP Equation Solver
- 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 comparisons
- Notes and pictures
- 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 packs for IBM-PC or Macintosh
- Powered by 3 AAA batteries
- Sturdy sliding hard case
- 1-year warranty

Accessories for HP Graphic Calculators

Classroom Overhead Display

The Overhead Display Unit (ODU) is a great way to present lessons, demonstrating HP 38G, HP 48GX or HP 49G calculations to the whole class, step by step. Just set this unit on an overhead projector, connect it to your calculator, adjust the contrast, and you're ready for class. The ODU has cables for the HP 38G, HP 48SX/GX and HP 49G, and a built-in cable storage compartment.

HP F1212A Overhead Display Unit
Includes the display unit, one 9V battery, 2 cables and a User's Guide.

Memory Cards

Take advantage of additional RAM—store more data and large programs 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. Your information is saved even when you unplug the RAM card—each card has its own long-lasting battery!

HP 82215A 128 KB Battery-backed RAM Card, for the HP 48GX
Includes a 128 KB battery-backed RAM card, CR2016 battery, installation card.

HP 82216A 1 MB Battery-backed RAM Card, for HP 48GX
Includes a 1 MB battery backed RAM Card, CR2016 battery, installation card.

Other Accessories

There's lots of concise information in book form for HP 48G Series calculators—replacement Owner's Manuals or extra help on programming and other topics.

00048-90136 HP 48G Series Advanced User's Reference Manual
Programming techniques and examples, tables of commands, equations, system messages, units, system flags and reserved variables.

00048-90126 HP 48G Series Replacement O. Manual & Quick Start Guide

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

Connectivity

Share your computer's peripherals with your HP 38G, HP 48G Series and HP 49G—and protect your calculator data and programs by storing them to your computer's disk drive! The HP Connectivity Pack provides desktop computer cables and utilities (including Windows-compatible programs) to capture HP 38G, HP 48G Series or HP 49G screen images.

F1897A Serial Interface Pack for IBM-compatible PC's
F1208B Serial Interface Pack for Macintosh computers
Program transfers files (libraries, programs, grobs, data sets, or ApLets) between calculator and computer. Includes screen capture/save utility. Controls HP 48G Series memory from the computer. PC version includes 1.5-meter serial cable, 4-pin to 10-pin connector, CD-ROM with PC software (Windows 95/98/NT4.0 and Win2000 versions), User's Guide; requires open PC serial port (9-pin to 25-pin). Macintosh version includes a 1.5-meter serial cable, a 4-pin to 10-pin connector, a 3.5-inch disk with Macintosh software, User's Guide; requires open serial port.

F1015A Serial Interface Cable for IBM-compatible PC's
F1016A Serial Interface Cable for Macintosh computers
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.

Printing

The battery-powered infrared printer is a revolutionary companion for your HP graphic calculator—now with easier-to-read output and automatic shutoff to extend battery life. Using an invisible infrared beam, it needs no cord to connect to the calculator, so producing hard copies in the field or office couldn't be easier! 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. Just 4 AA alkaline batteries give the printer go-anywhere portability—or use the optional AC adapter as you wish.

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

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 Bkstr....1020 Henderson Rd....Huntsville, AL 35816...205-837-9529
University Supply...P.O. Box 870291...Tuscaloosa, AL 35487...205-348-6168

Alaska

Lewis & Lewis Computer Store...611 Fairbank St....Anchorage, AK 99501...907-277-9432
Alaska Pacific Univ. Bkstr....4101 Univ. Dr....Anchorage, AK 99608-4625...907-564-8218
Univ. 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

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
University of Arizona Bookstore...850 E. 18th St....Tucson, AZ 85719...520-621-8870

California

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...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
Golden State Bus. Sys....1787 Tribute Rd., Suite E...Sacramento, CA 95815...916-922-9221
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
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

Colorado

University Book Center...Campus Box 36...Boulder, CO 80309...303-492-6411
Cadet Bkstr....Bldg. 2360, Vandenburg Hall...USAF Academy, CO 80841...719-472-6268
Follett's CSM Bkstr....Ben Parker Student Ctr....Golden, CO 80401-1887...303-273-3113

District of Columbia

Follett's GWU Bkstr....2110 "I" St., N.W....Washington D.C 20052-0001...202-994-6870

Florida	Univ. of Miami Bookstore...University Center...Coral Gables, FL 33124...305-284-3592
	ERAU Bkstr....Embry-Riddle Aero. Univ....Daytona Beach, FL 32114...904-226-6062
	Florida Bkstr. & Comp. 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
	Univ. of Florida Bookstore...Stadium Rd.-Hub...Gainesville, FL 32611-2011...904-392-0194
	International Calculator...2916 Corrine Dr....Orlando, FL 32803...800-535-5692
	UCF Computer 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 Office Supply...6120 Pensacola Blvd....Pensacola, FL 32589...904-477-1111
	FSU Store...New Union Bldg. #0127...Tallahassee, FL 32306...904-644-2072
	USF 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
	A. Baldwin Ag. College Bkstr....2802 Moore Hwy....Tifton, GA 31793-0016...912-386-3226
Hawaii	Univ. of Hawaii Bookstore...2465 Campus Rd....Honolulu, HI 96822-2216...808-956-6612
Idaho	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 Exch., 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
	The Write Stuff, Inc....1 S. 781 Country Club...Wheaton, IL 60564-5646...708-871-8545
Indiana	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
	University Book Store...360 State St....West Lafayette, IN 47906...765-743-9618
Iowa	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
	University Bookstore...Iowa Memorial Union...Iowa City, IA 52242...319-335-3179
Kansas	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
	K-State Union Bookstore...Manhattan, KS 66506-2809...913-532-6583
	University Book Store...623 N. Manhattan...Manhattan, KS 66502-5333...913-539-0511
Kentucky	University Book Store...106 Student Center...Lexington, KY 40506-0001...606-257-6304
Louisiana	Louisiana State Univ. Bkstr....110 Union Bldg....Baton Rouge, LA 70893...504-388-5137
	University Bookstore...P.O. Box 41209 USL...Lafayette, LA 70504-1209...318-482-6922
	Comp. 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
Maryland	U.S. Naval Academy Store...101 Wilson Rd....Annapolis, MD 21402-5081
	Maryland Book Exch....4500 College Ave....College Park, MD 27040...301-927-2510

Massachusetts

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
Harvard Coop...1400 Mass. Ave....Cambridge, MA 02238...617-499-2000
MIT Comp. Connect....84 Mass. Ave., Rm. W20-021...Cambridge, MA 02139...617-253-7241
Tek Calc...Stoneham, MA 02180...781-438-7346
Wholesale Products, Inc....18 Kenneth Terr....Stoneham, MA 02180...781-438-8622
Worcester Polytechnic Institute...Daniel Hall...Worcester, MA 01609...508-831-5247

Michigan

Ulrich's...549 E. University Ave....Ann Arbor, MI 48104...313-662-3201
Lundberg Bkstr....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. Bkstr....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
SSI Solutions, Inc....Westland, MI 48185

Minnesota

Univ. Ctr. Bkstr....175 Kirby Student Ctr....10 Univ. Dr....Duluth, MN 55812...218-726-7286
Harold Smith Bookstore...259 19th Ave., S....Minneapolis, MN 55455...612-626-0522
Office Products of Minn....7794 Bush Lake Rd....Minneapolis, MN 55439...612-835-6776
Univ. of Minn. Bookstore...231 Pillsbury Dr., S.E....Minneapolis, MN 55455...612-626-1782

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Miss. State Univ. Bkstr....Colvard Student Union...Miss. State, MS 39762...601-325-1576

Missouri

University Bookstore...Brady Commons...Columbia, MO 65201...573-882-7611
Rolla Bookstore...788 University Center, W....Rolla, MO 65401...314-341-4705
Washington Univ. Bookstore...One Brookings Dr....St. Louis, MO 63130...314-935-5500
University Store...University Union 128...Warrensburg, MO 64093...816-543-4801

Montana

MSU Bookstore...185 Student Union...Bozeman, MT 59717-0020...406-994-5836
Montana Tech Bookstore...W. Park St....Butte, MT 59701...406-496-4190

Nebraska

CRC Computer Store...501 N. 10th St., Rm. 123...Lincoln, NE 68588-0200...402-472-8444
Nebraska Bookstore...1300 Q St....Lincoln, NE 68508...402-476-0111

Nevada

A.S.U.N. Bookstore...Reno, NV 89507-8049...702-784-6597

New Hampshire

Dartmouth College...33 South Maine St....Dartmouth, NH 03755...603-643-3616

New Jersey

Campus Store...Castle Point Station...Hoboken, NJ 07030...201-420-5101
New Jersey Inst. of Tech....150 Bleeker St....Newark, NJ 07103-3902...973-596-3200
Princeton Univ. Store...36 University Place...Princeton, NJ 08540-5116...609-921-8500

New Mexico

Holman's Inc....420 Wisconsin St., N.E....Albuquerque, NM 87123...505-343-0007
Univ. of New Mexico Bookstore...Main Campus...Albuquerque, NM 87131...505-277-6364
New Mexico State Univ. Bkstr....Corbett Center...Las Cruces, NM 88001...505-646-4431

New York

Follett's Univ. Bookstore...200 Lee Entrance...Buffalo, NY 14260-0001...716-645-3131
Collegetown of Ithaca, Inc....111 N. Aurora Street...Ithaca, NY 14850-4301...607-272-4477
47th Street Photo...New York, NY...212-921-1287
Columbia Univ. Bookstore...2926 Broadway...New York, NY 10027-7088...212-854-4131
NY Inst. of Tech. Bookstr....Student Lecture Ctr....Old Westbury, NY 11568...516-686-7584
BASIX...Stony Brook Union, Rm. 046...Stony Brook, NY 11794-0001...516-632-9281
Orange Student Bkstr....Marshall Square Mall...Syracuse, NY 13210-1731...315-478-6821
Syracuse Univ. Bookstore...303 University Pl....Syracuse, NY 13244-0001...315-443-1647
ITS Product Ctr....Rensselaer Polytechnic Institute...Troy, NY 12180-3590...518-276-8164
Rensselaer Union Bookstore...Sage & 15th St....Troy, NY 12181...518-276-4021

North Carolina

Surveyors Supply Co....1511 N. Salem St....Apex, NC 27502...919-362-7000
Southern Photo & Supply...734 Chapel Hill Rd....Burlington, NC 27215...910-227-3477
Duke University Stores...PO Box 90850...Durham, NC 27708...919-684-2344
Southern Photo & Supply...314 E. Russell St....Fayetteville, NC 28301...919-483-4909
NC A&T Bookstore...Brown Hall...Greensboro, NC 27411-0001...910-334-7593
Southern Photo & Supply...340 N. Wrenn St....High Point, NC 27260...919-882-3127
Addam's Univ. Bkstr....2109 Avent Ferry Rd....Raleigh, NC 27606-2137...919-832-9938
DJ's Textbooks...2416 Hillsborough St....Raleigh, NC 27607-7248...919-787-3512
NCSU Bookstore...Dunn Ave....Raleigh, NC 27695-0001...919-515-2161

North Dakota

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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...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 Univ....11111 Euclid Ave...Cleveland, OH 44106...216-368-2650
University Bookstore...Thwing Center...Cleveland, OH 44106-1715...216-368-2650

Oklahoma

OU Computer Store...Norman, OK 73019...405-325-1925
Union Bookstore...900 Asp...Norman, OK 73019-0001...405-325-2171
Applied Computer Systems...2726 Classen...Oklahoma City, OK 73106...405-524-6852
Cowboy Books, Ltd....109 N. Knoblock...Stillwater, OK 74074...405-743-1383
Smith's Bookstore...301 S. Washington...Stillwater, OK 74074-3332
Copier and Computer Systems...6136 E St....Tulsa, OK 74135...918-622-0612

Oregon

Calculating Edge...899 N.W. Grant Ave....Corvallis, OR 97330...800-677-7001
Corvallis System Sales...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. Bkstr....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 Bkstr....P.O. Box 14007...Salem, OR 97309...503-399-5131

Pennsylvania

Lehigh Univ. Bkstr....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. Bkstr....13th & Montgomery Ave....Philadelphia, PA 19122...215-204-7385
Univ. of Penn. Bkstr....3729 Locust Walk...Philadelphia, PA 19104-3610...215-898-7595
CMU Bookstore...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...Manaquer, PR 00680...787-834-5559
HP Only...Binero Avenue #1031...Puerto Nuevo, PR 00920...787-793-8033

Rhode Island

Brown Univ. Bookstore...71244 Thayer St....Providence, RI 02912-0001...401-863-3216

South Carolina

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 Bkstr....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. Bkstr....The Russel House...Columbia, SC 29208-0001...803-777-4160

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Tennessee	University Center Bookstore...Box 5075...Cookville, TN 38505...931-372-3226
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	Univ. Book & Supply...U.T. Center, Rm. 147...Knoxville, TN 37916-4800...423-974-1040
Texas	University Cooperative Society...2246 Guadalupe...Austin, TX 78705...512-476-7211
	Professional Computing...505 Church St....College Station, TX 77840...409-846-5332
	U Bookstores & Aggie...700 Univ. 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
	R H Enterprises, Inc....3601 S. 2700 W....West Valley City, UT 84119...801-576-8301
Virginia	Tech Bookstore...118 S. Maine St....Blacksburg, VA 24060...703-552-6444
	Southern Photo & Supply...3813 Old Forest Rd....Lynchburg, VA 24502...804-385-6060
Washington	Student Book Corp....N.E. 700 Thatuna...Pullman, WA 99163...509-332-2537
	Univ. of Washington Bkstr....4326 Univ. Way, N.E....Seattle, WA 98105...206-634-3400
	Pacific Lutheran Bookstore...Tacoma, WA 98447...253-535-7665
Wisconsin	Weiherts Bus. Machines...18050 Continental Dr....Brookfield, WI 53045...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 Univ. Dr., N.W....Calgary T2N 1N4...403-220-4765
	Trentech Office Products...2828 18th St., N.E., #3...Calgary T2E 7B1...403-250-9267
British Columbia	UBC Bookstore...6200 University Blvd....Vancouver V6T 1Z4...604-822-2665
	Cariboo College Bookstore...900 College Dr....Kamloops V2C 5N3...250-828-5141
Nova Scotia	St. Francis Xavier University Bookstore...Antigonich B2G 1C0...902-867-2450
	Bkstr. – Tech. Univ. of Nova Scotia...P.O. Box 1000...Halifax B3J 2X4...902-420-7707
Ontario	McMaster University Bookstore...1280 Main St., W....Hamilton L8S 4L8...905-525-9140
	Queens Univ. Campus Bkstr....Queens Univ. Grounds...Kingston K7L 3N6...613-545-2955
	Downtown Electronics...356 Yonge Street...Toronto M5B 1S5
	University of Waterloo Bookstore...200 University Ave., W....Waterloo N2L 3G1
Quebec	COOP Concordia...1455 de Maisonneuve, O....Montreal H3G 1M8...514-848-3615
Saskatchewan	Univ. of Saskatchewan Bookstore...Marquis Hall...Saskatoon S7N 0W0...306-966-4468

The Numbers Tell the Story

Children of the Digital Age

When Math Goes Ape and 5537 is More

(Who Gnu?)

This cautionary tale is based on a story sent to us by Katherine Caldwell, a very creative fifth-grader living in Okinawa, Japan. (Thank you, Katherine!) The caution: You'll need a calculator—one whose display digits are of the segmented variety (rather than dot-matrix). For example, the new HP 6S calculator would work....

_____ (9,156 ÷ 654)! MY NAME _____ (2,856 ÷ 56) _____ (404 x 2), AND _____ (1.366 ÷ 1,366) WANT TO TELL YOU ABOUT THE TIME _____ (5,647 – 5,646) WENT WITH MY BEST FRIENDS, _____ (1,012 – 295), _____ (16,400 – 8,682) AND _____ (110.5 + 191.5), TO THE _____ (0.4 ÷ 20).

WHEN WE ARRIVED, _____ (239 x 3) SAID, "_____ (40 x 0.025) AM HUNGRY, AND THERE _____ (170 x 0.3) A STAND WHERE THEY _____ (22.1 x 350) _____ (9,864 – 4,201)!" _____ (8,380 ÷ 8,380) TOLD HER THAT THE _____ (1,219 + 4,444) COULD BE NASTY IF THE VENDORS DIDN'T _____ (888.5 x 8) THEM ENOUGH, AND THAT COULD MAKE HER _____ (2,570 x 0.3). _____ (13,590 ÷ 45) AND _____ (8,523 – 805) SAID THAT THE _____ (73,619 ÷ 13) WEREN'T NASTY, BUT _____ (180,435 ÷ 523) DIDN'T BELIEVE THEM.

IN THE _____ (1 ÷ 50), WE SAW A FROG _____ (299 + 18) DOWN ON A_____ (10,001 – 9,394), A SNAKE THAT WOULD _____ (919 x 6) AT US, AND SOME _____ (91 x 63) WITH _____ (3,708 ÷ 6) _____ (58,030 - 314). THEN, BEFORE WE COULD _____ (400 - 65) THE MONKEYS, THEY SCARED US BY SAYING "_____ (0.02 x 4)!!"

WHEN THE CHURCH _____ (100,000 - 42,262) RANG, WE KNEW IT WAS TIME TO _____ (12,654 ÷ 21,090) HOME. AS WE WERE WALKING HOME, _____ (100,000 - 99,698) HEARD A "_____ (4,456 ÷ 2)" BUT DIDN'T _____ (295 + 40) ANY _____ (2,669 x 2). _____ (599 + 118) SAW ONE AND SAID TO STAY CALM. SOON THE _____ (7,774 ÷ 23) LEFT.

WHEN _____ (40,152 ÷ 56), _____ (231,540 ÷ 30), _____ (604 ÷ 2) AND _____ (0.25 + 0.75) ALL GOT TO MY HOUSE, MY MOTHER DIDN'T _____ (26,800 ÷ 80) US, AND WE SCARED HER BY SAYING "_____ (1.84 ÷ 23)!" — JUST AS THE MONKEYS DID TO US. LATER, _____ (1,793 – 1,448) FORGAVE US AND MADE US LUNCH.

If you're looking here for the solution, sorry (but at least you have the right perspective on things...).

Correction

OK, so *we* didn't quite get a perfect score on the quiz, either (previous issue—4/99).

Alert reader Duncan Faus, of Pacific Grove, CA, wrote to point out that you'd need to gather 23 persons to have at least an even chance that two of them share the same birthday. (We said you'd need only 22 persons. We were wrong. Horribly, horribly wrong.)

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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.