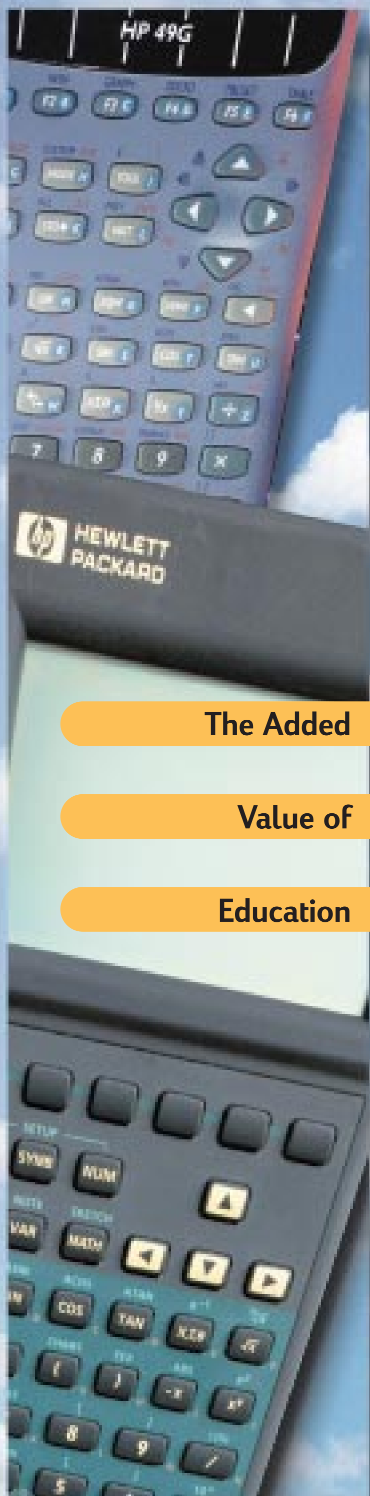
The Magazine with New Solutions for Hewlett-Packard Calculators

hpc

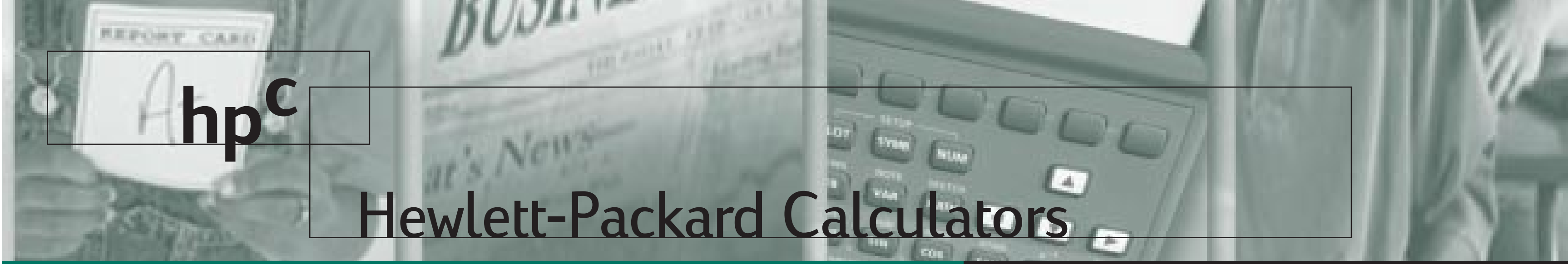
Hewlett-Packard Calculators

January 2000 Vol. 6 No. 1



The Added Value of Education

In This Issue...



hp^c

Hewlett-Packard Calculators

In This Issue

Editor's Note

Timely Thoughts

(i) *The Y2K problem was called the Millennium Bug, but it was really a Century Bug. We'd have had the same computer problems if the calendar were changing from 1899 to 1900.*

(ii) *Of course, January 1 wasn't the start of a new century, let alone a new millennium. I blame PMOS (Premature Millennium Observance Syndrome) mainly on our automobile culture: We all like to watch the odometer turn over the 100,000th mile, so it was exciting to watch the calendar turn to the 2000th year. And hey, any excuse for an extra jolly New Year's party is fine with me. But an odometer displays the mile when it's completed, while a calendar displays the year as it begins. If we were to mark our own ages that way, with calendars that change on our birthdays, every new 39-year-old would suddenly see 40 written on the wall. (Now **there's** a cure for PMOS.) But I guess that happens anyway....*

(iii) *Speaking of time, there are many more fascinating ways to worry about it on page 48.*

If adults can't keep straight such simple things as counting the years, imagine what kids face. Today's math curricula are indeed fighting "innumeracy"—teaching the difference between numerical impression and mathematical fact. But how do you get kids to "know and feel" numbers? They have to want to play with them, build them, take them apart, dress them up, or crash them into each other. Something needs to make kids say, "Whoa—look at this!"

Something will. In the 1990's, graphing calculators began to spark kids' affinity for numbers, but it was evolutionary, not revolutionary—nothing to call futuristic, really. As with the calendar and the millennium, it was a little early to celebrate.

So, when does the real party start? This April—in Chicago (see page 1). Get your invitation now to HP's sneak preview. That's when the "whoa-dometer" is really going to turn over.

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For subscriptions, corrections, letters to the editors, and information on submitting articles or other materials, please see page 48 and the inside back cover.

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HP Kicks Off Another Barn-Burner in Chicago

Get in the Loop at NCTM 2000

A Sneak Preview of the Future By Invitation Only

Mark your Brave New Calendar now. The year 2000 launches with tidings of big news this spring at NCTM's national conference in Chicago. Winds of revolutionary change are blowing, as Hewlett-Packard calls math and science educators to a sneak-preview: the future of graphic calculators.

Request An Invitation to the Future Now

This closed-door, sneak-preview session is open by invitation only. It will be held during the regular NCTM national conference (April 13-15, 2000) in Chicago.

To allow for space and materials planning, HP is now accepting requests for invitations. All interested educators who want invitations are encouraged to contact HP (see page 3 here) or to **send in the reply card** on the inside back cover. **Space is limited**, so don't delay.

More details about the sneak-preview session will follow after you have received your invitation.

Get in the Loop in The Loop

Hewlett-Packard's Innovation 2000 debuts fully at NCTM in Chicago. For other news, new products, features and events, be sure to visit HP's booth (#105-312) on the floor of the convention center, as well as the sneak-preview session.

NCTM won't be conventional this year.

(More HP news on the next page.)

HP's Customized Help: Your Topics, Your Speed, Your Schedule

More Workshops, More Help in 2000

The First Scheduled HP Workshops

Hewlett-Packard has announced the first of the 2000 series of scheduled workshops on graphic calculators. The two-day sessions are free and open to all classroom teachers, educators and other interested staff.

The first workshop, which will cover the HP 38G graphic calculator, will be held in Portland, Oregon, on February 4th (5:30p - 8:30p) and 5th (8:30a - 4:30p). For more information on exact locations, or to register, call 503-725-4828.

Arranging Workshops to Fit Any Schedule

These HP calculator workshops are also available on an as-needed basis. They are arranged and conducted by the Math Learning Center (MLC), of Portland, Oregon. MLC welcomes inquiries from any teacher who wants MLC to present a workshop in his/her own district—at a time best suited to the local attendees.

Interested teachers/educators should contact:

Darrell F. Clukey
Workshops Division Manager
The Math Learning Center
Portland State University
P.O. Box 9278
Portland, OR 97207
Phone: 503-725-4896
Toll-free: 800-547-8887 x4896
Fax: 503-725-3021
E-mail: clukeyd@pdx.edu

HP Custom Presentations Also Available

If the full HP workshop format is too long or addressed to an inappropriate audience or skill level, HP and MLC will custom-tailor presentations on any HP graphic calculators to fit the needs of teachers, staff, or students. Contact MLC for full details.

MLC Announces Additional Online Help

The Math Learning Center has recently opened a new bulletin board service to help address questions on Hewlett-Packard graphic calculators. All teachers with how-to questions, operating difficulties, or curriculum inquiries to fellow teachers can post messages at **hphelp@bbs.mlc.pdx.edu**. This is also linked on HP's own web site, which is continually updated with the latest product and support information, at **www.hp.com/calculators**.

All That—and Rebates, Too

Hewlett-Packard is now offering a $10 rebate on every HP graphing calculator purchased in the U.S. between January 15 and March 31. (Rebate coupons must be postmarked by May 5.)

For complete details, call the HP Awards Center at 800-728-9665 between 7 am - 6:30 pm CST, M-F.

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	1.305.267.4220	

(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
hphelp@bbs.mlc.pdx.edu

HP 38G Feedback

It's Elementary to These Kids

By John Gregory

"Cool!" is the first thing most grade-4 students say when handed an HP 38G. We're sitting on the floor, working in groups—not your typical math class (probably a good thing). Finding their way around the keypad is a cinch for members of the Nintendo generation. Some are already sketching or lost in an Aplet before we start.

It's particularly fun to see how the girls in the class light up. They do more than just keep up with the boys. Huddling in their instinctively collaborative way, they often leap ahead of their male counterparts, proving to me that technology needs to be introduced before puberty, while they are still less inhibited.

The HP 38G for grade-4 students? Yes, absolutely. Will they use the advanced features such as "polynomial roots"? Of course not. But we adults don't use half the computing power on our desktops, either. Word processing on a desktop PC—what most of us do most of the time—is the equivalent of arithmetic computation on an HP 38G.

The HP 38G for grade-4 students?

Yes, absolutely...
It makes math "cool" by making numbers "cool."

Elementary students like discovering and being entrusted with serious technology like this.

The benefits of the calculator are evident. After four years of workshops with nearly 2000 teachers of grades 4 to 6, across Canada, clear trends emerge. Watching and working with elementary students as they explore number patterns on the HP 38G, we are sold on putting its technology into young students' hands (and into the hands of joyful teachers who use the Store command to enter formulae for calculating math test scores).

Graphic calculators are mandated in the Canadian math curriculum for grade 6. Teachers go to workshops to learn the technology. Students just want to learn "what you can do" with the HP 38G. It's amazing and rewarding to watch them—teachers and students—discover together.

The HP 38G makes math "cool" simply by making numbers "cool." Oddly enough, though the machine makes "finding the answer" easier, students are no longer just interested in finding the answer. They want more than just number crunching. They want to find out why and how things work.

The broad scope of the HP 38G invites this broader scope of inquiry—it just appeals to kids' inherent curiosity—which addresses the big initial concern of the teacher: "How can I use calculators at this level when I still need to focus on computational fluency?"

Truly the HP 38G is an investigative tool. Its infrared port and universal overhead encourage group problem-solving, and its ability to keep a "history" of keystrokes lets the students see and explore different solutions. But the HP 38G doesn't replace pencil and paper; the answer alone is no longer enough. Playing with that answer is the true solution.

Where to start with kids that age? Math is the study of patterns, so we start by looking at the patterns on the HP 38G. First the keypad: We find the differences between the 3-digit numbers formed by descending or ascending adjoining digits. Then we do rows, then columns; then diagonals and crosses. Recording these subtraction sentences on paper, we look for patterns and, eventually, the "magic number." And then discovering the square of 3—the arrangement of keypad digits—leads us to the 9-times tables, which, in turn, opens an investigation into the patterns of all the digits in the times table.

Then, of course, beyond visual cues, the math abilities of the HP 38G also reveal such patterns. It's fascinating, for example, when they compute the decimal equivalent of 1/7 and its multiples. In standard mode, they quickly see how the digits in the repeating decimals are recycled. (Then, by dividing the repeating digits by the same number of nines, they get their fraction back!)

(continued on page 6, column 1)

The HP 49G For Young Students, Too

Sometimes One Size Does Fit All

By Carolyn Krause and Tom Meyers

Certainly it's a powerful and cutting-edge math tool, but when you stop and consider the options the HP 49G offers, it can make sense even for young students. There's a real advantage to learning and using the same reliable machine throughout school. The HP 49G lets students do just that: use a single calculator in middle and high school math and science, where the Algebraic mode is preferred; and then also for engineering or other technical training in college, where RPN is more often preferred.

The HP 49G also offers a wide spectrum of uses. Students who are undecided about their future academic or career interests can get the HP 49G, confident that it will help them in a business track (statistics, finance, etc.), as well as in math, science or engineering.

Yes, you read it correctly: we did say "middle school." We're now using the HP 49G in grades 6-8 in the Saturday Academy Program at Delaware State University—and not for just number crunching. Though most of the time we stay in Algebraic mode, we use RPN mode to demonstrate the order of operations and the concepts of binary vs. unary.

This really shouldn't be that surprising if you've looked at the features list of the HP 49G and then considered how they're presented to the user. In the first place, most common tasks are done with common, intuitive keystrokes — these days, most students are familiar with some calculator already. And for the younger grades, where math is presented in "do-it-like-you-say-it" syntax, the HP 49G's algebraic mode fits perfectly. Students can get instant success with that mode and learn to use RPN later, if need be. (In Delaware State's Intensive Summer Science Program for grades 9-12, for example, the HP 49G is extremely helpful in allowing students to make that modal transition. In fact, they often prefer the RPN, once they master it.)

Then there's the multiple-approach power of the HP 49G as a graphing calculator. Solving tougher problems graphically helps young students to "get-it-by-seeing-it"—and enhances their visualization skills, too. When students better grasp and retain concepts, it saves class time later, eliminating the need to review prior or prerequisite material.

Of course, what really puts the HP 49G to the head of the math class (besides its dual-mode flexibility) is the breadth of its teaching tools. Here's a summary of what we find most helpful throughout various levels of the curriculum.

Calculus I

Often the algebraic capabilities of the HP 49G can aid calculus students' algebra weaknesses "on the fly," such as factoring a polynomial to find critical points or intervals of increase or decrease. (But let us hasten to add here: We don't believe calculators should be used *instead* of learning algebra; sometimes we give tests where calculators are not permitted. But when we are presenting a calculus concept, they're valuable tools that let students focus on a concept rather than get bogged down in algebraic details.)

> "There's a real advantage to learning and keeping the same reliable machine throughout school. Now a single calculator will work—for middle school on."

Often we have students graph the function itself, the derivative function, and the second derivative function to see relationships. There is curve sketching, showing limits, concavity, inflection points, asymptotes, max/min, etc. They can also view tangent lines, areas under curves, and get a better, more visual understanding of limits at infinity, roots of higher degree equations, and of course numerical integration (which is particularly wonderful, as they can work many examples to get a thorough understanding).

Calculus II and Calculus III

In the more advanced areas of the calculus curriculum, you can use the HP 49G's differentiation and integration capabilities to help students in applications that might otherwise be beyond them due to the algebraic requirements. For example, power series representations are practically a *"must"* this way. Students can look at progressive graphs of

(continued on page 6, column 2)

The Elementary HP 38G (continued from page 4)

The HP 38G's "history" is the key here. We can see both the problem—expressed as a math sentence—and the solution at the same time. We can survey the history to make comparisons, analyze number patterns, and seek mathematical truths to test. (And the history stack also reassures students that mistakes are fixable without starting over.)

Activities in these grades aren't limited to crunching numbers, either. We actually start up the Function Aplet to begin exploring the Cartesian plane: We use default settings in Plot Set-Up (though we don't define any equations) to estimate, then calculate, the area of the screen in pixels.

And yes, we do plot some graphs. By grade 6, students are studying data and know about histograms and Box and Whisker graphs. The HP 38G's Stats Aplet shines here. Its ability to superimpose several Box and Whiskers graphs lets students clearly understand the meaning of "median."

Elementary students like discovering and being entrusted with "serious technology" like this. And they won't need so-called "keystroke lessons" when later lessons on graphic calculators are introduced in grade 9. By then, they'll already have investigated the machine—back when it was just "playing with the keys." They will have built their own familiarity with the technology—which will grow along with them and with the sophistication of the math.

But the payoff is sooner, too. By grade 6, HP 38G-literate students are ready to use it as a tool for algebra and polynomials. They're familiar enough with the technology to explore the math without stumbling on the keystrokes. While using it to play, they have overcome their math fears. They now try things. They change things. They change them back (via Copy). And they show off their discoveries to classmates. You can really see them begin to love math.

Or do they just love the HP 38G? Sooner or later (usually sooner), the question comes up: "Does it play games?"

Yes, it does.

"Cool!"

John Gregory (john_g@cunngregco.com) develops curriculum-based resources for Hewlett-Packard North America, then trains teachers in their use.

The HP 49G: One Size Fits All (continued from page 5)

the approximated functions (even set them in motion). And then there's the visualization of three-dimensional graphs —also very important.

Algebra/Trigonometry

Besides the boost to calculus learners, in algebra and trig specifically, the HP 49G is good for helping students with systems of equations, trigonometric functions and their graphs, conversions from rectangular to polar coordinates, factoring, polar graphs, and complex numbers.

Finite Math

In our Finite Math course, we use the HP 49G to graph quadratic equations, solve systems of equations (matrix solutions), and work problems in finance (present value, future value, amortization, etc.). We also do permutations/combinations, inverse matrices and simple logarithms, and we draw graphs of exponential functions. And linear programming is a huge area of use.

Statistics

This is an area that HP enhanced in the HP 49G greatly over its previous calculator models. Not only can we use it for basic summary statistics, evaluations of mean and standard deviation, and linear regression, we can also use it for inferential *t*-statistics. With such powerful data-crunching tools at their fingertips, students can now concentrate more on the applications and analysis of material. They can solve more meaningful problems—without the need for rigorous calculations drills during class. That leaves us freer to assign projects which apply the statistics—and to test more on the applications and concepts, rather than the "crunching" skills. Everybody wins.

All this—and we know we've only just scratched the surface of the HP 49G! No doubt we'll soon discover many more exciting applications with this powerful graphic calculator.

Thomas H. Meyers is Chairman of the Math Department at Delaware Technical and Community College. Carolyn Krause is an Instructor in that Department. In addition, she is the Project Director for the Intensive Summer Science Program and also Project Coordinator for Saturday Academy, both at Delaware State University.

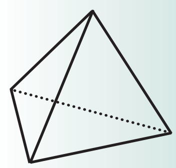
The Handshake Problem

Combinatorial Calculations on the HP 38G

By Carla Randall

How many different pairs can you choose from a group? How many games are played in a "round-robin" tournament? How many handshakes occur in a group of people if each person shakes hands with every other person exactly once?

You can model these situations with graphs consisting of points, called vertices, and lines, called edges. For example, a complete graph with 2 vertices has one edge while a complete graph with 4 vertices has 6 edges. Fill in the rest of the table by sketching complete graphs with the given number of vertices and counting the number of edges for each graph.



What's the pattern? You can use the Statistics Aplet on the HP38G to find out. Press LIB, highlight Statistics, and press START. Clear all columns of data by pressing ■CLEAR, highlight All columns, and press OK.

Enter the number of vertices in C1 (column 1) by pressing OK after entering each data value. Press ▶ and enter the corresponding data for the number of edges in C2 (column 2). Before leaving the Numeric view of Statistics, make sure 2VAR is showing on the menu bar. (If 1VAR is showing, press it to change it.)

Press SYMB, ■CLEAR and YES to reset the STATISTICS SYMBOLIC VIEW to its default settings. Then highlight S1 and press ✓CHK to select S1: C1 C2.

COMPLETE GRAPHS

# of vertices	# of edges
1	0
2	1
3	______
4	6
5	______
6	______
7	______

1. Set the viewing window: ■SETUP PLOT. What are your choices for the plotting parameters? (You'll have to press PAGE▼ to get to XTICK and YTICK.)

XRNG________ YRNG________ XTICK________ YTICK________

Set those four fields to your chosen values.

2. Press PLOT to see the scatter plot of your data. What type of equation would best model these data points?

3. Predict the number of edges in a complete graph with 8 vertices. How about 9 vertices? Explain.

Plot your predictions: Press NUM and ▼ to the end of the current data. Now enter your data for 8 and 9 vertices. Use ■SETUP PLOT to readjust the STATISTICS PLOT SETUP window, then PLOT to see a scatter plot that includes your new points for 8 and 9 vertices.

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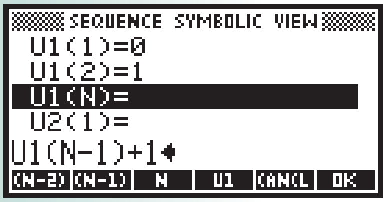
Answers

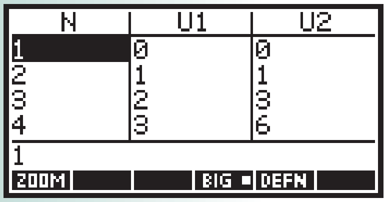
1. XRNG: 0 8
YRNG: −5 30
XTICK: 5 YTICK: 5

2. A quadratic equation.

3. 28 (7 more than the previous number); 36 (8 more than the previous number).

Persons in the room	New handshakes	Total handshakes
1	0	0
1 + 1 new = 2	1	1
2 + 1 new = 3	2	3
3 + 1 new = 4	____	____
4 + 1 new = 5	____	____
:	:	:
:	:	:
n	t_n	S_n





Answers

4. Pers: 4; New hs: 3; Total hs: 6
Pers: 5; New hs: 4; Total hs: 10
Pers: 6; New hs: 5; Total hs: 15
Pers: 7; New hs: 6; Total hs: 21

5. An arithmetic sequence.

6. 7

7. $t_n = n - 1$

8. The sum of the first n terms of U1.

9. 28

10. $S_n = n(0+t_n)/2$

11. $S_n = n(n-1)/2$

4. Can you write an equation to determine the number of edges in any complete graph, given the number of vertices? It helps to think of the vertices as persons and the edges as their handshakes, then count the number of new handshakes that occur each time one new person enters the room. Complete the chart at left.

Press LIB, highlight Sequence and START. Press ■ CLEAR YES to clear the SEQUENCE SYMBOLIC VIEW screen. N will represent the number of persons; U1(N) will be the number of new handshakes as a new person enters the room. Enter 0 for U1(1) and 1 for U1(2). Press U1. Now press (N-1), then + 1. This enters U1(N-1)+1 for U1(N), as shown here, at left. Press OK.

U2(N) will represent the total handshakes for N people. Enter 0 for U2(1) and 1 for U2(2). Enter U2(N-1)+U1(N) for U2(N), because you need to add the total handshakes for N-1 persons to the new handshakes from the Nth person in order to get the total handshakes for N persons.

When you're ready to view these sequences of numbers, press ■ SETUP NUM and set NUMSTART: 1, NUMSTEP: 1 and NUMTYPE: Automatic. Then press NUM, to get the screen shown here. (If you press BIG you'll see only 3 columns.)

5. What type of sequence appears in the U1 column? ___________

6. What is the eighth term in this sequence? ___________

7. Use the formula for the nth term in an arithmetic sequence, $t_n = x + (n-1)d$, to write the general term, t_n, in terms of n. t_n = ___________

8. What type of sequence appears in the U2 column? ___________

9. What is the eighth term in this sequence? ___________

10. Use the formula for the sum of the first n terms in an arithmetic sequence, $S_n = \dfrac{n(t_n + t_1)}{2}$, to write the general term, S_n, in terms of t_n and n. S_n = ___________

11. Now substitute your expression for t_n into the S_n formula to write a formula for S_n in terms of n. S_n = ___________

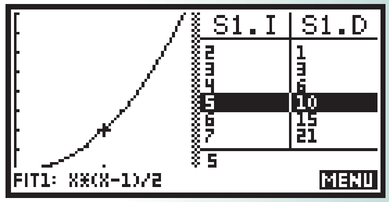
Does this explicit formula give you the same sequence of numbers as does the recursive formula for U2(N)?

To find out, press SYMB, highlight U3(1) and enter 0. Enter 1 for U3(2), and then type your formula (S_n in terms of n) for U3(N). (Note: You must explicitly type N*(N-1); the calculator will interpret N(N-1) as a function.)
Press NUM and compare the numbers in columns 3 and 4. If they do not match, check your work and revise your formula.

Now compare your formula for the total handshakes to the number of edges in a complete graph of edges and vertices.

Press (LIB), highlight `Statistics`, press **START**, then SETUP(SYMB). Now use ▼ to highlight `S1FIT:`, press **CHOOS**, highlight `User Defined`, and press **OK**. Press (SYMB), highlight `Fit1:`, enter the expression you determined for the number of handshakes given the number of people (S_n in terms of n—or, in this case, S_x in terms of x, since you're going to use x). Press **OK**.

To see the plot and data table together, press (VIEWS), highlight `Plot-Table`, and **OK**. Press **FIT** (if necessary) to see the curve fit the points.



As you trace points on the graph, using ◀ or ▶, you can see the coordinates highlighted in the table. While viewing the table and plot, you can press **DEFN** to see the equation for the curve of best fit.

If you choose three students from your class in a particular order, you are creating a *permutation*. If you choose three students without paying any attention to order, you are creating a *combination*.

The handshake problem lets you write a formula to count combinations of two items chosen from a group. The same formula would compute the number of games played in a round-robin tournament of n teams. It's the number of combinations of 2 items chosen from a group of n items:* ${}_nC_2 = \frac{n(n-1)}{2!}$

And there are ${}_nC_3 = \frac{n(n-1)(n-2)}{3!}$ combinations of 3 items chosen from a group of n.

Examples: ${}_5C_2 = \frac{5(4)}{2(1)} = 10$ ${}_5C_3 = \frac{5(4)(3)}{3(2)(1)} = 10.$

Try these problems:

12. Paul is leading a workshop for 20 people. He wants each person to meet every other person (shake hands once). How many handshakes will occur?

13. Cecilia asks three students to lead the class discussion of the assigned reading from the previous day. With a class of 28 students, can she choose a different group of 3 students each day over the 180-day school year? Explain.

Verify your answer to problem 13, calculating the number of combinations directly on the HP 38G. That is, rather than calculating ${}_{28}C_3 = \frac{28(27)(26)}{3(2)(1)}$ by doing the multiplication and division, try this:

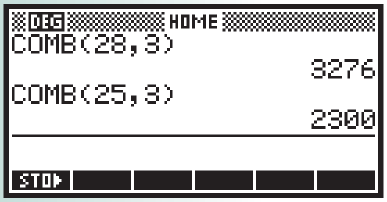
Press (HOME), (MATH), then ▼ down** to `Prob.`

*Note: $n!$ ("n factorial") is defined as $n(n-1)(n-2)\ldots(2)(1)$. So $2! = (2)(1) = 1$; and $3! = (3)(2)(1)$, etc.
**After pressing (MATH), you can save keystrokes by pressing (P) to jump right to that portion of the menu.

Answers

12. 190

13. Yes, because COMB(28,3) = 3276 > 180.



(continued from page 9)

Press ▶ to highlight COMB, then OK. Now type 2 8 , 3, ENTER. So $_{28}C_3$ = 3276. To calculate another combination, such as $_{25}C_3$, ▲▲ to highlight the COMB(28,3) command and press COPY. Use ◀ to move onto the 8, press DEL, 5, and then ENTER,to get COMB(25,3)=2300.

14. A 12-member student council is sending a two-person delegation to the state model legislature. How many two-person delegations are possible? How many three-person delegations are possible?

15. Jill Keyes asked her students to answer two of five essay questions on an English test. How many different choices do her students have? What if they have to answer three questions?

16. Draw three points on a circle. How many triangles can you draw connecting the points? Draw four points on a circle. How many triangles can you draw by connecting any three of these? Make a table for the number of triangles you can draw for 3, 4, 5, and 6 points on a circle. How is this related to the formula for $_nC_3$?

17. The COMB(n, r) function on your HP 38G computes the number of ways you can choose r items from a list of n possibilities. If the local pizza parlor offers a total of 9 pizza toppings, how many different pizzas can they make? Make a table of the number of pizzas with r toppings for values of r from 1 to 9 on your calculator. Explain any patterns you see.

18. North Central High is planning a 9-team volleyball tournament. Each team will play a three-game match against each of the other teams. There are enough volleyball courts to play about ten matches each day of the tournament. How many days will the tournament take to complete? Explain.

19. How many diagonals are there in a polygon with 5 sides? How is this related to the number of edges in a complete graph with 5 vertices? Explain how to change the formula for the edges in a complete graph of n vertices to get a formula for the number of diagonals of an n-sided polygon.

Answers

14. 66; 220

15. 10; 10

16. Points: 3 Triangles: 1
Points: 4 Triangles: 4
Points: 5 Triangles: 10
Points: 6 Triangles: 20

17. 511 pizzas:
COMB(9,1)=9; COMB(9,2)=36
COMB(9,3)=84; COMB(9,4)=126
COMB(9,5)=126; COMB(9,6)=84
COMB(9,7)=36; COMB(9,8)=9
COMB(9,9)=1

18. COMB(9,2)=36 matches. So the tournament will take 4 days.

19. Diagonals (D) = 5
Edges (E) = 10
$D = E - n = n(n-1)/2 - n$

Teacher Notes – Bibliography

*Leiva, Miriam A., Richard G. Brown: **Algebra 1 Explorations and Applications**. McDougal Littel, Evanston, Illinois:, 1997, pp. 536-541.*

*Ellis, Wade, James Schultz, Kathleen Hollowell: **Advanced Algebra**. Holt, Rinehart and Winston, Austin, Texas, 1997, p. 653, 669.*

*Crisler, Nancy, Patience Fisher, Gary Froelich: **Discrete Mathematics Through Applications**. W.H. Freeman and Company, New York, 1994, pp. 131-142.*

Carla Randall is Curriculum Vice Principal at Cleveland High School in Portland, Oregon. She also taught calculus for many years at Lake Oswego High School. Carla has been using and teaching with HP graphing calculators since 1990. She has conducted teacher workshops, designed curricula, and served on HP's Advisory Committee for the development of the HP 38G.

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 EVAL 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.)

Keeping Tools Within Reach

Understanding Menus on the HP 48G Series

By Chris Coffin and Tom Dick

A Few Handy Programs

Here are some small programs that are particularly useful when you're doing a lot of solving and graphing on the HP 48G Series. These are good examples of tools that would be very handy on a custom menu.

```
CLEAN « { EQ EXPR
          ΣDAT ΣPAR
          PPAR ZPAR
          VPAR IOPAR
          PRTPAR IERR
        }
        PURGE
      »
```

CLEAN purges the reserved variables, thereby setting each back to default status.

```
LOAD  « DUP STEQ
        'EXPR' STO »
```

LOAD loads the contents of stack level 1 into the variable EQ (for the plotter and solver) and into EXPR for the SYMBOLIC application.

(*continued on opposite page*)

What Menus Are—and Aren't

Menus in the HP 48G series are sometimes misunderstood. They're just typing aids—nothing more. Using a menu key to invoke a name is simply a quick way to enter that name. You could just as well type the name, one character at a time, on the command line (although when typing manually, you have to press ENTER manually, too—a step most menus save you).

In fact, if you think about it, the calculator keyboard itself is just another menu. It's just another collection of typing/entering shortcuts. (And it's a large enough menu to need a bit of subdividing, as you've probably noticed: Most unshifted keys give you access to the most common things—arithmetic, trig, exponentiation, storage, recall, "navigation," etc.—the ↱-shifted version of many keys gives a handy, fill-in-the-blanks application screen; and the ↰-shifted version of those same keys offer screen menus of related programmable commands.)

Above all, don't confuse menus with directories. Directories are the partitioned areas in memory where object names are actually stored. Menus are just "access lines" to them. Menus are selected groups of name-typing aids collected in the display for your convenience. The names presented on a single menu may actually be stored in many different directories all throughout calculator memory.

In particular, it's easy to confuse the VAR menu (accessed via VAR) with a directory, because the names contained in the VAR menu *do* happen to be located all in one directory—namely, the current directory. And if you move to a different directory, you'll instantly see a different VAR menu.

This can give you the (false) impression that, to invoke the name of an object you've stored, you must "move" to the directory where that name is stored. No. Remember that you can invoke any name (typed "longhand" or via menu, no difference) and the calculator will find and evaluate that name, as long as it is stored somewhere in the *current directory path*—i.e. somewhere along the line between the current directory and the HOME directory.*

**Thus, although they don't appear on-screen, all built-in command names reside, in effect, in the HOME menu, so that you can indeed invoke them from anywhere, without needing to worry about it. Any other location scheme wouldn't be so handy.*

Menu Numbers

As you probably know, menus can have more than one "page" (i.e. more than six typing aids); you access additional page(s) via NXT or ← PREV. What you may not know is that there are over 100 pre-defined menus, and each is uniquely numbered; you can select any page of any menu via the MENU command, rather than via the keyboard. For example, the ← CHARS menu is #62; its 2nd page is denoted 62.02. Instead of accessing it via ← CHARS NXT, try `62.02 MENU`.

Custom Menus

Menu number 1 is reserved for a menu you specify by storing a menu list into the reserved name CST. Then pressing CST (same as `1 MENU`) will present that menu on screen—your own custom menu.* You use a menu list of this form:

{ { "$label_A$" { *unshifted object$_A$* ←*-shifted object$_A$* →*-shifted object$_A$* } }
{ "label$_B$" { *unshifted object$_B$* ←*-shifted object$_B$* →*-shifted object$_B$* } }
...(etc.)
}

For example, suppose you want to create a custom menu containing the little programs shown here in the sidebars, plus a built-in command (DRAX), and maybe an unnamed routine to alphabetize the current VAR menu (totally acceptable—any object in a menu list is simply evaluated when that menu key is pressed). Here is one menu list that would work:

```
{ { "LOAD" { LOAD MLOAD PAIR } } PLUG PTON DRAX
 SEE { "TIDY" { CLEAN « VARS SORT ORDER » } } }
```

Can you tell what each of the six** menu keys will do if you press CST after storing the above into CST?***

*As you might expect, if you haven't stored anything into CST, pressing CST will give you a blank menu. Note, too, that you can have a different version of CST stored in every directory; CST looks only in the current directory. You can also make a ***temporary*** custom menu—without using CST—in cases where you need the menu only once. Just enter a menu list (just as for CST), then simply execute TMENU.*

***This menu uses only one page (6 items), but it would simply expand onto a new page if you gave it more items. And a reminder: Although built-in menus offer objects that are accessible from anywhere—you don't need even to think about it—that's not so with custom menus. In order for such a menu to work as you expect, the objects it specifies must all be stored in memory—in whatever directory(s) you choose—but somewhere in the current path.*

****Note: You can omit the inner bracketing wherever you want menu items with only unshifted custom actions; the label will then match the item. But then any of those "unshiftable" items that are names will behave as on the VAR menu: ← will store into that name; and → will recall its contents. So be careful when mixing "shiftable" and "unshiftable" items on one custom menu (as above). Using ← or → on the wrong item would unintentionally overwrite variables—such as the PLUG, PTON and SEE programs here—just as on the VAR menu.*

This article was excerpted in part from "The HP 48G/GX Pocket Guide," a book co-authored by Chris Coffin and Tom Dick, published by Grapevine Publications (800-338-4331 or www.read-gpi.com).

Chris Coffin (chris@read-gpi.com) is the author or co-author of some 30 instruction books. He is CEO of Grapevine Publications, a Corvallis, Oregon, publisher of plain-English books on technology since 1983.

Tom Dick (tpdick@math.orst.edu) is a professor in the Department of Mathematics at Oregon State University in Corvallis, Oregon.

```
MLOAD « →LIST LOAD »
```

MLOAD behaves just like →LIST (i.e. it needs a length argument as well as the items to be put into the list), then LOADs the result.

```
PAIR « 'i' * + »
```

PAIR uses the values on stack levels 1 and 2 to form an algebraic expression representing a complex number. (This is primarily useful in LOADing the parametric plotter.)

```
PLUG « 30 MENU »
```

PLUG is equivalent to ← SOLVE ROOT SOLVR.

```
PTON « R→C PIXON »
```

PTON plots one point, using the values on stack levels 1 and 2 as co-ordinates. You can then view that point by pressing ← PICTURE (so long as it is within the current viewing window).

```
SEE   « EVAL PICT
        STO PICTURE »
```

SEE displays the contents of the graphic object (grob) currently at level 1 of the stack.

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 that E 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?

If you're in the U.S. or Canada, call Hewlett-Packard at 970-392-1001. (For other locations see "How to Contact HP" in this issue.)

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 ⬑ X^2 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 +/− ⬑ X^2 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 KILL (PRG NXT RUN KILL).

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 VARS NXT PURG, then select your units.

One Idea, Three Views

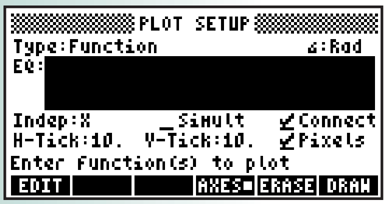
Exploring Limits on the HP 49G

By Mark Howell

This activity allows the student to explore the idea of limits from a multi-representational approach: numerically, through a table of values; algebraically, with the help of the HP 49G's computer algebra system; and graphically.

You can use this early in the chapter on limits. Since that usually comes early in the year, this activity doesn't assume much familiarity with the calculator. Students should be able to follow through this on their own.

The idea of limit is central to calculus. To best understand limits, it helps to consider them in different ways. In this activity, you'll explore limits using three different approaches: numerical, graphical, and analytical.

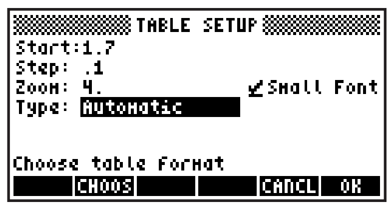


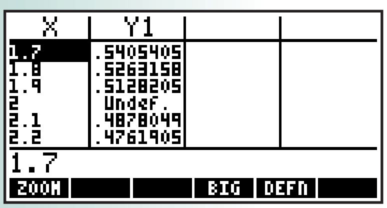
Take a look at the function $f(x) = (2x - 4)/(x^2 - 4)$, for values of x close to 2.

With the calculator in symbolic and exact modes, press (↰)(2D/3D). If the plot Type is other than Function, press CHOOS, highlight Function, and press OK. The Indep field names the independent variable for the graph and table. If it's not X now, highlight it, and press (X)(ENTER). The screen should appear as shown here.

Now move to the EQ field and enter the function: (↰)(Y=) (NXT) CLEAR OK (NXT) ADD (2)(X)(−)(4)(▶)(▶)(÷)(X)(y^x)(2)(▶)(−)(4)(ENTER).
The PLOT - FUNCTION screen should appear as shown here (at left).

Next, press (↰)(TBLSET) and set up the table as shown here (right):





Finally, press (↰)(TABLE) to look at the resulting table, which should resemble the screen shown here (at left). Notice that when X = 2, Y1 is not defined.

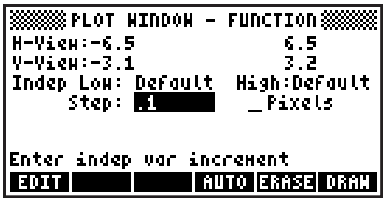
To take a closer look at that region, scroll down the table to highlight the row at $x = 2$. Press ZOOM OK to zoom in. Notice how the increment between adjacent x-values in the table then reduces by a factor of 4; where before they were 0.1 apart, now they're .025 apart.

Zoom in at $x = 2$ a couple more times.

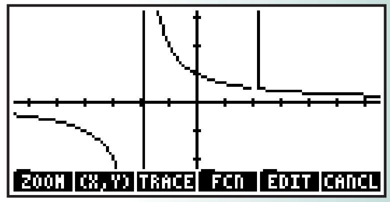
1. Use the calculator's table of values to fill in this table:

x	1.9953125	1.996875	1.9984375	2	2.0015625	2.003125
$f(x)$						

2. What happens to the values of $f(x)$ as x gets close to 2?



How does this limit look on a graph? To find out, press [←][WIN] and set your viewing window as shown here:



Now press ERASE DRAW. You should see something like this:

Press TRACE (X,Y) and use the arrow keys to investigate the behavior of the function near $x = 2$.

3. What happens to the graph of $f(x)$ as x gets close to 2?

Can you determine the behavior of this limit analytically—with algebra? Press [CANCEL] until you get back to the stack. Press [←][Y=], select the `Y1(X)` expression, and then EDIT. This will take you to the Equation Writer. Now highlight the right side by pressing [▼] [▶]. Then press [←][CALC][2][ENTER] [2][ENTER] [X][→][=][2], to apply the limit command at x approaching 2. Press [▶][▶] to highlight the limit expression, then EVAL to evaluate it.

4. What did the calculator give for $\lim\limits_{x \to 2} \dfrac{2x-4}{x^2-4}$?

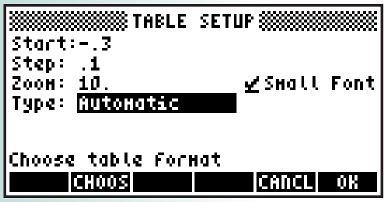
5. How does the calculator's answer compare with your answers from the table and graph?

6. Press [→][UNDO] to recover your original limit expression. Press [▼] [▼] so that just `2*X-4` is selected, then FACTO to factor the numerator. Press [▶] FACTO to factor the denominator. The numerator and denominator have a common factor, so press [▲] EVAL to simplify. What does the original quotient simplify to?

7. These two expressions, `(2*X-4)/(X^2-4)` and its simplified cousin, are equal for all values of x except 2. But when taking a limit as x *approaches* 2, you're not concerned with the function's behavior exactly *at* 2. What does the simplified limit evaluate to?

(continued on page 18)

Limits at Infinity



What happens to a function of x as x gets arbitrarily large? That's a different sort of limit, one whose "approach" is customarily denoted as $x \to \infty$. For example, look at $\lim_{x \to \infty} \frac{2x-4}{x^2-4}$. If necessary, press CANCEL to get to the stack. Then press ← TBLSET and change your settings as shown here (at left):

8. Now press ← TABLE and fill in this table:

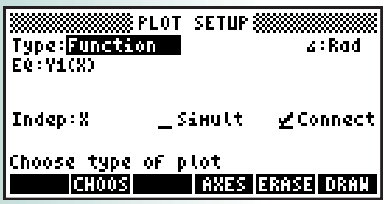
x	-0.3	-0.2	-0.1	0	0.1	0.2
$g(x)$						

9. Position the highlight bar on $x = 0$, and press ZOOM ▽ ENTER to zoom out of the table. Doing so multiplies the increment between adjacent table inputs by a factor of 10. f is undefined at $x = -2$ and at $x = 2$. Why?

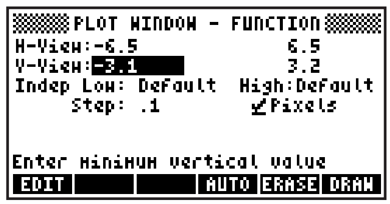
10. With the row at $x = 0$ highlighted, zoom out three more times, paying attention to how the inputs and outputs change as you do so. Fill in this table:

x	-3000	-2000	-1000	0	1000	2000
$g(x)$						

11. Looking at the table, what can you say about $\lim_{x \to \infty} \frac{2x-4}{x^2-4}$?



To explore this limit graphically, first press ← 2D/3D and ← WIN to prepare as shown here (left and right, respectively). Be sure to change AXES✓ to AXES, as shown (left), so that coordinate axes will not be drawn.



Press ERASE DRAW, then ZOOM ZFACT, set the H-Factor to 10, and OK. Then press NXT HZOUT ("Horizontal Zoom Out"). The window is resized, multiplying the inter-column distance by 10 (without affecting the inter-row distance). Zoom out horizontally again, and see the screen shown at left (if you move the cursor).

12. Except near $x = 0$, the graph looks flat. (One more H-zoom out would flatten it completely.) What does this say about the outputs from the function, f?

13. What does this say about $\lim_{x \to \infty} \frac{2x-4}{x^2-4}$?

14. Press CANCEL ← Y= EDIT to take your function to the Equation Writer. Then apply the limit command: ▽ ▷ ← CALC 2 ENTER 2 ENTER X → = ← ∞. Press ▷ ▷, then EVAL. What does the CAS evaluate it to be? How does this compare with your answers to questions 11 and 13?

In question 6 above, you found that $\lim_{x \to \infty} \frac{2x - 4}{x^2 - 4} = \lim_{x \to \infty} \frac{2}{x + 2}$.

The numerator, 2, stays constant; the denominator, $x + 2$, becomes infinitely large with x. The quotient, therefore, approaches 0.

Answers

1.

x	1.9953125	1.996875	1.9984375	2	2.0015625	2.003125
$f(x)$	0.5005866	0.5003909	0.5001954	*(undefined)*	0.4998048	0.4996097

2. As x approaches 2, the values of $f(x)$ appear to approach 0.5.

3. As x approaches 2, the y-coordinates of the points on the graph of $f(x)$ appear to approach 0.5.

4. 1/2

5. They are all the same.

6. $\frac{2}{x + 2}$

7. $\frac{2}{2 + 2} = 0.5$

8.

x	-0.3	-0.2	-0.1	0	0.1	0.2
$g(x)$	1.176471	1.111111	1.052632	1	0.952381	0.9090909

9. At $x = -2$ and $x = 2$, the value of the denominator, $x^2 - 4$, is 0. Division by zero is not defined.

10.

x	-3000	-2000	-1000	0	1000	2000
$g(x)$	-0.000667	-0.001001	-0.002004	1	0.001996	0.000999

11. As x approaches ∞, the values of $f(x)$ appear to approach 0.

12. Since the graph flattens out, the values of f are getting close to one another.

13. Since the outputs are getting close to one another, you have evidence that the limit exists. Tracing on the graph indicates that the limit is 0.

14. 0, the same as indicated from the table and graph.

Mark Howell has been teaching math and computer science at Gonzaga High School in Washington, D.C., since 1977. He is a longtime Reader and Leader at the AP Calculus exam reading and is a member of the AP Calculus Test Development Committee. He and his wife, Maureen, have a budding computer science guru: son Ryan, age 4.

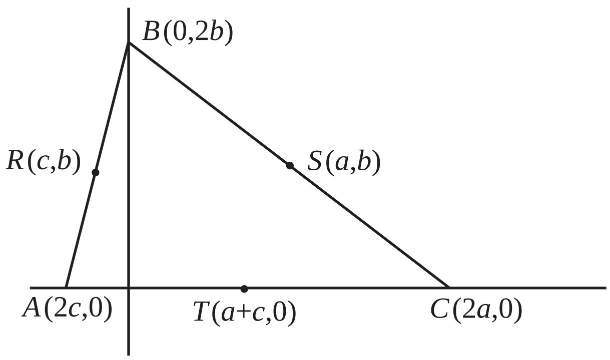
Another Triangle Proof Made Easy

Coordinate Geometry on the HP 49G

By Kevin Fitzpatrick

Here's another good proof that you can demonstrate with the help of the HP 49G. Your mission: Show that the perpendicular bisectors of the sides of any triangle meet in a single point.

To do this, choose any arbitrary triangle and orient it so that its base sits on the x-axis. Then name the coordinates of its vertices in a convenient manner, like this:



The equations of the lines forming the perpendicular bisectors of the sides of this triangle are therefore:

For segment AB: $y - b = c/b(x - c)$
For segment BC: $y - b = a/b(x - a)$
For segment AC: $x = a + c$

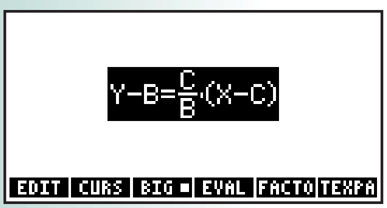
You need to show that these three lines intersect in a single point.

First, before you do anything else, you need to purge (erase) the variables A, B, C, X, and Y if they appear on your VAR menu. Press [TOOL] [PURGE] [←] [{}] [→] ['] [ALPHA] [A] [▶] [→] [,] [→] ['] [ALPHA] [B]..., etc., then [ENTER].

Now, for convenience, type the equation for the perpendicular bisector of segment AC first: [EQW] [X] [→] [=] [ALPHA] [A] [+] [ALPHA] [C].

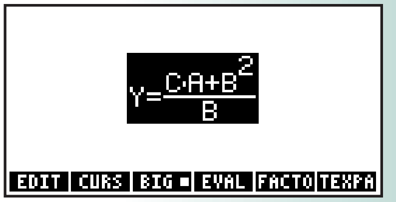
Save this for later pasting: [→] [▲] [→] [CUT].

Next, type the equation for the perpendicular bisector of segment AB:



[ALPHA] [Y] [−] [ALPHA] [B] [→] [▲] [→] [=]
[ALPHA] [C] [÷] [ALPHA] [B] [▶] [×] [←] [()] [X] [−] [ALPHA] [C] [→] [▲].
You should see the screen shown here (left).

Now substitute into this equation the expression for X that you saved (that is, segment AC), and isolate Y:



↱ ALG 6 ENTER ↱ PASTE ↱ ▲ EVAL + ALPHA B
↱ ▲ EVAL EVAL.

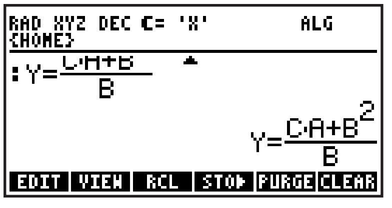
You should see the screen shown here (right):

Press ENTER ENTER to send that expression back to the stack. You're going to compare it to the expression for Y that you get from the other equation.

Now go back into the Equation Writer to enter the other equation (for the bisector of BC): EQW ALPHA Y − ALPHA B ↱ ▲ ↱ =
ALPHA A ÷ ALPHA B ▶ × ↰ () X − ALPHA A ↱ ▲.

Now do the same substitution for X, and isolate Y:

↱ ALG 6 ENTER ↱ PASTE ↱ ▲ EVAL + ALPHA B
↱ ▲ EVAL EVAL ENTER ENTER.



Press ▲, and observe that the two equations for Y are indeed identical, proving that the perpendicular bisectors of the sides of a triangle intersect in a single point.

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. Kevin will be conducting HP 49G seminars in the coming year and is excited about the continuing advance of technology for the classroom.

About the HP 49G

Frequently Asked Questions

How do I adjust the contrast on my display?

Hold down the [ON] key and tap either the [+] key (to darken the contrast) or the [−] key (to lighten the contrast).

How do I change the number of decimal places displayed?

Press [MODE] and change the `Number Format` field to `Fixed`, then choose from `0` to `11` decimal places and press [ENTER]. The default mode is standard (`Std`), where you see only the number of decimal places necessary to display the result.

What does ▸ or … mean at the end of a display line?

It means the displayed object is too long to display on one line.

Why do some numbers have decimal points, while others don't?

On the HP 49G, there are two distinct types of numbers: real and integer. Only real numbers are displayed with a decimal point. Integers offer a larger range than real numbers. For example, you can calculate 100!, a 158-digit integer.

Why won't `SIN(π)` always give a result of exactly zero?

First, the HP 49G must be in radians mode; after all, sin(3.1415°) isn't zero. If the `RAD` annunciator does not appear at the top left of the display, press [MODE] and change the `Angle Measure` to `Radians`. Next, press `CAS` and clear (that is, un-"check") the `Numeric` and `Approx` fields. Otherwise, the HP 49G will assume you want a numeric calculation, which, for an irrational number like `π`, will always be an approximation if represented in a finite number of decimal places.

Why doesn't changing the angle mode affect a vector's display?

Since a converted display could require non-integer values, changing the angle mode affects the display only of real-valued—not integer-valued—vectors.

How do I convert units?

In Algebraic mode, use `CONVERT` (via [↱][UNITS], `Tools..`) with two arguments: the current value (with its unit), then a `1` with the target unit. (To avoid implying multiplication, you must type the underscore, `_`, between value and unit.) For example, to convert 100 meters to yards, use `CONVERT(100_m,1_yd)`.

In RPN mode, the syntax is `100_m 1_yd CONVERT`. (Or, if flag -117 is set, you can use a menu shortcut: `100_m` [↰]`yd`.)

How do the function keys, [F1]-[F6], work in RPN mode?

In RPN mode, to access the top row of keyboard functions ([Y=], [WIN], etc.), you must **hold down** the [↰] key. For example, to go to the `TABLE SETUP` window, you must press [↰]-**HOLD**[TBLSET]. This is to allow for menus with "shifted" shortcuts. For example, the VAR menu has shortcuts for store ([↰]) and recall ([↱]); and the UNITS menu has shortcuts for conversion ([↰]) and division ([↱]).

How do I make the HP 49G work like a HP 48?

First, set it to RPN mode ([MODE] [+/−] [ENTER]). Then specify choose boxes instead of menus, by setting flag -117 (`-117 SF`). (The HP 49G even supports the HP 48's menu system: You can get to any HP 48 menu by entering the appropriate menu number, then using the `MENU` command.)

How do I check how much free memory is left in my calculator?

[↰][FILES] shows the unused memory in each of the HP 49G's ports. Port 0 is the calculator's main memory (RAM). Port 1 is extended memory (like a RAM card in the HP 48). Port 2 is the FLASH ROM. FLASH memory will hold data even when no power is available—a good place to archive if you lack a connection to a PC.

What keyboard shortcuts does the HP 49G offer?

These shortcuts are available in Version 1.16 of the HP 49G ROM.

Navigation and environment aides:

[↰]-**HOLD**[NXT]: Last menu
[↱]-**HOLD**[ENTER]: Toggle Exact/Approximate mode
[↱][▶]: Xmodem Server
[↱]-**HOLD**[▶]: Kermit Server
[↰]-**HOLD**[VAR]: HOME
[↰]-**HOLD**[ANS]: Last Argument
[↱]-**HOLD**[9]: Time-Tools menu
[ON]-[C] [⬅]-**HOLD**: Bypass library configuration routines.
(Useful when downloaded software malfunctions or is incompatible.)

Typing aides:

[ALPHA][↱]-**HOLD**[O]: Ω
[ALPHA][↱]-**HOLD**[2]: ¡
[ALPHA][↱]-**HOLD**[3]: ¿
[ALPHA][↱]-**HOLD**[6]: °
[↱]-**HOLD**[,]: ;
[↱]-**HOLD**[']: ` `

Other shortcuts not requiring you to hold down a key:

[ENTER]: DUP
[⬅]: DROP
[◀]: Display PICTURE environment
[▶]: SWAP (RPN mode only)
[▲]: HIST or interactive stack (RPN mode)
[▼]: Edit object with context sensitive editor
[↰][▼]: Invoke command line editor on object
[↱][▼]: List menus in display

I downloaded some software and now my calculator has locked up. What can I do?

Try bypassing the startup routine by pressing [ON]-[C] and holding down the [⬅] key while the calculator boots. If that doesn't do it, use a paper clip in the reset hole on the back of the machine, then repeat the above [ON]-[C] procedure.

I've lost/broken a battery door, port cover or rubber foot.

To replace it, call your nearest Calculator Support team. The information is on the inside back cover of the HP 49G Owner's Handbook.

Where can I get replacement batteries for my calculator?

The HP 49G uses three standard size AAA batteries, available in most drug stores, camera stores, or grocery stores. Use all the same brand and type. Avoid Nicad batteries, which have low capacity and short low battery warning times.

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 6S, HP 38G, HP 48G series, or HP 49G.
- Overhead transparencies of all HP calculator keyboards.
- Training guides and examples for the HP 6S and HP 6S Solar, HP 38G, HP 48G series, and HP 49G.
- 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.)

Or what if the full teacher-training workshop format doesn't quite fit? What if you want to include students or other staff? No problem. MLC and HP can arrange custom presentations, tailored to your exact audience.

Online Help

Don't forget HP's web site: **www.hp.com/calculators**. And there is additional help at MLC's bulletin board. E-mail to **hphelp@bbs.mlc.pdx.edu**.

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 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 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.

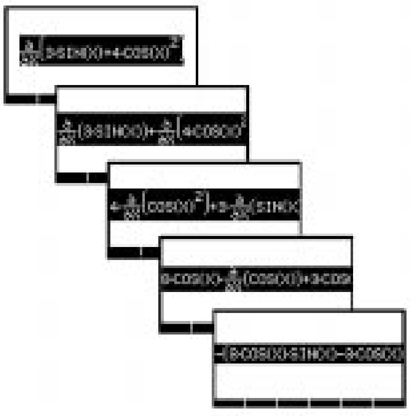
A large 1.5 MB of Memory (512KB RAM and 1 MB Flash ROM for data storage) takes full advantage of the largest, most comprehensive library of third party calculator software: programs, games and software applications. And 2MB of Flash ROM allows for future electronic software upgrades—no need to buy a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

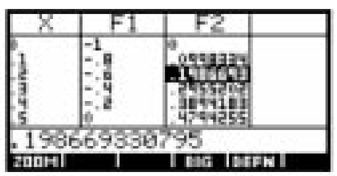
You see everything better and bigger too. Not only can you input and view expressions on the big 131 x 64-pixel display in "textbook" mode (i.e. as in a book or on the chalkboard), but you get all output steps and results that way, too, for easy viewing and understanding—in your choice of four font sizes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

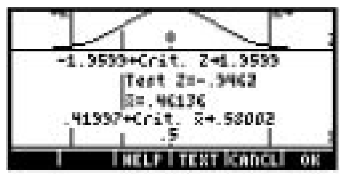
Got an example or solution you want to share with others? No problem: You can easily exchange programs, data and games with other HP 49G's and HP 48G Series models, via a unit-to-unit link serial cable. (But there's no infrared—which prevents "untimely communication" between students during exams!)

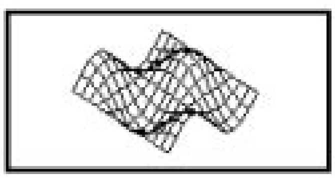
Power to the Pupil

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 the HP 49G Graphic Calculator.)

In Detail: The HP 48G 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.

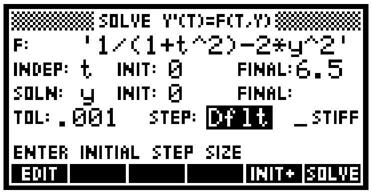
Power and Smarts

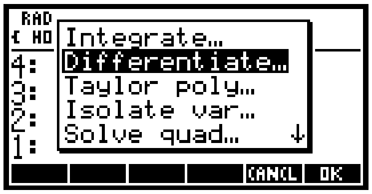
The power packed by the HP 48G Series is staggering. Graphics and calculus combine as in no other calculator. While you view the graph, the HP 48 finds roots, intersections, local extrema, derivatives, slopes, and areas under curves.

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

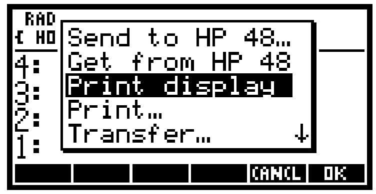




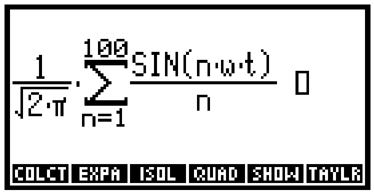
But is all this power only for the technically gifted? Not at all! The HP 48G Series is easy to use, even for beginners.

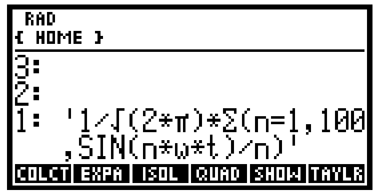
Look at the easy-to-use forms that speed up learning: each built-in application tool has an input form you just fill in.

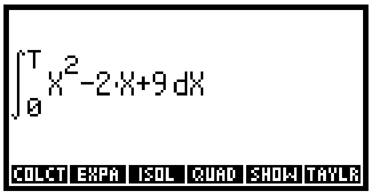
With clear prompts and menus organized for easy access, you and your students get satisfying results quickly.



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….

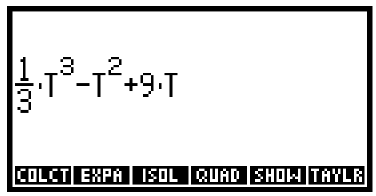






And its symbolic math capabilities open new possibilities for your students. They can create expressions on the calculator,

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

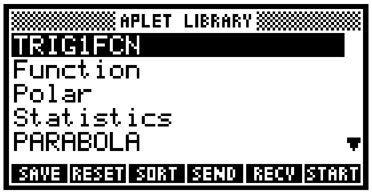
The HP 38G offers over 200 easy-to-find commands in clear, organized menus. Evaluate expressions symbolically, isolate variables, solve quadratic equations, and use HP Solve to conduct "What if..." investigations. Other features include:

- 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

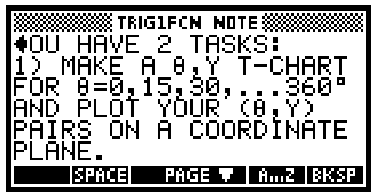
ApLets combine variables, pictures, graphs and custom-designed views into one complete package. With ApLets, students can explore the problems without your guidance—and without fear of losing their work or the original lesson. They can save their work or start over if necessary. ApLets are so natural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

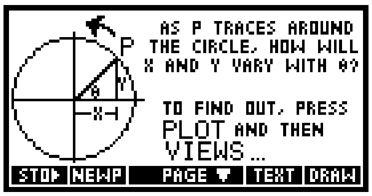
It's easy to create ApLets! Once you set up a problem for use in the classroom, just save it. All of the configuration information is saved—along with any notes and sketches you've created—together in a package easily transferred to your students via wireless infrared. (You just point two calculators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

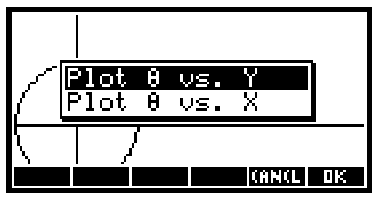
It can begin with a note....



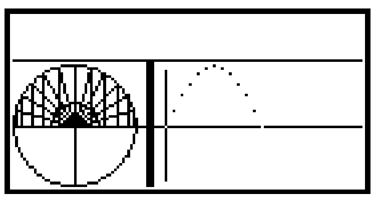


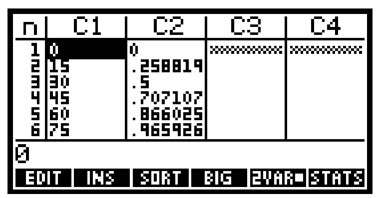
Students can then see a sketch of the problem...

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 11 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/Algebraic
	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

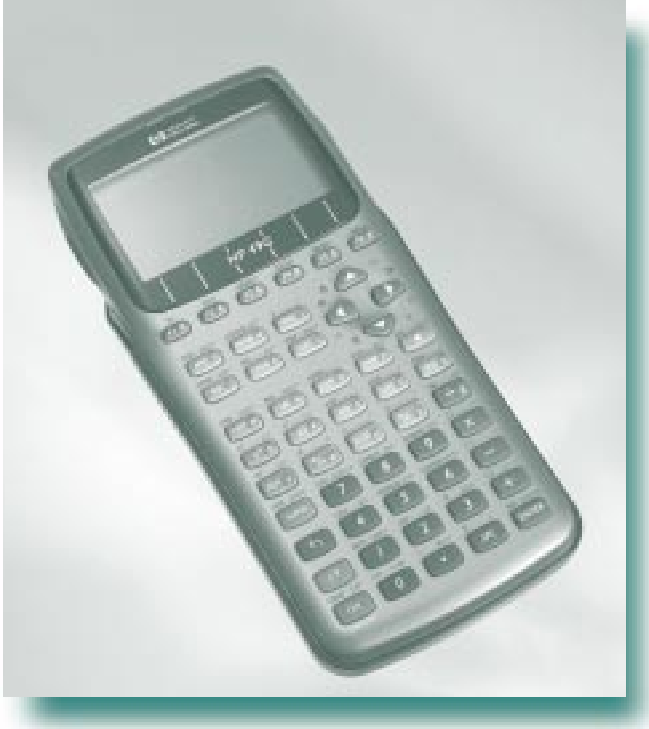
HP 48GX	HP 48G+	HP 38G
Yes	Yes	Yes
128 KB	128 KB	32 KB
No	No	No
Gray	Gray	Green-gray
Soft, dark grey pouch	Soft, dark grey pouch	Slide-over (attached) green-gray
Enhancements	Enhancements	Enhancements
7.1 × 3.2 × 1.15in (18.0 × 8.1 × 2.9cm)	7.1 × 3.2 × 1.15 in (18.0 × 8.1 × 2.9cm)	7.1 × 3.4 × 1.0 in (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
Algebraic only	Algebraic only	Algebraic
Results only	Results only	Results/objects
3	3	3
No	No	No
3	3	3
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	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

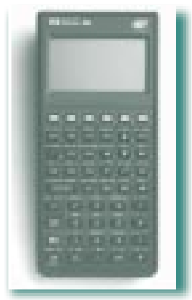
- 1.5 MB RAM built in, with Flash ROM for electronic upgrades
- 131 x 64-dot display
- 12-digit numeric values with 3-digit exponents
- Dual operating modes: RPN or Algebraic, with results and history stacks
- Computer Algebra System allows enhanced and dynamic manipulation and solving
- 4 font sizes 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



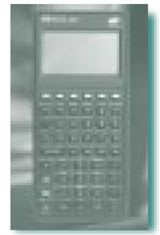
- Factorization, expansions and substitutions of expressions
- Select, Cut, Paste and Copy operations
- Step-by-step numeric and symbolic solutions
- "Textbook" format for equations and expressions in the Equation Writer and stack
- Symbolic and numeric integration and differentiation
- Differential 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 by 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...800-937-1300
PRO Distributors...212-840-6830
Taylor...check local area listings
United Stationers...check local area listings

National Retailers

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...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
Mississippi	**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

Varsity Mart...PO Box 5476...Fargo, ND 58105-7761
Univ. of N. Dakota...Univ. Station, Campus Dr....Grand Forks, ND 58202...701-777-2681

Ohio

Safe Technologies Corp....4131 State Park Dr....Akron, OH 44319...800-638-9121
College Book Store...50 S. Court St....Athens, OH 45701...614-594-3505
Univ. of Cincinnati Bkstr....123 W. Univ. Ave., ML 217...Cincinnati, OH 45221...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

CalcPro...33890 S.E. Eastgate Circle...Corvallis, OR 97333...888-200-4220
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
	Surveyors Module, Inc....412 Payne Ridge Rd....Church Hill, TN 37642...423-357-8931
	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

Late For Class? Says Who?

Whoops—Look at the Time!

A Teacher's Challenge: Can Someone Explain It?

A Student's Challenge: Can Someone Program It?

Sorry this issue is a bit later than usual—we just lost track of the time. But no wonder! Did you notice, amidst all the hoopla surrounding our recent calendar rollover, those earnest little articles attempting to explain not only why it wasn't the end of the millennium, but why our calendar is so bollixed up in the first place? And did any of those explanations completely satisfy you? Of course not.

As a public service, therefore, it is incumbent upon us to assume this solemn burden, which we now promptly fob off onto our learned readers. We hereby petition some enterprising souls and their students to set us all straight with the following two-part *tour de force* of chronological clarity, which we are prepared to reward most handsomely (i.e. exposition in a future issue of this august journal, plus whatever goodies we can wheedle out of HP). To wit:

A. Can anyone explain both clearly and *succinctly*—in qualitative terms, to laypersons such as us—exactly why timekeeping on this planet is so difficult? Since in practical terms it's related to astronomical cycles (day, month, season, year), it would seem at first glance to be a set of straightforward overlays of geometry and trigonometry. Well, it ain't. Everything in the universe is in motion—but it's not quite regular motion. Things are slowing down, wobbling, sloshing, precessing, messing with each other's orbits—and Einstein's relativity is always in the act, too. It's all terribly untidy (no pun intended). And even a cursory perusal of fuller explanations (such as **www.maa.mhn.de/Scholar/times.html#intro** and **www.xylem.demon.co.uk/kepler/** and their links) will usually drive the point home: Exact time is just a fiction we all try to agree upon.

So what we're looking for here is just the list of the known factors (not equations or numbers, just the motions or forces) that make your watch wrong no matter what it says. What are the intricate patterns—and the chaotic gotchas—of our humble little universe that can get even the snappiest of our supercomputers to overheat simply in calculating when the sun rises, when the moon is in the 7th House, and when to set out the tomatoes? Extra points for a list of the names and acronyms of the smoothings and approximations we've learned to fudge with. And it must all fit on this page. (This is more entertaining than it sounds. Really.)

B. The HP 49G has a decent clock (and an adjustment command handy for those pesky leap seconds), but it doesn't seem to display any more of the calendar than the current day. Surely it can do better—with a little help from you (or a tinkering student you wish to challenge): Program it to display the current month in "wall-calendar" style. Extra points for elegance and ease of use; silent awe for including the phases of the moon, the solstices and equinoces.

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