Stylus, style and math savvy: Xpanded learning power is at hand.

Your Wildest Dreams

By G.T. Springer

Go grab any software package on the market today and you're likely to read claims of "interactive" or "dynamic," or a user interface that is "intuitive" or "easy-to-use." Few actually deliver on that promise, of course—with no concrete definition of such attributes, anyone can claim them—which makes those products that do deliver so startlingly superior that it's a shame you can't tell just by reading the box.

So, how will I recognize such qualities in the next generation of software, specifically in my field, which is hand-held technology designed exclusively for education? Surely it will claim to be all of the above. It must be interactive to engage students, and it must be dynamic to help them make connections. The interface must be easy-to-use and intuitive so that classroom time is spent on using the device to learn mathematics, not on learning how to use the device.

Now, how could such promises be delivered?
Let me fantasize....

An interactive grapher would let us enter graphs in a variety of ways. We'd just make a sketch right on the screen, and convert it into a mathematically correct graph on the fly. If that grapher were truly dynamic, moreover, we could control the graph window—move around or zoom in or out directly—without a separate environment for the window settings. And we'd have equally direct ways of translating and dilating existing graphs, seeing the effects on the equations at the same time that the transformations occur.

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Likewise, a dynamic and interactive geometry environment would proactively encourage speculation and exploration. A triangle could be constrained to be a right triangle at one time and obtuse at another, without reconstructing. If a student were to draw what appears to be a right triangle, the device might even ask the student if he/she would like the triangle to have that property.

Wouldn't that be great? Such an intuitive interface in these fundamental topic areas would really foster mathematical thinking—with a maximum of transparency between thought and deed. It would accept the way we work with paper and pencil and try to bring those ways to life on an active screen. It might even offer electronic lessons, formatted to focus a student's attention, engage the student's imagination, and encourage conceptual rather than computational development.

And a *truly* revolutionary device might even go one step farther and give teachers the tools they need to create their own electronic lessons—faster than they could document them in their lesson plans. *That* would be a dream come true.

(And by the way: shouldn't a product this interactive and dynamic be useful in science, too? And languages, social studies, art, music, football...? You heard it here first.)

G.T. Springer is currently a teacher advocate for the Hewlett-Packard Calculator division. You can contact him at gt_springer@hp.com.

Checking Out Xpander

What is Xpander?

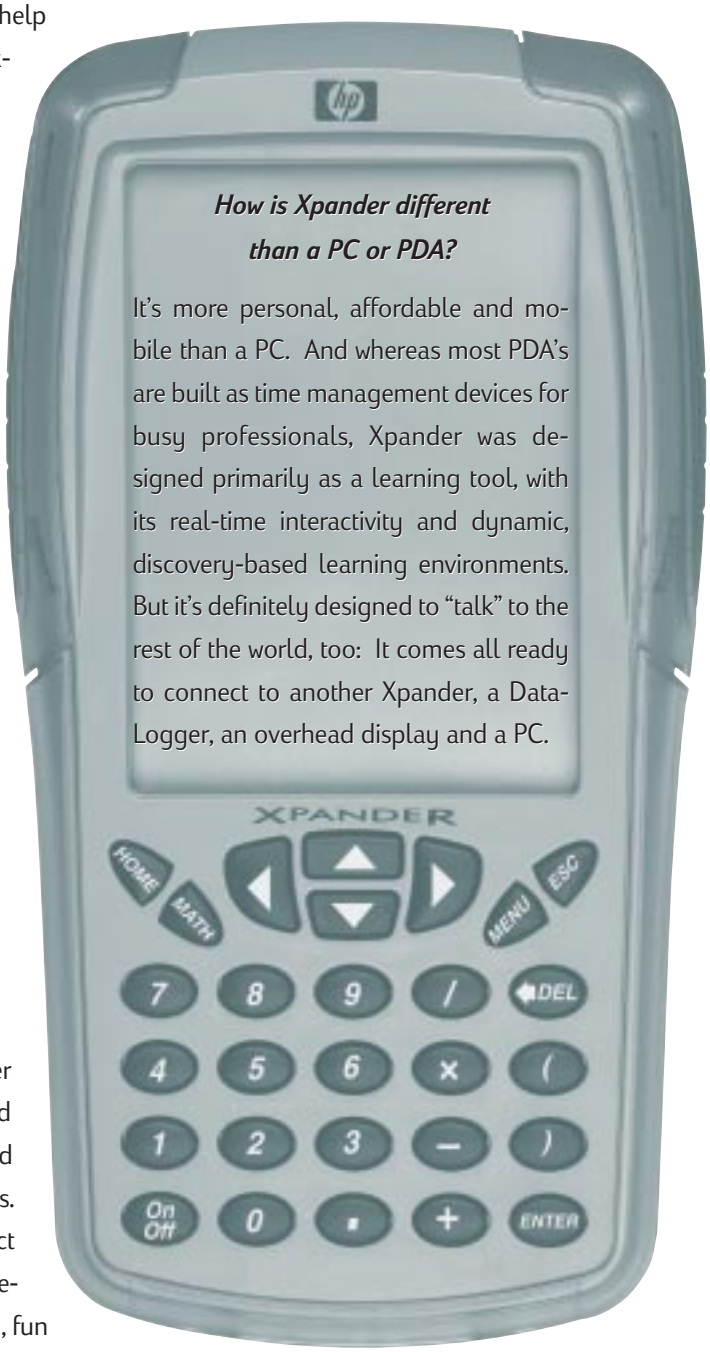
Xpander is a friendly, engaging, personal handheld learning partner for high school teachers and students. It has fewer keys, a larger screen and easy stylus input for seamless learning—anywhere, anytime. Xpander comes ready with exploratory math learning software and e-lessons to help students learn by doing, not by rote. And its flexible expansion card slot and PC connectivity open the door to multi-subject learning, communication, memory expansion and many other exciting future possibilities. All this—in a package that fits into the palm of your hand (6.4" x 3.5" x 0.9") and runs on two rechargeable AA batteries.

What does this mean for math learning?

It means that students can learn more intuitively, flexibly and individually. Xpander has interactive and dynamic environments for geometry, algebra, tables and matrices. As students use the stylus (pen) directly on the large grayscale screen, they see equations, graphs and table values all change together, in real time. And with built-in demonstration interactive e-lessons, teachers can harness this dynamic power in self-contained lesson units to reach more students with less time, effort and stress.

How is Xpander different than a calculator?

First, it's more user-friendly and engaging. It has fewer buttons, a larger screen, on-line help and pen-based input. It's also more exploratory, with a discovery-based interface, built-in math learning software and e-lessons. And even with all that, it's more flexible too. Its compact flash card slot presents opportunities for learning beyond math and science: with future memory expansion, fun and communication possibilities, the sky's the limit.



Cash For Teachers and Calculators for Class

HP Awards Curriculum Contest Winners

During last November and January, Hewlett-Packard and Northern Kentucky University collaborated to present a series of three calculator workshops at NKU, drawing some 50 attendees among local area elementary, middle-school and high-school teachers, as well as faculty from the university. Besides the instruction sessions, each attendee received a free calculator and packet of teaching materials, and all were invited to enter a contest for the best curriculum activity utilizing the calculator(s) in the classroom. Top prize for each model was $500 and a 30-unit classroom set of those calculators.

The results are now in, and Hewlett-Packard is pleased to note and congratulate these winners (and their winning curriculum activities may appear in future issues of **HP^{C}**):

Judy Manning (for an **HP 6S**-based activity for grades 6-8: "It's a Hit!") is a 16-year veteran middle-school teacher. *"Although I had originally intended to teach high-school math, I believe my assignment as a middle school teacher was a blessing in disguise. By their very nature, my students continually challenge me to be a better teacher. In the quest of making math more interesting, relevant, and exciting, I have participated in numerous workshops, conferences, and training programs geared toward hands-on, discovery learning. I hope to pursue National Certification in the near future. However, before I tackle that goal, I plan to focus on using technology in the classroom to better engage my students."*

Debbie Kuchey (for an **HP 38G**-based activity for grades 7-8: "Exponential Growth!") is an experienced teacher and also an education instructor. *"I am moving to Xavier University in Cincinnati, Ohio, this fall to continue teaching elementary and middle-school education courses, while I complete my doctorate in Curriculum and Instruction at the University of Cincinnati. Prior to working at the University, I have fifteen years of teaching experience in grades 2 through 8. Eleven of those years involved teaching middle-school mathematics in public schools. Mathematics is where my passion lies, especially in advancing students' proficiency in the use of tehnology to aid them in tackling realistic mathematical adventures."*

Sister Anita Marie and **Dave Bezanson** (for an **HP 49G**-based activity for grades 11-12: "Investigating Lines Using Parametric Equations") both teach at Bishop Brossart High School in northern Kentucky.

Sister Anita Marie teaches mathematics and computer science and is now in her 17th year at the school. She is a National Presidential Awardee in Mathematics and a GIFT (Growth Initiative For Teachers) recipient from GTE. She has given numerous presentations at the state and national level and is presently the president of the Northern Kentucky Council of Teachers of Mathematics.

Dave Bezanson teaches chemistry and integrated science and is developing an AP environmental course. Now in his 11th year of teaching—his 2nd at Bishop Brossart—Dave is preparing a Legos-based robotics competition for grade and middle schools, hoping to instill in younger students an evolving interest in both science and math.

Writes Sister Anita: *"The calculators will be used in several of the mathematics classes, including PreCalculus, Advanced Topics and AP Calculus, chemistry and AP Environmental Science. The calculators will be valuable tools to help visualize concepts and formulate generalizations that would be very tedious to do with time-consuming number-crunching and endless plotting of points for graphs. It is a great benefit to our students to have access to a classroom set of such powerful calculators, and we are sincerely grateful to Hewlett-Packard for the opportunity. Thanks again."*

hp.com/go/math

A Community of Educators Meets Online

Welcome! Pull up a chair and share

Come In and Get Acquainted

Did you know? There's a place you can go to meet and chat with other educators, colleagues and anyone else who's interested in the educational world of HP calculators. This is just an informal community get-together site, with a variety of topics and forum spaces to share them.

hp.com/go/math

Drop by and sit a spell.

E-Lessons for All

Want to know more about HP's E-lessons? Or are you an E-lesson veteran with ideas and knowledge to share? Either way, come into this forum and work with other teachers, students and HP experts to get the most from these great applications!

Subject Forums

Choose the math subject area that suits your interests and talk to your peers or to HP Experts about how to best apply the calculators:

Pre-Algebra	Algebra
Trigonometry	Geometry
Pre-Calculus	Calculus

The Teachers' Lounge

Have you come up with a new way to use an HP calculator in the classroom? Looking for ways to spice up your lessons? Join this discussion forum to exchange ideas, anecdotes or problems and solutions. Fill your cup, relax and do a little networking.

Trade tips, share stories, chat with experts—
or just sit on the porch and listen.

*It all happens at **hp.com/go/math**.*
You don't even need to bring a covered dish.

Calc Skills Study Hall

Just pick a calculator and come on in. Hone your skills, clear up misconceptions, learn handy tips and shortcuts—Q & A galore:

- HP 6S and HP 30S
- HP 38G and HP 39G
- HP 48G Series and HP 49G

Network for special purchase opportunities

Share news tips on factory incentive promotions and pricing (such as the ones noted below). You and your colleagues can often save big by consolidating your purchases of HP calculators and equipment!

Whatever You Do, Don't Be a Stranger!

The Educators' Community Site is where we can all get to know each other by name, and there's a lot of good stuff to share and pass around, so be sure to introduce yourself.

NEWS FLASHES

Back-To-School calculator specials—now through October 31: Get FREE extra faceplates with purchase of an HP 30S. Get a FREE Connectivity Kit with purchase of an HP 39G. And with purchase of an HP 6S, HP 30S or HP 39G, you'll be entered to win a trip for four to Walt Disney World. Visit **hpshopping.com** , call 1-888-999-4747, or see page 48. . . . . .

. . . . . ***Get great prices*** on calculators for you or your classroom! See your local reseller or visit **hp.com/go/education** and click on **Products**. . . . . .

. . . . . HP is still ***doubling*** the normal redemption points on purchases of certain calculators. See page 30. . . . . .

Advice, Mentoring, Workshops: Your Topics, Your Speed, Your Schedule

HP LEARN: Expert Help as You Need It

Looking for experienced help or advice on how best to use technology to enhance learning in the classroom? There's a web site you should visit: **hplearn.org**.

HP LEARN (Local Education Advocacy Resource Network) helps connect educators with students, technology and curriculum through innovative locally-based support. HP LEARN math advocates are situated in communities all over North America, sharing their wealth of knowledge in best teaching practices and their infectious enthusiasm for math and new technology.

These math advocates are building long-term relationships with local educators, offering them ongoing support, technical expertise, help with applying for technology grants, and encouragement in the adoption of appropriate technology in schools.

HP LEARN math advocates also conduct a range of in-service training to meet local needs with local solutions, connecting up-to-date educational standards to innovative teaching strategies and classroom uses of the inventive technology of Hewlett-Packard. Their detailed knowledge of the math standards in their states enables them to design and lead superb in-service sessions. The result is professional development that meets specific teacher needs.

Make the Connection

Math advocates are located throughout North America, in areas such as Baltimore, Boston, Chicago, Denver, El Paso, Los Angeles, Miami, Portland (Ore.) and Toronto. For more information, visit **hplearn.org**, or e-mail **info@hplearn.org**.

Arranging Workshops For Your Schedule

HP calculator workshops may be arranged on an as-needed basis, to fit attendees' schedules. Also adjustable are the workshop format, length, skill level and emphasis. HP and The Math Learning Center can custom-tailor presentations on any HP scientific or graphing calculator. To inquire, contact:

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

Workshop Schedules Posted

For a current schedule of HP calculator workshops, be sure to visit the web site of The Math Learning Center:

www.mlc.pdx.edu

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) 3747.7799	
Canada	1.970.392.1001	
Chile	(56) 2.800.360.999	
Colombia	(57) 1.629.5030	
Mexico	(52) 5258.4044	01.800.900.7200 *(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

Why Factor?

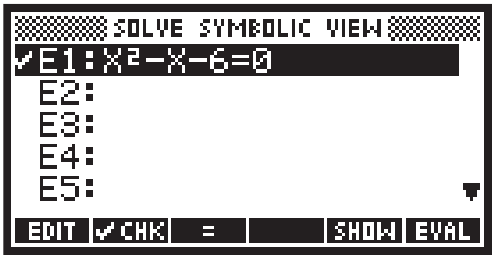
Making Connections with the HP 39G

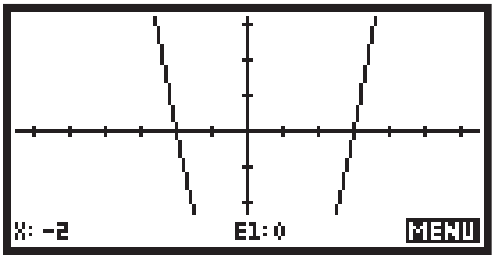
By Claudia Carter

In math, the verb *factor* means to write a number or expression as a product (multiplication) of its parts. Take a simple example. To factor the number 12, there are numerous possibilities among the integers alone: 3 x 4, 2 x 6, or 2 x 2 x 3.

The same idea applies when factoring trinomials or quadratic expressions of the form $ax^2 + bx + c$. You probably already know this if you've worked with algebra tiles. But did you realize that factoring relates to solving quadratic equations? It tells you if—and how many times—the graph of the equation crosses the x-axis, and it provides meaning for the words roots, zeros and x-intercepts.

Consider the expression $x^2 - x - 6$. This factors into $(x - 3)(x + 2)$. Try looking at it in a variety of ways and see the connections. Use the Solve aplet, which lets you view the graph as well as solve the equation. Press APLET and start the Solve aplet. At the E1 prompt, enter $X^2-X-6=0$.





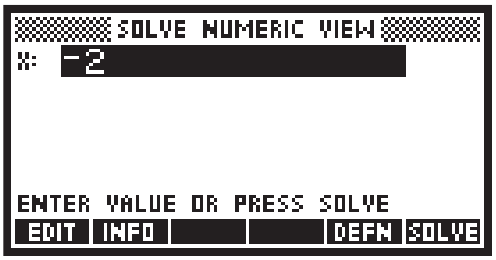
Press VIEWS, then highlight and select Decimal to get a friendly window of the plot (and hereafter you can get the graph back simply by pressing PLOT).

1. Press MENU and then activate TRACE. Then use ◀ and ▶ to move along the curve. Where does the graph cross the x-axis? (These are the x-intercepts.) How many times does it cross?

2. Press GOTO 3 ENTER. What is the y-value (i.e. the value of the expression E1) for this x-value? Press MENU. Try GOTO (−) 2 ENTER. What is that y-value? What does this tell you about 3 and −2?

3. Press NUM, enter a positive x value and press SOLVE. What value do you get? What does INFO tell you?

   Repeat the process, using a negative value for x.



4. How does all of this relate to the original factored form?

Teacher Notes

Although the NCTM Standards 2000 Draft recommends that less time be spent on factoring, the teacher is always seeking interesting ways to teach it and make connections with it to other topics of more concern in the math curriculum. Solutions to quadratic equations and their connections to their graphs fulfill just those connections and make factoring more meaningful for students. This discussion also lays a strong foundation for other graphing topics.

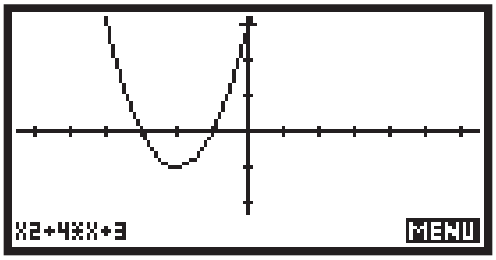
The activities can be done in pairs or within small groups, where students can discuss insights as they go along. It's important that the teacher summarize and clarify findings once the worksheets have been completed. Depending upon the timing and the strength of the group, the teacher may or may not share examples of trinomials with real irrational roots, such as $x^2 - x - 1$. It may be better to wait until discussing the quadratic formula.

Answers

1. *At x = 3 and x = −2; 2 times.*
2. *0; 0; tells me that (3,0) and (−2,0) are the x-intercepts.*
3. *3; 3 is a zero; −2; −2 is a zero.*
4. *The second term in each factor, with opposite sign, represents a root (that is, a zero or x-intercept) of the graphed version of the polynomial.*

Use the graphing process to see if you can factor each of the following. Identify the zeros (also called the roots or x-intercepts), then write the factored form. Use PLOT or SOLVE to help you. (#**5** is plotted for you.)

5. $x^2 + 4x + 3$



6. $x^2 + 10x + 21$

7. $x^2 + 9x + 20$

8. $x^2 + 8x + 12$

9. $x^2 + 17x + 72$

10. Notice that all the expressions in #**5-9** above are of the form $x^2 + bx + c$. What do you notice about the operational signs in the parentheses of the factors?

11. How can you determine "b" when you look at the factors? What is the relationship?

12. How can you determine "c" when you look at the factors? What is the relationship?

Now change to the form of $x^2 - bx + c$. In the following five problems, write the factored form of the expression. Again, use PLOT or SOLVE to help you.

13. $x^2 - 5x + 6$

14. $x^2 - 11x + 28$

15. $x^2 - 6x + 5$

16. $x^2 - 11x + 24$

17. $x^2 - 10x + 9$

18. What is different about the factored forms of **13-17** than in **5-9**?

19. Can you make a generalization about the factors of $x^2 - bx + c$?

(continued on page 10)

5. *(x + 1)(x + 3)*

6. *(x + 7)(x + 3)*

7. *(x + 4)(x + 5)*

8. *(x + 2)(x + 6)*

9. *(x + 8)(x + 9)*

10. *All the operation signs are positive.*

11. *b = the sum of the last terms of the factors.*

12. *c = the product of the last terms of the factors.*

13. *(x – 3)(x – 2)*

14. *(x – 7)(x – 4)*

15. *(x – 1)(x – 5)*

16. *(x – 8)(x – 3)*

17. *(x – 9)(x – 1)*

18. *All signs change to negatives.*

19. *For the trinomial, when the first operation sign is negative and the second is positive, the factors will use negative signs.*

Note: b = sum, and c = product.

(continued from page 9)

Now consider $x^2 + bx - c$.

20. $x^2 + 3x - 28$ **21.** $x^2 + 7x - 18$ **22.** $x^2 + x - 20$

23. $x^2 + 7x - 8$ **24.** $x^2 + 3x - 18$

25. How can you use the factored form to see where "b" comes from this time?

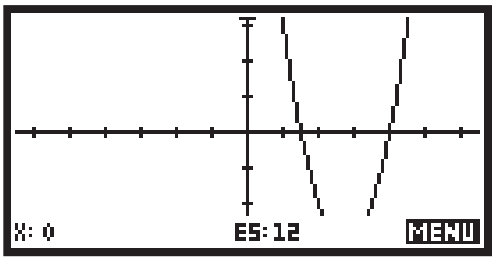
How about $x^2 - bx - c$?

26. $x^2 - 2x - 24$ **27.** $x^2 - 2x - 63$ **28.** $x^2 - 4x - 21$

29. $x^2 - x - 2$ **30.** $x^2 - 3x - 40$

31. Make a generalization about the factors of $x^2 + bx - c$ and $x^2 - bx - c$.

Now suppose you have a trinomial of the form $ax^2 \pm bx \pm c$, where a is something other than 1? For example, if $2x^2 - 11x + 12$ has zeros at x = 3/2 and x = 4 (which you can see by looking at the x-intercepts of its graph), how do you find the factors? "Working Backwards" is the technique here.



Of course, the root at x = 4 would help you see immediately from the previously established pattern that one factor is (x − 4). but what about the other factor? Think "x = 3/2 becomes 2x = 3" (undoing division with multiplication). Then to get the factor to equal zero, just subtract 3 from both sides: 2x − 3 = 0.

Check the product of (2x − 3)(x − 4). Note that the operational signs follow the same patterns you observed previously, too, though they might change slightly with the $ax^2 \pm bx \pm c$ form. Try these.

32. $2x^2 + 3x - 5$ **33.** $4x^2 - 7x + 3$ **34.** $2x^2 - x - 3$

35. $2x^2 - 9x - 5$

36. So far, the graphs of all these trinomials have crossed the x-axis twice. Now plot $x^2 + 4x + 4$ and describe what its graph does regarding the x-axis.

The factored form of $x^2 + 4x + 4$ is (x + 2)(x+ 2). The x-value –2 is called a double root, because it is the same value that results from solving x + 2 = 0 twice. But the graph would touch the x-axis just once. (Try it.)

20. *(x + 7)(x − 4)*

21. *(x + 9)(x − 2)*

22. *(x + 5)(x − 4)*

23. *(x + 8)(x − 1)*

24. *(x + 6)(x − 3)*

25. *Again, b = the sum of the last terms (including the signs) of the factors.*

26. *(x − 6)(x + 4)*

27. *(x − 9)(x + 7)*

28. *(x − 7)(x + 3)*

29. *(x − 2)(x + 1)*

30. *(x − 8)(x + 5)*

31. *The sum of the last terms of the factors = b; the product of the last terms of the factors = c; the factors use opposite operational signs.*

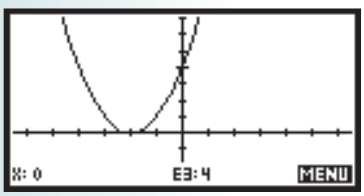
32. *(2x + 5)(x − 1)*

33. *(4x − 3)(x − 1)*

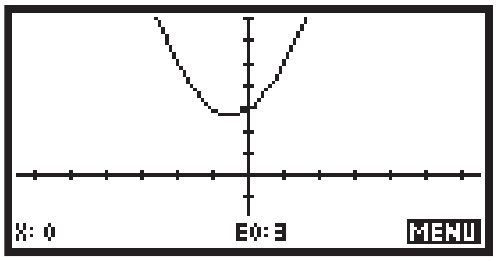
34. *(2x − 3)(x + 1)*

35. *(2x + 1)(x − 5)*

36. *The graph touches the x-axis at one point: x = −2.*



But look at the plot of $x^2 + x + 3$. How many times does this graph cross the x-axis? None! It has *no real roots*, so it doesn't cross the x-axis at all and therefore *cannot be factored in the manner shown above*. (But just because you can't factor a trinomial doesn't necessarily mean it has no real roots. Some trinomials, such as $x^2 - x - 1$, do indeed have roots (their graphs cross the x-axis), but you can't factor them as you've been doing here, because their roots are *irrational*—not simple integers or fractions. In such cases, you must find approximations of the roots graphically or use the quadratic formula to calculate them.)



Based on everything you've observed in this activity, complete the following chart. Use your plots to help you fill in the spaces.

SYMB	"crosses" x-axis 0, 1 or 2 times?	Factors as
37. $4X^2-4X+1$		
38. $2X^2+5X+2$		
39. $5X^2+7X-6$		
40. X^2-X+1		
41. X^2-6X+9		
42. $2X^2-7X+3$		
43. X^2+2X+4		
44. X^2-2X+1		
45. $X^2+3X-10$		

37. *Crosses x-axis once; factors as $(2x-1)^2$.*

38. *Crosses x-axis twice; factors as $(2x+1)(x+2)$.*

39. *Crosses x-axis twice; factors as $(5x-3)(x+2)$.*

40. *Does not cross x-axis; cannot be factored.*

41. *Crosses x-axis once; factors as $(x-3)^2$.*

42. *Crosses x-axis twice; factors as $(2x-1)(x-3)$.*

43. *Does not cross x-axis; cannot be factored.*

44. *Crosses x-axis once; factors as $(x-1)^2$.*

45. *Crosses x-axis twice; factors as $(x-2)(x+5)$.*

This article was excerpted from "HP 39G Classroom Activities" a book of curriculum ideas for the HP 39G, available from HP through the HP Educator Program at The Math Learning Center. (See page 7 for full details on how to contact MLC to acquire this book.)

Claudia Carter has been teaching for 28 years and is a Presidential Awardee, Tandy Scholar, Christa McAuliffe Fellow, National Board Certified Teacher, President of National Mu Alpha Theta, and Chair of the Mathematics Education Trust Committee. Now teaching at Mississippi School for Mathematics and Science in Columbus, MS, she has been using graphing calculators since 1989, when she attended the Woodrow Wilson fellowship Institute in Algebra. She enjoys tennis, walking and listening to 50's music.

Fraction Farey Tales

Exploring an Interesting Sequence with the HP 30S

By Colin Croft

Although the idea may seem a little bizarre to you, mathematicians often spend valuable TV time just playing around with numbers! Sometimes they discover interesting things. John Farey (1766 - 1826) was one of those who found a small but interesting fact about fractions.

He began by writing down all the possible fractions, no larger than 1, that could be made by using only the numbers 1 through 4:

$$\frac{1}{1}$$

$$\frac{1}{2} \quad \frac{2}{2}$$

$$\frac{1}{3} \quad \frac{2}{3} \quad \frac{3}{3}$$

$$\frac{1}{4} \quad \cancel{\frac{2}{4}} \quad \frac{3}{4} \quad \frac{4}{4}$$

He then went through the list and removed any fractions that reduced to another simpler form earlier in the list. For example, this is why he crossed out 2/4, as shown above, since it reduces to 1/2, which appears earlier in the list.

1. Cross out any other fractions which reduce to others appearing earlier in the list above. (There should only be six terms left.)

2. Starting with zero, write the list of remaining fractions in ascending order below. (If you're not sure which of two fractions is greater, you can convert them to decimals on your HP 30S. For example, to see the decimal value of 2/3, you would press [2] [A b/c] [3] [2nd] [F◄►D] [ENTER].)

0, _____, _____, _____, _____, _____, _____,

3. Choose any pair of consecutive fractions from your list in #**2** and find their difference. Repeat this for any two other consecutive pairs, also.

$$\frac{\square}{\square} - \frac{\square}{\square} = \frac{\square}{\square} \qquad \frac{\square}{\square} - \frac{\square}{\square} = \frac{\square}{\square} \qquad \frac{\square}{\square} - \frac{\square}{\square} = \frac{\square}{\square}$$

Teacher Notes

John Farey (1766 - 1826) was a geologist who occasionally dabbled in mathematics and thereby discovered an interesting sequence of fractions (which was later named for him).

The Farey Sequence of order n is created by starting with 0, then using the positive integers from 1 through n to form all possible positive fractions (reduced to lowest terms) no greater than 1. The fractions are arranged in increasing order, and duplicate values are omitted.

For example, the Farey Sequence of order 7 would be: 0, 1/7, 1/6, 1/5, 1/4, 2/7, 1/3, 2/5, 3/7, 1/2, 4/7, 3/5 2/3, 5/7, 3/4, 4/5, 5/6, 6/7, 1.

Such a sequence has at least two interesting properties:

- *The difference between any two consecutive fractions always has a numerator of 1.*
- *The sequence is palindromic by addition: any two fractions which occur at an equal number of terms from their respective ends of the sequence always sum to 1.*

Later mathematicians who investigated Farey's sequence subsequently proved these properties for all integers n, and they deduced a number of results which were later to prove usefully applicable to Pick's Area Theorem.

More information on John Farey and other mathematicians can be found at a number of web sites. In particular, visit www.cut-the-knot.com/ctk/Farey.html.

4. Compare your results to those of the person next to you. See if you can spot the pattern that John Farey saw. (Hint: Look at the numerators—and don't expect too much, because it's a very simple pattern.) Explain it in words.

5. Look at your list of fractions again, and add the first and last. Now add the second term and the second-to-last term. Keep working in this way toward the center of the sequence. What do you notice?

This is known as a palindromic pattern. A palindrome reads the same backwards as forwards (such as, "Able was I, ere I saw Elba"). John Farey wondered if his pattern worked only for the fractions in his first list or whether it might work for any such list. (Mathematicians often ask this sort of question.)

6. This sequence of ascending fractions is named the Farey Sequence in honor of its discoverer. The one you just saw is the Farey Sequence of order 4. Now write down the Farey Sequence of order 7. (Don't forget to include zero.)

7. Now test Farey's patterns on the order-7 sequence. Test at least three fractions when subtracting. (Choose a different set of three from your neighbor, so you can compare results.) Check also that the palindromic pattern works for your sequence.

In this activity, suitable for grades 6 and 7, students investigate Farey Sequences of various orders. In doing so, they gain practice in the skills of addition, subtraction and ordering of fractions. They are also encouraged to form mathematical conjectures and to extend their mathematical knowledge by communicating hypotheses and considering the work of others.

There are no special materials required (except access to HP 30S calculators). Students are assumed to be able to order, add and subtract proper fractions.

This article was excerpted from "Investigating Mathematics through Patterns," a book of curriculum ideas for the HP 30S, available from HP through the HP Educator Program at The Math Learning Center. (See page 7 for full details on how to contact MLC to acquire this book.)

The author, Colin Croft, has been a math teacher at St. Hilda's Anglican School for Girls in Western Australia for the past 12 years. In addition to other math texts, he is the author of many ApLets and a book on the HP 38G, and he maintains an HP 38G user's web page. Colin is currently serving as a consultant for Hewlett-Packard.

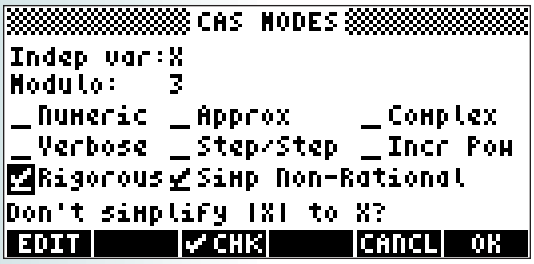
Three Approaches to the Derivative

Unifying the Concept on the HP 49G

By Mark Howell

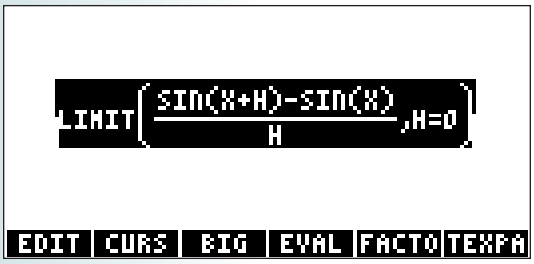
What does a derivative "look like?" How does it behave? Here's an exercise that gives you three different ways to think about a derivative.

As you know, for any function, $g(x)$, its derivative, $g'(x)$, is defined as $\lim_{h \to 0} \frac{g(x+h)-g(x)}{h}$ for all x, if the limit exists. For the function $g(x) = \sin(x)$, this definition becomes $g'(x) = \lim_{h \to 0} \frac{\sin(x+h) - \sin(x)}{h}$



First purge the variables X and H. Then to evaluate this limit, start by entering it into the HP 49G's Equation Writer and using the symbolic algebra tools.

First, set the modes correctly. Press MODE CAS, and make sure your screen appears as shown here.



Press OK OK to accept the mode settings, then go to the equation writer, EQW. Enter the difference quotient first: SIN X + ALPHA H ▶▲ − SIN X ▶▲ ÷ ALPHA H. Now highlight the entire expression, ▶▲, then apply the limit command to the highlighted expression: ◀ CALC 2 ENTER 2 ENTER ALPHA H ▶ = 0 ▶▲.

If BIG appears in the menu (i.e. if the "big" font is currently selected) change it to BIG (press it once) to select the smaller font, so that you can see the entire expression. The calculator is capable of evaluating this limit—press EVAL....

Voila! How is this done? Magic? No—people have been evaluating limits long before computer algebra systems. They simply expanded the quotient expression and looked at its behavior as H became very small....

Press ▶ UNDO to recover the limit expression. Now use a trigonometric identity to expand SIN(X+H). Press ▼▼▼, which will highlight SIN(X+H). Then press TEXPA, which will apply the trig identity SIN(A+B)=SIN(A)*COS(B)+COS(A)*SIN(B). Press ▲▲ to highlight the entire quotient. Now split the fraction into two terms by applying PARTFRAC (◀ ARITH 2 ENTER 1 4 ENTER).

Now you have the following limit expression, equivalent to your original:

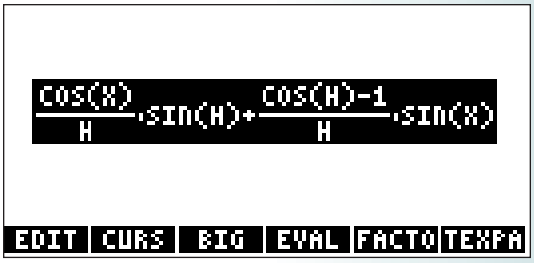
$$\lim_{H \to 0} \frac{COS(X)SIN(H)}{H} + \frac{(COS(H)-1)SIN(X)}{H}$$

Teacher Notes

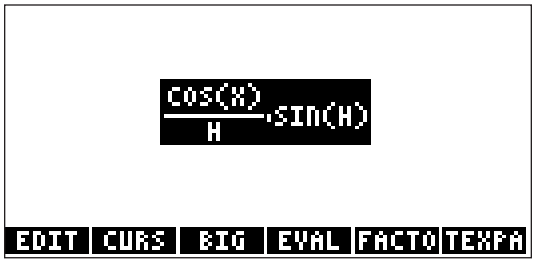
This activity introduces the idea of the derivative function and the connections between the graph of a function and its derivative.

Before beginning this activity, students should know the definition of derivative and be familiar with defining functions and looking at tables and graphs. (Most keystrokes are shown, but some familiarity with graphs and tables is assumed.)

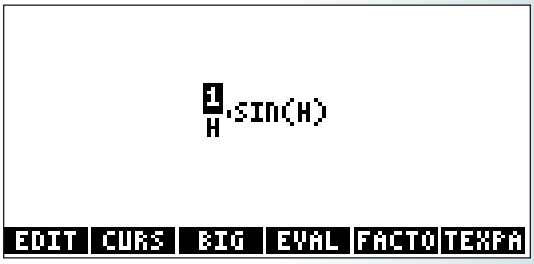
To find the limit of a sum, notice that you can find the sum of the limits (of each addend). Also, note that in the first term, COS(X) does not depend on H, so it can be factored through the limit. Similarly, in the second term, SIN(X) can be factored through. All you really need to do is find how SIN(H)/H and (COS(H)−1)/H behave for H near 0. To do that, use the calculator's table and graphing features.



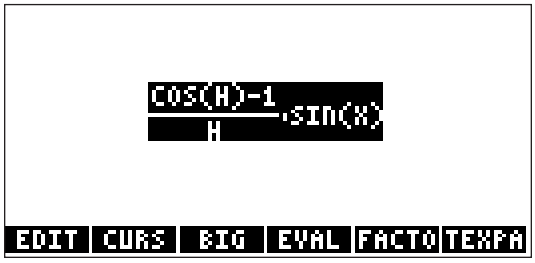
First, press →COPY to make a copy of the expression in the limit, as shown here (right). Now press CANCEL ←2D/3D and set Type to Function. Then ←Y= NXT CLEAR ▓OK▓ NXT ▓ADD▓ ←→CLEAR. (You delete the left sides of the equations so that the definitions will be in EQ, rather than in Y1, Y2, etc. You'll see them via ▓DEFN▓ in the table.)



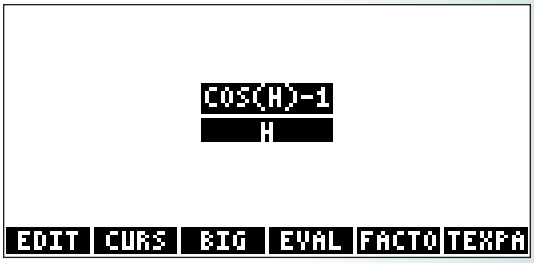
In the Equation Writer, →PASTE the expression you copied earlier. Now delete the second addend, by pressing ▽▷ ←DEL. The display will now appear as shown here (left).



To delete the COS(X) factor, press ▽▽ ▓EDIT▓ →CLEAR 1 ENTER. Your display should appear as shown here (right).

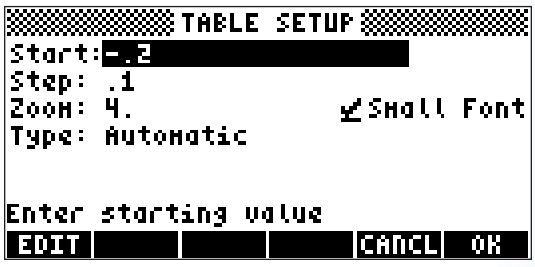


Use ENTER to put that expression into EQ. Then press ▓NXT▓ ← →CLEAR →PASTE to use the original expression, and ▽ ←DEL. Your display should appear as shown here (left).



Press ▽▷ ←DEL ←DEL. Your display should appear as shown here (right). Press ENTER to put that expression into EQ also.

Now press ←2D/3D and set up your plot as shown below, left. (Be sure to change the independent variable to H.) Then press ←TBLSET and set up the table as shown below, right.



(continued on page 16)

Press [2nd] [TABLE] [DEL]. Press [▼] [▼] [▶] to position the cursor on the row with `H=0` and in the column with `1/H*SIN(H)`. Zoom in to the table twice, by pressing [ZOOM] [OK] [ZOOM] [OK], and you'll see outputs for `1/H*SIN(H)` and `(COS(H)-1)/H` for values of `H` near 0.

1. What does it appear $\lim_{H \to 0} \frac{SIN(H)}{H}$ is?

2. What does it appear $\lim_{H \to 0} \frac{COS(H) - 1}{H}$ is ?

Go back to your separated, factored limit expression:

$$\lim_{H \to 0} \left(\frac{SIN(X + H) - SIN(X)}{H} \right) = COS(X) \lim_{H \to 0} \frac{SIN(H)}{H}$$

$$+ SIN(X) \lim_{H \to 0} \left(\frac{COS(H) - 1}{H} \right)$$

Replace each limit expression on the right hand side of this equation with your answers from above.

3. What is $\lim_{H \to 0} \left(\frac{SIN(X + H) - SIN(X)}{H} \right)$?

4. If $g(x) = \sin(x)$, what is its derivative, $g'(x)$?

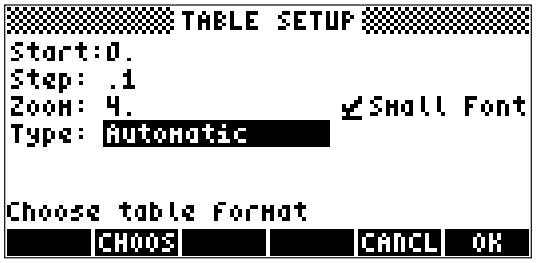
Take a graphical and numerical look at this result. Press [2nd] [2D/3D], highlight the `INDEP` field, and press [X] [ENTER] to change the independent variable to `X`. Press [2nd] [Y=] [NXT] [CLEAR] [OK] [NXT] [DEL]. Enter the expression `(SIN(X+.001)-SIN(X))/.001` for `Y1`. (Or it may be `Y2` or `Y3`, etc., depending on what else you have stored.) This is the difference quotient for `SIN(X)`, with a small value, `.001`, substituted for `H`. Enter the expression `COS(X)` for `Y2` (or `Y3`, `Y4`, etc.).

Press [ERASE] [DRAW] to see the graphs.

5. Trace on the two graphs, observing function outputs for different inputs. What do you notice?

6. What does this tell you about the derivative of the function $g(x) = \sin(x)$?

Press [↰][TBLSET], and set up the table as shown here:



Then press [↰][TABLE] and look at the resulting table of values.

7. What do you notice about the table of values for the difference quotient and `COS(X)`?

8. What does this numerical evidence tell you about the derivative of $\sin(x)$?

9. How could you change the definition of `Y1` to make the values of `Y1` and `Y2` even closer?

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Answers

1. *1*

2. *0*

3. *cos(x)*

4. *cos(x)*

5. *The two graphs are virtually indistinguishable in the default viewing window.*

6. *This gives graphical evidence that the derivative of sin(x) is cos(x).*

7. *The outputs from the difference quotient are close, but not exactly equal, to the outputs from cos(x).*

8. *The answer to number **7** gives numeric support to the conclusion that the derivative of sin(x) is indeed cos(x).*

Extensions

As a further exploration, students can investigate the difference in behavior between the difference quotient definition of derivative, covered here, and the symmetric difference quotient, which states

$$g'(x) = \lim_{h \to 0} \frac{\sin(x + h) - \sin(x - h)}{2h}$$

They can do this by looking at the errors in the two approximations—subtracting the exact value of the derivative from the difference quotient (or symmetric difference quotient) approximation.

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 ← CONV.)

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
← ANS: Last Argument(s) or previous calculation
→-HOLD 9: Time-Tools menu
ON-HOLD C ←-HOLD: Bypass library configuration routines.
(Useful when downloaded software malfunctions or is incompatible.)

Typing aides:

ALPHA →-HOLD O: ù
ALPHA →-HOLD 2: ¡
ALPHA →-HOLD 3: ¿
ALPHA →-HOLD 6: ª
→-HOLD ': ;
→-HOLD ': ' ' (RPN mode only)

Other shortcuts not requiring you to hold down a key:

ENTER: DUP
←: DROP
◀: Display PICTURE environment
▶: SWAP (RPN mode only)
▲: HIST or interactive stack
▼: 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-HOLD 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-HOLD 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.

Sports Spheres!

Exploring Circular Measure with the HP 6S

Adapted from HP's "Keys to the Calculator"

Say you run a company that makes packaging for sports balls of all kinds: soccer balls, ping pong balls, tennis balls, basketballs, etc. How can you use the mathematical constants found in circles to find an efficient way to package these balls?

1. Gather together 5 sports balls of different sizes.
2. Find the circumference of each ball. Use a method that will give you the most accurate measurement. Explain your method.
3. Find the diameter of each ball. Use a method that will give you the most accurate measurement. Explain your method.
4. Complete the chart below. (See the notes to the left here for hints.)

Sports Ball	Circumference (C)	Diameter (D)	C/D as a Fraction	C/D as a Decimal
			MEAN:	

5. What is the name for the ratio of circumference ÷ diameter?
6. How close was your mean to the calculator's built-in value? Why the difference?
7. Pick one ball from above and design a cube so that the ball just fits inside it, touching all six cube faces. Sketch a flat cutout of the cube you designed.
8. Design a cylinder so that the ball just fits inside, touching the top and bottom and all around the sides. Sketch a flat cutout of the cylinder you designed.
9. Calculate the surface area (i.e. the amount of packaging material) required by each of your designs above. Show your work.
10. Which design requires less? Why is this important to your company?

Locate the [π] key on your HP 6S.

- Press [INV][π]. What does your display read?
- Is this all of π? Explain.
- Do not clear your display. Press [×][2][x^2][=]. Now what does your display read? Explain what you have calculated. What happened when you pressed [x^2]?
- Do not clear your display. List the keystrokes you use to retrace your steps and find the radius in #3.
- To find the mean of all the C/D values, first press [MODE][SD] to set statistical data mode. Then enter the various decimal values for C/D, pressing [DATA] after each entry. Finally, press [INV][$\bar{x}$] to calculate the mean.

This article was excerpted in part from "Keys to the Calculator: NCTM-based Middle School Activities for the HP 6S," a book available from HP through the HP Educator Program at The Math Learning Center. See page 7 for full details on how to contact MLC to acquire this book.

About the HP 6S

Frequently Asked Questions

How do I make the shifted functions work on the HP 6S?

Press the colored key, [INV], prior to pressing the desired key. (Notice that the shifted functions of the keys are labelled in the same color as [INV].)

What's that letter E in the display —and how do I get rid of it?

The E indicates that an error has occurred. To remove it, press [C/CE].

What's that letter M in the display , and how do I get rid of it?

The M indicates that the memory register contains a non-zero value. To remove the M, press [0][X→M].

How do I power off the HP 6S Solar model?

The HP 6S Solar model is powered by both a battery and a solar cell. When the light is low, the battery powers the unit. There is no way to turn the calculator off, but the battery should last approximately 3 years in constant use (total darkness).

Some of the keys appear not to be working. What's wrong?

By design, in certain modes such as BIN, OCT and HEX, not all keys work. If you press [MODE][DEC], then all keys should function correctly.

Why do I get an error whenever I take the square root of a negative number?

The square root of a negative number is a non-real number. The HP 6S works only with real numbers.

Where can I find a new manual for the HP 6S?

Visit **http://www.hp.com/calculators**.

Where can I get more help using the HP 6S with my students?

Contact the **HP Educator Program** (see "How to Contact HP" in this issue).

Where Does it All Go?

Names, Variables and Directories on the HP 48G Series

By Chris Coffin and Tom Dick

Reserved Names and Constants

On the HP 48G Series, you should avoid using certain names for general-purpose storage because their contents are interpreted by the calculator for specific purposes:

ALRMDAT Current data for current alarms.
CST Current contents of custom menu.
EQ Current equation used by SOLVE and PLOT.
EXPR Current expression used by symbolic operations.
e (Symbolic constant*) 2.71828182846.
IERR Uncertainty in current integration.
IOPAR Current parameters for I/O operations.**
i (Symbolic constant*) (0,1).
MAXR (Symb. constant*) 9.99999999999E499.
MHpar Data of currently saved Minehunt game.
MINR (Symbolic constant*) 1.E-499.
Mpar Current equation set for Mult. Equation Solver.
Nmines Current number of mines in Minehunt.
PICT Current contents of graphic display.
PPAR Current parameters for plot operations.
PRTPAR Current parameters for print operations.**
VPAR Current parameters for viewing 3-D plots.
ZPAR Saves previous PPAR for zoom operations.
der... Indicates a user-defined derivative.
n1,n2, ... Integer coefficients used by ISOL.
s1,s2, ... Sign coefficients used by ISOL and QUAD.
π (Symbolic constant*) 3.14159265359.
ΣDAT Current matrix of data used for statistics.
ΣPAR Current paramaters for statistics calculations.

**Contents of this name cannot be changed — STO▶ gives an error. The display results depend upon the states of flags -2 and -3.*

***Interpreted this way in the HOME directory only.*

Storing Objects in Names

When you want to save an object in the HP 48G+/GX, you simply name it. That is, you position the object at stack level 2 and the desired name at level 1 (using algebraic apostrophes around the name, like this: '*name*'). Then press STO▶

Examples: To store the value 93 into the name QUIZ: 9 3 ENTER ' α α Q U I Z α STO▶ To store the expression 'L*W' into Area: ' α L × α W ENTER ' α α ↶ α ↶ A R E A α STO▶ To store the name 'QUIZ' into TEST: ' α α Q U I Z ENTER ' α α T E S T α STO▶

After each STO▶ both name and object (the two arguments) disappear from the stack, but the name then appears as an item (on the far left, if a new item) in the VARiable menu, which you can see via VAR. This menu shows the names of all objects stored in the current directory. (More about directories on the next page.)

Names may not contain delimiter characters nor begin with numerals, but they may be quite long and include lowercase and many non-alphabetic characters. But note that menu items display only the first 4 or 5 characters (and only uppercase—the name Area appears as AREA in the VAR menu), so be sure to choose names that are distinct—and descriptive—in their first few characters.

Invoking Names

Remember that any menu item is just a typing aid—a shortcut for typing that name and pressing ENTER. So pressing a menu key on the VAR menu does just that: it puts the name on the stack and evaluates it—just as if you had pressed ENTER afterward. Thus, after the above example, if you then press QUIZ at the VARiable menu, this is the same as typing α α Q U I Z ENTER. The value 93 will be entered onto the stack. (By contrast, to put a name onto the stack without evaluating it, use ' ': ' QUIZ ENTER or ' α α Q U I Z ENTER.*) And what happens when you press TEST? You get 93 also. When a name contains another name, that "inner name" is evaluated, too.

Purging (Erasing) Names

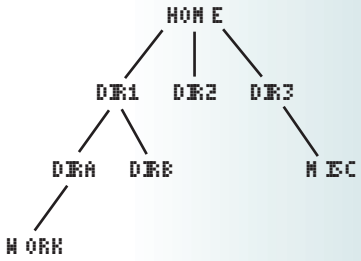
To purge a name from the current directory, put the '*name*' onto the stack and use ↶ PURG. To purge a group of names at once, put them into a list (and again the VAR menu is a typing aid): ↶ { } QUIZ AREA ... (etc.) ENTER ↶ PURG.

**Keep in mind, too, that you can use ↶ to store and ↷ to recall VAR name values: 9 9 ↶ QUIZ is the same as 9 9 ENTER ' QUIZ STO▶ And ↷ QUIZ is the same as ' QUIZ ↷ RCL.*

Directories

The machine's memory is organized into a hierarchical tree of directories, which you construct; the only built-in directory is the top one, HOME. Each *parent* directory can have one or more *subdirectories*, which, in turn, can be parents to their own subdirectories, etc. When you store (name) an object, it goes into the current *directory*—the directory where the machine's memory "pointer" is currently positioned. This is the rightmost name in the list showing in the annunciator area. So if you see just `{ HOME }` in the display, you're working in the HOME directory. But, say, `{ HOME DIR2 MISC }` would mean the current directory is MISC.

To build the example directory structure shown at right, you'd start at the HOME directory (press →HOME) and then use CRDIR to create subdirectories. As with many commands that require names as arguments, you can either enter the names one at a time or all together, in a list: ←{}ααDIR1SPCDIR2SPCDIR3ENTERααCRDIR ENTER. Those three subdirectories now appear as menu items in the VAR menu of the HOME directory. (Note how they have little folder-like tabs to distinguish them from ordinary variables.)



Press DIR1. This new directory is empty—nothing stored there yet. Now create its subdirectory: 'ααMISC ENTER ααCRDIR ENTER. Next, create the two subdirectories of DIR1: Press →HOME DIR1 to move to DIR1. Then ←{}ααDIRASPCDIRB ENTER ααCRDIR ENTER. Finally, press DIRA and create its one subdirectory: 'ααWORK ENTER ααCRDIR ENTER.

The structure of the directories—indicated by lines in the diagram here—is very important and is therefore reflected in the annunciator area: The right-most name is that of the current directory, but the others indicate the complete directory *path* —all the way from HOME. (To move the pointer clear to the top, you use →HOME; to move up a level at a time, you could instead use ←UP.)

The path from any directory back up to HOME is the only area in which the machine will look for a name when asked to evaluate it. It searches the current directory first, then its parent above it, etc.—all the way back to home. It does *not* search any "sibling" or "cousin" directories. So in the example structure here, all names stored in DIR1 are visible and accessible from DIRA, DIRB and WORK, but *not* from DIR2, DIR3, MISC or HOME. This helps you shield names from accidental "clobbering" or incorrect usage during unrelated operations.

**To purge an empty directory, just use ←PURG as with any variable. To purge a non-empty directory, though, you have to use the non-keyboard command, PGDIR. (This is purposely different and less convenient, to help you avoid over-hasty keyboard erasures of vast amounts of data and/or programs.)*

This article was excerpted 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.

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 ←x² on the HP 48 doesn't return 2.

Why do I get an Undefined Name error when integrating or differentiating?

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

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

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

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

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

How do I turn off the HALT annunciator?

Use 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 UNITS NXT PURGE, then select your units.

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

If you've made your evaluation—and liked what you saw—you can see how your students will fare, too. HP offers complete classroom loaner sets:

HP 6S: 30 HP 6S calculators, 1 HP 6S manual, shipping case.

HP 30S: 30 HP 30S calculators, 1 HP 30S overhead calculator, 1 HP 30S manual, shipping case.

HP 39G: 30 HP 39G calculators, 1 overhead display panel (and cable), 1 Connectivity Pack, 1 HP 39G manual, shipping case.

HP 48G+: 29 HP 48G+ calculators, 1 HP 48GX calculator, 1 overhead display panel (& cable), 1 Connectivity Pack, 1 HP 48G+ manual set, shipping case.

HP 49G: 30 HP 49G calculators, 1 overhead display panel (& cable), 1 Connectivity Pack, 1 HP 49G manual set, 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 30S, HP 39G, HP 48G series, or HP 49G.
- Overhead transparencies of all HP calculator keyboards.
- Training guides, examples and lesson ideas for the HP 6S, HP 30S, HP 39G, 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 for educators via e-mail at **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 Smart 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.) seizes these opportunities, taking full advantage of the computational power of the HP 49G, HP 48G Series, HP 39G 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 for HP 38G, HP 39G, 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 keywords such as "HP 48G," "HP 39G" 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: Redemption Program

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** *or* **HP 30S**	**HP 10B** *or* **HP 20S** *or* **HP F1897A*** (PC Connect. Pack)	**HP 12C** *or* **HP 32SII** *or* **HP 39G**	**HP 17BII** *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, HP 30S *or* **HP Connect. Pack (PC)**	2
HP 12C, HP 32SII *or* **HP 39G**	3
HP 17BII, 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 can be used with the HP 38G, HP 39G, HP 48G Series and HP 49G. It works with Windows versions 95, 98, 2000 and NT. The HP Infrared Printer works with the HP 17BII, HP 19BII, HP 38G, HP 39G and HP 48G Series. The HP Overhead Display Unit can be used with the HP 38G, HP 39G, HP 48GX and the HP 49G. The Firmware Portable DataLab can be used with the HP 38G, HP 39G, HP 48G Series and the HP 49G.*

Special Limited-Time Offer:

Double Bonus Points

For a limited time, HP will ***double*** the normal point values (shown here) on purchases of the HP 6S, HP 30S and HP 39G calculators, if the points are redeemed by October 31, 2000. With double points, each HP 6S purchase thus earns 2 points; each HP 30S purchase 4 points; and each HP 39G purchase 6 points.

What Documentation Do You Need?

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

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

1. A statement that HP 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.

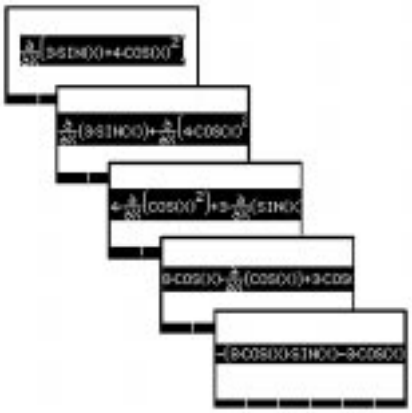
A large 1.5 MB of Memory (512KB RAM and 1 MB Flash ROM for data storage) takes full advantage of the largest, most comprehensive library of third party calculator software: programs, games and software applications. And 1 MB of Flash ROM allows for future electronic software upgrades—no need to buy a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

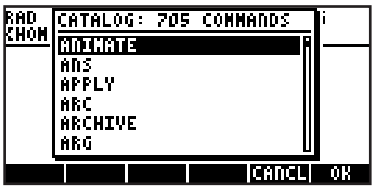


In homework or exams, the answer is only part of the solution, and now there's a calculator that can show you how it got there, too! (And the HP 49G's history display retains every result, so you can see and correct where you erred—or combine previous results to get fast new related solutions.) Use the 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.

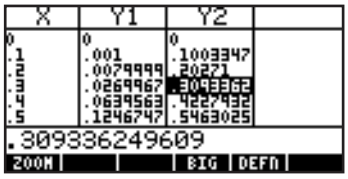
Got an example or solution you want to share with others? No problem: You can easily exchange programs, data and games with other HP 49G's and HP 48G Series models, via a unit-to-unit link serial cable. (But there's no infrared—which prevents "untimely communication" between students during exams!)

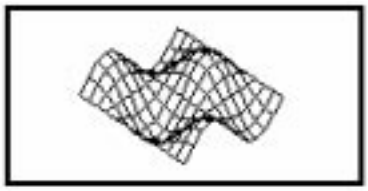
Power to the Pupil



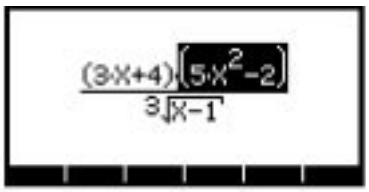
Behind the clear, clean displays and user-friendly features of the HP 49G lies a stunningly powerful math engine that can instantly cut your work. The HP 49G offers over 2000 commands, all grouped in various menus, but the built-in catalogue serves them up to you, all under one convenient key.

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 41 for Bid Specifications for the HP 49G Graphic Calculator.)

In Detail: The HP 48G Series Graphic Calculator

The Platform of Choice

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

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

The HP 48G+ Graphic Calculator has 128 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 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 1.125 MB of RAM, it's the most power you'll find in a calculator anywhere.

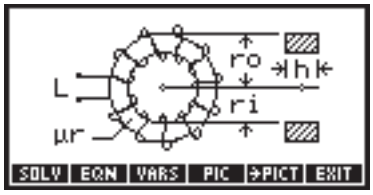
Power and Smarts

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 48G Series 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.

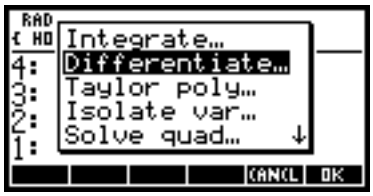
Built to Make Sense



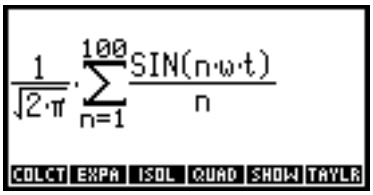
But is all this power only for the technically gifted? Not at all! The HP 48G Series is easy to use, even for beginners.

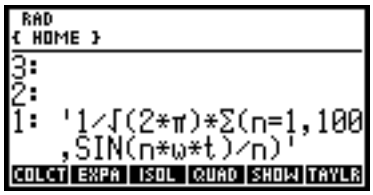
Look at the easy-to-use forms that speed up learning: each built-in application tool has an input form you just fill in.

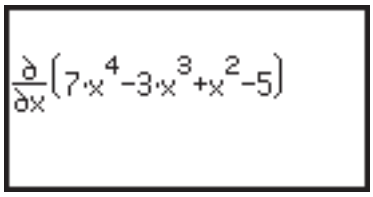
With clear prompts and menus organized for easy access, you and your students get satisfying results quickly.



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....

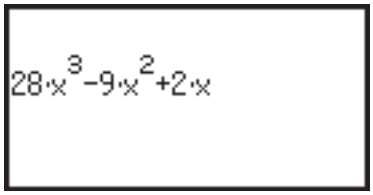






And its symbolic math capabilities open new possibilities for your students. They can create expressions on the calculator,

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+ offers 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 42 for Bid Specifications for HP 48G Series graphic calculators.)

In Detail: The HP 39G Graphic Calculator

Easy, Powerful and Built for Math Class

The HP 39G 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 39G features E-lessons (also called ApLets), an exciting new set of built-in tools adapted from topics in textbooks, neatly packaged to help students learn faster and get more from classroom and homework sessions. E-lessons are the future of calculator-based instruction: powerful, flexible, easy. And the HP 39G can connect directly to a personal computer or an overhead display unit, so students can see your keystrokes or share their own work!

The HP 39G makes math make sense to students. Understanding comes more naturally when the calculator shows an expression in textbook format—just as it would appear in a book or on the board in class. And it can represent mathematical relationships numerically, graphically and/or symbolically: split-screen views let students compare two views at once, for a better conceptual grasp.

Easy Menus and Commands

The HP 39G uses standard algebraic notation for its operations—no need to learn new methods to do the same old calculations. And the HP 39G 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.

Built-in Tools, Lots of Power

The HP 39G offers over 600 easy-to-find functions in clear, organized menus:

- HP Equation Solver • Factorization, expansion, substitution
- Function analysis—roots, extrema, slopes, areas and intersections
- Plotting—multiple types (function, parametric, polar, conic and statistical), with tracing and zooming
- Differentiation and Integration • Trig, exponential and log functions
- Linear systems, linear algebra and matrices (real and complex)
- Factorials & combinatorials • Lists & sequences • Complex numbers
- 1- and 2-variable summary and inferential statistics; regression models and plot types
- Programming to automate Views, E-lessons and calculations • Online help

E-lessons Make Teaching Easier for You

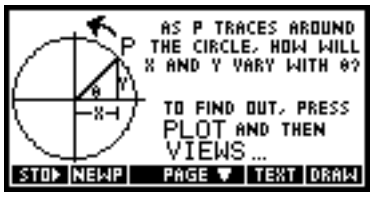
E-lessons combine variables, pictures, graphs and custom-designed views into one complete package. With E-lessons, students can explore the problems without your guidance—and without fear of losing their work or the original lesson. They can save their work or start over if necessary. E-lessons are so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

Of course, the most popular E-lessons are built right into the HP 39G with many others freely available for download from HP's web site (such as the example below). But it's also easy to create your own. Once you set up a problem for use in the classroom, you 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!) In very little time, everyone in class is working with the same information and problems—a complete lesson that *you* prepared.

Look at an example. Every E-lesson (also called an ApLet)—no matter whether it's built-in or downloaded, like that shown here—is stored under the APLET key.

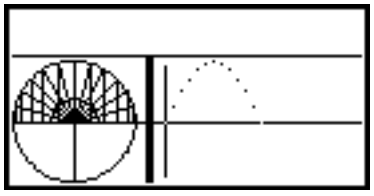
It can begin with a note....

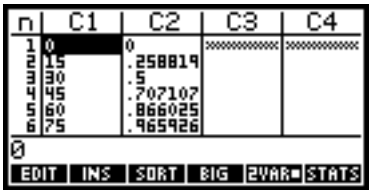
Students can then see a sketch of the problem...



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.

(Please turn to page 42 for Bid Specifications for the HP 39G Graphic Calculator.)

In Detail: The HP 30S Scientific Calculator

What Students Like Students Use

The HP 30S has all the functionality and features of other scientific calculators, plus the distinctive HP quality and style for today's discerning student: large, generously spaced, soft-edged keys and interchangeable colored faceplates—two extra come with each calculator!

Easy on the Homework Easy on the Pocketbook Easy on the Eyes

The HP 30S combines value, power and convenience into one sleek, low-cost package. Students see and understand more in the large two-line display, with a convenient, editable command line history to save keystrokes in subsequent calculations. And to save even more keystrokes, there are also easy-to-use memory and a calculation repeat feature.

Easy to Learn and Use, Too

Then there's the intuitive way it works: On the HP 30S, you just enter operators and data in the order you would use to solve the problem on paper. And what if they involve fractions or physical units? No problem! The HP 30S can convert fractions to decimals—and decimals to fractions—and handle a variety of units, both metric or imperial.

Lots of Tools for Class and Homework

Packed in a smart little case is a smart little calculator. With 250 built-in functions and 10 memory registers, and the ability to evaluate expressions involving multiple variables, the HP 30S gives students room to maneuver as they crunch numbers and solve problems. They get:

- Fractions and fraction/decimal conversions
- Percentage and percentage change
- Trigonometric functions
- Log and exponential functions
- Universal powers and roots
- Polar/rectangular conversions
- Univariate and bivariate statistics, with easy editing of the data sets

There's also an equation solver built into the HP 30S, so that students can quickly solve problems such as quadratic and linear simultaneous equations without tedious calculations.

Flexible for Math and Science

With all the above math features, plus unit conversions and physical constants, the HP 30S is well-suited for a wide variety of subjects in math and science:

- General Math
- Pre-Algebra
- Algebra I
- Algebra II
- Geometry
- Trigonometry
- Statistics
- Pre-Calculus
- Earth Sciences
- Life Sciences
- Chemistry
- Physics

(Please turn to page 43 for Bid Specifications for the HP 30S Scientific Calculator.)

In Detail: The HP 6S Scientific Calculator

Affordable Essentials Kids Can See Themselves Using

*The HP 6S shouts "Future!" from the moment it slips out of its soft cover. With solar power, brilliant metallic finish, slim profile and large tactile keys, its looks almost outshine its calculating power—**almost**....*

High Tech, High Touch

Sure, its "Wow" factor is high. Students love to play with it, be seen with it, and check out its solar features. But beneath the gloss is serious power—a package with everything today's student needs to keep up and shine in math class.

It has all the basics, of course—powers, roots, logs, trig, pi—some 66 functions in all. But don't overlook the extra smarts that HP packed in its ultra-slim case:

- Fractions – help students make the connections to decimals and back.
- Angle and polar/rectangular conversions – a first look at vectors and the math of circular measure.
- Statistics – explore the basics of mean and standard deviation.
- Base conversions and arithmetic – for the budding programmers.

Into the Future With Confidence

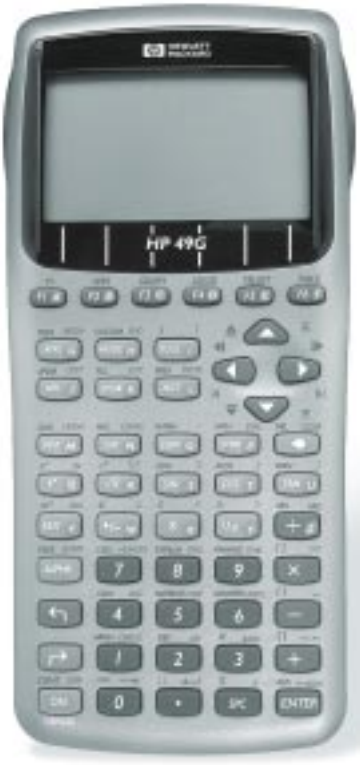
Here's a bright little device to bring out the best in active, inquisitive math learning. When students are successful early, it's a feeling they remember—and aim for, again and again.

(Please turn to page 43 for Bid Specifications for the HP 6S Scientific Calculator.)

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
- 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
- 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
- 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 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 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 (9.3 oz)
- 1-year warranty



HP 48G Series

- 128KB in both the HP 48G+ and HP 48GX
- 131 x 64-dot display
- 12-digit numeric values with 3-digit exponents
- HP EquationWriter allows "textbook"-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 PC interface
- Size: 8.1 x 18.0 x 2.9 cm (3.2 x 7.1 x 1.2 inches)
- Weight: 264 g (9.3 oz)
- 1-year warranty
- The HP 48GX has two expansion ports, allowing plug-in applications or RAM memory cards

HP 39G

- 131 x 64-pixel (8 lines x 22 char.) display, with textbook formatting mode for easy recognition
- Over 600 functions, accessed via pop-up display windows
- Electronic lesson ("E-lesson" or "ApLet") modules, limited only by available memory
- Presents mathematical solutions in multiple views
- Split-screen capability displays 2 screens side-by-side for dynamic comparisons

- Notes and sketches
- HP Equation Solver
- Differentiation and integration
- Graph rectangular functions, parametric and polar expressions, recursively-defined sequences
- Multiple graphing functions defined, saved, graphed and analyzed simultaneously
- Multiple functions traceable on a single graph
- Interactive zoom features accessible from the display
- Sequence graphing mode: time series and cobweb/stairstep plot
- Interactive function analysis: values, roots, maxima and minima, integrals, derivatives
- Matrix math and operations
- 1- and 2- variable summary and inferential statistics; regression (linear, log, power, exponential, quadratic, cubic, logistic)
- Histograms, scatter plots, regression equation graphs, box and whisker plots
- Programming (HP Basic)
- Dynamic results history stack
- Linear algebra and linear system solutions
- Polynomial root finding
- Complex numbers, logs, exponentials, combinatorials
- 256 KB memory
- Data transfer with built-in IR (infrared) and serial port
- Connects to a PC, overhead projector, data/lab analyzer
- Powered by 3 AAA batteries
- Sturdy sliding hard case
- 1-year warranty
- Size: 18.7 x 8.9 x 2.8 cm (7.4 x 3.5 x 1.1 inches)
- Weight: 264 g (9.3 oz)

HP 30S

- 2-line display, with editable command line history
- 250 built-in functions
- 10 memory registers
- Enhanced constant mode
- Percentage and percentage change calculations
- Fractions and fraction/decimal conversions
- Trigonometric functions and pi
- Powers, logs, roots and exponential functions
- Polar/rectangular conversions
- Unit conversions
- 11 physical constants
- Univariate and bivariate statistics, with editable data sets
- Hard cover
- Interchangeable faceplates (with two extra colored faceplates included)
- Size: 15.5 x 8.1 x 1.4 cm (6.1 x 3.2 x 0.5 inches)
- Weight: 135 g (4.8 oz)
- 1-year warranty

HP 6S

- 1-line x 10-character display
- Algebraic entry system
- Over 66 built-in functions
- 3 memory registers (plus statistical registers)

- Percentage calculations
- Fractions and fraction/decimal conversions
- Pi, trig and hyperbolic trig functions
- Powers, logs, roots and exponential functions
- Polar/rectangular and angle conversions
- Hours/hour-angle conversions
- Summary and univariate statistics (mean and standard deviation)
- Base conversions and arithmetic
- Bit and boolean operations
- Solar power with battery backup
- Size: 12.7 x 7.2 x 0.8 cm (5.0 x 2.8 x 0.3 inches)
- Weight: 91 g (3.2 oz)
- 1-year warranty

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" (18.7×8.9×2.8cm)
	Weight (with batteries)	9.3 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
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 Connectivity Pack (F1897A)	Yes

HP 48G Series	HP 39G	HP 30S	HP 6S
Yes	Yes	No	No
128 KB	256 KB	10 registers	3 registers + statistic registers
No	No	No	No
Gray	Dark metallic blue	Gray	Bright metallic blue
Soft, dark grey pouch	Slide-over translucent blue	Slide-over, extra face plates	Soft black vinyl
Enhancements	Enhancements	Yes	Yes
7.1×3.2×1.2" (18.0×8.1×2.9cm)	7.4×3.5×1.1" (18.7×8.9×2.8cm)	6.1×3.2×0.6" (15.5×8.1×1.4cm)	5.0×2.8×0.3" (12.7×7.2×0.8cm)
9.3 oz (264 g)	9.3 oz (264 g)	4.8 oz (135 g)	3.2 oz (91 g)
131×64 pixels LCD	131×64 pixels LCD	2 line × 10 character LCD	1 line × 10 character LCD
49	51	45	42
Yes	Yes	No	No
Yes (HP 48GX model)	No	No	No
Yes, 4-pin	Yes, 10-pin	No	No
No	Yes	No	No
RPN/Textbook	Algebraic/Textbook	Algebraic	Algebraic
Algebraic	Algebraic/Textbook	Algebraic	Algebraic
Results only	Results/objects	Results only	Results only
3	4	1	1
No	Yes	No	No
3	3	1	1
No	Yes	Operation repeat feature	Operation repeat feature
Yes	No	No	No
No	Yes	No	No
Yes	Variables and E-lessons	No	No
Yes	Date and time only	No	No
No	Algebraic manipulations	No	No
Yes	No	No	No
Yes	Yes	Fractions	Fractions
Yes	Yes	Yes	No
Yes	Yes	No	No
Numeric only	No	No	No
Yes	Yes	Yes	No
Yes	Yes	No	No
Yes	Numeric solve	Numeric solve	No
Yes	No	No	No
Yes	Yes	Yes	No
Yes	Yes	Yes	Yes
Yes	Yes	No	No
Yes	Yes	No	No
Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes
Yes	E-lessons (ApLets)	No	No
Yes	No	Yes	No
Yes	No	No	No
Yes	No	Yes	No
No	Yes	No	No
Yes	Yes	Yes	Yes
Yes	No	No	No
Yes	No	No	No
128KB, 1MB	No	No	No
Yes	No	No	No
RPL	HP Basic	None	None
No	Yes	No	No
Yes	E-lessons, w/custom views	No	No
Yes	2D only	No	No
Yes	Yes	No	No
Yes	Yes	No	No
Yes	Yes	No	No
Yes	Yes	No	No
Yes	Yes	No	No

Accessories for HP Graphic Calculators

Classroom Overhead Display

The Overhead Display Unit (ODU) is a great way to present lessons, showing HP 38G, HP 39G, HP 48GX or HP 49G calculations to the whole class, step by step. Just set this unit on an overhead projector, connect your calculator, adjust the contrast, and you're ready for class. The ODU comes with cables for the HP 38G, HP 39G, HP 48SX/GX and HP 49G, and built-in cable storage.

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

You can share your computer's peripherals with the HP 38G, HP 39G, 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 39G, HP 48G Series or HP 49G screen images.

F1897A Serial Interface Pack for IBM-compatible PC's

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. 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).

F1015A Serial Interface Cable for IBM-compatible PC's

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

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 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

Best Buy...check local area listings
Boise Cascade...check local area listings
Business Depot (Canada)...905-513-6116
CDW Computer...check local area listings
Circuit City...check local area listings
Corporate Express...check local area listings
CostCo...check local area listings
Fred Meyer...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

There may also be locally-owned HP calculator retailers in your area. For more information on all retailer(s) near you, call **1-800-752-0900**, or visit **www.hp.com/calculators/purchase**.

And don't miss the specials! Besides offering their own seasonal sale pricing, many retailers also participate in HP's manufacturer's promotions. (See pages 5 and 30 in this issue.) ***Ask your retailer!***