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The HP 39gs Graphing Calculator is an ideal classroom tool for math and science -- it's powerful, easy to learn and has HP exclusive features such as HP Aplets (e-lessons) and wireless communication. And now, for this month only, it is 20% off for newsletter readers only. [Click here](#) to get your special discount.

Upcoming HP Calculator events

Event	Dates - Location
TCEA	February 4-8 - Austin, TX
CoSN	March 9-12 - Crystal City, VA
NCTM National	April 9-12 - Salt Lake City, UT
ASEE	June 22-25 - Pittsburgh, PA
NECC	June 29-July 2 - San Antonio, TX
AP Annual	July 16-20 - Seattle, WA
WIPTE	October 15-16 - Westville, IN
Educause	October 28-31 - Orlando, FL

HP Calculator Blog

Check out Wing Kin Cheung's blog, "The Calculating World with Wing and You."

[View blog »](#)

**Volume 1
February 2008**

Welcome to the first edition of the HP Solve newsletter. Learn calculation concepts, get advice to help you succeed in the office or the classroom, and be the first to find out about new HP calculating solutions and special offers.

FEATURED CALCULATOR



» [HP 39gs Graphing Calculator](#)

Learn why the HP 39gs Graphing Calculator is your ideal classroom graphing tool.

RPN TIP #1

Press ENTER an extra once or twice if you will (or may) need the value again.

Example: If you are going to calculate the 8.5% sales tax on \$111 you would press 111 ENTER, ENTER, ENTER, 0.085, X. At this point you will have 111, 111, 111, and 9.435 on the stack. Press + and you have the total (\$120.435) including the tax, with the total (111) above it on the stack.

THE CALCULATOR CLUB

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RPN: “INVEST 15 MINUTES & SAVE TIME FOR THE REST OF YOUR LIFE”

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Isn't everyone looking to save time? Just imagine investing 15 minutes of your time today, to save time for the rest of your life. A solid professional future depends on mastering time management skills; for this, there is HP's unique data entry system called Reverse Polish Notation (RPN). In as little as 15 minutes, RPN training can positively impact your ability to be more efficient, effective, and help you save time for the rest of your life versus the standard Algebraic data input. HP is the only calculator manufacturer that offers RPN on its advanced calculators either as a standard or an optional data entry method. RPN is standard on the HP 12c Financial Calculator, selectable on the HP 12c Platinum Financial Calculator, HP 17bII+ Financial Calculator, HP 35s Scientific Calculator, HP 48gII Graphing Calculator, and HP 50g Graphing Calculator.

RPN Benefits:

- RPN saves time and keystrokes. You never have to account for the parentheses while doing calculations. The process is similar to the way you learned math on paper.
- You can see the intermediary results as you perform your computations rather than just the answer at the end. This is an extremely helpful byproduct. Math teachers are using this feature to improve student understanding of mathematics
- An intermediate result allows the user to check the results and correct errors more easily. It's easier to follow the stream of calculation. The user defines the priority of operators.
- RPN is logical because the user first gives the number and then tells what to do with it.

Curious about this mysterious data entry system? Click here to learn more about [RPN](#).

FEATURED CALCULATOR OF THE MONTH: HP 39GS GRAPHING CALCULATOR

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The HP 39gs Graphing Calculator is your ideal classroom graphing tool, featuring easy readability on a large (131x64) display with adjustable contrast. Easy to learn and use with an intuitive and logical structure for entering mathematical expressions and exploring mathematical concepts with dedicated keys for familiar symbolic, numeric and graphic views. Keep a copy of your work electronically as an Aplet that you can share with your classmates wirelessly. An Aplet is an HP-exclusive programmable software application. All Aplets maintain a uniform look and feel with the easy Symbolic, Plot, and Numeric key views – so they're easy to learn and use! It's a must for math and science students, with 256KB of RAM memory to create and store your Aplets. Easily share data and connect with PCs using USB, serial and infrared ports. Enjoy added protection from its slide-on hard cover and reassurance of award-winning HP support.

Fun facts about the HP 39gs Graphing Calculator:

- Born: May 15th, 2006

- First graphing calculator to save graphs, tables, equations, notes, sketches, and data as an electronic file (Aplet)
- Only graphing calculator to use Infrared technology to connect unit-to-unit wirelessly
- No battery is required to operate the HP 39gs Graphing Calculator if it is connected to a PC via the provided USB cable
- 75 MHz processor is the fastest in its class
- 131x64 pixel display makes graphs smoother and text more readable
- Free electronic lessons (Aplets) available on the Web

Click here for more information about the [HP 39gs Graphing Calculator](#).

USE PI TO MEASURE A PIE -- OR ANY CIRCULAR OBJECT

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A Short History of π

Do you remember when you learned Pi? Do you remember what it is? The exact value of π has been investigated from early in man's history, not least because this number is used in the calculation of the circumference and area of circles from pizza to pies to pipes. We now know the value of π accurate to over 200 billion digits! However, even a thousand years ago, less than 10 digits of the value of π were known. In this activity, we look at improper fractions that approximate the value of π and when they were first used.

Turn the HP 39gs on and press the HOME key to access the command line and calculation history. To see what value the calculator uses for π , type π (shift of the 3 key) and press the ENTER key. You should see 3.14159265359, which is accurate for the first 11 digits (the last digit, 9, is correctly rounded from 8979...). Interestingly enough, this 12-digit approximation for π was first calculated by Madhava Sangamagrana in 14th Century India.

Below are sample lesson plans for teaching and understanding π :



Exercise 1

In this exercise, you will make your own measurements to approximate π , using a CD and DVD disc, and other circular objects. You will need a CD disc, a DVD disk, and either a meter stick or tape measure for this activity. One definition of π is that it is the ratio of the circumference to the diameter for any circle:

$$\pi = \frac{C}{D}, \text{ where } C \text{ stands for the circumference of a circle and } D \text{ stands for the diameter of the same circle.}$$

First, we will use the CD disc as our model of a circle. Use two pieces of tape to secure the meter stick (or about 50cm of the tape measure) to the surface of a table. Now put a small pen mark anywhere on the

edge of the CD. Stand the CD disc vertically on the zero mark of the meter stick so that the pen mark on the CD is touching (or very close to) the zero mark on the meter stick. Now carefully roll the CD, without slipping, along the meter stick until the pen mark falls on the meter stick again. The value on the meter stick where the pen mark touches the second time is your measurement for the circumference of the CD. Now measure the diameter of the CD. Finally, divide the two measurements to get your own approximation for π . Record your answers for the CD and two other circular objects in Table 1.

Object	Circumference	Diameter	C/D
CD			
DVD			

Your teacher will ask you to write your approximations on the board. When all the groups have finished, average the approximations and record your average below.

Most modern sources use 3.14 as a good approximation of π . How close is your average to this value?

Exercise 2

From the 19th Century BC through modern times, people have used fractions to approximate π . One of the most famous approximations for π is $22/7$. Use the HP 39gs to give a decimal representation for $22/7$. How accurate is this approximation for π ? Can you find a better fraction for approximating π whose denominator has just one digit? There are only 8 other fractions besides $22/7$ that have a single digit in the denominator (you can't use 0, remember!). Record your best approximation for π other than $22/7$ in Table 2.

Exercise 3

In the approximation $22/7$, the denominator has exactly one digit. Can we get a better approximation if we use a 2-digit denominator? Use the HP 39gs to find a fraction that is the best approximation to π that you can find with a 2-digit denominator. This is considerably harder to do if you just guess and check. Here's a hint: how can you make $22/7$ into an equivalent fraction with a 2-digit denominator? You may find more than one good approximation by thinking in this direction. Record your results in Table 2.

HP 39gs decimal approximation of π : 3.14159265359			
Number of digits in the denominator	Rational Approximation	Decimal Representation	Number of digits of accuracy
1			
	$\frac{22}{7}$		
2			

Exercise 4

In this exercise, we find a whole set of rational approximations for π . But instead of searching for them by trial and error, we use the Fraction mode of the HP 39gs!

To start, make sure the HP 39gs is in Fraction mode. Press the MODES key (shift of the HOME key) to access the HOME MODES menu and navigate to the NUMBER FORMAT field. Once there, press the CHOOSE menu key and select the Fraction option. Decrease the accuracy level to 1. Your Home Modes menu should appear as in Figure 1.

Go back to the Home screen and enter π again. With the accuracy level set at 1, you should see the familiar approximation, $22/7$ (see Figure 2). The accuracy level can vary from 1 to 11. Fill in the second column of the Table 3 by increasing the accuracy level and repeating the calculation of π .



Figure 1: Setting fraction mode



Figure 2: 1 approximation of π is $22/7$

Table 3: Rational Approximations of π			
HP 39gs decimal representation of π : 3.14159265359			
Number of digits in the denominator	Rational Approximation	Decimal Representation	Number of digits of accuracy
1	$\frac{22}{7}$	3.14285714286	3 (3.14)
2			
3			
4			
5			
6			

Once you have finished with the second column, change the Number Format back to Standard and use the HP 39gs to calculate decimal representations for each of the rational approximations. Then determine how accurate each rational approximation really is. The first column has been filled in for you as a guideline.

Extension 1

Here is a continued fraction for the approximation of π :

$$\pi = 3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{6 + \frac{49}{6 + \frac{81}{6 + \dots}}}}}$$

Notice the pattern of squares of the odd numbers in the numerators. As its name implies, the continued fraction can be continued indefinitely. The first four continued fractions based on this procedure are listed in Table 4. Each continued fraction can be represented as an improper fraction and as a decimal. The first row has been done for you. Can you fill in the last three rows?

Continued Fraction	Improper Fraction	Decimal
$3 + \frac{1}{9}$	$\frac{28}{9}$	3.11111
$3 + \frac{1}{6 + \frac{9}{25}}$		
$3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{49}}}$		
$3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{6 + \frac{49}{81}}}}$		

Extension 2

π Day and π Approximation Day are two unofficial holidays. π Day can be celebrated on March 14th, July 22nd, or November 10th. Can you figure out the connection each of these dates has with the approximation of π ?

Extension 3

In this activity, you learned that we now know the first 200 billion digits of π . How many 8.5"x11" pages would it take to print out this number?

Teacher Notes

This activity looks at the historical rational approximations of π and investigating how accurate the various approximations are. This activity can be used to introduce the student to π , either as an introduction to irrational numbers or as an introduction to using π to calculate the circumference and area of circles.

Glencoe Mathematics Series textbook activity

As an introduction to irrational numbers, use this activity with *Texas Mathematics, Course 2*, Chapters 12 or 13, or *Course 3*, Chapters 3 or 7. As an introduction to using π to find circumference or area of circles, use this activity with *Texas Mathematics, Course 1*, Chapter 10, *Course 2*, Chapter 12, or *Course 3*, Chapter 7.

TEKS

The following TEKS, found in this activity set, are listed in grade-level order, not the order in which they appear in the activities. Some of the statements are paraphrased.

- 6.1B: generate equivalent forms of rational numbers
- 6.8A: estimate measurements (including circumference) and evaluate reasonableness of results
- 6.13A (7.15A, 8.16A): make conjectures from patterns or sets of examples
- 7.1A: compare and order integers and positive rational numbers

- 7.1B: convert between fractions, decimals, whole numbers, and percents mentally, on paper, or with a calculator
- 7.2B: use addition, subtraction, multiplication, and division to solve problems involving fractions and decimals
- 7.2D: use division to find unit rates and ratios in proportional relationships
- 7.2E: simplify numerical expressions involving order of operations
- 7.3B (8.3B): estimate and find solutions to application problems involving proportional relationships such as similarity and rates
- 7.13C (8.14C): select or develop a problem-solving strategy
- 8.1C: approximate (mentally and with calculators) the value of irrational numbers as they arise from problem situations (such as π , $\sqrt{2}$)
- 8.2C: examine a solution for reasonableness

Table 1 correlates the Exercises and Extensions to the TEKS so that the teacher can fine tune a lesson to meet the needs of the class.

Activity	TEKS Covered
Exercise 1	6.8A, 8.1C, 8.2C
Exercise 2	6.1B, 7.1A, 7.1B, 8.1C, 8.2C
Exercise 3-4	6.1B, 7.1A, 7.1B, 7.13C (same as 8.14C), 8.1C, 8.2C
Extension 1	7.1B, 7.2B, 7.2E,
Extension 2	6.13A (same as 7.15A and 8.16A)
Extension 3	7.2D, 7.3B (same as 8.3B)

The teacher has several options available for printing the student activities. The introduction and Exercises 1-3 will all fit printed front and back on a single sheet. From there, the teacher can either print Exercise 4 on its own sheet and the Extensions on a third sheet, or print both Exercise 4 and the Extensions front and back on another single sheet. Each of the Extensions is independent of the others, giving the teacher freedom to tailor the lesson.

Overview

The history of rational approximations of π is a global one, with contributions from the Middle East, India, China, and Greece, among others. Table 2 lists some of the major efforts, approximately where and when they occurred, and who is credited with the work. This summary is adapted from the Wikipedia entry for *History of Numerical Approximations of π* .

Time	Location	Who	Approximation	Accuracy (digits)
2000 BC	Babylonia	?	25/8	2
1650 BC	Egypt	Ahmes	256/81	2
9 th C. BC	India	Yajnavalkya	339/108	2
250 BC	Greece	Archimedes	$223/71 < \pi < 22/7$	3
3 rd C. AD	China	Liu Hui	3.141014 (3.14 is OK)	4
5 th C. AD	China	Ze Chengzhi	$355/113 < \pi < 22/7$	7
14 th C. AD	India	Madhava Sangamagrana	3.141592653589793	14
15 th C. AD	Persia	al Kashi	3.14159265358979325	16

Notice that the pure rational approximations of ancient times begin to give way to decimal approximations, beginning with Chinese writers and then spreading to the Europe, where decimal notation was introduced in the 13th century AD. The Mayans must have had a good approximation of π as well, in order to have such an accurate calendar. Since most Mayan literature was lost during the Spanish Conquest, we do not

know what the Mayan approximation was. Students should appreciate that the approximation of π is a mathematical effort shared by all cultures.

Web Resources

[\$\pi\$ day home page](#)

[Albion College printable \$\pi\$ chart](#)

[Teacher's resources for \$\pi\$ day](#)

[Wikipedia's numerical approximations of \$\pi\$](#)

Answer Key for A Short History of π

The answer key section is designed to give teachers some hints and tips as well as the answers to the student exercises and extensions.

Exercise 1

In this exercise, the students measure the circumference and diameter of a common CD disc to come up with their own approximation of π . These discs have a circumference right around 38cm and a diameter of 12.1 cm, for an approximation of 3.140.... With just a little care, your students should get approximations with 2-digit accuracy (3.1...). Averaging all the approximations in your class may get you to 3-digit accuracy, but it is not important how accurate the approximations are. The important notion here is to get hands-on experience approximating the value of π and using that experience to get oriented for the rest of the exercises.

Exercise 2

In this exercise, students discover that $22/7$ is the best rational approximation for π with a 1-digit denominator. The only other candidate is $25/8$, which is the value used by the ancient Babylonians around 2000 BC. One way to do this exercise is to write the incomplete fractions $\frac{?}{1}, \frac{?}{2}, \frac{?}{3}, \dots, \frac{?}{9}$ on the board and have students come up with the numerators that make each fraction as close as possible to π .

Exercise 3

At first glance, getting a rational approximation with a 2-digit denominator seems like a daunting task for students approaching it by trial and error. However, the teacher can give the students enough guidance to ensure success without giving the answers away. For example, students can be told to start with $22/7$ and make it into the equivalent fraction with a 2-digit denominator: $220/70$. With this starting point, changing the numerator and denominator slightly with trial-and-error thinking is likely to be successful in just a few minutes.

Another possible starting point is to use $314/100$, which we know is equivalent to 3.14. In this approach, there is an interesting pattern you and your students can follow. Start with $314/100$ and reduce it to $157/50$. With this fraction as a starting point, add 22 to the numerator and 7 to the denominator to get other rational approximations with 2-digit denominators, each more accurate an approximation than the one before. Here is a chart with these values:

157/50	179/57	201/64	223/71	245/78	267/85	289/92	311/99
3.14	3.14035	3.14062	3.14084	3.14102	3.14117	3.14130	3.14141

Note that Archimedes approximation, $223/71$, is in this progression! The important point is to arrive at the conclusion that $223/71$ is a closer approximation than $22/7$ – even though both have the same number of digits of accuracy.

Table 2: Rational Approximations of π			
HP 39gs decimal approximation of π : 3.14159265359			
Number of digits in the denominator	Rational Approximation	Decimal Representation	Number of digits of accuracy
1	$\frac{25}{8}$	3.125	2
	$\frac{22}{7}$	3.142857	3
2	$\frac{256}{81}$	3.16049382716	2
	$\frac{223}{71}$	3.14084507042	3

Note that both $22/7$ and $223/71$ are accurate to 3 digits. One good question to ask is which is closer to π ?

Exercise 4

The HP 39gs will give the students the best rational approximations for all but the 2-digit and 4-digit denominator cases. The 2-digit case can be pulled from Table 1. Completing the 4-digit denominator case is not necessary to the success of the exercise; it can be used as an extra-credit homework problem. You can even award points to the best 3 approximations! In fact, Extension 1 can be used as a hint to help students find a rational approximation with a 4-digit denominator.

Table 3: Rational Approximations of π			
HP 39gs decimal representation of π : 3.14159265359			
Number of digits in the denominator	Rational Approximation	Decimal Representation	Number of digits of accuracy
1	$\frac{22}{7}$	3.14285714286	3
2	$\frac{223}{71}$	3.14084507042	3
3	$\frac{355}{113}$	3.14159292035	7
4	?		
5	$\frac{312684}{99532}$	3.14159265362	10
6	$\frac{1146408}{364913}$	3.14159265359	At least 12

Extension 1

This extension is important for moving students from trial and error methods of finding rational approximations of π to patterns and formulas that give progressively better decimal approximations. Table 4 shows the approximations given by each stage in the continued fraction. Note that the approximations

alternate between being over and under the value of π . Although this method converges very slowly, it guarantees a better approximation with each continuation and a pattern that can be easily followed.

In Figure 3, the continued fraction (up to the square 121) has been entered on the HP 39gs. One unique feature of the HP 39gs is the SHOW menu button. When a previous expression is highlighted, the HP 39gs always gives you the option to COPY the expression to the command line or SHOW the expression in standard textbook format. Figure 4 shows the expression as it appears using the SHOW command. Press the OK menu key when you are done inspecting the continued fraction.



Figure 3: The continued fraction

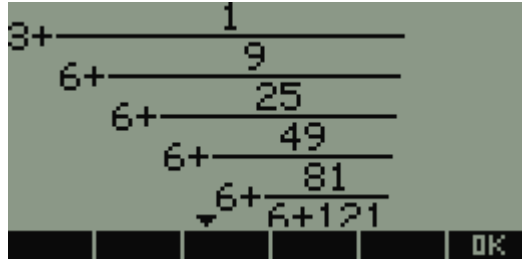


Figure 4: SHOW the continued fraction

Another direction this extension can take is to convert each continued fraction into an improper fraction. The equivalent improper fractions are included in Table 4 (next page). Note that 2 of the entries have 4-digit denominators. You can use this as a hint to get students started on the extra credit homework from Exercise 4.

Continued Fraction	Improper Fraction	Decimal
$3 + \frac{1}{9}$	$\frac{28}{9}$	3.11111
$3 + \frac{1}{6 + \frac{9}{25}}$	$\frac{502}{159}$	3.1572327044
$3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{49}}}$	$\frac{7384}{2355}$	3.13545647558
$3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{6 + \frac{49}{81}}}}$	$\frac{7594}{2415}$	3.14451345756
$3 + \frac{1}{6 + \frac{9}{6 + \frac{25}{6 + \frac{49}{6 + \frac{81}{121}}}}}$	$\frac{634012}{201915}$	3.13999455216

Extension 2

When you celebrate π Day may depend on how you write dates. In the US, we tend to write dates in the form Day/Month/Year, while in Europe and Latin America the form Month/Day/Year is commonly used. In China, Year/Month/Day is used as well.

For the US, March 14 is 3/14, which resembles the decimal approximation of π .

For Europe, July 22 is 22/7, which resembles the famous rational approximation.

For those who like to count, November 10 is the 314th day of a non-leap year.

As you can see, all three dates can lay claim to the title. There are some more obscure contenders as well.

Extension 3

The answer to the question of how many pages it would take to print the first 200 billion digits of π depends on a number of variables. Assume that you are using a standard word processor program, with 1" top and bottom margins, and 1.25" left and right margins, a piece of 8.5"x11" paper has 46 lines, each of which can hold approximately 72 digits, as shown below:

123456789012345678901234567890123456789012345678901234567890123456789012

With these assumptions, you can get 3,312 digits per page. This means you will need over 60 million pages (60,386,474).

As of this printing, we know the first TRILLION digits of π . Guess how many pages you need now!

LOOKING FOR AN EDGE WHEN TAKING EXAMS?

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Students are always looking for an edge when taking exams. Now, the HP 33s and HP 35s Scientific Calculators are the best way to fast track yourself into your professional career. In November 2007, the National Council of Examiners for Engineering and Surveying (NCEES) announced their approved calculators for 2008 and BOTH the HP 33s and new HP 35s are approved for the FE/PE exam. NCEES develops, scores, and administers the examinations used for engineering and surveying licensing throughout the United States. The HP 33s and HP 35s are the only scientific programmable calculators in the market and allow you to store commonly used equations prior to the exam. In addition, both calculators include HP's exclusive time-saving input method, [RPN](#), which stands for Reverse Polish Notation. RPN saves keystrokes because you never have to account for the parentheses and brackets while doing calculations and you get intermediary results that allow you to check the answer and correct errors more easily. Check out the FE/PE testing schedule below so you can study early and be prepared!

YEAR	PE exams	PS exams	FE exams	FS exams
2008	April 11 October 24	April 11 October 24	April 12 October 25	April 12 October 25

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Are you a real estate professional looking to be more efficient and effective? HP can help. All over the US, successful real estate brokers give their new associates the industry-standard tool that lets people know they mean business -- the [HP 12c Financial Calculator](#). Instantly recognized by its unique horizontal design as a symbol of professionalism, the HP 12c has become the tool of the trade for real estate and mortgage professionals. Real estate agents are frequently on-the-go with their customers showing homes and neighborhoods and need a portable and accurate tool to give them instant answers anywhere. While buying a home can be stressful and a significant investment, the HP 12c enables the real estate professional to help make the customer experience easier. Using the HP 12c, with its onboard amortization schedules and dedicated finance keys, real estate professionals can quickly calculate various mortgage payments based on the home buyer's down payment or interest rate needs and let them know if their dream home is within reach. In real estate, quick answers to financial questions result in greater customer satisfaction and faster sales. Today, real estate brokers need the right products and solutions for their employees/real estate sales agents to meet the customer needs. Real estate brokers who choose HP are able to deliver positive results, increase customer loyalty, and remarkable payoffs.

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HP is committed to developing products and solutions that meet the needs of the business customer. At HP, we understand that business customers need a product that will withstand the test of time and at the same time separate them from the rest. As Theodore Levitt stated in a recent Harvard Business Review article, "Marketing Malpractice: The Cause and the Cure, "...the marketer's task is to understand the job the customer wants to get done, and design products and brands that fill that need." At HP, we understand this and as a result develop our financial calculators to meet every desire of the business customer.

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