

Date: 04/07/2010

First, I want to thank Viktor Toth for this great site. 2nd I want to thank him for continually posting my calculator reviews.

This is my ninth edition of these calculator reviews and I have made major revisions from the earlier review. First I group them by category of CAS or Non CAS calculators and I now introduce the most popular or best sellers first, as these are generally the best documented and supported available and leaving the less popular and often lower end models for last. This allows the hurried reader to scan the first two or three calculators of the class to buy the best available. Or you can leisurely read down to all of the models offered. As usual, I will make the normal disclaimer that this review will be dated, nearly as soon as it is posted. I have added a couple of calculators and deleted some others as the market has changed since my last review. I still factor in up front costs of calculators, but only in passing and perhaps a brief comment. Most will agree that the upfront costs of ownership are quickly forgotten in comparison to the time and effort expended to actually learn how to master these mathematical marvels.

I have also decided to review (offer my own biased opinions) a few new entries into the computational environment as well, such as the Casio Classpad and Ti's new Tinspire as well as a Microsoft low end math package that is meant to compete with graphics calculators ie directly marketed to students, or meant to be loaded onto PDAs, laptops or desktop systems and is cheap enough to compete with a graphics calculator. These comments are at the end of this review.

Today all graphing calculators offer the EOS (Equation Operation System) system of algebraic entry. Hp also offers an RPN (Reverse Polish Notation) option on their high end line of Hp48/50G calculators as well. Today's calculators all have an acrylic lens to cover the LCD to reduce breakage and failure, an improvement over the original lines of graphics calculators.

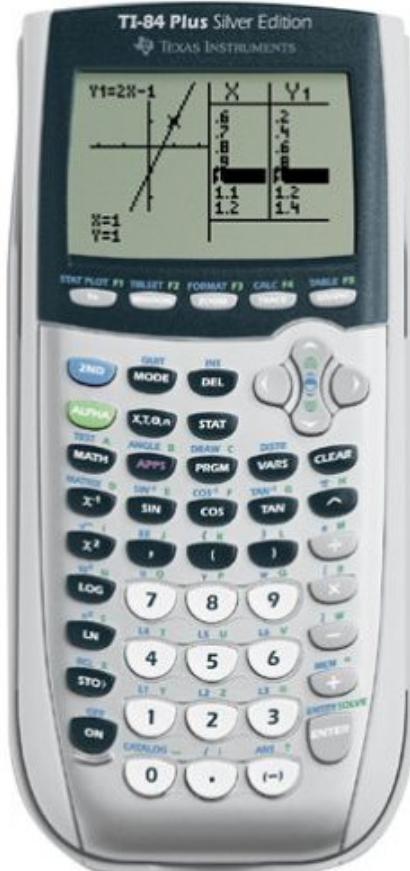
I am not going to provide comparison tables as most of these calculators have the required functions for which they are going to be used. I may comment about missing functions if I feel the calculator should have them and it is left to the reader to determine if that is indeed the case.

I will start the review with graphics calculators that are intended for the High School or general studies college student. These calculators lack a CAS (Calculator Algebra System) and are limited in their features of advanced algebra or calculus functions so as to encourage student involvement. They purposefully lack some functions so as to not become a crutch for learning, although they do include the standard numerical functions for this class of calculators. I also start my reviews with the most popular or the common first choice selection. As you read down through the features, you will discover that the first selection may not be your best selection. Since you are reading this review, it can be assumed that you are not the typical user and may have other needs that this review should address. All graphing calculators offer some form of programmability and this

allows for customized operations and flexibility. With this in mind, nearly any graphing calculator can be used to handle your needs. Good luck with your selection and I hope that this review will provide you with informed guidance.

Ti-84

My first review and recommendation for the typical High School student in the U.S. is the **Ti-84** series as it is the most popular and the standard calculator used by most texts and classroom instructions. This is what I suggest for anyone who isn't sure about what they need or require? This is Ti's main seller



and is designed to be easy to learn, use and master. The keyboard is well laid out to use many functions without having to resort to shift keys, something that the Ti-89, Ti's other top end calculator suffers from. If you have a textbook with demonstrations on how to use a graphics calculator, odds are this is the calculator that will be shown. This calculator sets the standard in the American educational system. The newer 84 series includes a lot of apps (application programs) that enhance this calculator above the earlier 82/83 line and close the gap with the older discontinued Ti-86.

This calculator's lineage originated from the Ti-82 as it evolved into the Ti-83 and is now offered as the Ti-84. All have nearly identical keyboard placement and if your text shows one, that same text can be used near verbatim to learn with any other calculator of this line. The differences between the original 82 is an added equation solver, better statistics functions and TVM (and extra memory on the plus models). The 84 series is really just an 83 with a new face, memory and speed enhancements plus extra apps (such as units conversions and science tools which close the gap with the higher end calculators), and a USB port. The statistics features of this line are not matched by any of the calculators in this group out of the box. This calculator is an excellent choice for the business major

that needs to tackle linear programming or other high-end business related math. Cellsheet is also included in the higher end Ti-84 SE and this allows you to work with Excel and the calculator and share data and limited spreadsheet applications (math functions in a spreadsheet will certainly cause problems as Ti most likely hasn't enhanced this feature above data collection and transfer).

This is undoubtedly the most popular calculator line in the US. It has attained this distinction, not because it is the best, but because it has had the best marketing applied on its behalf. It is an exceptionally good calculator for its intended audience offering its intended users 99% of all the features they most likely will ever need. And what features aren't offered can usually be added via an application or constructed with the included BASIC by programming. I say usually, because there are some functions and features that cannot be overcome due to the limited function set included and the only real solution is to upgrade to a better calculator. Some major drawbacks are the lack of complex matrix abilities and the lack of HEX, DEC, BIN or any extensive unit conversions make this a poor choice for technical fields such as EE, ME, or Physics. However, even if you do intend to pursue these particular courses, I have seen graduates from the above fields use this calculator and do well. Often high end users migrate straight to high powered math software packages and continue to use this calculator as a programmable scientific as it does have such a well designed keyboard layout.

The PC cable calculator interface is easy to set up and run and is readily available, something most other calculators here in this group cannot claim.



My own favorite from this class of calculators is the **Casio CFX 9860G Slim**. It is easily my preferred choice for the best solution if you do not want or need to run with the High school crowd. It is a recent offering and is the most powerful pocket calculator available since it does fit in your pocket. It is basically the same graphics calculator offered by Casio as the 9950G mentioned below with the added feature of more memory and a better computer interface.

Casio's programming features are not considered as good as the

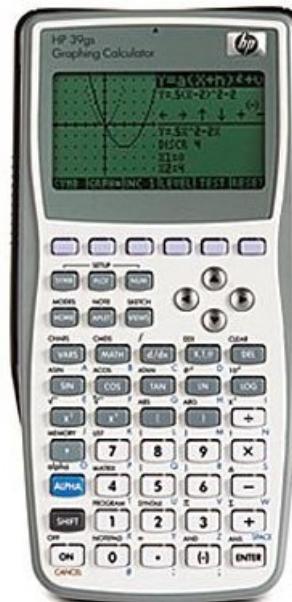
Ti implemented BASIC. However, it is a great buy if you need a graphics for work or school and are not committed to a textbook or class that is using a Ti. It also includes

HEX, DEC, BIN conversions and the associated logic as well (something an EE or Comp Sci tech would appreciate over the Ti-83/84 line). No other calculator offers this much power that still fits in your pocket and travels so well. The form factor and layout of this calculator is truly a welcome sight to the high end calculator user who wants something that doesn't shout out, "I AM A NERD!"

What is the next best graphics calculator for the High School or college bound student who isn't allowed a Ti-89 or other CAS equipped calculator? Function wise and out of the box the **Hp 39GS** easily takes this title. This calculator has more functions than the Ti-83/84 line above and actually has some rudimentary CAS and this is why it is banned by the ACT testing services.

It is an algebraic EOS calculator only, not even offering the typical RPN of Hp's other high end lines (although there is a software program to provide an rpn mode). This calculator has the famous Hp click and feel of a genuine Hp keypad. Also, it has a staggering amount of RAM (around 230K available or about 10 times the RAM available to the Ti-83/84). Of course this is somewhat misleading as newer calculators have Flash ROM and RAM for archiving that makes them able to store more than their addressable RAM.

However should someone want to crunch a large matrix (both Real or Complex) or some other memory intensive program; the RAM shortage would become apparent on many of the calculators in this group. This Hp also offers comparable statistics features similar to the Ti-83/84 (The Ti-83/84 series does have the best statistics function out of this whole class of calculators).



With all of this ability, why isn't it rated above the Ti-83/84? First, it isn't nearly as popular and therefore few (if any!) textbooks use the Hp 39GS for their examples. 2nd, the Hp39GS has some shortcomings; the most serious is its non-standard programming in applets with a convoluted form of BASIC. The applets work for some types of applications, but do not help the novice develop a simple straight forward program for their needs or problems. However, to keep this in perspective, this is a calculator marketed at the High School audience, where programming isn't considered critical for the normal student. Additionally the ability to store 10 individual equations for immediate use by the solver also offsets the programming quirks for the typical student, in comparison to all other calculators that only store one equation in their solver. It also has a notes application built in that allows for text to be entered or transferred in. Of course if you are considering this calculator you should really consider Hp's next step up, an Hp 40GS for only a few dollars more. It is reviewed in the CAS selection and I suspect will ultimately replace this model completely.



Casio CFX 9950 PLUS

The **Casio CFX 9950 PLUS** (60K RAM) color graphics is a well priced line that allows you to see and differentiate three separate colors of graphs. These are newly repackaged models with more curvature on the cases and new colors the color screen is a nice feature to demonstrate different function behavior. Since their actual programming features are not as good as the ti-83/84 series as it is somewhat less powerful but the CFX-9850 is often found at office supply stores for \$55-, about

half the price of the Ti's. It is a great buy if you need a graphics for work or school and are not committed to a textbook or class that is using a Ti (If you are, spend the extra \$50 and make life a lot easier for yourself). In fact it also includes HEX, DEC, BIN conversions and the associated logic as well (something an EE or Comp Sci tech would appreciate over the Ti-83/84 line).



and TVM for business users. Its feature set places it about here in my review.

The **Sharp EL9900c** is literally a two faced calculator! Really! It has a reversible faceplate, one for intermediate use and the flip side for advanced use. Why not make one side financial, the other scientific instead? Well, if you want a simple start, yet want a more sophisticated calculator for later, it might be one to consider. However, you might then consider the TiNspire as the non-CAS version offers you a Ti-83 keyboard and the TiNspire Keyboard although admittedly, it would be quite a bit more cost. Both this Sharp and the one below feature an adequate stats package



The **Sharp EL9650c** is a 32K graphics calculator with a pen based input for menu navigation. It has half of the Ram of the previous EL9900c, no reversible faceplate and a pen based input device. It is an okay calculator, but frequent use of the pen stylus will most likely wear or scratch the LCD screen over time. LCD screen covers may be a good investment if you make extensive use of the stylus. The Sharp line has very little software available. The I/O cable is nearly impossible to find retail and when you do, it is close to the cost of the calculator. This makes the Sharp (and Casio) a poor choice to

purchase if you cannot program and need additional features/functions not found on the calculator.



Ti-73

Ti's middle school line, the **Ti-73** is basically a re-packaged Ti-83 with the trig functions moved into hidden menus and some of the simpler functions such as fraction handling moved onto the main keyboard. This calculator also offers some of the best units' conversions available in this group of calculators, which is not in the higher end Ti-83/84 series. If you wanted a shop calculator that works great for fractions and has units' conversions, this calculator is superior

to everything else in this group. Why don't I move it further up in my recommendations? Because its trig functions are buried in menus and lacks some higher end math functions that are what is needed by most people who need a graphing calculator. This Calculator usually sells for more than the Ti-83/84 and is not readily available aside from mail order.

Casio FX 7400G

The **Casio 7400G** is a big step down in features on this list. It has 8 K of RAM and without I/O that is about the most you need for this type of graphics. It is actually little more than a top notch scientific that can also support function graphics. As such, it makes a great field type calculator, but is a bit light in features for a student in comparison to the other offerings, especially from Casio as much more capable calculators are available for about \$10 more. However, its more compact design may make it a suitable choice for many.



Hp 9G

The **Hp 9G** is close to last on my list for a graphics calculator. As a high end graphics, it fails miserably. However, I like it for what it is, a scientific calculator that can do graphing. It is fairly well laid out and easy to use for most applications. It doesn't have extensive programmability, but it is fairly compact and has a thought out feature set. I wouldn't really give this serious consideration as a graphics, but as a scientific calculator, it's actually well featured as it is the same size as most

pocket calculators. It features a nice solver and includes lots of physics constants. If you do need a graphing calculator, and price is all important, buy a Casio.

Actually the **Ti-86** was the best calculator available without CAS offered by Ti and is sadly, no longer available. Ti discontinued this model and this graphics calculator never

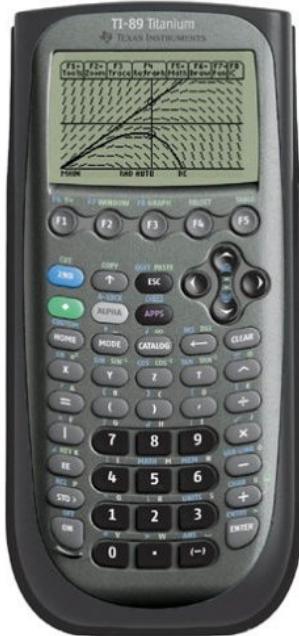
was marketed heavily so as to not rob sales from Ti's higher end calculators with CAS, the Ti-89 or V200 series. It has a large amount of features for higher end mathematics and supported long variable names and complex matrices as well as other advanced features. Actually, the Ti-85/86 line predates the 82/83/84 line. After Ti released the Ti-85, many educators complained about the complexity of the Ti-85 and after extensive research by Ti with the educational community's involvement, the Ti-82 was developed and released. This has probably had a long term effect on Ti's marketing and development of its calculator lines that is still having an effect on Ti's development efforts. It compares with, and in some areas surpassed the Hp48G series which it was meant to compete against. Sadly, it didn't compete well with its lower end siblings the Ti-83/84 series, not because it was less capable, but because it was not marketed well (especially since it is now discontinued). Nearly all the High School and many of the college texts today gear their literature to support the Ti-83/84 line or the higher end Ti-89 that left this calculator in a calculator purgatory of sorts. It is an older design without any upgrades (sans LCD acrylic lens protection or Flash ROM). It also lacks the great statistics functions of the other Ti graphics calculators and other downloads made available by Ti for its other calculators.

There are three issues or shortcomings that I would let you be aware of in this present line of calculators listed above (aside from the discontinued Ti-86). First, the limitation of only 27 Variables which is actually common for entry level graphics calculators and a good indication of which audience the calculator is marketed for. This is a design choice to satisfy the High School teaching community. If you are being taught about solution methods or techniques, who cares whether the variables are x, y or z and limited to a single letter? But if you are taking advanced physics, chemistry or engineering courses you can easily start mixing up your variables if you are restricted to a single letter. An Engineering or Physics student (or professional) usually needs to have a more descriptive name to remind him of the actual use of that equation 1-6 months later. That is why I would suggest to any student who is planning to use their calculator for engineering or science to step up to the Ti-89 or Hp 48/50G series.

CAS (Calculator Algebra System) Calculators.

The previous calculators reviewed are usually considered for High School or entry level college calculators for the non technical major. These calculators can and often do take many through an engineering degree, and I have seen several Engineers come to work with their Ti-83/84s. But you will certainly realize their constraints and limitations if you are in an Engineering, Physics or other math intensive Major. A calculator with a CAS is going to be superior and to choose the best in this category was difficult as it depends upon one's requirements for a high end calculator. As far as choice only two companies actually offer truly high end calculators, Ti and Hp. Both have their advocates. I finally settled on choosing the Ti-89 to lead off for the following reasons. It is the most popular and best supported by educators and students. The choice is really clear for a quick choice based upon these criteria. If you need additional features, users will resort to high end math packages on a computer. This reasoning makes the Ti line the best choice for most high end calculator users.

The **Ti-89** is far easier calculators to use right out of the box in comparison to its Hp rival. The Ti-89 come with an easy to use BASIC and has a lot of built in apps included to help many high end users right away. Perhaps most importantly, the Ti-89 is much easier to set up and graph functions than its Hp rival (these are graphics calculators, and that obvious point should not be overlooked). And Ti has made other quality apps available for either free or a moderate price for download. Higher end programming is also available should you really wish to pursue calculator optimization (I don't consider this a practical reason, as if you going to be using a computer to generate a program, why even use the calculator? Of course I am not writing this review for a software developer.). Games of course are a major reason PC's are used to program calculators and the reason PC programming the calculator in C has developed. These reasons are why the Ti-89 has established itself as the best calculator for most high-end calculator user's.



Ti-89

However, the Ti's strengths are also the Ti's weaknesses. The Ti-89 specifically suffers from a poor keyboard arrangement and is furthermore crippled by an inefficient menu system as compared to its rival Hp. The menu system is keystroke intensive, however once learned by a knowledgeable user, it can be navigated very quickly. A solver is present but not nearly as well integrated as Hp has done. All of these features are there and easy to

use, but lack an optimization for the experienced user. Yet, this does make for consistency and for an easy initial learning experience that is less troublesome.

The Ti-89 Titanium offers a couple of free apps (these apps are nice, especially for engineers, as EE Pro and ME Pro were expensive apps when first released, ironically for the Hp line). The Ti-89 Titanium is the tool of choice for the typical student simply because the V200 is often banned from classes and all standard tests due to its form factor that is similar to palmtop devices because it does resemble a computer.

The Hp50G is the best available graphics calculator for features, functions and layout. That in no way means it is the best for even the average high end math user as it is also the most complex calculator available as well. It has a steep learning curve, painful amounts of settings, lots of idiosyncrasies, and twice as many functions as its nearest rival. Many can argue that something this complex may still be inferior to the more

popular Ti-89 and strong and compelling arguments can be made for the Ti89. The Hp has improved its hardware dramatically with the HP50G although it remained software identical to the Hp49G+ but with a new and better cosmetic overhaul, an added serial port, an added extra battery to prolong battery life and a significantly better keyboard than the albatross laden 49G series. The improved keyboard is the most welcome change, but the new color scheme is also much improved as well. Aside from these important changes, the Hp50G is in reality a renamed Hp49G+. This was simply a (necessary) marketing ploy to distance the failed Hp49G+ keyboard from its now marketed Hp 50G.

The Hp50G comes with an SD card slot, 1+ Meg RAM, both USB and Serial ports and a bi-directional IRDA port to beam data and programs back and forth between other Hp graphics calculators (it is extremely short range, 2-3 inches max).

The Hp50G has some serious drawbacks as well. One is its RPN/algebraic mode. A drawback? Yes, because Hp did not integrate its algebraic mode nearly as well as its lower end Hp39/40GS line. The algebraic mode and its Hp BASIC are poorly integrated when compared to its rival the Ti-89. As an RPN calculator, it is not nearly as popular either. However, it does still have a sizable RPN following since Hp is really the only supplier of RPN logic calculators. The Hp50G is built around an earlier Hp48G series which was designed with RPN as its central logic. With that basis, the rest of the calculator operates and navigates through its menus best in RPN mode after you set flag 117. This allows for a much cleaner and efficient interface, which isn't available to the algebraic mode user. A glaring example would be units conversions. Easily done in the Hp 48G RPN mode, extremely awkward to do in algebraic mode and you only need to reference the User's guide for an example in algebraic mode to realize how poorly done this is.

Hp 50G



Why get an Hp50G over a Ti-89? As I have stated, actually there are many more reasons to buy the Ti-89. First Ti is now the standard yardstick that everything else is measured by. Nearly everyone, in your case EVERYONE ELSE will have one. No work or assignments that require a calculator will bother you or if you have trouble, you will be able to ask someone else. It is as good (or better) for any undergraduate calculus or differential eq. course you may take.

However, if you plan on taking engineering or other scientific or technical courses along with the math, the Hp50G offers lots of extra

functionality (much of which is hard to access or use in its algebraic mode, so if you don't want to learn RPN, I would still advise staying with the Ti). The Hp blows the Ti out of the water with the following features.

Units conversions (a biggy in chem. Or physics) Numeric Eq Solver (the Ti also has, but limited in comparison, as the Hp allows you to name and keep hundreds of equations in a folder type hierarchy as well), Eq. Library (nice and handy for information you don't have, it just might be in there) Eq. Writer allows you to write (and save) equations as you see them in a text (ultra fancy algebraic equation entry). The Matrix writer allows you to enter and build a matrix as easily as filling in a spreadsheet (Granted the Ti is also easy to enter a matrix, once you name and size it).

All of the above are available for the Ti as well as either after market software as well. But they are NOT as well implemented (and in algebraic mode on the Hp, are so poorly implemented as to be considered crippled, hence my strong recommendation to learn RPN, if you buy the Hp).

Simply put, if you only need the calculator to get you through a few math classes (even advanced ones) and you are not taking any other technical course work, simply buy the Ti-89. It will serve you well.

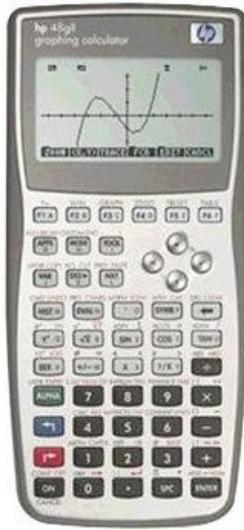
However, if you are taking any physics, mechanical, electrical, or chemical engineering course work, the Hp has better features for these courses in that it can manipulate and handle a larger volume of equations in a more orderly way. Therefore you will have at your fingertips more equations to tackle a varied amount of problems without having to get up and find another reference or crack open another text as you build up your own personal equation library inside of your calculator vs. the Ti makes use of another APP such as Notefolio and cutting and pasting to get similar results (not so bad, but again, more steps vs having it in a catalog folder, just like another function). The Hp allows you to retain your functions and features as you build them. There are so many times when I can do something so easily on the Hp and am surprised by how awkward or difficult it is to do the same (and usually simple) function on the Ti.

However, from scratch, the Ti will beat an Hp out of the box, and until you invest time to learn it you will be behind the learning curve. If you don't buy into RPN, you really will be missing out on other features besides the RPN in the Hp. The algebraic mode in the Hp leaves so many features untapped or poorly implemented that you would be definitely better off with the Ti that you should have bought in the first place.

Therefore, before you purchase an Hp, ask yourself, do you want (and can you afford to) struggle with a radically different calculator than the rest of the class? If you are upgrading from the Ti-83, it is more similar to the Ti-89 (or Hp40GS) than an Hp50G is (even in algebraic mode).

Many calculator NERDS will tell you how much better the Hp is, as I would too, but again for math, the Ti is just as capable. Any text book that uses calculator examples will most certainly use a Ti for its examples.

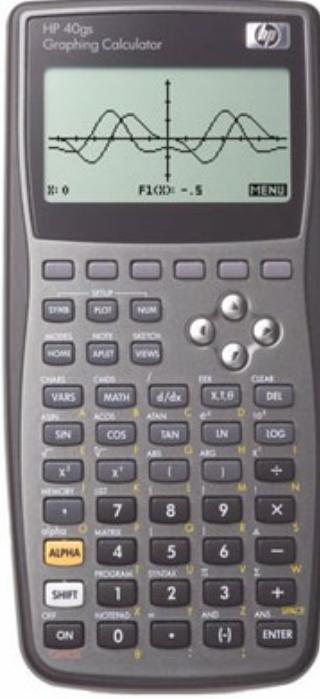
Buy Hp and you are buying into a select club (but a small and lonely club as there may be NO ONE else at your school to give you any help what so ever). That can be a tough place to put yourself.



Hp 48Gii

The next step down in calculator power is the **HP 48Gii** series calculator. I must admit that Hp made some significant and welcome changes to this model that has turned my opinion around. It is an upgrade of the original Hp48G series family, like the Hp50G but stripped down. This is the Hp50G with reduced memory (however it has been

increased to 256K, over twice as much as originally released!). It has the same keyboard layout, CAS and all the functions of a 50G. The 48GII now has the equation library as well as the equation writer. The equation writer is very useful and makes using an Hp worth the switch. The 48GII series still offers RPN. This is an operating system that is more efficient and better to use with the stack than an algebraic system. However many students don't want to bother to learn a new system and some people never get used to or feel comfortable with RPN. This is both a blessing and a curse for the RPN calculator. However, Hp has made their new calculators RPN/Algebraic selectable with algebraic as the default upon reset or initial power up. It won't be allowed anywhere a 50G isn't, but it does come with a plastic hardcover to protect it in a book bag compared to the softer case of the Hp 50G. I suggest it over the Casio FX2.0 since it is about the same list price and is a much more powerful calculator. If you are constrained to a \$100 calculator and want power and complexity this is the calculator to have.



Hp 40GS

Hp has just released the **Hp 40GS** onto the US market. This calculator was originally limited to the overseas market and aside from its dark color is the Hp39GS calculator with the added CAS of the Hp50G. It is an easy calculator to use with the CAS also providing an Eq writer of sorts that isn't available to the Hp39GS. I place it above the Casio because of its sophisticated CAS and its really well implemented eq writer included with the CAS. If you want a simple to use, yet powerful

math tool, this is it. This calculator could easily be considered a Ti-83 with CAS. Its lineage is actually a copy of the Ti-82, so this analogy is appropriate. If you want a simple to use, but mathematically powerful calculator at low price, this is perhaps the lowest cost calculator with a CAS available. This calculator and the others that follow are limited to 27 variables with single character names. All can perform fairly sophisticated algebraic manipulations on par with the previous CAS calculators, but keeping track of your equations and their purpose can be very difficult with only single variable naming conventions.

Casio FX2.0 plus

The **Casio FX2.0 plus** is Casio's CAS calculator. The FX2.0+ has a few extra preloaded applications over the original FX2.0. It is priced the same as TI-83 and is feature wise more powerful due to its CAS. And though programming is considered a weakness for the Casio line, the FX



2.0 has more RAM available to the user (144K vs. 24K) than a Ti- 83. However only the CAS capability allows it to be grouped with CAS equipped Hp or TI. It does not offer the functionality or capability of the Ti 89 or the Hp50G. One big reason is it only has 27 variables available to the user unless you make use of text strings. This is really a good rule of thumb to distinguish a powerful college calculator from a high school grade unit. It is much less than the price of the TI 89 or Hp 50 (however, the Hp48GII is the same price and better). Most people never ever use these calculators to their potential and the straightforward ease of use of this calculator can easily justify buying it. In fact, if you had a previous Casio graphics, this has the same type of start up menu system. This calculator could have been a real contender with TI or HP, but the software is not nearly as mature and therefore cannot be customized to handle the same types of problems that the TIs or HPs routinely handle at higher math levels. In fact, third party software is non-existent for this calculator at the moment, unless YOU BUY ONE!!! And post! Something to consider??? (My observation as of 4/02/2010) This calculator does have Flash ROM so there is always the possibility of a big breakthrough and release of a real power house OS. "Reality check! This isn't likely to happen."

UPGRADING INFO:

Concerning OS upgrades, don't upgrade at a critical time ie 1-2 weeks before finals. That is simply moronic. The extra features a new OS might offer just aren't worth it! And don't be first to upgrade to a newly released calculator OS. Sure its been tested, but by knowledgeable beta testers looking to crash the system with high end gimmicks, but often overlooking the simple and more obvious trial and error testing methods such as the ones YOU are most apt to find! Let the OS circulate for a couple of months so others can check for bugs instead of YOU! Remember, the calculator you purchased was fine before the new and wonderful OS was released. So that same calculator sans upgrade is probably adequate now.

Which model should you choose if you want to move from an earlier model to a newer released model w/o having to relearn a new tool? Below is a quick upgrade comment sheet. I do not offer advice that forces you to hunt down hard to find calculators on ebay, all my suggestions are current models that are readily available. I will address the most popular first to save some reading for many.

Ti-82 or Ti-83 series. The Ti-84 is a direct replacement with some additional features. If you're looking to upgrade to a more powerful calculator, your best choice is probably the Ti-89 or V200.

Ti-85 or the more recently discontinued Ti-86. Numbers of models indicate the features and capabilities of the calculator in most ALL calculator lines, not just Ti. The lower end Ti s may not have the features you may need as the overall math capabilities are going to be less than the 85/86 series. However Ti no longer markets a direct replacement line, you either step down to the 83/84 or up to Ti-89/V200 series. Another option is the

Hp48Gii in algebraic mode for consideration if you want a sub \$100 calculator with all the capability of your Ti-85 or Ti-86. I do not recommend this for the typical user as the algebraic mode of the Hp 48/50G line isn't as good as buying a Ti-89. However, if you can adopt the RPL entry of the Hp line, this calculator will have the closest feel to the Ti-85/86 line (probably due to Ti going after the Hp 48S/G line with its introduction).

Casio Graphics: Casio's have always offered a good consistency of their products. If you have an older Casio 7000 line, the newer 7400 line is nearly identical aside from minor improvements. If you have an older Fx 8000 or 9000 model, the newer fx9850 will be an easy (and cheap) path of replacement. The newer Casio **Fx 9860G Slim** is an excellent pocket graphics that offers all the features of the higher end Casio's with the pocket portability of most scientifics. It has the same look and feel of Casio's previous lines with a new bi-fold case.

Aside from the newer Slimline mentioned above, Sharp and Casio users should give serious consideration of buying into the Ti line if they are in or returning to school, not because the Ti is so much better, but because the Ti's are so much more entrenched and supported. Nearly every textbook uses the Ti-83/84 series calculator for their example calculations. If you are upgrading you should consider the Ti-89 if you are pursuing higher math or engineering work. Casio products are well made, but none offer more than 27 variables and this can hinder an engineering student or professional. The higher end Casio FX2.0 plus is a big step up from a Casio 7000 series, but better calculators from Ti and Hp are then available and should be considered.

A few comments to Hp 48s or Hp 48g users, you would be very comfortable (aside from the ENTER key placement) with either new Hp 48Gii or Hp 50G calculators after you set them to RPN mode. The Hp50G offers an SD card option which allows for easiest file/program transfer and extra built in RAM. However the Hp48Gii does offer a durable slide on cover. Both are big improvements in speed and response, they are blindingly fast in comparison to the slow poke Hp 48/49 series. However these calculators no longer offer the standard placement of the enter key. If you just need a high end RPN scientific and want the traditional large ENTER key, you might consider Hp's new offering of the **Hp 35s**, a scientific programmable calculator or the **Hp 17Bii**, a business calculator with a solver. Both offer 32K of RAM. Hp also offers a low end business model with trig functions called the **Hp 30B** with limited programmability. Keep in mind that the Hp 35s, Hp30B, and 17bii calculators are true RPN calculators with a 4 line stack and not RPL calculators with an unlimited stack. If you like or use the unlimited stack, only the Hp 48/50G graphics offers this.

If you are a business major and want a high end graphics, consider the Ti-83/84 or the Ti-89. Both have lots of functions, and most importantly, are loaded with statistics and business functions (or can be downloaded with good apps right from Ti, though some are not free). Most textbooks use the Ti-83 for textbook examples and some higher courses (calculus based) may use the Ti-89. Textbook and outside publications support should not be overlooked. Dummy's Books are available for the Ti-83, Ti-84 and Ti-89. Books such as these add value and knowledge in how to apply these calculators to their best

advantage. This is certainly something to consider if you need additional help with using a sophisticated calculator. If you are just looking for a high end programmable, you might consider the Hp17Bii. It is a pocket business calculator with 32K of RAM with Hp's equation solver, where you enter the equation as you see in the text book and can save hundreds of these equations, to use as you need.

MY OWN SUGGESTIONS AND RECOMENDATIONS

Any graphing calculator will be an asset to the normal student. However, there are other gadgets that are now available and cannot be ignored for the atypical user. One such consideration for the Iphone user is a graphing calculator app. Good ones are available for less than \$5-. That and a cheap pocket calculator might be all you need in comparison to a \$100+ calculator that you won't use after that required algebra class. Would I suggest this for the normal user? No, I don't feel you can replace a keyboard for reliable number entry, but the occasional user who doesn't miss a keyboard might find this a viable solution.

Most students entering High School should simply buy the Ti-83/84 calculator. Upgrade later if you feel you want better. However, it is just as likely you will appreciate the no-nonsense well thought out layout of this calculator and if you need more math power, get a notebook/netbook and load up some math software package that suites your needs.

If you want the best or most powerful, the argument will quickly turn to the two top contenders, the Ti-89 or the Hp 50G. As stated earlier, I would suggest to 4 out of 5 people that want an all powerful calculator to simply buy the Ti-89. It is a great machine that has a lot going for it. To that 5th person I might suggest an Hp 50G for the following reasons: 1st, the Hp 50G SD memory expansion of RAM is a great addition. 2nd, the screen has better control of font sizes and makes the numbers far easier to read. 3rd, the RPL is very appealing to a former Hp 48G user. A 4th reason is that the Hp has over twice as many functions included, a few examples are LaPlace and Fourier transforms. However for symbolic integration the Hp still cannot compare to the speed of the Ti's, since a calculation cannot compete with a table. Often, real world problems have no pretty answers and that is why Hp chose to use a slower algorithm approach; not nearly as fast or pretty, but this can be more effective and with the added caveat of a step by step solution. However, the real truth is that there are infinitely many integrals with no solution and it is a hit or miss proposition either way. Theoretically Hp chose the better approach, practically, it probably doesn't matter, and admittedly I have had better results obtained by Ti's table approach.

My own suggestions:

First check how good the solver is implemented by the calculator. This is one of the most beneficial features a calculator can offer. It allows you to check multiple, "what if" conditions. If the calculator doesn't offer a solver, you might want to pass it up. That is how useful I feel a solver is. Serious work is certainly possible without this feature, but it does make playing with the numbers, take on a whole new meaning (for the better, I might add).

If you are a business major consider the Ti-83/84 or the Ti-89. Both have lots of functions, and most importantly, are loaded with statistics and business functions (or can

be downloaded with good apps right from Ti, though some are not free). Most textbooks use the Ti-83 for textbook examples and if there are any exceptions it would be for some higher courses (calculus based) may use the Ti-89. Textbook and outside publications support should not be overlooked. Dummy's Books are available for the Ti-83, Ti-84 and Ti-89. Books such as these add value and knowledge in how to apply these calculators to their best advantage. This is certainly something to consider if you need additional help with using a sophisticated calculator.

If you are a science or engineering major, you will undoubtedly need or use lots of conversions as well as extensive number crunching. While CAS is nice to prove a point or show steps, often you are just interested in the answer. As such, you need a calculator that has lots of functions and units conversions. Long variable names to use so that you can provide descriptive labels in your programs are also a definite plus. CAS is just icing on the cake. As such, I suggest the following if there are no restrictions on your choice of calculators: A Ti-89, Hp48Gii, or Hp50G. You could certainly buy any other, but these three would give you a big edge on exams and make life easier in your studies with their available features.

A Ti-89 is certainly easier to use out of the box and is much more prevalent. This allows you to ask around should you need additional help or guidance when using the calculator at school. Programming is very straight forward as it is a simplified BASIC and is easily learned even if you know nothing about programming. Higher level language is also available should you want to optimize or become serious about programming.

The Hp 50G is another matter, as it can be used in algebraic mode which is very similar to the Ti-89 or RPN which is more popular with the Hp crowd. The Hp 50G has more settings and features available that can hinder the new user and cause lots of problems for a new user. People that have both generally agree that the Hp 50G has more functions, features, and power than a Ti-89. Most of this is due to the versatility of the Hp more than its math capabilities. However, both have more than most geeks will even use, and if it isn't there, it can be added via a program or download. An EE or a Physic's major may lean towards the Hp due to its feature set (built in LaPlace transforms) and the large depth of units' conversions. The intent of the Hp 50G is to be the best available, period.

If you want a high end graphics, you really have only two choices, the Ti-89 (V-200) or the Hp 50G. If you want an immediate use calculator out of the Box and have no experience or a dislike of RPN, you should buy the Ti. If you feel you can learn to like RPN (buying an Hp 50G and NOT using RPN will cheat you out of the convenience of the great units' conversion and easy vector manipulation as well as other functions that were originally designed for RPN, then converted (or NOT) into a more awkward function in algebraic). It is just easier and smarter to buy the Ti and bypass this aggravation.

Final Comments:

Another aspect to consider when you purchase a calculator is the learning curve you are

going to encounter and the time you will invest. If you want a straight forward easy to use calculator, you will want a calculator that is similar to what you have used in the past. If you want powerful, you generally get complex and complex requires work. Keep that in mind. Engineering students have numerous courses that require units' conversions and higher end math. There are lots of obscure functions that aren't used often on the higher end machines, but they are great to have when you do vs. having to ad hoc something on a calculator that was purposely crippled or simplified (And the Ti-83/84 is a classic example). The most glaring example is single letter variables used by the lower end calculators. This is to make algebraic manipulation of equations used by the calculator very easy, but it also makes them difficult to use after one or two semesters of serious number crunching (multitudes of equations and only a few variables to use and distinguish from).

One last point to make is that some calculators such as the TI-83/84 are designed to teach you math. These calculators are very capable, just awkward compared to some of the higher end machines. Less informed people may argue the opposite: that the high end models deviate away from standard notation and therefore are more difficult to learn to use. There is certainly much more to learn (which equals a very steep learning curve) with a higher end graphics, and therefore the Ti-83 is designed to bridge the gap between overly complex and more usable for the student.

A new generation of calculation tools:

PDAs and other high end hand held devices are now being released that have even more features than the high end calculators offered above.

My comments on the newest generation of computational tools and software. While I am not competent enough to offer opinions on high end Math software and do not own all of the devices that follow, I have played with them and feel that my own opinions are about as good as any. First off, I readily admit to being a button pusher and am biased towards a good well laid out keyboard. That means, I still prefer a calculator over the devices that follow. However, you the reader may have different needs and values and I will elaborate on my experience and what I perceive about each device. a few revolutionary devices as well, such as the Casio Classpad and Ti's Tinspire as well as a few low end math packages that are meant to compete with graphics calculators ie directly marketed to students, or meant to be loaded onto PDAs or are cheap enough to compete with a graphics calculator.

V200 is one of Ti's desktop units that is an evolution of the Ti-92 which predates the Ti-89. It has all the features and functions of a Ti-89 with a better keyboard layout. It obtains this superiority by simply offering more keys and functions laid out on a QWERTY style layout, with math specific functions readily available. It is my first choice among this group as it still offers buttons, a big plus for me. It also offers a readable screen, a common complaint of



prospective Ti-89 users. While it is significantly larger and bulkier than other graphing calculators, it gives you a Ti-89 with a large screen and a more efficient keyboard and it is still fairly portable in comparison to larger laptops. However, this device now has to compete with low cost netbooks with low cost to free math software.

My next selection is the Casio **Classpad** as I feel it tries and succeeds in making a calculator less complex and more accessible while still having many advanced complex functions available. It has a support base that feels the same. It combines the simple calculator with a PDA stylist input that feels straightforward and works well for its intended audience. It has a lot more portability in comparison to the V200 above.



Casio **Classpad 300**



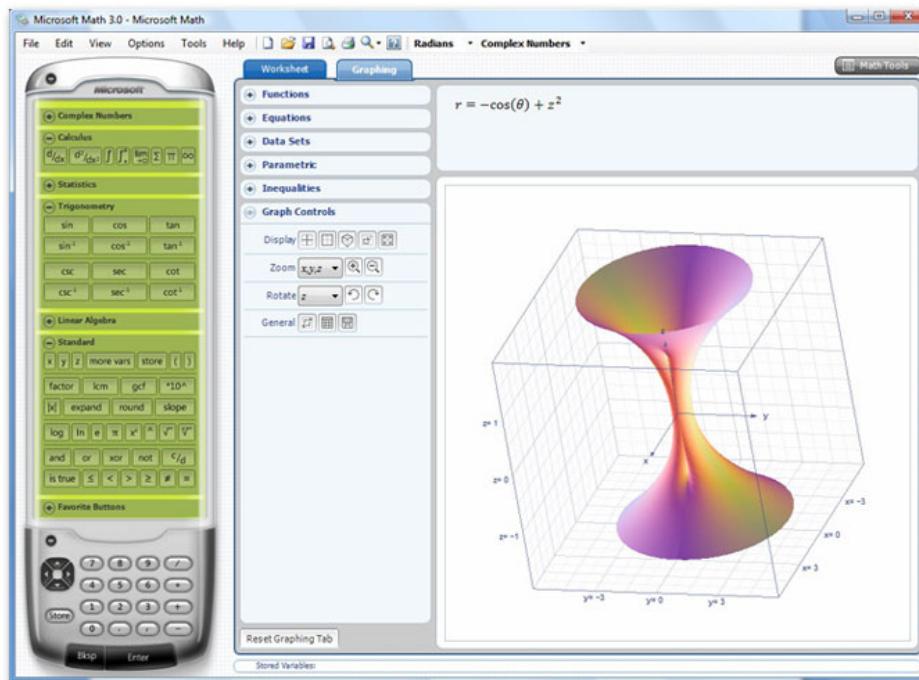
Another option would be the **I-Phone** or **I-Pad** with graphing software. If you don't have an I-Phone or I-pad, this is a very expensive option as you buy into an I-Phone (\$199-299), a phone plan with AT&T, and an internet service plan. However if you already have this, it is actually a very cheap option with software that is free to \$1-5 depending upon your selection and needs (more if you choose an Hp emulator). I feel this selection is okay for an occasional user, but something more is required for extensive use.

However here is an example of a FREE application. <http://www.appcraver.com/math-geeks-love-grapcalc-app/>. Others such as Mathematica even offer high end math and science apps that work with interaction to the WWW as well. This kind of interaction is simply not possible with standard high end graphing calculators.

The I-Pad may indeed be a great experience, depending upon how well implemented the software is or evolves into. The I-Phone however still doesn't thrill me due to its lack of a keyboard. The I-Pad computational abilities can be obtained with a netbook and a low end software package (or a high end package, if you want to buy it!). I would still suggest to the high school student to buy a graphing calculator for their math and science coursework and sell it off later if they want one of these platforms instead.

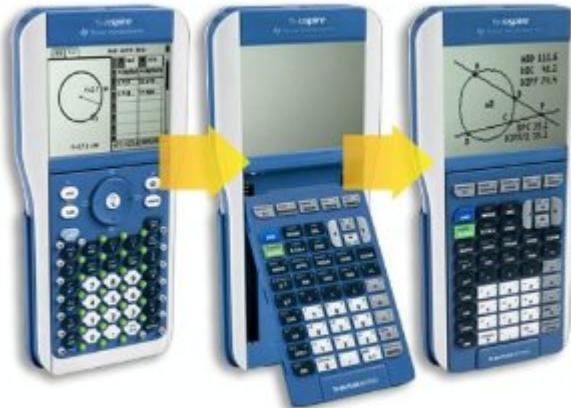
Even Microsoft has jumped on this bandwagon by offering a student version of software called **Microsoft Math** that can easily be loaded onto any windows device such as a low cost netbook. With this low cost application on a low cost PC, you have a very powerful tool that allows you to publish your calculations for review and follow up, a really powerful feature for the professional as well. While Microsoft offers a commercial polished product, there is certainly other software available for less and performs as well as most graphing calculators. If you have Microsoft Office Suite, Excel has lots of functions and capability as well.

And of course you could always download a graphing calculator and use that on your PC as a windows calc. You would get the exact same look and figurative feel as the real calculator. Is this a viable substitute? I guess that depends upon your needs, requirements and if you have exam or class restrictions.



Screen shot of Microsoft Math

My last review is Ti's replacement of its Derive software line. This hardware is released in two versions, both called **TiNspire**, one with CAS and the other without, but with an extra keyboard to mimic the Ti-84. I have the CAS model and am absolutely blown away by many of the features this calculation tool offers. My best analogy is that this device is like an animated math text with various modules (chapters) to segment out assignments for the student. It offers an astounding amount of features and can certainly demonstrate both simple and deep insights in the subjects of math. I am astounded by what it offers. Then why don't I rate or suggest this higher in my review? Because it is sophisticated beyond belief, and has sacrificed simplicity of use and is no longer a tool for calculation. It is designed to be mastered by an instructor that can then step the student(s) through examples to discover math insights in a classroom environment. In short, it is a learning platform and not an easy to use calculation tool. This philosophy is something that most everyone has overlooked or forgotten. It isn't a nice straight forward direct number crunching tool that I would use as an engineer. However, a math major might successfully argue that it's the best thing since sliced bread, but this calculator has developed a long list of detractors and after I have used it, realize it was developed for a different user than people like me. Ti markets this to teachers and the education market. I suspect that the idea was to sell it like a textbook and have the school buy new sets every 3-5 years or sell it to freshmen and have it as a tool to use in math for the next four years. And given Ti's resources and marketing, there is the slim possibility of them succeeding, but I don't see it, especially given the harsh criticism this device has received.



TiNspires w/o CAS The lower picture is with the new touchpad

The TiNspire that comes with the Ti-84 adapter faceplate tries to bridge this difference by offering an extra keypad that is actually a Ti-84. If you are an instructor, this may be a good approach as you then have the Ti-84 to use, should you abandon or end up using the Ti-84 more often. The cost of this TiNspire is only \$20-30 more than a conventional calculator and could certainly



not hurt your budget and would allow you to use the TiNspire as well. However, the TiNspire is significantly more bulky than the standard Ti-84 and if your school doesn't

use it and you don't have a brilliant nerd friend or an instructor to guide you on how to use it, you may not make the best use of this system. I certainly don't use this machine often. When I do, I am always impressed with what it can do, but I never get my answers quickly. That may certainly change if I were to switch over to this system on a regular continuous basis. However, since it is not nearly as portable as a standard graphing calculator and I don't really like the keyboard (I don't have the newest keyboard though), I haven't embraced this machine as something I use and recommend.

**TiNspires w/ CAS
Newer touch pad above
Original keyboard on right**



I would like to thank the following people (in alphabetical order) for their information they have made available either through their own websites or answers to questions to either myself or others on various calculator support groups. There are more that I did not list (almost everyone who has an English based calculator website), and to those I apologize.

Thanks:

Valentin Albilo	Math guru/calculator connoisseur
Jean-Yves Avenard	Hp48G/Hp50G guru – Entrepreneur in calculation technologies
Bhuvanesh	Ti-89 wizard, Math professional
Doug Burkett	www.ibiblio.org/technicalc/tiplist/en/html/index.htm

Colin Croft	www.hphomeview.com/index.htm
Cryille De Brebisson	Calculator Development at Hp
Dave Hicks	http://www.hpmuseum.org/
Ray Kramer	http://www.technicalc.org/tifaq/
John Mayer	Hp48G/Hp50G guru
Bernard Parisse	http://www-fourier.ujf-grenoble.fr/~parisse/english.html
Roberto Perez-Franco	http://rp-f.com/works.php
James Pratt	Knowledgeable calculator enthusiast
John David Ratliff	http://www.technoplaza.net/
Eric Rechlin	http://www.hpcalc.org/
Viktor Toth	http://www.rskey.org/ (The site you are now on)
Tim Wessman	Calculator Development at Hp
Jorge Woerner	http://www.datamath.org/
Gene Wright	Calculator Development at Hp

And others I am sure to have overlooked and have liberally taken from.

If you have any comments or questions, you are welcome to email me at:
ssorknor@gmail.com. I do check my email on a weekly basis and try to answer any comments within 7-10 days.