

As compiled by: Ron Ross

Date: 8/30/05

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 **eighth edition** of these calculator reviews. It is appropriate for North American users as some calculators are for sale in Europe and the Far East that are not available here in the US. I arranged their order from weakest, least functions to more features and programmability. The model codes of these calculators may change (or more accurately evolve) from time to time but these descriptors usually only reflect minor changes. These lists will be probably dated almost as soon as it is re-posted. However it should still be useful as a rough guide as to which calculator you should buy or consider. I have made minor errors in previous reviews and am always trying to improve this document and the information provided. Hp's availability is still scarce and not available retail, and this has been the status quo for years now with no large chain stores stocking their graphing calculators. College bookstores at engineering or technical schools may be the exception.

Graphing Calculators:

Today all graphing calculators offer an EOS (equation operating system) system of algebraic entry. Hp's line of 48/49 graphics also offer an RPN selection option (Reverse Polish Notation or more accurately RPL). All the higher end models now offer a clear acrylic lens to cover the LCD's, which will certainly reduce LCD breakage and failure, a weak spot on the older calculators.

In the tables below I exclude many common lists of scientific functions. This includes trig functions (sin, cos, etc), x^2 and square root, $1/x$, logs, natural logs, e^x and 10^x , so that I will not provide any repetition or clutter on the tables. If you do not see the function, it is either common to all, or less likely, offered on none.

I list them in order with the fewest features to the most features out of the box. Some of the higher end calculators can be expanded and software added to make them move higher up on the list comparable to much higher end calculators. All present TI graphics are able to interface into a Ti CBL (Calculator Based Laboratory) device, which is a neat feature and with the addition of a clock on the Ti-89 and recently released Ti-84, would allow for budget priced data acquisition. Other brands also have equivalent products, but not in the same price range or availability (Hp used to RULE this arena). Much of my own opinions will creep into the reviews as well. I am often forgiving and generous in praise to a low retail priced calculator and harsh on a high priced unit, but please remember you do generally get what you pay for. Therefore my comments may seem overly kind, others overly critical, but keep in mind the retail cost of the calculator I am reviewing as well. I expect a lot for \$150, I don't expect as much for \$40. I try to benchmark my standards and comparisons based upon the Ti-83/84 series. This is

because these are the standard in education. Most textbooks now include examples using a Ti-83+ and most certainly will follow with later editions geared towards the Ti-84 series (The keyboard layouts are identical aside from cosmetics). Other calculators are similar, but to follow along in the text can be difficult unless you have a Ti-83+ or are very comfortable with your existing calculator. If you have an inferior calculator, you will not be able to keep up without considerable foreknowledge of the subject and make adjustments or do programming. If you have a superior calculator, you will have to know how to find the equivalent functions. Comparisons and placement of calculators is tough and not exact. As an example many of the calculators I deem superior to the Ti-83/84 series are not nearly as feature laden in statistics and business functions (indeed, the Ti-83/84 series has few equals in this area).

A quick word on CAS (usually means Calculator Algebra System). This is a feature that is now built in on the very high end calculators. This feature allows a calculator to solve for and isolate unknown variables, and even differentiate and integrate symbolically as well. The answer can be returned as simplified or expanded values that eliminate the need to actually understand algebra. A student with this type of calculator could take math courses up to and including calculus without having any real understanding of the material and passing (and with a good grade as well). That is why these calculators are often banned at the high school and lower college level. Five calculators that have CAS as a standard feature are the Casio FX2.0, Hp48GII, Ti-89 Titanium, V-200 and the Hp49G+.

I am leaving out Casio's new **ClassPad 300** for two reasons. First I don't feel it is a true calculator but a PDA type device and 2nd, I don't own one and therefore cannot really give it a thorough or fair review. However I will make these comments. It is a very powerful calculation tool, it uses soft menus and screens with a pen based entry system. Many people would and could use this in place of a traditional calculator. However these same people could take a palmtop and download a decent calculator emulator. That doesn't mean you should overlook it, if you don't mind using this type of interface and you do not need a traditional keyboard. I would advise most people to buy a calculator though for school and engineering/science applications. Looking through its manual, I surmise that it is superior to the Ti-89 and at least equal to or possibly better than the Hp49G+ in mathematical capability. Casio has a solid reputation that is often overshadowed by Ti and Hp in the US. However, I saw no mention of unit's usage or conversions which an engineering or physics student would miss. Indeed this is a must have item unless you don't mind programming in conversions or having conversion tables handy. A math major would not mind and its built in math feature set is extensive.

The first graphics I will list is the **Hp9G** because of its specs. And being first on my list is not a sought after position. All information reveals a low cost, no frills graphics with barely enough functions for general use (as compared to the rest, however all of these calculators have plenty of functions and power for typical use). The Hp9G comes with no real RAM other than enough for some down and dirty programming. The graphics screen is half the size of the display and is not nearly as large as any other graphics now available. A student looking for a cheap graphics shouldn't consider this, but consider a

Casio, listed next, or just buy a Ti. For a professional, interested in a simple portable programmable, this might be enough, although I doubt it. This calculator's features and small size make it a portable all around calculator for general use. If you do need a powerful graphics calculator though, this is lacking in all areas especially statistics. And worse, there is no I/O capability leaving keyboard entry as all that is available. A note to general Hp users: this is an algebraic unit, not RPN. Aside from the added graphics, this calculator would substitute well for the discontinued programmable Scientifics such as an Hp20s, Ti 68, or Casio's 4000 or 6300 series except for its limited statistics (only 30 samples, PATHETIC!). And lastly, it is no longer allowed by the NCEES for their exams either.

The **Casio 7400G** or **7450G** are great low priced graphics at department stores. No, they are not as powerful as most of the graphics available and offer low amounts of RAM (8 K or 20K), but are cheap in cost, well made, and graph functions. These calculators offers a lot for a low cost and are certainly a much better buy than the Hp9G or the higher priced TI-73 (even though the TI-73 has much more RAM) unless you want to make use of a CBL. This would be adequate for an elementary algebra class or entry level statistics. If you plan on going further, it could also work, but you would be better served with a Ti-83 or better. This calculator has comparable math functions to the Ti-83/84 except for statistics functions and no real RAM or backup communications software to PC. And it is smaller than most graphics, but you should also consider the next step up from Casio for about \$10- more retail.

The **TI-73+** is a basic graphics calculator, but since it offers flash ROM there is always the faint possibility that it could be upgraded. The TI-73 has replaced the TI-80. It is aimed at the junior high school market and is useful for the study of algebra and trigonometry. It is a good calculator for its intended audience and it also has a built in solver that makes this calculator very useful and versatile. Keep in mind that it probably does not have enough functions for higher math users. At its relatively high price, for \$10 more you could buy a Ti83+ and have a more capable calculator that is a hundred times more popular and have much better support and software available to you. Because of this, there is almost no real third party software available for this calculator. One place it may work fairly well is in a shop environment since it supports fractions and has unit's conversions, both very nice features for shop work. Both these features are lacking in the higher end Ti-83/84 series. This calculator is very tough to find unless special ordered. I may drop my review of it, if it continues to be a hard find.

Sharp's **EL-9600c** is an okay graphics calculator with the unique pen touch LCD (you can enter menus with a touch pen or quickly zoom in on selected areas of a graph). This allows you to navigate through the screen and some people like this feature. It is a unique selling feature. It does have a diverse amount of functions including TVM and decent statistics and could easily work as a business or statistical calculator. Sharp is not as good a programming platform as the TI line. The EL-9600's calculating power is adequate but its software base is almost non-existent. While the calculator spec's show 32K of RAM, only a little over 20K is actually available. All this adds up to a poorly supported calculator for outside programs and software. Again, this calculator would be

fine for most entry level college math or statistics courses, but you need to read the manual, where with a Ti-83 you could probably follow along in the text (most textbooks use a Ti-83 for their examples) or class. This calculator is also not readily available via retail outlets.

Sharp has also introduced a new **EL9900c** which is a two faced calculator (no, not a metaphor). The keypad can be reversed to provide two types of calculators, a lower end simplified graphics and a higher end model to place it here in this area. The lower end faceplate would be on par with the Ti-73 series. While some of its specs would place it higher in this lineup, there is no real software or hardware base to support it. Again, this would be an adequate calculator, but if you want outside support and help, you would be better served by the Ti series. It is basically an EL9600c with 64K RAM, but the pen input was dropped in favor of a reversible faceplate.

The Casio **CFX-9850PLUS** (28K RAM) or **CFX-9950PLUS** (60K RAM) color graphics 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 it is somewhat less powerful, but the CFX-9850 is often found at office supply stores for \$49-, about half the price of the Ti's. It is a good buy if you need a graphics for work or school and are not committed to following along with textbook examples. This calculator is a big step up from Casio's 7400 line and is more than worth the extra \$10- in cost. An EE or Comp Sci student will appreciate the few extras you pick up over the Ti-83/84 as well i.e. number conversions and direct logic functions.

The **TI-83+**, **Ti-83SE** or new **Ti-84** series (it is better because of a clock and USB) are now the standard calculators for education and these are TI's main sellers. The Ti-83 (and now Ti-84) calculator keeps TI on top. These are the standard calculators for education. These are the upgrade from the still available **TI-82** (which should be passed over unless you find it cheap). The Ti-82 doesn't have a solver, doesn't have nearly as good of statistics functions, and doesn't run Ti-83 programs (without some modifications anyway). Otherwise the keyboard layout is still very similar, as the 83/84 is the upgrade path and stayed with the original 82 keyboard layout. The Ti-82 or original Ti-83 should be passed over for new Ti-83 SE or 84 series, unless the price is right, i.e. really cheap and you only need the features of the calculator only. The new 84+ and SE line of these calculators have numerous programs now available. The Flash ROM allows applications to be loaded into permanent memory which makes this a very versatile learning tool. The statistics functions that are offered out of the box by this calculator are as good as any of the higher priced and featured calculators listed below. Most of the functions can be downloaded for the other calculators listed, but out of the box and ready to use make this calculator attractive to buyers who want something now and don't want to bother to load applications.

The Silver edition of the TI-83/84 line includes these features: 15MHz CPU, 1.5 Meg of Flash Rom which makes them the fastest calculators offered by Ti. Although they are

priced about \$20 higher than the Ti + series, they come with a serial cable to connect it to a PC. This cable sells for \$20 if bought separately; effectively making the Ti SE models a much better buy. None still include Boolean or unit conversions! Since it does have such a huge amount of ROM available, programs galore can be stored on board. If you are a student and are required to buy a TI-83/84, the SE would be the one to buy. As a statistics or business major, either calculator should be considered. CellSheet (an Excel compatible spreadsheet and also available for the Ti-89) software is available which would make this even more attractive to someone who uses Excel. Depending upon how well integrated this system is, this could be a very powerful analytical tool. The Organizer and Periodic Table will also be useful, but these features are also available on the higher end calculators listed below in one form or another. The TI-83/84 series cannot directly access the huge amount of its RAM directly but is limited by TI to 24K. This is plenty for the average user. Do not misunderstand this placement. These are good calculators, it is just that the ones that follow offer more in the way of features and functions that either of these calculators do not or will not offer (this is often due to marketing or fear of robbing from sales of higher end calculators. Also certain features such as CAS would get these calculators banned from their intended market).

The TI-83/84 calculator offers even the most advanced calculator users 95% of what they would need (they would have to resort to programming), but that last 5% is sorely missed (some functions are just beyond this calculator even with above average programming skills). This calculator could take any student through any four year engineering degree, but the rest that follow, could and would be better. It doesn't offer Boolean conversions, nor do any of the lower end TI graphics. However, since most teachers use a TI-83, your following along in a classroom might indeed be better with this calculator. If you enjoy reading manuals and learning hardware, you might consider some of the following.

I have three problems with the Ti-83/84 series, 1st the lack of HEX, BIN, Dec conversions. 2nd, units conversions are not provided with this calculator. 3rd is the restriction to single letter variable names (27 letters). The first is nice for an electronics class and the second comes in useful for all types of real world applications. Without them, this is just a calculator to crunch numbers, but not a tool for my desk. Both of these features can be downloaded onto a calculator, but as all know, occasionally, you will lose programs (and this always happens at the worst time). The 3rd restriction is actually a plus for this calculator's intended audience so that at the High School level, no confusion with algebraic manipulation is possible. The 27 variable limit is a common feature or shortcoming in nearly all of the lower end graphics calculators, and is a rule of thumb guide to how powerful the calculator really is. If you can have descriptive variable names (not single letters), you are bound to have more features.

The **Hp39G+** is well equipped for mathematics and retails for \$89. The large amount of RAM is all directly accessible. It is an algebraic only (no RPN selection feature) calculator (so as not to rob 48 or 49 sales). The 39G can do some symbolics out of the box and has a rudimentary CAS. The Equation Writer is disabled but can be used to view an equation entry to give you WYSIWYG. Step by Step numeric solutions are possible

although sometimes not the same as a textbook would use (my experience is >75% of the time it is). The functions available and the programming are very well integrated. This series calculator was meant to challenge Ti's 83 series head to head. It is a superior calculator in most every category. But it is also limited in many of the same areas as well. Only single character names, no HEX, DEC, BIN conversions, and no 3D (rectangular, cylindrical, spherical conversions or plots). Hp now includes units' conversions (I feel a needed addition for years) and has a tactile feel keyboards. However, specs do not indicate an upgradeable ROM, which is becoming a standard on many calculators.

The **TI-86** is an upgraded TI-85 with 4 times as much Ram (128K, 96K available to user) and some extra graphing functionality. It doesn't offer flash technology, but allows full name (8 character anyway, with both upper AND lower case, something even the 89 doesn't do) variables which is a big improvement over single letter variables offered by the TI-83, Sharp, Casio, and the lower end calculators. This calculator has many avid followers and deserves its following. It does lack a CAS (calculator algebra system) but this is not allowed on many standard tests or most math courses anyway. This is the best algebraic graphics calculator with out CAS available. Keep in mind that this calculator was Ti's answer the original Hp48G series. It is designed for the advanced math user who did not want an RPN Hp48 and before CAS became available. Since it is an older design, it lacks the nice acrylic lens cover over the LCD which makes it a more fragile calculator in comparison to the 84 or 89 series now offered by Ti.

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 this far down with Hp or TI. It does not offer the functionality or capability of the Ti 89 or the Hp48/49. 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 49 (however, the Hp48GII is the same price, better, and has an awfully nice leatherette case). Most people never ever use these calculators to their potential and the straightforward ease of use of this calculator can easily justify buying it. 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 8/30/05) 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."

The next step up in calculator power is the new and completely redesigned **HP48GII** series calculator. It really should be called an Hp49G- (minus) as it is NOT related to or an upgrade of the Hp48G series family, but the older Hp49G stripped down, aside from

an upgraded CPU! This is the Hp49G without the Flash ROM, memory but now has a 48MHz ARM CPU. It has the same keyboard layout, CAS and all the functions of a 49G+. It is designed with an RS-232. Since it doesn't have flash rom, no upgrades to fix bugs or add extra features are possible. The 48GII still has an 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 49 isn't, and many new (uninformed) users will probably buy the 39G (however this calculator is only algebraic and only has 27 Variables available) since it is twice as fast and has twice as much RAM. This calculator will probably suffer the same fate as the Ti86 in the Ti line, too powerful for High School, but not powerful enough for the High End user. 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. Its major drawback is the limited amount of RAM (80 K) that is now standard or expected for a calculator in this class.

The best Ti's available are the new **TI-89 Titanium** and **Voyage 200** series calculators. The TI-89/Voyage 200 series do offer so much. These calculators have large amounts of RAM, Flash ROM, CAS, multitudes of functions. The TI-89 (the new Titanium version has the same specs as the Voyage) and Voyage are the same calculator aside from the enclosure and the Geometry application pac that is included with the Voyage 200. The geometry pac can be downloaded to the TI-89 if needed. And with the new memory increase, the Ti-89 actually surpasses the Hp49G+ in on board memory (although it isn't used in the same way or as efficiently) This pair also uses a Motorola 68000 based processor at 12 MHz. While compared to today's palmtop CPU speeds this seems slow, it is not. I have seen many complaints about Ti's not bumping the speed up and while Ti could have, and perhaps should have, the Ti-89 is not a slow calculator. If doubling the speed meant reducing the battery life to one month, how many would still want the faster speed and find this unacceptable? The competition (HP) eats batteries at about this rate. The Ti is a very powerful and fast system that gives very quick answers to most problems. The TI line CAS is based upon Derive software that is also available for your PC and was a huge academic favorite due to its low cost and ease of use to the academic world. For symbolic integration, Ti uses a very thorough lookup table based system, which Hp does not. This allows for fast answers to standard textbook type problems. Most students and professionals appreciate this as it returns a standard answer that nearly always agrees with the textbooks. The drawback is that step by step solutions are not possible with this type of implementation. This is a great calculator line and you will be happy with either calculator. I prefer and would recommend the Ti89 over the Voyage 200 due to the smaller size and portability of the 89 and it is not banned by as many exams as the Voyage 200. One example where the Voyage 200 is banned but the 89 is not is the SAT. However many favor the larger screen and key layout of the Voyage 200.

If you keep your calculator on your own desk and don't like shift keys to enter alpha characters (who does?), this is an excellent choice.

My major gripe with the Ti and its line of calculators is Ti's backhanded restrictions on program development. This is what cripples the release and availability of high end quality software comparable to what is available to Hp users. A serious developer is restricted or hampered by Ti's certificate policies and memory restrictions. This doesn't affect the normal user of which is 99.9% of us, and general BASIC programming is straight forward and easy. However it reduces the amount and quality of high end ASM programs due to the hassles of memory restrictions imposed Ti upon the calculator programmer and the annoyance of obtaining certificates for an ASM program. There are ways to circumvent this (and admittedly fairly easy), but Ti shouldn't have these restrictions at all. This minor inconvenience has in reality strangled software development for the Ti line. If these restrictions were not in place, I wouldn't be surprised to see a 10 fold increase in real quality technical software explode upon the net.

Well Hp's **49G+** is the unquestioned top dog in the calculator kingdom. This calculator was a big step over the original Ti-89/92 series from Ti. No, it hasn't challenged the Ti, as Ti has established itself as the dominant calculator manufacturer and the Ti-89 established itself as a reliable and mature product. The Ti-89 is fast enough and good enough for 99 % (probably 100% of everyone's needs if it came with an RPN option, because at this level, you probably also need a math package for your computer to really tackle the tough stuff) of anyone's needs. However compared side by side with the new Hp 49G+, the Ti's get blown away. In fact, I will use a quote from Doug Burkett, who is someone very knowledgeable with the high end Ti line; make what is probably as unbiased a review as you will find:

“In terms of hardware, the 49G+ bests the 89 in every way: speed, memory, memory expansion (SD card), connectivity (IRDA + USB), slightly more display pixels, buzzer, better clock resolution, etc etc etc. Customizability far outstrips the 89: keyboard assignments (for built-in & user functions), sub-sub-...-sub folders, run programs at power-up & at defined alarm times, change display fonts, for example. Unit conversion is a pleasure instead of a hassle when soft-key menus are enabled. Gradians are supported. In a very personal opinion, if you are a committed science/engineering student, and you have the freedom to choose any calculator you want, the 49G+ is the obvious choice. If, of course, you're willing to put the effort into the admittedly much steeper learning curve, and you can live with the fact that everyone else at your school is using TIs. In fact, if you're an engineering student and you choose the 89 instead of the G+, you can just burn that geek card right now.”

Admittedly Doug is being quoted somewhat out of context and in jest, but the simple truth is, that Hp has set a new standard. Hp's 75 MHz ARM processor eliminates nearly all the criticism of the earlier Hp49G's speed (no calculator can match a dedicated work station in complexity, power, or speed). The new keyboard is a big improvement in feel

over the discontinued 49G and is nearly on par with the Hp quality and feel of the older Hp line. The Hp 49G+ SD memory expansion of RAM is a great addition. What makes this a better calculator than a Ti? At this level, it is a geek thing pure and simple; both calculators provide 10 times more functions than the average user will need. But a power user will appreciate the better file system of the Hp vs. Ti. Programming in RPL is not quite as straight forward as basic (to the new user), but once learned is actually much more direct and powerful. Both offer C compilers, although the Ti line is more developed vs. only a recently released version for the Hp. Larger available RAM and all is directly accessible, while Ti has restrictions on their RAM and issues certificates for programs. Hp has over twice as many functions included, a few examples are LaPlace and Fourier transforms. It should now be two-three times faster than the Ti-89 for most calculations. 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 better results are often obtained by the Ti's table approach. If your problems are that complex, you should be using a Math package or learning your calculus without the calculator. The Hp's CAS is more feature rich (or more bloated, if you are an Hp critic) and the latest versions is ROM 2.00. This ROM version has returned the much missed equation library. This is another big plus over other calculators for a reference tool (over 300 equations with some pictures) and its ability to be used by the solver.

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 some higher courses (calculus based) may use the Ti-89. Textbook and outside publications support should not be overlooked. A Dummy's Book is available for both the Ti-83 and Ti-84. 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 sophisticated 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: Ti-86 (doesn't have CAS and may therefore be allowed where CAS is banned), Hp48GII, Ti-89, or Hp49G+. You could certainly buy any other, but these four would give you a big edge on exams and make life easier in your studies with their available features. Below are charts with calculator models across the top and the features listed on the left. I have researched these features, but I not an authority on most models so there could certainly be errors in this table.

I actually recommend the new Ti-89 Titanium or Hp 49G+ for the engineering or physics major if there are no restrictions on your choice of calculators. 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 Hp49G+ 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 Hp49G+ 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 Hp49G+ 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.

I have a couple of historical comments about the Hp49G+ as well. It is the direct descendant of the Hp28/48 line of calculators that were designed/developed from scratch by Bill Wicks PhD. of Physics from the University of Maryland and a very dedicated team put together at Hp. As such, you cannot find a better tool for physics or engineering, once you learn the intricacies of this tool. Because of this, units' conversions and vector handling are much easier on this calculator than anything else. Numerical and matrix methods are also superior to its competition as well. Then Hp brought aboard two gifted enthusiasts (Jean-Yves Avenard and Bernard Parisse) who had developed successful third party software for the Hp48G. These features were incorporated into the new Hp49G (perhaps too many as it went from being a nearly manageable piece of technology to what it is today, a monumental smorgasbord of features). The intent of the Hp49G+ 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 Hp49G+. 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 Hp49G+ 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 into a more awkward function in algebraic). It is just easier and smarter to buy the Ti and bypass this aggravation.

Calculator Model >	Hp9G	FX-7400	Ti-73+	EL-9600c/9650	EL-9900
Functions					
Entry System	EOS	EOS	EOS	EOS	EOS
Typical Cost	\$29-	39-	79-	75-	75-
Units					
Conversion	Yes	Yes	Yes	Yes	Yes
Physics Const.	Yes	Yes	Yes	Yes	Yes
%, delta %	Yes	Yes	Yes	Yes	Yes
Comb, Perm	Yes	Yes	Yes	Yes	Yes
Fraction<>Dec	Yes	Yes	Yes	Yes	Yes
HMS<>Hrs	Yes	Yes	Yes	Yes	Yes
ANOVA, advncd stats	No	No	No	Yes	Yes
TVM	No	No	No	Yes	Yes
Hyp Trig	Yes	Yes	Yes	Yes	Yes
HEX, DEC, BIN conv.	Yes	Yes	No	Yes	Yes
Logic i.e. And, Not	Yes	No	Yes	Yes	Yes
Rect>Polar	Yes	Yes	Yes	Yes	Yes
Complex	Yes	Yes	Yes	Yes	Yes
Cylindrical	No	No	No	No	No
Spherical	No	No	No	No	No
Graphics Functions	2D	2D	2D	2D	2D
Solver	Yes	No	Yes	Yes	Yes
Programmable	Yes	Yes	Yes	Yes	Yes
Variables	26	26	27	27	27
Direct Memory (RAM)	0.4 K	20K	24K	20K/60K	64K
FlashRAM-Storage			128K		
CAS	No	No	No	No	No
PC					
Communication	No	No	Yes	Yes	Yes
Linear					
Regression	Yes	Yes	Yes	Yes	Yes
Curve Fit	Yes	Yes	Yes	Yes	Yes
Unique features	None	None	Flash Mem	Pen touch Screen	Reversible Faceplate

Calculator Model >	Ti-83/84 SE	FX-9850 /9950GB	HP 39G+	Ti-86
Functions				
Entry System	EOS	EOS	EOS	EOS
Typical Cost Units	84/129-	49-79	89-	109-
Conversion	No	Yes	No	Yes
Physics Const.	No	Yes	No	Yes
%, delta %	No	Yes	Yes	Yes
Comb, Perm	Yes	Yes	Yes	Yes
Fraction<>Dec	Yes	Yes	Yes	Yes
HMS<>Hrs	Yes	Yes	Yes	Yes
ANOVA, advncd stats	Yes	Yes	Yes	No
TVM	Yes	Yes	Yes	No
Hyp Trig	Yes	Yes	Yes	Yes
HEX, DEC, BIN conv.	No	Yes	No	Yes
Logic ie And, Not	Yes *	Yes	Yes*	Yes
Rect>Polar	Yes	Yes	Yes	Yes
Complex	Yes	Yes	Yes	Yes
Cylindrical	No	No	No	No
Spherical	No	No	No	No
Graphics Functions	2D	2D	2D	2D
Solver	Yes	Yes	Yes	Yes
Programmable Variables	Yes	Yes	Yes	Yes
Direct Memory (RAM)	27	27	27	Unlimited
FlashRAM-Storage	24K	28K / 60K	240K	96K
CAS	128k/1 Meg			
PC	No	No	Limited	No
Communication	Serial/USB	Yes	Yes	Yes
Linear Regression	Yes	Yes	Yes	Yes
Curve Fit	Yes	Yes	Yes	Yes
Unique features	Flash Mem Clock on 84	Color display	IR / USB Clock	None

Calculator Model >	Hp 48GII	FX 2.0	Ti-89	Voyage 200	HP 49G+
Functions					
Entry System	RPN / EOS	EOS	EOS	EOS	RPN / EOS
Typical Cost Units	99-	99-	149-	209-	149-
Conversion	Yes	Yes	Yes	Yes	Yes
Physics Const.	Yes	Yes	Yes	Yes	Yes
%, delta %	Yes	Yes	Yes	Yes	Yes
Comb, Perm	Yes	Yes	Yes	Yes	Yes
Fraction<>Dec	Yes	Yes	Yes	Yes	Yes
HMS<>Hrs	Yes	Yes	Yes	Yes	Yes
ANOVA, advncd stats	Yes	No	Yes	Yes	Yes
TVM	Yes	No	Yes	Yes	Yes
Hyp Trig	Yes	Yes	Yes	Yes	Yes
HEX, DEC, BIN conv.	Yes	Yes	Yes	Yes	Yes
Logic i.e. And, Not	Yes	Yes	Yes	Yes	Yes
Rect>Polar	Yes	Yes	Yes	Yes	Yes
Complex	Yes	Yes	Yes	Yes	Yes
Cylindrical	Yes	No	Yes	Yes	Yes
Spherical	Yes	No	Yes	Yes	Yes
Graphics Functions	3D	2D	3D	3D	3D
Solver	Yes	Yes	Yes	Yes	Yes
Programmable Variables	Yes	Yes	Yes	Yes	Yes
Direct Memory (RAM)	Unlimited	27	Unlimited	Unlimited	Unlimited
FlashRAM-Storage	86 K	144 K	188 K	188 K	256+800 K
CAS		768K	702K/ 3 Meg	3 Meg	Any size SD RAM Card
PC Communication	Yes	Yes	Yes	Yes	Yes
Linear Regression	Yes	Yes	Yes	Yes	Yes
Curve Fit	Yes	Yes	Yes	Yes	Yes
Unique features	IR and serial port	None	Upgradable Flash OS	Qwerty Keyboard	SD memory Cards
	Not a real RS232 port		Calc to Calc cable included	Clock	Clock
	Clock		Clock w/AMS2.08+	Clock	Clock

Final Comments:

One comment about software OS upgrades. Don't be first! Let others try out the OS for at least a month before you rush in and download a problem (two or three months is even better). While every upgrade has nifty new features, it can also have lots of nasty little gremlins tucked in as well. Let other's infest, ahem,.. upgrade their calculators. And don't upgrade before finals. A student should upgrade at the beginning of a semester (or at the very end, after every final) and only at those two times! If you have a quirk that you don't like, I suggest putting up with it until then. I think, "MORON!" every time I see a person ask for help in December about upgrade problems and especially the weekend of finals!

I hope this review has answered some of your questions. I own many of the calculators listed above and feel that most any one of them can be adapted and used for nearly any job! If you just need a calculator to graph functions or customize to a particular task all will work. However for a specific graphics for the average student (something to follow along with the texts, teacher, and classroom examples), I would suggest a Ti-83/84 for almost everyone. It is not my favorite but it is the most used for examples in all texts. If you are an engineering or physics student in college or plan to pursue engineering or physics, you should consider a Ti 86 or above (something with more than 27 variable names).

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). A classic 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. As such, these calculators do not attempt to lay out their menu systems for efficient use, but rather to show or teach you math functions. 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.

Some advice if you are replacing a former graphics calculator. If you had an older Ti-80, 81, or 82, the newer Ti-84 series would be a big step up and fairly straight forward transition. But the older Ti's are actually very comparable to the much cheaper Casio Fx7400G and the quality is still there.

A Sharp user might be best served by staying with Sharp. This is only because of their unique keyboard arrangement. As far as capability and quality, Sharp is on the bottom of the pile (again this is subjective, their quality is good), but still capable calculators and often they are discounted which makes them a good buy.

A Casio user should consider upgrading to Ti-86 or 89 if they 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 or science student or professional. The lower range Casio Fx7400G and the next step up Fx9850 are both a best buy in their price range and if they are enough, there is no reason to spend more. The higher end Casio FX2.0 plus is a big step up from the Casio Fx7400, but better calculators from Ti and Hp are then available and should be considered.

A few comments to Hp users. Hp now makes a quality keyboard nearly equivalent to the discontinued Hp48 series. But they no longer offer the standard placement of the enter key. The new Hp48GII is really just the Hp49G+ with every decent feature removed so as to not rob sales from the high end 49G+. If you just want/need RPN and the latest and fastest calculator: the Hp49G+ is a good buy. It is worth the extra money. If you are a student or surveyor, your calculator is probably exposed to many high risks (i.e. damage or theft), then you might be justified buying the new 48Gii and saving the difference (between \$30-50). But you will sacrifice RAM and that is a big sacrifice considering all the free software that is available to this line.

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:

Doug Burkett http://www.geocities.com/ti_tiplist/

Dave Hicks <http://www.hpmuseum.org/>

Ray Kramer <http://tifaq.calc.org/>

Bernard Parisse <http://www-fourier.ujf-grenoble.fr/~parisse/english.html>

Roberto Perez-Franco <http://www.perez-franco.i.am/>

John David Ratliff <http://www.hp49g.cjb.net/>

Rick Rechlin <http://www.hpcalc.org/>

Viktor Toth <http://www.rskey.org/> (The site you are now on)

Jean-Yves Avenard http://etud.epita.fr:8000/~avenar_j_hp/39.html

Gene Wright <http://www.rskey.org/gene/>

Hewlett Packard <http://www.hp.com/calculators/>

Texas Instruments <http://www-s.ti.com/cgi-bin/discuss/>