

Calculator Skills Required for the AP Calculus Exams

Students may use a calculator any way they want on the two calculator allowed sections of the exams. They may have built-in operations or programs. However, with the exception of the four things listed below students must show sufficient mathematical (non-calculator) steps to produce the results.

Questions where programs or the Computer Algebra Systems (CAS) features of some calculators are in the sections that do not permit calculators. In other words, programs and more expensive calculators will not give anyone an advantage.

For the four operations below, to receive full credit a student must show the set-up (the equation they are solving, the derivative they are finding, or the definite integral they are evaluating. The set-up must be written in standard mathematical notation – not calculator notation; they do not need to show any other work.

1. Graph a function in an appropriate window.

- a. Students may not be specifically told to graph, they may have to decide this for themselves.
- b. The window may or may not be given so students should be able to determine this also.

2. Solve equations numerically.

- a. Students may use any solving operation built into their calculator: solver, polysolve, etc.
- b. The most efficient way is often to solve by graphing. The best way is to graph both sides of the equation separately and find the point(s) of intersection using the INTERSECT operation
 - i. TI84: [2nd][F4:CALC][5] or
 - ii. TI89: from the graph screen [F5][5] or
 - iii. TI-Nspire CAS: Home screen [MENU][3: Algebra][1:Solve] or
 - iv. Casio Prism [shift] [G-solve][intsect]
 - v. Another way is to set the equation equal to zero and use the ZERO operation on the graph screen. TI84: [2nd][calc][2] or TI89: [F5][2], Casio Prism [shift] [G-solve][root]
- c. **DO NOT** use the arrow keys to move the cursor to the *apparent* point of intersection; you are finding the close by pixel coordinates, not the actual coordinates.

- d. Store and recall the coordinate(s) of the intersections (see below) and use them in calculations.

3. Find the numerical value of a derivative at a point $f'(a)$.

- a. TI84 syntax:

- i. Home screen [MATH][8] and fill in the template

$$\frac{d}{dx} (\text{)} |_{x=}$$

Old syntax: $\mathbf{nDeriv(f(x), x, a)}$ gives $f'(a)$.

- ii. Graph screen [2nd][calc][6] then enter the value of a from the keyboard (or trace to the point if it shows up *exactly* at the bottom of the screen.

- b. TI89 syntax:

- i. Home screen [2nd][8] or [F3][1] then $\mathbf{d(f(x), x) | x=a}$ the “|” is the “with bar” [2nd][k] or use $\mathbf{d(f(x), x, n) | x=a}$ for the n-th derivative.

- ii. Graph screen: [F5][6], choose the function if more than one is graphed and type in the value of a.

- c. TI-Nspire CAS: Home Screen [MENU][4:Calculus][2] fill in the values, push [OK] then use the template that appears.

- d. Casio Prism syntax:

- i. Run-Matrix screen [F4 math], [F4 d/dx] then enter the function and the point

4. Evaluate a definite integral $\int_a^b f(x)$.

- a. TI84 syntax:

- i. Home screen [math][9] and fill in the template.

$$\int_{\blacksquare}^{\blacksquare} (\text{)} d\blacksquare$$

Old syntax: $\mathbf{fnInt(f(x), x, a, b)}$ when a, and b are the lower and upper limits of integration.

- ii. Graph screen **DO NOT** integrate on the graph screen: the algorithm the calculator is using may not be accurate enough.

- b. TI89 syntax: Home screen: [2nd][7] or [F3][2]. $\int (f(x), x, a, b)$ (Without the a and b you will get the symbolic antiderivative; with $\int (f(x), x, c)$ you will get the antiderivative "+ c")
- c. TI-Nspite CAS: Home Screen [MENU] [4: Calculus] [3] and fill in the template.
- d. Casio Prism syntax: Run-Matrix screen [F4 math], [F6],[F1] enter functions and values

Other useful ideas

1. Be sure the calculator is in radian mode. The AP Calculus exam is always in radians (but not the physics exam).
2. Computations can be entered in their entirety on the home screen; there is no need to break them into parts and reenter the intermediate answer. Use "ANS" to recall the previous answer; or select and paste (TI89).
3. If a function or functions are to be used more than once, enter them in the [Y =] editor. Then you may recall them as arguments of other functions.
 - a. TI84: Functions stored in the equation editor (Y = screen) may be recalled and used on the home screen or the graph screen and used in computations. Use functional notation as in these examples.
 - i. $Y1(x-2)$ or $(Y2(x+h) - Y2(x)) / h$
 - ii. $\text{fnInt}(Y1, x, a, b)$, Note you may use either $Y1$ or $Y1(X)$
 - iii. You may graph the antiderivative of the function stored in $Y1$ by entering $Y2 = \text{fnInt}(Y1, x, a, x)$
 - b. TI89: Functions stored in the equation editor may be used exactly as for the TI84 above. In addition functions may be stored to any variable name from the home screen. For example: $x^2 - 3x + 7$ [STO>] $g(x)$ stores the function to $g(x)$; now you may do the computations using $g(x)$ instead of writing the function.
 - i. TI89: $\int (y1(x), x, a, b)$ Note: you must use the $y1(x)$ here, not just $y1$.
 - ii. Or $\int (g(x), x, a, b)$
 - c. On both the TI84 and the TI89 functions may be entered as the arguments of other functions. For example, on the TI84 you may graph the antiderivative of the function stored in $Y1$ by entering $Y2 = \text{fnInt}(Y1, x, a, x)$

- d. Casio Prism works the same way. The “Y” is [VARS], [F4],[F] and enter the number for after the Y.
4. Storing and recalling numbers. This works on all calculators. Any number may be saved to a variable using the [STO>] on the TI calculators or the [→] key on the Prism, and then later recalled in a computation. For example after finding the point of intersection of 2 graphs on the graph screen the coordinates will be at the bottom of the screen: On the TI84 and PRIZM they are X and Y; on the TI89 they are xc and yc. It is not necessary to copy these. Return to the home screen on the TI84 and type X[STO>]A [ENTER]. On the TI89 type xc [STO>]A [ENTER]. (The [STO>] will show up as an arrow on the screen of both calculators.) Store other values to different letters (B, C, D, ...) When even you need the value just type the letter; this includes inside the derivative or integral operations.

This may be done with the result of any computation. Use [ans] [sto>] [A]