Using Maple in Calculus: Part 1

COMMANDS

Maple is actually a kind of programming language. Each line that you type is called a “command.” When you press the Return key, Maple then interprets your command and executes the directions you provided. **IMPORTANT**: Every line must end with a semicolon (`;`).

If you want to add a “comment” line, a line that Maple will ignore (such as typing your name at the beginning), begin with a **#** sign. You don’t need a semicolon at the end of a comment line.

Maple is very unforgiving. Everything has to be entered absolutely correctly, or Maple will give you an error message. The way that things are typed in is called the “syntax.” Fortunately, if you do make a mistake, you can just move your cursor back into the incorrect command line and correct the error, much the same way you would correct an error in a word processing program, and then press Enter again.

OPERATIONS AND BUILT-IN FUNCTIONS

Operations are very similar to those on a graphing calculator, with a few notable exceptions. The table below lists the most common ones along with the equivalent keys on the graphing calculator.

OPERATION	MAPLE	GRAPHING CALCULATOR
addition	`+`	[+]
subtraction	`-`	[−]
multiplication(1)	`*`	[×]
division	`/`	[÷]
exponentiation	`^`	[^]
$\sqrt{x}$	`sqrt()`	[√]
$\sin x$	`sin(x)`	[SIN]
$\cos x$	`cos(x)`	[COS]
$\tan x$	`tan(x)`	[TAN]
e^x	`exp(x)`	[e^x]
$\ln x$	`ln(x)`	[LN]
$\log_b x$	`log [b](x)`	not available
$\|x\|$	`abs(x)`	not available
π (2)	`Pi`	[π]
$-\pi$	`-Pi`	[(-)][π]
∞	`infinity`	not available
$-\infty$	`-infinity`	not available

Two important notes follow on the next page.

(1) When entering something such as $3x$ on a graphing calculator, you simply press the $\boxed{3}\boxed{X,T,\Theta,n}$ keys with no multiplication sign in between. The calculator *knows* you mean multiplication. In Maple, you must include the multiplication sign: **`3*x`**.

(2) The number π must be entered as **`Pi`** (upper case P).

ASSIGNING FUNCTIONS

On a graphing calculator, you "assign" a function by pressing the $\boxed{Y=}$ key and then typing the function into `Y1` or `Y2` or `Y3`, etc. In Maple, you follow a similar procedure, but you have to name the function yourself by using the **`f:=x->`** command, where **`f`** is the chosen letter (and the "arrow" is a minus sign followed by the greater than symbol). You may choose another letter instead.

Example: The function $y = 5x^2 - 3x + 2$ would be entered into Maple like this:

```
f:=x->5*x^2-3*x+2;
```

Note the **`*`**'s for multiplication and the **`;`** at the end of the line.

Example: The function $g(x) = \dfrac{2x+3}{3x+2}$ would be entered into Maple like this:

```
g:=x->(2*x+3)/(3*x+2);
```

Note all those parentheses (the same as on a graphing calculator).

The function remains assigned to whatever letter you chose until you either re-assign another function to that letter, you quit Maple, or you unassign it with the **`unassign('f')`** command.

Once you have a function assigned, you can evaluate it (find the value for a particular value of *x*) very easily.

Example: Assuming you have already assigned the function *f* as above, then to find out what $f(1.1)$ is, you simply enter the following in Maple:

```
f(1.1);
```

Again, note the **`;`** at the end of the line, which *must* be at the end of every command line.

GRAPHING FUNCTIONS

You graph a function by using the **plot** command after you have assigned a letter to the function. The full syntax for the plot command follows:

```
plot([f(x),g(x)],x=a..b,c..d,discont=true);
```

where

[f(x),g(x)] are the function(s) to be plotted (omit the brackets [ ] if you are plotting only one function)

x=a..b represents the beginning and ending values of the horizontal domain

c..d (optional) represents the beginning and ending values of the vertical range

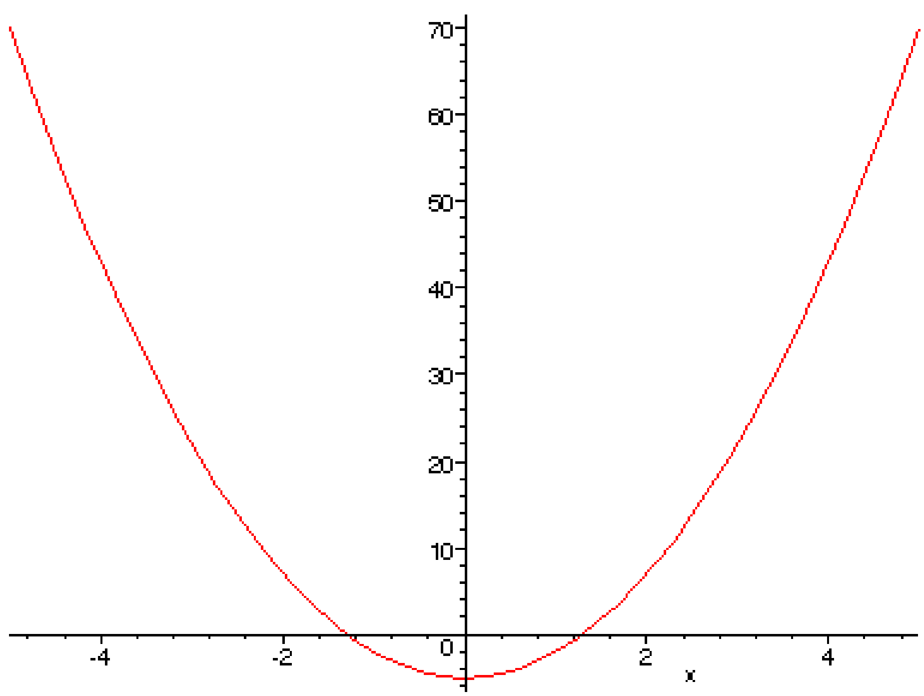
discont=true (optional) removes lines connecting positive and negative infinity

Example: To plot $f(x) = 3x^2 - 5$ over the interval $[-5,5]$, first assign the function, then plot it:

```
f:=x->3*x^2-5;

plot(f(x),x=-5..5);
```

Note that the brackets weren't necessary since we are graphing just one function, and the two options weren't used.

The result looks like this:

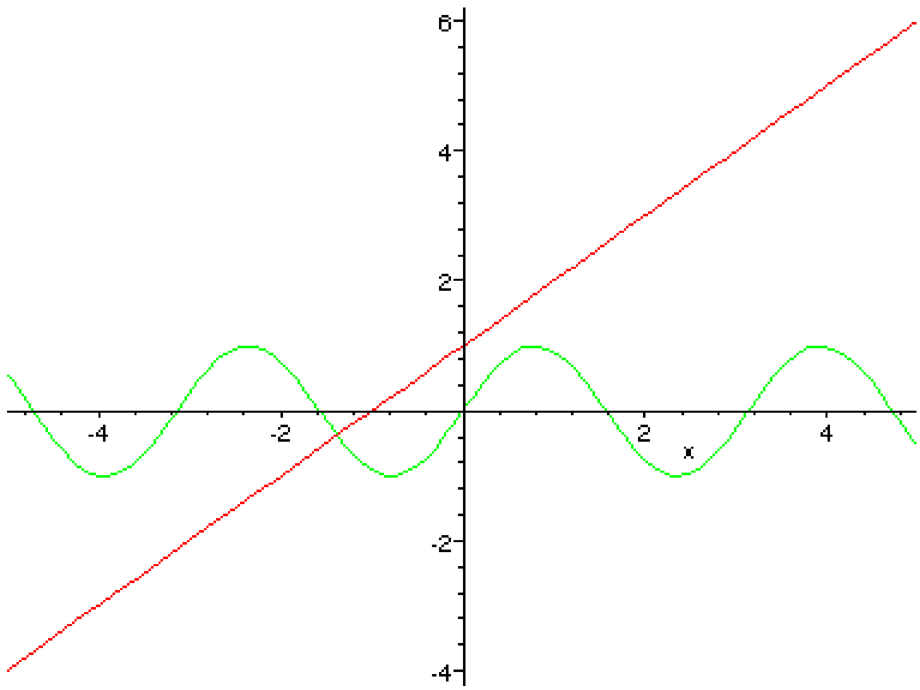


Example: To plot both $f(x) = x + 1$ and $g(x) = \sin(2x)$ over the interval $[-5, 5]$, first assign both functions, then plot them.

```
f:=x->x+1;

g:=x->sin(2*x);

plot([f(x),g(x)],x=-5..5);
```

Note that the brackets are necessary this time since we have two functions.

The result looks like this:

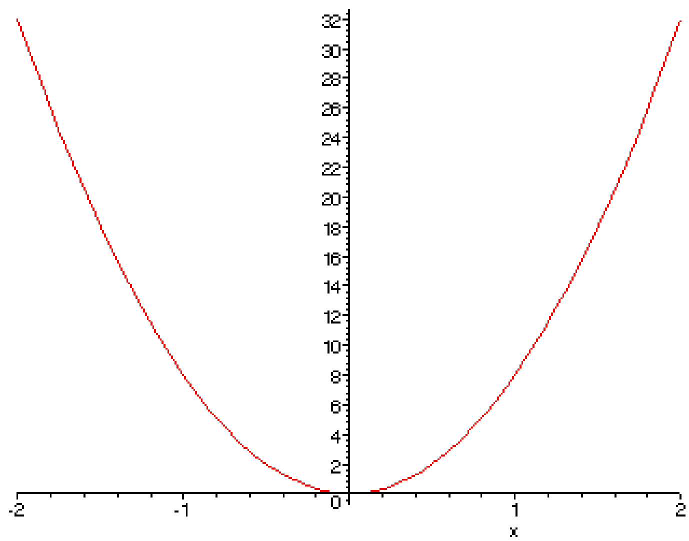


More on the Vertical Range Option

If you do not assign values for the vertical range, Maple makes its own choice, sometimes badly! Sometimes the addition of the vertical range makes it easier to “see” what the function is doing. If after you plot a function, you discover that the vertical range as determined by Maple isn’t very good, you can simply go back into the plot command line, add the vertical range, and press Enter to re-graph the function. An example follows on the next page.

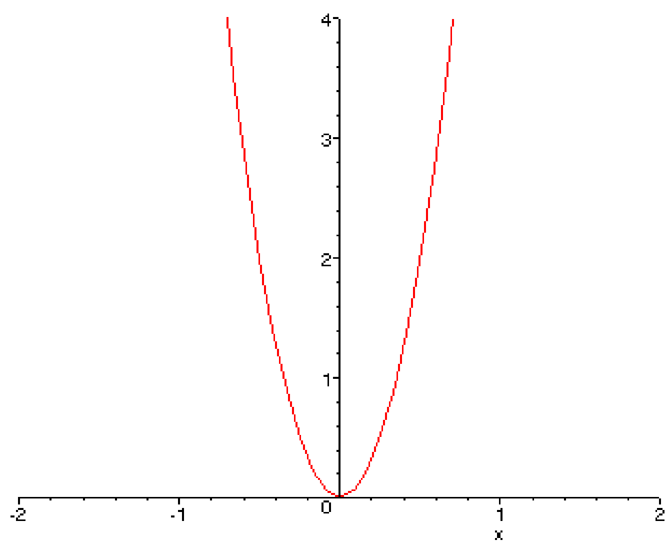
Example: If you plot $f(x) = 8x^2$, and don't specify a vertical range, you get the following result:

```
f:=x->8*x^2;

plot(f(x),x=-2..2);
```



As you can see, the vertical scale has been compressed and is not at all the same scale as that used for the horizontal. It gives a distorted view of what this parabola really looks like. By adding the vertical range, we'll get a more realiztic view. Choosing 0 to 4, the vertical range will be a total of 4 units, the same as the horizontal.

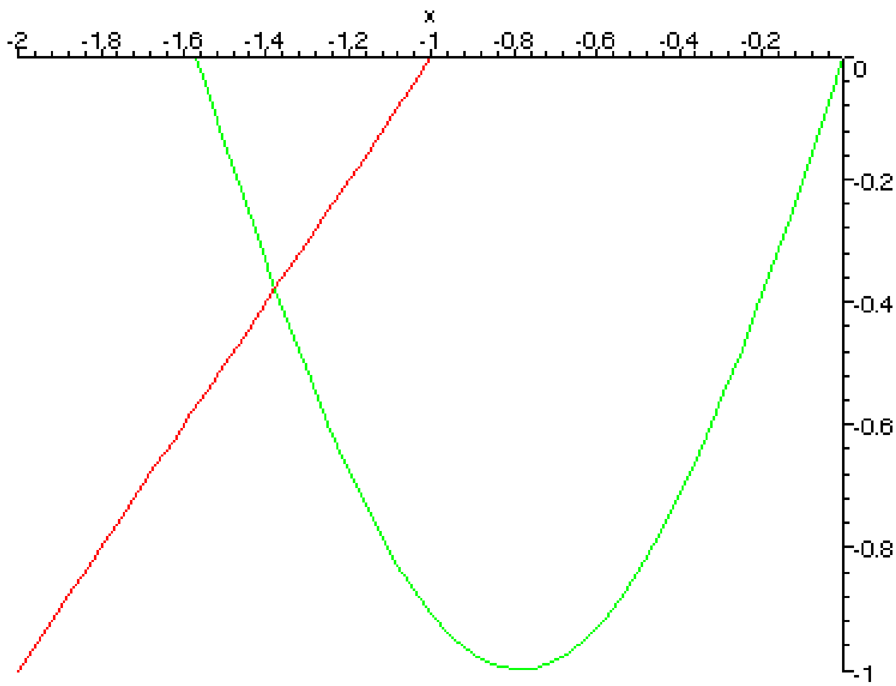
```
plot(f(x),x=-2..2,0..4);
```



Now we get a truer picture of what this parabola really looks like: tall and thin!

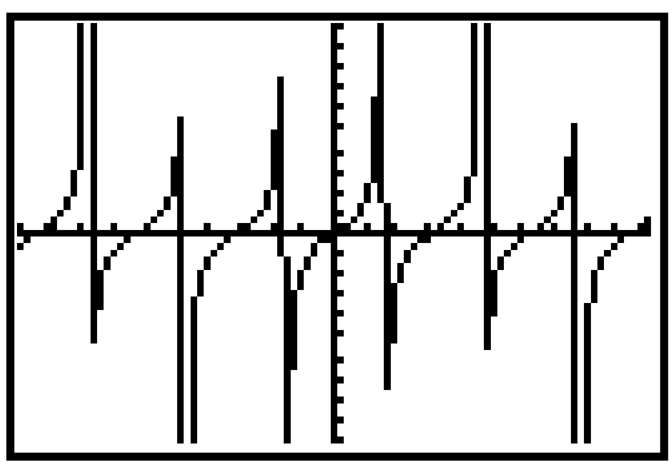
You can also use the vertical range to “zoom” in on a graph. In the previous example with the functions $f(x) = x + 1$ and $g(x) = \sin(2x)$, we can see that they intersect somewhere between the x-values of –2 and 0 and the y-values of –1 and 0. By using these values, we can take a closer look at that point of intersection.

```
plot([f(x),g(x)],x=-2..0,-1..0);
```



More on the `discont=true` Option

As you should have noticed by now, graphing calculators do not handle asymptotes very well. They usually end up as vertical lines on the graph, as in the example of $y=\tan(x)$ shown below.



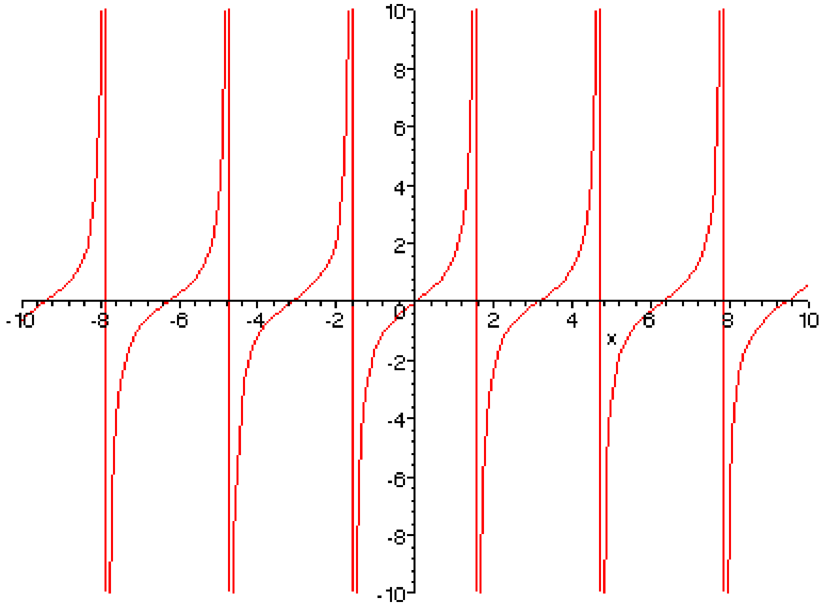
This is not what the graph should look like. Those vertical lines should not be there, and the “pieces” of the graph should extend all the way to the top and the bottom of the picture.

In Maple, if you do not use the **discont=true** option, then your graph will look like that below.

```
f:=x->tan(x);
```

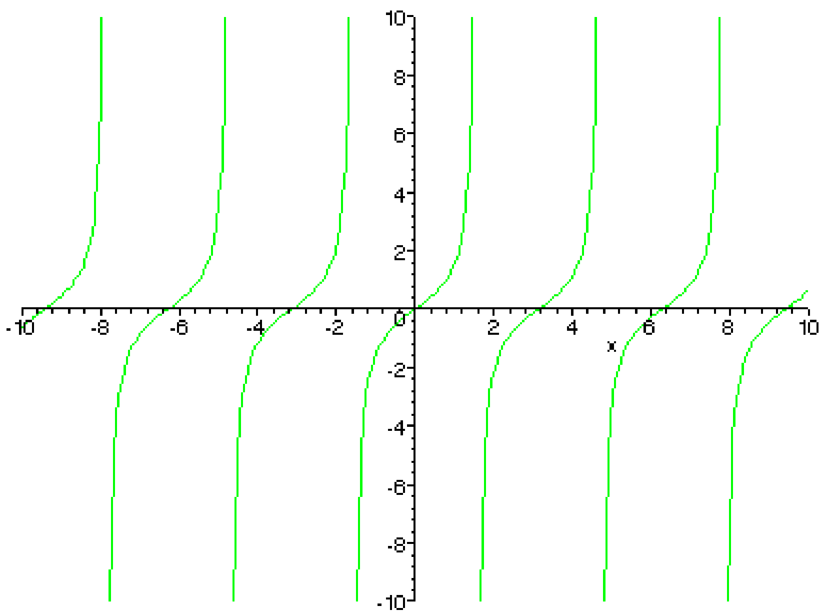
```
plot(f(x),x=-10..10,-10..10);
```

(note that we used the same Window settings as on the graphing calculator)



This is clearly better since the pieces of the graph extend all the way to the top and bottom of the graph, but there are still those pesky vertical lines that shouldn't be there. The addition of the **discont=true** option will remove them.

```
plot(f(x),x=-10..10,-10..10,discont=true);
```



SOLVING EQUATIONS

"Solving" an equation means finding all the x-values for which the equation is true. This is most often done when finding the zeros (or roots) of an equation.

Example: Find the solution(s) to $x^2 + x - 6 = 0$. To solve this "by hand," we would do the following:

$$x^2 + x - 6 = 0$$

$$(x + 3)(x - 2) = 0$$

$$x + 3 = 0 \text{ or } x - 2 = 0$$

$$x = -3 \text{ or } x = 2$$

In Maple, we use the **`solve`** command to get the same result:

```
f:=x->x^2+x-6;
```

```
solve(f(x)=0,x);
```

Note the **`x`** after the equation. This tells Maple what variable to solve for.

Example: Find the solutions of $x^2 - 5 = 0$.

In Maple, if we use the **`solve`** command

```
g:=x->x^2-5;
```

```
solve(g(x)=0,x);
```

we get the following result:

$\sqrt{5}, -\sqrt{5}$ (the exact solution)

If we would rather have decimal answers, then we use the **`fsolve`** command:

```
g:=x->x^2-5;
```

```
fsolve(g(x)=0,x);
```

we get the following result:

```
-2.236067977, 2.236067977
```

We can also use the **`fsolve`** command to the value(s) of x that "work" for two functions, that is, the values of x for which $f(x) = g(x)$.

Example: Find the values of x for which $\sin(x) = x^2$.

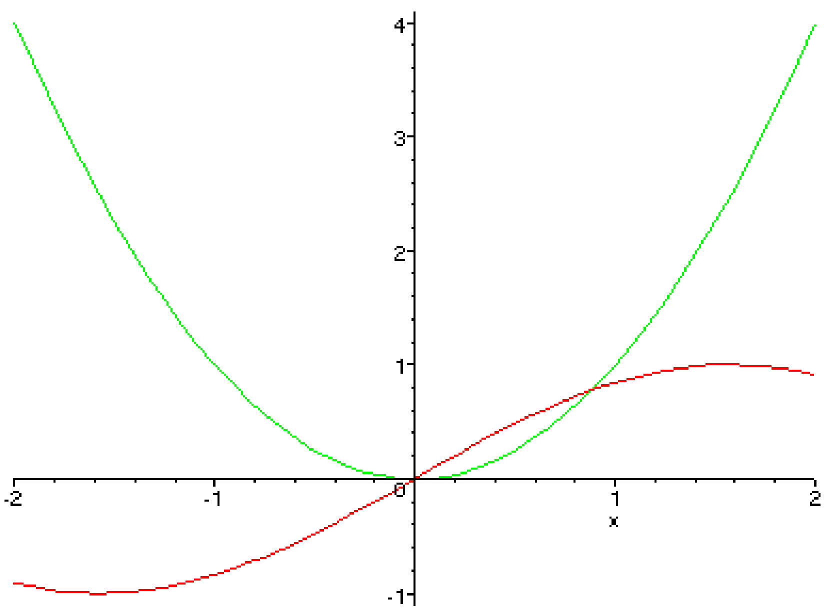
In Maple, we enter the following:

```
f:=x->sin(x);

g:=x->x^2;

fsolve(f(x)=g(x),x);
```

and we get the following single answer:

```
0
```

Unfortunately, Maple doesn't always give us ***all*** the solutions(which in some cases might be infinite in number!). If we graph the two functions above, we get the following graph:



We can see that there are actually two solutions: one at 0 (which we previously found) and another with a value of a little less than 1. To get this other answer, we have to tell Maple what value the other solution is near, in this case 1. We enter

```
fsolve(f(x)=g(x),x=1);
```

and we get `.8767262154` for the solution

We used **`fsolve`** instead of **`solve`** since the answer is probably not "nice," judging by the graph. When in doubt, or if you get a "weird" answer, use **`fsolve`**!

