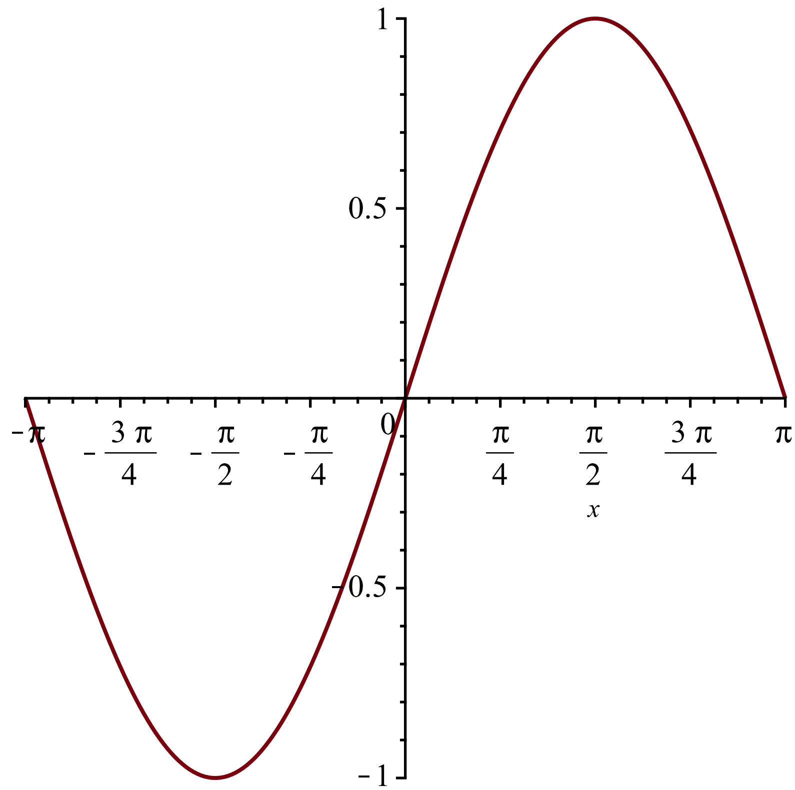
Plotting with Maple, a Recall

An introduction with functions of one variable:

```
> plot(sin(x), x=-Pi..Pi);
```



Specifying the y-range

We would like to be able to specify the y-range of a plot.
If a plot has a vertical asymptote, Maple will give such a large y-range that we miss details we are interested in. The solution is to specify the y-range. Specifying the y-range is done using the same conventions used to specify the x-range. The command

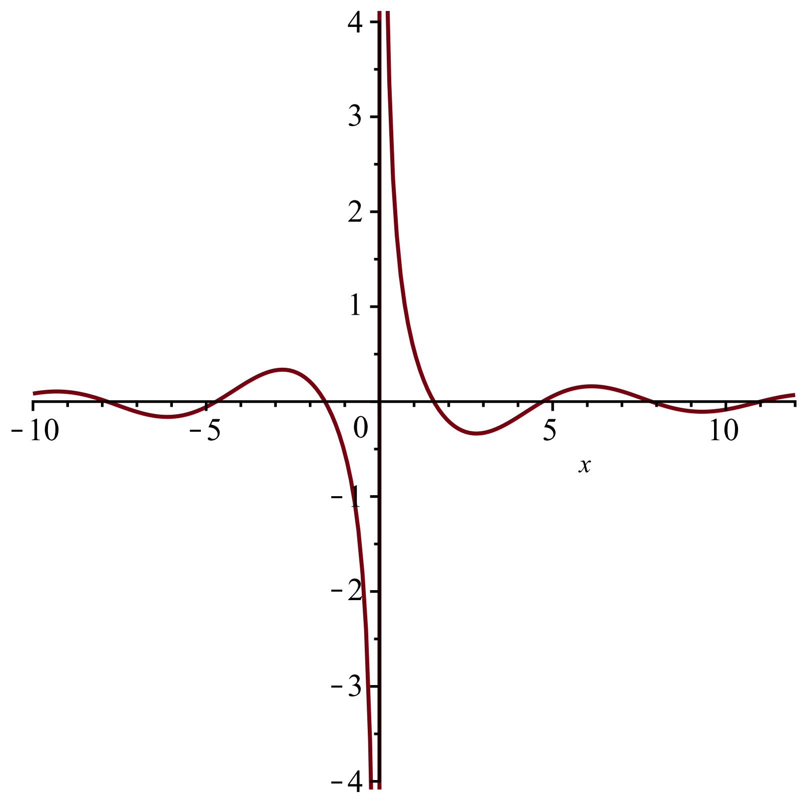
    plot("function of x", x="low value of x".."high value of x");

becomes

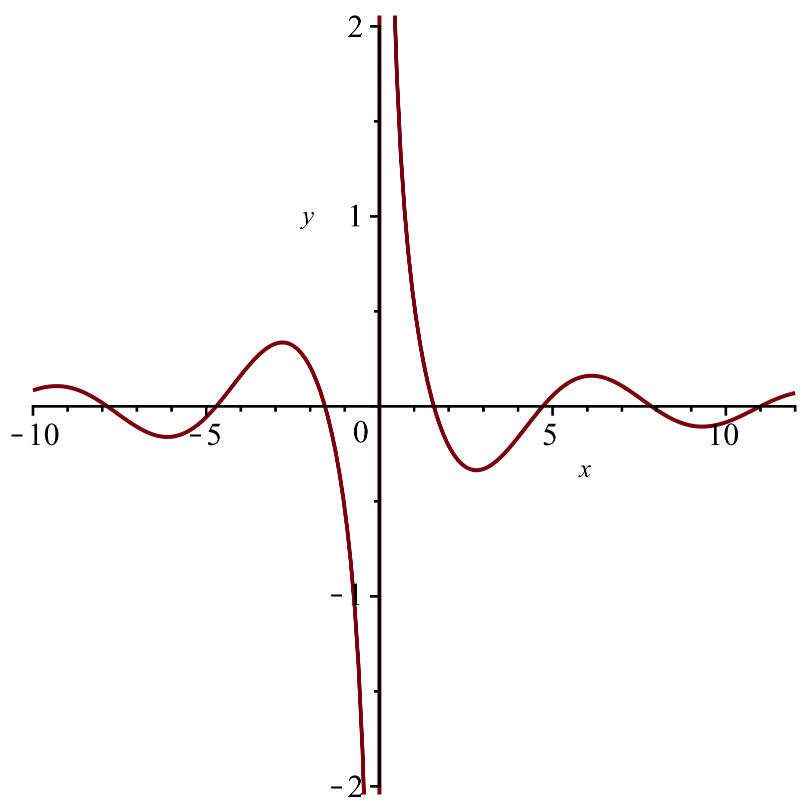
    plot("function of x", x="low value of x".."high value of x", y="low value of y".."high value of y");

For an example, execute the plotting commands given below.

```
> plot(1/x * cos(x), x=-10..12);
```



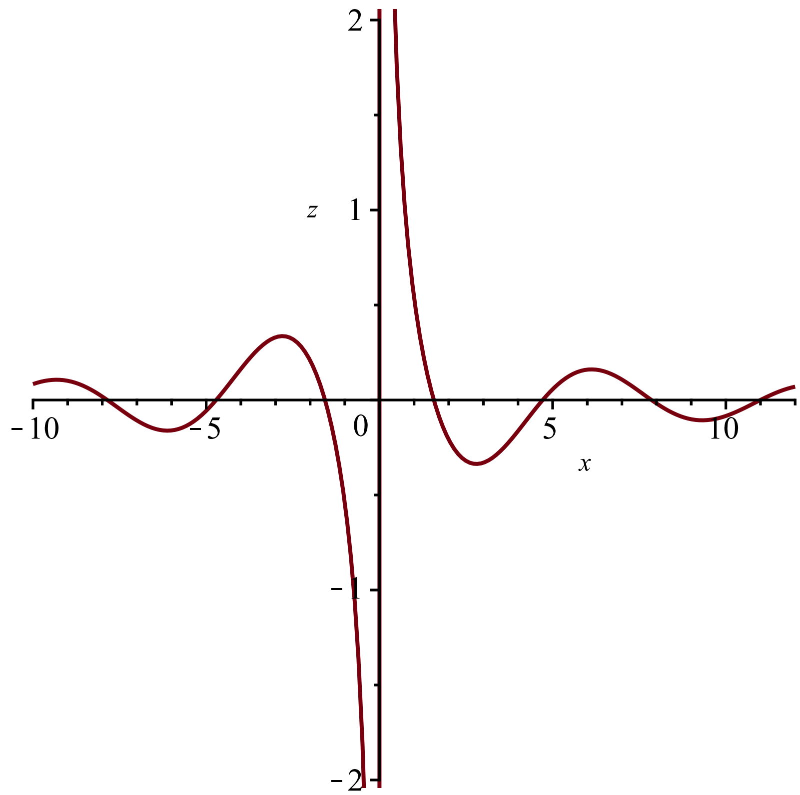

```
> plot(1/x * cos(x), x=-10..12, y=-2..2);
```



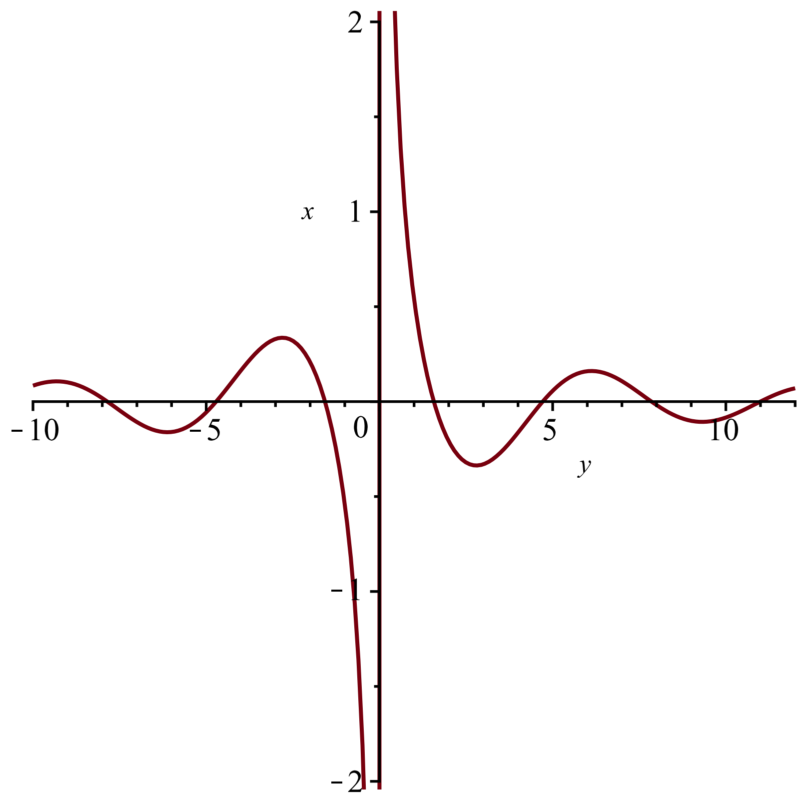
The second graph is much more informative than the first about the behavior of this function.

It is worthwhile at this point to note where we have been using inprecise language. By "x-range" we mean "the range of the independent variable", while "y-range" is "the range of the dependent variable". Equivalently, x-range and y-range respectively stand for the ranges of the input and output variables. The examples below show what happens when we change the names of the variables.

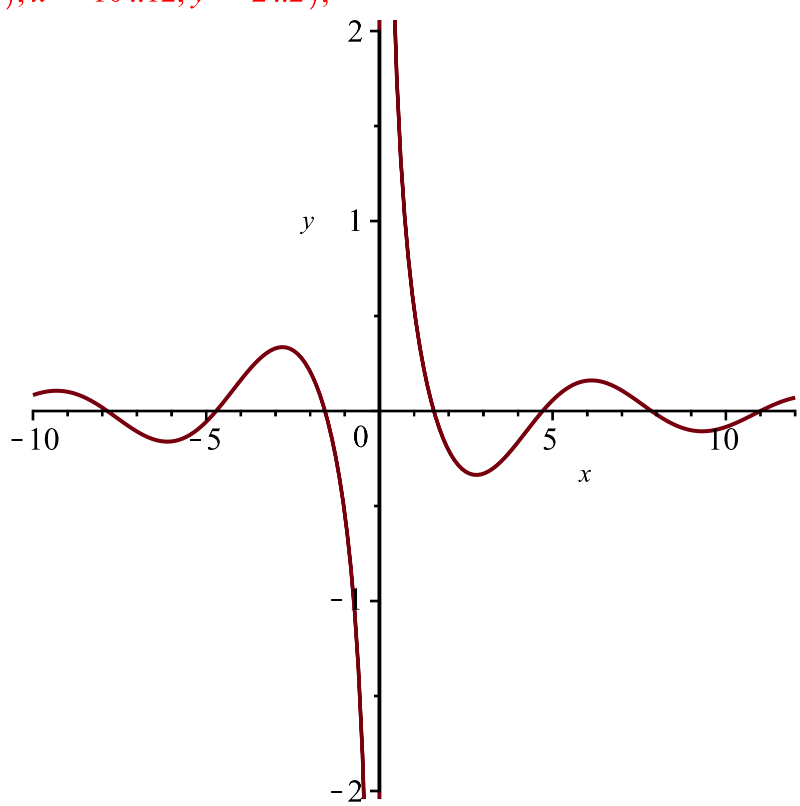
```
> plot(1/x * cos(x), x=-10..12, z=-2..2);
```




```
> plot(1/y * cos(y), y=-10..12, x=-2..2);
```



> $plot(1/x*\cos(x), x=-10..12, y=-2..2);$



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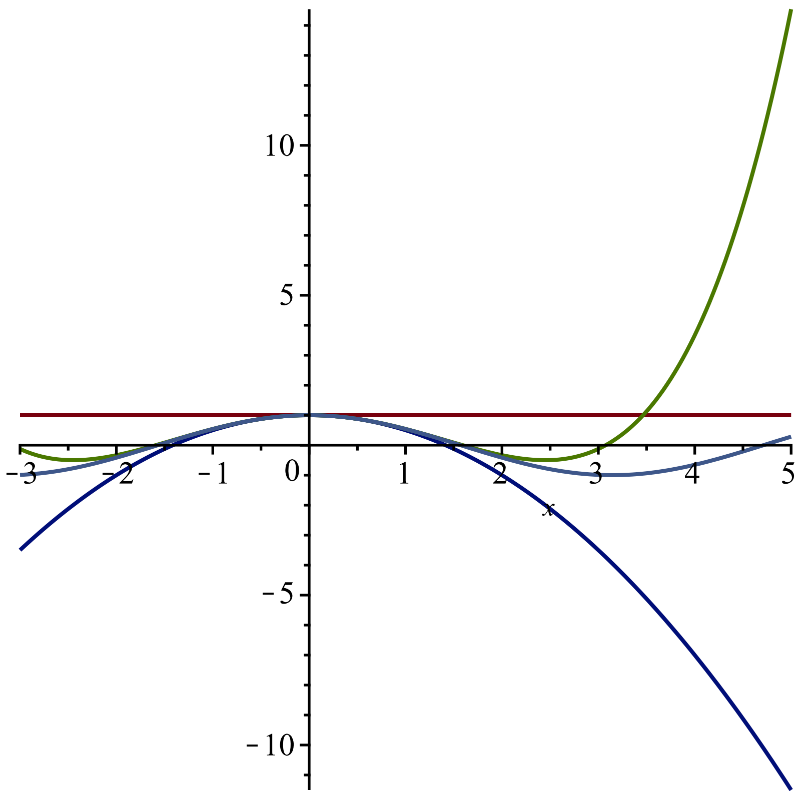
Plotting several functions on the same graph

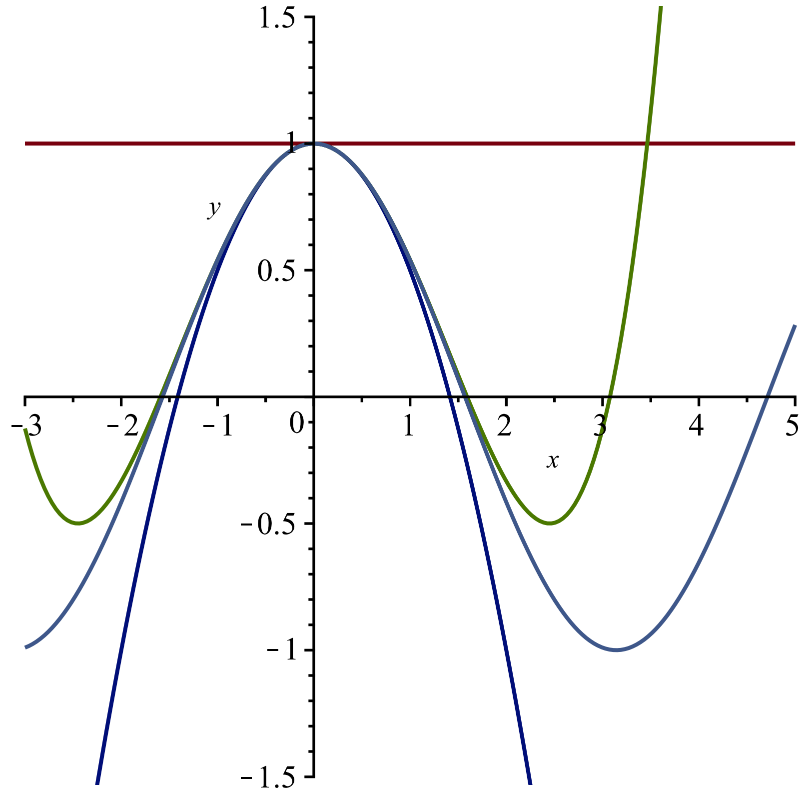
It is also useful to be able to see the graphs of several functions on the same graph. In Calculus I and II we were interested in seeing the graph of a function and its derivative at the same time. We also wanted to compare a function with the polynomial approximations we obtained for it.

To plot several functions at the same time, the command
    plot("function of x", x="low value of x".."high value of x");
becomes
    plot({"function1 of x", "function2 of x", "etc."}, x="low value of x".."high value of x");
Note that the set of functions is enclosed in braces.
For an example, consider the following commands which plot cos(x) along with some of the Taylor polynomial approximations of cos(x).

```
> plot( {cos(x), 1, 1-x^2/2, 1-x^2/2 + x^4/24}, x =-3 ..5 );
```




```
> plot( {cos(x), 1, 1-x^2/2, 1-x^2/2 + x^4/24}, x =-3 ..5, y =-1.5 ..1.5 );
```



Plotting with functions of two variables:

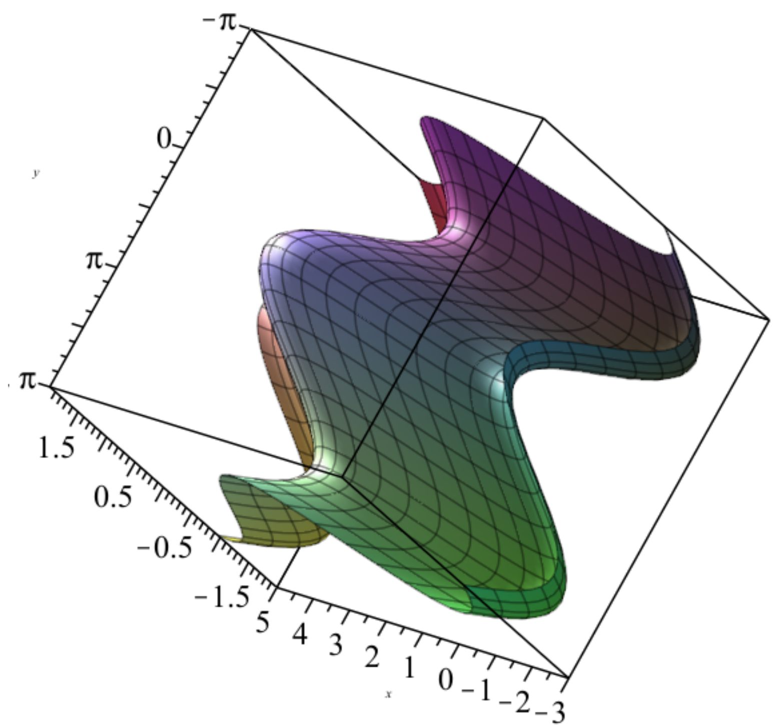
Basic plotting

The syntax for plotting the graph of a function in 2 variables is similar to the one variable case. We use the command:

plot3d("function of x and y", x="low x".."high x", y="lowy".."high y");

as we see with the following command.

```
> plot3d(sin(x) + sin(y), x=-3..5, y = -Pi..2*Pi);
```

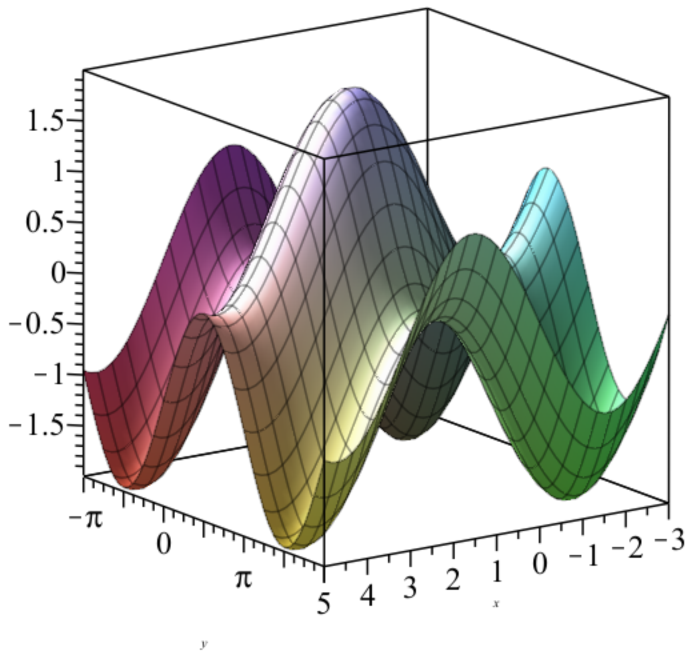


Once again, if you click once on the graph, it will be enclosed in a box, and a set of buttons will appear up on the menu bar. There are 2 boxes labeled θ and ϕ with scroll arrows for specifying the viewing angle, a set of 7 buttons for style used on the graph itself, a set of 4 buttons for style used on the axes, a "1:1" button to use the same scale on all 3 axes, and an "R" button to redraw the graph when all the options are chosen.

The default has a wire frame model, that is opaque (the front bump hides the back bump), the axes are not printed, from a viewing angle of 45 degrees on both angles.

Exercise:
Redraw the graph given above. Then use the buttons to produce an image that
shades the image, draws a grid of lines on the image, and boxes the axes around the image;

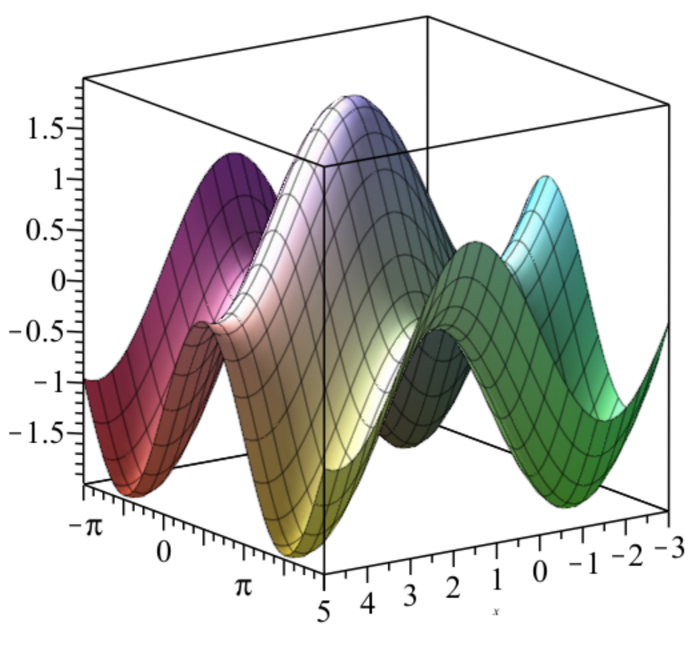
```
> plot3d(sin(x) + sin(y), x=-3..5, y= -Pi..2*Pi);
```



>

Shades the image and draws contour lines on it, while putting the axes in standard position through the origin;

> $plot3d(\sin(x) + \sin(y), x=-3..5, y=-\text{Pi}..2*\text{Pi});$



Viewing angles and contour plots

The list of controls for changing the appearance of a graph includes controls for theta and phi, the coordinates of the position in spherical coordinates that the graph is viewed from. The angle phi is the angle to the positive z-axes. Thus an angle of $\phi = 0$ looks down on the x-y plane from above, $\phi = 90$ gives a viewpoint looking down the x-y plane, while $\phi = 180$ looks up from below. The angle theta measures the rotation of the x-y plane. If $\phi = 0$ so we are looking down the z-axis, then $\theta = 0$ has the y-axis horizontal increasing from left to right and the x-axis vertical decreasing as you go up. The default setting has θ and ϕ both set to 45.

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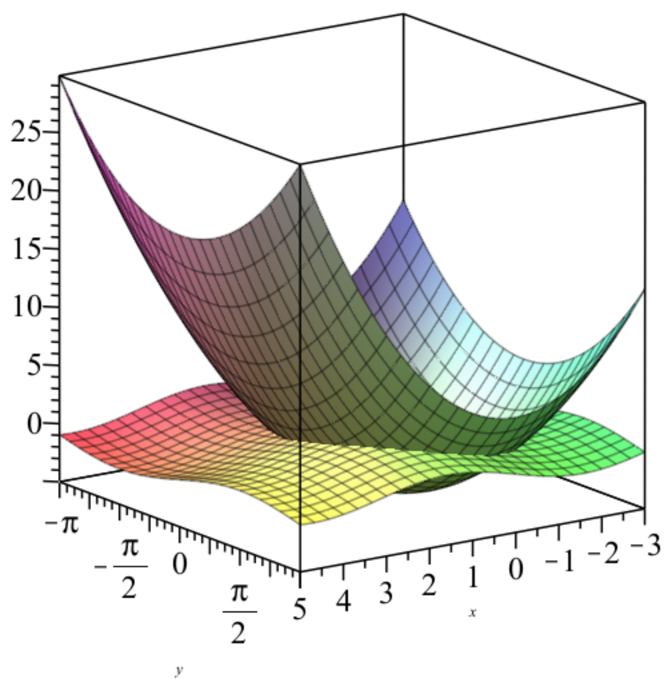
Multiple graphs and controling the z-range

The syntax for doing more than one graph on the same plot is similar to the one variable case. We simply replace the function with a set of functions.

```
> plot3d({sin(x) + sin(y), x^2 + y^2 - 5}, x=-3..5, y=-Pi..Pi);
```

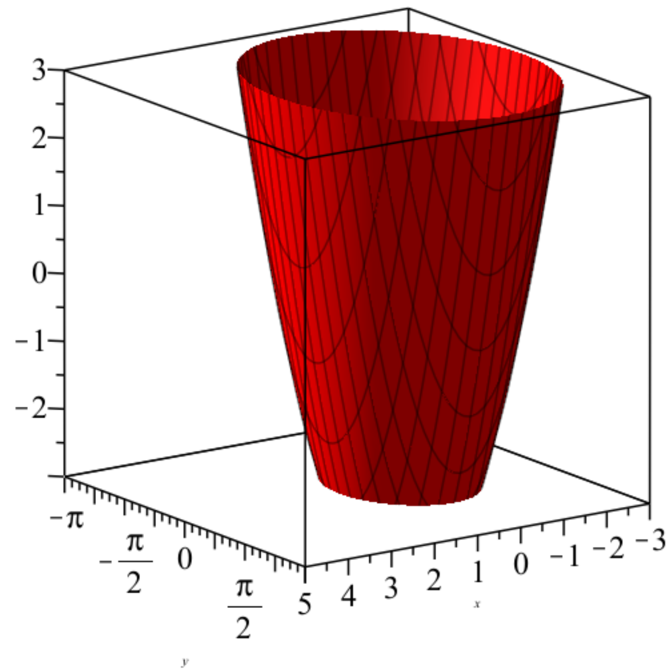


The control of the z-range is done with a

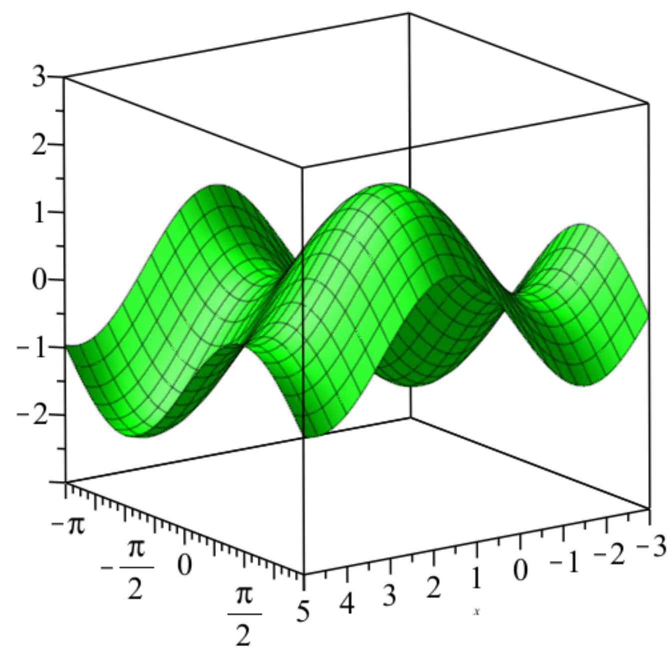
view = "low value of z".."high value of z"

clause inserted into the plot3d command.

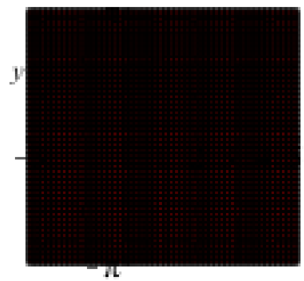
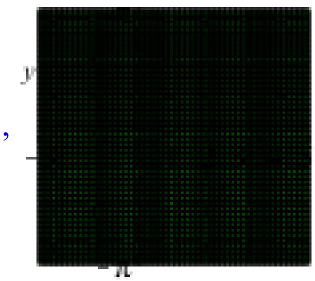
```
> f1 := plot3d(x^2 + y^2 - 5, x=-3..5, y=-Pi..Pi, view=-3..3, color=red);
```



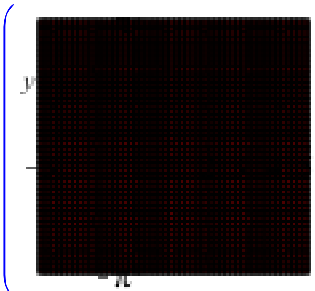
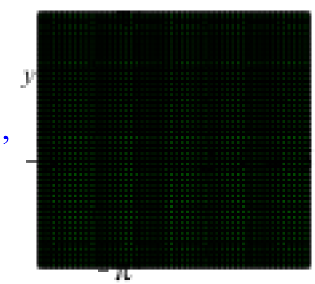
> $f2 := plot3d(\sin(x) + \sin(y), x = -3..5, y = -\mathrm{Pi}..\mathrm{Pi}, view = -3..3, color = green);$



> $display(f1, f2);$

display( , )

```
> restart;
> f1 := plot3d(x^2 + y^2 - 5, x=-3..5, y= -Pi..Pi, view = -3..3, color=red):
> f2 := plot3d(sin(x)+sin(y), x=-3..5, y= -Pi..Pi, view = -3..3, color=green):
> display(f1, f2);
```

display( , )

Exercises:

11) Plot the functions $z = x^2 + 2y^2$ and $z = 2(x-1) + 4(y-1) + 3$ on the same axes. Plot over the rectangle with x and y between -1 and 3.

12) Regraph the same pair of functions, this time constraining the z-range between -1 and 7.

These 2 surfaces have a simple relationship. Describe the relationship and replot the graph viewed at an angle to make the relationship clear visually.

The relationship is.......
The viewing angle that makes this obvious is ......

```
>
```